MANAGEMENT OF INHALATION INJURY AND ITS EFFECT ON PATIENTS' OUTCOME IN BURNS UNIT KENYATTA NATIONAL HOSPITAL

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DECLARATION

This research is my original work, and has never been submitted for approval in any other institution and should not be duplicated for the purpose of fulfillment of similar awards in any college or university.

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DEDICATION

This study is dedicated to the nurses and doctors working in burns unit Kenyatta National Hospital for their tireless commitment in caring for the victims of burns despite limited resources; and to all patients who lost their fight to burns due to inhalation injury.

I further dedicate this study to my children Charles, Michael and Bilhah as a testimonial of their support during my study time.

In loving memory of my dear husband Thomas who would be more than excited to see me graduate.

Further to my sister Eunice who always stood by my side to assist me and wondered what I will do next.

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ABBREVIATIONS

ABGA: Arterial blood gas analysis

ACLS: Advanced cardiac life support

ACN: Assistant Chief Nurse

AD: Assistant Director Specialized surgery

ARDS: Adult respiratory distress syndrome

ATP: Adenosine Triphosphate

CDC: Center of Disease Control

CNS: Central nervous system

CO: Carbon monoxide

CPAP: Continuous positive airway pressure

CVP: Central venous pressure

DNA: Deoxyribonucleic acid

ERC: Ethical and Research Committee

ETT: Endotracheal tube

EVB: Evidence based

HCN: Hydrogen Cyanide

HOD: Head of Department

ICU: Intensive care unit

ISO: Organization of international standards

IV: Intravenous

Kgs: Kilograms

KNH: Kenyatta National Hospital

Mls: Milliliters

NAC: N- Acetyl cysteine, used for nebulization.

NAD: Nicotinamide adenine dinucleotide

NDMT: National disaster management team

NO: Nitric Oxide

ONOO-: Peroxynitrite

PEEP: Positive End Expiratory pressure

RD: Respiratory distress

RR: Respiratory rate

SAD: Senior Assistant Director Surgery Department

SIMV: Spontaneous intermittent mechanical ventilation

SPSS: Statistical package of social studies

TBSA: Total body surface area

U.O.N.: University of Nairobi

V/Q: Ventilation/ perfusion mismatch

OPERATIONAL DEFINITION OF TERMS

Clerking: Patient's clinical assessment by burns specialist, the plastic surgeon on duty.
Confirmed inhalation injury: Sighed nasal hair, sooty sputum, hoarse voice, coughing, evidenced respiratory edema, labored breathing.
Crusts: Hardened mucus along the airway resulting from cellular debris and dried mucus of the mucociliary lining following its destruction by hot flames/smoke or steam. It can easily block the airway.
Eschar: Hardened dead tissue that forms on top of a burn wound.
ETT Suction: Suction of mucolytic secretions through endotracheal tube but the suction catheter does not go beyond the carina. Secretions within the bronchus and alveoli should either be drained or coughed out for effective suctioning.
Fibreoptic bronchoscopy: Use of a fiber-like tube, inserted into the lungs for diagnosis or bronchus-alveolar wash out.
Hyperbaric oxygenation: Administration of 100% oxygen to a patient regardless of the mode of ventilation.
Inhalation injury: Combination of effects of smoke toxicity, steam and thermal burns on the respiratory tract mucous membrane and parenchyma cells.
Key informants: Nurses or doctors who will be working and might have important information. At least three years experience.
Mechanical ventilation: By-passing patient's effort of breathing or enhancing his little effort to ensure hyperbaric oxygenation by use of artificial ventilators.
Patient's outcome: Patient's clinical condition in relation to healing process following pathological effects of inhalation injury after four weeks of treatment.
Polyps: Fibrous connective tissue that forms during the healing process of inhalation injury.
Prolonged intubation: Patients with inhalation injury who stay with an endotracheal tube for more than three weeks while in the ward.
Prophylactic intubation: Intubating a patient who has facial burns or neck burns and history of enclosed in a burning house although breathing spontaneously well at the time of contact. Arterial blood gases may be within normal ranges.
Smoke: Dark and white thick vaporous cloud associated with incomplete combustion of organic matter, coal or petroleum products. It comprises noxious chemicals and carbonaceous particles.
Suspected inhalation injury: Facial burns, neck burns, history of having been enclosed in a burning house but no evidence of respiratory edema.

ABSTRACT

Background: Smoke inhalation is responsible for pulmonary injury common in burn victims and is a major contributing factor to the morbidity and mortality of burn victims both in the hospital and at incident sites. Inhalation burn injury predisposes burn victims to a major risk for permanent pulmonary dysfunction and however small, should be central to the management of burns. Cleaning up of the patients' lungs after smoke exposure is not a priority yet it may be of significant value in preventing progress of inhalation injury and mortality following the rising incidents of fire disasters and high mortality recently reported in Kenya. Much of the care given to burns patients in Kenya has overlooked the inhalation injury and concentrated on airway maintenance as in general critical care patients. Endotracheal intubation traumatizes the airway of patients with inhalation injury more easily than it would to an intact airway. This calls for attention even after extubation since it might be a contributing factor to high mortality among burns patients. Occurrence of tracheal stenosis post extubation was reported 3(7.9%; n=38) and its prevention requires attention.

Main objective: The aim of this study was to determine the relationship between the management of inhalation injury and the outcome of patients in Burns Unit, KNH.

Study design: This was a longitudinal descriptive study with both quantitative and qualitative components. A sample size of 84 patients with inhalation injury was purposively selected from Burns unit, KNH and study duration was three months. Key informants were purposively selected and interviewed for in-depth information on management of inhalation injury. A checklist of variables, a questionnaire and an interview guide were used. Data was managed using SPSS soft ware version 20.0 while statistical inferences were based on p-values and ODDS ratio.

