

UNIVERSITY OF KWAZULU-NATAL

**CHARACTERISTICS AND RISK FACTORS OF BURN INJURIES IN CENTER
HOSPITAL UNIVERSITY OF KIGALI (CHUK)/ RWANDA**

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**CHARACTERISTICS AND RISK FACTORS OF BURN INJURIES IN
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By


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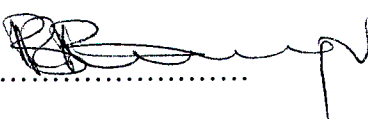
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DECLARATION

I, Florence Mukarugwiza, declare that this dissertation titled “**Characteristics and risk factors of burn injuries in Rwanda**” is my own work. It has not been used previously in fulfillment of another degree at this University, or any other. Any use of the work of others has been fully noted in the text and in the reference list.

Student Signature.....

Date.....28.11.2008

Supervisor Signature.....

Date.....29.11.2008

DEDICATION

***THIS DISSERTATION IS DEDICATED TO THE ALMIGHTY, THE GOD OF THE
WHOLE HUMAN RACE TO WHOM NOTHING IS TOO DIFFICULT.
TO ALL TRAUMA AND CRITICAL CARE NURSES FOR THEIR COMMITMENT
TO SAVE AND SUSTAIN LIFE, TO MY FAMILY AS WELL.***

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ABSTRACT

Introduction: Burns are serious health problems associated with high mortality and morbidity. Burn deaths include burns from residential fires and scalds, clothing burns, industrial injuries, electrical injuries, among other sources of thermal energy.

Aim: The aim of the study was to identify risk factors and describe characteristics of burn injuries in Rwanda. Ninety eight patients of all ages were selected and stratified by age, sex, burn size, causes of burn, and province of residence. Most of the patients (54.5%) were below the age of 12. Among children, 6% were aged between 0 and 11 months, 38% were aged between 1 and 5 years, 11% were between 13 and 21 years, 34% were adult between 22 and 49 years, and 3% were senior persons of above 50 years. The male population accounted for 55% of the total sample population, whereas the female population accounted for 41%.

Method: A quantitative retrospective descriptive survey was used in this study intended at reporting the characteristics and risk factors of burns in Rwanda.

Results: The study finds a statistical correlation between gender and agent since 90% of contact burns occurred among the female population, although more male persons were affected by chemical burns (73%) in comparison to incidence among the female population (27%). Scalds were the most common type of burn among children of 0 to 5 years of age as well as among adults.

Flame burns predominated in older children. Large burn size was the strongest predictor of mortality. Among the twenty eight resultant deaths observed, twenty (71.4%) had a TBSA > 20%. Burn patients from rural areas had a higher mortality rate compared to patients that came from the urban context of the city of Kigali. The Southern Province recorded the highest mortality rate (100%) followed by the Northern Province (62.5%) and the Eastern Province (45.4%). The city of Kigali has a mortality rate of 19%, notwithstanding its high frequency rate in terms of hospital admission (34.7%).

Moreover, the study found that 25% of patients from the city of Kigali with major (more than 20%) TBSA recovered without disability, while none (0%) from the rural areas survived. Large burn size was the strongest predictor of mortality, followed by the rural factor (residence), and by the presence of inhalation injury. Infants and young children had the highest risk of death from burn injury. Burns smaller than 20% TBSA, without an inhalation injury (such as small scald injuries), are occasionally lethal in burns for both adults and children.

Conclusion: The consequences of fire and burn injuries are so large and potentially devastating that efforts for their prevention should be proportionally much greater than reflected in mortality statistics. Some individuals feel that large burns are a worse fate than death (MacKenzie et al 1989). The scars of burn victims should remind us that prevention of these injuries must have high priority and attention now than they have had in the past.

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LIST OF ABBREVIATIONS

1. ABA: American Burn Association.
2. AAAPCC: American Association of Poison Control Centers
3. CHUK: Center Hospital University of Kigali
4. ED: Emergency Department
5. EMR: Emergency Medical Response
6. FEMA: Federal Emergency Management Agency
7. IRTAD: International Road Traffic and Accident Database.
8. ICU: Intensive Care Unit.
9. LMICs: low- and middle-income countries
10. SOU: Statens Offentliga Utredningar (*State Public Inquiries, in Swedish*).
11. TBSA: Total body Surface Area.
12. US: United States
13. USFA: US Fire Administration (USFA).
14. WHO: World Health Organization

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CHAPTER ONE: INTRODUCTION

1.1 Problem background

Burns are among the most severe kinds of harm that may ever affect a human being. In all societies, burns continue to constitute a medical, psychological and economic problem (Hemeda, Maher and Mabrouk, 2003). Physical and psychological effects increase markedly according to the extent of the burn. As a result of this, extensive burn survivors are more prone to develop long-term physical and psychological sequelae with devastating consequences, not only to them but also to their families and the larger society (Pruitt and Mason, 1998).

Globally, fire related burns are responsible for about 265 000 deaths annually (Murray and Lopez, 1996). Over 90% of fatal fire related burns occur in developing or low and middle income countries (LMICs), with Southeast Asia alone accounting for over half of these fatalities (Murray and Lopez, 1996). In the United States, close to 1.2 million people are treated annually for burn injuries. Of these, approximately 6000 die and 60 000 require hospitalisation (Newberry, 2003). The Centre for Disease Control reports that approximately 4000 fire and burn related deaths occur annually in the United States (CDCP, 1997)¹. The burn problem is even relatively worse in less industrialised countries where absence of specialized burn care results in much worse morbidity, disability, and mortality of burn victims (Mock, Adzotor, Denno, Conkilin and Rivara, 1995). While much has been accomplished in the areas of primary and secondary fire and burn prevention in many developed or high income countries (HICs), such as

¹ Centre for Disease Control and Prevention (CDCP)

the United States, through sustained research on epidemiology and risk factors, the same cannot be said of many low and middle income countries (LMICs) (Forjuoh, 1996).

Developing countries have a high incidence of burn injuries which have aggravated public health problems (Rajeev and Ahuja, 2004). High population density, illiteracy, and poverty are the main demographic factors associated with high risk to burn injury (Rajeev and Ahuja, 2004). Although it is difficult to determine the exact number of burns that occur, judicious extrapolation suggests that India, with a population of over 1 billion, has 700 000 to 800 000 burn admissions annually. This high incidence makes burns an endemic health hazard. The interaction of social, economic, and cultural factors with such incidences makes the management, reporting, and prevention of burn related stress more complex (Rajeev and Ahuja, 2004).

In South Africa, burns are the third most common external cause of death among children under 18 years of age (Van Niekerk, Rode and Laflamme, 2004). Most burns are caused by thermal energy, including scalding and fires, while some are caused by exposure to chemicals, electricity, ultraviolet radiation, and ionizing radiation (Murray and Lopez, 1996). In China, and especially in Shanghai, flame related injuries outweigh scald-related injuries (Tang, Liu, Zhang, Liao and Gomez, 2006). In terms of gender, women are at greater risk of fire related burn injuries than men. However, data from population and medical centres' surveys suggest that in some settings, males may be at greater risk than females (Chan, Hairol, Imtiaz, Zailani, Kunar and Somasundaram, 2002; Zhu, Yang and Meng, 1988). Also, many studies reveal a higher proportion of burn related injuries among young children compared to other age groups (Liu, Khatri, Shakya and Richard, 1998; Tang *et al*, 2006). In turn, most of the deaths from burn

incidences are caused by smoke inhalation in residential fires rather than by the burns themselves. Smoke inhalation can increase mortality rate by 10 fold more than the same size burns (Murray and Lopez, 1996), and most of such deaths occur at the fire scene. Burn deaths include burns from residential fires and scalds, clothing burns, industrial injuries, electrical injuries and other sources of thermal energy.

Like other injury mechanisms, burn prevention requires adequate knowledge of epidemiological characteristics and associated risk factors (Forjuoh, 1996). In Rwanda, not unlike other developing countries, the load of burn related injuries is poorly recorded. In a study on injuries at the CHUK hospital, Nsereko (2007) found that burn related injuries accounted for 14% of all observed injuries. Some of the incidents occurred in the area surrounding the Kigali Referral Hospital, while others were referrals from hospitals all over the country. Awareness of burn risk factors and specific associated characteristics can contribute towards the provision of effective prevention measures.

1.2 Problem statement

Burns continue to be a major environmental factor responsible for significant morbidity and mortality in developing countries (Lairi, and Rossignol, 2000). Over 90% of fatal fire burns occur in developing or low and middle income countries (LMICs), with Southeast Asia alone accounting for over half of these fire deaths (Murray and Lopez, 1996). However, the extent of the problem varies significantly according to demographic sub-groups, regions and national income level (WHO, 2002). One factor which makes burn injury more problematic in less

developed countries, is the absence of specialised burn care. This factor contributes to the worsening of morbidity, disability and mortality among burn victims (Barss, Smith, Baker and Mohan, 1998).

Burn management in developing countries is fraught with difficulties (Rajeev and Ahuja, 2004). Lack of government initiative and low literacy levels preclude effective prevention programs. Regarding poor burn management in developing countries, Rajeev and Ahuja cite a number of causal factors, including the fact that most burn centres are situated in large cities and are inadequate to cater for high burn injury incidence; resuscitation is often delayed as patients have to travel long distances, which is exacerbated by poor transport facilities as is the case in Rwanda, due to the lack of formal pre-hospital care. Many burn centres are plagued by a lack of resources and lack of operating time; often there are no dedicated burn surgeons, and serving general surgeons lack formal training. There is generally no coordination between district hospitals and tertiary burn centres; and burn nursing is not a recognised concept. All these factors make excisional surgery impossible for a large percentage of patients (Rajeev and Ahuja, 2004).

Rural location appears to be a consistent risk factor in burn related injuries (Courtright, Haile and Kohls, 1993; Zhu, Yang and Meng, 1988) as is it for the home (Delgado, Ramirez-Cardich, Gilman, Lavarello, Dahodwala, Bazan, 2002; Liu, Khatri, Shakya and Richard, 1998). Developing countries are predominantly rural, and the time delay in patients reaching specialised care contributes to increased morbidity. This is the case with this study on burn injuries in Rwanda, which is predominantly rural. This is further exacerbated by the presence of environmental risk factors, including storage of flammable substances in the home, shelving of

cooking equipments within reach of children, and the location of houses in slums and congested surroundings.

Since the etiological factors of burn injuries vary from one community to another, careful analysis of epidemiological features in every community is needed before sound prevention programmes can be designed and implemented (Ashraf, Aida, Ahmed, Mandil, Nabil, Mervat and Moustafa, 1997). In Rwanda, causal and exposure factors to burn injuries are hardly known, which means it is not viable to develop preventive measures. Hence, learning about burn injuries' characteristics and associated risk factors seems to be of serious importance in Rwanda, given the country's retarded state of scientific achievement and practice (especially with regard to the problem of burn injuries).

1.3 Purpose of the study

The purpose of this study was to describe characteristics and risk factors associated with burn injuries in Rwanda.

1.4 Research objectives

The study has pursued the following objectives:

1. To analyse characteristics of burns in Rwanda,
2. To identify socio-demographic features of burn patients in Rwanda,
3. To identify causes of burn injuries in Rwanda,

4. To ascertain risk factors associated with burn injuries in Rwanda,
5. To ascertain outcomes of burn patients in Rwanda.

1.5 Research questions

To pursue the above objectives, the study sought to answer the following questions:

1. What are the characteristics of burn injuries in Rwanda?
2. What is the rate of burn injuries in relation to socio-demographic trends in Rwanda?
3. What are the causes of burn injuries in Rwanda?
4. What are the risk factors associated with burns in Rwanda?
5. What are the outcomes of burn injury patients in Rwanda?

1.6 Significance of the study

Injuries, including burns and their related morbidity, disability and mortality, represent a public health problem of increasing importance in developing countries (Mashaly, Graitcer and Youssef, 1993). Epidemiological studies of burn injuries have highlighted risk factors that have led to the establishment of effective prevention programs (Bouter, Knipschild, van Rijn and Meertens, 1999). Anlatıcı, Ozerdema, Dalay, Kesikta, Acarturk and Seydao (2001) posit that the factors and demographic features associated with burns differ from country to country. For this reason, it is important that every nation carries out its own epidemiological study of burns. Thus, understanding of the characteristics and risk factors associated with burns in Rwanda is necessary so that adequate intervention measures may be devised. Through such understanding it

would be possible to diagnose the seriousness of the burn injury problem affecting the country, as well as obtain information on how and what prevention, treatment and rehabilitation measures are most urgently needed (WHO, 2001). The limited body of knowledge about the characteristics of burn injuries and their related risk factors in Rwanda is a major hindrance to the development of preventive and healing strategies. Hence information from this study will contribute to increasing health workers' knowledge about burns.

The findings of this study aim to underline specific characteristics and risk factors associated with burns in Rwanda, as well as their consequences. In this way, the study seeks to make available useful information for the development of adequate burn prevention programmes, thereby contributing to the improvement of burn management and the reduction of the frequency of burn incidence and burn related deaths in the country.

These findings would be particularly helpful to medical and administrative bodies, and would contribute to the creation of greater awareness, commitment and informed decision making at all levels regarding burn injury. Moreover, the study would serve as a baseline guide for further research on the quality of burn injury care in Rwanda.

1.7 Definition of terms

Polit and Beck (2006) recommend two types of definitions, namely, conceptual and operational definitions as these authors assert that a dictionary definition alone is not adequate.

1.7.1 Burn injury

The World Health Organization (WHO) defines burn injury as an unintentional or intentional damage to the body resulting from acute exposure to thermal, electrical, or chemical energy (WHO, 2001). In this study, burn injury refers to a patient admitted to the Kigali University Hospital because of burns suffered as a result of any of the above factors advanced by WHO.

1.7.2 Risk factors for burn

Risk factors for burn are factors which do not appear to be the direct cause of a disease, but are nevertheless in some way associated with the disease (Wrong diagnosis, 2007). According to this source, although a risk factor embodies the hazard which may result in a condition, it still does not always lead to a burn. Also, the absence of any risk factor, or having a protective factor, does not necessarily provide a guard against incurring a burn.

1.7.3 Characteristics of burn injury

In this study, the characteristics of a burn focus on demographic, etiologic and clinical trends. The American Burn Association (ABA) (2000) describes the characteristics of a burn in terms of depth and total burn surface area (TBSA).

Conclusion

This chapter has described the background to the problem, problem statement, purpose and objectives of the study including the significance and definitions of terms used in this study. The following chapter will examine how relevant literature can be applied to the particular analysis conducted by this study.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introductions

This chapter surveys literature on the epidemiology of burn injury. This review is posited as a wider knowledge context within which the current findings are interpreted. The review focuses on risk factors and characteristics of burns from different global contexts.

2.2 Epidemiology of burn

Burns are serious health problems associated with high mortality and morbidity (Anlati *et al*, 2001). Burn deaths include burns from residential fires and scalds, clothing burns, industrial injuries, electrical injuries, among other sources of thermal energy. Globally, fire related burns are responsible for about 265 000 deaths annually (Murray and Lopez, 1996). Over 90% of fatal fire burns occur in developing or low and middle income countries (LMICs), with Southeast Asia alone accounting for over half of such fatalities (Murray and Lopez 1996).

In the United States, close to 1.2 million people are annually treated for burn injuries. Of these, approximately 6000 die and 60 000 require hospitalisation (Newberry 2003). However The Centre for Disease Control report that approximately 4000 fire and burn related deaths occur annually in the United States (CDCP, 1997). A similar figure can be found in most of the developed countries. A World Fire Statistics Centre report, cited in Naradzay (2006), indicates that in the United Kingdom, more than 47 fire related injuries occur every day. Generally,

however, the incidence of burn injury varies from country to country, with holiday periods being a typically peak time (ibid).

The burn problem is relatively worse in less industrialised countries where the absence of specialised burn care results in much greater morbidity, disability, and mortality among burn victims (Mock *et al*, 1995). A 2001 report issued in South Africa² reveals that about 12,191 burn patients were admitted to a burn unit. In developing countries, the rate of burn injury incidences is very high. This factor has in turn further affected these countries' already weak public health systems (Rajeev and Ahuja, 2004). High population density, illiteracy, and poverty are the main demographic factors associated with a high risk of burn injury. Despite the difficulty in determining the exact number of burn occurrences, judicious extrapolation suggests that India, with a population of over 1 billion, has 700 000 to 800 000 burn admissions annually. Such high incidence makes burns an endemic health hazard there, and the interaction between this and social, economic, and cultural factors renders the management, reporting, and prevention of burns more complex (Rajeev and Ahuja, 2004).

Burn trauma continues to be a major challenge to caregivers (Newberry, 2003). In the United States, close to 1.2 million people are treated annually for burn injuries. Of these, approximately 6000 die and 60 000 require hospitalisation (Newberry, 2003). Medical care for burns has had a markedly improved survival rate. In 1940, 50% of patients with burns involving 30% or more of their total body surface area (TBSA) died. In contrast, a recent study reported no deaths for children with burns up to 40% and 59% TBSA treated between 1991 and 1997. In fact, the death rate was only 14.3% for very large burns involving 60% or more TBSA (Sheridan, and Jay,

² <http://www.doh.gov.za/docs/reports/2001/annexures.html> (In Albertyn, 2005)

2000). Another study from the same burn centre reported 3% mortality for individuals less than 60 years of age admitted without smoke inhalation (Runyan, Johnson, Yang, Waller, Perkis, Marshall, Coyne-Beasley and McGee, 2005). This decline in mortality is attributed to early excision and closure of the burn wound. Other factors contributing to this decline are improved resuscitation, control of infection, and support of hypermetabolic response. Pulmonary pathology from inhalation injury is the major cause of burn trauma deaths, most of which occur at extreme ages (Newberry, 2003).

The increased survival rate has come at a price, however, and that price is the large number of patients with disfiguring and disabling scars. Studies of burn wound healing may ultimately make a difference in controlling burn wound healing (Cass, Meuli and Adzic, 1997). Further decreases in morbidity and mortality from fire and burns will almost certainly require improvements in prevention. On this account, three different papers examined the epidemiology of fire and burn injuries with the hopes of providing information to guide prevention programs. Quayle, Wick, Gnauck, Schootman and Jaffe (2000) provide a more complete view of the epidemiology of burn injuries because of appropriate use of a registry for injuries that are treated in emergency departments, as well as those requiring hospitalisation. They found that children under five years of age suffered the highest rate of burns. Injuries were more common in poor children and those living in urban areas. The causes of these burns were diverse and varied according to age. Fire accounted for the minority of the burns, while hot objects and hot liquids were much more frequent causes, especially for those under five years.

A study by DiGuseppi, Edwards and Godward (2000) in the inner city of London found somewhat different causes for burns. Such burns resulted in emergency department visits, hospitalisation, or death. House fires were the leading cause, accounting for nearly two thirds of these injuries, followed by assaults and clothing ignition. This report differs from Quayle *et al*'s (2000) study, in that it includes individuals of all ages. Children and elderly persons were at greatest burn injury risk, just as earlier studies had demonstrated (Marshall *et al*, 1998). The London study represents an incredibly ambitious data collection effort. Multiple sources of data were examined to identify 131 injuries. DiGuseppi *et al* (2000) conclude their paper by stating that because the causes of fire and flame injuries are so varied, it is likely that “diverse interventions” are needed to reduce the toll of burn injury. A report by Clark, Dainiak and Reeder (2000) importantly gives us a glimmer of hope in stating that better prevention efforts may be possible. In Rwanda, limited data on burn injuries are available due to the lack of a burn registry in the country, however a study done by Nsereko (2007) in a referral hospital revealed that burn related injuries accounted for 14% of all observed injuries.

2.3 Risk factors

Risk factors discussed in this section include causal agents, epidemiological and environmental factors.

