ASSESSMENT OF SEVERITY AND EARLY RESUSCITATION OUTCOMES OF PATIENTS WITH BURN INJURIES ADMITTED AT IRINGA AND DODOMA REGIONAL REFERRAL HOSPITAL IN TANZANIA.

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I, **Gloria Wilcharles Lyimo**, declare that this dissertation is own my original work and that it has not been presented and will not be presented for a similar or any other or any other degree award.

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CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the University of Dodoma dissertation **"assessment of severity, and early resuscitation outcomes of patients with burn injuries admitted at Iringa and Dodoma Regional Referral Hospital in Tanzania,"** in partial fulfilment of the requirements for the degree of Masters Medicine in Surgery of the University of Dodoma.

Dr. Masumbuko Y Mwashambwa

Signature: .... Date: 16/11/2020

(SUPERVISOR)

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DEDICATION

This study is dedicated to; my supervisors, the surgical department in IRRH and DRRH, and the College of Health Science at the University of Dodoma for their cooperation, assistance, support, word of advice, and encouragement.

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ABSTRACT

Background: Burn injury is a significant health problem worldwide, where in Africa, it is estimated that over a million patients are burned annually, wherein in Tanzania, the prevalence is 16%. It contributes to 18% of all hospital admission, with a 6% mortality to 10% (Peden et al., 2008; Roman, Lewis, Kigwangalla, & Wilson, 2012). In addition, the common causes of early (less than 48 hours) mortality and morbidity in burn injury are; burns shock, inhalational injury, and systemic inflammatory response syndrome (Brusselaers et al., 2010). Therefore, burn management requires a strict protocol to reduce associated morbidity and mortality, which includes strict protocols of fluid resuscitation. In our settings, fluid management may not follow a strict prescription. And there are fewer studies on early resuscitation outcomes that have been done in Africa and Tanzania, but more importantly, not in our local settings.

Methodology: A hospital-based, prospective study conducted at IRRH and DRRH from April 2019 to June 2020. This study used a purposeful sampling technique and questionnaire to collect data that was entered into the Excel sheet, then imported into SPSS version 26 for analysis.

Results: The mean ABSI score among survivors was 4.68 ± 0.18 and 10.67 ± 2.03 among non-survivors, mean TBSA among survivors were 25.07 ± 1.44 % and 71.67 ± 13.64 % among non-survivors. The risk factors contributing to the severity of burn injury are age above ten years, flames, and male patients who had more severe burn injuries. There was 49.1% patients who received inadequate amount of fluid, these patients were seven times likely to have the bad outcome (deteriorated or died), **[AOR = 7.283, (95% CI 3.281 – 18.518), P < 0.05]**.

Conclusion and Recommendation: The common causes of burn injury in this study were scald followed by flames, of which flame injury contributed more to the severity of burn injury. There were 49.1% of the patients received inadequate fluid, and were 7 times more likely to have a bad outcome (deteriorated or died). ABSI score should be adapted in local setting and strict fluid resuscitation should be followed, especially to patients with ABSI score more than 6.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

ABSI	Abbreviated Burn Severity Index
AIS	Abbreviated Injury Scale
BMH	Benjamin Mkapa Hospital
BP	Blood Pressure
CI	Confidence Interval
CO	Cardiac Output
CVP	Central Venous Pressure
DBP	Diastolic Blood Pressure
DRRH	Dodoma Regional Referral Hospital
HICs	High Income Countries
HR	Heart Rate
Hrs	Hours
ICU	Intensive Care Unit
IRRH	Iringa Regional Referral Hospital
IV	Intravenous Fluid
Kg	Kilograms
LMICs	Low and Middle Income Countries
LOS	Length of Hospital Stay
MAP	Mean Arterial Pressure
mmHg	Millimeter of Mercury
mls	Milliliters
OR	Odds Ratio
PR	Pulse Rate
RR	Respiratory Rate
SBP	Systolic Blood Pressure

TBSA	Total Body Surface Area
UDOM	The University of Dodoma
WHO	World Health Organization

OPERATIONAL AND DEFINITION OF TERMS

Burn injury: it is coagulative necrosis of the skin caused by thermal (hot liquids, flames, and contact), electrical, chemical, radiation, friction, and cold. (Tiwari, 2019).

Deteriorating: this is a poor prognosis of a patient's vitals, that the patient presents with shock and hypovolemia.

Gender: male and female

Resuscitation Outcome: the outcome after fluid therapy in the first 24hrs post-burn injury. It has been evaluated using vitals and summarized into three categories; stabilized, deteriorating and died.

Severity of Burn: it is measured using the TBSA and depth of burn injury, where both of these are incorporated into burn severity scores with other variables such as sex, presence of inhalational injury and age. (Tiwari, 2019).

Stabilizing: the patient ends up with stable vitals after the first 24 hours of fluid resuscitation, despite the patient's initial vitals.

CHAPTER ONE

INTRODUCTION

1.1 Epidemiology

Burn injury is a significant health problem worldwide. There are 300,000 deaths each year caused by burn injury. Most of these deaths occur in low and middle-income countries because of poor infrastructure and prevention strategies (Peden et al., 2008). The mortality rate in these countries is 4.3 per 100,000, but in high-income countries (HICs), it is 0.4 per 100,000. The common cause of early (less than 48 hours) mortality and morbidity in burn injury is burn shock, inhalational injury and systemic inflammatory response syndrome (Brusselaers et al., 2010). The prevalence of burn injury is 5.9% among all injuries and the calculated incidence is 152.7 per 100,000 population (Peden et al., 2008). In Africa, it is estimated that there are over a million patients annually with burn injury; 18% of hospital admission is due to burn, with a mortality of 6% to 10%. In Tanzania, the prevalence of burn injury is reported to be 16% of all injuries; a one-month incidence was calculated to be 1.73% (Roman et al., 2012).

1.2 Causes and Pathophysiology of Burn Injury

Burn injury is a type of injury caused by thermal, cold, electricity, chemicals, and radiation, resulting in coagulative necrosis of the affected tissue (Nielson, Duethman, Howard, Moncure, & Wood, 2016). All these causes have different pathophysiological pathways on how they cause coagulative necrosis. These are described as follows:

Thermal burn injury contributes to 6.6 million injuries per year worldwide, according to WHO. Thermal burn injury is divided into scald (hot liquid), open flames and contact (hot objects) burn. Scald burn injury contributes to 41% of all thermal burn injuries, followed by fire and contact (Fagan, Bilodeau, & Goverman, 2014). In the pathophysiology of thermal burn injury, it is essential to know the heat capacity, heat transfer, and temperature of a substance that will cause injury; and the specific heat and heat conductance of tissue or skin, together with the duration of contact. When a hot object comes into contact with the skin, it will transfer heat to the skin. The human skin can tolerate a temperature of 44 degrees Celsius for 6 hours; beyond this, it will cause a thermal injury resulting in coagulative necrosis (Nielson et al., 2016).

The area of injury will compose of three-zone, which are called Jacksonian zones. The innermost area is called the zone of coagulation, the intermediate area is the zone of stasis and the outer area is the zone of hyperemia. The stasis zone's significance is that with adequate early resuscitation, the effect can be reversed (it can be converted to a zone of hyperemic). But in inadequate fluid resuscitation, this zone will turn into a zone of coagulation (Keck, Herndon, Kamolz, Frey, & Jeschke, 2009).

Electrical burn injury contributes to around 2% of all burn injuries in Tanzania, similar to other parts of the world. It involves four properties: current, voltage, resistance, and conductance (Dzhokic, Jovchevska, & Dika, 2008). The current is the flow rate of electrons measured by amperes, and voltage is the driving force pushing electrons in one direction. Resistance is the opposition of electrons flow, and conductance is the ability to allow current flow in combining all these properties, energy = current^2 x resistance. This energy is converted to heat energy in the tissue causing coagulative necrosis (Kobernick & Health, 1982). Also, repetitive muscle contractions, mostly due to the alternating current in-home appliance, may cause fractures, joint dislocation, and soft tissue injuries (Kobernick & Health, 1982).

Chemical burn injury is another cause of burn injury, which accounts for 2.4% of all burn injury cases (Cartotto, Peters, & Neligan, 1996). It is caused by acids and bases, which are also called caustic, meaning that they cause extensive tissue damage. The acidic fluids are defined by pH < 7, and they are proton donors (H+) (Cartotto et al., 1996). These acids cause tissue damage by denaturing protein and forming an eschar, which is hard and fibrotic. This eschar will prevent further fluid penetration, preventing further tissue damage (Kaddoura, Ibrahim, Karamanoukian, & Papazian, 2017). In alkaline chemicals are defined by pH>7 were the strongest one being 13 to 14; these are proton acceptors (OH-) (Cartotto et al., 1996). They cause tissue damage by denaturing proteins and saponification, causing liquefaction necrosis (Palao, Monge, Ruiz, & Barret, 2010). Liquefaction necrosis is transforming the tissue into liquid form. Thus, the alkaline acoustic fluid causes a deeper injury than acidic acoustic fluids (Maghsoudi & Gabraely, 2008).

Cold burn injury contributes to less than 1% of all burn cases, where the most common injury mechanism is by deodorant. (Nizamoglu et al., 2016). Other causes of cold injury include; prolonged contact with ice (21.7%), cryotherapy, cold environments, industrial, and lastly, in contact with dry ice, which is very rare (Nizamoglu et al., 2016).