Results: Diagnosis of inhalation injury was mainly clinical, based on history of the incidence and presenting signs and symptoms. Other parameters like chest X-ray were primarily used to confirm position of central lines and only 7 (8.3%) patients had this done. Grading inhalation injury and determining levels of toxicity were not part of the diagnosis.

Purpose of intubation was to secure the airway and tracheal lavage for removing excess secretions. However,12 (64.7%) nurses reported using tracheal lavage to remove smoke from the lungs while 5 (29.4%) reported smoke is never removed. Literature recommends broncho alveolar toileting for smoke removal and as such tracheal lavage (dry or wet) is not effective to remove soot and carbonaceous particles from the base of lungs. This might explain the deranged arterial blood gas results reported in majority 23 (39.4%) of the patients who died during research period.Majority 27 (69.2%) of deaths occurred during the first week and arterial blood gas analysis showed 13 (15.5%; n=84) of patients with hypoxemia. Intubation was found to be significant in relation to mortality with (p-value 0.0001) but in relation with other significant interventional parameters, it was not significant (p-value 0.63). Use of steroids had no significant relationship with mortality (p-value 0.322). Assessment of carbon monoxide blood levels was recommended as a guide to oxygenation of individual patients in managing inhalation injury. Also, a documented standardized protocol of managing inhalation injury was recommended to enhance uniformity in decision making and reduce personal discretions.

1.0 CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND OF STUDY

Different approaches in the care of patients with major burns have progressively reduced the rate of mortality by a specific cause and changed the cause of death. According to Herndon (2007), burn shock accounted for 20% of burn deaths in 1940s, but due to early and vigorous fluid resuscitation of burn patients, it is no longer a problem. Second was burn wound sepsis after burn shock, but this has also been controlled by use of topical antibiotics and timely surgical debridement. Woodson (2009) reports inhalation injury as the commonest cause of death in burn patients today, with smoke inhalation alone causing up to 11% deaths. Combined with cutaneous burns, smoke inhalation led to (30- 90) % deaths of burn patients (Woodson, 2009).

The aim of this study is to determine the relationship between management of inhalation injury and the outcome of burns patients. Inhalation burn injury predisposes a patient to a considerable risk for permanent pulmonary dysfunction and however small, should be central to the management of burn victims. Managing a burnt airway and its consequences is a challenge to anaesthetists, nurses and doctors who play a central role in stabilizing the patient clinically. Inhalation injury results from thermal or chemical irritation after inspiration of smoke, steam, toxic fumes or mists (Maybaurer, 2009). Its damage can result from direct cytotoxic effects of the aspirated materials or the tissue inflammatory response. In addition to damage of the airways and pulmonary parenchyma by heat, inhalation of carbon monoxide or cyanide also produces toxic systemic effects.

In his study in Germany, Toon et al (2010), reports that 22% of all burn patients and 60% of those with central facial burns have inhalation injury. In comparison, 30% of burn patients who had smoke inhalation injury died compared to 2% of those without smoke inhalation. In conclusion, (80–90) % of all fire-related deaths was attributed to smoke inhalation.

Study done in Turkey between 2009 and 2011 compared a burn of 50% of the total body surface area (TBSA) with smoke inhalation injury to a burn of 73% TBSA without inhalation injury; in that they both carry a 10% mortality risk (Kabalak & Yasti,2012). Inhalation injury predisposes patients to severe clinical consequences such as respiratory failure, acute respiratory distress syndrome, pulmonary infections or prolonged ventilatory support.

Study done in KNH year 2010/2011 showed open flame burns as the major cause of burns (49%) followed by hot water (26%); while the major cause of death was inhalation injury (68.9 %) (Mugambi et al, 2012). The Kenya guideline on management of inhalation burns only specifies intubation and airway suction. This implies that much of other interventions will be decided by individual care givers. Standard treatment guidelines for Gertrudes hospital also has very little about inhalation injury except early intubation (Gertrudes, 2010). Early decontamination of the lungs after smoke exposure is not stressed upon, yet may be very significant in preventing progress of inhalation injury and mortality.

1.2 STATEMENT OF THE PROBLEM

Massive fire incidents have been on rising trend in Kenya since the time of tribal crashes in 2007 with increased risk for smoke inhalation and massive deaths. Just to mention is the Sachangwani and Molo petrol explosion fires, Sinai pipeline leak fire, students burning in dormitories, domestic accidents / fights, mob burning suspects etc. Sachangwani realized 139 deaths; Molo realized 133 deaths and Sinai realized 100 deaths (Kenya Red Cross, 2011).Since majority died at the scene, the cause of death can be attributed more to inhalation injury than to burn wound. Open flame burns seem to take toll compared to steam inhalation, scalds or electricity. Burns unit admits an average of 39 patients per month, 50% having inhalation injury out of which majority die. Study done in KNH year 2010/2011 showed open flame burns as the major cause of burns (49%) followed by hot water (26%); while the major cause of death was inhalation injury (68.9 %) (Mugambi et al, 2012).

Inhalation burns is estimated at 10% of the total body surface area (TBSA) but it is the major cause of death among patients with burn injuries, 80%–90% by smoke inhalation (Toon et al, 2010). This implies that if inhalation burns are effectively managed, mortality rate in burns patients would reduce significantly. Guidelines of managing inhalation injury in Kenya are not specific leaving a lot of room for personal discretions and thus, inhalation injury has not received adequate attention to reduce mortality risk among burn patients. It would be appropriate to have a well organized protocol driven approach of managing inhalation burn injury so as to reduce morbidity and mortality associated with inhalation injury. Tom Lewis (2012) from John Hopkins hospital reviewed their burn management protocol inspired by the mass casualty event that killed over 100 people here in Kenya. He comments that the hospital staffs were overwhelmed and majority of patients mismanaged.

