INCIDENCE AND RISK FACTORS OF ACUTE KIDNEY INJURY IN SEVERELY BURNED PATIENTS IN MULAGO NATIONAL REFERRAL HOSPITAL

BY

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A DISSERTATION SUBMITTED TO MakCHS IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF DEGREE OF MASTER OF MEDICINE IN GENERAL SURGERY OF MAKERERE UNIVERSITY

JUNE 2018
DECLARATION

I, Wandabwa Joel, hereby declare that the work submitted in this dissertation is my own original compilation and has not been submitted to any other institution of higher learning for any award of any academic qualification. All this work is original unless otherwise stated.

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ACKNOWLEDGEMENT

I would like to appreciate my supervisors MS Alenyo Rose and Dr. Kalyesubula Robert for their guidance and devotion to the study. I am also thankful to the research assistants for their effort to ensure that the study was well done. I also extend my appreciation to my classmates for the ideas shared during the course of the study.

Above all, I extend my heartfelt gratitude to the patients who were gracious enough to participate in the study, my family for the moral support and the Lord Almighty for the far He has brought me in life.
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ACRONYMS

AKI: Acute Kidney Injury
ABA: American Burns Association
APD: Automated Peritoneal Dialysis
ARDS: Acute Respiratory Distress Syndrome
ARF: Acute Renal Failure
ESRD: End Stage Renal disease
GFR: Glomerular Filtration Rate
ICU: Intensive Care Unit
MODS: Multiple Organ Dysfunction Syndrome
RIFLE: Risk, Injury, Failure, Loss and End-stage
RRT: Renal Replacement Therapy
SIRS: Systemic Inflammatory Response Syndrome
TBSA: Total Body Surface Area
UOP: Urine Output
IAH- Intra-abdominal hypertension.
ABSI-Abbreviated Burns Severity Index
DALY-Disability-Adjusted life year
KDIGO- Kidney Disease: Improving Global Outcome
MAP- Mean Arterial Pressure
OPERATIONAL DEFINITIONS

Acute kidney injury: Acute Kidney Injury is defined by KDIGO as increase in serum creatinine by 0.3mg/dl or more than or equal to 26.5 micromoles/L within 48hrs or increase in serum creatinine to more than or equal to 1.5 times the baseline which is presumed to have occurred within the prior 7 days (Kerry Willis, Michael Cheung, & Sean Slifer, 2012).

Chronic kidney disease: This is defined by KDIGO as glomerular filtration rate less than 60/min/1.73m² for >3 months or kidney damage for 3 months (Kerry Willis et al., 2012).

Severe burns: These are defined by the American Burns Association as partial thickness burns involving greater or equal to 20% total body surface area in an adult or 10% in a child, full thickness burns of 10% TBSA in adults or 5% in a child or any percentage skin burns with associated inhalation or high voltage electrical (ABA, 1996).

Sepsis: Diagnosis for sepsis in burns patients is made after establishing the existence of infection (documented by clinical response to antibiotics, pathological analysis of tissues from wound or positive cultures) and at least three of the following; fever >39°C, hypothermia <36.5°C, progressive tachycardia >110 beats/min, progressive tachypnoea >25/min, thrombocytopenia <100,000/microliter, hyperglycemia in the absence of diabetes mellitus, inability to continue enteral feedings for >24hrs (D. G. Greenhalgh et al., 2007).

Child: Human being of 12 years of age and below.

Mixed burns: Burns with more than one etiology.
ABSTRACT

Introduction: According to the World Health Organization, 11 million people suffer from burns annually worldwide and burns contribute to 180,000 deaths yearly. According to the 2015 global health estimates, about 95% of these burns and burn-related mortality occur in the Low and Middle-Income Countries. Severely burned patients have a high incidence of Acute Kidney Injury (AKI) of 45.5% and associated high mortality of up to 85%. Currently there is no published data on the epidemiological patterns, risk factors and outcomes of AKI among patients with severe burns in Uganda and yet early identification through screening of high risk patients as well as early treatment has been shown to improve survival.

Objective: To determine the incidence and risk factors of AKI among patients admitted with severe burns in Mulago National Referral Hospital.

Methods: This was a prospective cohort study conducted over a period of four months in the Mulago National Referral Hospital Burns unit. Adults with partial thickness burns involving greater or equal to 20% total body surface area or children with TBSA of burns equal to or greater than 10%, full thickness burns of 10% TBSA in adults or 5% in children or any percentage skin burns with associated inhalation or high voltage electrical burns were recruited consecutively. AKI was assessed using the KDIGO criteria at admission and then at 48 hours, 7 days and 14 days post admission. Risk factors for development of AKI were obtained from patient history, demographics and clinical characteristics which were captured on a pre-tested questionnaire. Data was entered in Epi-info and analyzed using Stata version 13.0. Factors with P-values less than 0.2 at bivariate were considered for multivariate analysis. Modified Passion regression was used at multivariate and variables with P-values less than 0.05 were considered risk factors for AKI.

Results: During the study, 147 patients were screened and 92 met the inclusion criteria but 2 of these declined to participate in the study. Of the study participants, 48(53.3%) were male, 60(66.7%) were aged 12 years and below and the median total burn surface area was 17 (IQR; 13 - 23). Those who had scalds were 66(73.4%) and 49(54.9%) had mixed burns. Of the recruited patients, 31 developed AKI. Sepsis was found in 9(10%) of the participants, 59(66.3%) had low albumin levels and 16(18.6%) had inhalation burns. The incidence of AKI was found to be 34.4% (95% CI; 25.9 - 45.9; P= <0.001) with a mortality of 32.3%. The median survival of patients with AKI was found to be above 50%. Total burn surface area PR 3.07 (95% CI; 1.42 to
6.60 \( P = 0.004 \) was the only independent risk factor AKI. Hypoalbuminemia \( PR = 0.23 \) (95% CI; 0.08 to 0.65 \( P = 0.006 \)) and inhalation burns \( PR = 3.36 \) (95% CI; 1.69 to 6.72 \( P = 0.001 \)) were found to be risk factors for AKI in the presence of hypertension.

**Conclusion:** The incidence of AKI in patients with severe burns was found to be high with a high mortality rate. Having burns greater than 18% TBSA was an independent risk factor for AKI while hypoalbuminaemia and presence of inhalation burns were found to be significant risk factors for development of AKI in the presence of hypertension.

**Recommendations:** Patients with inhalation burns, burns greater than 18% TBSA and hypoalbuminaemia should be assessed regularly so that treatment is instituted early should they develop AKI.
CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

According to the World Health Organization (WHO), 11 million people suffer from burns annually worldwide to require medical attention and approximately 180,000 deaths yearly are due to burns. According to the 2015 global health estimates, about 95% of these burns and burn-related mortality occur in the Low and Middle-Income Countries (WHO, 2018). A study in Kampala, Uganda found that in children under 10 years, 41% of all severe injuries were due to burns while in the adolescents and young adults, severe burns were among the top three causes of injury (Demyttenaere S, 2009). In the same study, it was reported that 15% of all trauma-associated deaths were due to severe burns. Furthermore, 9% and 11% of fatal injuries in urban and rural areas respectively were due to burns (Demyttenaere S, 2009). In another study, the crude mortality among severely burned children at Mulago Hospital in Uganda was 33% (Mosier, 2010). Yet another study in 2009 established that severe burns were associated with high mortality mostly due to sepsis and its associated complications; AKI being one. In the same study, it was reported that 50% of the patients with severe burns developed multi-organ dysfunction (Felicia N Williams, 2009).

Severe burns cause extensive damage by injuring the skin the extent of which is assessed basing on the depth and total surface area burned. This causes pathology majorly by causing excess fluid loss through the damaged skin. This results in hypotension with burn shock. Severe burns are usually associated with complications classified as early or late. As earlier stated, one of the major early complications is fluid loss resulting in severe dehydration and shock followed by acute kidney injury occurring in 45.5% of severely burned patients, while sepsis remains one of the major late complications (Tina Palmieri, 2009). Acute kidney injury (AKI) in severely burned patients is often associated with worse morbidity such as multiple organ dysfunction and high mortality rate of up to 85% (I. Steinvall, Bak, Z, Sjoberg, F, 2008). Burn related kidney injury is typically classified as early (0-2 days after injury) or late (3-14 days after injury) (Nguyen, 2002). Early AKI or AKI during resuscitation is considered to be due to inadequate fluid resuscitation during the initial post-burn period resulting in hypovolemia and poor renal perfusion, direct cardiac suppression from TNF-Alpha and precipitation of denatured proteins in
the renal tubules (Bosch, Poch, & Grau, 2009). Improvements in early fluid resuscitation have decreased the incidence of early AKI but have only modestly improved the overall mortality rate (David.F.Schneider, 2012). Late AKI is often related to sepsis, multiple organ dysfunction (MODS) and nephrotoxic drugs (Belba, 2012). The pathophysiology of late AKI in burned patients is still poorly understood because of the overlapping risk factors and complications such as sepsis and respiratory failure (Recinos, Hartford, & Ziffren, 1975). Sepsis is common among burn patients and the burn wounds are the usual sources of infection. Other sources of infection include bronchopneumonia, pyelonephritis and thrombophlebitis (D. Greenhalgh, 2017).

In addition to sepsis, other identified risk factors of AKI in burned patients include physical characteristics such as extremes of age, female sex, obesity, respiratory failure, total body surface area (TBSA) burned, low blood pressure, high white blood cell counts and proteinuria (Witkowski et al., 2016) Infants and the elderly, the obese patients, patients with renal and cardiac co-morbidities, females, patients with TBSA of burns greater than 20% and those who sustained burns from flames had high risk of developing AKI (Kimmel, Wilson, Walker, Singer, & Cleland, 2018). Despite the high morbidity and mortality associated with AKI in severely burned patients, the diagnosis and management of AKI in these patients was inadequate with severely burned patients only being considered to have renal dysfunction if they required renal replacement therapy (RRT) which was usually late(Davies, 1994).

Management of AKI among burns patients includes dialysis and renal replacement therapy. These should be initiated as soon as possible. Renal replacement therapy has significantly improved mortality of burn patients with AKI, but this is not readily available to patients in low and middle income countries. In addition, access to dialysis is limited with high costs of up to 300 dollars per session. 49.5% of adults and 64% of children who need dialysis are able to access it in sub Saharan Africa. Of the burns patients who survive AKI, the vast majority do not need long-term hemodialysis(Maccariello, 2007).

1.2 Problem Statement
While the burden of severe burns remains high and the associated AKI carries a high morbidity and mortality, there is paucity of data on the incidence of acute kidney injury and its risk factors
among patients with severe burns in Uganda. A study done in 2009 in Shriners Hospital for children in California found the incidence of AKI in children to be 45.5% and a mortality of 60% among those who developed AKI with sepsis as the major risk factor for the development of AKI other risk factors being use of nephrotoxic drugs and presence of intra-abdominal hypertension (Tina Palmieri, 2009). This study having been carried out in a hospital in California where management of severely burned patients is more advanced than that in sub-Saharan Africa makes it impractical to extrapolate its findings to a hospital in Uganda. Another global study done in 2010 by meta-analysis of 57 published articles found incidence of AKI in severely burned patients to be 25% but none of the articles was a publication from sub-Saharan Africa (N. Brusselaers et al., 2010). This study therefore seeks to determine the incidence of acute kidney injury and its risk factors among patients with severe burns in Mulago National Referral Hospital.

