CORRELATION BETWEEN BURN SEVERITY INDEX AND BURN WOUND SEPSIS

Investigator:

Dr Manvinder Singh Mann, MBChB (Nbi),

Department of Surgery,

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A dissertation presented in partial fulfilment for the award of the degree of Master of Medicine in General Surgery.

The University of Nairobi School of Medicine

DECLARATION

STUDENTS DECLARATION

This thesis is my original work and has not been presented for a degree in any other University.

Signature…… Date……

DR MANVINDER MANN

SUPERVISORS' DECLARATION

This thesis has been presented with my full approval as a supervisor.

DR. ELLY NYAIM OPOT

MBChB (UON), MMED, GENERAL SURGERY (UON), FCS (COSECSA),

SENIOR LECTURER, UON, SCHOOL OF MEDICINE

GENERAL SURGEON

Signature…… Date……

DR. FERDINAND NANGOLE

MBChB, MMED, GENERAL SURGERY (UON), PRAS FELLOW,

SENIOR LECTURER, UON, SCHOOL OF MEDICINE

PLASTIC AND RECONSTRUCTIVE SURGEON

Signature…… Date……

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Registration Number:	H58/74988/2014
College:	Health Science
Faculty/School/Institute:	School of Medicine
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DEDICATIONS

This book is dedicated to my wife Shamsa, for her patience, encouragement and support in all that I set out to accomplish.

My parents and grandparents for their unconditional love and support.

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LIST OF ABBREVIATIONS

ABA	-	American Burn Association
BU	-	Burns Unit
CoNS	-	Coagulase Negative Staphylococci
KNH	-	Kenyatta National Hospital
MDR	-	Multi-drug Resistant
MRSA	-	Methicillin Resistant Staphyloccocal Aureus
PI	-	Principal Investigator
TBSA	-	Total Burn Surface Area
UON	-	University of Nairobi

ABSTRACT

Background

Burn injuries incur a significant cost to the healthcare system worldwide (1). Prolonged hospital stays and size of burn wound are among the strongest risk factors for the development of infection. Burns involving large body surface area and those that form eschars are associated with increased predisposition to sepsis (2). Burn severity is one of the risk factors for the development of burn wound sepsis and has been shown to be a predictor of mortality (3). There is lack of data on the correlation between burn severity parameters and burn wound sepsis among burns patients at the Kenyatta National Hospital and in Kenya.

Objective of the Study

To determine the correlation between burn severity index and burn wound sepsis among burn patients at the Kenyatta National Hospital.

Study design and Setting

This was a hospital based prospective cohort study among patients admitted in the burns unit and ward 4D at Kenyatta National Hospital, carried out over three months.

Study Subjects

All burns patients admitted in the burns unit and ward 4D who met the inclusion criteria were eligible to participate in the study.

Methodology

Patient with burns who were admitted to KNH over three months were recruited. Consecutive sampling procedure was used. Every burns patient admitted to the burns unit who fulfilled the inclusion criteria was included in the study in order to achieve the sample size of 84 patients. History and physical exam was undertaken and TBSA was determined by the Lund and Browder chart and recorded (4). Data was collected using guidelines as per the American Burn Association parameters for burn severity and patients classified into major, moderate and minor burn wound injuries. Patients progress was monitored for 28 days and those who demonstrated clinical characteristics of sepsis were further investigated as per the American burn sepsis score including pus wound swabs, blood and urine cultures to determine burn wound sepsis (5, 6). Correlation between burn severity and burn wound sepsis was established using multivariate analysis within 5% margin of error.

Results

A total of **84** patients were recruited during the study duration. Most patients admitted had major burns (88.1%). The median age of patients recruited was 28 years with more males being admitted (57.1%) while the mean age of those with sepsis was 23.5 years. Burn wound sepsis was present in 11 patients and only in those with major burns. 3 out of the 11 patients with burn wound sepsis died, a further 19 not diagnosed to have sepsis (26.2%), died of other causes. Although Burn Wound Sepsis was present in patients with major burns it was not statistically significant. (P=0.73).

1.0 CHAPTER ONE: INTRODUCTION

1.1 Background

The Burn Severity index has been shown to be a useful tool to document burn severity and predict outcome. This study will use the Burn Severity Index to determine if different degrees of burn injury, or, cause of burn injury correlates with the development of Burn wound Sepsis in affected patients.

Burn wound sepsis occurs when a burn wound infection becomes invasive, and, as per the American Burn Association (ABA) consensus was defined as a burn patient who meets the following criteria. This criterion required at least three of the indicators listed below (7): Temperature of more than 39°C or < less than 36.5°C, Heart rate of more than 90 beats per minute in adults and in children more than two standard deviations above age specific normal values., Progressive tachypnea defined as a rate of more than 30 breathes per minute in adults while in children less than two standard deviation above age specific normal values (appendix IV), Refractory hypotension defined as systolic blood pressure less than 90 mmHg or a decrease of more than 40 mmHg, or mean arterial pressure of less 70 mmHg in adults while in children less than two standard deviation below normal reference ranges (appendix IV), Leukocytosis defined as more than 12,000 white cells/microliter in adults and in children >2 SD above normal) or leukocytopenia defined as less than 4000 cells (appendix IV),Thrombocytopenia that occurs three days after resuscitation- in adults a platelet count of less 100,000 cells while in children less than two standard deviation below age-specific normal values, Elevated blood sugar of more than 6.1 millimoles per liter in the absence of pre-existing diabetes mellitus and inability to tolerate enteral feedings for more than 24 hours based upon: Abdominal distention, residual volumes (twice the feeding rate in adults and more than 150 mL/hour in children) and profuse diarrhea (defined as more than 2500 mL/day for adults and more than 400 mL/day for children).

The American Burns Association definition **required** that the infection must be confirmed by one of the following methods (7);Culture of either wound swab, blood, urine **or** Pathologic tissue source is identified (more than 10^5 bacteria on quantitative wound tissue biopsy **or** microbial invasion on biopsy) **or** A clinical response to antimicrobial administration is documented.

The incidence of burn wound sepsis has declined from 6 to 1 percent since the practice of early burn wound excision; however, for patients with total body surface area (TBSA) burns >15 percent, the rate has remained the same. Case fatality rates were 40% or higher depending on the extent of the burn injury (8, 9).

Sepsis is an independent risk factor of mortality in a burns patient but presents a diagnostic challenge, since the signs of sepsis may be present without infection due to the high metabolic state (5). Identifying burn wound sepsis early in the course of the burn may lead to its prevention by high index of suspicion and isolation with rational use of antibiotics. Burns lead to breakdown in the physical barrier of the skin leading to increased risk of infection (1). Other factors that promote infections following burns is impaired immune function and poor blood supply to the eschar that prevent antibiotics and leukocytes from reaching the burn site (1). Due to the difficulty in diagnosing sepsis in burns, the American Burns Association published burn-specific sepsis criteria with clinical, laboratory and microbiological parameters (Table 1).

Locally, burn severity index was shown to be useful not only to document burn injury severity and predict outcome but as a self-evaluation tool for institution performance in burn patient management by Ndungu *et al* (6).

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Burn Wound Severity

The American Burn Association developed a clinically useful and simple score derived from multivariate logistic regression termed the burn severity index to establish guidelines for the classification of burn severity (4). The parameters are: Extent (total burn surface area), depth and the location of burn injury, presence of inhalation injury, causative agent, patient's age and coexisting injuries or preexisting illnesses.

The parameters used are evident at admission, do not require highly trained personnel and are readily reproducible. It has been validated in a number of studies. Knob *et al* showed in their study that general trauma scores performed poorly when applied to patients with burn injuries (10). The individual parameters have variable correlation with burn wound sepsis as explained later, with causative agents and inhalation injuries having no known studies. Ryan C, M *et al* in 1998 noted in their study that mortality from burns injuries could be accurately predicted by using age of patient, % TBSA and presence or absence of inhalation injury (11). This classification helps to determine the best setting for the treatment of the patient.

This classification leads to placing of burn injuries into three categories; major, moderate and minor and helps to determine the best setting for the treatment of the patient. The overall severity index leads to classification of burn injury into three categories; major, moderate and minor (3).

Major burn injury was defined as (3): Partial-thickness burns involving more than 25% of TBSA in adults or 20% of TBSA in children younger than 10 years or adults older than 50 years; full-thickness burns involving more than 10% of TBSA; Burns involving the face, eyes, ears, hands, feet, or perineum that may result in functional or cosmetic impairment.; Burns caused by caustic chemical agents or high-voltage electrical injury ;Burns complicated by inhalation injury or major trauma or burns sustained by high-risk patients (those with underlying debilitating diseases).