1.3 JUSTIFICATION OF THE STUDY

Being the only referral burns center east and central Africa, burns unit (KNH) attends to majority of patients with inhalation injury from both public and private health facilities. Since many patients die of inhalation injury and there is no previous study on this subject in Kenya, this research intends to evaluate the care given against evidenced research recommendations, determine patients' outcome and identify other outcome influences hoping to come up with recommendations on mortality reduction. Smoke inhalation is responsible for pulmonary injury and significantly contributes to the morbidity and mortality of fire-related injuries in burn victims. In Kenya, open flame burns are very common especially due to stove explosion and usually accompanied by smoke toxicity. Apart from home accidents and domestic violence resulting to burns, disasters involving open flame burns and carbon toxicity have become common in Kenya and many patients die due to inhalation injury even while in the hospital. Example is the Molo fire victims where, out of the 22 patients admitted in burns unit KNH, 13 (59%) died of inhalation injury (Red Cross Kenya, 2011). Fire disaster can affect

anybody and therefore requires highly skilled burns personnel, ideal equipments and clear protocols of inhalation burns management. Findings of this research will be useful as the baseline of care given to inhalation injury patients in KNH. The research findings will benefit the patients through mortality reduction and provide guidance to the burns management team on formulating management protocol for inhalation injury. Care given to the participants was closely monitored unlike other patients thus benefiting the participating patients. The researcher hoped to gain more insight on burns management approaches and add knowledge to the management of inhalation injury and mortality reduction. National disaster management team (NDMT) can also utilize the findings of this research to design a policy of care specific for inhalation injury aimed at mortality reduction in burns patients.

1.4 RESEARCH QUESTIONS

1. How does intubation influence patient's outcome?
2. How is inhalation injury diagnosed?
3. What medications are used to combat respiratory inflammatory process?
4. What treatment protocols are applied to enhance lung healing following inhalation injury?
5. What factors influence the management of inhalation injury in burns unit, KNH?

1.5 STUDY HYPOTHESIS

Outcome of patients with inhalation injury is not dependent on intubation.

1.6 STUDY OBJECTIVES

1.6.1 MAIN OBJECTIVE

The main objective of this study is to determine the relationship between the management of inhalation injury and the outcome of patients in Burns Unit, Kenyatta National Hospital.

1.6.2 SPECIFIC OBJECTIVES

1. To ascertain the current management of inhalation injury in burns unit, KNH

2. To identify factors influencing the management of inhalation injury in burns unit, KNH

3. To determine the outcome of patients with inhalation injury in relation to the care given in burns unit, KNH

1.7 THEORETICAL FRAME WORK: Betty Neuman Systems Model

1.7.1 Overview

In her theory of nursing, Betty Neuman as cited in Julia (2002) addresses stress and reaction to stress. She viewed client as an open system in which cycles of input, process, output and feedback constitute a dynamic organizational pattern. The aim of her theory was to achieve optimal system stability and maintain balance among the various stressors. Reactions to the stressors may be identifiable responses and symptoms. The usual level of health was identified as the normal line of defense that is protected by a flexible line of defense. She labeled stressors as intra, inter, and extra-personal in nature as they arise from the internal, external, and created environments. She reasoned that, when stressors by pass the normal lines and break through the flexible lines of defense, the system is invaded and the lines of resistance are activated. At this point, system is described as moving into illness on a wellness-illness continuum. According to Neuman, the system will be reconstituted and normal lines of defense restored if adequate energy is available.

1.7.2 Application of Neuman's theory to inhalation injury

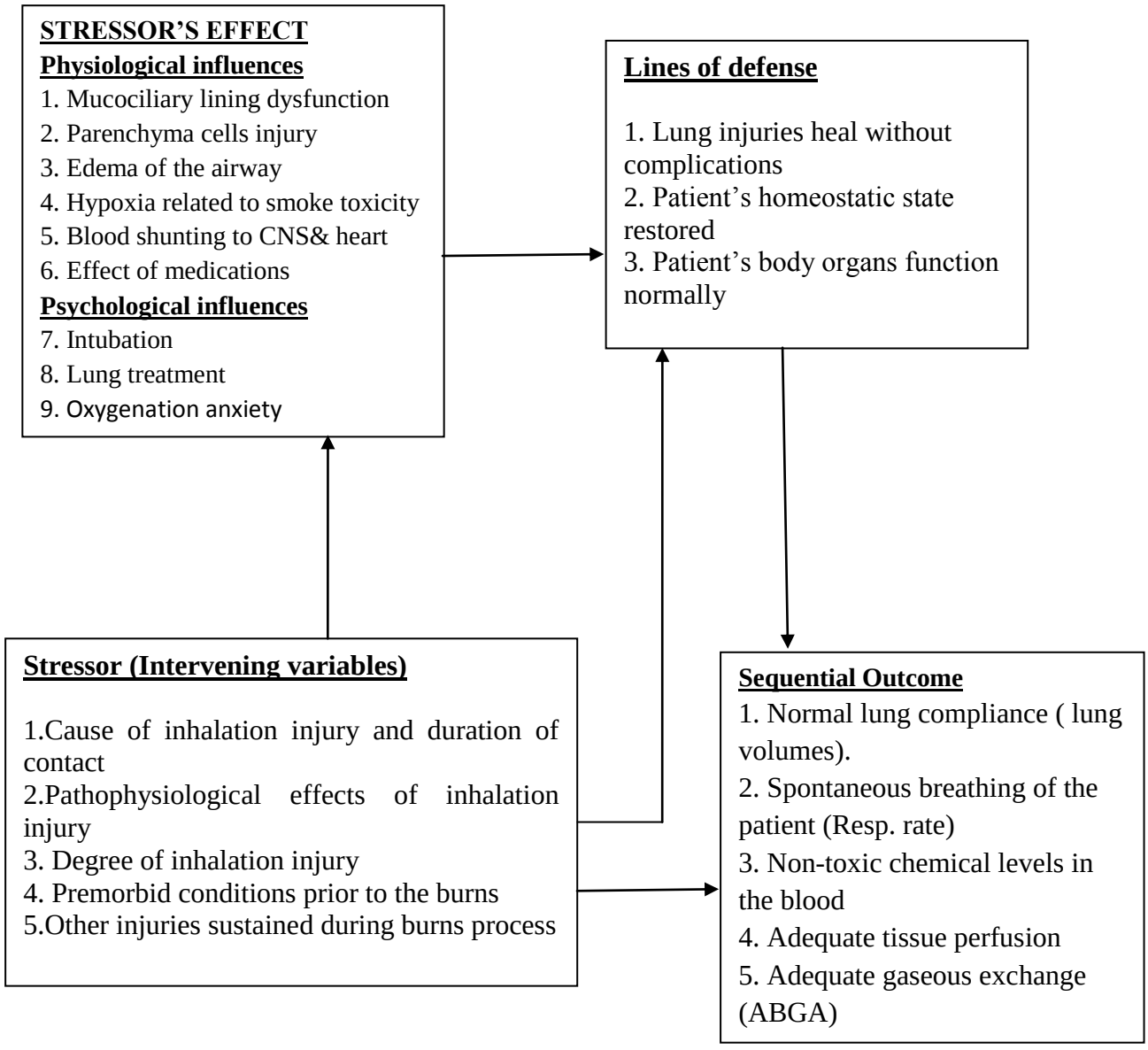
Patient is a system and burn is a stressor. Inability to maintain stability balance follows the pathologic effect of burns and inhalation injury. Betty Neuman identifies system stability or