1.3 Justification
In this study, the incidence and risk factors of AKI among patients with severe burns was determined. This information will highlight the burden of AKI in our setting and possibly contribute to the review of the management of patients with severe burns. There are no protocols for the assessment of AKI among patients with severe burns at Mulago National Referral Hospital. Furthermore, results from our study may inform further research such as interventions in the management of severely burned patients.

1.4 General Objective
To determine the incidence and risk factors of acute kidney injury among patients with severe burns admitted in the burns unit at Mulago National Referral Hospital.
1.4.1 Specific Objectives
1. To determine the incidence of acute kidney injury among patients with severe burns admitted in the burns unit at Mulago National Referral Hospital
2. To identify the risk factors of AKI among patients with severe burns admitted in the burns unit at Mulago National Referral Hospital

1.5 Research Questions
1. What is the incidence of AKI among patients with severe burns admitted in the burns unit at Mulago National Referral Hospital?
2. What are the risk factors for development of AKI among patients with severe burns admitted in the burns unit at Mulago National Referral Hospital?
1.6 Concept Map
The concept map outlines risk factors for development of AKI and possible outcomes due to development of AKI.

Figure 1: The concept map showing risk factors and consequences due to development of AKI.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction
Severe burns in adolescents are usually due to flammable liquids while in toddlers and adults usually suffer scalds from hot liquids. Other less common causes of burns include chemicals, electricity, cold and radiation.

2.2 Classification of Burns
Burns are classified according to total body surface area (TBSA) of burnt skin, depth of the burns, presence of inhalation injuries, type of the burn, involvement of extremities, circumferential burns as well as perineal burns (Sabry, 2013). Total body surface area burned is widely assessed using the Lund and Browder chart and sometimes with Wallace’s rule of nines. The American Burns classification grades burns as minor, moderate and major burns.

- Minor burns refer to partial thickness burns less than 10% and 5% in adults and children respectively or less than 2% full thickness burns.
- Moderate burns refers to 10-20% TBSA burnt (partial thickness) and 5-10% partial thickness burns in children or 2-5% full thickness burns.
- Major burns refers to partial thickness burns involving greater or equal to 20% total body surface area in an adult or 10% in a child, full thickness burns of 10% TBSA in adults or 5% in a child or any percentage skin burns with associated inhalation or high voltage electrical burns. There exist various methods of assessing the burned surface area. Of these the commonly used is the Wallace rule of nines and the Lund Browder Chart.

Burns are also classified according to depth.

- Superficial or first degree burns are those that involve only the epidermis. They are warm, painful, red, soft, blanch when touched and usually have no blistering.
- Partial thickness or second degree burns involve epidermis and dermis. They are painful, red, blistered, moist, soft and blanch when touched.
- Full thickness or third degree burns involve all layers of skin; epidermis, dermis, hypodermis. There is little to no pain, can be white or charred and feel firm and leathery with no blanching.
Fourth degree burns have exposure of underlying tissues like muscles, tendons and bone (Sabry, 2013).

2.3 Physiological Changes in Burns
Burns typically cause local tissue damage resulting in coagulative necrosis of the skin and subcutaneous tissue. Necrosis is considered to be due to release of several vaso-active peptides such as histamine, nitric oxide, thromboxane A\textsubscript{2} that induce localized vasodilatation with increased capillary permeability at the burnt area. Local injury patterns follow the Jackson’s burn zones: zone of coagulation, zone of stasis and zone of hyperemia (Shehan Hettiaratchy, 2004). Burns greater than 25% TBSA result in alteration in physiological function in areas remote to the burnt site with resultant systemic responses (Audra Clark, 2017). There is mass release of inflammatory mediators like histamine, bradykinin, vasoactive amines, prostaglandins, leukotrienes and catecholamines leading to vasodilatation, increased capillary permeability then edema locally and in distant organs. The resultant fluid loss can result in severe hypovolemia. Severe hypovolemia starts a cascade of hypovolemic shock and multiple organ failure if early resuscitative intervention is not instituted (Hoste, 2008). In addition, the circulating cytokines and inflammatory mediators such as histamine released from the damaged tissue induce various changes in the organ-system of the body resulting in a defective immune response, initiation of a hyper-metabolic state and respiratory distress (Audra Clark, 2017).

2.4 Resuscitation Guidelines and Effects of Fluid Resuscitation on Renal Physiology
The primary effect of the burns occurs because of massive fluid losses (N. Brusselaers, Monstrey, S, Colpaert, K, Decruyenaere, J, Blot, 2010). The immediate resuscitation goal is to replenish fluid through aggressive fluid resuscitation. The most commonly used protocol for fluid resuscitation is the Parkland’s formula. This is the most used fluid resuscitation formula, being used in up to 78% of burns units in USA and the only resuscitation formula used in Mulago Hospital. Other resuscitation formulas include Modified parkland formula, Brooke formula and modified Brooke formula. However, effective monitoring using a fluid balance chart is critical with Urine output (UOP) target of 0.5 to 1.0 ml/kg/hour being optimum (Audra Clark, 2017). Parkland formula derives fluid required in the first 24 hours following burns. It is obtained as a product of TBSA, body weight multiplied by four. The first half is given in the first 8 hours while the remainder in the subsequent 16 hours (Mosier, 2010).
There is growing evidence that patients with major burns receive far more fluid than they require this being in excess of the volume recommended by the Parkland formula. This often predisposes them to complications such as acute respiratory distress syndrome (ARDS) and acute kidney injury (Chung K, 2009).

2.5 Acute Kidney Injury in Severe Burns
Acute kidney injury (AKI) is a well-known complication of severe burns and contributes to the increased mortality in this group. Patients with severe burns have a high incidence of AKI of 30% and a mortality rate of more than 80% (Tina Palmieri, 2009). AKI is divided into an early and late form depending on its time of onset. Early AKI develops within 0-2 days after injury and late AKI develops 3-14 days following the injury (Nguyen, 2002). Early AKI was associated with early multiple organ dysfunction and higher mortality risk (Leblanc, 1997). Early AKI in burned patients is typically due to hypovolemia and poor renal perfusion, direct cardiac suppression from TNF-alpha and precipitation of denatured proteins. Diminished blood volume and cardiac output result in decreased renal blood flow and Glomerular filtration rate. Other stress hormones and mediators like angiotensin, aldosterone and vasopressin further reduce renal blood flow. These result in tubular necrosis, oliguria and thus renal failure. Late burn AKI is often due to sepsis, multi-organ failure and nephrotoxic drugs like aminoglycosides and NSAIDs (Marc.G.Jesche, 1997).

2.6 Pathophysiology of Acute Kidney Injury in Patients with Severe Burns
The general causes of Acute Kidney Injury can be grouped into three types:

- Pre-renal or functional AKI (inadequate perfusion) - Renal hypoperfusion is accompanied by increase in sodium reabsorption and subsequent decrease in urine sodium concentration (Urine sodium<20mEq/L) (Mahboob Rahman, 2012).
- Renal AKI (tubular, glomerular, or tubulo-interstitial damage) - Renal tubulopathies are accompanied by impaired sodium reabsorption and increased urinary sodium losses (urine sodium>40mEq/L) (Clarkson M R, 2004).  
- Post-renal AKI: This usually occurs due to obstruction distal to the kidneys. It can be bilateral. Causes of this include kidney stones, Benign Prostate Hyperplasia, neuropathies

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affecting bladder emptying, blood clots, malignancies like cancer of the prostate, cervix and colon (Mahboob Rahman, 2012). The most common types of AKI in clinical practice among patients with burns are pre-renal and renal (Mahboob Rahman, 2012). Post renal type is rare, often occurring when the burn patient also has renal calculi. Immediately after the burn, the patient suffers from extracellular dehydration, which presents clinically as severe hypotension (shock state) (Charlotte Horm, 2012).

In general, the clinical conditions in which AKI may occur after severe burns are as follows:

1. Hypovolemia during burn shock, which proceeds proportionally to the severity of the pathology. This hypovolemia is responsible in nearly all cases for pre-renal AKI as a result of inadequate resuscitation (Belba, 2012).

2. Presence of necrotic tissues after third- and fourth-degree electrical and chemical burns. This can cause AKI or acute tubular necrosis. In such patients there is evidence of myoglobinuria and haemoglobinuria in the first urinary portions. This condition is more serious if the patient is aged or presents concomitant diseases. Analogously, the same clinical situation appears in patients with deep necrotic avulsion or in burns combined with the crush syndrome (Better, 1990).

3. Septic period of the burn illness with or without bacteraemia; the presence of bacteraemia indicates that the clinical situation is aggravated as a result of systemic infection. If the condition develops unfavorably, the patient will suffer from endotoxaemia of septic shock, which may cause pre-renal or renal ARF. This last condition is subdivided into acute tubular necrosis and tubulo-interstitial nephropathy. Tubulo-interstitial nephropathy is usually due to hypersensitivity reaction to drugs, viral or atypical pathogens. The clinical picture is dominated by persistent hypotension due to the release of circulating toxin (D. Greenhalgh, 2017).

4. Inflammation and apoptosis play an important role in the pathogenesis of acute kidney injury. Acute tubular necrosis occurs due to inflammatory injury in the epithelial cell lining of renal tubules (D. Greenhalgh, 2017). The damaged cells are sloughed into the lumen of renal tubules where they create obstruction. The luminal obstruction creates a back pressure on the luminal side of the Glomerular and this decreases the net filtration rate as a tubuloglomerular feedback.
Acute tubular necrosis (ATN) occurs due to sepsis, radiocontrast dye, nephrotoxic drugs and rhabdomyolysis with myoglobinuric renal injury (Chung, 2009). Furthermore, major burn trauma patient differ from other intensive care trauma patients by experiencing an inflammatory response that is often more severe and lasts much longer compared with other trauma patients (Shehan Hettiaratchy, 2004).

Another factor that may contribute to AKI in a second stage after burn shock is that volume resuscitation leads to development of intra-abdominal hypertension and abdominal compartment syndrome (Belba, 2012).

2.7 Diagnosis
There are at least 35 definitions of AKI due to different diagnostic criteria. With the various definitions, the incidence estimates for AKI are quite variable from 1-25% among ICU patients and subsequent mortality rate estimates from 15% to 60% (konstantinos Makris, 2016). There are three standard diagnostic criteria for AKI most commonly used including Risk, Injury, Failure, Loss and End-stage (RIFLE), Acute Kidney Injury Network (AKIN) and Kidney Disease: Improving Global Outcome (KIDGO) (Talita Machado, 2013). Studies using different criteria often cite large difference in the incidence of AKI. For example, the studies of Coca et al and Steinvall et al cite incidences of 26.6% and 24.4% when using RIFLE compared with that of Lopes et al that cite an incidence of 35.7%. However, these differences cannot be explained by baseline characteristics, such as age and or total burned surface area (I. Steinvall, Bak, Z, Sjoberg, F, 2008).

Risk, Injury, Failure, Loss and End-stage (RIFLE) defines three grades of increasing severity of acute kidney injury (AKI) basing on the changes in serum Creatinine or urine output along with two outcome categories- Loss and End-stage kidney disease (Talita Machado, 2013). RIFLE criteria has been used in the burns population to correlate early Acute Kidney Injury, late Acute Kidney Injury and worst RIFLE score with hospital outcomes (Bagshaw, 2008). Early AKI was associated with early multiple organ dysfunction and higher mortality risk (konstantinos Makris, 2016). However, the RIFLE criteria has been criticized to have two major short comings. First, it depended directly on obtaining the baseline Creatinine for each patient yet even small changes in serum Creatinine may be associated with increased mortality. Second, there was no definition of which specific stage indicated patients who required renal replacement therapy (Talita Machado, 2013).
The AKIN criteria emerged from joint work of nephrologists and intensivists to make the RIFLE criteria more sensitive and reliable. AKIN criteria proposed a new definition by taking into account these minor changes in serum Creatinine and establishing a period of 48 hours to determine the change in Creatinine with no need to first correlate with a baseline value (Talita Machado, 2013). In burn patients, the serum Creatinine concentration may underestimate kidney function. Catabolism leading to loss of muscle mass may contribute to low serum concentrations of Creatinine. As the muscles are the source of Creatinine, less muscle mass will result in lower serum creatinine concentrations for the same glomerular filtration rate (Lameire, 2004). Secondly, the cornerstone in severe burn care therapy is large-volume resuscitation to compensate for the massive fluid losses and decreased effective circulating volume. This may lead to hemodilution, and to false low serum Creatinine concentrations that do not reflect true kidney function (Huang, 1996).