1.3 Systemic Effect in Burn injury

The systemic response of burn injury might differ according to the cause of burn injury and more pronounced when the TBSA is more than 30% (Jeschke et al., 2007). The following are systemic response to burn injury.

1.3.1 Hypovolemic shock and edema:

Hypovolemia and edema are the immediate response in a burn injury. The pathophysiology of hypovolemia is divided into two phases: the hypodynamic/Ebb phase and the hyperdynamic/flow phase (Fagan et al., 2014). The hypodynamic phase lasts for 24 to 72 hours from the time of burn injury. In this phase, there is a release of inflammatory mediators (reactive oxygen species), which damages the capillary endothelial cells, leading to increased capillary permeability (Nielson et al., 2016). Therefore, this will result in the loss of fluid and proteins from the intravascular compartment into the interstitial compartment (Nielson et al., 2016). This effect will decrease oncotic pressure in the intravascular compartment, eventually causing fluid shift into interstitial from the intravascular compartment, resulting in edema of the burn injured site and non-injured site (Fagan et al., 2014). However, after 24 to 72 hours of post-burn injury, the hyperdynamic phase (flow phase) commences. Microvascular injury begins to heal, leading to decreased microvascular permeability, which will increase peripheral blood flow, together with decreased vascular resistance, increased cardiac output, and increased heart rate (Fagan et al., 2014).

1.3.2 Renal response

The incidence of acute kidney injury (AKI) accounts for 0.5% to 30% in burn injury, which can occur early, or late (Albertyn, Bickler, & Rode, 2006). Factors contributing to early AKI include; hypovolemia, inflammatory mediators, the release of denatured protein (for example, rhabdomyolysis in electric burn injury causes renal tubular necrosis), and release of nephrotoxic agents, however sepsis cause late AKI (Haut, Intensiveinheiten, & Königreichs, 2011). The early causes of AKI can be prevented by adequate fluid resuscitation. The other cause of acute kidney injury is decreased cardiac output, especially in extensive surface area burn injuries, resulting in poor organs' perfusion. The goal of resuscitation is to re-expand the plasma volume, restore the cardiac output, and improve organ perfusion (Haut et al., 2011).

1.3.3 Hypermetabolic response

Hypermetabolic state after burn injury persists up to one year, and it manifests as a 50 fold elevation of plasma catecholamines, cortisol, and inflammatory cells with the elevation of body catabolism and resting energy expenditures, and multi-organ dysfunction. Again this can be prevented by early and continuous enteral feeding with foods containing high protein and carbohydrates (Herndon & Tompkins, 2004) & (Mandell & Gibran, 2013). Insulin administration, recombinant human growth hormone, or an anticatabolic drug such as propranolol can reduce these effects, especially in large surface area burns of more than 40% (Herndon & Tompkins, 2004) & (Williams, Herndon, & Jeschke, 2009).

1.3.4 Cardiovascular response

Several mechanisms are involved in cardiac response to burn injury. One of the mechanisms is induced oxidative stress, causing an increase of cytosolic cytochrome-c more than three folds and lipid peroxidation in the first 24hrs post burn injury. This causes damage to the cardiac cells' mitochondria, and hence injury to cardiac cells, which is the reason to give antioxidants in major burns for prevention (Nielson, Duethman, Howard, Moncure, & Wood, 2017). Tachycardia increased myocardial oxygen consumption, and increased cardiac output might be mediated by increased catecholamine (Williams, Herndon, & Jeschke, 2009).

1.3.5 Gastrointestinal tract

In burn injury above 30% of TBSA, blood flow to the bowels decreases nearly 60%, resulting in the bowels' ischemia leading to curling ulcer formation on the stomach and rarely in intestines. Also, thromboxane two and other cytokines cause vasoconstriction of mesenteric arterioles, mediating the same effect. Additionally, epithelial apoptosis in the first 12 hours and decreased intestinal absorption contributes to curling ulcers. To prevent curling ulcers, patients should start enteral feeding immediately or proton pump inhibitors, especially in the first 72 hours post-burn (Keck et al., 2009).

1.4 Severity of Burn Injury

Severity of burn injury can be assessed using different parameters, including; total body surface area, depth of burn injury, associated trauma, vital signs, and laboratory investigation. Total body surface area is measured in percentage, using different charts such as Wallace rule of 9, Lund and Browder chart mostly recommended in pediatric patients, and the rule of palm (Ho & Ying, 2001). Wallace rule of 9 and the rule of palm are primarily used in IRRH and DRRH.

The depth of burn injury is assessed by clinical examination of the burn wound, which is classified into four degrees (Jeschke et al., 2020).

Table 1: Classification of burn injury according to depth/degree and clinical findings. (Jeschke et al., 2020).

Current Nomenclature	Previous Nomenclature	Depth	Clinical Findings
Superficial thickness	1st degree	Epidermis	Erythema, significant pain, no blisters
Partial-thickness – superficial	2nd degree	Superficial (papillary) dermis	Blisters, clear fluid, and pain
Partial-thickness – deep	2nd degree	Deep (reticular) dermis	Whiter appearance or fixed red staining (no blanching), reduced sensation
Full-thickness	3rd degree	Epidermis, dermis, and complete destruction to subcutaneous fat and/or muscle and bone, eschar formation.	Dry, charred or leathery, thrombosed blood vessels, insensate

The parameters above can be assessed using different scoring systems. The common types of scoring systems used include: abbreviated burn severity index (ABSI), abbreviated injury scale (AIS), injury severity score system (ISS), Pediatric Risk of

Mortality (PRISM) score, and Baux score (Lin et al., 2018). In this study ABSI scoring system was used.

The abbreviated burn severity index in the appendix 1, is a scoring system used to measure severity of burn injury. This scoring system was developed in 1982, by Tobiasen J et al. in Virginia, at the University of Virginia in Medical Center Charlottesville. Their objectives were to create a scoring system that adheres to the guidelines suggested for injury severity scoring systems, to maintain high standard, accuracy and simple to use in clinical settings. It includes five variables and the scores range from 2 to 13 (Ayodeji Olanrewaju Oladele1, Anthony Alome Olekwu2, Olakunle Fatai Babalola3 & Babalola5, 2018; Lin et al., 2018).

1.5 Management of Burn Injury

1.5.1 First Aid

In burn injury, it is recommended to remove the patient from the burn source in managing burn patients. Then, run cold water on the injury site in thermal, chemical, electric, and radiation burn injuries. The type of first aid that is usually given depends on the environment and knowledge of the people (Care, 2010).

1.5.2 Resuscitation

The goal is to replace the fluid loss in the intravascular compartment to maintain organ perfusion and function. Different formulas to calculate the required amount of fluid all depend upon the TBSA and weight of the patient.

The formula commonly used is Parkland Formulae, which has been used in this research; **For adults:** Initial 24hrs: 4ml/kg/% crystalloids example Ringer Lactate (RL), Next 24hrs: colloid infusion of 5% albumin 0.3-1ml/kg/% burn/16 per hour (Jier, Bowen, Lundb, Reedb, & Bert, 1995). **For children:** Initial 24hrs: 3ml/kg/% crystalloid example of RL. RL solution can be added for maintenance: 4 ml/kg/hour for children weighing 0-10 kg; 40 ml/hour + 2 ml/hour for children weighing 10-20 kg; 60 ml/hour + 1ml/kg/hour for children weighing 20kg or higher. In the next 24hrs, glucose in water is added in required amount to maintain urinary output of 1ml/hour (Endorf & Dries, 2011).

The above formula maximum TBSA used is 50%. Any patients above this will be considered 50% TBSA to prevent fluid overload (Haut et al., 2011). An ideal fluid for resuscitation in burn patients is the one that effectively restores plasma volume and without adverse effects. Isotonic crystalloids, hypertonic solutions and colloids restore the plasma volume, but all have adverse effects (Haberal, Abali, & Karakayali, 2010). Their side effects are: in normal saline administration, and they might lead to hyperchloremic acidosis (Todd, Malinoski, Muller, & Schreiber, 2007). In RL, due to the presence of a racemic mixture of D-lactate and L-lactate isomers, there is an increase in reactive oxygen species, which exacerbates inflammatory response syndrome; also they increase coagulation (Koustova et al., 2002), (Ruttmann, James, & Finlayson, 2002). Hypertonic fluids and colloids are suitable in burn patients since they are quick volume expanders with evidence to decrease cellular edema (Huang et al., 1995). However, their administration is preferred after 24 hours of burn injury when the capillaries and venules' endothelial wall has started to heal, and the capillary leak has decreased. It also requires close follow up due to the risk of hypernatremia and renal failure (Huang et al., 1995).

After the first 24 hours of burn injury, the patient is kept under maintenance fluid. This needs to be titrated to maintenance goal rate, depending on; the daily fluid requirement, fluid losses, salt, and the patient's weight. The ongoing fluid losses should include the normal physiological fluid losses and fluid loss from the burned skin called the evaporative loss (Flüssigkeitsverlust, 2010). This evaporative loss (EL) is calculated by the following equations; weight less than 20kg, EL= [(35+%TBSA) x BSA m^2] per hour and weight above 20kg, EL= [(25+%TBSA) X BSA m^2 per hour. Therefore the patient maintenance fluid will be basal fluid plus the evaporative loss until the burned skin starts to heal or after skin grafting has fully engrafted (Flüssigkeitsverlust, 2010).