homeostasis as occurring when energy available exceeds that being utilized by the system; but in a patient with burns, more energy is required to cope with burn shock hence the homeostatic imbalance.

The physiological variable explains how burns alter the physiological structure and functions of the person burnt as detailed out in pathophysiology of inhalation burns. Psychological variable explains the anxiety due to respiratory distress, alteration of body image, discomfort of intubation, unusual feeding mode etc. Social cultural variable refers to sudden stoppage of social role expectations since all burn incidents are accidents and emergencies. The dependence role sets in and patient feels helpless. Developmental variable is better explained by the homeostatic processes that become altered due to fluid and electrolyte loss, shunting of blood to vital organs, tissue edema and tissue injury. It is at this point when believers wonder why God allowed them to burn and non believers get closer to God. Effect of the stressor influences individual spiritual beliefs either positively or negatively.

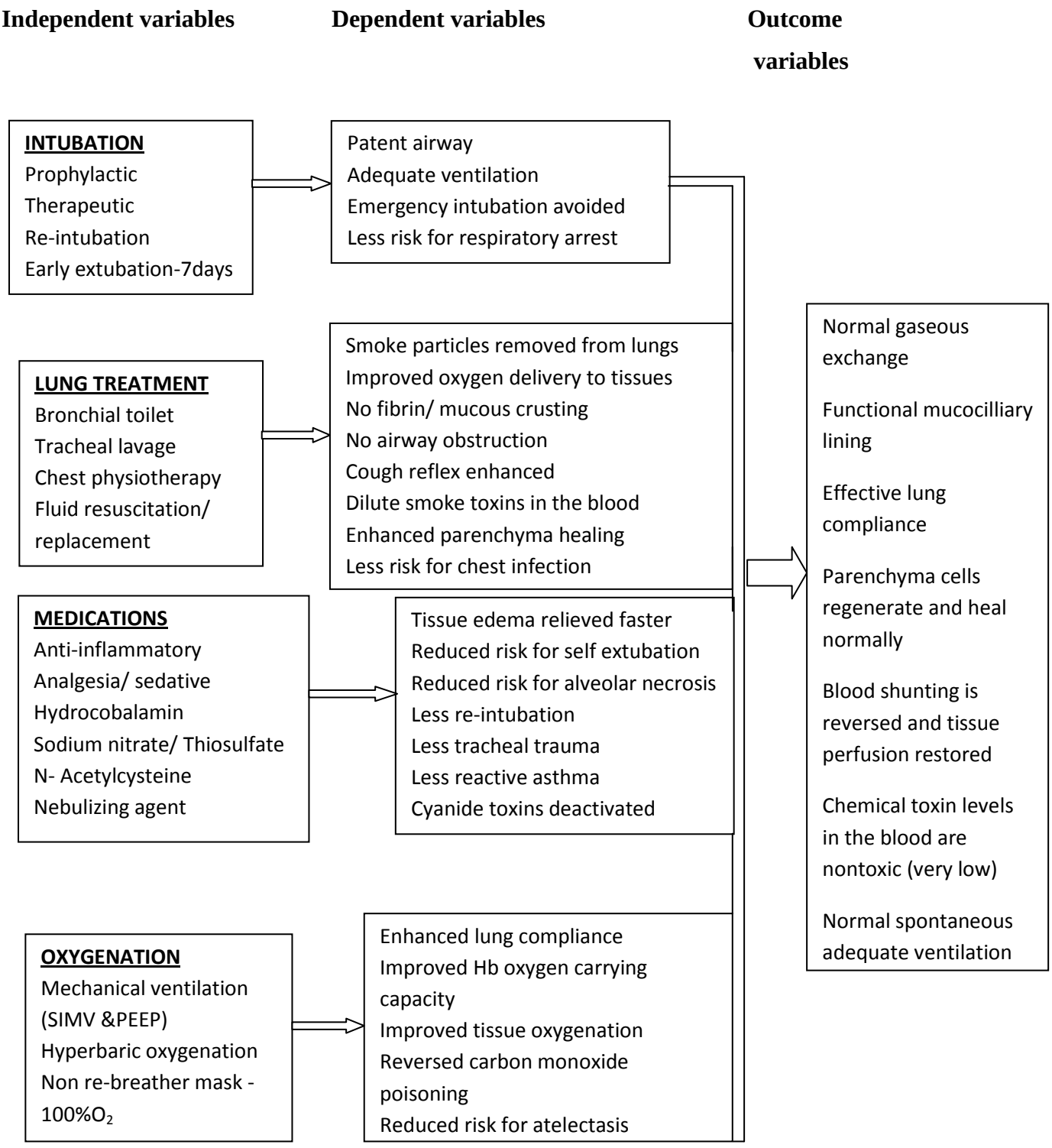
Betty Neuman's four variables are well applicable to the management of inhalation injury and burns as they form a basis for nursing diagnosis. Burns is an environmental stressor which invades the normal lines of defense of a patient, making the lines of resistance to respond by first shunting blood to protect vital organs while compromising the gastro intestinal functions. Another response involving lines of resistance is the activation of immune system leading to swelling of tissues beneath the burn. With this understanding, prophylactic intubation is indicated in patients with inhalation, facial or neck burns. If the lines of resistance are not effective, patient may suffer kidney failure. However, if no provision respiratory support, effect of lines of resistance may cause respiratory failure leading to death of the victim. In this case, flexible lines of defense would mean taking precaution to avoid the fire source or reducing the time of direct contact with the source and applying appropriate and timely first aid.