2.3.1 Causal agent of burn

Burns can occur in a variety of ways. In every case, burns result from the death of skin tissue and in some cases underlying tissue. Burns caused by hot objects result from the death of cells

through heat. In many cases, contact with a very hot object can damage tissue extensively. Runyan *et al* (2005) note that hot tap water is a major cause of scald, resulting in more than 3500 emergency department visits each year in the United States. Scalds from hot tap water are often more severe than other type of scalds, because they tend to involve larger portions of the body surface. Stoves, ovens, space heaters, and other appliances are also prominent sources of residential burns.

Not all burns are caused by fire. Tissue damage may be secondary to chemicals, tar, electricity, lightning, or frostbite. The location and duration of exposure to the source affects the outcome regardless of the specific source of injury (Newberry, 2003).

2.3.1.1 Thermal burns

In the USA, thermal injuries account for 60% of all burns (Newberry, 2003). They may result from flame, flash, steam, or scalding liquid (Aurerbach, 2001). In China, burn and scald injuries were within the top eight main causes of death (Tang *et al*, 2006).

2.3.1.1.1 Scald burns

Scalds from hot liquids are the most common cause of all burns (Newberry, 2003). They account for about 70% of children's burns (Hettiarachy and Dziewulski, 2004). Exposure to water at 60° C (140° F) for 3 seconds can cause a deep partial-thickness or full-thickness burn. If the water is 69° C (156° F), the same burn occurs in one second (Newberry, 2003). Other liquids that cause

scalds are cooking oil and grease. When used for cooking, oil and grease may reach 204° C (400°F).

2.3.1.1.2 Flame burns

Burns from flames are the next most common cause of burn (Newberry, 2003). They comprise 50% of adult burns (Hettiaratchy and Dziewulski, 2004). In developed countries, the number of house fires has decreased with the increased use of smoke detectors. Most flame burns are caused by careless smoking, motor vehicle accidents, and clothing ignition from stoves or space heaters. Flame burns that occur indoors are usually secondary to the misuse of cooking stoves fuelled by white gasoline, smoking while in a sleeping bag, and gasoline or kerosene on a charcoal fire (Auerbach, 2001).

According to 2003 data from the United States Fire Administration (USFA), burn injuries account for an estimated 700,000 annual emergency department (ED) visits per year. Of these, 45,000 require hospitalisation. Approximately half of these patients are hospitalized at one of the 125 specialised burn treatment centres. Studies done in Turkey, by Anlatici *et al* (2002), in Cairo, Egypt by Hemeda *et al* (2002), in Zambia by Rajeev and Ahuja (2004), and in China by Tang *et al* (2006), to list just a few, found a predominance of fire burns. Explosions of natural gas, propane, gasoline, or other flammable liquids cause flash burns, the third most common type of thermal burn (Newberry, 2003). Flash burns are usually partial thickness burns, although depth is dependent on the amount and type of fuel that explodes. Flash burns can be large, and are often associated with significant thermal upper airway damage (Auerbach, 2001).

2.3.1.1.3 Contact burns

Contact with hot objects such as metal, plastic, glass, or hot coals results in contact burns which are usually not extensive but tend to be deep (Newberry, 2003). An incidental increase has been observed among toddlers regarding contact burns caused by an increase in wood-burning stoves (Auerbach, 2001). In a retrospective review of burn patients discharged from the Shanghai's Rui Jin Hospital Burn Unit conducted by Tang *et al* (2006) between March 01, 2002 and April 30, 2003, the contact burn incidence rate was found to be 14.9%.

2.3.1.2 Electrical burn

Injuries from electricity have been reported for almost 300 years. The first recorded death caused by electrical current from an artificial source was reported in 1879 when a carpenter in Lyons, France inadvertently made contact with a 250-volt AC generator (Jex-Blake, 1975). The first United States fatality occurred in 1881, when a local inebriate, Samuel W. Smith, passed out on a similar generator in front of a crowd in Buffalo, New York. The apparent painlessness of his death impressed the crowd; as a result of which electrocution became considered a “humane” mode of execution (Kobernick, 1986). Electrical burns account for 4% to 6.5% of all admissions to burn units, and for approximately 1000 fatalities per year in the United States (Lee, 1997). Most electrical fatalities and adult admissions to burn centres from electrical injuries are occupationally related. Children have a predisposition to injuries from low voltage sources, such as electric cords, because of their limited mobility within a relatively confined environment (Baker and Chiaviello 1889). During adolescence, however, a more active exploration of the

environment is possible, which may lead to more severe high voltage injuries or death. In Turkey, Anlatıcı *et al* (2001) found quite a high incidence (16.8%) of electrical injuries among children. Playing with electrical devices, contact between kites and power lines, and lack of parental supervision were prominent causal factors of electrical burn injuries in this population age group. Globally, as pointed by Hettiaratchy and Dziewulski (2004), some 3-4% of burn unit admissions are caused by electrocution injuries which can result in extensive tissue damage.

2.3.1.3 Lightning injuries

Since no agency requires lightning injury report, and many victims of lightning injuries do not seek treatment at the time of injury, injuries and deaths caused by lightning have been virtually unnoticed. In the United States, nearly 7000 deaths were reported in a 34 year period study that ended in 1974 (Cooper and Andrews, 1995), and fewer than 2000 deaths were reported in a 17 year period study in 1986 (Duclos and Sanderson, 2007). It is currently estimated that lightning causes 50 to 300 deaths per year in the United States, with four to five times as many victims suffering non-lethal injuries (Cooper and Andrews, 1995). Lightning injury kills more people in the United States than any other natural disaster except for floods, which have consistently been one of the top four factors of weather related mortality (Lopez, Holle and Heitkamp, 1993).

2.3.1.4 Chemical burns

Chemical burns are usually a result of industrial accidents, withstanding the fact that they may also be caused by household chemical products (Hettiaratchy and Dziewulski 2004). The many

risk factors identified include inadequate rules and regulations for managing chemicals, and inadequate first aid management of chemical burns (Tang et al, 2006). The coagulation associated with chemical injuries is related to the type, strength and concentration, duration of contact and the mechanism of action. Chemical agents may be divided into several groups depending on the mechanism by which they coagulate protein and cause tissue necrosis. Chemicals are categorized into broad groups of acidic or alkaline, and attempts to neutralize the agent can increase the thermal reaction and extent of an injury (MCQuillan, Von Rueden, Hartsock, Flynn and Whalen, 2005).

According to Cox (2005), acids are defined as proton donors (H^+), and bases are defined as proton acceptors (OH^-). Bases are also known as alkaline. Both acids and bases can be defined as caustics which cause significant tissue damage on contact. The strength of an acid is defined by how easily it gives up proton, and the strength of a base is determined by how avidly it binds proton. The strength of acids and bases is defined by using the pH scale, which ranges from 1 to 14 and is negative logarithmic. A strong acid has a pH of 1, and a strong base has a pH of 14. A pH of 7 is neutral.

Most acids produce a coagulation necrosis by denaturing proteins, forming a coagulum (such as eschar) that limits the penetration of acid. Bases typically produce a more severe injury known as liquefaction necrosis. This involves denaturing of proteins as well as saponification of fats, which does not limit tissue penetration. Hydrofluoric acid is somewhat different from other acids, as it produces a liquefaction necrosis (Cox, 2005). The severity of chemical burn relates to a number of factors, including the pH of the agent, the concentration of the agent, the length of

the contact time, the volume of the offending agent, and the physical form of the agent. The ingestion of solid pellets of alkaline substances results in prolonged contact time in the stomach, thus leading to more severe burns. In addition, concentrated forms of some acids and bases generate significant heat when diluted, resulting in thermal and caustic injury (Cox, 2005)

The long-term effect of caustic dermal burns is scarring and, depending on the site of the burn, scarring can be significant. Ocular burns can result in opacification of the cornea and complete loss of vision. Oesophageal and gastric burns can result in stricture formation (Cox, 2005). In 2003, the American Association of Poison Control Centres (AAPCC) reported that in the United States there were 22000 cases of exposure to acid, 50500 cases of exposures to alkali, 16272 cases of peroxide exposures, and 54300 cases of bleach exposures, and 2322 cases of exposure to phenols or phenol products (Cox, 2005). Still in the same year, exposure to acid products and chemicals resulted in 20 deaths, 120 cases of major toxicity, and 2362 cases of moderate toxicity. Exposure to alkali products and chemicals resulted in 12 deaths, 233 cases of major toxicity, and 4014 cases of moderate toxicity, exposure to peroxides resulted in no deaths, eight (8) cases of major toxicity, and 217 cases of moderate toxicity. Exposure to bleach and chlorate containing products resulted in one (1) death, 62 cases of major toxicity, and 2533 cases of moderate toxicity. Exposure to phenol products resulted in no deaths, nine (9) cases of major toxicity, and 242 cases of moderate toxicity. Adults and children are nearly equally exposed to chemical burns (Cox, 2005).

Clinical signs and symptoms vary depending on the route of exposure and the particular substances involved. Because of the variety of presentations, emergency physicians must be

prepared to handle all possibilities. Some exposures, such as hydrofluoric acid, may result in immediate pain and should be considered in patients with complaints of slow onset deep pain occurring after exposure to an appropriate product. Patient history should include the following: offending agent, concentration, physical form, PH, route of exposure, time of exposure, volume of exposure, possibility of coexisting injury, and timing and extent of irrigation. Cox (2005) argues that a large number of industrial and commercial products contain potentially toxic concentrations of acids, bases, or other chemicals that can cause burns (Cox, 2005).

2.3.1.5 Inhalation injury

The majority of fire deaths are caused by smoke inhalation in residential fires, rather than by the burn itself. Smoke inhalation can increase mortality by 10 fold for the same size burn, and most of these deaths occur at the fire scene (Runyan *et al*, 2005). The presence of inhalation injury is known as a predictive power for mortality secondary to burn injuries (ABA, 2000; Bloemsma, Dokter, Boxmaa and Oena, 2008; Fallon and Thomson, 2006). In addition to being associated with residential fires, heating equipment and other appliances can result in carbon monoxide poisoning. Any time a carbon based fuel, such as gas, oil, kerosene, propane, wood, charcoal, is burned, carbon monoxide is released (Runyan *et al*, 2005).

2.3.2 Demographic Risk factors

Demographic risk factors discussed hereunder include age, place and circumstances of burn, gender, season and race.

2.3.2.1. Age

In the United States, burn injuries associated with fire are the third leading cause of accidental deaths in children between the ages of 1 and 14 (McCloskey and Orr 1995; NAEMT 2001³; NFA 1995⁴; NFNA 1996⁵; Ramzy, Barret and Nerndon, 1999). Many controversies are found in the literature about the relationship between age and burn injury. In Canada, Hebert (1994) and Ad-El (2007) found that children younger than five years of age sustained the majority of burns (74%) from a 1,878 selected record. This is consistent with the findings from Shanghai where Tang *et al* (2006) observed the highest number of burn injuries to occur in patients under three years of age. However, some studies have not found any variation between adult and child incidences. This is a case with the study conducted by Anlatıcı *et al* (2001) in Turkey. In contrast, in their investigation of burn epidemiology in Cairo, Hameda *et al* (2002) found a higher incidence of burns among the adult population than among infants.

Most international findings show that fire and burn injury is the fifth leading cause of child accidental injury related death (Ad-El, 2007). Children make up 20% of all fire deaths, and over 30% of all fires that kill children are ignited by children playing with fire (Ad-El, 2007). This author posits that children aged four and under are at the greatest risk because of several factors. Young children have an underdeveloped perception of danger which is combined with a limited ability to respond appropriately to a life threatening burn or fire situation. They are also more susceptible to fire related asphyxiation, and are more prone to burn than adults (Ad-El, 2007). In Greece, the estimated annual incidence of childhood firework injuries treated in EDs is seven (7)

³ National Association of Emergency Medical Technicians (NAEMT)

⁴ National Fire Association (NFA)

⁵ National Flight Nurses Association (NFNA)

injuries per 100,000 children. 70% of these injuries occur among children aged between 10 and 14 years. Boys sustain self-inflicted accidental injuries, whereas girls are injured as bystanders (Naradzay, 2006).

The United State Fire Administration (USFA) (2003) encourages parents to teach children about the danger of playing with fire from an early age in order to help prevent childhood injuries, fire deaths and the number of fires set in homes. The observation that children less than five years of age form the majority of scald cases has been consistently noted in various international studies (Alden, Hyden, Rabbitts, Bessey and Yurt, 2005; Turner *et al*, 2005). In Shanghai, Tang *et al* (2006) found that among older people (65+ years) the majority of burns are caused by flame burns related to domestic activities like cooking. In this regard, older people in this age group should be a primary target of burn preventive education. A study done by Runyan *et al* (2005) on risk and protective factors for fires, burns and carbon monoxide poisoning among households in the United States reveals that the fire burn death rate is higher among older adults, young children, people from the southern part of the country, and those living in manufactured housing or who have a relatively low income. The study further asserted that tap water that is above 49^o C (120^o F) represents a scald hazard for young children, older adults and those with sensory deprivation (*ibid*).

Findings from a study done in Alexandria, Egypt by Ashraf *et al* (1997) found a significant association between age and agent of burn injury. Most scald burns (76.5%) occurred in children of 10+ years, while in the older age groups flame was the most common agent. In Shanghai, a developing country, Tang *et al* (2006) observed the highest number of injuries occurred in

patients under three years of age. In another study that focused specifically on paediatric burns in Shanghai, Tang *et al* (2006) indicated that children of migrant workers are at much higher risk of sustaining burns than are Shanghai residents, and that most of the injuries are associated with hot water scalding and, where reported, “domestic incidents” (ibid). And since care-givers to these child victims may lack adequate education, it would be helpful to evaluate the level of knowledge of household safety and first aid among migrants (Ashraff *et al*, 1997). A 2000 report by The World Fire Statistics (WFS) reveals that in Bergen, Norway, the incidence of burns was then 17 cases per 10,000 inhabitants, with about 10% incidence occurring among people aged over 60 years, while over a third of the incidences occurred among children younger than 15 years of age (Naradzay, 2006). Most scald burns on children, especially small children aged six months to two years, are caused by hot foods or liquids spilled in the kitchen or other areas where food is prepared and served. Within three seconds, a child's skin can be burned severely enough to require surgery when they are scalded with water temperature greater than 49⁰ C (120°F) (Naradzay, 2006)⁶.

2.3.2.2 Place and circumstances of burn and gender

The home is the principal environment in which fire related burn injuries occur (Runyan *et al* 2005). Stoves, ovens, space heaters and other appliances are also major sources of residential burns. In an epidemiological and socio-cultural study on burn patients in Alexandria, Egypt, Ashraf *et al* (1997) posit that the majority of burn injuries (91.4%) occurred in the home. Ying and Ho (2001) reviewed paediatric burns in Hong Kong, and found that scald injuries at home accounted for the majority of burns. The place of occurrence of injury and gender were found to

⁶ Water heater temperature must be set lower than 49⁰ C (120°F) (Naradzay 2006).

be significantly associated. A vast majority (93%) of occupational and street burns were found among males, more than half (56.9%) of domestic cases were found to have occurred in the kitchen, while about 20.4% of incidences were found to have occurred in the bathroom. Cooking was the activity most often responsible for burn occurrence and was rated at 63.5% in a study by Ying and Ho (2001).

Minor burns are more common among younger adults, often as a result of cooking or occupational exposures. Teenage males are at increased risk of injury from fireworks, and scald injuries are more common in young children. Most scald injuries in young children result from improper setting of domestic hot water heaters and spillage of cooking pots or beverages, although both types of injuries are easily preventable (Naradzay, 2006). Naradzay (2006) also found that workplace based adult injuries were the most common. The majority of these injuries were reported as flame burns, but other etiologies were also prominent and thus cannot be overlooked. The diversity of burn etiologies reflected the wide range of working environments involved. It included a vast range of professionals from construction workers, factory workers, technicians and manual laborers who run their own firms. This diversity makes the workplace one of the most difficult environments for injury prevention.

The general categories of burn injuries include various contrasts between life-threatening and non-life-threatening injuries, accidental and intentional injuries, recreational and occupational injuries, and between domestic (home or residence) and industrial injuries (Naradzay, 2006). In the United States, nearly 1 million Americans seek ED treatment or an entity of the Department of Homeland Security and Federal Emergency Management Agency (FEMA). Between 1994

and 2003 an average of 4060 Americans lost their lives and another 22650 were injured annually as a result of fire. Not included in this data are deaths attributed to terrorists made fire in the September 11, 2001 event (Naradzay, 2006).

A study by Runyan *et al* (2005) reported that flame represented the most common agent of burn injuries (66.8%) and tended to affect more females than males, with kerosene stoves being the most common source (53.2%) of incidence. The agent and the place of occurrence of burn injury were significantly associated with most flame, scald and electrical burns in the home (94.9%, 95.0% and 61.9%, respectively), while most chemical burns (56.3%) occurred in the streets. Most of the burns in the age group of 10+ years of age were by scalding (76.3%), while flame was the most common agent in other age groups. Clothing ignition was found in 82.9% patients of flame burn, of which 61% were females. Among those with clothing ignition, 71% were wearing clothing made of synthetic material, 20% had clothes soiled with flammable liquids, and 51% were wearing tight clothing (*ibid*).

2.3.2.3 Gender

In terms of gender, findings are not *per se* uniform. Some studies have found that burns are predominant among males (Ahmad, Shahid, Khan and Malik, 2006; Anlatıcı *et al*, 2001; Tang *et al*, 2006), while others have found a higher prevalence of burns among females (Albertyn, Bickler and Rode, 2005; Hemeda *et al*, 2002). For example, on the one hand, Albertyn *et al* (2005) found a higher burn rate among adolescent girls than boys in Africa, as a result of the former's greater involvement in household chores. On the other hand, Hemeda *et al* (2003) and

Anlatici *et al* (2001) found that burns were most frequent among older male children than among older female children. Many international studies (Ahmad *et al*, 2006; Naradzay, 2006; Tang *et al*, 2006) indicate that most burns experienced by females occur in the context of the home, while men experience burn injuries outdoors in association with a working environment. Moreover, rural location appears to be a consistent risk factor for burn related injuries (Courtright *et al*, 1993; Zhu *et al*, 1988) as it is home of many (Delgado *et al*, 2002; Liu *et al*, 1998).

2.3.2.4 Season

Season is considered to be one of the risk factors of burn injury. Many studies show that burns are common during winter (Ahmad *et al*, 2006; Anlatici *et al*, 2001; Hemedda *et al*, 2005; Naradzay, 2006). In Greece, for example, a sharp peak of firework injuries occurs in spring when the Greek Orthodox Easter is celebrated (WFBSC⁷ 2000, cited in Naradzay, 2006). However, in Alexandria, Ashraf, Aida, Ahmed, Mandil, Nabil, Mervat and Moustafa (1997) found that summer had the highest percentage (29.6%) of burns followed by spring (27.8%).

2.3.2.5 Race

African American children are more than three times more likely to die in a fire than white children. Native American children are more than doubly more likely to die in a fire than white children are (Naradzay, 2006).