These injuries are best managed in a specialized burn center staffed by a team of professionals with expertise in the care of burn patients, including both acute care and rehabilitation.

Moderate burn injury was defined as (3):Partial-thickness burns of 15-25% of TBSA in adults or 10-20% of TBSA in children or older adults and full-thickness burns involving 2-10% of

TBSA or Burn injury to the eyes, ears, face, hands, feet, or perineum that do not present serious threat of functional or cosmetic impairment.

Patients with moderate burn injuries should be hospitalized for their initial care but not necessarily at a burn center.

Minor burn injury was defined as (3): Burns involving less than 15% of TBSA in adults or 10% of TBSA in children or older persons and full-thickness burns involving less than 2% of TBSA or Burn injury to the face, eyes, ears, hands, feet or perineum that do not present a serious threat of functional or cosmetic impairment.

These burns usually can be managed safely in the outpatient setting.

Univariate analysis of individual parameters showed that each has different predictive value but as a combination, the predictive value increases exponentially (12). It is used in many centers both as a prognostic tool but also as a descriptive measure of burns severity that is easily understood in the process of conducting studies involving burn injuries.

2.2 TBSA

Tissue injury in burns can be assessed by two methods. The total burn surface area (TBSA) is measured in percentage by the rule of nines or by Lund and Browder estimation protocol (4). The Lund and Browder method is the most accurate for estimating TBSA for both adults and children (Appendix V). It factors in the relative percentage of body surface area affected by growth (4). Individuals who sustain a TBSA burn >20% are at particularly high risk of burn wound sepsis; however, burn wound infection can occur in smaller burns (13). The bigger the burn, the greater the risk of subsequent burn wound and systemic infections (14).

2.3 Burn Depth

A precise classification of the burn wound is difficult as it may take weeks for a final determination (15,16). Thin skin, especially on the forearms, medial aspect of the thighs, perineum, and ears, usually sustains deeper burn injuries than suggested by initial appearance (16). The classification of burn injury according the American Burn Association was; first degree, second degree, third degree and fourth degree (3). The definitions are as described as First degree involving the epidermal layer of skin only. These burns are very painful, dry, red

and blanch with pressure but do not form blisters. Healing occurs without a scar in about six days (3).

Second degree involves both the epidermis and portions of the dermis. They are further classified as either superficial or deep. Superficial tend to form blisters within twenty-four hours between the epidermis and dermis (papillary). Superficial second-degree burns are painful, red, weep and blanch with pressure. Healing occurs within seven to twenty-one days and scarring rarely occurs. Deep second-degree burns extend into the deeper dermis (reticular) and cause injury to glands and hair follicles. These burns are painful when pressure is applied and blister easily but do not blanch with pressure. Healing is with scarring (3).

Third degree burns involve the entire layers of the dermis. These burns are painless, waxy leathery grey or charcoal black and do not form blisters (3). Fourth degree burns extend all the way to deep underlying tissues i.e. fascia, muscle, and/or bone (3).

The deeper the burn depth is, the more likely the formation of eschars and thus less penetration of antibiotics leading to burn wound infection (2).

2.4 Presence of Inhalation Injury

The presence of inhalation injury has been shown to increase mortality in every age and burn size category. The lung injury noted with smoke inhalation is related to the micro vascular permeability (17). Inhalation injury increases burn mortality by 20% to 60% (6). Mortality statistics for burn size and inhalation injury has been proven to be additive.

2.5 Causative Agent

The agent causing the injury determines the depth and severity as well as type of burn sustained. Individuals with deliberate self-inflicted burn injuries and the disabled have been shown to have more severe injuries and longer hospital stays than those with accidental injuries (17).

2.6 Impact of Patient's Age

Very young children and the elderly have an increased risk of being burned and worse clinical outcomes than patients in other age groups. Children and the elderly are prone to deep burns because of their thin skin (1, 18).

Burns in the elderly constitute more severe injuries than in the general population and result in a higher number of fatalities. Substance abuse was a factor in some elderly patients, because

toxicology screening showed that 10% had used alcohol and almost one-third tested positive for other drugs. Mortality was highest in elderly patients who had more severe burns and/or smoke inhalation injury that had existing underlying disease.

Children have a much higher risk of being burned than adults. In the United States in 2001 to 2002, an estimated 92,500 children aged 14 years and under required emergency care for burn-related injuries, and approximately 500 of these children died. Children who show failure to thrive (e.g., height and/or weight <5% of that expected by age) also have a higher risk of burn injury, perhaps due to the combined effects of malnutrition and neglect or abuse (18).

2.7 Injuries or Preexisting Illnesses

Obese adults and those who have an underlying medical condition such as diabetes have also been shown to have higher morbidity and mortality (16). AIDS patients appear to have more complications due to infection, delayed wound healing, and increased mortality, although reported outcome data for human immunodeficiency virus-infected and AIDS patients are limited It is expected that burn patients with other types of severe immunosuppression would have similar problems, particularly increased problems with wound infection and sepsis and a higher mortality, although this group has not been studied (17).

2.8 Burn Sepsis

Sepsis is an independent risk factor of mortality in a burns patient but is a diagnostic challenge because the signs of sepsis may be present without infection due to the high metabolic state (5,19). Due the difficulty in sepsis diagnosis, the American Burns Association published burn-specific sepsis criteria with clinical, laboratory and microbiological parameters (Table 1). A patient meets the definition of burn wound sepsis if he has at least three clinical or lab parameters plus at least one microbiological parameter (7).

Burn wound sepsis was defined based on the American Burn Association consensus criteria. (Appendix IV).

2.9 Risk factors

A variety of factors increase the risk of developing invasive burn wound infection (burn wound sepsis). Individuals who sustain a TBSA burn >20 percent are at particularly high risk; however, burn wound infection and sepsis can occur in smaller burns (2). Other risk factors include delays in burn wound excision, extremes in age (very old, very young), and impaired

immunity. Microbial factors, such as type and number of organisms, enzyme and toxin production, and motility, also contribute. Much of the decline in burn wound infections, subsequent tissue invasion and sepsis, and associated mortality has been attributed to the substantial advances that have occurred in burn wound care (8). Regular assessment of burn wounds is important as it allows for early and prompt recognition of infection. Prolonged hospital stays and size of burn wound are one of the strongest risk factors for the development of colonization or infection (7). Burn wound infections commonly occur within the first weeks of hospitalization and the most common isolated organism were Staphylococcus aureus and Klebsiella pneumoniae (2). As would be expected, infections by nosocomial microbes especially Pseudomonas aeruginosa and Acetinobacter baumannii which tend to be hospital acquired infections appeared later typically after two weeks of admission (2).

Large surface area burns wounds were associated with increased risk of burn wound infection (1). Burn Severity index was shown to be useful not only to document burn injury severity and predict outcome but as a self-evaluation tool for institution performance in burn patient management by Ndungu *et al* (6).

There is currently no literature is available locally correlating burn severity index with burn wound sepsis.

3.0 CHAPTER THREE: JUSTIFICATION & METHODOLOGY

The Burn Severity index has been shown to be a useful tool to document burn severity and predict outcome. It can also be used for self-evaluation for institutional performance in burn management (19). Early identification of at risk patients has been shown to be effective in reducing the morbidity and mortality associated with burn wound sepsis (20). However, no studies have been done to determine any correlation between the burn severity and sepsis in our environment. The results will allow us to standardize our surveillance practices, identify at risk patients and promote early intervention (21).

3.1 Research Question

Does the severity of burns influence burn sepsis?

3.2 Null Hypothesis

There is no correlation between burn severity and burn sepsis.

3.3 Objectives

3.3.1 Broad Objectives

To determine the correlation between burn severity index and burn wound sepsis among patients in burns unit (BU) and ward 4D at KNH

3.4 Specific Objectives

1. To determine the Burn Severity Index of patients admitted to KNH with burns
2. To determine the Burn Wound Sepsis of patients admitted to KNH with burns

3.5 Methodology

3.5.1 Study Design

This was a prospective cohort study design.

3.5.2 Study Area

The study was carried out at Kenyatta National Hospital, a tertiary referral hospital located in the capital city of Kenya, Nairobi. It was established in 1900 and is the largest hospital in Eastern and Central Africa. It has a capacity of 2000 beds. It serves as the teaching hospital for the University of Nairobi, College of Health Sciences, both for the undergraduate and the post-graduate programs. The hospital has a burns unit which has a bed capacity of twenty-four beds

and approximately thirty-five patients are admitted in a month directly from the casualty department while ward 4D has a bed capacity of sixty beds and approximately fifteen patients are admitted in a month directly from casualty, the remainder transferred from burns unit.