More recently the Kidney Disease: Improving Global Outcomes (KDIGO) acute kidney injury working group proposed changes to staging for AKI. It included changes to both RIFLE and AKIN criteria taking into account changes in serum Creatinine within 48 hours or decline in Glomerular filtration rate over 7 days (Talita Machado, 2013).

2.8 Clinical and Laboratory Diagnosis of Acute Kidney injury
Prompt evaluation of AKI is vital because it can often be reversed or attenuated through therapy directed at the underlying condition. Evaluation begins with careful review of the patient's history, previous medical records, physical examination, urinalysis, and available laboratory data. Routine urine chemical indices, calculation of the fractional excretion of sodium, and examination of the urine sediment are valuable in characterizing the cause of AKI (Anderson, 2004). If this evaluation fails to yield a diagnosis, further testing may be required to evaluate intravascular volume status or diagnose a systemic disorder or Glomerular cause of AKI. Response to therapeutic trials may also provide a diagnosis. However, if a diagnosis cannot be made with reasonable certainty through this evaluation, renal biopsy should be considered (Anderson, 2004).

Acute kidney injury is usually accompanied by Oliguria or Anuria. Polyuria may occur due to either reduced fluid reabsorption by damaged renal tubules or osmotic effect of accumulated metabolites. Nausea and vomiting, dehydration, confusion and features of fluid overload can also occur (Steven, 2007).
2.9 Severe Burns in Relation to other Organs

Acute Kidney Injury is often preceded by other organ dysfunctions or sepsis in majority of the patients with severe burns. Kidney injury is a feared complication of critical illness and is also often an early sign of multiple organ dysfunction, which complicates the care of critically ill patients(I. Steinvall, Bak,Z,Sjoberg,F, 2008). In modern burn care, in which most patients now survive early resuscitation, multiple organ failure is the major cause of death. In the largest database of patients with burn injuries, the American Burn Association burn registry, records of the cause of death, indicate that 49% of the non-survivors died of organ failure(Audra Clark, 2017).

Cardiovascular system: Capillary permeability is increased leading to loss of intravascular proteins and fluids into the interstitial compartment. Peripheral and splanchnic vasoconstriction also occurs. Myocardial contractility is decreased possibly due to TNF-α. These changes coupled with fluid loss from the burn wound result in hypotension and end organ hypoperfusion.

Bone Marrow: Macrophage production after burn decreases and this is related to spontaneous elaboration of negative regulators of myeloid growth. This effect is enhanced by presence of endotoxin and can be partially reversed with Granulocyte Colony Stimulating Factor (G-CSF) treatment or inhibition of prostaglandin E₂. Bone marrow G-CSF receptor expression decreases G-CSF increases. Neutrophil count increases initially but they are dysfunctional. Function of cytotoxic T-Cells is also impaired after burns making the patient susceptible to infection by fungi and viruses.

Gastrointestinal Tract: Mucosal atrophy occurs and there are changes in absorption and increased intestinal permeability. Atrophy of small bowel mucosa occurs within 12 hours of injury in proportion to the burn size and is related to increased epithelial cell death by apoptosis. The cytoskeleton of the mucosal brush border undergoes atrophic changes associated with vesiculation of microvilli and disruption of terminal web actin filaments. There is decreased uptake of glucose, amino acids and fatty acids. Intestinal blood flow is shown to reduce after burns in animal models.

Respiratory changes: Inflammatory mediators cause bronchoconstriction and in severe burns acute respiratory distress syndrome (ARDS) can occur.
In conclusion, AKI is also an important complication in burn patients as it is frequent and it is associated with mortality. Inflammation and volume overload play an important role in pathogenesis of AKI. After decades of care for burn patients, therefore, we definitely need good studies into optimal volume resuscitation strategy (Sabry, 2013).

**Management**
Largely supportive; Monitor fluid and electrolytes, optimize haemodynamic status, restrict oral potassium and sodium, identify and treat infection. Renal replacement therapy should be considered if hyperkalaemia is refractory to medical management, severe metabolic acidaemia, and progressive renal failure with Creatinine greater than 300 micromoles per liter and or rise in serum Creatinine of more than 100 micromoles per liter in a day, complications of uraemia like pericarditis and uremic encephalopathy. AKI as a result of pre-renal cause will often respond to fluid replacement and temporary withdrawal of drugs that adversely affect kidney function.

### 2.10 Risk factors for acute kidney injury
There are a number of socio-demographic and clinical factors that have been studied and found to be risk factors for AKI. A retrospective cohort study of 3471 participants done in the UK showed that hypertension, presence of proteinuria and being male were independent risk factors of AKI (Jain, McDonald, Nitsch, Tomlinson, & Thomas, 2017). In Uganda, 26.4% of the population are hypertensive hence the need to assess if hypertension is a risk factor for development of AKI in patients with severe burns (Guwatudde et al., 2015). Another prospective cohort study of 127 participants carried out in Sweden by Steinvall showed that proteinuria and being were significant risk factors for AKI (I. Steinvall, Bak, & Sjoberg, 2008). Proteinuria being one of the key indicators of glomerular and renal injury, it is important to assess if this factor is a risk to development of AKI. Degree of burns, TBSA of burns and old age have also been studied and found to be significant risk factors for AKI. A retrospective study of 225
participants by Wojciech showed that the elderly and extent of burns were risk factors for AKI (Witkowski et al., 2016). According to the Uganda demographics profile 2018, about 1.3 million people are above 60 years of age hence the need to assess for this factor in our population. In addition, inhalation burns have been studied and found to be risk factors for development of AKI. A meta-analysis and systematic review of 18 articles showed that inhalation burns, sepsis, age and total burn surface area were risk factors for development of AKI (Wu et al., 2017). In Uganda, there is no published literature to show influence of these factors on AKI.

Another studied and established risk factor for AKI in patients with severe burns is hypoalbuminemia. A systematic review and meta-analysis by Christian that included 43 studies showed evidence that low albumin levels were a risk factor for AKI and also a factor that led to subsequent death of these patients with AKI (Wiedermann, Wiedermann, & Joannidis, 2017). Comorbidities have also been found to risk factors for development of AKI. However, a systematic review by Olowu that included 41 studies with both adult and pediatric study participants from sub-Saharan Africa found no significant association between co-morbidities like hypertension and AKI and concluded that this may be more significant in the high income countries (Olowu et al., 2016). Another cross-sectional study of 374,286 adults carried out in China showed that these comorbidities were a risk factor for AKI with increasing age thus comorbidities will influence AKI with varying age of the participants (Wei et al., 2016).

The use of nephrotoxic drugs was also demonstrated to be a risk factor for AKI in a meta-analysis and systematic review that included 31 observational studies (Cartin-Ceba et al., 2012). Nephrotoxic drugs are widely used across the globe and in Uganda. Thus it is important to assess if this factor is a risk for development of AKI in severely burned patients in the Ugandan setting.
Education as a risk factor for AKI has widely been attached to knowledge and skills of the health workers to manage patients with AKI. In our study we assessed if education level of the patient would also have an influence to development of AKI (Ponce & Balbi, 2016). A systematic review that included 18 articles, concluded that timely initial treatment of the patients with burn injury in hospitals would reduce the occurrence of AKI and also time as a factor was considered in terms of period taken in intensive care unit as a risk factor for AKI and mortality in these patients (Wu et al., 2017). In our study we assessed if time from burn injury to admission in hospital would have an influence on development of AKI.

Elevated urea levels at admission have been found to be risk factors for development of AKI. A retrospective study of 152 patients admitted in intensive care unit (ICU) were assessed for AKI and its associated risk factors. This study showed that elevated urea levels at admission were independent predictors of AKI (Peres, Wandeur, & Matsuo, 2015). Another systematic review that included 18 studies also showed that baseline blood urea nitrogen was associated with development of AKI (Wu et al., 2017).
CHAPTER THREE: METHODS

3.1 Study Design
This was a prospective cohort study including patients with severe burns admitted in the burns unit at Mulago National Referral Hospital between February 2018 and May 2018. Study participants were followed up for 14 days or up to time of discharge or death.

3.2 Study site and Setting
This study was conducted in the Burns Unit of Mulago National Referral Hospital. This is the largest burns Unit in the country comprising of the Burns Intensive care unit (ICU) and a general ward. The unit has a 50 bed capacity on the general ward, as well as a 9 bed capacity in the ICU. From a review of ward records, the burns unit attends to close to a monthly admission of 40 patients. On average, 10 have severe burns a week. Patient recruitment, laboratory tests for diagnosis of AKI and assessment for its risk factors were carried out at the same site.

3.3 Study Population
Reference population: All burns patients admitted to tertiary hospitals in Uganda.
Target population: All patients with severe burns admitted to Mulago National Referral Hospital.
Accessible population: Patients with severe burns admitted to the burns unit of Mulago National Referral Hospital between February 2018 and May 2018.

3.3.0 Eligibility Criteria
3.3.1 Inclusion criteria
a. Adults with partial thickness burns greater or equal to 20% TBSA or full thickness burns equal or greater than 10% TBSA, children with partial thickness burns equal to or greater than 10% TBSA and full thickness burns equal to or greater than 5% TBSA presenting to the emergency unit within 14 days after the burn injury.
b. Presence of inhalation burns and high voltage electrical burns.
c. Patients who gave informed consent to participate in the study.

3.3.2 Exclusion criteria
a. Patients on Renal Replacement Therapy or dialysis.
b. Patients with a diagnosis of ESRD or AKI prior to injury.
3.4 SAMPLE SIZE ESTIMATION

We shall use the Kish-Leslie formula for objective one.

\[ N = \frac{4Z^2 \alpha^2 P (1-P)}{W^2} \]

Where; \( N \): The sample size required.
\( Z\alpha \): critical value at 95% confidence, 1.96.
\( P \): The estimated incidence of acute kidney injury among patients with severe burns
\( W \): The total width of confidence interval. Using precision at 5%, \( W = 0.05 \times 2 = 0.10 \).

3.4.1 Objective one

Using the study by Tina Palmieri incidence of AKI was 30%. The same Kish-Leslie formula was used to calculate the sample size.

\[ N = 215.04 = 216 \]

Sample size according to finite population

About 40 patients are admitted monthly in the Mulago burns unit. Therefore, \( =40 \times 4 \text{months} \)

\[ =160 \]

\[ = \frac{N}{1+N/\text{popn size}} \]

\[ = \frac{91}{1+91} \]

3.4.2 Objective two

Considering sex as a risk factor according to Witwoski W et al 2016 at p value <0.001.