There are different proposed methods to monitor fluid adequacy, including; cardiac index (CI), mean arterial pressure (MAP), heart rate (HR), urine output, pulmonary artery occlusion pressure (PAOP), respiratory rate, or any signs of acute respiratory distress syndrome (ARDS), hematocrit, and central venous pressure (CVP) (Béchir et al., 2010; Dulhunty, Boots, Rudd, Muller, & Lipman, 2008; Robert, 2017).

1.6 Problem Statement

The burn is highly prevalent worldwide but more in developing countries Tanzania inclusive. The prevalence of burn injury is 5.9% among all injuries (Peden et al., 2008). In Tanzania, the prevalence of burn injury is 16% of all injuries; a one-month incidence was calculated to be 1.73% (Roman, Lewis, Kigwangalla, & Wilson, 2012). The common cause of early (less than 48 hours) mortality and morbidity burn injury is burn shock, inhalational injury and systemic inflammatory response syndrome (Brusselaers et al., 2010). Management of burn requires strict protocols to reduce associated morbidity and mortality. Strict protocols include fluid resuscitation. Experience shows that fluid management may not follow a strict prescription in DRRH and IRRH. Few studies have been done in Africa and Tanzania, but more importantly, not in our local settings.

1.7 Objectives

1.7.1 Broad Objective

To assess the severity and early resuscitation outcome (in the first 24hrs) of burn-injured patients admitted in Dodoma and Iringa Regional Referral Hospital.

1.7.2 Specific Objectives

i. To assess the adequacy of fluid resuscitation of burn-injured patients admitted in IRRH and DRRH.
ii. To assess the early resuscitation outcome of patients admitted in IRRH and DRRH.
iii. To establish how burn severity influences resuscitation outcome of burn-injured patients admitted in IRRH and DRRH.
iv. To determine the causes and risk factors contributing to the severity of burn-injured patients admitted in IRRH and DRRH.

1.8 Research Questions

i. What is the association between severity and risk factors of burn-injured patients admitted in IRRH and DRRH?
ii. What is the proportion of patients who received adequate fluid resuscitation?

iii. What is the early resuscitation outcome of burn-injured patients after 24 hours of burn injury?

iv. What is the relationship between severity and early resuscitation outcomes?

1.9 Significance of the Study

This study provides the association between severity and risk factors of burn injury. This study has assessed the practice of fluid resuscitation that is done in our local setting, which will improve the quality of service and reduce morbidity and mortality. Highlight on the identification of high risk patients using ABSI, for aggressive resuscitation so as to improve their outcome to reduce morbididty and mortality in burn injured patients.

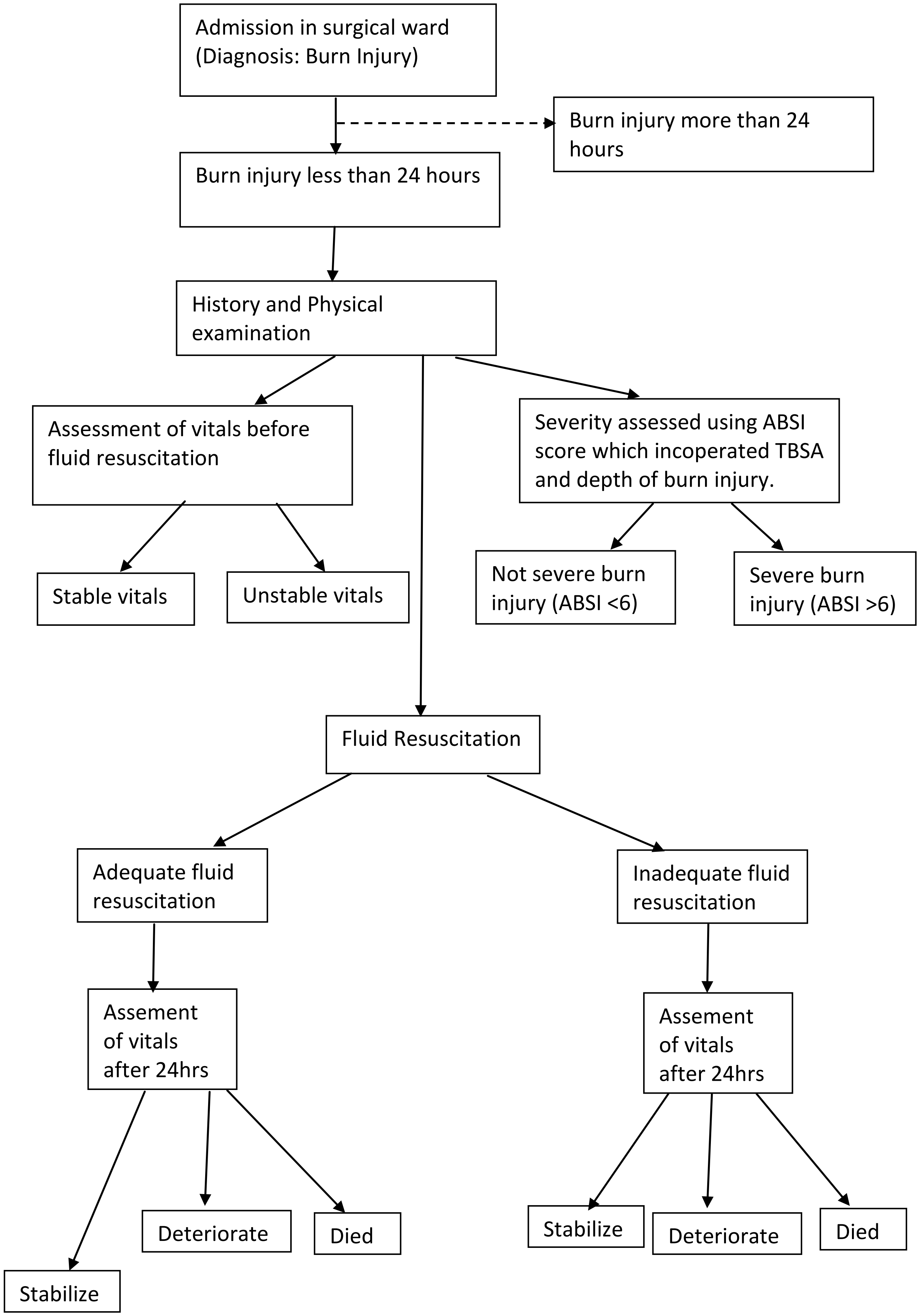

Figure 1: Conceptual framework;

This study included patients with burn injury less than 24 hours. History and physical examination was done so as to assess vitals and severity of burn injury before fluid resuscitation. Then vitals were taken again after 24 hours of fluid resuscitaton, which were summarized as stabilized, deteriorate and died. The amount of fluid was also recorded.

CHAPTER TWO
LITERATURE REVIEW

2.1 Risk Factors of burn injury

It is estimated that 180,000 deaths every year occur secondary to burn injury, where more than 90% occur in low and middle-income countries compared to high-income countries. The mortality rate is reported to be 14.4% in Kenyatta National Hospital (KNH); 69% died within the first week of admission (Moderate et al., 2005). Though non-fatal burn injuries are the leading cause of morbidity, around 18 million cases, such as disabilities, prolonged hospital stay, or disfigurement, increase costs (Peden et al., 2008).

The common cause of mortality and morbidity in burn injury it is sepsis (47%), inhalational injury (29%), brain hypoxia (16%), and burn shock (8%), reported by studies done in USA, Europe, India and Egypt (Afify, Mahmoud, Abd El Azzim, & El Desouky, 2012; Güldoğan, Kendirci, Gündoğdu, & Yastı, 2019; Lip et al., 2019; F. N. Williams, Herndon, Hawkins, et al., 2009). Burn shock, inhalational injury and systemic inflammatory response syndrome; are the most common cause of early (less than 48 hours) mortality and morbidity in burn injury (Brusselaers, Monstrey, Vogelaers, Hoste, & Blot, 2010). In pediatric patients, the common cause of morbidity and mortality is sepsis, inhalational injury and TBSA above 25% caused by flames, according to studies done in Africa (Agbenorku, Agbenorku, & Fiifi-yankson, 2013; Fomukong et al., 2019; A. Van Niekerk, Laubscher, & Laflamme, 2009).

A study done in the USA reported that the male to female ratio was 1.9:1, and the most prevalent age group was 5 to 15 years, similarly to a study done in China reported male to female ratio of 1.8:1 with the most frequent age group being below 15 years. The male patients had an average ABSI score of 8.2 ± 0.3 with a higher mortality rate, and patients below 15 years had the most severe burn injury (Ho & Ying, 2001). However, in Africa, a meta-analysis reported the most prevalent age group was children under five years of age, with a predominance of the male gender, similar to studies done in Tanzania, the male to female ratio was 1.9:1 and the most prevalent age group was below five years of age, and they had more severe burn injury (Ringo & Chilonga, 2014; Rybarczyk et al., 2017). However, this was different for Bain et al. (2014) in India; the female to male ratio was 1.7:1 and the predominant age group was 15 to 29 years. This study reported that female patients had a higher TBSA (above 50%), and the mortality rate was higher in female patients (Bain, Lal, Yedalwar, Cupta & Singh, 2014).