3.5.3 Study Population

All patients with burns admitted in the burns unit and ward 4D at KNH

3.5.4 Case Definitions

1. Any patient who presented with burn wounds in the burns unit and ward 4D at KNH was eligible to participate in the study.

3.5.5 Inclusion Criteria

1. All new burns patients who were admitted in the burns unit and ward 4D at KNH during the study period

3.5.6 Exclusion Criteria

1. Patients in burns unit who did not give informed consent to participate in the study
2. Patients in burns unit admitted with burn wounds that were more than 48 hours since injury
3. Patients who were transferred from another medical facility for further management
4. Patients who were already undergoing treatment for burn sepsis

3.6 Sample Size Calculation

There was an estimated number of 35 patients seen monthly in the burns unit, and 5 new patients seen in ward 4D. A representative sample was drawn from this population and the sample size calculated using a formula for finite population (less than 10,000). The calculation was as follows:

N = population of patients presenting with burns in KNH during the study period = 120 (number seen in 3 months)

n – minimum required sample size

Z – standard normal for a 2-sided test at 95% confidence interval (CI) = 1.96

P – Estimated proportion of patients with severe burn wounds = 23.6% (Ngugi, 2013)

d – margin of error of estimation = 5%

Substituting into the formula,

$$n = \frac{120 \times 1.96^2 \times 0.236\ (1 - 0.236)}{0.05^2(120 - 1) + 1.96^2 \times 0.236(1 - 0.236)}$$

n = 84

A minimum of **84** patients was required to determine correlation of burn wound severity and burn sepsis within 5% margin of error.

3.7 Sampling

Consecutive sampling procedure was used. Every burns patient who was admitted to the burns unit and fulfilled the inclusion criteria was included in the study in order to achieve the sample size of at least 84 study participants.

3.8 Screening and Recruitment

The principal investigator (PI) and two research assistants (qualified clinical officers) went every morning go to the burns unit during the study period to identify the patients admitted in the burns unit for eligibility. Those who met the inclusion criteria were invited to participate in the study. The participants were then given all the relevant information about the study and only those who gave informed written consent (Appendix I) were recruited.

For patients under age 18 years, assent was given by informed parent or guardian.

Patient Flow Chart

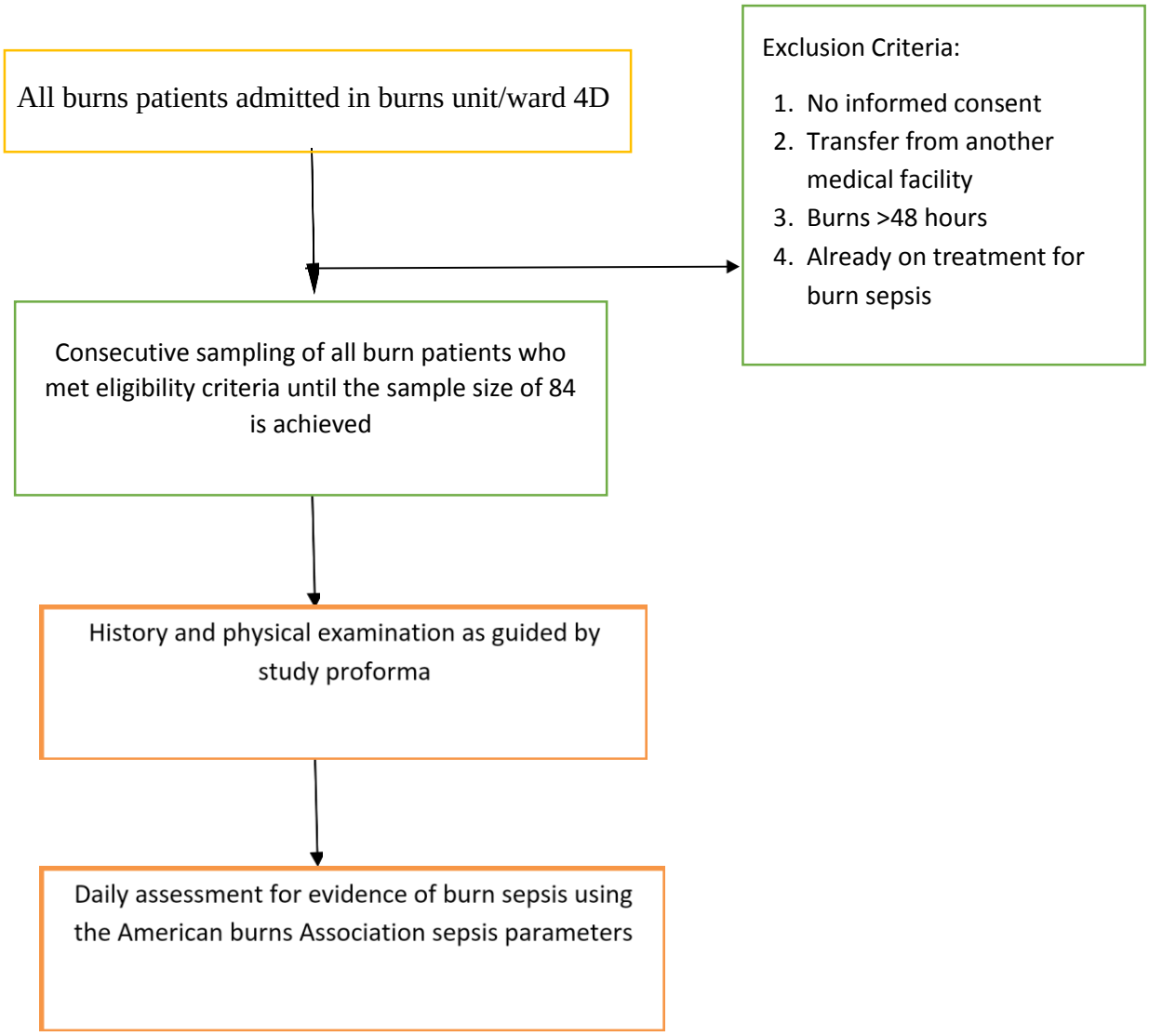

Figure 1: Study participants recruitment flow chart

3.9 Data Collection

3.9.1 Clinical And Laboratory Methods

After obtaining informed consent (Appendix I) from the participants, a study proforma (Appendix II) was administered to capture demographic data and relevant history.

The principal investigator carried out a focused examination to assess the burn wound and was able to classify the wound according to the American Burn Association for burn wound severity. The total burn surface area was determined using Lund and Browder chart (6). Burn wound depth was determined and classified as either first, second, third or fourth degree. Patients were then classified into major, moderate and minor burn wound injuries. 10ml of blood from two different sites was taken from each patient for blood cultures in appropriate sample collection bottles, (Appendix II)

Patients progress was monitored for 28 days and those who demonstrated clinical characteristics of sepsis were further investigated as per the American burn sepsis scoring including pus wound swabs, blood and urine cultures to determine Burn Wound Sepsis (7). (Appendix II)

All the results were communicated to the primary doctor and the results filed.

3.10 Quality Control

The PI recruited patients who were admitted to the burns unit every day. The burn wound assessment and examination was carried out by the principal investigator for consistency and to minimize errors. The research assistants were trained by the PI. The research assistants ensured that data was collected efficiently, on time and recorded accurately. All recorded data was verified by the PI, who also ensured that the study proforma was completely and accurately filled.

Standard operating procedures for specimen collection, transport, preparation and storage was followed to minimize pre-analytical errors. To ensure quality will be maintained, the laboratory tests were carried out in the microbiology laboratory at KNH by a study dedicated technician. The PI and the research assistants were trained on sample labelling, collection, storage and transportation. All laboratory personnel including the study dedicated technician was trained on good laboratory practice as well as good clinical practice. All reagents were prepared in

accordance with standard operating procedures used at UON/KNH. Equipment operation was done according to manufacturer's instructions. (Appendix III).

3.11 Data Management and Analysis

3.11.1 Data Collection

Data was collected by use of study proforma specifically designed for this study (appendix II). The participants' files were reviewed and study specific information was identified and entered appropriately. Patients were interviewed to verify the information on the files and give any additional information required.

3.11.2 Data Privacy

Standards to protect personal data were followed. Data collection instruments had minimum possible subject identifiers; only the first name and a serial number were entered in the study questionnaire and specimen labels.

3.11.3 Data Storage

The completely filled study proforma and wound culture results forms were verified for completeness by the principal investigator. The data forms were stored in a secure lockable cabinet only accessible by the PI and the statistician.