Proportion of females with severe burns who developed AKI, \( p_1 = 64.2\% \)

Proportion of males with severe burns who developed AKI, \( p_2 = 44.9\% \)

Assuming there is no difference in the prevalence of burns according to sex, \( q_1 = q_2 = 0.5 \)

\[ N = \left\{ \frac{Z^2 \alpha}{2} P (1-P) \left( \frac{1}{q_1} + \frac{1}{q_2} \right) + Z^2 \alpha \sqrt{P_1 (1-P_1) (1/q_1) + P_2 (1+P_2) (1/q_2)} \right\}^2 \]

\[ P = p_1 q_1 + p_2 q_2 \]

\[ = 0.5455 \]

\[ N = 206.3 = 207 \]
3.5 Sampling Method
Patients with severe burns at the emergency unit of Mulago National Referral Hospital were sampled consecutively and assessed for eligibility.

3.6 STUDY VARIABLES
3.6.1 Outcome variables
Acute kidney Injury: The primary outcome in this study was acute kidney injury which was assessed according to the KIDGO criteria. Blood samples were taken by a venous puncture from the patients at admission using 5mL Kojak syringes to determine the baseline serum creatinine level using a Cobas 6000 analyzer. Measurements for serum creatinine were repeated at 48hours and 7 days and 14days. Acute kidney injury was diagnosed by 50% increase in serum Creatinine within 1 week or 0.03mgdl\(^{-1}\) (26.5 micromoles/L) increase within 48 hours.

The severity of acute kidney injury was staged as:

i) Stage 1-1.5-1.9 times the baseline serum Creatinine or urine output less than 0.5mL/kg/hr for 6-12 hours.

ii) Stage 2-2.9 times the baseline serum Creatinine or urine output less than 0.5mL/kg/hr for 12 hours or more.

iii) Stage 3 times the baseline or increase in serum Creatinine to 353.6 micromoles or more or initiation of renal replacement therapy. In this stage, urine output is less than 0.3mL/kg/hr for equal to or greater than 24hours or anuria for more than 12hours.

3.6.2 Predictor variables
- Patient demographics: age, sex, duration to reach health facility from time of burns. These were determined from patient history at admission.
- Physical characteristics: weight in kilograms, height in meters. These were obtained from patient examination at admission.
- Characteristics of burns:
  - TBSA: The total body surface area of the participant was assessed using the Lund Browder Chart.
  - Degree of burns - Burn depth was assessed by examination of the patients whereby superficial or first degree burns were those that involved only the epidermis. They are warm, painful, red, soft, blanch when touched and usually have no blistering. Partial thickness or second degree burns were those that
involved both epidermis and dermis. They are painful, red, blistered, moist, soft and blanch when touched. Full thickness burns involve all layers of skin; epidermis, dermis, hypodermis which consists of subcutaneous tissue and fat. There is little to no pain, can be white or charred and feel firm and leathery with no blanching. Fourth degree burns have exposure of underlying tissues like muscles, tendons and bone.

- Presence of inhalation injuries: This was assessed from patient history and examination; history of burning in closed space, burns to face, hoarseness of voice, burnt nasal fibrisae and soot in sputum.
- Type of burn- The aetiology of burns was determined from history; flames, hot liquids, electricity, chemicals, mixed burns.
- Presence of co-morbidities: diabetes mellitus, hypertension, chronic kidney injury were assessed from patient history.
- Sepsis: Diagnosis for sepsis in burns patients were made after establishing the existence of infection. This was by documented clinical response to antibiotics and at least three of the following; fever>39°C or hypothermia<36.5°C, progressive tachycardia >110 beats/min, progressive tachypnoea >25/min, thrombocytopenia <100,000/microliter, hyperglycaemia in the absence of Diabetes Mellitus, inability to continue enteral feedings >24hrs.
- Multi organ dysfunction: Respiratory function was assessed by taking respiratory rate, level of consciousness determined using the Glasgow Coma Scale and blood pressure measured using Omron BP786 machine at admission, 48 hours, 7 days and 14 days after time of admission
- Laboratory indices: hemoglobin, haematocrit, white blood cell count was obtained from a Full hemogram done at admission, 48 hours, 72 hours, 7 days and 14 days post admission.
- Time of admission: The time was marked on the questionnaire. This was defined as the time of initial interface with the clinician, and this was time prior to the resuscitation process at the unit. The aim of this time was to establish baseline parameters that were compared to the subsequent measurements. The time does not reflect the start of the burn pathophysiological process or its effect and neither does it reflect prior intervention
process but merely gives a baseline start value that was used as a reference point to development of the AKI.

- Patient vital characteristics: Axillary temperature, pulse rate, respiratory rate and blood pressure were measured and recorded at admission and 48 hours, 7 days and 14 days after admission.
- Time between injury and admission was obtained from patient history
- History of prior resuscitation and volume of fluids used during resuscitation were obtained from the participants’ referral forms.

### 3.7 PROCEDURE

#### 3.7.1 Flow Chart

- **PATIENT RECRUITMENT**

  - **INITIAL CONTACT WITH PATIENT AT ADMISSION:** Initial readings
  - **SECOND CONTACT WITH PATIENT AT 48 HOURS:** second assessment for AKI and its risk factors; Age, sex, sepsis

- **Exclusion criteria:** patients on dialysis for renal failure

- **Patient has AKI on admission. Ward team informed but patient followed up as rest**

- **Patient has AKI at 48 hours. Ward team informed but patient followed up as rest at 7 days and 14 days**

- **CONTACT WITH PATIENT ON THE 14th DAY:** Final assessment for late AKI and risk factors
3.7.2 Screening
At admission, patients with burns were screened for eligibility. Screening for the degree of burns severity was done using the American Burns Association Burn severity classification. These are defined by the American Burns Association as partial thickness burns involving greater or equal to 20% total body surface area in an adult or 10% in a child, full thickness burns of 10% TBSA in adults or 5% in a child or any percentage skin burns with associated inhalation or high voltage electrical burns. The burns surface area was assessed using the Lund Browder chart. Burn depth was assessed by examination of the patients whereby superficial or first degree burns were those that involved only the epidermis. They are warm, painful, red, soft, blanch when touched and usually have no blistering. Partial thickness or second degree burns involve epidermis and dermis. They are painful, red, blistered, moist, soft and blanch when touched. Full thickness burns involve all layers of skin; epidermis, dermis, hypodermis. There is little to no pain, can be white or charred and feel firm and leathery with no blanching. Fourth degree burns have exposure of underlying tissues like muscles, tendons and bone. Patients above 12 years of age with partial thickness burns involving greater or equal to 20% TBSA or full thickness burns equal to or greater than 10% TBSA were recruited into the study. Patients 12 years and below with partial thickness burns equal to or greater than 10% TBSA or full thickness burns equal to or greater than 5% were recruited. Patients with inhalation burns were recruited into the study regardless of percentage of burns surface area. These were patients who had history of flame burns to the face, burning in closed spaces, had hoarseness of voice, burnt nasal fibrissae, soot on the palate, burnt lips, noisy breathing and altered phonation. Patients with high voltage electric burns were also recruited.

3.7.3 Enrollment:
Eligible participants were then undertaken through an informed consent process or assent after emergency management had been done. A baseline assessment was done using a pre-tested semi-structured questionnaire for the individual participants by a research assistant. History of Diabetes Mellitus, hypertension and use of nephrotoxic drugs were noted.
3.8 DATA MANAGEMENT

3:8:1 Data Collection

A semi structured questionnaire was used for data collection. This was done at admission, 48 hours, 7 days and 14 days post admission. For the Independent Variables, Demographic data was collected at admission. The age of the patient, sex, height, weight, source of burns, the total body surface area burnt, presence of inhalation burns and duration in hours since burn took place and prior resuscitation were documented. The patient’s vitals including the temperature, pulse rate, respiratory rate and blood pressure were measured and recorded whenever they were assessed for AKI; that is, at admission, 48 hours, 7 days and 14 days post admission. Serum Creatinine and urea were measured at admission and in the event that a patient was found to have AKI at admission, the ward team was informed. The patients were still followed up at 48 hours, 7 days and 14 days. During this follow up, the data capture form was used to record the Patients vital signs; that is the temperature, pulse rate, respiratory rate, blood pressure, level of consciousness. Serum creatinine was also measured and diagnosis of AKI made using KDIGO criteria; that is, patients who registered an increase in serum creatinine by 0.3mg/dl or more than or equal to 26.5 micromoles/L within 48hrs or increase in serum creatinine to more than or equal to 1.5 times the baseline which is presumed to have occurred within the prior 7 days were diagnosed with AKI. All patients with severe burns were assessed for sepsis at 48 hours, 7 days and 14 days from time of admission; Clinical response to antibiotics for those thought to have developed it was documented. Temperature, pulse rate and respiratory rate were determined and recorded. Complete blood count was done and thrombocytopenia <100,000/microliter noted. FBS was done and hyperglycemia in the absence of Diabetes Mellitus noted. Inability to continue enteral feedings for more than 24 hours was also documented. A diagnosis of sepsis was made after establishing the existence of infection; documented by clinical response to antibiotics and at least three of the following; fever>39°C, hypothermia<36.5°C, progressive tachycardia >110 beats/min, progressive tachypnoea >25/min, thrombocytopenia <100,000/microliter, hyperglycemia in the absence of Diabetes Mellitus, inability to continue enteral feedings for >24hrs. Nephrotoxic drugs administered to the patients were also recorded.
3.8.2 Quality Assurance

Two research assistants were recruited to assist in data collection. The research assistants were trained in the study procedures and use of data collection forms. The questionnaires were pre-tested and standardized before data collection. For each participant, a questionnaire and a copy of completed laboratory results forms were kept for cross referencing. Measurements such as SpO₂, weight, height and pulse rate were done using standard machines that were calibrated each day. Serum creatinine, urea, albumin and total protein were measured using the Abbott Architect plus ci4100 analyzer machine. The same brand of machines was used to minimize any bias associated with the devices, and secondly, only the trained staff took the measurements to eliminate operator bias. The equipment was calibrated each morning to ensure accurate readings. Data was cross-checked to ensure completeness and accuracy by the principal investigator at the end of each day. Data was also entered by double data entry.

3.8.3 The role of the Principal investigator

The principal investigator participated in the recruitment and training of research assistants in data collection and filling of the questionnaires. The principal investigator also participated in recruitment, consenting and physical examination of the study participants as well as collection of samples, taking of different measurements and filling of questionnaires during the study. The principal investigator also ensured that standard operating procedures were followed and participated in data management.

3.8.4 Data Analysis

Data was captured into the computer using EPI DATA version 3.1 and exported into Stata 13.0 for analysis. Descriptive statistics approach was done to summarize baseline data. Categorical data such as sex, sepsis was summarized as proportions while numerical variables such as age, weight, hemoglobin, white blood cell count was summarized as means and standard deviation or median and inter-quartile range depending on the distribution.

3.8.4.1 Objective 1

To determine the incidence of AKI among patients admitted with severe burns admitted in the burns unit at Mulago National Referral Hospital.
Incidence is expressed as:

\[
\text{Incidence of AKI in severe burns} = \frac{\text{New cases of AKI during follow up}}{\text{Total number of patients on the ward with severe burns followed up}}
\]

This was assessed using Poisson distribution. Kaplan Meier graph was used to estimate the median survival of patients with and without AKI.

### 3.8.4.2 Objective 2

To determine the risk factors of AKI in patients with severe burns admitted in the burns unit at Mulago National Referral Hospital. Bivariate analysis was done by fitting the Modified Poisson model for all the independent variables with AKI. Where presence of AKI was coded 1 and 0 was coded for absence of AKI. Variables with a P-value < 0.2 were considered for the multivariate model.