Socioeconomic status is another risk factor of burn injury, which is composed of different elements which include; single parenting, many children in the family, very young maternal age, level of overcrowding, number of occupants in the house, low level of education, type of house, e.g., masonry and clay homes, source of light in the family, type of fuel for cooking and low monthly family income. (Petersburgo et al., 2010). Within these factors; source of light, type of house, and type of fuel for cooking have been shown to contribute to severity of burn injury, according to studies done in East Africa, which is similar to a study done in India reported that the source of fuel which is kerosene caused more severe burn injury (Roman et al., 2012; Edelman, Cook, & Saffle, 2010). A study done in Korea reported that poor household infrastructure contributed to the severity of burn injury, which differed from studies done in South Africa (Ok et al., 2009; Weedon & Potterton, 2011).

The other risk factor of burn injury is epilepsy, which contributes to 20% of all burn injuries (Prevett, 2013). In Africa, there are 10 million patients with epilepsy, 75% of them have no proper treatment, and 80% of these patients do not receive treatment (Prevett, 2013). Instead, these patients use traditional medications, which all together contribute to poor follow up of proper medicines and increase the risk and severity of burn injury; however, these patients are at risk of a severe burn injury caused by flames (Albertyn et al., 2006; Lagunju, Oyinlade, & Babatunde, 2016). In India, the prevalence of burn injury in epileptic patients is 8.3%, and in the USA, the prevalence is 1.6%, 70% of these patients had full-thickness burn injury (Baba, Sharma & Waini, 2019; Lam, Duc, & Nam, 2019). Child abuse injury occurs in 6% to 20% of all child abuse cases, but in burn injury, it occurs 1% to 10% both in pediatric cases and in adults, does not contribute to the severity of burn injury (Chester, Jose, Aldlyami, King, & Moiemen, 2006 & Lloyd, 2015; Mutto & Mutto, 2011).

Worldwide the common cause of burn injury is thermal burn, which accounts for 36.3%, followed by 29.4% of scald. Flame burn injury contributes to 45.1% of deaths secondary to burn injury, followed by 15.0% for scald burn, 2.2% for electric burn and 3.0 for contact burn, similar to studies done in developed countries (States & Departments, 2016; American Burn Association, 2018). However, in Africa, the most common cause of burn injury is flames (56%), followed by scald (33%) and electric injury (6%). The mortality rate in this study was 59.6% in flames and 11.5% in scald burn. In addition, in a study done in Tanzania, Temu et al. (2008) reported that scald to be the most common cause of burn injury, similar to Chalya et al. (2011), but different from Ringo et al. (2013) reported that flames burn was the most common cause of burn injury. However, flames were found to cause more severe burn and contributed to a higher mortality rate within all these causes.

More than 50% of burn-injured patients had TBSA of 40% to 50% in Canada, while in Hong Kong, most patients had TBSA of less than 20% (Ho & Ying, 2001). However, in Kenya, Africa reported; 50% of the burn-injured patients admitted had TBSA of 5% to 15% (Rybarczyk et al., 2017). In Mwanza, 94% of burn-injured patients admitted had less than 40% TBSA involving the extremities (Chalya et al., 2011). Another study done in KCMC reported that most patients admitted had TBSA of less than 15%, mostly upper extremities. Patients in both studies had second-degree superficial burn injury (Ringo & Chilonga, 2014).

2.2 Adequacy of fluid in association with early resuscitation outcome

Over the recent years, the improved survival rates in critically burn patients are due to the development of resuscitation protocols and early burn wound closure, improved respiratory and renal support, control of the hypermetabolic response, and early enteral nutrition. The goal of the initial resuscitation of critically burn patients is to replace extracellular fluid losses to maintain end-organ perfusion and prevent burn shock. These patients have a much higher capillary leak than septic or trauma patients; thus, they require more aggressive fluid resuscitation (Sanchez et al., 2015 in Spain).

It is recommended to start giving intravenous fluid when TBSA is above 15% in adults and 10% in pediatric patients, and this is the protocol of admission in some centers in parts of Asia and Africa (Rode et al., 2014). Most studies, Parkland formula, were used to estimate fluid resuscitation compared to other formulas. The most common route of fluid administration used was intravenous, but an oral route was used (Rode et al., 2014; Haut et al., 2011). Fluid resuscitation is critical because the fluid deficit is one of the leading causes of mortality in burn patients apart from other causes, reported by Felicia N Williams et al., (2009) (F. N. Williams, Herndon, Hawkins, et al., 2009). Fluid resuscitation adequacy can be measured by both; the Parkland formulae and monitoring vitals before and after fluid rescusitation.

Studies done in Africa measures fluid adequacy using the Parkland formulae and few use vitals. Within these studies it is reported that, less than 50% of the patients receive adequate fluid resuscitation, somewhat similar to studies done in MICs, and contrary to studies done in HICs reporting that more than 50% of the patients receive adequate fluid resuscitation according to vitals and the amount of fluid using the Parkland formulae. (Outwater et al., 2014; Ringo & Chilonga, 2014; A. Van Niekerk et al., 2009; Chalya et al., 2011; Lip et al., 2019). A study done in n KCMC Tanzania reported that, 46.3% of patients receive adequate fluid and 4.9% received inadequate fluid for resuscitation which is similar to studies done in Mwanza region. (Ringo & Chilonga, 2014; Rybarczyk et al., 2017). Alemayehu et al. in Ethiopia (2020) reported that patients receiving inadequate fluid resuscitation were 2.8 times more likely to deteriorate after the first 24 hours as compared to those who were adequately resuscitated.

In addition there are several studies done stating that there is a significant change in adequate fluid resuscitation before and after fluid rescusitaton (Mitra, Fitzgerald, 2006). A study done in Australia reported a significant change of blood pressure and urine output before and after adequate fluid resuscitation, similar to a study in UK by Guly et al., 2011 (Bak, Sjo, Eriksson, Steinvall, & Janerot-sjoberg, 2009). But contrary to a study done in Sweden reporting there was only significant change in urine output, which was 0.77 ml/kg/hr and 1.11 ml/kg/hr before and after fluid resuscitation respectively (Bak et al., 2009).

2.3 Association between Severity and outcomes in Burn Injury

A study done in the USA reported the average ABSI score among survivors was 7.7 ± 0.2 and 10.3 ± 0.6 amongst non-survivors (Berndtson, Sen, Greenhalgh, & Palmieri, 2013). In Africa, Nigeria, a study done by Oladele AO et al. (2018) validating the ABSI scoring system as a predictor of outcome, showed that the mean score for patient of all age range, it was 4.7 where the survival rate was around 98%, majority of the patient had an ABSI score of 4-5 with the similar survival rate. The higher the score, the poorer the outcome of burn injury, despite the management that was provided. Most of the patients who were discharged had ABSI of less than 6-9. This is similar to Mostafa AAES et al. (2018), a study done in Egypt to modify the ABSI score reported similar findings. Kuan-Hsun Lin et al. (2018) showed that with inhalational injury, the score of ABSI increases because it causes acute respiratory distress syndrome, therefore increasing the severity.

The reported average range of TBSA among survivors was 38.33 ± 15.23 % to 46.3 ± 2.1 % and 66.4 ± 4.6 % to 66.92 ± 22.74 % among non-survivors according to different studies done HICs. (Berndtson, Sen, Greenhalgh, & Palmieri, 2013; Kazis et al., 2002). A study in India by Jayaraman, et al. 1993 reported that 90% of the deaths had a TBSA of more than 50%, 54% died within the first 24hrs of burn injury (Jayaramanl, Ramakrishnan, & Davies, 1993). Similar to a study done by Berndtson et al. (2013) showed that patients who died had an average TBSA above 66% ±4.6, a third-degree burn with an average TBSA of 66.2 ±4.6, 53% had inhalation injury, reduced length of hospital stay, and more days in a ventilator. In Africa, Oladele AO et al. (2018) reported the average TBSA in survivors was 16.1% and 55.8% among non-survivors, and this is somewhat similar to different studies done in different parts of Africa. (Parvizi et al., 2016; Dongo et al., 2007).

A systematic review also showed that there is an association between TBSA and mortality of the patient. In this review, the mean TBSA ranged from 11% to 50% depending upon the study area, and the patient’s admitting criteria. This study showed that there an increased mortality rate with TBSA above 22%. In relation to Pearson et al. (2011), this is suggested that higher mortality is when the TBSA increases. This systemic review also showed increased mortality about 8 to 10 times fold with an inhalational injury. This was found to be more prevalent in flames injury. The incidence of inhalational injury was 0.3% to 43% in severely injured patients, more common in elderly patients (Endorf & Gamelli, 2007).

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Study Design

This is a hospital-based, prospective study, to assess the early resuscitation outcome in the first 24 hours, of burn injury.

3.2 Study Approach

This was a quantitave study that assessed the severity of burn injuries using the abbreviated burn severity index, and early resuscitation outcome by monitoring the patient's vitals before and after fluid resuscitation and the amount of fluid given to the patient (Dulhunty et al., 2008).

3.3 Study Areas

This study was conducted in IRRH and DRRH, in Iringa and Dodoma regional respectively. Iringa Regional Referral Hospital has inpatient services: Internal Medicine, Surgery, Intensive Care Unit, pediatrics and Obstetrics, and Gynaecological. The hospital has about 310 beds, and its outpatient department attends about 45-50 patients daily. In addition, it has a 24-hour casualty department and other general clinics. The surgical ward has a bed capacity of 39 males and 27 females, and the pediatric surgical wing has a capacity of 14 beds. In a month there are 15 to 20 patinets admitted with burn injury. In this hospital there is no formsal specific protocol for burn resuscitation, but the most commonly used formulae is Parkland and there is no burn unit.