3.11.4 Data Entry and Analysis

Data was recorded in the study proforma and entered into secure password-protected data entry sheets after verification and cleaning on a weekly basis to ensure cleanness and completion of the information. Data entry and analysis was done using SPSS version 23.0. Upon completion of entry, the hard copy forms were used to clean and verify correctness of the entered data and then stored safely in the lockable cabinet. The electronic file was backed up in three compact discs and stored offsite

The study population was described using socio-demographic characteristics and clinical history. Categorical variables were presented as percentages and continuous data summarized into means (standard deviations) or medians (interquartile ranges). Association of burns severity parameters and burn sepsis was assessed using Chi square test. All statistical tests were performed at 5% level of significance. Data summary was presented in tables and graphs.

3.12 Ethical Consideration

This study was carried out upon approval from the Department of Surgery (UON), Kenyatta Hospital Administration and the Kenyatta National Hospital /University of Nairobi – Ethics & Research committee (KNH/UON-ERC).

Informed consent and assent was obtained from all the study participants. Cases found to have burn wound sepsis or multidrug resistant bacterial isolates was brought to the attention of the attending doctor to ensure proper antibiotic therapy.

Confidentiality was maintained at all times. An anonymous study-number was assigned to each study subject and was the only identification that appeared on the study proforma, specimen swabs, laboratory request forms and culture plates. Patients were free to withdraw from the study during the study period without discrimination.

4.0 CHAPTER FOUR: RESULTS

4.1 Patient Screening

A total of 84 patients who met the inclusion criteria were consecutively enrolled in the study. Assent to participate was given by those under 18 years and consent by those over 18 years.

4.2 Patient Demographics

The mean age of the study subjects was 27.6 years (SD 12.3) with a range of 6-56 years. Of the 84 recruited, 48 (57.1%) were male, and 36(42.9%) were female. Majority of the population hailed from urban areas 64(76.2%).The population recruited was generally well educated with most having at least attained primary school education 39(46.4%), secondary school 23(27.4%), and tertiary level 18(21.4%), while 4 patients had no formal education. However despite having some formal education most patients were unemployed 40(47.6%) and a further 23 (27.4%) were students.

Table 1:Sociodemographic characteristics of patients recruited

VARIABLE	**FREQUENCY (%)**
GENDER	
Male	48(57.1)
Female	36(48.9)
AGE	
0-10	9(10.7)
11-20	15(17.9)
21-30	21(25)
31-40	26(30.9)
41-50	9(10.7)
51-60	4(4.8)
MARITAL STATUS	
Single	38(45.2)
Married	41(48.8)
Separated/divorced	4(4.8)
Widowed	1(1.2)
LEVEL OF EDUCATION	
None	4(4.8)
Primary	39(46.4)
Secondary	23(27.4)
Tertiary	18(21.4)
OCCUPATION	
Unemployed	40(47.6)
Employed	20(23.8)
Retired	1(1.2)
Student	23(27.4)

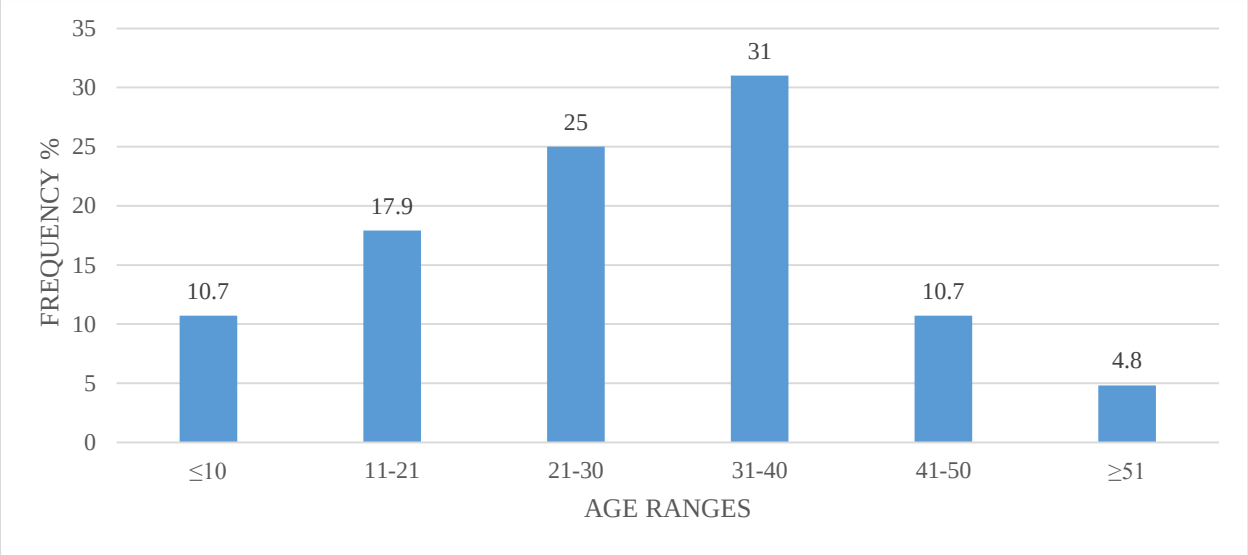

Figure 2:Graph showing the age distribution of the study population.

4.3 Causes of Burns

Most patients sustained open flame and inhalational burns 39(46.4%), 18 (21.4%) sustained open flame, electrical burns were seen in 13(15.5%). The less likely cause of burns was chemical less than 3% as shown in figure 4 below.

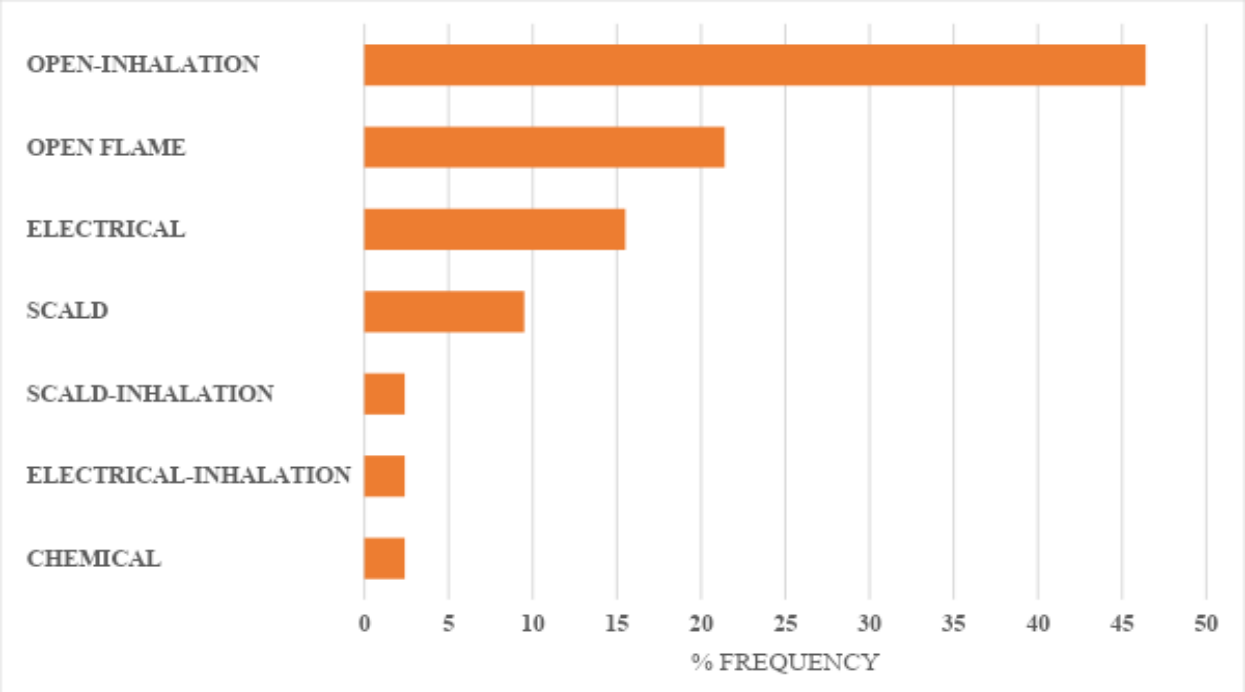

Figure 3:Graph showing causes of burns

4.4 Depth of Burn Wound

Majority sustained partial thickness burns 69(82.1%). There were no patients with fourth degree burns as shown in table 6 below.

Table 2 : Depth of burn wounds.

BURN DEPTH	**FREQUENCY (%)**
Superficial/epidermal	1(1.2)
Partial thickness (superficial/deep)	69(82.1)
Full thickness	14(16.7)
TOTAL	**84(100)**

4.5 Classification of Burn Injury

Major burn injury occurred in the majority of patients 74 (88.1%), moderate burn injury in 7 (8.3%), and minor burn injury in 3(3.6%) of patients.