⁷ The World Federation for Burn Statistics Center (WFBS)

2.4 Clinical Characteristics of burn injuries

Burns are characterized by their degree, which is determined by the severity of tissue damage and the amount of body surface area (BSA) involved (ABA, 2000; Fallon, Thomson and Detroit, 2006). Both of these characteristics determine the severity of burn injury (ABA 2000; Fallon *et al*, 2006). Regardless of methods employed to calculate TBSA, estimation of the burned areas is somewhat subjective, with areas of clinical discrepancy (McQuillan *et al*, 2005). The primary goals in estimating the TBSA involved in a burn are to predict morbidity survival, physiological responses in relation to fluid shifts and fluid resuscitation requirement, and metabolic responses. The American Burn Association (2000) include other factors for determining the severity of burn injury, namely, over 20% TBSA burn in adult, over 10% TBSA burn in a young person, or over 5% TBSA full-thickness burn, high-voltage burn, known inhalation injury, any significant burn to face, eyes, ears, genitalia or joints significantly associated with injuries (for example a fracture or a major trauma). The concept of depth of burn injury is a significant predictor of survival, overall morbidity (including surgical management), and functional outcome. Because of depth of burn, a variety of nomenclature is used (McQuillan *et al* 2005). Generally, the depth of a burn wound describes tissue damage according to anatomic thickness of the skin involved as determined by the clinician. As a general rule, the more superficial the burn wound, the more rapidly the wound will heal (McQuillan *et al*, 2005).

A study conducted by Anlatici *et al* (2001) in Turkey on 1083 burned patients found that most of the cases were either mixed second and third degree burns (49.2% and 44.3%) or isolated second degree burns. The burn agent was significantly associated with the degree, depth and severity of

the burn wound. For example, flame burns tended to cause mixed second and third degrees, deep and severe burns. A significant association was found between the occurrence of clothing ignition and depth of burn. Many studies found a significant association between age and agent of burn injury. Most scald burns occurred among children less than 10 years, while in older age groups, flame was the most common agent (Albertyn *et al*, 2005; Anlatıcı *et al*, 2001; Delgado *et al*, 2002; Naradzay, 2006). The extent of damage depends on surface temperature and how long the skin is exposed to it. Thermal burns commonly occur in the home during ironing, cooking, and touching hot water, and can result in first degree, second degree and third degree burns (Fallon *et al*, 2006). While many thermal burns occur in the home, they are also common in the workplace in certain industries. Asphalt and tar burns, for example, are serious injuries and are often sustained by roofers, persons repairing roads, and construction workers. In many instances, burns sustained in these situations occur on the hands, but can also affect other extremities that come in contact with hot liquid. Adherence to workplace safety procedures is essential to prevent incurring such serious burn injuries (Brenner, 2001).

2.5 Management and prevention of burn injuries

Burn management in developing countries is riddled with difficulties (Rajeev and Ahuja, 2004; Albertyn *et al*, 2005). Lack of government initiative and low literacy rates preclude effective prevention programmes. Many uneducated households are fraught with superstition, taboos, peculiar religious rituals, and faith in alternative systems of "medicine" which complicates management (Rajeev and Ahuja, 2004). Most burn centres are situated in large cities, and are inadequate for the high incidence of these injuries (Albertyn *et al*, 2005). These authors note that

resuscitation is often delayed as patients have to travel long distances in poor transport facilities. Many burn centres are also plagued by a lack of resources, delay, and blood shortage. There are often no dedicated burn surgeons. Generally, surgeons involved in care are not professionally trained for the job. Also, burn nursing is not a recognised concept. All these conditions together make excisional surgery (debridement) impossible for most people. There is generally no coordination between district hospitals and tertiary burn centres. The current unsatisfactory attitudes and management of burns in Africa should not continue (Albertyn *et al*, 2005). Many factors that have devastating consequences have been identified. Not only does burn care place a heavy strain on available financial resources at all levels of care, it exerts pressure on patients' families. Estimates have indicated that the provision of adequate burn care could reduce the time spent in hospital by 35% and the overall mortality rate by 30% (Albertyn *et al*, 2005). The improvement of burn care is therefore crucial, as available epidemiological evidence suggests a significant increase in the incidence of childhood burn injuries. Because of prevention and education programs employed in developed countries, the rate there has dropped by 50% in the last 30 years. Because of the advances in treatment of burns, an individual is now much more likely to survive a serious burn injury. Since more individuals are surviving even the most severe of burn injuries, especially those burned as children, there is also, in turn, a proportionally higher rate of burn survivors in the workplace there (ABA, 2000)⁸.

In the United States, annual fire and flame mortality rate decreased by 64% between 1961 and 1996 (Clark *et al*, 2000). In rural Maine, the decrease was even larger at 73%. More notably, the rate of hospitalisation from fire and flame injuries among this population, decreased by 70%. Decreases in the rate of burn injuries between 1973 and 1998 are ascribed to the increased use of

⁸ American Burn Association (ABA)

smoke detectors and better building codes. Given the many different causes of these injuries, how should one proceed? One way to make sense of the data is to separate these burns into two groups: severe and fatal burn and fire injuries, and less severe non-fatal burns. Either way, passive strategies should be emphasized. There is little evidence that intervention programmes based on education can help to prevent burn (McLoughlin, Vince, Lee and Crawford, 1982). Instead, there is much stronger evidence indicating that passive strategies, such as smoke detectors, reducing water heater temperatures, fire-safe cigarettes, and reduced flammability of fabrics, are or could be effective (Lairi and Rossignol, 2000). Because of people like McGuire (1999) who for two decades has been working on its development and implementation, we are now closer to a fire-safe cigarette. This is very important, considering that cigarettes have been a major cause of residential fires and burn deaths (McGuire, 1999). All countries should follow these guidelines and subscribe to flammability standards for cigarettes. Although smoke detectors may work, the major challenge has been for risk exposed households to make appropriate use of them. The consequences of fire and burn injuries are so serious and potentially devastating, that efforts for their prevention should be proportionally much greater than those reflected by mortality statistics. Some individuals feel that large burns are a worse fate than death (Rice and McKenzie, 1989). Burn victims' scars should unambiguously remind us that the prevention of such injuries should receive high priority. Much more attention ought to be paid to this problem than it has received in the past.

2.6 Outcomes of burn injuries

Mortality is the most important and most readily quantifiable outcome in burn patients and can serve as an objective end point for quality control (Bloemsma, Doktera, Boxmaa and Oena, 2008). The factors determining the severity of the burn are the area of the burn, the thickness, and the localization of the burn, patient's age, general condition and the cause of the burn as well (American Burn Association, 2000; Fallon et al, 2006). It is recommended that the time of admission and appropriateness of the centre should be added to these factors (Arife, Emrah, Mahir, Hakan, Yusuf and Faruk, 2003).

A comparison study by Bloemsma, Doktera, Boxmaa and Oena, (2008) between results from the Rotterdam Burn Centre (RBC) and the American National Burn Repository (NBR) found that mortality rate at the RBC was 6.9% and at the NBR was 5.6%, while almost no differences in age or total body surface area were involved. The discrepancy in mortality rate might have been due to the high incidence of inhalation injury among the RBC population. However, the mortality rate at the RBC after admission with intention to treat decreased to 4.9%. The most frequent cause of death appeared to be multi-system organ failure in 64.9% of cases; 93% of these had systemic inflammatory response syndrome at the time of death and, in 45.9%, infection was deemed responsible for the fatal clinical deterioration (in 21.3% sepsis was proved and in 24.6% sepsis was highly suspected).

In a study conducted by Ashraf *et al* (1997) in Alexandria, the case fatality rate found was 33%. Through the application of univariate analysis, a higher case fatality rate was observed among older age groups through flame as agent, a larger TSAB with deep burns and high degrees

especially among patients who had delayed in seeking professional care. According to the USFA (2003), 3925 American civilians lost their lives in 2003 as a result of fire; 18125 civilian injuries occurred due to fire; and 111 fire-fighters were killed in duty-related incidents. It is however estimated that the number of fire and burn related deaths in developed countries has declined since the 1969s. This decline has been factored by various reasons including improved burn care (i.e. quality burn centres, recognition, and effective management of burn shock) (Clark, Dainiak and Reeder, 2000). Improved wound management and antibiotics have decreased deaths from burn wound infections (Naradzay, 2006). However, the greatest factor in the reduction of burn related deaths is the use of smoke detectors. In the United States, most of the people killed in house fires die from smoke inhalation rather than burns (Runyan *et al*, 2005).

In developing countries, however, the picture is significantly different. In Pakistan, for example, the overall mortality rate found in a study conducted by Ahmad *et al* (2006) was 34%. The authors attributed this rate to the low preventable nature of injury, to social and environmental factors associated with it and the age group involved, thus making the study of burn epidemiology a necessity. As is the case in many African countries, few adequately equipped centres were found in Pakistan. Patients are still largely treated in hospitals without established burns units (Ahmad *et al*, 2006; Albertyn *et al*, 2005). Most burns are not life-threatening, but each burn brings a significant amount of pain to patients, and some degree of psychological trauma to all those involved. Thermal burns are generally the most common types of burns. They result from exposure to or contact with steam, flames, flash, and hot surfaces or hot liquids with a temperature above 46 ° C (115° F) (Fallon *et al*, 2006). Mashrekya, Rahmana, Chowdhurya, Giashuddina, Svanströmb, Linnanc, Shafinazd, Uhaad and Rahmana (2008) found that an

estimated 3400 children become permanently disabled as a result of burn injuries every year in Bangladesh.

2.7 Conceptual framework

This study was guided by Haddon's Matrix, developed by Haddon (1970). The matrix combines public health concepts of the host agent environment as targets of change, with the concepts of primary, secondary, and tertiary prevention. This paradigm has been extended to consider each factor in relation to the time of injury, that is, to consider factors operating before, during and after injury which might be associated with both its incidence and its severity (WHO, 2001).

According to the epidemiological "disease triangle", the following must interact simultaneously for an illness to occur: (i) an agent that causes the illness, (ii) a host in which the agent can reside, and (iii) a suitable environment in which the agent and host meet together (Barss *et al*, 1998). According to Haddon (1970), for injury to occur, a host (i.e. a human person) must exist. In case of burn injury, a host might be a curious, mobile two-year-old child, the agent of injury might be a lit candle, and the environment might be an unstable table on top of which a lit candle is placed. With host, agent, and environment all coming together at the same time, an unintentional injury (i.e. burn injury) can occur.

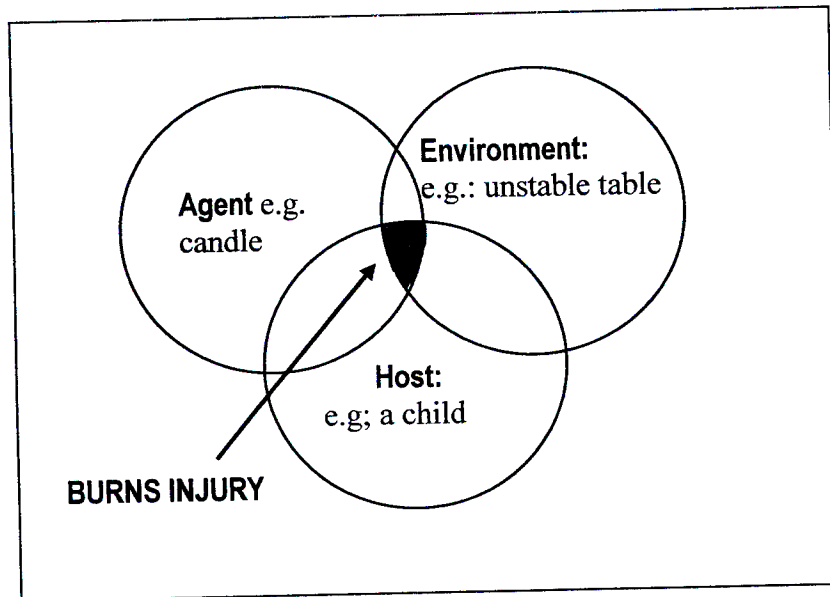


Figure 2.1: Graphic illustration of the conceptual model Haddon (1970)

Haddon's Matrix is concerned with the process of a trauma event, which is assumed to be suitable for the current study. As illustrated above, this concept posits that injuries in general, and burns in particular are different from accidents. Rather, they are understandable, predictable and preventable. Central to this epidemiological concept is the element of 'phase-factor matrix' which identifies three (3) stages of event-related modifiable risk factors in the science of epidemiology.

1. Pre-event factors: Refer to predisposing factors of burn injuries.
2. Event factors: When agent and host interact together in an environment that favour the occurrence of a burn injury.
3. Post-event factors: Are the outcomes of burn injuries in terms of morbidity, mortality and disabilities.

Later, Haddon examined how these time-phases related to host or victim, agent (or fire), physical environment, and to social environment. By taking all these elements into account and creating a matrix, one can obtain a framework on how intervention can be made in each of the matrix cells (see table below).

Table 1: Phase-factor matrix : A constructed conceptual framework for the study

Haddon (1972)

	Human / Host	Agent	Environment
Pre-event	Is the host pre – disposed or overexposed to risk?	Is the agent hazardous?	Does environment encourage or discourage risk-taking and hazard?
Event	Is the host able to tolerate the effect of burn? (from the agent)	Does the agent provide protection, or contribute to the burn occurrence?	Does the environment contribute to burns during event?
Post Event	How severe is the burn to the human being in terms of morbidity, mortality and disabilities.	Is the agent harmful, mortal or disabling	Does environment (Socio-economical, Health care system) facilitate, hinder or contribute recovery/ rehabilitation?

2.8 Conclusion

The factors and demographic features associated with burn injury differ in each country. For this reason, it is important that every nation carries out its own epidemiological studies on burns. The home is the most frequent place of burn, followed by outdoor and industrial burns. People need to be warned more earnestly about outdoor dangers and high voltage lines. Male adults should be warned about specific risks in the workplace. The review of the literature reveals significant differences between male and female patients and between adult and child patients with respect to burn causes, demographic factors, and burn outcomes.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

The following chapter describes the overall design that guided this study, the research setting, population, sampling method and process, how information was gathered, analysed and ordered. Criteria for evaluation instruments which include validity and reliability are outlined as well as ethical considerations.

3.2 Study design

A quantitative retrospective descriptive survey was employed with the aim of describing characteristics and risk factors of burns in Rwanda. This design was found appropriate because, as stated by Polit and Beck (2005), this approach is especially true for descriptive studies which seek to capture characteristics, prevalence, or intensity of phenomena. The used secondary data obtained from the archive of burns records of patients received at the CHUK hospital, the main medical centre in the city of Kigali, Rwanda.

3.3 Setting

According to Polit and Beck (2005), a setting refers to the physical location and conditions in which data collection takes place. This study was conducted at CHUK hospital, the largest referral hospital in Rwanda. This is a public hospital situated in Kigali, the crowded capital of

Rwanda. The population of Kigali is approximately 1000 000 habitants (NPC, 2002)⁹. Being the largest public referral hospital in Rwanda, CHUK provides health services to the majority of the city's population, including hospitalisation and ambulatory consultation. This hospital also has a high number of specialist doctors which makes for a better quality of care when compared to district hospitals. As a teaching hospital, CHUK is also concerned with the education and clinical training of medical and paramedical professionals and research (Rwandan Ministry of Health, 2005). It receives burn patients from the whole country. By choosing this hospital, the researcher envisaged an access to a larger population, a fact that can best help to detect burn characteristics and their related risk factors. As such, the study is likely to obtain an encompassing picture of the country's burn related incidences and risks.

3.4 Study population

In scientific research, 'population' refers to the aggregate or totality of those conforming to a set of characteristics (Polit and Beck, 2005). Files of the patients admitted to the surgical unit, emergency department and intensive care unit comprised the study population. All records of patients that were admitted from 1 January 2006 to 31 December 2006 were included in the sample.

3.5 Sampling methods

Sampling method refers to the process of selecting the representative size of an entire study population (Polit and Beck, 2008). In this study, a systematic sampling technique was used to

⁹ National Population Census (NPC)

select the sample whereby the researcher used burn file numbers from the emergency registry for 2006. The researcher documented every second burn file number that appeared on the registry. It is these file numbers that made up the final sample size.

3.6 Sample size

According to the Emergency Department Patient Registry (EDPR) (2006), 201 burn injury cases were recorded based on the formula used in epidemiology¹⁰. The representative sample size was calculated using the logical reasoning of the following statistical methods available for calculating an appropriate sample size as explained in Katzenellenbogen, Joubert and Karim (1999).

$$n = Z^2 \cdot P \cdot Q / d^2$$

n= the sample size, Z= the normal deviation (1, 96), P= the expected proportion, Q=1-p.

In general, the formula $n = Z^2 \cdot P \cdot Q / d^2$ is written like this (while passing by Insert):

$$n =: \frac{Z^2 \cdot p \cdot q}{d^2}$$

For saying that finally the formula is written: $n = \frac{Z_{\frac{\alpha}{2}}^2 \cdot p \cdot q}{d^2}$

D= required precision.

The sampling process was done using the limited population recorded in the injury registry in the casualty unit which results in a correction for finite population being appropriate for this case:

New $n = n/n + ((n-1)/pop)$ where population = 201 injury cases a year. The final formula is $n =$

¹⁰ <http://www.surveysystem.com/sscalc.htm>

$\frac{Z_{\frac{\alpha}{2}} \cdot p \cdot q}{d^2}$ by supposing that the population has a normal distribution $Z_{\frac{\alpha}{2}} = 1.96$. One can take equal proportions: $P = Q = 0.5$. If, moreover, the researcher gives herself a margin of error $D = 0.099$, then

$$n = n = \frac{Z_{\frac{\alpha}{2}} \cdot p \cdot q}{d^2} = \frac{1.96^2 \times 0.5 \times 0.5}{0.099^2} = 98$$

According to the calculation, the sample size required was 98 files.

3.7 Data collection Instrument

To collect the data a checklist for data collection was employed. This checklist had been used previously by other researchers (Nsereko, 2007). Permission to use it was granted through a formal request with leverage to modification, which the current researcher effected in order to fit the specificity of the current research. The tool involved five sections, namely, (1) social demographic data, (2) status on admission, (3) circumstance of burns, (4) medical and surgical history, (5) complications and outcomes of care (refer to Appendix 1).

3.7.1 Validity and reliability of instrument

Validity refers to the degree with which an instrument measures what it is supposed to measure. There are various approaches to validate an instrument, such as content validity, criterion related validity, and construct validity (Polit and Hunger, 1993). In this study, face and content validity were employed to validate the data collection tool. This element is intended to make sure that the

full content of an operational concept of a conceptual framework and objectives are represented in the measuring tools. The validity of the instrument guarantees the researcher that the instrument covers all relevant information related to the variables to be investigated. To ensure content validity, the objectives and operational concepts of the framework were measured. The instrument was examined for face validity by the school.

Table 3.1: Content validity of the data collection tool

OBJECTIVES OF THE STUDY	CONCEPTS FROM THE FRAMEWORK	CHECKLIST ITEMS
1. Identify the socio-demographic profile of burn patients in Rwanda.	Environment	I.1, I.2, I.5.
2. Identify causes of burns in Rwanda.	Agent	III,A
3. Identify risk factors associated with burn injuries in Rwanda.	Host	I.1, I.2, I.3, I.5,II.1, II.2 II.3, III.B.,V.A,V.B.
4. Identify outcome of burn injuries in Rwanda.		V.C,V.D.

Reliability refers to the accuracy and consistency of information obtained in a study. Polit and Beck (2005) add that statistical reliability refers to the probability that the same results would be obtained with a completely new sample. To ensure this, the researcher used a pilot study to test the data collection instrument. Five files from ICU were reviewed and analyzed to find out

whether required information was available, and if it was consistent. The data from this was made part of the overall data set.

3.8 Data collection process

The study sought permission to conduct research at the CHUK hospital from the Hospital Director, the Head of the hospital's Research Committee, and the Medical Records Manager. The permission enabled the researcher to access the patients' files which are the property of the hospital (see Appendix 3).

Besides accessing the medical records, the researcher was also granted an opportunity to inquire about the files from the Medical Records Manager in charge, so he could explain any questions the researcher had about them. The records were reviewed in a special room. No file was removed from the hospital. Files were sampled as discussed earlier in the chapter. After use, the researcher took responsibility for returning the records to the hospital's records department.