Dodoma Regional Referral Hospital has inpatient services: Internal Medicine, Surgery, Intensive Care Unit, pediatrics and Obstetrics, and Gynaecology. The hospital has about 436 beds. The surgical ward has a bed capacity of 37 males and 29 females. The pediatric surgical bed capacity was not well defined because neonatal patients were being taken care of in the general neonatal ward, and older children were being cared for in a combined adult male or female general surgical ward. In a month there are 12 to 15 patinets admitted with burn injury. In this hospital there is no formal specific protocol for burn resuscitation, but the most commonly used formulae is Parkland and there is no burn unit.

3.4 Study Population

All patients with burn injuries were admitted to Iringa and Dodoma regional referral hospital from April 2019 to June 2020.

3.5 Inclusion and Exclusion Criteria

3.5.1 Inclusion Criteria

- All patients admitted for less than 24 hours from the time of burn injury
- All patient who consented

3.5.2 Exclusion Criteria

- Patients who were admitted more than 24 hours post-burn injury
- Patients with co-morbid conditions

3.6 Sample Size Estimation and Sampling

3.6.1 Sample Size Estimation

The sample size was calculated using Kish and Leslie formulae.

$$n = \frac{Z^2 \times P \times (1 - P)}{d^2}$$

Where n =simple size

Z = is standard normal variate (at 5% type 1 error) it is 1.96.with P value significant at <0.05.

P = Expected proportion in population base on previous studies, which 7% in a study done in Nigeria (Ibeanusi & Kejeh, 2018).

d = Absolute error was 0.05 (Ringo & Chilonga, 2013).

Hence:

$$n = \frac{1.96^2 \times 0.07 \times (1 - 0.05)}{0.05^2}$$

$n \approx 98.06$

3.6.2 Sampling Method

This study used a purposeful sampling technique. All patients who sustained burn injury less than 24 hours from the time of injury admitted in surgical wards at DRRH and IRRH from April 2019 to June 2020 participated.

3.7 Variables

3.7.1 Dependent Variables

- Severity of burn injury
    - TBSA
    - Depth of burn injury
- Early resuscitation outcome
    - Stabilization
    - Deteriorating
    - Decease

3.7.2 Independent Variables

- Age
- Gender
- Cause of burn
- Adequacy of fluid
    - Adequate (100% to 80% of the calculated fluid)
    - Inadequate (less than 80% of the calculated fluid)

3.8 Data Collection Method and Tools

The data collection methods were interviews, measurements, and physical examination. Then this information was fed into a questionnaire and then into an excel sheet.

3.8.1 Interview

This method was used to collect the demographic data, cause of burn injury, and the mechanism of burn injury and the information was fed into the questionnaire.

3.8.2 Measurements and Physical Examination

This method was used to measure vitals before and after resuscitation, TBSA, fluid amount, and burn injury depth. The total body surface area was obtained by estimating using the Wallace rule of nine adult and pediatric patients or using the palm of the patient (Sharma & Parashar, 2010).

In addition, the depth of burn injury was obtained from local examination of the burned site, by inspecting and palpating the burned wound, wherein:-

- The first-degree injury, the burned wound, had pain on touch, and the skin was hyperemic.
- The second-degree injury was further divided, were in;
    - Superficial second degree the burned wound is inspected for presence of blisters, and tender on touch (Sharma & Parashar, 2010).
    - Deep second degree the wound was whitish in colour on the floor and it might be tender or non-tender on touch (Sharma & Parashar, 2010)
- Third-degree burned wounds had whitish, black, with eschar that is leathery or insensate (Sharma & Parashar, 2010).

The amount of fluid was estimated using Parkland formulae. The early resuscitation outcome was assessed by measuring the vitals before and after 24hrs of fluid resuscitation (Dulhunty et al., 2008). The measured vitals were blood pressure, pulse rate, respiratory cycles, urine output, and GCS.

Blood pressure measurement

The blood pressure was measured using a digital blood pressure machine with automated reading. Both the blood pressure machine was placed on the forearm, where the cuff is placed 2-3 cm above the antecubital folds. The cuff was kept 2-3cm above the wrist joint and the elbow joint for the digital blood pressure machine. Then after getting the values, mean arterial pressure was calculated; the formula was MAP (mean arterial pressure) = DP (diastolic pressure) + 1/3(Systolic pressure – Diastolic pressure).

Pulse rate and respiratory cycle measurement

The pulse rate was measured by counting the pulse per minute of the radial or femoral pulses, and the respiratory rate was measured by counting the number of breaths per minute.

Urine output measurement

A calibrated urine bag measured the urine output. In the absence of a calibrated urine bag, the patient was asked to urinate in a bottle or in a bucket, then the urine was measured before discarding. (Warden, 1992). But for peadiatric patients the pumpers or a piece of cloth was weighed before wearing and after changing. (Bak et al., 2009).

GCS

The level of consciousness was assessed using the Glasgow coma scale for patients with age above 12yrs old. For pediatric patients, the AVPU (alert, verbal, pain, unresponsive) score was used, and the values were equated with the GCS.

3.9 Definition of Variables

In this study, the severity of burn injury was assessed using the recommended severity score for a burn injury, which is the abbreviated burn severity index (Ayodeji Olanrewaju Oladele1*, Anthony Alome Olekwu2, Olakunle Fatai Babalola3 & Babalola5, 2018).

The abbreviated burn severity index considers the gender, presence of inhalational burn injury, and the patient's age, which is subdivided into five categories (0-20, 21–40, 61–80, 81-100). It also considers the depth of burn divided into partial and full-thickness, and the total body surface area is divided into ten categories (1-10 up to 91–100). Therefore, this score consists of 6 categories; 2-3 is considered very low severity, 4-5 moderate, 6-7 moderately severe, 8-9 serious, 10-11 severe, and 12-13 maximum.

The above variable that was considered in the ABSI was obtained from the questionnaire. The age and the sex of the patient were obtained in the demographic data. The total body surface area was obtained by measuring using the Wallace rule of nine both adult and pediatric patients or using the rule of the palm of the patient (Sharma & Parashar, 2010).

The early resuscitation outcome was assessed by measuring the vitals before and after 24 hours of fluid resuscitation. (Dulhunty et al., 2008). The measured vitals were blood pressure, pulse rate, respiratory cycles, urine output, and GCS. The vitals taken after 24 hours of fluid resuscitation were evaluated whether the patient was becoming stable, deteriorating, or died after 24 hours of fluid resuscitation (Bak et al., 2009; Paydar et al., 2016; C. Williams, 2008).

Adequacy of fluid

In assessing fluid resuscitation, patients who received 100% to 80% of the calculated fluid requirements as per Parkland formulae were termed as adequate. Patients who received less than 80% of the calculated fluid as per Parkland formulae, this was termed as inadequate, and all the data was collected in a questionnaire (Ringo & Chilonga, 2014).

3.10 Validity and Reliability

The following measures were taken into account;

- The questionnaire was used to collect all the data after interviews, measurements, physical examination, and evaluation were done.
- The assistant researcher/data collector was well trained on how to use the instrument on data collection.
- Severity of burn injury was assessed using a valid ABSI score.
- The pulse rate, respiratory rate and blood pressure were atleast two times, and the average of these were taken.
- The data was fed into an excel sheet for storage and backup.

3.11 Data processing and analysis

Primary data was analyzed using quantitative methods by using both descriptive and inferential statistics. Quantitative data from the patients were identified, coded, and categorized according to emerging issues and theme in the study.

The dependent and independent variables were inserted into the excel sheet. All the statistical analysis was performed by using SPSS, version 26.

The frequencies of vitals, which were the outcome variables, were compared before and after fluid resuscitation. The mean, median, and standard deviation of vitals were also compared before and after fluid resuscitation. Furthermore, these vitals were also categorized according to age intervals as pediatric and adults patients. Also, in assessing fluid adequacy, the vitals were summarized into stable vitals, deteriorating, meaning unstable vitals, and died. These categories were associated with fluid adequacy, using chi-square and logistic regression analysis. The statistical significance was considered a p-value of less than 0.05 and a 95% confidence interval.

The severity of burn injury was assessed using the ABSI in which the values were categorized into six categories. These six categories were associated with the causes and risk factors of burn injury, using the chi-square. Then patients with sever burn injury had ABSI above 6 and vice versa had non-sever burn injury. Logistic regression analysis was done for these two groups were associated with the risk factors of burn injury. The statistical significance was considered a p-value less than 0.05, with a 95% confidence interval.

3.12 Ethical Consideration and Ethical issues

Ethical clearance was obtained from the University of Dodoma Research Committee. Permission to undertake the research was sought from the Regional Medical Officers (RMO) of Iringa and Dodoma and the Medical Officer In-charge of Iringa Regional Referral Hospital and Dodoma Regional Referral Hospital.

Participants had the full right to decide whether to participate or not, which was respected. Researchers adequately informed the patients about the study and a patient less than 18 years or those unable to consent; instead, caregivers were fully informed. The privacy of the patient was guaranteed. The loss of data was prevented by using backups.