At multivariate analysis, first the assumption of no collinearity was assessed. Modified Poisson regression was used for multivariate analysis instead of logistic regression as earlier suggested in the proposal because the incidence obtained was more than 10% and this was considered not to be a rare outcome. Prevalence ratios were used instead of odds ratios estimated by logistic regression because odds ratios would overestimate the true prevalence. Variables from bivariate were run in the Modified Poisson regression model using the backward stepwise method and variables with P-values < 0.05 were retained in the model and assessed for interaction using the chunk test. The other variables which were dropped at backward stepwise analysis were assessed for confounding and they were considered to be confounders if the difference between the crude prevalence ratio and adjusted prevalence ratio was more than 10%. Variables with P-values <0.05 remained in the model and were considered to be significant risk factors for AKI.

### 3.9 Dissemination of Results

Results will be distributed to the:

- Department of surgery
- Albert cook library
- School of Medicine Research and Ethics Committee
- School of Graduate studies Makerere University
- Published journals
3.10 ETHICAL CONSIDERATIONS

Informed written consent was obtained from the participants; a translated consent form was availled to non-English speaking respondents. Assent was obtained from children between 8 and 17 years. If the children were below 8 years, written informed consent was obtained from the guardian. Confidentiality was observed through strict storage of data and no use of names. Ethical Approval was obtained from; Mulago Hospital Ethics Committee, Makerere University School of Medicine Ethics and Research committee.
CHAPTER FOUR: RESULTS
Between February 2018 and May 2018, a total of 147 patients were screened for severe burns at Mulago National Referral Hospital burns unit. Of the 147 patients screened, 92 met the inclusion criteria and were enrolled in the study as demonstrated by the flow chart below.

4.1 Patient flow chart:

Figure 3: Flow chart of patients with severe burns at Mulago National Referral Hospital between February 2018 and May 2018
4.1 Socio demographics and clinical characteristics of study participants

From February 2018 to May 2018, a total of 90 patients were consecutively enrolled in the study. Of these, 60 (66.7%) were 12 years and below, 48 (53.3%) of the participants were male, a large proportion of the participants 49 (57.0%) had not received any form of education, 45 (50%) of the participants had taken less than 22 hours to seek medical attention from time of burn injury, 4 (13.3%) were obese and 44 (48.9%) had a total burn surface area of greater than 18 as shown in table 1.

Among the participants, 9(10%) developed sepsis, 66 (73.4%) had scalds, 49 (54.5%) had mixed degree of burns, 24 (26.7%) had low urea levels, 59 (66.3%) of the participants had hypoalbuminemia, 6 (18.8%) of the 32 adults had high blood pressure while 16 (18.6) of the participants had inhalation burns as demonstrated in table 2.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Number (n=90)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age categorized at 12 years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12 years</td>
<td>60</td>
<td>66.7</td>
</tr>
<tr>
<td>13-75 years</td>
<td>30</td>
<td>33.3</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>48</td>
<td>53.3</td>
</tr>
<tr>
<td>Females</td>
<td>42</td>
<td>46.7</td>
</tr>
<tr>
<td><strong>Time from injury to admission in hrs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in hrs (categorized at median)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – 22</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>23 – 513</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td><strong>BMI (categorized at normal ranges in adults)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.0 – 29</td>
<td>26/30</td>
<td>86.7</td>
</tr>
<tr>
<td>30 - 35.3</td>
<td>4/30</td>
<td>13.3</td>
</tr>
<tr>
<td><strong>BMI percentile in children</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(categorized at median)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 - 66.5</td>
<td>24/48</td>
<td>50</td>
</tr>
<tr>
<td>66.6 - 96</td>
<td>24/48</td>
<td>50</td>
</tr>
<tr>
<td><strong>Burn surface area (categorized at median)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-17</td>
<td>46</td>
<td>51.1</td>
</tr>
<tr>
<td>18-71</td>
<td>44</td>
<td>48.9</td>
</tr>
</tbody>
</table>
Table 2: Clinical characteristics of study participants in Mulago National Referral Hospital

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number (n=90)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sepsis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>No</td>
<td>81</td>
<td>90</td>
</tr>
<tr>
<td><strong>Nature of burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame burns</td>
<td>19</td>
<td>21.1</td>
</tr>
<tr>
<td>Scalds</td>
<td>66</td>
<td>73.4</td>
</tr>
<tr>
<td>Chemical</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Electrical</td>
<td>3</td>
<td>3.3</td>
</tr>
<tr>
<td>Mixed burns</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td><strong>Degree of burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second degree</td>
<td>19</td>
<td>21.1</td>
</tr>
<tr>
<td>Third degree</td>
<td>21</td>
<td>23.3</td>
</tr>
<tr>
<td>Fourth degree</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Mixed degree</td>
<td>49</td>
<td>54.5</td>
</tr>
<tr>
<td><strong>Protein (cat at median)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.90 – 53.90</td>
<td>44</td>
<td>50.6</td>
</tr>
<tr>
<td>53.91 – 70.40</td>
<td>43</td>
<td>49.4</td>
</tr>
<tr>
<td><strong>Albumin (cat at normal ranges)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.2 - 34.9</td>
<td>59/89</td>
<td>66.3</td>
</tr>
<tr>
<td>35.0 - 44.2</td>
<td>30/89</td>
<td>33.7</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>26/32</td>
<td>81.2</td>
</tr>
<tr>
<td>Abnormal</td>
<td>6/32</td>
<td>18.8</td>
</tr>
<tr>
<td><strong>Inhalation burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>70/86</td>
<td>81.4</td>
</tr>
<tr>
<td>Yes</td>
<td>16/86</td>
<td>18.6</td>
</tr>
<tr>
<td><strong>Fluids before admission</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>55/72</td>
<td>76.4</td>
</tr>
<tr>
<td>Yes</td>
<td>17/72</td>
<td>23.6</td>
</tr>
</tbody>
</table>
4.2 Incidence of AKI

Among the 90 study participants enrolled in the study, 31 developed AKI resulting in an incidence of 34.4% (95% CI; 25.9 - 45.9; P <0.001) by the KDIGO criteria. Of the 31 patients with AKI, 11(35.5%) died within 14 days of follow up. With the Kaplan Meier survival graph, the median survival of patients with AKI was above 50%. At the beginning of the follow up, the survival of the patients drops on day one, but it latter becomes constant up to day 6 where the survival becomes poor up to day 10 but latter becomes constant up to day 14. From the graph, the survival of patients without AKI is constant throughout the follow up period as shown in figure 4. Out of the 31 patients with AKI, 18(58.1%) developed early AKI, 19(61.3%) were less than 18 years, 17(54.8%) were males, 29(93.5%) did not develop sepsis, 21(67.7%) had mixed degree burns, 20(64.5%) had scalds while 23(74.2%) had a total burn surface area of greater than 18 as shown in table 3.

![Kaplan-Meier survival estimates](image)

**Figure 4:** Kaplan Meier curves showing survival of patients with and without AKI at Mulago National Referral Hospital
Table 3: Socio demographic and clinical characteristics of study participants with AKI in Mulago National Referral Hospital, February 2018 to May 2018

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number (n=31)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age categorized at 17 years</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-17 years</td>
<td>19</td>
<td>61.3</td>
</tr>
<tr>
<td>18-75 years</td>
<td>12</td>
<td>38.7</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>17</td>
<td>54.8</td>
</tr>
<tr>
<td>Females</td>
<td>14</td>
<td>45.2</td>
</tr>
<tr>
<td><strong>Sepsis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>No</td>
<td>29</td>
<td>93.5</td>
</tr>
<tr>
<td><strong>Degree of burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second degree</td>
<td>2</td>
<td>6.5</td>
</tr>
<tr>
<td>Third degree</td>
<td>7</td>
<td>22.6</td>
</tr>
<tr>
<td>Fourth degree</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>Mixed degree</td>
<td>21</td>
<td>67.7</td>
</tr>
<tr>
<td><strong>Nature of burns</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame burns</td>
<td>6</td>
<td>19.4</td>
</tr>
<tr>
<td>Scalds</td>
<td>20</td>
<td>64.5</td>
</tr>
<tr>
<td>Chemical</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td>Electrical</td>
<td>3</td>
<td>9.7</td>
</tr>
<tr>
<td>Mixed burns</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>Burn surface area (cat at median)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-17</td>
<td>8</td>
<td>25.8</td>
</tr>
<tr>
<td>18-71</td>
<td>23</td>
<td>74.2</td>
</tr>
<tr>
<td><strong>Stages of AKI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>14</td>
<td>45.2</td>
</tr>
<tr>
<td>Stage 2</td>
<td>16</td>
<td>51.6</td>
</tr>
<tr>
<td>Stage 3</td>
<td>1</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>AKI type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>18</td>
<td>58.1</td>
</tr>
<tr>
<td>Late</td>
<td>13</td>
<td>41.9</td>
</tr>
</tbody>
</table>
4.3 Socio demographic characteristics as risk factors for AKI

The development of AKI was similar among males and females. It was also similar regardless of the age of the patient. Time from injury to admission did not have any significance with development of AKI. Education level, BMI percentile in children and total burn surface area had p-values less than 0.2 and were included for multivariate analysis. Table 4 shows the association of the demographics with AKI.

Table 4: Bivariate analysis of association between socio demographic characteristics and AKI in Mulago National Referral Hospital

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prevalence ratio (PR)</th>
<th>95% CI</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (categorized at 12)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-12 years (60)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13-75 years (30)</td>
<td>1.26</td>
<td>0.71 to 2.25</td>
<td>0.428</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males (48)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Females (42)</td>
<td>0.94</td>
<td>0.53 to 1.68</td>
<td>0.837</td>
</tr>
<tr>
<td>Time from injury to admission in hrs (categorized at median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 – 22 (45)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23 – 513 (45)</td>
<td>0.92</td>
<td>0.51 to 1.65</td>
<td>0.768</td>
</tr>
<tr>
<td>BMI (categorized at normal ranges in adults)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.0 - 29 (26)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 - 35.3 (6)</td>
<td>0.79</td>
<td>0.15 to 4.28</td>
<td>0.782</td>
</tr>
<tr>
<td>Burn surface area (categorized at median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-17 (46)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-71 (44)</td>
<td>3.01</td>
<td>1.50 to 6.02</td>
<td>0.002</td>
</tr>
</tbody>
</table>
4.4 Patient clinical characteristics and AKI

The development of AKI was similar in patients with sepsis and those without. Fluid administration prior to admission was also not a predictor of AKI and therefore not included for multivariate analysis. Nature of burns, burns degree, protein, albumin, blood pressure and inhalation burns had p-values less than 0.2 and were included in multivariate analysis. This is demonstrated in table 5 below.
### Table 5: Bivariate analysis of association between clinical characteristics and AKI in Mulago National Referral Hospital