3.9 Data analysis

Data analysis is the process of organizing data so as to answer research questions and test hypothesis (Polit and Beck, 2005). After data collection, the analysis was done using the

Statistical Package for Social Science (SPSS, 15.0). The analysis of data in this study was based on distribution, frequencies and cross tabulation.

3.10 Data management

The researcher maintained confidentiality of records through proper storage of the study documents in a secured cupboard under lock and key. The checklists in the locked cabinets will be kept for five years, with access limited to the researcher. No personal identifiers will be attached to any of the checklists and they will be disposed of by burning at the appropriate time.

3.11 Ethical considerations

The researcher presented a proposal to the Nursing School Research Committee for comments and ethical approval. This was also submitted to the Ethics Committee of the Faculty of Health Sciences at the University of KwaZulu Natal for review and approval.

Permission to conduct research was sought from the Director of CHUK. Anonymity of the burn injury victims was ensured by not requiring any identification on the data collection tool. For confidentiality purposes, the files were checked in an office, the data collected was kept in a locked cupboard, and no one else had access to them except for the researcher and research supervisor. The data were only and specifically used for the intended research purpose. Anonymity and confidentiality were protected by ensuring that research report or any publication would maintain the details of the research subjects as anonymous.

3.13 Conclusion

This chapter described the overall design that guided this study, the research setting, population, sampling method and process, how information was gathered, analysed and ordered. Criteria for evaluation instruments which include validity and reliability are outlined as well as ethical considerations.

CHAPTER FOUR: PRESENTATION OF FINDINGS

4.1 Introduction

This section presents findings on the factors involved in the occurrence of burn injuries in Rwanda, including their clinical and demographic characteristics. The data analysis was based on the Statistical Package for Social Sciences (SPSS) Version 15 for Windows. Frequency distributions were used to describe the sample, and a retrospective cross sectional study was used in order to determine and describe the relationships between variables.

4.2 Results

This section describes the characteristics of the sample according to age, gender, occupation, province of residence and month of admission of patients. Furthermore, it presents the findings in terms of the key analytical variables that the study employs, namely, time interval between injury and patient admission to hospital, interval between dates of admission from PHC/district to CHUK, patient ward admission, patient level of consciousness on admission, airway patency and classification of burns by depth.

4.2.1 Age of participants

The patients were grouped according to age. As demonstrated in figure 4.1, a high distribution of burn injuries were found in the age group of 1-5 years with a proportion of 37% (n=36), followed

by the age group of 22-49 with 34% (n=33). The proportion of children aged 6-12 years was 11% (n=11), of young children aged 0-11 months was 6 % (n=6), and adults above 50 years accounted for the least proportion of 3 % (n=3).

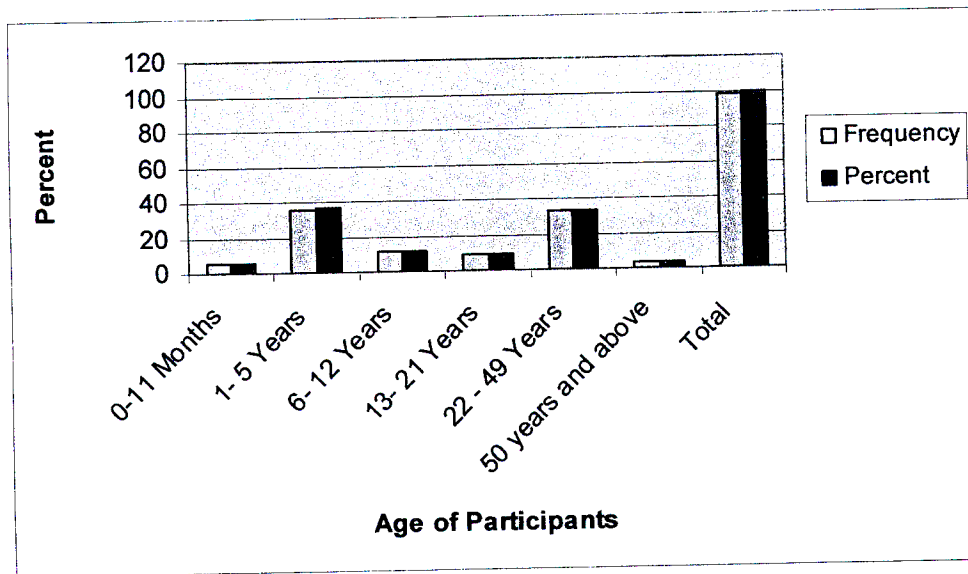


Figure 4.1.: Age of participants

4.2.2 Gender of Participants

Figure 4.2 shows that male patients had a higher incidence of burns, 55% (n=54), compared to female patients, 45% (n= 44).

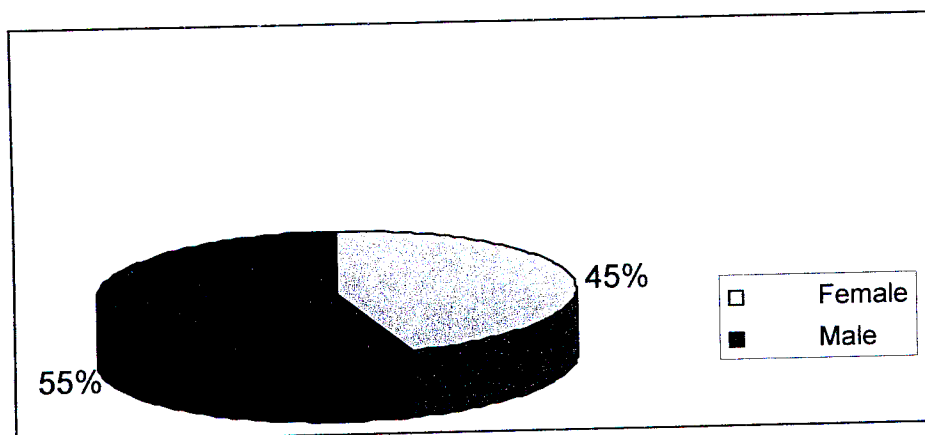


Figure 4.2: Participants' Gender

4.2.3 Occupation of Participants

Forty-six percent (n=47) of the participants were below five (5) years of age. As such, the occupation category was not applicable to them. Twenty-eight percent (n=27) of the participants did not have the occupation category recorded on their files, 22% (n=22) were peasants (farmers), and 2% (n=2) of the participants were recorded as students. See figure 4.3

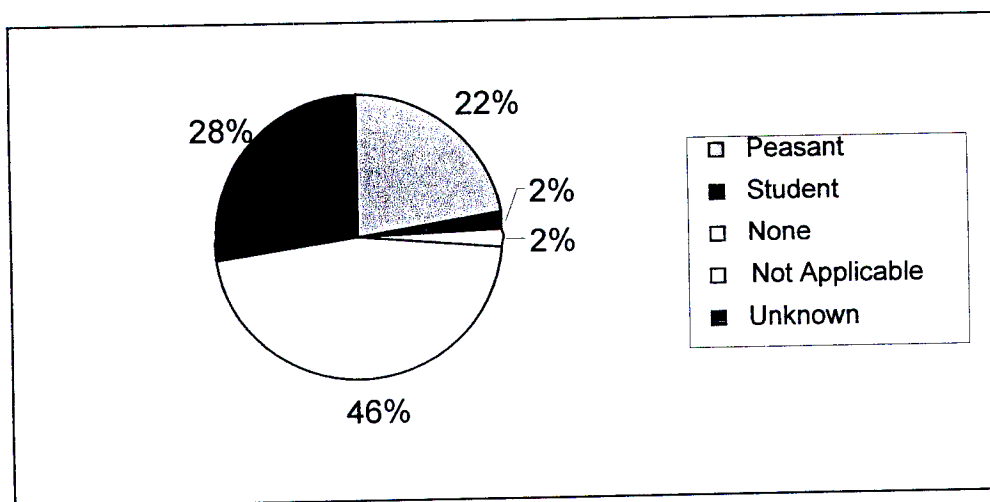


Figure 4.3: Participants' Occupation

4.2.4 Participants' provinces of residence

As figure 4.4 illustrates, 75% (n=73) of the patients came from the city of Kigali, 11% (n=11) from the Eastern Province 11% (n=11), 8% (n=8) from the Northern Province, 4% (n=4) from the Southern Province, and 2% (n=2) came from the Western Province.

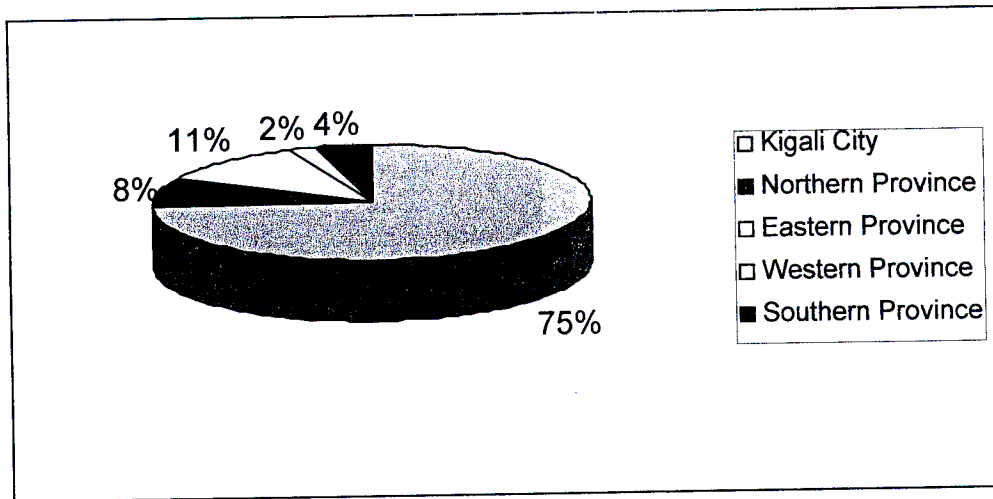


Figure 4.4: Province of Origin

4.2.5 Month of admission

Figure 4.5 shows that months of May, June, July and August (the hot season in Rwanda) had a higher frequency of burn injuries, ranging between 12% (n=12) and 13% (n=13) of burn related injuries.

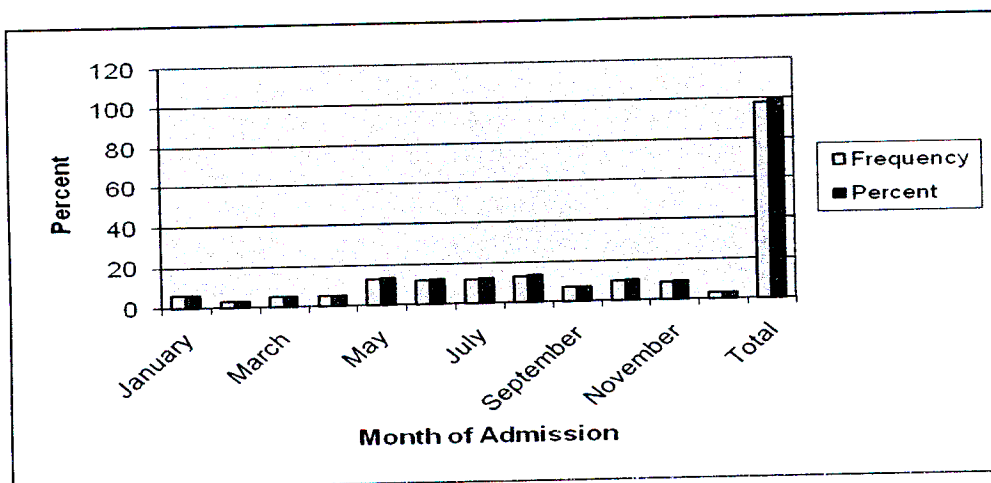


Figure 4.5. Month of Admission

4.2.6 Time interval between injury and admission to any primary health care

Figure 4.6 illustrates that 58% (n=57) of the patients were admitted within 24 hours, 37% (n=36) were self-referred to the hospital without previous admission to any lower level of health service, and 5% (n=5) were admitted to the hospital seven (7) days after sustaining injury. These included patients from the city and surrounding areas.

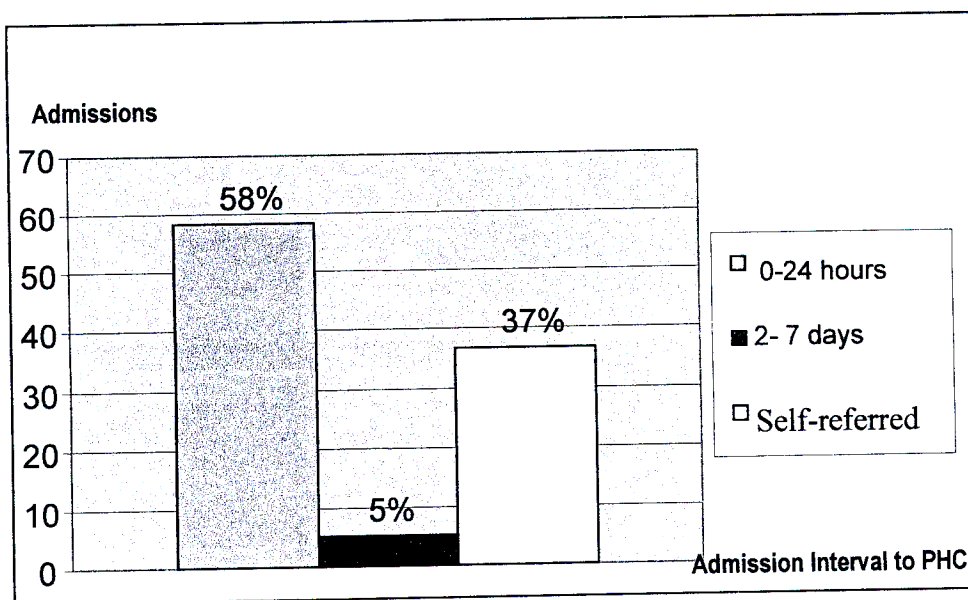


Figure 4.6: Interval between burns and Admission to PHC

4.2.7 Interval between dates of admission from PHC/District to CHUK

As illustrated in figure 4.7, 58% (n=56) of the patients were referred to CHUK within 24 hours, 37% (n= 34) were self-referred (went directly to the hospital), 5% (n=5) were referred within 2-7 days after sustaining injury, including patients from both the city and rural areas.

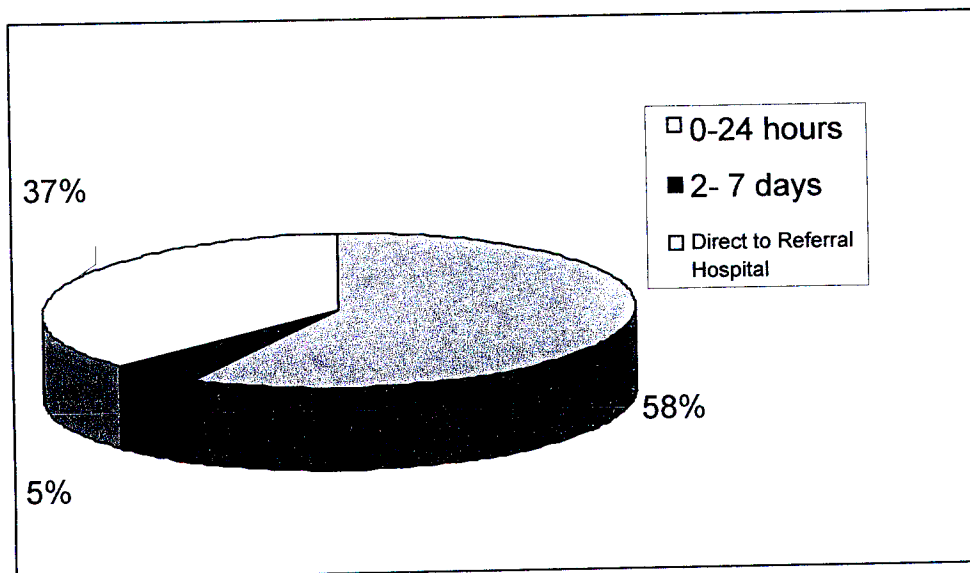


Figure 4.7: Interval of Admission to CHUK

4.2.8 Ward admission

All patients were admitted to various units/wards through the emergency department. Of the 98 patients, as reflected in figure 4.8, 67% (n=66) were admitted in the surgical ward, 22% (n=22) were admitted to the emergency department for a short stay, and 10% (n=10) were admitted to the Intensive Care Unit.

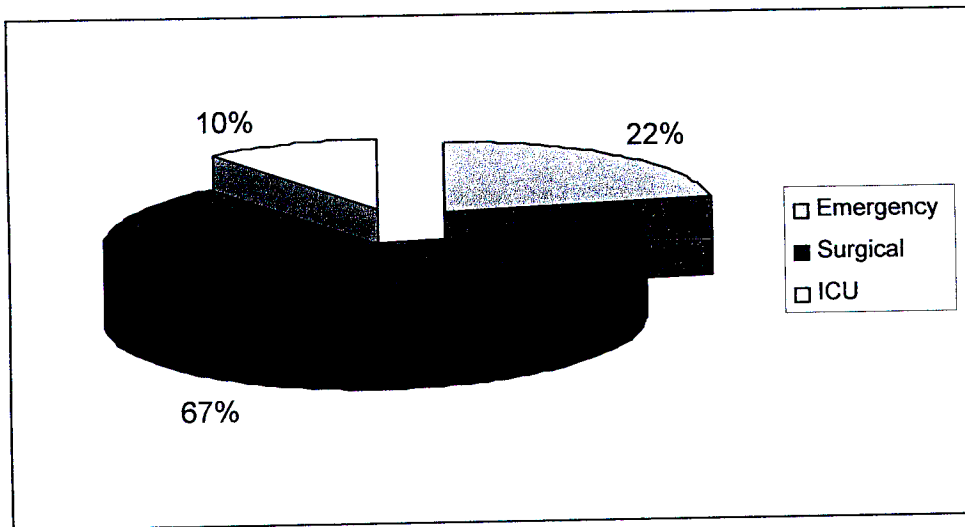


Figure 4.8: Ward Admission

4.2.9 Patient level of consciousness on admission: using Glasgow Coma Scale (GCS)

Figure 4.9 shows that on admission to CHUK, 89% (n=87) of the patients were fully conscious, with a GCS of 13 and above; 5% (n=5) of the patients had a GCS between 9 and 12, and only 6% (n=6) of the patients were GCS 3-8 on their admission to the hospital.

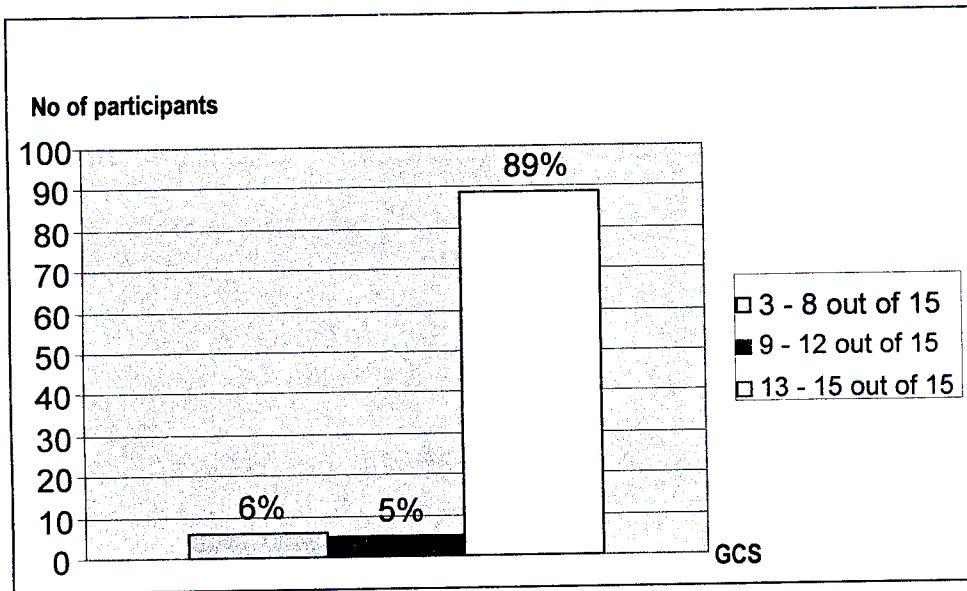


Figure 4.9: Level of consciousness

4.2.10 Airway patency

As figure 4.10 indicates, 67.3% (n=66) of the patients had patent airways on admission, while the remaining 32.7% (n=32) had obstructed airways. This also included patients with burns to the face with actual or potential airway obstructions.