Table 3:Classification of burn injury

SEVERITY	**FREQUENCY (%)**
MINOR	3(3.6%)
MODERATE	7(8.3%)
MAJOR	74(88.1%)
TOTAL (N)	84(100%)

4.6 Age and Injury

Most who sustained burn injuries were between the ages of 31 – 40 (31%), and this age group also had majority of major burns.

Table 4:Age versus injury severity

AGE	**FREQUENCY**	**MINOR**	**MODERATE**	**MAJOR**	**P-VALUE**
0-10	9	1	0	8	0.48
11-20	15	0	2	13	
21-30	21	1	0	20	
31-40	26	1	3	22	
41-50	9	0	2	7	
51-60	4	0	0	4	

4.7 Burn Wound Sepsis and Cause Of Burns

Sepsis was present in 11(13.1%) patients. 5 sustained open flame and inhalational burns.

Table 5:Cause of burns and sepsis

Cause of burn	**Frequency**	**Sepsis**	**No sepsis**	**p-value**
Open flame	18	2	16	0.12
Scald	8	0	8	
Electrical	13	2	11	
Chemical	2	0	2	
Open inhalation	39	5	34	
Scald inhalation	2	0	2	
Electrical inhalation	2	2	0	
TOTAL	**84**	**11**	**73**	

4.8 Age and Sepsis

Sepsis was highest among those in the age group 21-30yrs, (P=0.8).

Mean age among those with sepsis was 23.5yrs, and 28.3yrs among those without sepsis (P=0.23).

Table 6 :Frequency of Sepsis according to age

AGE	FREQUENCY(N)	SEPSIS	NO SEPSIS	P
0-10	9	1	8	0.80
11-20	15	3	12	
21-30	21	4	17	
31-40	26	3	23	
41-50	9	0	9	
51-60	4	0	4	

4.9 Days to Suspicion of Sepsis and Culture

The number of days to culture pus, urine and blood in patients who were suspected of having sepsis was a range of 13 days, mean of 12.27 (SD 4.3).

Table 7 :Organisms isolated from patients with sepsis.

ORGANISM	**FREQUENCY (%)**
Acinetobacter spp	4(4.8%)
Klebsiella pneumonia	1(1.2%)
Proteus mirabilis	2(2.4%)
Pseudomonas aeruginosa	1(1.2%)
Pseudomonas spp	1(1.2%)
Staphylococcus spp	1(1.2%)
Stapylococcus aureus	1(1.2%)
TOTAL	11(13.2%)

4.10 Sepsis and Immunosuppression

Among patients with HIV (5), only 1(20%) developed sepsis (OR=1.73, P=0.51). Among patients with DM (5), only 1(20%) developed sepsis (OR=1.73, P=0.51)

4.11 Burn Severity and Sepsis

Sepsis was only present in patients with major burns but the relationship was not statistically significant (P=0.73)

Table 8 :Relationship between burn severity and burn sepsis

BURN SEVERITY	PRESENCE OF SEPSIS	NO SEPSIS	P-VALUE
MINOR	0	3	0.73
MODERATE	0	7	
MAJOR	11	74	

4.12 Mortality Rate

Of the 84 patients with burn injury, 22 (26.2%) died. Of the 11 patients with burn wound sepsis 3 died (13.6%), **(**P=0.002) which was statistically significant.

5.0 CHAPTER FIVE: DISCUSSION

The basis of this study was to assess the correlation between burn severity index and burn wound sepsis. Our patient population presenting with varying burns had a median age of 27.6 years, with only 9 patients under age ten and none above the age of 60. Overall majority of patients were male unemployed with a minimum of primary education. In terms of development of burn wound sepsis the extreme age groups again did not go on to develop sepsis which is in contrast to most worldwide surveys which showed that very young children and the elderly have an increased risk of being burned and worse clinical outcomes than patients in other age groups. (1, 18).

Most patients sustained open flame and inhalational burns 39(46.4%), 18 (21.4%) sustained open flame, electrical burns were seen in 13(15.5%). The less likely cause of burns was chemical, less than 3%.This was attributed to the use of kerosene gas lamps as light sources within the patient population. Studies looking at burns find that kerosene related accidents account for a considerable share of thermal injury admissions as noted by Ghaffar et al (22). The World Health Organization (WHO, 2011, 2016) argues that "the use of kerosene (paraffin) stoves and lanterns are major risk factors for burn injuries and that millions of people suffer burns from using kerosene lamps every year.

Major burn injury occurred in the majority of patients 74 (88.1%), moderate burn injury in 7 (8.3%), and minor burn injury in 3(3.6%) of patients. Majority sustained partial thickness burns 69 (82.1%). There were no patients with fourth degree burns. Studies have shown the bigger the burn, the greater the risk of subsequent burn wound and systemic infections (14). The deeper the burn depth is, the more likely the formation of eschars and thus less penetration of antibiotics leading to burn wound infection (2).

Sepsis was present in 11(13.1%) patients. 45.5% (5) of the patients had sustained both open flame and inhalational burns. The presence of inhalation injury has been shown to increase mortality in every age and burn size category (6). Among patients with HIV (5) and Diabetes Mellitus(5) only 1 of each developed sepsis although it is expected that burn patients with other types of severe immunosuppression would have increased likelihood of wound infection and sepsis and a higher mortality (17). Of the 84 patients with burn injury, 22 (26.2%) died. Of the 11 patients with burn wound sepsis 3 died (13.6%), (P=0.002) which was statistically significant. Sepsis remains an independent risk factor of mortality in a burns patient (6).

All patients with burn wound sepsis had major burns in our study. Although ultimately the correlation between Burn wound Severity and burn wound sepsis was not statistically significant (P=0.73).

6.0 CHAPTER SIX: CONCLUSION

In conclusion, prevalence of burn wound sepsis was high at 13.2%. There was no statistically significant correlation between burn severity index and burn wound sepsis. Major, moderate or minor burns did not have an influence on the development of burn wound sepsis.

The mortality rate among the burns patients was at 26.2%. However, in those who developed burn wound sepsis mortality rate was 13.6% and this was statistically significant, indicating a correlation between the numbers who developed burn wound sepsis and the number who died from burn wound sepsis.

The Burn Severity Index is a useful tool but may require other data to determine the development of Burn wound Sepsis in affected patients.

6.1 Study Limitations

a) Our study carried out a single pus, urine and blood culture to determine burn wound sepsis when it was suspected. Repeat cultures in the same patients at different dates may have yielded more data.

b) Other markers of inflammation and sepsis such as C reactive protein (CRP) and Procalcitonin (PCT) would have been useful to determine suspect burn wound sepsis faster and therefore culture earlier.

6.2 Recommendations

a) We recommend a strict protocol of management for patients admitted to burns unit in terms of assessing daily for signs and symptoms of burn wound sepsis as per the American Burn Sepsis criteria.

b) Further studies into why educated young males who are married and unemployed are a high risk group to sustain burn injuries as in our study should be investigated.

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APPENDICES

Appendix I: Consent Form

CORRELATION BETWEEN BURN SEVERITY INDEX AND BURN SEPSIS

RESEARCHER: DR MANVINDER SINGH MANN, REGISTRAR, GENERAL SURGERY.

You have been chosen to participate in a research study looking at degree of burn severity influencing burn wound infection as seen at the Kenyatta National Hospital. We are asking you to take part because you are admitted in the burns unit or ward 4D at the Kenyatta National Hospital. Make sure you thoroughly read this form and feel free to ask any questions/ clarifications at any point, before going ahead and taking part in the study.

What the study is about: the aim of this study is to look at the degree of burn severity and its influence on burn sepsis as seen in the burns unit at the Kenyatta National Hospital.

What we will ask you to do: should you accept to participate in the study we will ask you a few questions based on the study proforma to help us know more about you and then upon filing it completely, we will perform a full physical exam that includes examination burn wound to assess degree of burns.

Risks: there is no risks involved during your participation in this study.

Benefits: the benefit involved is that the culture and sensitivity will be done at no extra cost to the participant and the results of the swabs will be available to the managing doctor to be able to institute appropriate antibiotic use.

Compensation: there will be no compensation for participating in this study.

Confidentiality: information obtained from of this study will be kept private. In the event that we publish the results obtained we will not include any information that will make it possible to identify you. The records will be kept in a secure lock cabinet/ password protected computer only the researchers will have access to the records.