The ethical issues were; inflicting pain while taking vitals or any other measurements and catheterizing the patients. Therefore, while taking the measures required, all the unnecessary movements were avoided.

3.13 Dissemination of Results

This study findings will be disseminated in respective hospitals, which were IRRH and DRRH. Also, in academic forums, in journals for publications, and in scientific conferences.

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSION

4.1 Results

4.1.1 Demographic Data and Clinical Presentation of Patients

This study included a total of 106 patients, 57% of the patients were from IRRH, the majority were males 68 (64%), with a predominance of under-fives 59 (53%) followed by 16 to 50 years of age (22.6%). The median age was 12, and the mode was one year. The 12.3% of the patients had a history of epilepsy, out of which 16.7% were in regular treatment and 83.3% were in irregular treatment.

The most common burn injury cause was scalding 82 (77.4%), followed by fire (20.8%). In degree of burn, there were 83% of patients admitted with a superficial second-degree burn, 53.4% of the patients had a TBSA of 16% to 30%, and 4.7% had an Abbreviated Burn Severity Index (ABSI) of 10 to 13 considered as maximally injured, and 25.5% of patients had the minimum score of 2 to 3 considered as very low injuries.

Also, 22 (20.8%) patients had a history not related to the mechanism of injury. All of these patients were below 14 years. The common cause of burn injury was scalding 20 (90.9%), followed by flames accounting 22 (20.8) of the patients.

Table 2: Demography and Clinical characteristics of burn patients at Iringa and Dodoma Regional Referral Hospitals in Tanzania in 2019 - 2020 (n=106)

Variables	Categories	Frequency	Percent
Age (years)	<5	**59**	**55.7**
	15 – 5	20	18.9
	16 – 50	24	22.6
	>50	3	2.8
Gender	Female	38	35.8
	Male	**68**	**64.2**
Occupation	No	55	51.9
	Student	30	28.3
	Peasant	14	13.2
	Others	7	6.6
Education level	Informal education	53	50
	Primary education	37	34.9
	Secondary education and above	16	15.1
Address	Iringa	60	57
	Dodoma	46	43
Epilepsy	No	93	87.7
	Yes	13	12.3
Cause of burn	Scald	82	77.4
	Flame	22	20.8
	Electric	2	1.8
Degree of burn injury	Superficial second degree	88	83
	Deep second degree	15	14.2
	Third-degree	3	2.8
TBSA	≤15	23	21.7
	16 – 30	57	53.8
	31 – 45	19	17.9
	46 – 60	2	1.9
	≥76	5	4.7

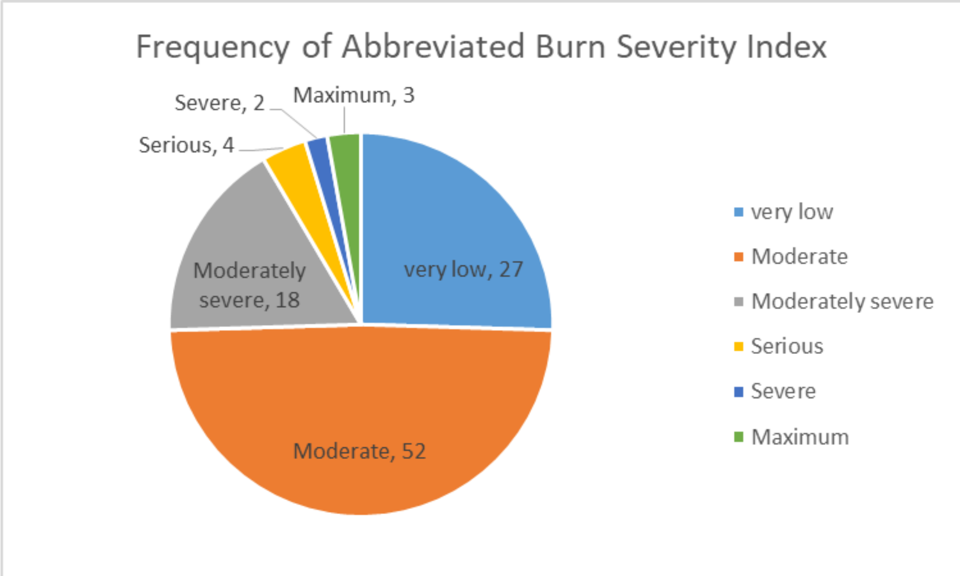

Figure 2: Abbreviated Burn Severity Index

4.1.2 Adequacy of Fluid Resuscitation

Table 5 below shows the frequency distribution of the patient's vitals before and after fluid resuscitation. Despite adequate or inadequate fluid resuscitation, there was an increased frequency of patients with a standard range of vitals.

Table 3: Clinical Assessment of Vitals Before and After Fluid Resuscitation

Characteristics	Categories	Frequency (%) Before	Frequency (%) After
Glasgow Coma Scale			
	8 – 3	23 (21.7%)	7 (6.6%)
	12 – 9	28 (26.4%)	26 (24.5%)
	15 – 13	55 (51.9%)	73 (68.9%)
Pulse Rate (bpm)	Normal	34 (32.1%)	50 (47.2%)
	Deranged	72 (67.9%)	56 (52.8%)
Respiratory rate (CPM)	Normal	50 (47.2%)	60 (56.6%)
	Deranged	56 (52.8)	46 (43.4%)
MAP (mm Hg)	Normotensive	70 (66%)	72 (67.9%)
	Deranged	36 (34%)	34 (32.1%)
Urine (mls/kg/hr)			
	Normal (≥0.5)	57 (53.8%)	55 (51.9%)
	Deranged (<0.5)	49 (46.2%)	51 (48.1%)

4.1.3 Early Resuscitation Outcome

In this study, 67% of the patient stabilized after the first 24 hours and 49.1% of the patient received inadequate fluid. Binary regression analysis was done; patients who had not received an adequate amount of fluid were seven times likely to have a bad outcome (deteriorated or died) **(OR = 7.283, 95% CI = 3.281 – 18.518, P < 0.001).** These findings are presented in Table 8.

Those patients admitted with stable vitals, none died, but 42.1% of those who received inadequate fluid deteriorated after the first 24 hours with a statistical significance difference. In contrast, those patients admitted with unstable vital, 76% received adequate fluid and stabilized, while 62.9% who were given an inadequate amount of fluid deteriorated and 66.7% of those patients who died had received an inadequate amount of fluid, with a p-value less than 0.05 statistical significance.

Table 4: Binary regression for Fluid adequacy and early outcome of burn injuries

	OUTCOME		**Binary Regression**		
Fluid resuscitation	**Good (Stabilized)**	**Bad (Deteriorate/Died)**	**OR**	**95% Confidence Interval**	**P-value**
Adequate	46 (90.2%)	6 (9.8%)	**REF**		
Inadequate	22 (40%)	32 (60%)	7.283	3.28 - 18.51	<0.001

Table 5: Assessment of the Patients Before and after the first 24 to 72 hours

			Stabilized (n=68)	**Deteriorating (n= 35)**	**Died (n=3)**	**Total (n=106)**	**P-value**
Stable	**Fluid**	**Adequate**	27 (100%)	0	0	27 (25.5%)	<0.001
		Not Adequate	11(57.9%)	8(42.1%)	0	19 (17.9%)	
Unstable	**Fluid**	**Adequate**	19(76%)	5(20%)	1(4%)	25(23.6%)	<0.001
		Not Adequate	11(31.4%)	22(62.9%)	2(5.7%)	35(33.0%)	

4.1.3.1 Severity of Burn Injury and Early Outcome of Burn Injury

The three patients who died had ABSI score above 6, while those with ABSI score less than 6; most of them became stable after the first 24 hours. The mean ABSI score for survivors and non-survivors were; **4.680 ± 1.436** and **10.667 ± 2.027,** respectively, and the mean TBSA for survivors and non-survivors was **25.068 ± 1.436** and **71.667 ± 13.642,** respectively.

Table 6: Association of Early Outcome with Severity of Burn Injury

		Died	**Deteriorate**	**Stabilize**	**P - Value**
ABSI	**Very Low/Moderate**	0(0%)	17(21.5%)	62(78.5%)	<0.05
	Moderately Severe	1(5.6%)	4(22.2%)	13(38.9%)	
	Serious	0(0%)	2(50%)	2(50%)	
	Severe/Maximum	2(40%)	3(60%)	0(0%)	

Key: for the cell with a value below 5 Fisher exactly Test was used to calculating the P-value

Table 7: Mean ABSI and TBSA for survivors and non-survivors

Variables	**Mean score for survivors ± SD**	**Mean score for non-survivors ± SD**
ABSI	4.680 ± 1.436	10.667 ± 2.027
TBSA	25.068 ± 1.436	71.667 ± 13.642

4.1.4 Severity of Burn Injury

The logistic regression analysis findings showed a statistically significant association of severity of burn injury with age, gender, address, and cause of burn injury. Patients above or equal to 10 years were 3.158 times more likely to have more severe burn injuries than those below ten years (AOR = 3.158, 95% CI 2.897 – 3.443, p 0.006). Male patients were two times more likely to have more severe burn injuries than females (AOR = 2.24, 95% CI = 0.414 – 35.92, p 0.003). Burn injury caused by fire resulted in four times more severe burn injury than scald (AOR = 4.30, 95% CI 1.460 – 23.17, p 0.033). Patients living in Iringa were around three times more likely to suffer from severe burn injuries than those in Dodoma (AOR = 2.83, 95% CI = 0.834 – 4.738, p <0.05)).