According to Betty Neuman as cited in Julia (2002), interventions can occur before or after the resistance lines; and in burns patients, intervention occur during and after resistance lines. Interventions are based on degree of injury, goals and anticipated sequential outcome. The diagram below illustrates this theoretical framework.



Source: Mugambi (2013)

1.8 INTERVENTIONAL CONCEPTUAL FRAMEWORK



Source: Mugambi (2013)

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 BURN DEFINITION AND PATHOLOGY

Herndon (2007) viewed burns as the most common and devastating form of trauma; caused by heat, friction, electricity, radiation or chemicals. Burn injury is a result of heat transfer from its source to body tissues leading to tissue destruction. Tissue destruction result from coagulation, protein denaturation or ionization of cellular contents. The skin and the mucosa of the upper airway are sites of tissue destruction while deep tissues including the viscera and bone can be damaged by electrical burns or prolonged contact with heat source. Skin disruption may lead to increased fluid loss, infection, hypothermia, scarring, compromised immunity and physiologic functional changes (Brunner & Saddarth, 2010). Depth of injury depends on the temperature of the burning agent and the duration of contact. Physiologic responses usually involve fluid and electrolytes, cardiovascular, renal, gastrointestinal, and pulmonary alterations.

Pathophysiologic changes resulting from major burns during initial burn shock period include tissue hypoperfusion, and organ hypofunction secondary to decreased cardiac output following blood shunting to vital organs. Hemodynamic instability results from loss of capillary integrity and a subsequent shift of fluid, sodium and protein from intravascular to interstitial spaces. (Polaski & Suzanne, 2010).

2.2 EPIDEMIOLOGY OF BURNS AND INHALATION INJURY

Burn injury can affect people of all age groups, in all social economic levels. In China, it is estimated that 50,000 people are treated for minor burns annually (Pitts et al, 2008). Patients hospitalized each year are more than 40,000 with 25,000 requiring specialized burn care. Just like Kenya, China reports an increase in patients requiring specialized burn care. Of all the burns admitted to burn centers, 40% are open flame burns, 30% are scalds, 4% electrical and

3% chemical burns (Miller et al, 2008). This implies that 40% have smoke inhalation and 30% might have steam inhalation.

Data from the National Center for Injury Prevention and Control in the United States reports approximately 2 million fires each year which result in 1.2 million people with burn injuries (Brunner & Saddarth, 2010). Moderate to severe burn injuries requiring hospitalization are about 100,000 while about 5,000 patients die each year from burn-related complications (Brunner & Saddarth, 2010). For patients with over 40% of the total body surface area (TBSA), 75% of all deaths are currently related to either sepsis from burn wound infection, other infection complications or inhalation injury.

2.3 INHALATION BURN INJURY

Inhalation injury results from thermal or chemical irritation following inspiration of smoke, burning embers, steam, chemical fumes, cytotoxic fumes or mists (Toon et al, 2010). Damage to the airway parenchyma cells result from direct heat damage and toxic effects of the aspirated materials plus the consequence of inflammatory response. Further to the damage, inhalation of carbon monoxide or cyanide also produces toxic systemic effects.

Inhalation injury is very common in patients who sustain burns and it has high morbidity and mortality rates (Traber et al, 2007). Isolated inhalation injury can as well pose a significant risk of mortality or permanent pulmonary dysfunction. When combined with cutaneous burns, inhalation injury increases fluid requirements for resuscitation, risk for pulmonary complications and mortality.