Participation is voluntary: taking part in this study is completely voluntary. If you decide not to participate, it will not affect the quality of are you receive at the burns unit and there will be no victimization. If you decide to participate, you are allowed to withdraw at any time.

If you have any question during the course of the study, you may contact the following:

1. DR MANVINDER MANN, UNIVERSITY OF NAIROBI, DEPARTMENT OF GENERALSURGERY, TEL: 0722-699161. Email: manvinder_mann@hotmail.com ***OR***
2. DR FERDINAND NANGOLE, PLASTIC SURGEON, KENYATTA NATIONAL HOSPITAL, TEL: 0714-342214. Email: nangole2212@gmail.com ***OR***
3. CHAIRPERSON, KNH/UON ETHICAL REVIEW COMMITTEE, TEL: 020-2726300/0722829500/0733606400/EXT 44102. P.O. Box 20723, Nairobi.

CONSENT FORM - PATIENTS

STUDY NO…… DATE……TIME……

I hereby give my written and informed consent to allow myself or my…… participate in this study on burn severity and bourn wound infection among burns patients in burns unit at Kenyatta national hospital.

I have been adequately explained to about the study by Dr. Manvinder Mann. I do this with the full understanding of the purpose of the study and procedures which include a pus swab for culture and sensitivity and answering to a proforma which have been explained to me. I understand that my rights will be respected, and confidentiality maintained at all times. I also understand that the consent is voluntary, and I am at liberty to withdraw from the study without my care being affected.

Patient's signature……Patient's Name……

Patients below 18 years of age or those unable to give consent due to current medical incapacitation in cases of intubation/sedation.I have been adequately informed that my …… is being recruited in a study. The investigator has also informed me that his/her participation in this study is voluntary and will not exclude him/her from their routine care even if he/she were to opt out. She has also informed me that I will not be required to pay for any part of the assessments done for the purposes of this study.

Patient's PARENT/GUARDIAN:

Sign: …….

Name: …….

Date: …….

ASSENT:

For patients between ages 6-18,

You should know that:

- You do not have to be in this study if you do not want to. You won't get into any trouble with *(the doctors, parents, or the hospital)* if you say no.
- You may stop being in the study at any time.
- Your parent(s)/guardian(s) were asked if it is OK for you to be in this study. Even if they say it's OK, it is still your choice whether or not to take part.
- You can ask any questions you have, now or later. If you think of a question later, you or your parents can contact me.

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, and
- agree to take part in this research

Patient's Details:

Sign: …….

Name: …….

Date: …….

INVESTIGATOR'S STATEMENT:

I, the Principal Investigator, have fully educated the research participant on the purpose and implication of this study.

Signed…… Date…….

For any further clarification, you may contact

Dr. Manvinder Mann, at Tel No: 0722-699161.

Or: KNH/ERC (Kenyatta National Hospital/Ethics & Review Committee)

TEL: 020-2726300/0722829500/0733606400/EXT 44102. P.O. Box 20723, Nairobi

USHAWISHI WA KUCHOMA UKALI JUU YA KUCHOMA JERAHA MAAMBUKIZI KATIKA HOSPITALI KUU YA KENYATTA

MTAFITI: DR MANVINDER SINGH MANN, MSAJILI UPASUAJI UJUMLA

Mimi ni Dkt. Manvinder Mann, kutoka Chuo Kikuu cha Nairobi. Kwa sasa nasomea upasuaji ujumla. Kama sehemu ya masomo yangu ya uzamifu, nahitajika kufanya mradi wa utafiti. Ninafanya uchunguzi kuhusuushawishi wa kuchoma ukali juu ya kuchoma jeraha maambukizi kati ya waginjwa nzito katika nzito kitengo saa katika Hospitali Kuu ya Kenyatta.

Lengo kuu la utafiti: lengo la utafiti huu ni kuangalia kiwango cha kuchoma ukali juu ya maambukizi kuchoma jeraha kama inavyoonekana kati ya wagonjwa nzito katika hospital kuu ya Kenyatta.

Taratibu zitakazohusishwa: lazima kukubali kushiriki katika utafiti sisi kuuliza maswali machahe kulingana na utafiti profoma. Ndipo tutakuwa kufanya mtihani wa kimwili ambayo itaangalia kiwango cha kuchoma ukali kuchoma halafu tutachukua usaha usufi kwanutamaduni nyeti.

Haki yako kama mshiriki katika utafiti huu: ushiriki wako katika utafiti huu ni wa kujitolea. Hata ukichagua kushiriki au ukatae kushiriki haitaathiri matibabu yako. Una uhuru wa kujiondoa katika utafiti huu wakati wowote. Una uhuru wa kuuliza maswali kabla ya kutia sahihi katika fomu ya idhini na wakati wa utafiti. Maswala yote yatahifadhiwa kwa siri wakati w ote.

Hasara za ushiriki: hakuna hasara yoyote utakayopitia au kupata.

Manufaa ya kushiriki: mwishoni mwa utafiti huu, nitawasilisha matokeo ya utafiti katika idara ya upasuaji jumla Chuo Kikuu cha Nairobi. Habari zozote muhimu zitakazotokana na utafiti na ambazo zitafanya malezi kuwa bora, walezi watafahamishwa ili hatua mwafaka ichukuliwe.

Siri: habari zote zitakazokusanywa wakati wa utafiti zitahifadhiwa kwa siri. Ni watafiti pekee ndio wanaoweza kufikia habari za kibinafsi. Habari zitakazokusanywa zitaandikwa na kuainishwa bila kutaja washiriki.

Ikiwa una swali lolote wakati wa utafiti, unaweza kuwasiliana na wafuatao:

1. DKT Manvinder Mann, chuo kikuu cha nairobi, idara ya mafundisho ya udaktari na matibabu ya magonjwa. Simu ya mkono: 0722-699161 ***AU***
2. DKT Ferdinand Nangole. Simu ya mkono: 0714-342214 ***AU***
3. Mwenyekiti, knh/uon kamati inayoshughulikia maadili, Nambari ya simu: 020-2726300/0722829500/0733606400/EXT 44102. P.O. Box 20723, Nairobi.

Kabla sijakuhusisha katika utafiti wangu, Naomba utie sahihi katika fomu ya idhini iliyopo hapo chini. Fomu hii ya idhini haitahusishwa na majibu yako.

Kauli ya ridhaa: Nimesoma habari hapo juu na nimepata majibu ya maswali yoyote

FOMU YA IDHINI /KUBALI- WAGONJWA

NAMBARI YA UCHUNGUZI……TAREHE……WAKATI……

Natoa idhini andishi na ninayoifahamu ili kuniruhusu au ……wangu kushiriki katika utafiti huu kuhusuushawishi wa kuchoma ukali juu ya kuchoma jeraha maambukizi kati ya waginjwa nzito katika nzito kitengo saa katika Hospitali Kuu ya Kenyatta. Nimepewa maelezo yanayofaa kuhusu utafiti wa Daktari Manvinder Mann/ msaidizi wake. Ninafanya hivi kwa vile naelewa lengo kuu la utafiti huu na taratibu zitakazohusishwa kama vile kujibu maswali katika fomu ambayo nimepewa maelezo yake.

Ninaelewa kuwa haki zangu zitaheshimiwa, na suala la kuhifadhi utambuzi wangu utadumishwa wakati wote.

Pia ninaelewa kuwa idhini ya kushiriki ni ya kujitolea, na nina uhuru wa kujiondoa katika utafiti huu bila malezi yangu kuathiriwa.

Sahihi ya Mgonjwa……..Jina la Mgonjwa……

Wagonjwa chini ya umri wa miaka 18 au wale ambao hawawezi kutoa ridhaa kwa sababu ya kutosha kwa matibabu wakati wa intubation / sedation.Nimekuwa na taarifa ya kutosha kuwa ..... yangu ni kuajiriwa katika utafiti. Mpelelezi amenitambua kuwa ushiriki wake katika utafiti huu ni kwa hiari na hautamzuia kutoka kwa utunzaji wao wa kawaida hata kama angeondoka. Pia ameniambia kuwa sitatakiwa kulipa kwa sehemu yoyote ya tathmini zilizofanyika kwa madhumuni ya utafiti huu.

Mzazi wa mgonjwa / MGARDI:

Ishara: .....

Jina: .....

Tarehe: .....

JIFUNA

Kwa wagonjwa kati ya miaka 6-18,

Unapaswa kujua kwamba:

• Huna haja ya kuwa katika utafiti huu ikiwa hutaki. Huwezi kupata shida yoyote na (*madaktari, wazazi, au hospitali*) ikiwa unasema hapana.

• Unaweza kuacha kuwa katika utafiti wakati wowote.