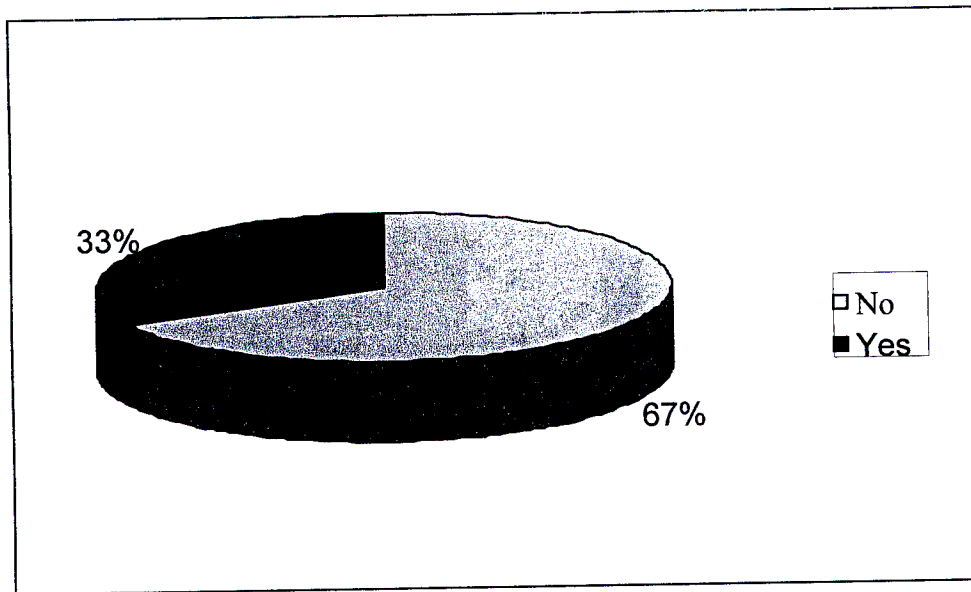


Figure 4.10: Airways Patency

4.2.11 Classification of burns by depth

To perform this classification, the constructs of first degree, second degree and third degree were used to describe injury depth instead of superficial, partial thickness and full thickness, respectively. This is because the former constructs were the ones used at CHUK hospital where data was collected. As reflected in figure 4.11, the highest distribution was the second degree burn with 57% (n=56), while 22% (n=21) of non-applicable cases were attributed to ingestion of chemical products. This made it difficult to estimate the burned surface area because no obvious wound could be detected. In turn, 16% (n=16) were third degree injuries, 4% (n=4) were mixed burns, and only 1 % (n=1) could be attributed to first degree burn injuries.

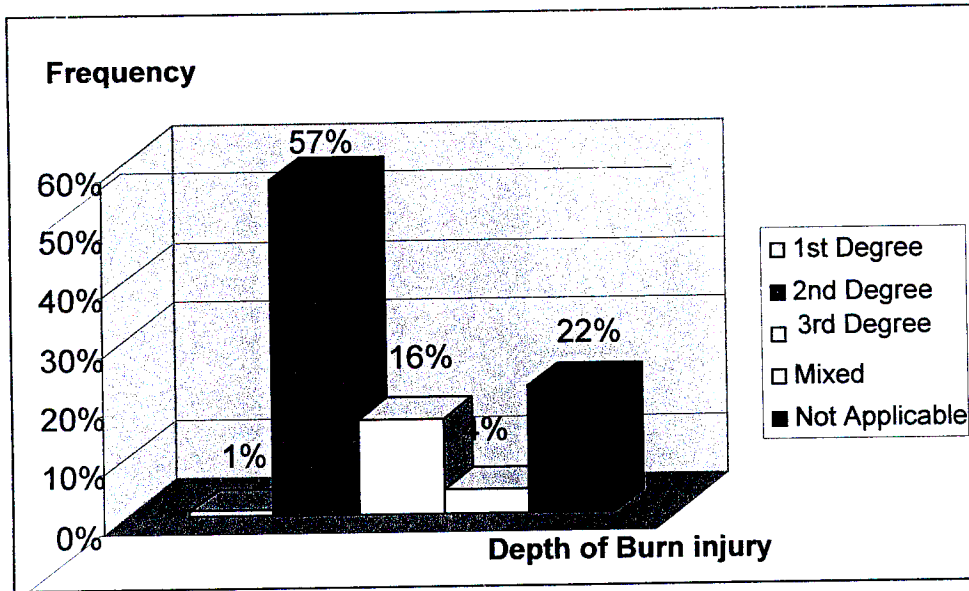


Figure 4.11: Classification of Burns by Depth

4.2.12 Classification of burns according to the TBSA

As illustrated in figure 4.12, 36% (n=35) of the patients had a TBSA above 20%, 21% (n=26) had a TBSA below 20%, 15% had a TBSA of 10% and below, and the remaining 23% (n=22) burns were provoked by ingested chemical agents, making it difficult to estimate the burned surface area.

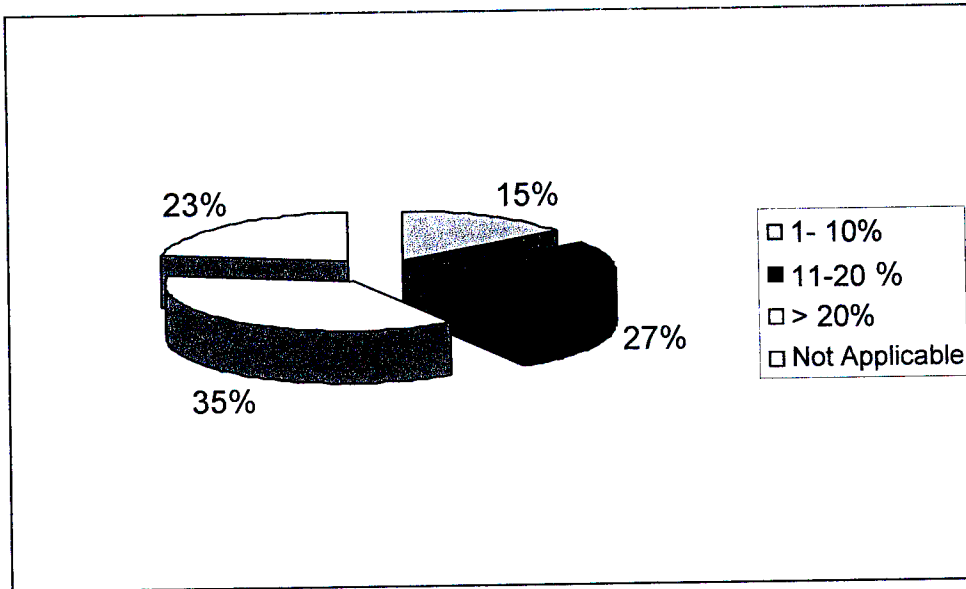


Figure 4.12: TBSA Classification

4.2.13 Body region burned

Body region burned was variable in this study. In many cases, burn injuries affected more than one part of the body, for instance, figure 4.13 indicates that 31 percent (n=30) of patients had concomitant burns that involved the face, trunk and limbs, 16% (n=16) had burns of limbs and buttocks, the study also found isolated burns; 12% (n=12) had burns to the limbs, 4% (n=4) had burns of the perineum, only 2% (n=2) had burns to the hand.

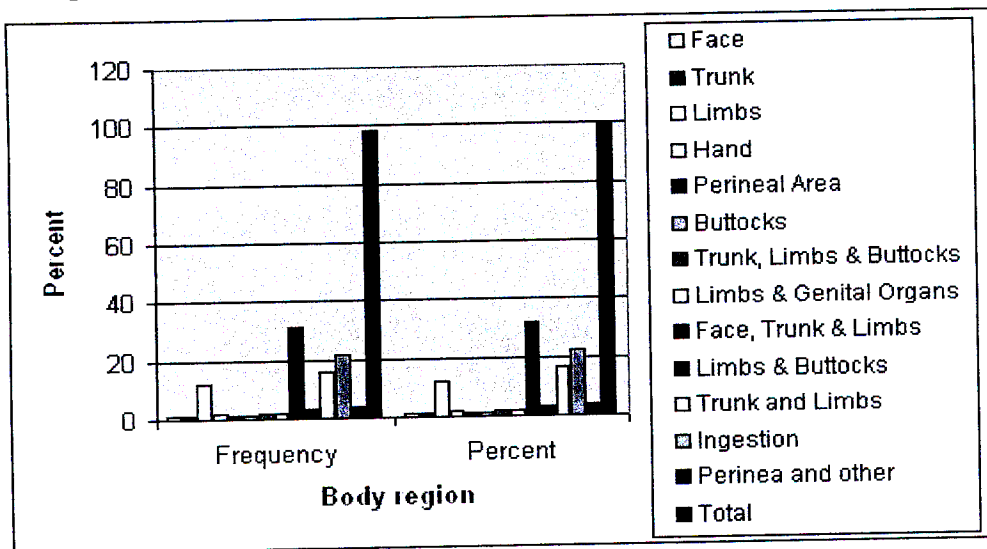


Figure 4.13 Body region burned

4.2.14 Causes of burn injury

Figure 4.14 shows that burn injuries from scalding with hot liquid had the highest incidence with 43% (n=42), followed by chemical burn at 22% (n=22), flash burn at 12% (n=12) was closer to contact burns at 11% (n=11), and flames and electrical burns had the same rate results of 5% (n=5).

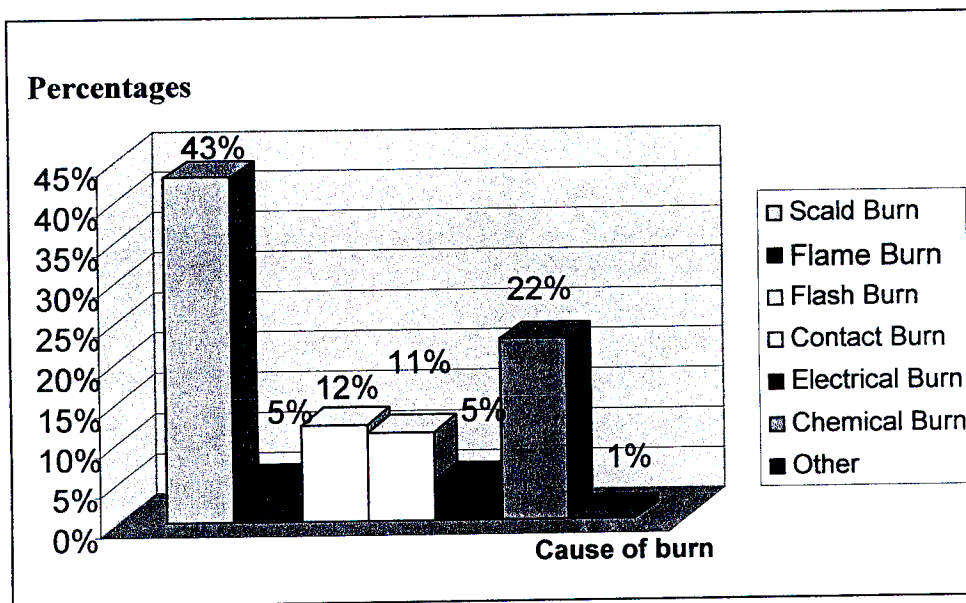


Figure 4.14: Cause of Burn Injury

4.2.15 Place where burns occurred

As reflected in figure 4.15, the home was the place where most burns occurred, accounting for 95.9% (n=94). The rest depicted a spread of various scenes.

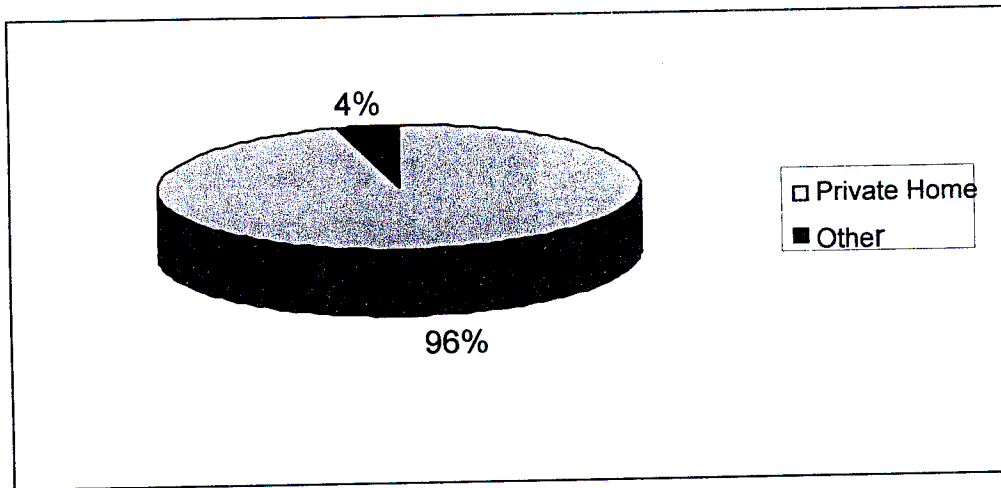


Figure: 4.15: Scene of Burn Injury

4.2.16 WHO 2002 Categorisation of Injuries

As illustrated in figure 4.16, the majority of burns, 71.4% (n=70), were unintentional, while the remaining 28.6% (n=28) were intentional. The researcher could not determine the self inflicted injuries because of poor documentation.

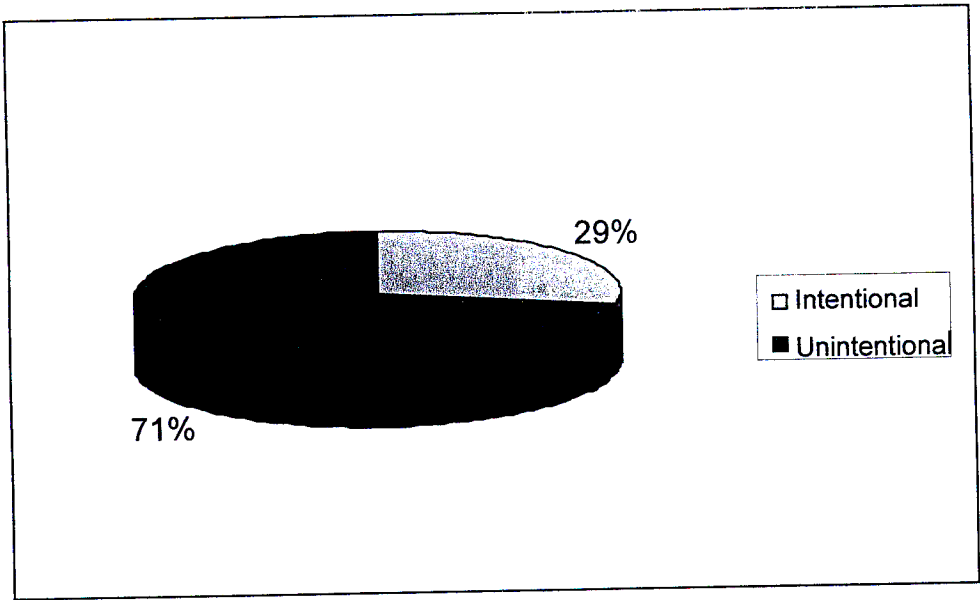


Figure: 4.16: Category of Burn Injuries

4.2.17 Intentional burns

Figure 4.17 reveals that 23% (n=22) of intentional burns were self-inflicted, 5% (n=5) were interpersonal, the remaining were unintentional burns.

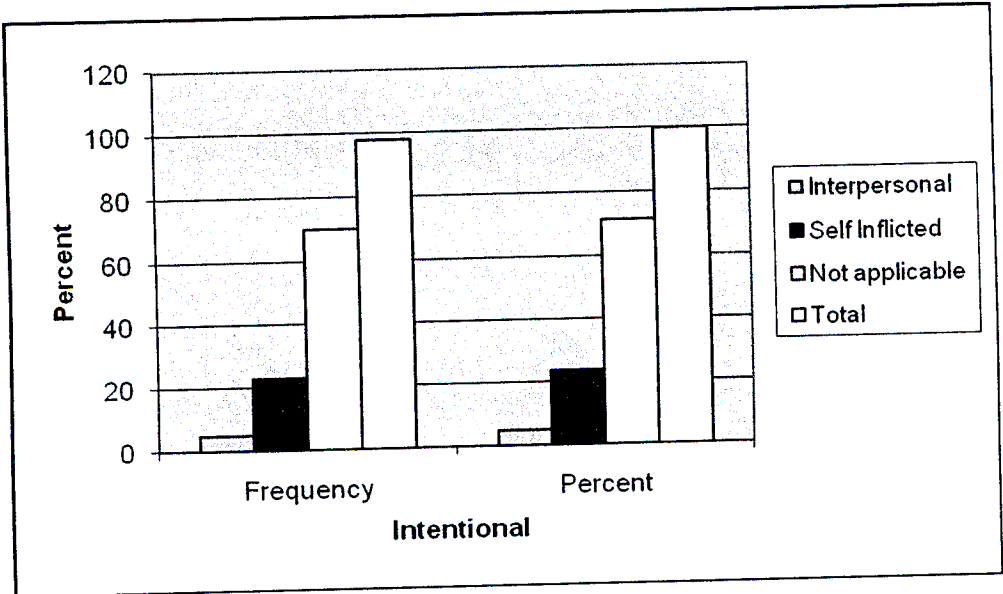


Figure 4.17 Intentional burns injuries

4.2.18 Complications

As demonstrated in figure 4.18, most of the patients, 56% (n=55), recovered from injuries without complication, 21% (N=21) had sepsis (infection), and 9% (n=9) had complications in the form of respiratory failures.

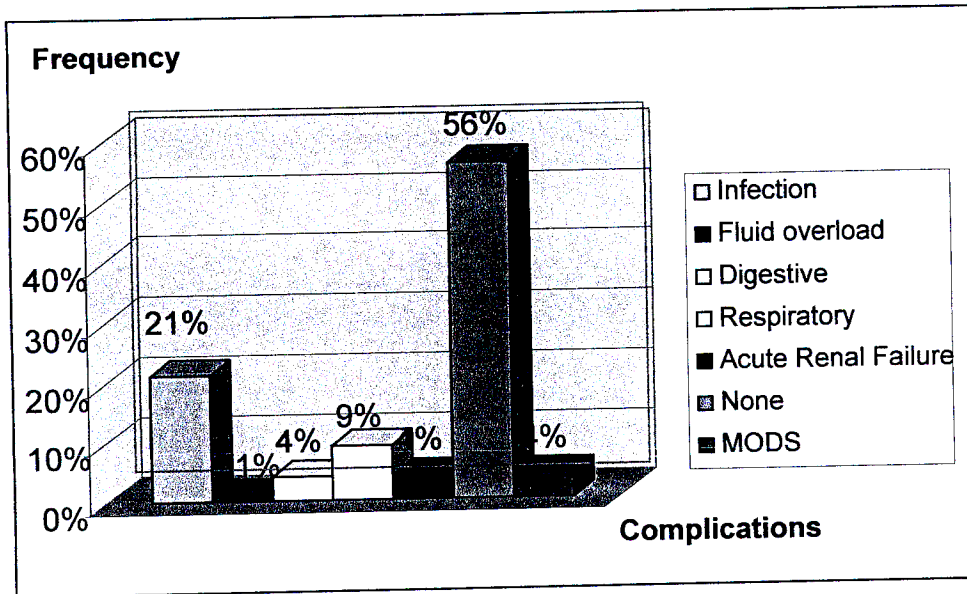


Figure: 4.18: Complications

4.2.19 Length of stay

As figure 1.19 illustrates, 38 % (n=37) of the patients stayed one to six days in the hospital, 32% (n=31) were hospitalized for one to two weeks, 15% (n=15) between two to six months, 11% (n=11) were discharged in the span between three (3) weeks to one (1) month after injury, and 4% (n=4) stayed hospitalized for more than six (6) months.