2.3.1 Assessment of inhalation injury

According to Palmieri (2007), there is insufficient data to support one treatment standard or any treatment guideline for the diagnosis of inhalation injury but it should be suspected if there is evidence in:

- Exposure in an enclosed space
- Death of persons at scene

• Decreased level of consciousness; Confusion • Steam burns

• Soot in mouth, nares, burnt nasal hairs • Facial burns

• Carbonaceous sputum

• Swelling, ulceration of oral mucosa or tongue (deeper examination may compromise the airway of the distressed child)

• Dyspnoea • Hoarseness

• Drooling • Stridor, wheeze, crepitations

• Increased work of breathing

• Oxygen saturations <90% in arterial blood (normal saturations do not exclude the diagnosis as carboxyhaemoglobin is recognized as oxyhaemoglobin by oxygen saturation monitors)

• Carboxyhaemoglobin >5% on CO-oximetry

2.3.2 Upper airway injury

Direct thermal injury to the mouth, nasopharynx, pharynx and larynx are common and generally appear erythematous and edematous with mucosal blisters or ulcerations. The mucosal edema can lead to upper airway obstruction particularly during the first 48 hours post burns. All clients with facial and neck burns are anticipates of upper airway obstruction and should have prophylactic intubation. Thermal burns to lower airways are rare.

2.3.3 Lower airway injury

No factors accurately and consistently predict the need for intubation. It is a clinical decision which is not based on laboratory data. Signs like drooling, stridor, hoarseness, facial or neck burn or increased work of breathing are indications for intubation (Ignatavicious & Linda (2013).

Patients with lower airway inhalation burns require intubation and should be managed in ICU. Patients tend to deteriorate as lower airway injury progresses. Sometimes consequences of inhalation burns may not manifest until after 48 hours when laryngeal edema peaks.

Toxins produce bronchospasm, mucosal oedema, increased vascular permeability, obstructive airway casts and surfactant dysfunction.

Depressed epithelial integrity, loss of mucociliary clearance mechanism, accumulation of secretions in the lower airway and immune-compromise predispose patient to bacterial colonization. Lower airway injury may progress to acute respiratory distress syndrome and strategies of management aim at minimizing iatrogenic ventilator induced lung injury.

2.4 PATHOPHYSIOLOGY OF INHALATION BURNS

Figure 1: Exploded oil tanker ***Source: Google pictures***

Inhalation injury occurs when a person is trapped inside a burning house or is involved in an explosion that leads to inhalation of super heated air, carbonaceous and noxious gases (McCall & Cahill, 2005). There are three ways in which inhalation injury occurs: 1) By irritants damaging parenchyma cells; 2) Interruption of oxygen delivery by asphyxiants; 3) End organ damage following hypoxemia. Respiratory embarrassment can be broadly

categorized as the result of thermal or chemical damage to epithelial surfaces of both the intrathoracic and extrathoracic airways.

Deterioration of patients with inhalation burns occur due to broncho-constriction following release of histamine, serotonin and thromboxane or chest constriction secondary to circumferential full thickness chest burns (Traber et al, 2007). Catecholamine release in response to stress of burn injury and hypermetabolism leads to increased oxygen consumption by the body tissues which can lead to hypoxia. For this reason, supplemental oxygen may be required.

Pulmonary burn injuries are categorized as above glottis or below glottis. The upper air way injury results from inhalation of greater than 150^{o}C to the epithelium. Result is severe upper airway edema which can cause upper airway obstruction up to the larynx (Palmieri, 2007). Due to the cooling effect of rapid vaporization in the pulmonary tract, direct heat injury does not occur below bronchus. Upper airway is treated by endo-tracheal intubation.

Maybaurer et al (2009) reports that injury below glottis results from inhalation of noxious gases, steam or incomplete combustion. These products include carbon monoxide, cyanide, ammonia, aldehydes, acrolein, sulfur dioxide and isocyanides. Once inhaled, they trigger a cascade of events, resulting to pulmonary oedema and ventilation/perfusion (V/Q) mismatch. Intrapulmonary leukocyte aggregation following activation of the classic complement cascade releases even more chemokines and cytokines, leading to production of oxygen free radicals.

Edelman et al (2006) explains how Nitric Oxide synthase is produced by respiratory epithelial cells and alveolar macrophages for the production of Nitric Oxide (NO), a powerful vasodilator. Nitric Oxide increases bronchial blood flow, decreases hypoxic pulmonary vasoconstriction in poorly ventilated areas of lung and results in ventilation/ perfusion (V/Q)

mismatch. Activated neutrophils produce superoxide (O_2^-) which combines with NO to form peroxynitrite (ONOO-). This reactive nitrogen species lead to DNA damage. Repair of the DNA by polymerase enzyme requires a lot of chemical energy in the form of ATP and NAD, depletion of which causes necrotic cell death to the tissues involved. Combination of these effects contributes to tissue injury and increased pulmonary vascular permeability, leading to decreased diffusion, oedema and V/Q mismatch.

Neutrophil infiltration and fibrinogen activation by inflammatory mediators causes airway crust formation and widespread plugging. Pathological lung specimens, after inhalation of smoke, demonstrate the presence of obstructive casts in the airways. Cox and Burke (2003) studied burnt sheep and discovered that crusts form at bronchial, bronchiolar and terminal bronchiolar levels. Obstructive changes were maximal at 24 hours in large airways, and rose continually up to 72 hours at the bronchiolar level. Crusts are composed of epithelial cells, neutrophils, mucus and fibrin. These crusts obstruct the airway and subsequent efforts to ventilate the lung mechanically can induce ventilator-induced barotrauma when the patient lung becomes overstretched. Much of the study of smoke inhalation injuries in animal models has focused on aspects of this pathophysiological sequence (Suman et al, 2007).

Inhalation injuries below glottis cause loss of cilliary function, hypersecretion, severe mucosal edema and bronchospasm. Impaired cilliary function leads to accumulation of airway debris. Mucosal edema in the smaller airways lead to audible wheezing or heard on auscultation. Pulmonary safurctant is reduced leading to atelectasis. Expectoration of sooty sputum is the obvious sign of lower airway injury. Early intubation and mechanical ventilation with 100% oxygen reduces the half life of carboxyhemoglobin from 4hours to 45minutes (Kealey, 2009). Macrophages within the alveoli are destroyed, allowing bacteria to proliferate enhanced by lack of an intact epithelial barrier leading to pneumonia.