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prevalence ratio (PR)</th>
<th>95% CI</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sepsis</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (81)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (9)</td>
<td>0.62</td>
<td>0.18 to 2.19</td>
<td>0.459</td>
</tr>
<tr>
<td><strong>Nature of burns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flame burns (19)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Scalds (66)</td>
<td>0.96</td>
<td>0.49 to 2.05</td>
<td>0.915</td>
</tr>
<tr>
<td>Chemical (1)</td>
<td>3.17</td>
<td>1.63 to 6.16</td>
<td>0.001</td>
</tr>
<tr>
<td>Electrical (3)</td>
<td>3.17</td>
<td>1.63 to 6.16</td>
<td>0.001</td>
</tr>
<tr>
<td>Mixed burns (1)</td>
<td>3.17</td>
<td>1.63 to 6.16</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Degree of burns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second degree (19)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third degree (21)</td>
<td>3.17</td>
<td>0.74 to 13.52</td>
<td>0.120</td>
</tr>
<tr>
<td>Fourth degree (1)</td>
<td>9.49</td>
<td>2.54 to 35.50</td>
<td>0.001</td>
</tr>
<tr>
<td>Mixed degree (49)</td>
<td>4.07</td>
<td>1.05 to 15.83</td>
<td>0.043</td>
</tr>
<tr>
<td><strong>Protein (cat at median)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38.90 – 53.90 (44)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53.91 – 70.40 (43)</td>
<td>0.59</td>
<td>0.32 to 1.09</td>
<td>0.096</td>
</tr>
<tr>
<td><strong>Albumin (cat at normal ranges)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.2 - 34.9 (59)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0 - 44.2 (30)</td>
<td>0.47</td>
<td>0.22 to 1.03</td>
<td>0.059</td>
</tr>
<tr>
<td><strong>Blood pressure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal (6)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (26)</td>
<td>0.52</td>
<td>0.24 to 1.14</td>
<td>0.102</td>
</tr>
<tr>
<td><strong>Fluid administered</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (55)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (17)</td>
<td>1.14</td>
<td>0.53 to 2.44</td>
<td>0.734</td>
</tr>
<tr>
<td><strong>Inhalation burns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No (70)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes (16)</td>
<td>1.59</td>
<td>0.87 to 2.91</td>
<td>0.131</td>
</tr>
</tbody>
</table>
4.5 Multivariate analysis of the factors associated with AKI

At multivariate analysis, all the factors with p-values less than 0.2 were included in the analysis. From the analysis none of the factors was found to have interaction with the predictor variables however blood pressure was found to have a confounding effect on inhalation burns and hypoalbuminemia. Total burn surface area of more than 18% PR 3.07 (95% CI; 1.42 to 6.60 P= 0.004) was found to be an independent risk factor for AKI. Hypoalbuminemia PR 0.23 (95% CI; 0.08 to 0.65 P= 0.006) and inhalation burns PR 3.36 (95% CI; 1.69 to 6.72 P= 0.001), were found to be significant risk factors for AKI in the presence of hypertension. Risk factors for AKI are summarized in table 6.
Table 6: Multivariate analysis of significant risk factors for AKI in Mulago National Referral Hospital, February 2018 to May 2018

<table>
<thead>
<tr>
<th>Variable</th>
<th>Prevalence ratio (PR)</th>
<th>95% CI</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Burn surface area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(categorized at median)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7-17</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-71</td>
<td>3.07</td>
<td>1.42 to 6.60</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>Albumin (cat at normal ranges)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.2 - 34.9</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35.0 - 44.2</td>
<td>0.23</td>
<td>0.08 to 0.65</td>
<td>0.006</td>
</tr>
<tr>
<td><em>Blood pressure</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>1.02</td>
<td>0.47 to 2.24</td>
<td>0.952</td>
</tr>
<tr>
<td><strong>Inhalation burns</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>3.36</td>
<td>1.69 to 6.72</td>
<td>0.001</td>
</tr>
</tbody>
</table>

**Key** *confounder*
CHAPTER FIVE: DISCUSSION

5.1 Incidence of acute kidney injury (AKI)

The incidence of acute kidney injury (AKI) among patients with severe burns in Mulago National Referral Hospital was found to be 34.4% and 95% CI; 25.9 to 45.9. This incidence is similar to that of 34.9% got from a systematic review carried out in 2010 that looked at AKI among patients with severe burns (N. Brusselaers et al., 2010). In 2013, a meta-analysis that looked at the world incidence of AKI in both children and adults found the incidence of AKI to be 33.7 in children and in current study, 68% of the study participants were children (Susantitaphong et al., 2013). Another study carried out in Chicago found the incidence of AKI to vary between 26 to 49% depending on a number of factors, in the current study the incidence of AKI is within the range found in similar studies (Sánchez-Sánchez et al., 2016). The mortality of patients with AKI was 32.3%. This percentage is lower than 42% which was reported by a study that assessed mortality among patients with AKI. However, even findings from the previous study show mortality may differ depending on the method used to diagnose AKI (Sánchez-Sánchez et al., 2016).

5.2 Risk factors for AKI

Total burn surface area was one of the significant risk factors of AKI. Those with total burn surface area greater than 18% were 3 times more likely to develop AKI than those with a burn surface area of 17% and below. These results are consistent with findings of other studies that showed burn surface area as an independent predictor of AKI (Witkowski et al., 2016). A systematic review also showed evidence that burn surface area is a significant factor for development of AKI (Wu et al., 2017). Hypoalbuminemia was another significant risk factor for development of AKI in the presence of hypertension in our study. Those with low albumin levels
were at greater risk of developing AKI than those with normal albumin levels. These findings are similar to studies that have reported hypoalbuminemia as an independent predictor of AKI. In addition, findings from a systematic review and meta-analysis established a causal relationship between AKI and low albumin levels (Wiedermann et al., 2017).

Inhalation burns were found to be another risk factor for AKI in the presence of hypertension in the study. Patients who had inhalation burns were 3.4 times more likely to develop AKI compared to those without inhalation burns. These findings in our study are similar to what others have found. A study showed that inhalation injury was a risk factor for development of AKI (I. Steinvall et al., 2008). Another systematic review and meta-analysis also produced evidence that inhalation injury was a risk factor for AKI (Wu et al., 2017). Elevated blood pressure was found to confound the relationship between AKI and the significant variables. Elevated blood pressure can be due to inhalation burns or hypoalbuminemia. Therefore, in our findings, we cannot state that elevated blood pressure was found to be a significant risk factor for AKI but rather a confounder. Other studies have found elevated blood pressure (BP) to be a risk factor for AKI (Jain et al., 2017). However, our findings were that only 6 adults had elevated BP. Majority of the participants were below 18 years so we didn’t have enough numbers to assess this factor. Age was not found to be a risk factor for AKI in our study yet other studies have found it to be a risk factor for AKI (Witkowski et al., 2016). This could be because patients with extremes of age especially above 60 years were the ones at greatest risk of AKI. In this study only 2 of the patients had age above 60 years and patients were enrolled consecutively as they came to the hospital during the study period of February to May 2018. Sepsis has also been known to be associated with AKI and in our study, we didn’t find it to be an independent predictor of AKI. This is consistent with other studies that have found sepsis as a late
complication of AKI but not a risk factor to development of AKI (Palmieri, Lavrentieva, & Greenhalgh, 2009).

Female sex, obesity and proteinuria have also been found to be risk factors for AKI (Jain et al., 2017). In our study these were not found to be significant risk factor since majority of our participants were male and only 5 out of the 90 patients were obese. Since we had majority of the participants with BMI that was within normal range, we did not find obesity to be a risk factor for AKI. In addition, all except one of our study participants had normal protein levels. Therefore, proteinuria was not observed in our study hence we found it not to be a risk factor. Elevated urea levels have been found to be risk factors for AKI (Peres et al., 2015) yet in our study we did not find urea to be a risk factor for AKI. This could be because in our study, among all the participants none had urea values above the normal range. Thus this factor was not a significant risk factor for AKI in our setting. Duration from injury to admission in hospital was not a risk factor for development of AKI. This is consistent with studies that equally did not find this as a risk factor. A meta-analysis and systematic review showed that time of stay in ICU was rather a risk factor for AKI and subsequent mortality (Wu et al., 2017). Studies have found early fluid administration to decrease the incidence of AKI. In our study we did not find fluid resuscitation prior to admission to be a risk factor for AKI. The volume of fluid administered within 48 hours was also not found to be a risk factor for AKI. This could imply that patients were well resuscitated according to the severity of the burns. However some studies have demonstrated that inadequate fluid resuscitation in severe burns is a risk factor for AKI. Additionally in our study only 11 (12.2%) of the 90 patients with severe burns were not adequately resuscitated within 48 hours. The non-significance of this factor could be attached to
early patient management which Schneider associated to reduced incidence of AKI (Schneider et al., 2012).

5.3 Limitations of the study

1. The study population had a short period for recruitment of participants thus the sample size had to be reduced to suit the study period but this was dealt with by consecutive recruitment of almost all patients as they came in. This improved the internal validity of the study.

2. Serum Creatinine can be elevated in absence of AKI there for this creates a measurement bias in the outcome however the obtained incidence was within the range of the known incidence by other studies and the minimum change in serum Creatinine required to make diagnosis of AKI was considered too large.

3. Serum Creatinine and Urine output can be normal in presence of significant AKI. Over 60-75% of nephrones must be lost before decline in renal function is manifested. This also created a measurement bias.

4. Single Centre study limits external validity because disease behavior varies and these results may not be generalizable.
CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS
The incidence and mortality due to AKI was found to be high among patients with severe burns as assessed by the KDIGO criteria. These patients also had a low probability survival. Total burn surface area was the only independent risk factor for AKI. Inhalation burns and hypoalbuminemia were risk factors for development of AKI only in the presence of hypertension. Age, sex, obesity, urea levels, fluid resuscitation, protein levels, chronic illnesses, use of nephrotoxic drugs, sepsis, degree and nature of burns were not found to be risk factors for AKI.

6.2 RECOMMENDATIONS
With the high incidence and mortality due to AKI, clinicians should actively look out for the development of AKI in severely burned patients so that treatment is instituted early. This cannot be emphasized enough for patients with inhalation burns, burn surface area greater than 18% and those with low albumin levels whom the study found to be at particular risk for developing AKI. Also since the incidence is within what other studies have found, serum creatinine levels alone can be used to make diagnosis of AKI. Uganda being a resource limited setting, this method is affordable and less tedious than monitoring of hourly urine output. However we recommend another study using both creatinine and hourly urine output in the diagnosis of AKI since the KDIGO criteria uses both parameters for comparison with our findings. We also recommend further studies assessing for risk factors of AKI while controlling for hypertension as a potential confounder.
REFERENCES

Hoste, E., Schurgers, Marie, M. D. (2008). Epidemiology of acute kidney injury; how big is the problem? Critical Care Medicine, 130-144.


Appendix 1: QUESTIONNIARE

Title: INCIDENCE AND RISK FACTORS OF ACUTE KIDNEY INJURY IN SEVERELY BURNED PATIENTS IN MULAGO HOSPITAL

Quality control ID No.