• Mzazi wako (s) / mlezi (walinzi) waliulizwa ikiwa ni sawa na wewe kuwa katika utafiti huu. Hata kama wanasema ni sawa, bado ni chaguo lako ikiwa ni lazima usiingie.

• Unaweza kuuliza maswali yoyote unayo, sasa au baadaye. Ikiwa unafikiria swali baadaye, wewe au wazazi wako unaweza kuwasiliana na mimi.

<u>Ishara fomu hii tu kama wewe:</u>

• umeelewa nini utafanya kwa ajili ya utafiti huu,

• Umejibu maswali yako yote,

• wamezungumza na mzazi wako (m) / mlezi wa kisheria kuhusu mradi huu, na

• kukubali kushiriki katika utafiti huu

Maelezo ya Mgonjwa:

Ishara: .....

Jina: .....

Tarehe: ……

Appendix II: Study Profoma

STUDY NUMBER …….

BURN SEVERITY INDEX AND ITS RELATIONSHIP TO BURN SEPSIS

BASIC INFORMATION

1. Study code number ……
2. Telephone Contact ……
3. Age ……
4. Gender Male □ Female □
5. Marital Status Single □ Married □ Separated/ Divorced □ Widowed □
6. Residence Rural □ Urban □ Peri-Urban □ (exact location ……)
7. Education Level None □ Primary □ Secondary □ Tertiary □
8. Occupation Employed □ Self-employed □ Unemployed □ Retired □ Training/Student □

HISTORY

Date of admission ……...

Duration of stay in burns unit ……...

Do you consume alcohol? YES ☐ NO ☐

IF YES for how long ……... (number in days)

Do you smoke cigarettes? YES ☐ NO ☐

IF YES for how long …… and number of pack years …….

Do you have any of the following medical conditions?

Diabetes mellitus YES ☐ NO ☐

Epilepsy YES ☐ NO ☐

HIV YES ☐ NO ☐

Hypertension YES ☐ NO ☐

Anemia YES ☐ NO ☐

If YES to any of the above is the medical condition well controlled? YES ☐ NO ☐

Table 1: Cause of burns

	Yes	No
Open flame		
Scald		
Electrical		
Chemical		
Inhalation		
Other		

If other in type of burns above, state here ……

Physical Exam

Blood pressure ……. (mmHg)

Total body surface area percentage of burns (%)……...

Table 2; Depth of burn wound (check the appropriate one

Superficial/ epidermal	
Partial thickness(superficial/ deep)	
Full thickness	
Fourth degree	

Table 3; Classification of burn injury (check the appropriate box)

Major burn injury	
Moderate burn injury	
Minor burn injury	

Table 4: Pus Swab Culture Results

Day post admission	Burn severity	Organisms isolated	Sensitivity pattern

Table 5: Urine Culture Results

Day post admission	Burn severity	Organisms isolated	Sensitivity pattern

Table 8: Blood Culture Results

Day post admission	Burn severity	Organisms isolated	Sensitivity pattern

Table 7: Criteria for Burn Wound Infection

Parameter	Recording
Temperature	
Heart rate	
Respiratory rate	
Blood pressure	
White blood cell count	
Platelet count	
Random blood sugar	
Blood culture results	
Urine culture results	
Pus swab results	

Jumu Ya II: Kiswahili Study Tool

KUJIFUNA PROFOMA STUDY NUMBER.....

BURN SEVERITY INDEX NA UFANO WAKE WA KUTUMA SEPSIS

MAELEZO YA MSINGI

1. Nambari ya namba ya kusoma .....

2. Mawasiliano ya simu .....

3. Umri .....

4. Jinsia ya Kiume □ Kike □

5.Hali ya ndoa ya pekee □ Mkewe □ Mgawanyiko / Talaka □ Mjane □

6. Makazi ya vijijini □ Mjini □ Peri-Mjini □ (eneo halisi .....)

7. Ngazi ya Elimu Hakuna □ Msingi □ Sekondari □ ya juu □

8. Kazini aliyetumika □ Mwenye kujitegemea □ Kazi □ Astaafu □ Mafunzo / Mwanafunzi □

HISTORY

Tarehe ya kuingia ....

Muda wa kukaa katika kitengo cha kuchoma ....

Je! Hutumia pombe? NDIO LA

Ikiwa Ndio kwa muda gani .... (namba katika siku)

Je, wewe sigara sigara? NDIO LA

Ikiwa NDIYO kwa muda gani ..... na idadi ya pakiti ya miaka .....

Kifafa NDIO LA

VVU NDIO LA

Shinikizo la damu NDIO LA

Anemia NDIO LA

Ikiwa Ndiyo kwa yoyote ya hapo juu ni hali ya matibabu inayodhibitiwa? NDIO LA

Sababu ya kuchoma

	Ndio	La
Fungua moto		
Scald		
Umeme		
Kemikali		
Kuvuta pumzi		
Nyingine		

Ikiwa nyingine katika aina ya kuchoma hapo juu, tazama hapa .....

Mtihani wa kimwili

Shinikizo la damu ……. (mmHg)

Jumla ya asilimia ya asilimia ya eneo la kuchoma (%) ....

Urefu wa jeraha la kuchoma (angalia moja sahihi

Hifadhi / epidermal	
Uwiano maalum (juu / juu)	
Unene kamili	
Shahada ya nne	

Uainishaji wa kuumia kwa kuchoma (angalia sanduku linalofaa)

Majeraha makubwa ya kuchoma	
Kuumia kwa kiasi kikubwa	
Uharibifu mdogo wa kuungua	

Utamaduni wa Mazao ya Supu Matokeo

Uingizaji wa baada ya siku	**Kuchoma ukali**	**Viumbe vyenye pekee**	**Sensitivity pattern**

Vigezo vya Kupunguza Vidonda Vidonda

Kurejesha Kipengele	
Joto	
Kiwango cha moyo	
Kiwango cha kupumua	
Shinikizo la damu	
Hesabu nyeupe ya seli ya damu	
Hesabu ya sahani	
Chanjo ya damu ya kawaida	
Matokeo ya utamaduni wa damu	
Matokeo ya utamaduni wa mkojo	
Pus matokeo ya swab	

Appendix III : Clinical Methods

After obtaining informed consent (Appendix 1) from the participants, the study proforma (Appendix 2) was administered to capture demographic data and relevant history.

The principal investigator carried out a focused examination to assess the burn wound and was able to classify the wound. The total burn surface area was determined using Lund and Browder chart (9). Burn wound depth was determined and classified as either first, second, third or fourth degree. The PI also looked for any features of burn sepsis as defined by the American Burns Association (15). The burn wound assessment and examination was carried out by the principal investigator for consistency and to minimize errors.

Laboratory Methods

In patients whom Burn sepsis was suspected based on clinical criteria:

Blood urine cultures and pus swabs

1) Blood samples were obtained for total blood counts to determine evidence of sepsis as indicated in the ABA scoring system and also for blood cultures.

2) Urine samples were also collected for urine culture. Blood and urine culture results were used to demonstrate if the burn wound isolated organism is causing sepsis.

3) All pus swab samples from patients suspected to have burn sepsis using the ABA sepsis score were collected by the principle investigator and the two trained research assistants. Pus swabs were obtained using sterile swabs provided by the microbiology department. The dressing on the burn wound was first removed and then using sterile gloves and a sterile dressing tray the wound was cleaned with normal saline. After cleaning with normal saline, the swab tip was rolled at the center of the wound and then in a clockwise method until at the edge of the burn wound. The swab was then be capped to avoid contamination. The swabs were labeled with unique numbers, date and time. Swabs obtained were sent to the microbiology laboratory in a cold chain within two hours and was processed within twenty-four hours. The swabs were dipped in Stuart's transport medium, and then placed on blood agar, chocolate

agar, MacConkey and Sabaraund's dextrose agar media. After incubation for 18-48 hours at 37^0C, the isolates were identified using conventional protocols.