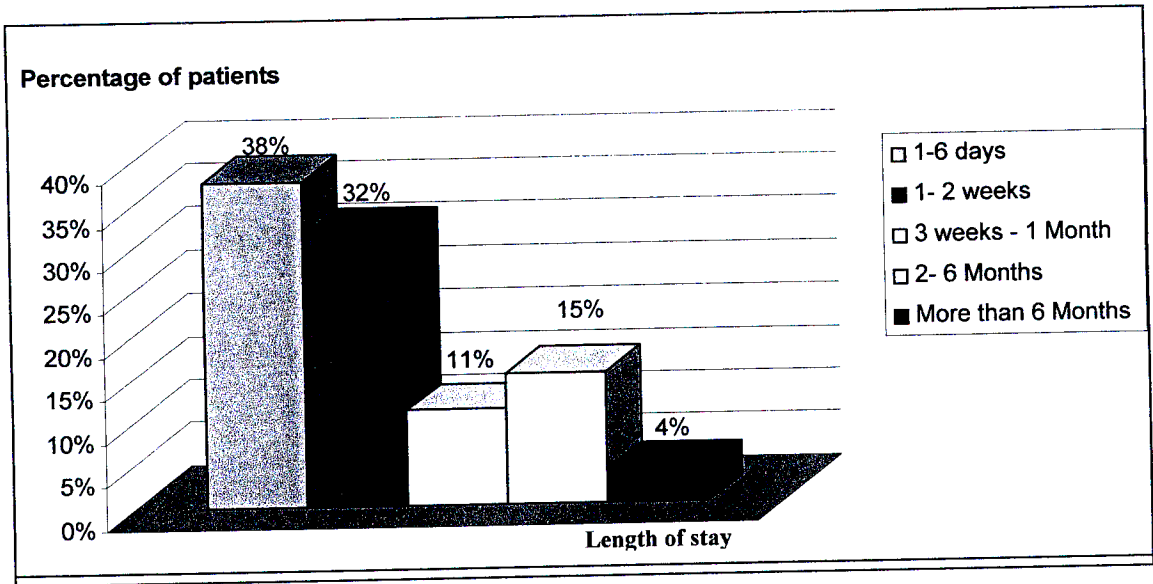


Figure 4.19 Length of Stay

4.2.20 Patient outcome

As demonstrated in figure 4.20, 51% (n= 50) of the patients recovered from injury without any disability, 29 % (n=28) died, and the remaining 20.4% (n=20) recovered with disabilities.

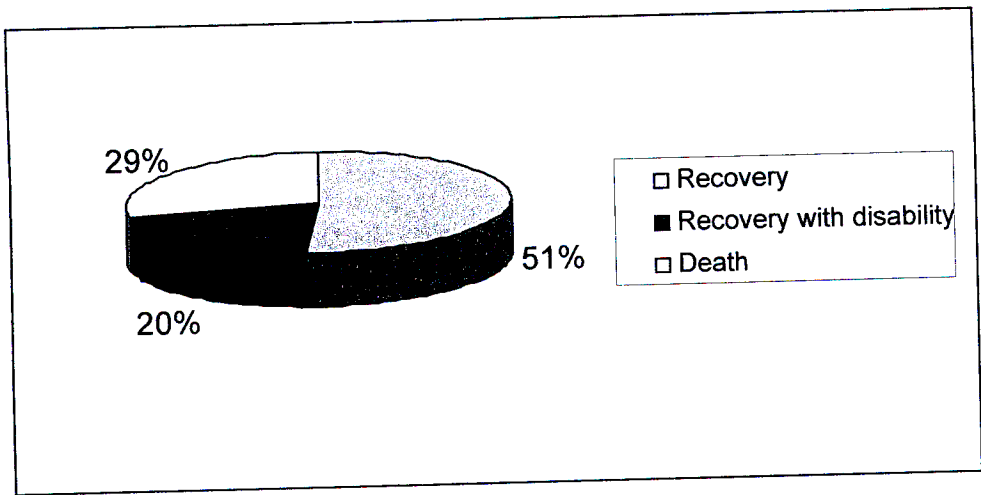


Figure 4.20: Outcome

4.2.21 Age of participants and causes of burn injury

Table 4.1 shows that, young children (one to five years) had a high incidence of scald injuries 86% (n=31), whereas in older children (six to twelve years) flash burns were common, with 36% (n= 4), followed by scald burns 27% (n=3). A high incidence of chemical exposure 44% (n=4) was found in the youth group (13-21 years), followed by contact burns 34% (n=3 out of 9), flash burns and electrical burns had same distribution, although there were no scald burns and flame burns 0 % (n=0) in this age category, just as there were none in the senior category (<50 years old). Incidence in the adult category (22-49 years) was dominated by chemical exposure, and thermal burns were variable, while scalds were most frequent 18% (n=6), followed by flash burns 15% (n=5), then electrical burns 6% (n=3). In the senior category (>50 years) there was equal distribution 33% (n=1) in each of burning agent (causes) (see table on the next page). Regarding paediatrics electrical burns were the highest 40% (3 out of 5) where children were below 12 years.

Table 4.1: Age of participants and cause of burn injury

Age of participants	Cause of Burn Injury							Total
	Scald Burn	Flame Burn	Flash Burn	Contact Burn	Electrical Burn	Chemical Burn	Other	
0-11 Months	2 (33%)	1 (17%)	1 (17%)	2 (33%)	0 (0%)	0 (0%)	0 (0%)	6 (100%)
1- 5 Years	31 (85%)	2 (6%)	0 (0%)	2 (6%)	1 (3%)	0 (0%)	0 (0%)	36 (100%)
6- 12 Years	3 (27%)	1 (9%)	4 (36%)	2 (18%)	1 (9%)	0 (0%)	0 (0%)	11 (100%)
13- 21	0 (0%)	0 (0%)	1 (11%)	3 (34%)	1 (11%)	4 (44%)	0 (0%)	9 (100%)
22 - 49 Years	6 (18%)	1 (3%)	5 (15%)	1 (3%)	2 (6%)	17 (52%)	1 (3%)	33 (100%)
50 years and above	0 (0%)	0 (0%)	1 (33%)	1 (33%)	0 (0%)	1 (33%)	0 (0%)	3 (100%)
Total	42 (43%)	5 (5%)	12 (12%)	11 (11%)	5 (5%)	22 (22%)	1 (1%)	98 (100%)

4.2.22 Participants' gender and cause of burn injury

As Table 4.2 indicates, both female and male patients sustained a high incidence of scald injuries, although incidence among male patients was comparatively higher, 57% (n=24) than that among female patients 43% (n=18). Ninety-one percent (n=10) of victims from contact burns were female patients, electrical burns were more frequent 80% (n= 4) among male patients

than among female patients 20% (n=1), and chemical burns were also more frequent 73% (n=15) among males than among female patients 27% (n=6).

Table 4.2: Participants' gender and causes of burn injury

Participants' Gender	Causes of Burn Injury							Total
	Scald Burn	Flame Burn	Flash Burn	Contact Burn	Electrical Burn	Chemical Burn	Other	
Female	18 (41%)	2 (4%)	7 (16%)	10 (23%)	1 (2%)	6 (14%)	0 (0%)	44 (100%)
Male	24 (44%)	3 (6%)	5 (9%)	1 (2%)	4 (7%)	16 (30%)	1 (2%)	54 (100%)
Total	42 (43%)	5 (5%)	12 (12%)	11 (11%)	5 (5%)	22 (22%)	1 (1%)	98 (100%)

4.2.23 Burn causes in relation to burn depth

Table 4.3 shows the correlation between burn causes and burn depth. Most scald burns 93% (n=39 out of 42) had second degree burns. Electrical injuries caused deeper burns 60% (n=3 out of 5) of them were third degree burns compared to second and first degree burns (20%, each). Contact burns also resulted in more third degree depth 45 % (n=5) than second degree 36% (n=4) depth (see table on the next page).

Table 4.3: Burn depth in relation to burn cause

Cause of Burn Injury	Classification of burns by depth					Total
	1st Degree	2nd Degree	3 rd Degree	mixed	Not Applicable	
Scald Burn	0 (0%)	39 (93%)	3 (7%)	0 (0%)	0 (0%)	42 (100%)
Flame Burn	0 (0)	3 (60%)	2 (40%)	0 (0%)	0 (0%)	5 (100%)
Flash Burn	0 (0%)	8 (67%)	3 (25%)	1 (8%)	0 (0%)	12 (100%)
Contact Burn	0 (0%)	4 (36%)	5 (45%)	2 (18%)	0 (0%)	11 (100%)
Electrical Burn	1 (20%)	1 (20%)	3 (60%)	0 (0%)	0 (0%)	5 (100%)
Chemical Burn	0 (0%)	0 (0%)	0 (0%)	1 (5%)	21 (95%)	22 (100%)
Other	0 (0%)	1 (100%)	0 (0%)	0 (0%)	0 (0%)	1 (100%)
Total	1 (1%)	56 (57%)	16 (16%)	4 (4%)	21 (22%)	98 (100%)

4.2.24 Participants' provinces of residence and time interval between dates of admission from PHC/District to CHUK

The majority of the participants lived in the city of Kigali (see Table 4.4). Of the 73 patients that were admitted to CHUK from this city, 68% (n=48) were admitted to the referral hospital within 24 hours, 29% (n=21) were admitted two to seven days later, and 4% (n=3) were admitted seven

days later. In the remaining provinces, more than 50% of the patients were referred to CHUK within either 48 hours or after seven days.

Table 4.4 Participants' provinces of residence and time interval before admission

Participants' Province of Residence	Interval between date of admission from PHC/District to CHUK				Total
	0-24 hours	2- 7 days	Above 7 days	unknown	
Kigali City	48 (68%)	21 (29%)	3 (4%)	1 (1%)	73 (100%)
Northern Province	4 (40%)	3 (38%)	1 (13%)	0 (0%)	8 (100%)
Eastern Province	2 (18%)	6 (55%)	3 (27%)	0 (0%)	11 (100%)
Western Province	1 (50%)	1 (50%)	0 (0%)	0 (0%)	2 (100%)
Southern Province	1 (25%)	3 (75%)	0 (0%)	0 (0%)	4 (100%)
Total	56 (57%)	34 (34%)	7 (8%)	1 (1%)	98 (100%)

4.2.25 Participants' provinces of residence and patient outcome

As reflected in table 4.5, the highest burn mortality rates were found among patients who came from the Southern province (100% i.e. 4 out 4), followed by patients from the Northern Province (62.5% i.e. 5 out of 8). The mortality rate among patients referred from the Eastern province was 45.4 % (5 out 11). The city of Kigali had the highest number of admissions at 74.4% (n=73) and

a mortality rate of 19 % (n=14) compared to the other provinces. No mortality was found among patients referred from the Western province though they accounted for the lowest admission number (n=2 out of 98 burns patients).

Table 4.5: Participants' Province of Residence and Patient Outcome

Participants' Province of Residence	Patient Outcome			Total
	Recovery	Recovery with disability	Death	
Kigali City	44 (60%)	15 (21%)	14 (19%)	73 (100%)
Northern Province	1 (12%)	2 (25%)	5 (63%)	8 (100%)
Eastern Province	4 (37%)	2 (18%)	5 (45%)	11 (100%)
Western Province	1 (50%)	1 (50%)	0 (0%)	2 (100%)
Southern Province	0 (0%)	0 (0%)	4 (100%)	4 (100%)
Total	50 (50%)	20 (20%)	28 (28%)	98 (100%)

4.2.26 Participants' provinces of residence, TBSA & outcomes

The current study defines major burns according to the American Burns Association (ABA) (2000) which are all burns with TBSA of more than 20%. Table 4.6 shows that 100 % (n= 5 out of 5) of the patients who recovered fully from major burns were from the city of Kigali, however they have a high incidence 70% (n= 7 out of 10) of disabilities. Regarding mortality rate from

major burns, Kigali City had a low mortality rate 35% (n=7 out of 20) compared to other provinces 65 % (n=13 out of 20) (see table on the next page).

Table 4. 6 Participants' provinces of residence, TBSA & outcomes

Patient Outcome		Classification of burns according to the TBSA				Total
	Participants' Province of Residence	1- 10%	11-20 %	> 20%	Not Applicable	
Full Recovery	Kigali City	11 (91%)	13 (81%)	5 (100%)	16 (36%)	44 (88%)
	Northern Province	1 (9%)	0 (0%)	0 (0%)	0 (0%)	1 (2%)
	Eastern Province	0 (0%)	2 (13%)	0 (0%)	2 (12%)	4 (8%)
	Western Province	0 (0%)	1 (6%)	0 (0%)	0 (0%)	1 (2%)
	S/Total	12 (100%)	16 (100%)	5 (100%)	17 (100%)	50 (100%)
	Recovery with disability	Kigali City	2 (100%)	6 (75%)	7 (70%)	0 (0%)
Northern Province		0 (0%)	2 (25%)	0 (0%)	0 (0%)	2 (10%)
Eastern Province		0 (0%)	0 (0%)	2 (20%)	0 (0%)	2 (10%)
Western Province		0 (0%)	0 (0%)	1 (10%)	0 (0%)	1 (5%)
S/Total		2 (10%)	8 (40%)	10 (50%)	0 (100%)	20 (100%)
Death		Kigali City	1 100%	1 (50%)	7 (35%)	5 (100%)
	Northern Province	0 (100%)	0 (0%)	5 (25%)	0 (0%)	5 (18%)
	Eastern Province	0 (100%)	0 (0%)	5 (25%)	0 (0%)	5 (18%)
	Southern Province	0(0%)	1 (50%)	3 (15%)	0 (0%)	4 (14%)
	Total	1 (100%)	2 (100%)	20 (100%)	5 (100%)	28 (100%)

4.2.27 Participants' wards of admission and TBSA

As table 4.7 indicates, the majority, 80% (n=8) of burn patients admitted to ICU had more than 20% TBSA, however the table also indicates that the category of patients with 11-20% of TBSA

and those with more than 20% of TBSA accounted for the same proportion 36% (n=24) of admission to the surgical ward.

Table 4.7: Participant's Ward of admission and TBSA

TBSA	Ward of admission			Total
	Emergency	Surgical	ICU	
1- 10%	2 (9%)	12 (18%)	1 (1%)	15 (16%)
11-20 %	1 (1%)	24 (36%)	1 (1%)	26 (27%)
> 20%	3 (13%)	24 (36%)	8 (80%)	35 (36%)
Not Applicable	16 (72%)	6 (9%)	0 (0%)	22 (21%)
Total	22 (100%)	66 (100%)	10 (100%)	98 (100%)

4.2.28 Participants' Province of Residence and admission to ICU

Considering only admission to ICU, as reflected in table 4.8 only 20% (n=2) of burn patients were dwellers in the city of Kigali, while the majority 80% (n=8) of the burn patients came from other provinces (see table on the next page).

Table 4.8: Participants' Province of Residence and Ward of admission

		Ward of admission			Total
		Emergency	Surgical	ICU	
Participants' Province of Residence	Kigali City	21 (95%)	50 (76%)	2 (20%)	73 (75%)
	Northern Province	0 (0%)	6 (9%)	2 (20%)	8 (8%)
	Eastern Province	1 (5%)	7 (11%)	3 (30%)	11 (11%)
	Western Province	0 (0%)	2 (3%)	0 (0%)	2 (2%)
	Southern Province	0 (0%)	1 (2%)	3 (30%)	4 (4%)
Total		22 (100%)	66 (100%)	10 (100%)	98 (100%)

4.2.29 Causes of burns and outcomes

As Table 4.9 indicates, a higher mortality rate was found in fire related burns (flame, flash, contact). All together, these accounted for 57% (n= 16), electrical burns accounted for 5% (n=5), and 14% (n=4) resulted from scald burns. In term of sequelae, 50 % (n=25) of all patients who totally recovered had suffered burns from scalds. Likewise, 65% (n=13) of those who recovered with disabilities had also suffered from scald burns. Flash burns accounted for a high percentage, 32% (n=9) mortality.

Table 4.9 Causes of burns and outcomes

Cause of Burn Injury	Patient Outcome			
	Total Recovery	Recovery with disability	Death	Total
Scald Burn	25 (50%)	13 (65%)	4 (14%)	42 (100%)
Flame Burn	1 (2%)	3 (15%)	1 (4%)	5 (5%)
Flash Burn	1 (2%)	2 (10%)	9 (32%)	12 (12%)
Contact Burn	3 (6%)	2 (10%)	6 (22%)	11 (11%)
Electrical Burn	3 (6%)	0 (0%)	2 (7%)	5 (5%)
Chemical Burn	17 (34%)	0 (0%)	5 (17%)	22 (22%)
Other	0 (0%)	0 (0%)	1 (4%)	1 (1%)
Total	50 (50%)	20 (20%)	28 (28%)	98 (100%)

4.2.30 Age and mortality

Table 4.10 shows that there was a higher mortality rate of 54% (n=15) among children under 12 years, and 46% (n=13) among other age groups. However, in isolated age groups those between 22-49 years had a higher mortality rate 36% (n=10).

Table 4.10 Age and mortality

Age of participants	Recovery	Recovery with disability	Death	Total
0-11 Months	2 (4%)	2 (10%)	2 (7%)	6 (100%)
1- 5 Years	15 (30%)	13 (65%)	8 (28.5)	36 (100%)
6- 12 Years	3 (6%)	3 (15%)	5 (18%)	11 (100%)
13- 21	7 (14%)	0 (0%)	2 (7%)	9 (100%)
22 - 49 Years	23 (46%)	0 (0%)	10 (36%)	33 (100%)
50 years and above	0 (0%)	2 (10%)	1 (4%)	3 (100%)
Total	50 (50%)	20 (20%)	28 (28%)	98 (100%)

4.2.30 Conclusion

This chapter aimed to present the findings from a sample of 98 burn patients admitted at the CHUK. Frequencies were used to illustrate, first, the demographic, and clinical features of the study population, as well as the agents responsible for burns and outcomes. The study also aimed at discovering the relationships among different variables by means of cross tabulation tables.

CHAPTER FIVE: DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Burns continue to be a major environmental factor responsible for significant morbidity and mortality in developing countries (Liao *et al*, 2000). The current study presents data from the major hospital in Kigali, Rwanda named CHUK. The study was retrospectively carried out on a sample of 98 records of burn patients that had been admitted to this hospital.

5.2 Discussion of Findings

The findings are presented within the context of the conceptual framework using host, agent and environment within the pre-event, event and post-event framework. These findings are also integrated into existing studies in the area.

5.2.1 Pre-event

This section discusses the demographic data associated with burns.