Table 8: Univariate and Multivariate Regression analysis of the severity of burn injury and risk factors of burn injury

Variables	OR	95% CI Lower	95% CI Upper	P-value	AOR	95% CI Lower	95% CI Upper	P-value
Age								
<10	**Ref**				**Ref**			
≥ 10	4.031	1.393	11.669	0.001	3.158	2.897	3.443	0.006
Gender								
Female	**Ref**				**Ref**			
Male	5.907	2.406	14.503	<0.001	2.24	0.414	35.92	0.003
Cause								
Scald	**Ref**				**Ref**			
Fire	7.283	2.486	23.118	<0.001				0.033
	0				4.30	1.460	23.17	
Address								
Dodoma	**Ref**				**Ref**			
Iringa	0.735	0.34	1.588	0.434	2.83	0.834	4.738	<0.001

4.2 DISCUSSION

4.2.1 Demographic Data

In this study, the predominant age group was under five years, similar to different studies done in Tanzania and other parts of East Africa. (Ringo & Chilonga, 2014; Chalya et al., 2011). But this study differed from the studies done in China and the USA, where the predominant age group was 5 to 15 years. This might be because proper kids' handling was done in HICs with proper housing infrastructures (Weedon & Potterton, 2011; Ho & Ying, 2001). Male patients were predominant in this study, which is not far from many studies done worldwide, but this differed from studies done in India, where female patients were more prevalent than male patients (Heng et al., 2014; Peden et al., 2008). The reason being that females were more involved in cooking more than males (Rimoy, Premji, & Matemu, 2008). The other significant risk factor was epilepsy, similar to epidemiological studies done in Africa. This is because; most of the patients were not on regular epileptic medications, poor follow-up, and traditional beliefs. (Chester, Jose, Aldlyami, King, & Moiemen, 2006). Nevertheless, the other risk factor was child abuse in study and other studies done in Africa, the reason being that most of the mothers were not aware of child abuse (Hight, Bakalar, & Lloyd, 2015).

The most common cause of burn injury in this study was scald, followed by flames burn injury, this might be due to our local settings kitchens and the common source of fire. This is similar to the research done in Tanzania, other parts of East Africa, and also studies done in the USA and South Africa that involved pediatric patients (Edelman et al., 2010.; Heng et al., 2014; Ashley Van Niekerk, 2007; Ok et al., 2009; Peden et al., 2008). In adults, the most common cause of burn injury is flames because of different risk factors: epilepsy, alcoholism, smoking, and cooking. However, in children, the most common cause of burn injury is scald because of poor handling or a proper caretaker of these kids (Baba, Sharma & Waini, 2019; Lam, Duc, & Nam, 2019 & Chalya et al., 2011).

4.2.2 Risk Factors and Severity of Burn Injury

In this study, patients with more than ten years had severe burn injuries compared to their younger counterparts. This finding is similar to a study done by Chalya et al. (2011) in Mwanza, Albertyn et al. (2006) in Kenya, and Ok et al. (2009) in Korea, and Bain et al. (2005) in India. In older patients, the most common cause of burn injury is fire, which contributes to 4 times the severity of burn due to long contact time in flames injury while removing the patient from the source of burn. But for patients below ten years, the most common cause of burn injury was scald in which the contact time was less compared to flames, which also depends on the viscosity of the fluid.

Male patients were reported to have more severe burn injury compared to female patients because the common cause of burn injury in older male patients being flame and electric burn injury, which are both associated with severity of burn injury similar to studies done by Ok et al., (2009), and Alberytyn et al., (2005). However, this was different from Bain et al. (2005) and other studies in India, Ghana, and Kenya, where females were at risk of more severe burn injuries than males. Also, the mortality rate was higher in females compared to male patients. The reason being that female patients had flames burn injury due to the common type of fuel used in cooking (Albertyn et al., 2006; Alemayehu et al., 2020).

Patients living in Iringa had more severe burn injuries than those residing in Dodoma; this could be because of cold weather in mountainous areas in Iringa, where these patients were using firewood to keep themselves warm. This is similar to the study done in the USA, showing that in cold weather, the skin is not able to tolerate a heat temperature of 44 degree Celsius, thus making it more susceptible to severe burn injury in flame exposure (Jeschke et al., 2020; Log, 2017).

4.2.3 Adequacy of Fluid Resuscitation

In this study, 51(48.1%) of the patients received an adequate amount of fluid resuscitation. This is close to the findings (46%) in a study done by Ringo et al. (2014) in Kilimanjaro (KCMC) and studies done in Mwanza (BMC) and Dar es salam (MNH) by Chalya et al. (2015) and Temu et al., (2008) respectively. These could be because all these studies were done in government hospitals with similar practices in the same country due to inadequate supplies in these hospitals. Also, they had the same treatment protocol. The other reason could be the patients' socioeconomic status, which resulted in delay and inadequate fluid resuscitation, compared to studies done in HICs where more than half of the patients had received an adequate amount of fluid. (Pruitt, 1978)

In this study, there was a significant mean difference of vitals in urine output and MAP of patients who had received adequate fluid resuscitation. Therefore these two vitals are critical in fluid resuscitation. These findings are similar to a study done by Reckler et al. (1971) in Texas, where the MAP and urine output was used to monitor fluid resuscitation adequacy. This is also, similar to a study done by Guly et al. (2011) in the UK, where it was reported that there was no significant change of pulse rate and respiratory rate because apart from fluid loss, these vitals were also influenced by anxiety, pain, core temperature and other injuries that the patient might have had.

These findings differs from a study by Paydar et al. (2016) in Australia, where there was no significant pulse rate change, blood pressure, and mean arterial pressure. This might be because this study was done on patients with blunt or penetrating trauma, where the pathophysiology of fluid loss in these patients differed from the burn injury patients, especially in the first 24 hours. The other reason could be that trauma patients in shock class III and above were given colloids and blood transfusions in the first 8 hours, which is not recommended in burn injury patients. Zoltan et al. (2007 in Sweden) also had different findings, where they reported no significant change of MAP, pulse rate, and respiratory rate in the first 12 hours of fluid resuscitation in significant burn injury above 20%. However, there was a substantial change in urine output in 24 hours of fluid resuscitation. This difference might be due to patients' selection; TBSA above 20%, and those who had required intermittent positive ventilation and the rate of fluid administration in these patients were slow. It was also reported that there was some delay in fluid resuscitation from the time the vitals were initially taken.

4.2.4 Association of Severity and Outcome of Burn Injury

In this study, the mean ABSI score among survivors was 4.68 ± 0.18 and 10.67 ± 2.03 among non-survivors; this is not far from a study done in the USA by Berndtson et al. (2013), who reported a mean score among survivors of 7.7 ± 0.2 and 10.3 ± 0.6 among non-survivors. These findings are similar to the results by Oladele et al.

(2018) and Moustafa et al. (2018), ABSI score above ten was associated with the probability of survival below 20%. In this study, the mean TBSA was 25.07 ± 1.44% among survivors and 71.67 ± 13.64 % among non-survivors, which was near similar to studies done In the USA and Australia by Kazis et al. (2002) and Allison et al. (2013). In Africa, Herndon et al. (2012), Lumenta et al. (2005), and Ringo et al. (2014) reported similar findings. The higher the TBSA, the higher the risk of systemic complications.

Patients who died had ABSI score above 6; despite being given adequate fluid resuscitation, there are other causes of mortality and morbidity of a burn injury: respiratory failure, sepsis, and multi-organ failure. However, the early causes of death are; shock, acute respiratory distress syndrome, fluid deficit despite the severity of burn injury, and multi-organ failure (Williams, Herndon, Hawkins, et al., 2009). Other complications occur while administering fluid for resuscitation. These also contribute to morbidity and mortality in burn injuries. These complications are coagulopathies and reperfusion-mediated injury (this is due to free radicals that are produced in injured tissue, and if blood from that area goes to other healthy tissue, it carries along with it the free radicals, which will cause damage to these healthy tissues). Coagulopathy has been reported because of a large amount of fluid resuscitation, causing hemodilution (Blajchman et al., 1994; Duke, 1910; Hellem et al., 1961; Marcus, 1990).

CHAPTER FIVE

CONCLUSION, RECOMMENDATION, AND SUGGESTIONS FOR FURTHER RESEARCH

5.1 Conclusion

In this study, the common causes of burn injury were scald followed by flames, of which flame injury was more severe. The common age group most affected were patients below ten years, but those above ten years had three times the risk of severe burn injury. Similarly, males had more severe burn injuries. The severity of burn injury had also an impact on early outcome despite the fluid adequacy. In this study less than 50% of the patients received inadequate fluid resuscitation, in which they were seven times more likely to have a poor outcome (deteriorate or died) within the first 48 hours of burn injury.

5.2 Recommendation

i. Patients with ABSI score above 6 are at higher risk of severe complications of burn injury. Therefore, this could be a criterion for admitting the patients in ICU for close monitoring. The ABSI score could also be adapted to assess the severity of burn injury in our local settings.
ii. A formal strict protocol of fluid resuscitation should be followed for more than 24 hours because for those patients who receive an adequate amount of fluid, the outcome is good despite the severity of burn injury.
iii. There should be other research that is done for 48 hours.