Date of Evaluation _______________

SECTION A: Demographics

1. Initials ____________________________

2. Age in year’s __________________ DOB _____________

3. Sex 
   1=Female   □   2=Male   □

4. Height: (in cm) ________________

5. Weight (Kg) _________________

6. Level of Education:


SECTION B: INITIAL EVALUATION:

1. Date of injury _______________________ Time of injury _____________ (HRS)

2. Date of arrival _____________________ Time of arrival ____________ (HRS)

3. FLUID ADMINISTRATION PRIOR TO ADMISSION (BY REFERRING CENTER)

   Fluid volume administered (in milliliters)
   _______________________________________________________________________

4. BURN SURFACE AREA (USING LUND AND BROWDER CHART) IN PERCENTAGE OF TOTAL BODY SURFACE AREA: ____________________________

5. DEGREE OF BURNS:

   2nd degree burns   □
   3rd degree burns   □
   4th degree burns   □
Mixed burns  
6. Presence of inhalation burns:   Yes  No  

Any two of these:  
Is the face burnt?  
Presence of soot on palate  
Lips burnt  
Nasal hair is burnt  
Noisy breathing  
Altered vocal phonation  
Smoke exposure in a closed room  
7. Nature or agent causing the burns  
1. Flame burns  
2. Scalds  
3. Chemical  
4. Electrical  
5. Mixed  
8. If Electrical:  

Are burns; 1. High voltage Low voltage  
9. GCS on arrival E  V  M  

Total score: _________________________  
10. Initial vitals  

<table>
<thead>
<tr>
<th>Time</th>
<th>BP</th>
<th>PR</th>
<th>RR</th>
<th>Temp</th>
</tr>
</thead>
</table>

11. Initial serum creatinine level (µmol/litre)  

| 1st reading |  |
| 2nd reading |  |
12. Are serum creatinine levels high?
   Yes  ☐  No  ☐

13. Has intervention been instituted?
   Yes  ☐  No  ☐

14. Results of blood investigations taken off at admission:

<table>
<thead>
<tr>
<th>Investigation</th>
<th>Specific parameter</th>
<th>values</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFT</td>
<td>Total protein</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Serum albumin</td>
<td></td>
</tr>
<tr>
<td>RFT</td>
<td>Urea</td>
<td></td>
</tr>
</tbody>
</table>

15. Prescribed choice of fluid resuscitation;
   1. Parkland formula  ☐
   2. Brooke formula    ☐
   3. Other (specify)   ☐
   4. No formula used   ☐

16. Does the patient have any known chronic illnesses?
   Yes  ☐  No  ☐

If yes, specify…………………………………………………………………………………………

17. Is the patient taking any potentially nephrotoxic drugs?
   Yes  ☐  No  ☐

If yes, which drugs...(list of drugs associated with nephrotoxicity at the back of questionnaire)

**SECTION C: TO BE FILLED 48 HOURS FOLLOWING ADMISSION:**

18. Is the patient alive?
   Yes  ☐  No  ☐

If yes, proceed to fill questionnaire.

19. Did the patient have AKI at admission?
   Yes  ☐  No  ☐
20. Vital signs:

<table>
<thead>
<tr>
<th>Time (48 hrs from admission)</th>
<th>BP</th>
<th>PR</th>
<th>RR</th>
<th>Temp</th>
<th>SPO₂</th>
</tr>
</thead>
</table>

21. Serum creatinine levels at 48 hours (µmol/litre)

| 1ˢᵗ reading |  |
| 2ⁿᵈ reading |  |
| 3ʳᵈ reading |  |
| Average reading |  |

22. Difference between serum creatinine at 48 hours and the admission:

23. 48 hours fluid balance (millimeters)

<table>
<thead>
<tr>
<th>INPUT(IV)</th>
<th>INPUT(NGT)</th>
<th>URINE OUTPUT</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1ˢᵗ 24 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2ⁿᵈ 24 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total at 48 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

24. Blood results at 48 hours

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>SPECIFIC PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFT</td>
<td>Total protein</td>
</tr>
<tr>
<td></td>
<td>Serum albumin</td>
</tr>
<tr>
<td>RFT</td>
<td>Urea</td>
</tr>
</tbody>
</table>

25. Results of urinalysis using urine dipstick at 48 hours post admission.

LEVEL OF ORGAN FUNCTION AT 48 HOURS

26. Level of consciousness:

GCS:  E  V  M
27. Cardiovascular function:

<table>
<thead>
<tr>
<th>Mean arterial pressure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction:  

Yes [ ] No [ ]

28. Respiratory function:

<table>
<thead>
<tr>
<th>Respiratory rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPO\textsubscript{2}&lt;90%</td>
<td></td>
</tr>
<tr>
<td>Patient needs ventilator support</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction:  

Yes [ ] No [ ]

SECTION D: ASSESSED ON DAY SEVEN SINCE ADMISSION;

29. Is the patient alive?

Yes [ ] No [ ]

30. If dead,

When did the death occur?: (hours since admission) and what was the cause of death?

__________________________________________________

31. If Alive;

Is the patient in ICU [ ] Discharged to ward? [ ]

32. Blood results on seventh day

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>SPECIFIC PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFT</td>
<td>Total protein</td>
</tr>
<tr>
<td></td>
<td>Serum albumin</td>
</tr>
<tr>
<td>RFT</td>
<td>Urea</td>
</tr>
<tr>
<td></td>
<td>Creatinine</td>
</tr>
</tbody>
</table>

LEVEL OF ORGAN FUNCTION ON SEVENTH DAY

33. Level of consciousness:

GCS: E [ ] V [ ] M [ ]

IS THERE dysfunction (compare to Admission and previous GCS)

Yes [ ] No [ ]
34. Cardiovascular function:

<table>
<thead>
<tr>
<th>Mean arterial Pressure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction: [ ] Yes [ ] No [ ]

35. Respiratory function:

<table>
<thead>
<tr>
<th>Respiratory rate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SPO$_2&lt;$90%</td>
<td></td>
</tr>
<tr>
<td>Patient needs ventilator support</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction: [ ] Yes [ ] No [ ]

**SECTION E: ASSESSED AT DAY FOURTEEN FROM ADMISSION**

36. Is the patient alive?

[ ] Yes [ ] No

37. If dead,

When did the death occur; (hours since admission) and what was the cause of death?

______________________________________________

38. If Alive;

Is the patient in ICU [ ] Discharged to ward? [ ]

39. Blood results on seventh day

<table>
<thead>
<tr>
<th>INVESTIGATION</th>
<th>SPECIFIC PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFT</td>
<td>Total protein</td>
</tr>
<tr>
<td></td>
<td>Serum albumin</td>
</tr>
<tr>
<td>RFT</td>
<td>Urea</td>
</tr>
<tr>
<td></td>
<td>Creatinine</td>
</tr>
</tbody>
</table>

**LEVEL OF ORGAN FUNCTION ON SEVENTH DAY**

40. Level of consciousness:

GCS: [ ] E [ ] V [ ] M [ ]

IS THERE dysfunction (compare to Admission and previous GCS)

[ ] Yes [ ] No
41. Cardiovascular function:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean arterial Pressure</td>
<td></td>
</tr>
<tr>
<td>Heart rate</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction:  
Yes ☐  No ☐

42. Respiratory function:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory rate</td>
<td></td>
</tr>
<tr>
<td>SPO$_2$$&lt;90%$</td>
<td></td>
</tr>
<tr>
<td>Patient needs ventilator support</td>
<td></td>
</tr>
</tbody>
</table>

Is there dysfunction:  
Yes ☐  No ☐
LIST OF DRUGS ASSOCIATED WITH NEPHROTOXICITY

1. ANALGESICS
   Acetaminophen
   NSAIDs like diclofenac, ibuprofen

2. Antidepressants /mood stabilisers
   Amitriptyline
   Doxepin
   Fluoxetine
   Lithium

3. Antihistamines
   Diphenhydramine
   Doxylamine

4. Antimicrobials
   Aminoglycosides e.g gentamicin
   Amphotericin B
   Betalactam antibiotics e.g penicillins, cephalosporins
   Quinolones
   Rifampin
   Sulfonamides
   Vancomycin
   Antivirals e.g Aciclovir, Foscavir
   Antiretrovirals e.g Adefovir, cidofovir, indinavir,

5. Benzodiazepines

6. Calcineurin inhibitors e.g cyclosporine, tacrolimus

7. Cardiovascular agents
   ACE inhibitors
   Clopidogrel
   Ticlopidine
   Statins
8. Chemotherapeutics
   Camustine
   Semustine
   Cisplatin
   Interferon alfa
   Methotrexate
   Mitomycin-C

9. Contrast dye

10. Diuretics e.g lasix

11. Drugs of abuse e.g cocaine, heroine, methadone

12. Herbals e.g chinese herbs with aristocholic acid

13. Proton pump inhibitors e.g lansoprazole, omeprazole, pantoprazole

14. Others
   Allopurinol
   Gold therapy
   Haloperidol
   Pamidronate
   Phenytoin
   Quinine
   Zoledranate
Appendix 2: CONSENT FORM (ENGLISH)

TITLE: INCIDENCE AND RISK FACTORS OF ACUTE KIDNEY INJURY IN SEVERELY BURNED PATIENTS IN MULAGO HOSPITAL

Study ID………………………..

Principal Investigator: I am (representing) Dr. Wandabwa Joel, a graduate student at the Department of Surgery, College of Health Sciences Makerere University

Introduction

We would like to request you/ your patient to allow participate in a research study. Participation in this study is voluntary. If you or your child accepts to be part of this study, you will be requested to sign at the end of this page.

Purpose of the Research

This study seeks to find the number of patients with severe burns who develop acute kidney injury and the risk factors for development of Acute Kidney Injury in these patients.

Study procedures

If you/ your patient volunteer to participate in this study, we will ask you some questions about the patient, when the burns occurred and what was done prior to arrival to hospital . We shall also carry out a full body examination and assess for the degree and severity of the burns as well as take vital parameters such as temperature, respiratory rate, heart rate, blood pressure and then have samples taken off for some investigations. Blood will be taken off and initial serum Creatinine and Urea levels measured. We shall follow the patient up at 48 hours as well as at seven days after admission. We shall carry out the same assessment of Vital signs such as blood pressure in addition to measuring the serum Creatinine level and taking off blood samples for assessment of organ function.

Benefits of the study: The enrolled patients will be assessed for acute kidney injury. Those who will have developed these will be reported to the doctors treating the patients and as such receive timely intervention measures and hence avert the poor outcome associated with the Acute Kidney Injury. The findings from this study could help to improve patient care in patients with the same condition as your patient.
Risks: We do not anticipate any harm to you/your patient as a result of this study.

Statement of Confidentiality:

Any information you or your patient shares with us will not be shared with any unauthorized persons. Your name/patients name or anything that may identify you/your patient will not be published in the result of this study.

Costs for Participation:

You will not incur any extra cost when you participate in this study. You will still receive all the services as provided at Mulago National Referral Hospital.

Contact Information for Questions or Concerns

In case you still have further question regarding this study you may contact us through the following persons: Dr. Wandabwa Joel; Mobile: 0783988248 E-mail: wandkitjoel@gmail.com.
You may also contact the study supervisors Dr Rose Alenyo on 0772608026 or Dr Kalyesubula Robert 0772442700 or the chairperson of Makerere University School of Medicine ethical review board on 0772421190

Signature and Consent/Permission to be in the Research

I have been requested on behalf of myself/my patient to participate in the study. I have read and understood the above information. 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 myself or for my patient to participate in this study.

Name of participant ……………………………………………………………..

Signature/thumb print …………………………………Date. ……………………

Name of investigator signature……………………….. Date …………………….
Appendix 3: ASSENT FORM

TITLE: INCIDENCE AND RISK FACTORS OF ACUTE KIDNEY INJURY IN SEVERELY BURNED PATIENTS IN MULAGO HOSPITAL

Study ID……………………………..

Principal Investigator: Dr. Wandabwa Joel is a Post graduate student at Department of Surgery, College of Health Sciences Makerere University

Introduction

We would like to ask you to be part of our study. You are free to choose to join the study.

Purpose of the Research

This study will look at people who get burnt and get very bad injuries involving a quarter or more of their skin. We shall take off some blood samples for measuring the serum Creatinine and Urea levels which increase when the kidney is injured. This creatinine levels will be recorded and we shall see how many of the patients develop this high creatinine levels and how many die.

Study procedures

If you accept to join the study, we shall ask you some questions like what burnt you, when you were burnt, and also perform some check up on you like your blood pressure. We shall also take off some blood from you to test if your liver, kidneys are working well. We shall also measure the creatinine level thrice; first when you have just come to hospital, second two days later and third on your seventh day in Hospital.