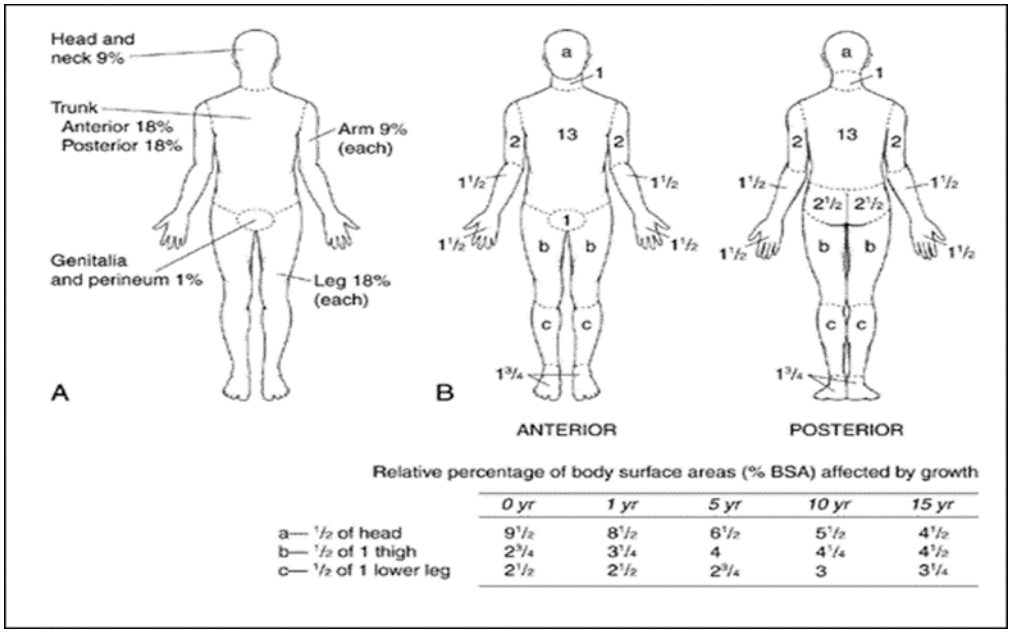
Data was collected using guidelines as per the American Burn Association parameters for burn severity and classified patients into major, moderate and minor burn wound injuries. Patients progress was monitored for 28 days and those who demonstrated clinical characteristics of sepsis were further monitored as per the American burn sepsis scoring including pus wound swabs, blood and urine cultures to determine Burn Wound Sepsis.

Appendix IV: American Burns Association burn-specific sepsis criteria

Table 11: American Burns Association burn-specific sepsis criteria

Parameters	Adults	Children
Temperature	Less than 36.5, or more than 39	More than 2 standard deviations
Heart rate	More than 90 beats per minute	Less than 2 standard deviations
Respiratory rate	More than 30 breaths per minute	Less than 2 standard deviations
Systolic blood pressure	Less than 90mmHg	Less than 2 standard deviations
White blood cell count	More than 12000 cells or less than 4000 cells	Less than 2 standard deviations
Platelet counts	Less than 100000 cells	Less than 2 standard deviations
Random blood sugar	More than 6.1 mmol/l	Less than 2 standard deviations
Feeding	Inability to tolerate enteric feeds for more than 24 hours	
Evidence of bacterial infection	1.culture of either wound swab, blood, urine **or** 2.Pathologic tissue source is identified (more than 10^5 bacteria on quantitative wound tissue biopsy or microbial invasion on biopsy) **or** 3.A clinical response to antimicrobial administration is documented	

Appendix V: Lund and Browder Burn Surface Area Estimation



Relative percentage of body surface areas (% BSA) affected by growth

	0 yr	*1 yr*	*5 yr*	*10 yr*	*15 yr*
a— ½ of head	9½	8½	6½	5½	4½
b— ½ of 1 thigh	2¾	3¼	4	4¼	4½
c— ½ of 1 lower leg	2½	2½	2¾	3	3¼

Appendix VI: Physiologic Parameters based on pediatric age

Physiologic parameters based on pediatric age

Age group	Heart rate, beats/min		Respiratory rate, breaths/min	Leukocyte count, leukocytes x 10^3 /mm^3	Systolic blood pressure, mmHg
	Tachycardia	Bradycardia			
0 days to 1 wk	>180	<100	>50	>34	<65
1 wk to 1 mo	>180	<100	>40	>19.5 or <5	<75
1 mo to 1 yr	>180	<90	>34	>17.5 or <5	<100
2-5 yrs	>140	NA	>22	>15.5 or <6	<94
6-12 yrs	>130	NA	>18	>13.5 or <4.5	<105
13 to <18 yrs	>110	NA	>14	>11 or <4.5	<117

NA: not applicable.

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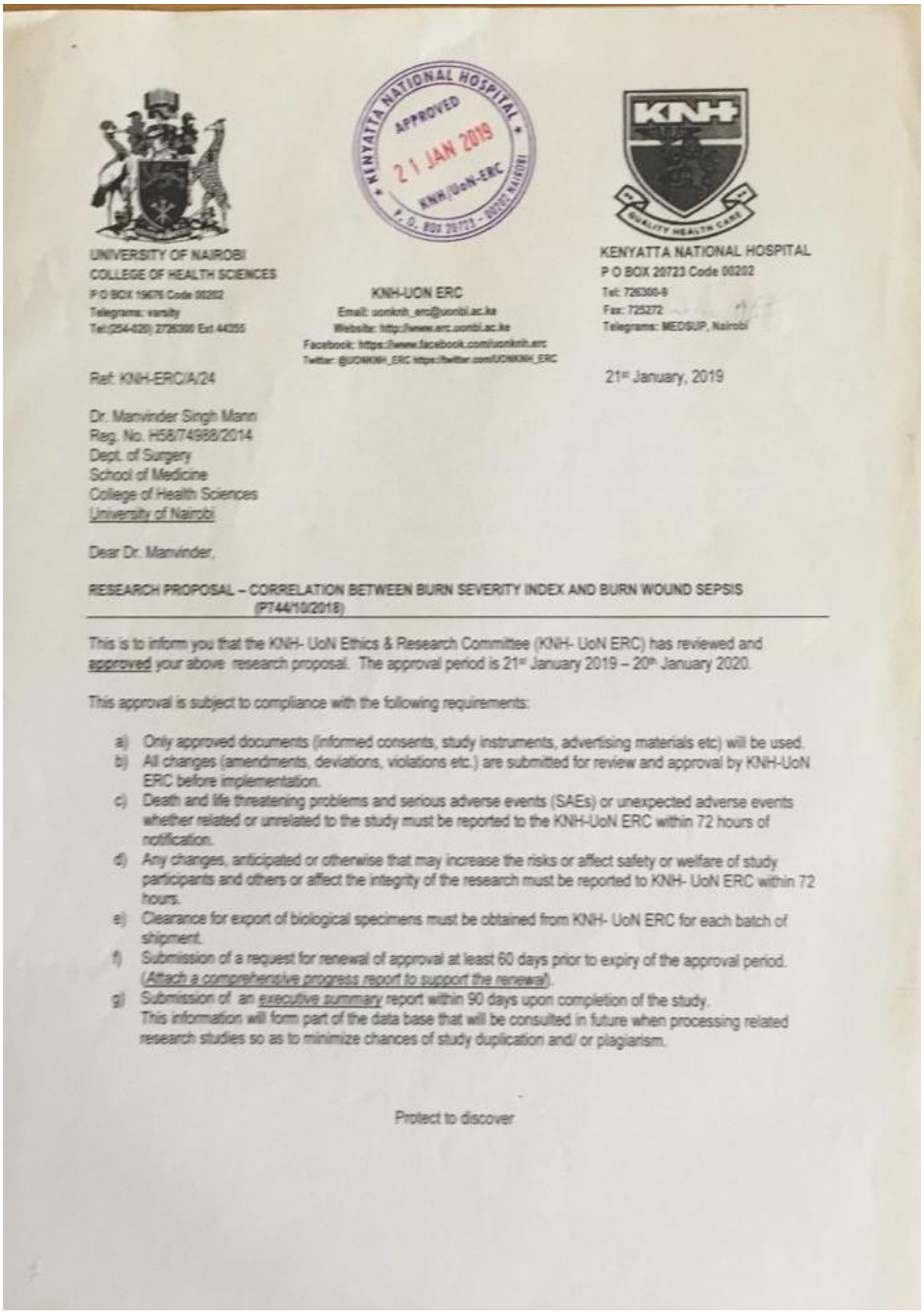
Appendix VII: KNH ETHICAL APPROVAL LETTER



KENYATTA NATIONAL HOSPITAL
APPROVED
21 JAN 2019
KNH/UoN-ERC
P. O. BOX 20723 - 00202 NAIROBI

UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/24

21st January, 2019

Dr. Manvinder Singh Mann
Reg. No. H58/74988/2014
Dept. of Surgery
School of Medicine
College of Health Sciences
University of Nairobi

Dear Dr. Manvinder,

RESEARCH PROPOSAL – CORRELATION BETWEEN BURN SEVERITY INDEX AND BURN WOUND SEPSIS (P744/10/2018)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and approved your above research proposal. The approval period is 21st January 2019 – 20th January 2020.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc.) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e) Clearance for export of biological specimens must be obtained from KNH- UoN ERC for each batch of shipment.
f) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
g) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

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