5.2.1.1 Host

The host (human) was defined in terms of age and gender. There was a relationship between the two variables. Analysis of age records showed that the incidence of paediatric burns exceeds the incidence of adult burns by 3%, with 54% of paediatric incidence compared to 51% of adult incidence. This finding is similar to findings made by many studies conducted across the world

(Alden *et al*, 2005; Carlsson, Ude', Hankinson and Dejin, 2005; Tang *et al*, 2006; Turner *et al*, 2005). The conclusion drawn from the four studies posits that children accounted for more than 50% of burn cases compared to adults. However, there have also been some varying results. A study conducted in Cairo, Egypt, Hemeda *et al* (2003) found that adults accounted for a higher number of burn injuries (61%) compared to the number of child burn injuries (39%). Statistical information obtained from the South African Medical Research Council has indicated that 3.2% of the South African population are burned annually, 50% of which are younger than 20 years of age (Albertyrn *et al*, 2005), which clearly suggests that childhood exhibits a high risk factor for burns. On the other hand, Sweden has the lowest rate of child burns in the world (IRTAD, 2003¹¹; SOU, 2002¹²). Burn mortality rate in Sweden in 1999 was 22 out of 100.

The current study found that the highest number of children suffering burn injuries at CHUK hospital was between the ages of one (1) and five (5) years, accounting for 37%. A community-based survey done by Mashrekya *et al* (2008) in Bangladesh found that the majority (58%) of the admitted burn patients were four years of age or below. Children are the most vulnerable group of burn victims because they have less perception of dangerous situations and a limited ability to react promptly and properly (Mashrekya, Rahmana, Chowdhurya, Giashuddina, Svanströmb, Linnanc, Shafinazd, Uhaad and Rahmana, 2008). Children suffer burns mostly by accident in homes, and the most affected age group is that between zero and four years (Den Hertog, Blankendaal and ten Hag, 2000; March and Kendrick, 2000). Children aged under three years often remain in close proximity to their parents when the latter are cooking, a factor that puts them at burn risk (Naradzay, 2006; Tang *et al*, 2006).

¹¹ International Road Traffic Accident Database (IRTAD).

¹² Statens Oftemtliga Utredningar (State Public Inquiries, in Swedish) (SOU).

The current study found that the age category 22 to 49 years yielded an important proportion (34%) of burn patients due to the fact that it is an active age, therefore patients are predisposed to work-related burn injuries and injuries resulting from household activities such as cooking. The elderly accounted for the least proportion of the incidences in the study sample, with only 3.1%. This finding corresponds with the studies by Tang *et al* (2006) in Shanghai, which found only a 4% rate of elderly burn patients. Naradzay (2006) and Ashraf *et al* (1997) found less than 10% of burns in old persons. The cause of burn in this category was mostly fire. In some instances, the elderly suffer burns from clothing ignition due to aging associated senility. In a study by Ho, Ying, and Chan (2001) on 94 elderly burn patients in Hong Kong, the identifiable risks included inadequate social and family support, lack of first aid knowledge, and delay in seeking medical attention (Ho *et al*, 2001).

In terms of gender, the incidence of burn injuries was higher (55%) in males than in females (45%). These findings correspond with observations carried out in other countries. In a study carried out in Turkey, Anlatıcı *et al* (2001) found that male patients accounted for a higher incidence of burns (54.3%) compared to female patients (44.7%). Tang *et al* (2006) found 71% of burns in males. Various international studies report a 50% average of male burn incidences (Ahmad *et al* 2006; World Fire Statistics Centre, 2000). However, Hemeda *et al* (2003) found that female incidences (53.1%) were more prevalent than male incidences (46.8%).

5.2.1.2 Agent

This section describes different kinds of agents or causes considered as hazards which contribute to burn morbidity and mortality. The study found that scald burns were the most common cause of burns (43%), followed by chemical ingestion (22.4%), flash (12.2%), flames (11.2%), and contact with hot object burns (5%) had an equal distribution to electrical burns. This agent sequence is different from recent findings by a study that systematically reviewed data from China from 28 articles by Kai-Yang, Zhao-Fan, Zhang, Yi-Tao, Tan, Wei, W., Bing, Xiong, Wang and Yus (2008). Most articles reported the sequence of reasons as hot liquid > flame > electricity > chemical, and scalding was by far the predominant cause of burns. However, in some countries, especially in the Asian continent, flame has been found to be the most common cause of burns (Ahmad *et al*, 2006; Tang *et al*, 2006). When relating age to cause, most studies showed that children are mostly burned by hot liquids (Albertin *et al*, 2006; Anlatıcı *et al*, 2001; Naradzay, 2006). In the current study, however, electrical injuries cannot be overlooked, since 40% of them affected children under 12 years old. Children have a predisposition to injuries from low-voltage sources, such as electric cords, because of their limited mobility within a relatively confined environment (Baker and Chiaviello, 1998). During adolescence, however, a more active exploration of the environment is possible and may lead to more severe high-voltage injuries or death. Gas and kerosene are found to be causal factors (12.2%) of burns alongside liquids. This can be explained by the fact that kerosene is widely used as a domestic fuel in Rwanda. According to Ashraf *et al* (1997), the difference in ranking between the agents could be attributed to the developmental stage of the country, the age composition of the sample, and to whether day-patients were included or not.

In Rwanda, the lack of clean tap-water can be a risk factor to both adult and children scald burning because people need to heat water on a stove for various purposes. Thus, when caregivers or parents are careless and leave hot water (in full pots) within the reach of children, they can get to them while they are playing or crawling. Another risk factor is environmental or spatial. Often homes lack division of space for different purposes. For example, cooking and sleeping often happen in the same space without any spatial barrier. These two factors are quite significant in the face of the fact that most paediatric scald burnings, especially among children aged six (6) months to two (2) years, are caused by hot food or liquid spill in the kitchen or other areas where food is prepared and served (Naradzay, 2006).

Open fire responsible for flash, contact and flame burns accounted for 27% in the current study due to the use of paraffin, wooden stoves, unsafe storage of fuels in houses and uses of candles and other open traditional lamps (commonly called “Itadowa”) used for lighting in the home related to the limited access to electricity. In Rwanda, according to the National Population Census (2002) 4% of the population has access to electricity though the media report an increase to 6%.

The main risk factors that the study has directly identified are inadequate rules and regulations for management of chemicals. Attempted suicide by chemical substances accounted for 22% of the total patient sample used (refer to figure 4:14). The majority were adult persons over 22 years of age, with males dominating the gender rate by 72.7% compared to females. In some instances, particularly in countries where Islam is popular as in Pakistan, the reason could be that men are the main stress-bearers and the only breadwinners in the household. In this instance, it appears

that people with a lower level of literacy find it harder to respond and easier to give up when faced with financial and economic crisis (Ahmad *et al*, 2006). In Rwanda, however, although both women and men contribute to household income, most women are housewives, especially in the rural setting.

5.2.1.3 Environment

This section discusses the environmental risk factors of burn injuries, including physical, socio-economic and geographical factors. The majority of the burn injury cases investigated in this study (95.5 %) occurred at home. On a global level, studies show that the commonest burn location is the home (50%) (Delgado *et al*, 2002; Liu *et al*, 1998; Hemeda *et al*, 2003; Naradzay, 2006; Runyan *et al*, 2005; Tang *et al*, 2006). In the home, the commonest incidence location is the kitchen, especially for the young ones. The kitchen is a busy place. Food preparation, eating and social and family interaction all take place, often simultaneously, in the kitchen. The unavoidable presence of children in the kitchen creates safety challenges that change as children grow, but which never disappear (*ibid*).

The study found that most of the patients coming for service at CHUK were from urban rather than rural areas. According to Albertyn *et al* (2006), urban migration, poverty and the development of slums are significantly related to overcrowding and to the risk of burn. Families are often forced to share small living spaces. The fact that the CHUK hospital is situated in Kigali, the lack of a district hospital within the city, and the non-existence of a patient referral policy or regulation also contributed to the high healthcare service demand. Thirty six percent of

the patients who sought service in the hospital were self-referred, meaning that they came directly to the hospital because of the lack of formal pre-hospital service and fire extinguishing services. Only one fire extinguishing service is available at the international airport in the capital. All these factors result in several disadvantages, such as delayed resuscitation time, unsafe transportation, infection, and unexpected death within 24 hours after a burn injury. Patients prefer the hospital because they believe they receive better service there than in smaller healthcare centres. This is in turn an overcrowding factor, especially at the ED, since even minor burns which should be treated at a lower level come to the ED. The percentage of patients coming from villages was only 25.5%, a size that corresponds to findings made in other studies, such as Anlatıcı *et al* (2001). The latter found that 73.4% of burn patients were from urban areas, while 24.6% were from rural areas. Hemeda *et al* (2003) found that more than 70% of his sample population consisted of city dwellers, caused by the long distance separating rural health centres and hospitals, and by poor ambulance availability.

5.2.2. Event

The circumstances associated with burn injury in relation to activities such as cooking, playing, and sleeping, are outlined in this section.

5.2.2.1 Host

Eighty percent of the burn injuries suffered by children aged five (5) and below at the CHUK hospital resulted from scalding. This finding corresponds with international studies which

indicate that paediatric burn incidences account for 65 to 85 percent of total scald burn injuries (Carlsson *et al*, 2005; Naradzay, 2006). In their study, Tang *et al* (2006) found that 83% of burn incidences among children below five years of age were caused by scalding, and these occurred at home.

In domestic incidences (such as cooking), gender was statistically correlated to agent. Contact burn was higher among female persons (90%) than among male persons (10%). As stated by Albertyn *et al* (2006), in the adolescent age group, girls sustain more burns than boys due to their higher involvement in household chores. In turn, electrical burn was more common among male persons (80%) than among female persons (20%). The latter was even lower compared to the incidence rate among children (40%). These findings differ from those by Ahmad *et al* (2006), which found that about 22% of females suffered burns through stove burns compared to 18% of males who suffered burns through flame.

As illustrated in table 4.1, the current study found that thermal burns (flames, contact burns, flash burn) at CHUK hospital were more common (more than 60%) than scald burns on children below one (1) year and those between 6 and 12 years of age. Albertyn *et al* (2005) found that flame burns (57%), hot liquid burns (32%) and chemical burns (7%) are the most common causes of paediatric burns in Africa. Most of the time, paediatric contact burns are caused by the ignition of mattresses by candles placed near the bed while children are asleep in the bed. In Rwanda, as in many other African countries, paediatric burn injuries are likely to happen when parents, in an attempt to find employment, leave their children unsupervised, or under the care of other children (Albertyn *et al*, 2005). This implies that economics could be a relative factor to

paediatric burning. On the other hand, it implies that many of the paediatric burn accidents could be avoided through more effective care-giving.

Occupation was largely non-applicable, since most of the respondents (42.8%) were children under five (5) years of age. In addition, the study sample also contained 34 files without occupational records. As observed under the section on study limitations, one disadvantage of a retrospective study is that it may be difficult to answer all statistical questions due to poor documentation. In the current case, the lack of a burn registry is the main problem. Of those who reported their occupations, 22% were peasants. Many studies have reported a link between burns and poverty (Albertyn *et al*, 2005; El-Badawy and Mabrouk, 2006; Goran, 2007; Rajeev and Ahuja, 2004;), and that children under five (5) years of age are exposed to high risk (Alden *et al*, 2005; Carlsson *et al*, 2005; Tang *et al* 2006; Turner, Spinks and McClure, 2005).

5.2.2.2 Agent

There was a statistical relationship between burn patterns and different kinds of agents. Burns are characterized by their degree, and a burn degree is determined by the severity of the tissue damage and the amount of body surface area (BSA) involved. These two features determine the severity of a burn injury (ABA 2000; Fallon *et al* 2006). The American Burn Association (2000) posits specific measures for determining the severity of a burn injury, namely, >20% TBSA burn in adult, >10% TBSA burn in young or old >5% TBSA full-thickness burn, high-voltage burn, known inhalation injury, any significant burn to face, eyes, ears, genitalia or joints and significantly associated injuries (e.g. fracture and other major trauma). This study followed these

criteria in its analysis. On this basis, current findings revealed that the majority of the burn patients who made it into the study sample suffered major burns which, according to the ABA (2000), should be treated in a Burn Unit. Unfortunately, there was no Burn Unit in the whole of Rwanda. The triage is done at hospital level when a patient arrives at the ED. Of the 98 research subjects, ten (10) were admitted to ICU, 66 to the surgical unit, and 22 to the ED acute care room. Eighty percent of the patients admitted to the ICU had more than 20% of TBSA. In some instances, due to the lack of availability of beds in the ICU, patients with major burns (24%) were admitted to the surgical department. According to Mashrekya *et al* (2008), all burns requiring hospitalisation for more than 10 days are major burns.

5.2.2.3 Environment

The main aim of this section is to answer the question about whether the environment contributes to burn incidence during the event. The environmental risk factors that this study has identified are the home, the rural area, and poverty. Hebert (1994) states that the home is meant to be a place of safety and rest, yet 43% of injuries that have resulted in visits to emergency rooms have occurred in or around a residence. Like many other studies, the current study found that more than 90% of burns occurred in the home.

The design of traditional dwellings and mud huts contributes to burn incidence. In many instances, the space inside a dwelling is used for both cooking and sleeping. In rural African homes, the charcoal stove (*Jiko*) is often the only equipment for cooking or heating besides an open, unguarded fire on the floor (Onuba and Udoidoik, 1987). In Rwanda, charcoal is

commonly used in urban areas, whereas in the rural areas people mostly use wood-fires for cooking. Burns through clothing ignition were prevalent amongst both children and adults. In western countries this is most common among adults. As a matter of fact, children are often left to play, unattended by their mothers, around charcoal stoves and fires on the ground. Children from two (2) to six (6) years old are mostly prone to such environmentally related injuries, as mothers usually pay more attention to younger children (0–2 years), leaving this helpless age group to their own devices for protection despite their lack of skill and their inability to safeguard themselves.

Electrical injuries accounted for 5% of the burn incidences. Children were not spared since they made up 40% of all the electrical burns. This might be due to the fact that children play with uncovered cords, plugs, and other power vectors or outlets. This figure is much higher in Egypt where, in Hemeda *et al's* study (2003), paediatric burns accounted for 16.2%. However, in Rwanda, the figure is potentially lower considering the limited number of those with access to electricity. Moreover, many studies have reported a link between burn and poverty, and that children under five (5) years of age are exposed to high risks of burn (Albertyn *et al*, 2006; El-Badawy and Mabrouk 2006; Goran, 2007; Rajeev and Ahuja, 2004).

5.2.3 Post-Event

The following section discusses the consequences of burn injuries and how serious they are to human beings (host).

5.2.3.1 Host

Burns are responsible for very high morbidity and mortality (Ahmet, Necmi, Mustafa and Mete, 2008). In Turkey, burn related deaths are accepted as medico-legal cases as all are regarded as unnatural deaths. Age is considered to be a predictor of burn injury related mortality. In the current study, a higher mortality rate was found in children between 12 years old and below. In Turkey, Ahmet *et al* (2008) found that the majority of the burn victims (175 cases, 35.9%) were in the 0–5 age group, followed by 21–30 age group with 83 cases. In Bangladesh, Mashrekya *et al* (2008) found higher rates of permanent disability among infant and adolescent girls. Due to burn, adolescent girls (10–14 years age) were also found to be the highest number of patients in terms of longer durations of hospital stay and higher management costs (Mashrekya *et al*, 2008).

Morbidity in burned patients was exacerbated by prolonged hospital admission processes and healing time. Thirty-eight percent (38%) of patients spent less than one (1) week in the hospital, 31.6% spent two weeks, 11% stayed in the hospital for about one (1) month, 15.35% for about six (6) months, and 4.1% had a LOS of more than six (6) months. The most common complication was sepsis (21.4%), followed by acute respiratory distress (9.2%). However, a significant proportion of patients (56.6%) were discharged without immediate complication. A study by Albertyn *et al* (2005) which explored burn injury in Africa, found that complications such as contractures, depigmentation and keloid formation were noted in burn patients. Delayed grafting of burn areas, lack of splinting and inadequate physical therapy contribute to the above problems (Albertyn *et al*, 2005). In Nigeria, post-burn squamous cell carcinoma in burned children was also observed (Sowemimo, 1993).

Hypovolaemia, a consequence of delayed treatment, was considered to be one of the most fatal early complications in burn treatment (Kalyai, 1997). In the current study, 57.2% of patients were hospitalized within 24 hours, 34.7 % in 48 hours to one week, 7.1 % were admitted in seven (7) days and above after sustaining burn injuries. Findings from a survey at the Calabar teaching Hospital in Southern Nigeria revealed that only 57.4% of the paediatric burn injuries were hospitalized within 24 hours after injuries had occurred, 26% within 48 hours and 16.6% waited for four (4) days or more before seeking medical help (Archibong, Antia and Udosen, 1997)

5.2.3.2 Agent

This section discusses the link between burn outcomes and the agent responsible for the occurrence of the burn. The current study found that a high mortality rate (60%), was as a result of fire related burns (flame, flash and contact burns). Although scald burns resulted in a lower mortality rate (4%), they yielded more disability (65%). In their study, Ahmet *et al* (2008) also found that flame burns were highest with 57%. Disfigurements resultant from burns to young children, especially girl children, will have a major impact on their lives as adults. For both children and adults, burns interfere with daily activities either temporarily or permanently. Mashreky *et al* (2008) found that an estimated 3400 children become permanently disabled every year in Bangladesh. In Rwanda, the lack of availability of such data is one of the factors leading to the underestimation of burns in the country.

Furthermore, this study found that most burns (57%) were of second degree, followed by third degree burns (16%), and a small burn portion (1%) was of first degree. The latter only recorded a 22 % of chemical ingestion related incidences, thus disqualifying the deep-burns from obtaining a chemical-burn status. Second degree burns have a high proportion, due to the fact that most of the burns were caused by hot liquids, which have been the commonest cause of second degree burns since this agent is significantly associated with the depth of burn injury (Anlatıcı *et al*, 2001). The commonest cause of the deeper burns was electrical injury, and flame burn was second in this category. Similar findings have been reported by other researchers (Ahmad *et al*, 2006; Anlatıcı *et al*, 2001) who revealed that electrical and flame burns accounted for more third degree burns than other agents.

International findings, whether in developed or developing countries, indicate a link between chemical burns and industrial accidents, whereas in Rwanda, the main economic activity is subsistence agriculture practiced using traditional instruments. Lack of regulations and policy on the handling of chemicals has exposed the population to harm, particularly considering the 22.7% chemical burn related mortality rate that the study found. This mortality rate surpasses that of the United States, which in 2003 had a mortality rate of 0.1% (Cox, 2005). Moreover, this issue remains underrated in the country, as demonstrated by the lack of prevention measures of either primary or secondary nature. This is the first study to provide this kind of evidence. And the fact that the evidence is based on a sample composed of mostly urban respondents raises an even higher concern, since most of the circulating agricultural chemicals are used primarily in the rural setting. Thus, much investigation is needed so that the specific properties that cause morbidity and mortality can be concretely identified.

In terms of burn classification, unintentional injuries had a higher distribution (71.4%) compared to intentional injuries (28.6%). In terms of intentional burns, self-inflicted injuries accounted for 23.5%, interpersonal injuries accounted for 5%, and child abuse related injuries accounted for 2%. Ahmet *et al* (2008) also found that unintentional burning recorded the most death incidences (91.4%) followed by suicide (4.6%) and homicide burning (2%). Most of the adult injury causes related to digestive exposure to chemical hazards. On this note, it is worth noting that a study by Ashraf has found that adult burns are also occupational (Ashraf *et al*, 1997).

On admission, the level of consciousness was not impaired in most patients (88.8%). According to Dolan (1991), it is unusual for burn patients to have an impaired level of consciousness. The percentage of those with patent airways (67.3%) exceeded the percentage of those with obstructed airways (32.7%). The latter included those with inhalation injuries and burn injuries involving the face (32.6%). The most risky factor with the highest mortality rate (75%) was smoke inhalation from flame burns due to explosions of combustible, usually kerosene and fuel, residential fires. Carbon dioxide released from these combustibles was the cause of the high mortality rate. The majority of fire deaths were due to smoke inhalation in residential fires rather than from the burn itself. Smoke inhalation can increase mortality rate ten-fold for the same size burn (Murray and Lopez, 1996).