Benefits of the study: When you join our study, and we check and find that the serum creatinine has increased, we shall inform the doctors and nurses on the ward, these will then treat you early and prevent your kidney and lungs from getting damaged and as a result you will improve earlier. We shall also use what we shall find to help treat other children like you who in the future will have been admitted due to burns.

Risks:

You will not get any injuries or side effects from the study.

Statement of Confidentiality: Your name or other personal information that you will give us will not be shared with anyone.

Costs for Participation: You will pay any extra money when you participate in this study. You will still receive all the services as provided at Mulago National Referral Hospital.
Contact Information for Questions or Concerns In case you still have further question regarding this study you may contact us through the following persons: Dr. Wandabwa Joel.Mobile:0783988248,E-mail:wandkitjoel@gmail.com. You may also contact the study supervisor Dr. Rose Alenyo on 0772608026 or the chairperson of Makerere University School of Medicine ethical review board.

Assent form

I have been requested to be part of above research study. I have been told all the tests that will be carried out on me. I am now aware that participation in this study is out of my own will. I have had the chance to ask questions and therefore have voluntarily agreed to participate in the study.

Name of child ..........................

Signature/thumb print .................. Date ..............................

Name of investigator ....................

Signature ................................. Date ..............................
Appendix 4: CONSENT FORM (TRANSLATED)

Study ID…………………………

Okukiriza okwenyigira mu kunonyereza Omutwe: Okukosebwa kw’esingo ne bizileteera okukosebwa mu balwadde abaaayi abawebwedwa ebitanda e Mulago oluvanyuma lw’okujibwa kw’omuliro.

Omunonyereza Omukulu: Dr Wandabwa Joel okuva mu kitongole ky’ebyobulamu eky’okulongosa Makerere Univasite.

Okwanjula

Tukusaba okukiriza omulwadde wo okwetaba mu kunonyereza kuno. Okwetaba mu kunonyereza kuno kwa kyeyagalire. Bw’okiriza omulwadde wo okwenyigira mu kunonyereza kuno, ojja kusabibwa oteeke ekinkumu ku nkomerero y’okulupapula lunno.

Ekigendererwa ky’okunonyereza kuno.

Okunonyereza kuno kulubirira okumannya obungi bwa obungi bw’ekirungo kya creatinine mu musaayi gwo n’ekikivilaako okweyongera ne kikivakko okuffa mu balwadde abaaayi abawebwedwa ebitanda e Mulago oluvanyuma lwokujibwa kwo muliro.

Ebinakolebwa mu kunonyereza /Entambula y’okunonyereza

Nga okiriza omulwadde wo okwetaba mu kunonyereza kuno, ojja kubuzibwa ebibuuzo ebikwata ku mulwadde neki ekya leeta omuliro, wwa we ma sokebwa okebelebwa, oluvanyuma tuuja kebera omubiri gwona wamu nokujako omsayi okwongela okwekebejja ebyomunda engeeri jebikolamu. Nga okwo kuliko n’okukebera ekirungo kya creatinine mu musaayi gwo. Nga wayiise essawa 48, tuuja kudamu tupime obuungi bw’ekirungo kya creatinine era tweyongele nokujaako omsayi okekebejja ebyomunda embela gebilimu. Oluvanyuma Iwe nnaku musanvu, tuuja kudamu tu kebele omsayi gwomulwadde okulabba enkola yebomunda mwomubili bwe billi.

Okuganyulwa mu kunonyereza

Singa omulwadde wo abba nga yiina pulesa eno eyo mulubuto, ejja bba nga ekwatiibwa nga bukyali ela nejanjabibwa.

Ebibi oba obutyabaga

Tetusuubira kibi eri omulwadde wo oba okurumizibwa, mpozi amasanyaraze eri mukunonyereza okwe bifananyi.
Okukiriza Kwa kyeyagalire: Okwetaba mu kunonyereza kuno kwa kyeyagalire. Osoobola okugaana okwenyigira mu kunonyereza, era nga kino tekijja kukossa bujjanjabi omulwadde wo bw’ayina okufuna mu ddwaliro ly’eMulago. **Okusasula mu kunonyereza** Gwe ne omulwadde wo temujja kusasuula sente yonna mu kunonyereza kuno. omulwadde wo kujjanjabibwa ku bwerere nga enkola y’eMulago.

**Okusasula mu kunonyereza:** Gwe n’omulwadde wo, temujja kusasula sente yonna mukunonyereza kuno. Omulwadde wo tumujjanjabira bwerere ng’enkola y’e Mulago bweri.

**Okubuuza ebibuuzo**

Osoobola okubuuza ebibuuzo byonna ku kunonyereza kuno ng’ontukirira ku ssimu yange, 0783988248-Dr Wandabwa Joel oba kumukuttu gwa E-mail: wandkitjoel@gmail.com. Osobola okutukirira abakulu bano singa oba oliina ebibuuzo oba okwemulugunya kwonna: Dr. Rose Aleny 0772608026, Dr Kalyesubula Robert 0772442700.

**Okukiriza n’okussako ekinkumu**


**Erinnya ly’alahirira omulwadde**

Erinnya ly’omulwadde

Erinnya ly’omulwadde

Anonyereza/akikiridde

Ekinkumu n’ennaku z’omwezi

Ekinkumu Ennaku z’omwezi

Ekinkumu Ennaku z’omwezi
Appendix 5: ASSENT FORM (TRANSLATED)

Study ID…………………………

Omulwade Okukiriza okwenyigira mu kunonyereza Omutwe: okukosebwa kw’ensigo ne biziviirako okwononeka mu balwadde abayı abawebwedwa ebitanda e Mulago oluvanyuma lwokujibwa kwo muliro.

Omunonyereza Omukulu: Dr. Wandabwa Joel okuva mu kitongole ky’ebiyobulamu eky’okulungosa Makerere Univasite.

Okwanjula
Tukusaba okukiriza omulwadde wo okwetaba mu kunonyereza kuno. Okwetaba mu kunonyereza kuno kwa kyeyagalire. Bw’okiriza omulwadde wo okwenyigira mu kunonyereza kuno, ojja kusabibwa oteeke ekinkumu ku nkomerero y’okulupapula lunno.

Ekigendererwa ky’okunonyereza kuno.

Omunonyereza kuno kulubirira okumannya okukosebwa kw’ensigo ne biziviirako okwononeka mu balwadde abayi abawebwedwa ebitanda e Mulago oluvanyuma lwokujibwa kwo muliro.

Ebinakolebwa mu kunonyereza /Entambula y’okunonyereza

Nga okiriza omulwadde wo okwetaba mu kunonyereza kuno, ojja kubuzibwa ebibuuze ebikwata ku mulwadde neki ekya leeta omuliro , wwa we mwasokebwa okebelebwa, oluvanyuma tuuja kukebera omubiri gwona wamu nokujuuko omusayi okwongela okwekebejja ebyomunda engeeri jebikolamu. Nga enbyo biweedde, tujja kujjako omusayi okumanya obungi bwe kirungo kya creatinine mu mubiri gwo. Nga wayiise essawa 48, tujja kudamu tupime obungi by’e kirungo kya creatinine n’okujaako omusayi okwekebejja ebyomunda embela gebilimu. Oluvanyuma lwe ennaku musanvu, tujja kudammo tujjeko omusayi tweyongelle okwekebejja embella ye byomunda mwolubutto bwelli.

Okuganyulwa mu kunonyereza

Singa omulwadde wo abba nga yiina creatinine mungi mu musayi gwe ajja kuba nga atwalibwa ajjanjabibwe nga bukyaali

Ebibi oba obutyabaga

Tetusuubira kibi eri omulwadde wo oba okurumizibwa , mpozi amasanyaraze eri mukunonyereza okwe bifenanyi.
Okukiriza Kwa kyeyagalire
Okwetaba mu kunonyereza kuno kwa kyeyagalire. Osoobola okugaana okwenyigira mu kunonyereza, era nga kino tekijja kukossa bujjanjabi omulwadde wo bw‘ayina okufuna mu ddwaliro ly’eMulago.

Okukuuma ebiva mu kunonyereza
Tewali bikwata ku omulwadde wo oba gwe ebinaweewba abantu abalala nga tokiriza. Erinnya omulwadde wo oba ebimukwatako tebijja kwassanguzibwa mu mpapula ezinakuuba ebiva mu kunonyereza kuno.

Okusasula mu kunonyereza
Gwe n’omulwadde wo temujja kusasuula sente yonna mu kunonyereza kuno. omulwadde wo kujjanjabibwa ku bwerere nga enkola y’eMulago.

Okubuuza ebibuuzo
Osoobola okubuuza ebibuuzo byonna ku kunonyereza kuno ng’ontukirira ku ssimu yange, 0783988248-Dr Wandabwa Joel oba kumukuttu gwa E-mail: wandkitjoel@gmail.com. Osobola okutukirira abakulu bano singa oba oliina ebibuuzo oba okwemulugunya kwonna: Dr. Rose Aleny 0772608026, Dr Kalyesubula Robert 0772442700.

Okukiriza n’okussako ekinkumu

Erinnya ly’omuzadde oba alina obuyinza ku mwaana Ekinkumu Ennaku z’omwezi
…………………………………………………………………………………………………..
Erinnya ly’omulwadde Ekinkumu Ennaku z’omwezi
…………………………………………………………………………………………………..
Anonyereza/akikiridde Ekinkumu Ennaku z’omwezi
…………………………………………………………………………………………………..
## Appendix 6: BUDGET

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>DESCRIPTION</th>
<th>COST PER UNIT</th>
<th>TOTAL COST (SHS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printing of proposal for presentation at the department</td>
<td>65 Pages</td>
<td>100</td>
<td>65,000</td>
</tr>
<tr>
<td>Printing application for IRB</td>
<td>65 Pages x 11Copies</td>
<td>100</td>
<td>71,500</td>
</tr>
<tr>
<td>Printing consent for form</td>
<td>8 Pages x 120 Copies</td>
<td>100</td>
<td>96,000</td>
</tr>
<tr>
<td>Printing of CV</td>
<td>8 Pages x 7 Pages</td>
<td>100</td>
<td>5,600</td>
</tr>
<tr>
<td>Printing questionnaire</td>
<td>120 Copies x 5</td>
<td>100</td>
<td>600,000</td>
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<tr>
<td>Research Assistance</td>
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<td>400,000</td>
</tr>
<tr>
<td>Pulse Oxymeter</td>
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<td>250,000</td>
<td>250,000</td>
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<tr>
<td>Blood Pressure machine</td>
<td>1</td>
<td>200,000</td>
<td>200,000</td>
</tr>
<tr>
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<td>80,000</td>
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<tr>
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<td>10 Boxes</td>
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<td>100,000</td>
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<tr>
<td>Box Files</td>
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<td>100,000</td>
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<tr>
<td>Urine Dip Sticks</td>
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</tr>
<tr>
<td>Urinalysis contains</td>
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<td>600</td>
<td>72,000</td>
</tr>
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<td>Syringes</td>
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<td>Transport</td>
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<tr>
<td>Miscellaneous</td>
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<td>1,000,000</td>
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<tr>
<td><strong>GRAND TOTAL</strong></td>
<td></td>
<td></td>
<td><strong>4,002,100/=</strong></td>
</tr>
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</table>
## Appendix 7: ACTIVITY SCHEDULE

<table>
<thead>
<tr>
<th>Activity</th>
<th>May 2017 – August 2017</th>
<th>September 2017 – February 2018</th>
<th>February 2018 – April 2018</th>
<th>April 2018 – May 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposal Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposal Presentation &amp; Submission</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data Analysis</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Report Writing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissertation Submission &amp; Presentation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>