Restrictive pulmonary excursion may occur with full thickness circumferential burns of neck and chest. This is a confounding factor because it causes decreased tidal volume (Rehbergs et al, 2009). Hypoxemia results from a decrease in inspired oxygen concentration at the scene of injury, a mechanical inability to exchange gases due to airway obstruction or parenchyma pulmonary disease. Inhibition of oxygen delivery and tissue use by toxins also causes hypoxemia. More than 50% of patients with inhalation burns do not initially demonstrate pulmonary signs and symptoms and as such, any patient with suspected or possible inhalation injury should be observed for at least 24 hours for respiratory complications (Kabalak & Yasti, 2012). With the advent of sophisticated intensive care support, patients who survive the acute injury should have less mortality. However, presence of multi-organ dysfunction is a common sequel of hypoxia and substantially raises morbidity and mortality of burns patients (Mc Call &Cahill, 2005).

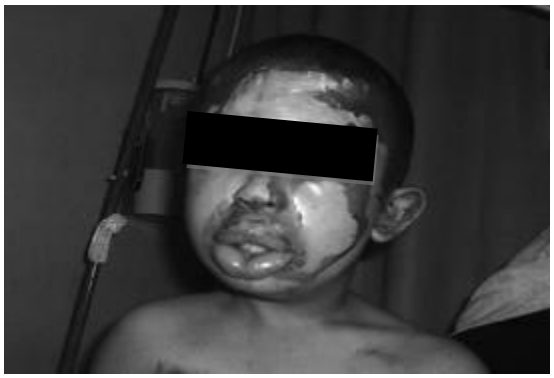
Carbon monoxide is a colourless odorless tasteless gas released from burning wood or coal. It displaces oxygen from hemoglobin binding sites thereby decreasing the oxygen carrying capacity of the blood. It not only has 250- fold increased affinity for hemoglobin but also shifts the oxyhemoglobin dissociation curve to the left (Kealey, 2009). The left shift results in increased tissue hypoxia because hemoglobin is less able to unload the little oxygen it's carrying. Carbon monoxide reacts with myoglobin to further impair oxygen uptake by decreasing facilitated diffusion of oxygen to muscles. It interacts with several heme-containing enzymes of the electron transport chain and so impairs tissue oxygen availability (Kealey, 2009).

Hydrogen cyanide (HCN) represents the gaseous form of cyanide, which is a colorless gas with the odor of bitter almonds. It is found in smoke especially from burning polyurethane and causes tissue asphyxiation by inhibiting intracellular cytochrome oxidase. It blocks the

final step in oxidative phosphorylation and prevents mitochondrial oxygen use. Affected cells convert to anaerobic metabolism and the lactic acid formed presents as metabolic acidosis.

The organs most sensitive to cellular hypoxia i.e. CNS and the heart react to low oxygen concentrations through hyperventilation thereby increasing exposure to intoxication. Airway obstruction may occur very rapidly especially during fluid resuscitation. Decreased lung compliance, decreased arterial oxygen levels and respiratory acidosis occur gradually over the first five days post burn.