5.3 Limitation of the Study

The technical limitations were;

i. The inability to take blood pressure when the patient was burned in all limbs. Instead, a gauze was kept before putting the cuff
ii. Not following patients for more than 24 hours.
iii. This study has not done laboratory investigation to rule out other causes of poor early outcome of burn injury.

5.4 Further Research

Duration of follow up should be prolonged for about five days so to follow up for proper severity of burn injury.

The type of fluid used for resuscitation in a large surface area after the hypodynamic phase of burn injury, which lasts for 24 hours, is above 50% as maintenance fluid in TBSA.

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APPENDICES

Abbreviated burn severity index (ABSI). (Ahmed, El, Ali, & Taha, 2018)**.**

Variable	Patient Characteristics	Score
Sex	Female	1
	Male	0
Age in years	0-20	1
	21-40	2
	41-60	3
	61-80	4
	81-100	5
Inhalation injury		1
Full-thickness burn		1
Total Body Surface Area (%)	1-10	1
	11-20	2
	21-30	3
	31-40	4
	41-50	5
	51-60	6
	61-70	7
	71-80	8
	81-90	9
	91-100	10
Total Burn Score	**Threat to Life**	
2-3	Very low	
4-5	Moderate	
6-7	Moderately severe	
8-9	Serious	
10-11	Severe	
12-13	Maximum	

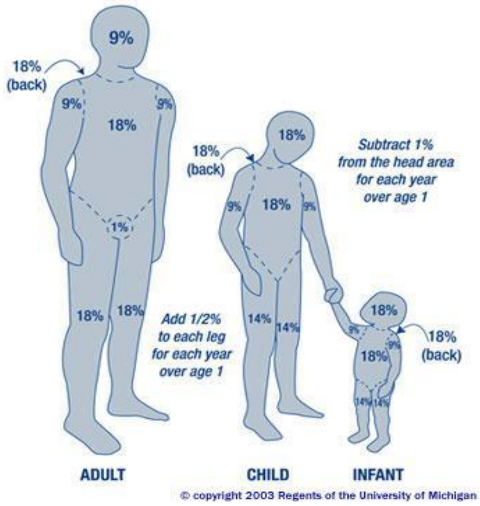
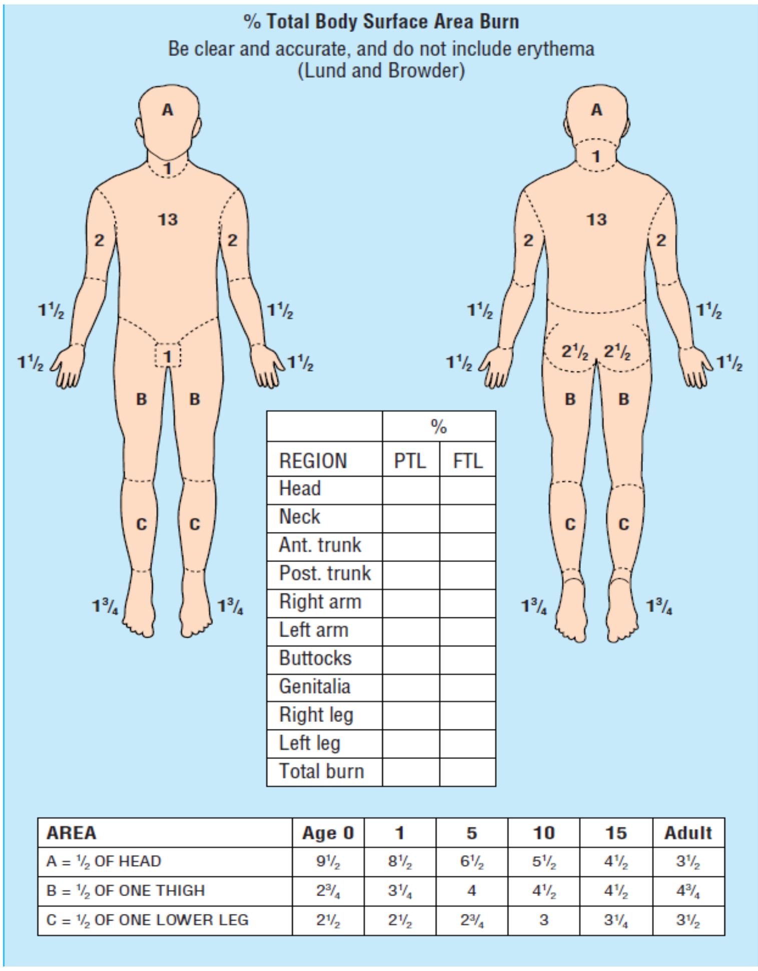


Figure 3: The Wallace rule of 9 for all age groups. (Hettiaratchy & Papini, 2004).



	%	
REGION	PTL	FTL
Head		
Neck		
Ant. trunk		
Post. trunk		
Right arm		
Left arm		
Buttocks		
Genitalia		
Right leg		
Left leg		
Total burn		

AREA	Age 0	1	5	10	15	Adult
A = ½ OF HEAD	9½	8½	6½	5½	4½	3½
B = ½ OF ONE THIGH	2¾	3¼	4	4½	4½	4¾
C = ½ OF ONE LOWER LEG	2½	2½	2¾	3	3¼	3½

Figure 6. Lund and Browder Chart (Hettiaratchy & Papini, 2004)

Appendix 1: Consent to participate in this study

Greetings! My name is Dr. Gloria Wilcharles Lyimo; I am working on this research project to assess the severity and resuscitation outcome of burned injured patients admitted in all affiliated UDOM teaching hospitals in Tanzania.

Purpose of the study

This study will collect information on the severity and resuscitation outcome of burned injured patients admitted to all affiliated teaching hospitals in Tanzania. You are being requested to participate in this study because you are particulars/ information that will be taken will be used for this research and will certainly not bother you or cause any discomfort to you.

What Participation Involves

If you agree to participate in this study, the following will occur:

1. Your information will be taken by interviewing, and vitals will also be measured. Then this information will be used to assess the outcome of resuscitation in burn injuries.

2. No identifying information will be collected from you during this, except your age, level of education, and residence.

Confidentiality

I assure you that all the information collected from you will be kept confidential. Only people working in this research study will have access to the data. We will be compiling a report, which will contain responses from patients admitted to these hospitals. We will not put your name or other identifying information on the records of the information you provide.

Risks

You will be asked questions about conflicts in your family. You may refuse to answer any particular question and may stop participation at any time.

Rights to Withdraw and Alternatives

Participating in this study is completely voluntary. If you choose not to participate in the study or decide to stop participating in the study, you will not be harmed. You can stop participating in this study at any time, even if you have already given your consent. Refusal to participate or withdraw from the study will not involve penalty or loss of any benefits you are otherwise entitled to in the health facility and community.

Benefits

The information you provide and the vitals that will be obtained will help formulate the resuscitation protocol in burn injuries and, therefore, improve the outcome.

In Case of Injury

We do not anticipate that any harm will occur to you or your family due to participation in this study.

Who to contact

If you ever have questions about this study, you should contact the Study Coordinator **Dr. Gloria W Lyimo,** University of Dodoma, Health, and Allied Sciences. (Tel. No. 0752025566).

Signature

Do you agree to participate and for you to answer questions?

Agrees [__]

Disagree [__]

I ______________________ have read/understood the contents in this form. I agree to participate in this study.

Signature of Participant _________________________

Signature of witness (if participant cannot read) _________________________

Signature of research assistant _________________________

Date of signed consent _________________________

Appendix 2: Questionnaire

SECTION A: Demographic Data:

1. Initial of the patient:
2. Age:
3. Gender:
4. Address:
5. Occupation:
6. Education level:
7. Date of admission:
8. Bodyweight:

SECTION B: RISK FACTORS OF BURN INJURY

9. Cause of Burn:
    a. Flame: from superheated, oxidized air
    b. Scald: hot liquids
    c. Contact: being in contact with a hot or cold object
    d. Chemicals: in contact with noxious chemicals
    e. Electrical: conduction of electricity in a tissue

10. Does the history correlate with the mechanism of injury?

11. History of epilepsy or seizer disorders that have caused burn injury YES/NO:
    - Regular treatment Yes or No:
    a. Is the patient having any disabilities:
        1. If yes, which:
        2. Was it predisposing to injury? Yes/No:

SECTION C: SEVERITY OF BURN INJURY

12. Total body surface area: (needs grading for assessment, Wallence rule of 9)

13. Degree of Depth of burn injury: (needs grading for assessment with)

14. Signs of inhalational burn injury: (list them)

15. Age of burn: (also needs grading system)

SECTION 4: TREATMENT OUTCOME

16. Assessment before the patient is resuscitated:
    a) Level of consciousness:
        - Pediatric patients use AVU:
        - Adult-use GCS:

    b) Dehydration status:
    c) BP
    d) PR
    e) RR
    f) Temp
17. Resuscitation
    a) The fluid administered:
        - Type

          ………………………………………………………………………
          ……………
        - The amount and for how long

          …………………………………………………………….
18. Assessment of the patient after 24hrs of resuscitation:
    a) Level of consciousness:
        - Pediatric patients use AVU:
        - Adult-use GCS:

    b) Dehydration status
    c) BP
    d) PR
    e) RR