5.2.3.3 Environment

The factors influencing the outcome (morbidity and mortality) of burn injuries are also stressed. However the rehabilitation phase is out of the scope of this study. This study found that patients

from rural areas had higher mortality rates (81%) than those from the city of Kigali (19%), making the rural area a consistent risk factor for burn-related injuries (Courtright *et al*, 1993; Zhu *et al*, 1988). The Southern Province has the highest mortality rate (100%) followed by the Northern Province (62.5%) and the Eastern Province (45.4%). The city of Kigali had a mortality rate of 19.1%, notwithstanding its high frequency rate in terms of hospital admission. Since 85% of the Rwandan population live in rural areas (National Population Census, 2002), it takes a long time for patients to be referred to hospital leading to a delay in receiving definitive care. As illustrated in Table 4.8, 80% of the patients admitted to ICU came from the rural areas. Twenty-five percent of patients from the city of Kigali with major burns (more than 20% TBSA) recovered without disability, while none (0%) from the rural area survived. Factors that led to the deaths included delayed resuscitation time (Kayak, 1997), infection (Albertyn *et al*, 2005), the long distance from the referral hospital to a specialised centre (Rajeev and Ahuja, 2004), the limited knowledge and lack of specialised care that accrued to the poor management of the acute phase of burn – a critical factor, limited resources (Rajeev and Ahuja, 2004), and the lack of triage in the entire country. The latter is a result of the lack of a coordinated referral system and communication between health facilities. This issue does not affect burn patients alone, but also patients suffering from other health conditions.

Burn related morbidity and mortality can be influenced by the environment where burn patients are treated. Septicaemia, a major complication, was found in 21.4% of burn patients. Extensive injuries and the absence of barrier nursing were the major contributors to wound infections. This is exacerbated by the lack of triage of burn injuries, delayed referral, and the lack of a Burn Unit. Burn patients were mixed with patients with various other diseases, leading to an increased risk

of infection. Results from a study on burns in Africa found that the common organisms are usually *Staphylococcus Aureus*, *Pseudomonas*, *Klebsiella*, *Escherichia coli* and *Streptococcus* (Albertyn *et al*, 2005). In the context of Rwanda, it is difficult to control or prevent infection, because of the lack of a specialised unit or area in the hospital designed for burn patients.

According to Barss *et al* (1998), the problem of burns is even greater in less developed countries where the absence of specialised burn care unit results in much greater morbidity, disability, and mortality of burn victims. This problem is experienced in many African countries, except for a few North-African countries and a small number of West Africa and Sub-Saharan countries, such as South Africa, Malawi, Zimbabwe and Nigeria. Consequently, the majority of burn patients in Africa are treated within the existing health services (rural health care centres, district hospitals or tertiary referral hospitals). Very few units dedicated solely to burn care exist within tertiary hospitals (Albertyn *et al*, 2005). Burn was found to be a major cause of school and work absenteeism, physical impairments, hospitalisation and medical expenses (Mashrekya *et al*, 2008).

Burn mortality rate was 28.6%, which is a high rate compared to that in developed countries. A study done by Ying and Ho (2001) on 50 burn patients in Hong Kong reported a 100% survival rate. Conversely, burn mortality in Africa is still critical. For example, a study undertaken between 1988 and 1997 in Cairo by Anlatici *et al* (2001) found a mortality rate of 33.5%. But because of prevention and education programs, burn mortality rate in developed countries has actually dropped by 50% in the last 30 years. Because of the advances in the treatment of burns in developed countries, a burn victim is much more likely to survive a serious injury. Since more

people are surviving even the most severe kinds of injuries, especially those burned as children, there are now more burn survivors in the workplace (ABA, 2000). The current study found that 20% percent of the burn survivors recovered with disabilities. According to Albertyn *et al* (2005), this is attributed to belated grafting of burn areas, lack of splinting, and inadequate physiotherapy.

5.3 Conclusions from findings

This is the first study to highlight the risk factors and patterns of burn injuries in Rwanda by providing a comprehensive overview of hospitalized burn patients in Rwanda. While prevention is always the rule for safety against burn, immediate and adequate care should be pursued once a burn occurs.

This study identified burn risk factors as the following: age, poverty, the rural context, lack of burn unit, TBSA, scald, chemical agents, combustibles (i.e.; kerosene), and candles. The study found that burn incidence among children was higher than among adults and that paediatric burns were largely associated with scalding (66%). However, electrical and fire related burns were also significant, since 40% of electrical burns involved children below 12 years of age. For children, prevention work should focus on scalding injuries of toddlers in the home by improving household safety.

There was a relationship between gender and agent since 90% of burns through contact with hot objects was made by female persons in the context of domestic incidence during chores like cooking. Because of this, children were also highly exposed to burns because females tended to

exercise household chores and child-care simultaneously. However, scald burns were prominent among both male and female adults. Fifty percent of these burns were caused by attempted suicide through chemical ingestions. To counter this situation, there is a need to establish legislation and regulations on the use of flammable chemicals.

Mortality rates were higher in patients coming from rural environments than in patients from urban settings. However, the actual condition may be worse, as the figure did not include cases who may have died before they reached hospital. The main factors behind this disparity were the distance between the living location and healthcare centres, the lack of coordination between district hospitals and tertiary or referral hospitals, the lack of specialised burn care services, and poverty which deprived people from accessing electricity, for example. As a result of the lack of electricity, people use candles, kerosene lamps and forms of open-fires such as wood-fires. These circumstances all exposed people to burn risks by bringing them into direct contact with open fires.

Based on the ABA classification of burn injuries, most of the burn victims involved in the study sample are found to have suffered major burns. In terms of burn depth 1% of the burns experienced were first degree. They were experienced on various parts of the body including face, trunk and limbs (31.6%). The patterns of injury in each age group suggested that there should be age-focused prevention strategies. The burn mortality rate was considerably high (28%), compared to developed countries where the rate of burn mortality has dropped by 50% in the last 30 years.

5.4 Recommendations

Developing countries have a high incidence of burn injuries, and this is causing serious public health problems (Rajeev and Ahuja, 2004). More than 90% of burn incidences in these countries are preventable (Newberry, 2003). Recommendations are presented below as they relate to practice, management, education and research.

5.4.1 Recommendations for practice

The National Flight Nurse Association of the United States (1996) and Neff and Kid (1992) recommend that an accurate classification of injury, timely intervention, and rapid transportation to appropriate burn facilities are central for the reduction of burn injury mortality and morbidity. In Rwanda these interventions could lead to better outcomes for burn injuries.

5.4.2 Recommendations with regard to management

Rwanda's Ministry of Health could coordinate and build relevant health facilities and services, such as Burns Units and facilities for the triage of burn injuries through a coordinated referral system.

The upgrading of burn-care facilities in Africa. For example, burned children admitted to the Queen Elizabeth Central Hospital in Blantyre, Malawi, were initially treated in overcrowded and understaffed general and paediatric surgical wards (Albertyn *et al*, 2005)

The development of simple protocols for treating burns at the primary, secondary and tertiary care levels. Such protocols could include information on how to assess a burn, fluid resuscitation and basic wound management, and nutrition.

Legislation to prevent the careless lighting of bush-fires in preparation for planting seasons.

The creation of a burn registry and a policy regarding record-keeping as an essential monitoring and evaluation tool for prevention.

Developing countries which improve their population's access to water and electricity and which have a growing middle class should witness a decrease in the incidence of burns. However, the implementation of intervention programs cannot wait until development occurs. Prevention efforts are urgently needed to reduce the rate of this unacceptably common cause of injury, and could be developed on a local level in response to risk factors identified in individual areas (Delgado *et al*, 2002).

5.4.3 Recommendations with regard to education

Education, particularly for the school aged population, combined with legislative efforts could help decrease the rate of burn injuries (Newberry, 2003).

For cases of occupational exposure, the Health Ministry could promote public education on adequate safety measures for work with hazardous materials. Local authorities could commit to informing the public about dangerous chemical products in the home and in the workplace. This could be done through training, provision of safety, and first aid equipment (Newbery, 2003), including education on how to obtain professional assistance.

The provision of information on the importance of raising cooking-fires on bricks or stones and the guarding of open-fires by using fire-grids.

The provision of information on the need for adequate ventilation and the consequences of carbon monoxide specifically in traditional dwellings.

Educating people on how to use the stop, drop, and roll technique to extinguish flame when clothing has caught fire.

The education of parents and children regarding the risks of burn by means of hot objects, fluids and open fires, as well as the safe storage of flammable and toxic substances.

Given the reality of limited resources, perhaps the best way to convey information on prevention is via the electronic media. Regular short radio messages on burn prevention were very successful in Brazil where they contributed to a reduction in the incidence of burn injuries (Piccolo as cited in Albertyn *et al*, 2005).

Training and administration of first aid treatment of burn injuries (Oluwasanmi, 1996).

5.4.4 Recommendations for future research

This study provides evidence for a pressing need to conduct larger population-based studies and to collect burn injury narratives to find specific risk factors to which the population is susceptible, in order to promote burn prevention programs in Rwanda and to improve management of burn patients. Furthermore, since burns are the single greatest cause of disability,

it would be of great relevance to conduct studies on the rehabilitation of burn patients in Rwanda in order to motivate policy-makers to focus on measures which could contribute to the reduction of disabilities related to burn injuries, thereby improving the quality of life of burn victims and their ability to function in society.

5.5 Limitations

The limitations of this study included poor record-keeping at the CHUK hospital. This warranted a collection of burn injury narratives outside the hospital confines in order to fill the gap. However, this was not possible because of time constraints. Thus, further work is needed to explore other circumstances associated with burn injuries in Rwanda at various stages and aspects of burn incidence.

5.6 Conclusion

This chapter discussed the findings from a sample of 98 burn patients admitted at the CHUK. Discussions were guided by the conceptual frame work in order to describe host, agents, and environmental risk factors and resultant clinical characteristics. This study provides information which can be used as targets of change in respect of the concepts of primary, secondary, and tertiary prevention since demographics and features of burns in the pre-event, event, and post-event phases were outlined.

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APPENDIX 1

**CHARACTERISTICS AND RISK FACTORS ASSOCIATED WITH BURN
INJURY IN RWANDA**

DATA COLLECTION TOOL

Checklist number _____

I Socio-Demographic data

- 1. Age (Years).....
- 2. Gender:.....M F
- 3. Job
- 4. Employed:.....Yes Non

5. Province of Residence:

- North
- West
- East
- South
- Kigali City

- 5. Place of burn injury (district): _____
- 6. Date of burn injury: ___/___/___
- 7. Date of admission to district hospital: ___/___/___

8. date of admission to CHUK: _ _ | _ _ | _ _ _ _

II patients' status on admission

1. Consciousness :

Conscious Confused Unconscious

2. Air way patency: Yes No

3. Burns on the face? – Yes: No:

Classification of burns:

 First degree Second degree Third degree
➤ **Depth:**

➤ **TBSA: Based on the American burns association grading system for**

▪ **Burn (2007):**

1-10% 11-20% >20%

➤ **Body region burned:**

1 faces 2.Trunk 3.limbs 4.Genital organs 5. Hand 6. Perineum

III. Circumstance of burn injury

A. Cause of burn injury:

1. Hot liquid burn: 2. Chemical burn 3. Electrical burn 4 Fire

Others:.....
.....
.....

B. Scene of burn injury

1. Private house

2. Residential institute

3. Bar/ night club

4. Road/street

5. Public transport

6. Industrial and construction area

7. Commercial area

8. School/ area

9. Recreation area

Others: (Specify):.....

C. Activity at the time of injury

1. Paid work

2. Unpaid work

3. Travelling

4. Playing sport

6. Education

7. Sleeping/eating

8. Nothing in particular

9. Cooking

Others:.....
.....
.....

D. Categories of burn injuries (WHO 2002)

1. Intentional 2.Unintentional

Intentional:

Interpersonal

Self-inflicted

Others (specify).....
.....

E. Perpetrator victim relationship (if applicable)

1. Spouse /partner 2. Parents (biological) 3. Step-parent

4. Unrelated care giver 5.Friend

6. Stranger

Other(specify):.....

.....

V. Medical surgical conditions associated:

A) Surgical:

fractures

visceral

lesions

head injury

Others:.....

.....

B) Medical:

1. Diabetic

2. Cardiac conditions

3.Renal failure

3.Respiratory conditions

4.Epilepsy

5. Immunity depression

Others: Specify:.....

C. Complications into the hospital:

	Yes	No
Infection	<input type="checkbox"/>	<input type="checkbox"/>
Pulmonary oedema	<input type="checkbox"/>	<input type="checkbox"/>
Fluid overload	<input type="checkbox"/>	<input type="checkbox"/>
Pressure sores	<input type="checkbox"/>	<input type="checkbox"/>
Digestive	<input type="checkbox"/>	<input type="checkbox"/>
Respiratory	<input type="checkbox"/>	<input type="checkbox"/>
Acute renal failure	<input type="checkbox"/>	<input type="checkbox"/>

D. Outcome

Survive	Death
<input type="checkbox"/>	<input type="checkbox"/>

Length of stay:.....days.

APPENDIX 2:

INFORMATION SHEET

**INFORMATION TO THE DIRECTOR OF UNIVERSITY CENTRAL HOSPITAL OF KIGALI (CHUK)
ON A RESEARCH PROJECT CONDUCTED IN PARTIAL FULFILMENT OF A MASTERS DEGREE
COURSEWORK IN TRAUMA AND CRITICAL CARE NURSING**

Introduction

My name is Mukarugwiza Florence. I am a postgraduate student at the University of KwaZulu-Natal studying for Master's degree Coursework in Trauma and Critical care nursing in the academic year 2007-2008. My thesis work is a partial fulfillment of the requirements for this degree.

TOPIC: CHARACTERISTICS AND RISK FACTORS ASSOCIATED WITH BURNS INJURY IN RWANDA.

I would like to conduct research at the University Central Hospital of Kigali (CHUK) in Surgical and ICU department. This study aims to determine the characteristics and risk factors associated with burn injury in Rwanda. The outcomes to be studied are: risk factors associated with burn in Rwanda. This is a necessary study as it will provide information for the hospital and decision makers in the health system in general about the characteristics and risk factors associated with burns in Rwanda, thereby highlighting risk factors that could lead to the establishment of effective prevention programs of burn injuries in the country. This is because

burns are a serious health issue associated with high mortality and morbidity (Anlatıcı *et al* 2002)

The adverse events will be collected from all discharged burn patients admitted to the hospital from 1 January to 31 December 2006. No hospital personnel will be involved in the study. Instead, the researcher will use all the discharged patients' files from the units that meet the inclusion criteria. The instrument to be used for data collection is a checklist for record collection.

To ensure anonymity, selected files will be coded. No patient name will appear on instrument used. In case of publication, another request will be made to the Director of CHUK hospital for consent.

For any further information needed, please do not hesitate to contact Mrs. Mukarugwiza Florence at 08 84 44 75 / +27 07 96 00 86 83, e-mail mukarugwizaflorence@yahoo.com. The study will have the following benefits for CHUK: the research results will be available for use by the hospital. The results will offer information regarding what may be needed in order to devise adequate responses, medically and in terms of policy, towards the implementation of both primary and secondary burn prevention mechanisms in Rwanda. This would potentially help to curb the adverse effects of burn injuries affecting the country. Moreover, the researcher will be available to share the findings at the hospital's request.

Mukarugwiza Florence (Master student)

APPENDIX 3

Mrs. Florence Mukarugwiza
Masters Student in Trauma and Critical Care
University of Kwa-Zulu Natal, Howard College
P.O. Box 4041 Durban, South Africa
E-mail: mukarugwizaflorence@yahoo.com

The Director of University Central Hospital of Kigali
P.O. Box 655
Kigali, Rwanda

Dear Sir,

APPLICATION FOR A PERMISSION TO CONDUCT A RESEARCH PROJECT IN UNIVERSITY CENTRAL HOSPITAL OF KIGALI IN 2007- 2008

I am a student at UKZN Durban, South Africa taking Masters Course work in Trauma and Critical Care Nursing for health professionals for academic year 2007-2008. As a requirement for the degree, I have to conduct a research project; the Topic is “Characteristics and risk factors of burn injury in Rwanda” I therefore request permission to collect the data from burn patients’ case files. I hope my application will meet with your favourable consideration as information obtained will be of relevance to those departments and the institution at large.

Yours faithfully,

Mukarugwiza Florence

Supervisor: Professor B. R. Bhengu

Cc: The Research Committee CHUK

APPENDIX 4

INFORMATION DOCUMENT

Topic: CHARACTERISTICS AND RISK FACTORS ASSOCIATED WITH BURN
IN RWANDA

I Florence Mukarugwiza , I am a Masters in Nursing Trauma and Critical Care student at the University of Kwazulu-Natal, South Africa. As part of my qualification for my program, I am required to conduct a research project in an area of interest. My area of interest is looking at the profile of burns in the Intensive Care Unit of Kigali Teaching Hospital.

The purpose of the study is to describe the characteristics and risk factors associated with burn injury in Rwanda. Findings and recommendations in this study could identify risk factors for burn injuries in Rwanda and provide a starting point for the establishment of a effective prevention plan and influence the improvement of care provided for burn patients.

In order to elicit the response necessary for my research, I have prepared a checklist which I myself will complete and use to assess the presence of vital aspects in the department.

I am therefore asking you to assist me to access the necessary information and documents in your department.

Thank you most sincerely for your cooperation.

Mukarugwiza Florence

Student No: 203506211 Tel: 0796008983

Supervisor: Prof Busisiwe Bhengu

C/O University of Kwa-Zulu Natal, South Africa

University Of KwaZulu Natal

4041 Durban South Africa



**CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL**

**CENTRE HOSPITALIER UNIVERSITAIRE
DE KIGALI (CHUK)**
Bureau de Nursing

N°

Kigali, le 26/07/2006
CHUK/PM/Nurs/06

TO WHOM IT MAY CONCERN.

DECLARATION

The undersigned Dr. MUNYARUGAMBA Protais Director of University Central Hospital of Kigali, declare that the patient files after discharge remain a Hospital property. The Director of the Hospital is the only person who gives permission to anyone who want to access patients files for any reasons.

Dr. MUNYARUGAMBA Protais

Director of CHUK

APPENDIX 6

The project title: CHARACTERISTICS AND RISK FACTORS OF BURN INJURY IN
RWANDA

DECLARATION

I, P. Niyongira Ndirakobuca (Full names of the Director of the hospital or the Head of Research committee) hereby confirm that I understand the contents and the nature of this study, and I consent that you have access to the documents for research project.

Signature:  Date: 2/2/08

Dr. NUYONGIRA NDIRAKOBUCA
Pediatrics
CHK

APPENDIX 7



RESEARCH OFFICE (GOVAN MBEKI CENTRE)
WESTVILLE CAMPUS
TELEPHONE NO.: 031 - 2603587
EMAIL : ximbap@ukzn.ac.za

28 FEBRUARY 2008

MRS. F MUKARUGWIZA (203506211)
SCHOOL OF NURSING

Dear Mrs. Mukarugwiza

ETHICAL CLEARANCE APPROVAL NUMBER: HSS/0012/08M

I wish to confirm that ethical clearance has been granted for the following project:

"Characteristics and risk factors of burn injury in Rwanda"

PLEASE NOTE: Research data should be securely stored in the school/department for a period of 5 years

Yours faithfully


.....
MS. PHUMELELE XIMBA

cc. Supervisor (Prof. B Bhengu)
cc. Mr. S Reddy