Facial burns &upper airway edema



Facial burns & inhalation injury

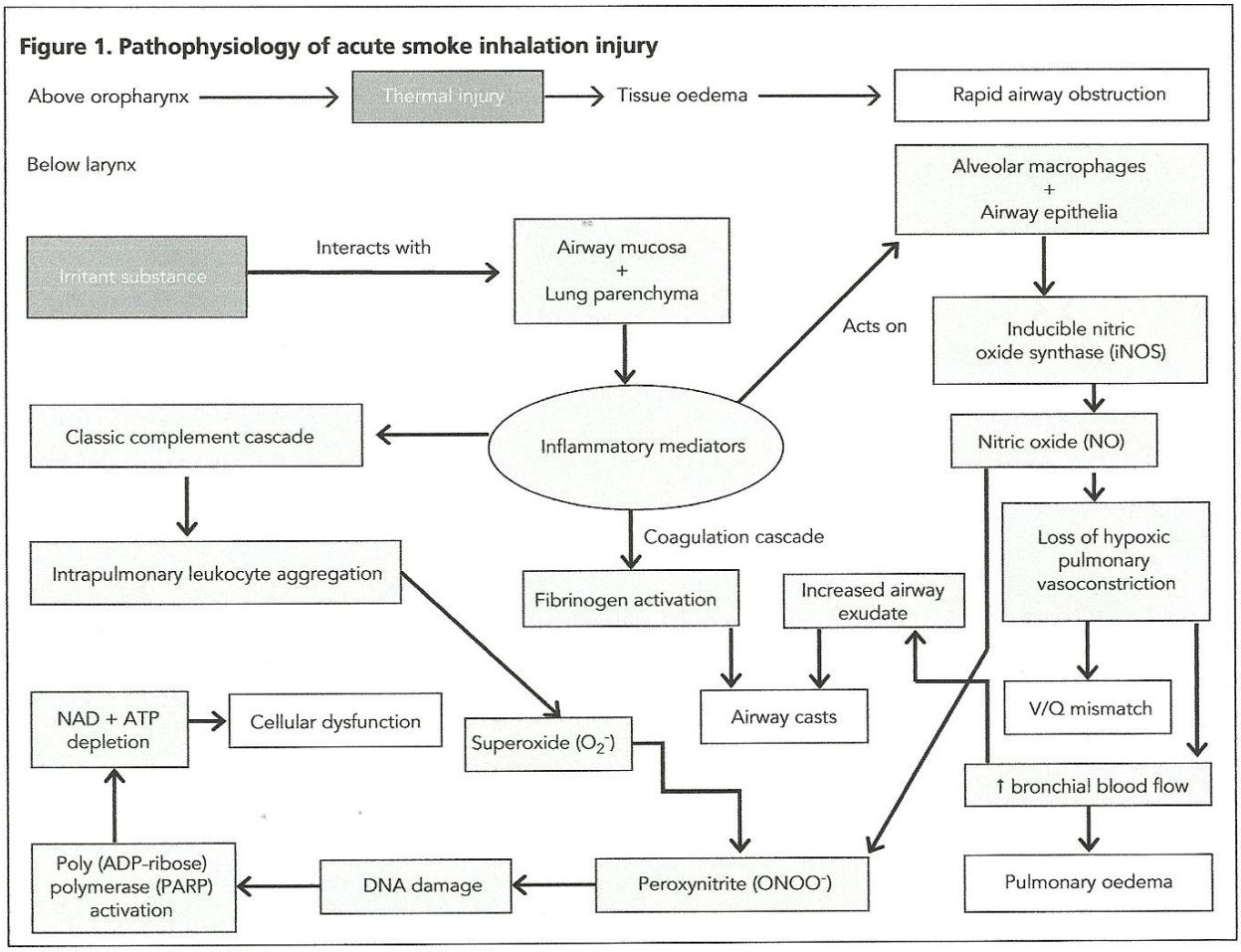
Source: Google pictures

Complications include sloughing of the airway, increased secretions and inflammation, atelectasis, airway obstruction, pulmonary edema, tissue hypoxia, and ulceration. As a result, respiratory failure, acute respiratory distress syndrome and pneumonia can develop (Edelman et al, 2006). Sloughing of trachea-bronchial epithelium may lead to hemorrhagic trachea-bronchitis and if the disease process continues, ARDS ensues.

Tracheal burns & inhalation injury

Source: Google pictures

The schematic diagram below (figure 4) illustrates the pathophysiology of inhalation injury as designed by Toon et al.



Extracted from Toon et al (2010).

2.4.1 Lung Damage from Inhalational Smoke Injury

Onset of symptoms is often delayed warranting all burns patients with suspected inhalation to be under close critical observation. Below are intoxicating compounds found in smoke and their sources.

Lung injury from toxins in smoke			
Compounds	**Source**	**Effect**	**Timing**
Ammonia, Sulfur dioxide, Chlorine	Clothing, furniture, wool, silk	Mucous membrane irritation, Bronchospasm, Bronchorrhea	Early onset (hours)
Hydrogen chloride, Phosgene	Polyvinyl, Chloride, Furniture, Floor coverings	Severe mucosal damage- (ulcers, plugs, slough), pulmonary edema.	Delayed (2days)
Acetylaldehyde, Formaldehyde, Acrolein	Wallpaper, Lacquered wood, Cotton, Acrylic	Severe mucosal ulcers- (ulcers, plugs, slough) ,pulmonary edema.	Delayed (2days)
Cyanide	Polyurethane, upholstery	Tissue hypoxia	Immediate
Carbon monoxide	Any combustible substance	Tissue hypoxia	Immediate

Source: Greenhalgh (2007)

2.5 CHEST WALL BURNS AND INHALATION INJURY

It is not common for a patient to have deep chest wall burns without inhalation injury. A full thickness burn of the anterior and lateral chest walls can lead to severe restricted chest wall expansion especially when eschar forms and edema develops beneath the eschar (Polaski &

Suzanne, 2010). Tight eschar on the abdomen also restricts movement of the diaphragm. Escharotomy on both eschars may be required as part of ventilation management.

The escharotomy incisions are placed along the anterior auxillary lines with bilateral incisions connected by a subcostal incision. These incisions must pass through the eschar so that the subeschar space can expand and decrease tissue pressure. Analgesics are usually not necessary as nerve endings are destroyed in a full thickness burn. The picture below demonstrates escharotomy performed on tight chest.

Source: google pictures

2.6 STEAM INHALATION INJURY

Feldman et al (2004) referred to immersion burns as either intentional or non intentional, out of child abuse or home accidents. Steam inhalation is common among babies or workers in industries that use steam for their processes. There is head immersion into boiling liquid where the baby breathes in steaming hot liquid or hot steam inhalation occurs. Due to congestion in slums, this is common among babies admitted in Burns Unit and causes lower lung injury. It is also common among people who use steam inhalation therapeutically.

2.7 COMPLICATIONS OF INHALATION INJURY

2.7.1 Short term complications

The most common short-term complications of inhalation injuries are those caused by microbial infection. Most common is mechanical ventilation associated pneumonia, with infection rates of up to 40% in those on artificial ventilation. It can be quite difficult to diagnose pulmonary infections due to the similarity of symptoms between infections and symptoms of the inhalation injuries (Kabalak &Yasti, 2012). The key to diagnosing an infection is by noting unexpected worsening or changing of symptoms. Gram stains can also be used to identify the bacteria responsible (Edelman et al, 2006).

The treatment of infection resulting from inhalation injury is accomplished with antibiotics specific to the pathogen. Prophylactic use of antibiotics has not proofed effective, except enhancing rapid development of antibiotic resistant strains (Klastersky as cited in Polaski & Suzanne, 2010).

Endotracheal intubation is necessary in about 80% of patients with inhalation injuries because of respiratory difficulties. However, prolonged intubation (over 3 weeks) can greatly increase the risk of pulmonary infection (Palmieri, 2009). Bacteria can colonize the plastic tubing and then cause infection. Long-term intubation is also believed to exacerbate laryngeal damage by occasionally causing ulcers or adhering to the tissue.

Tracheal stenosis is rare but can occur where airway heals with adhesions especially following traumatic intubation. Treatment is tracheostomy and early signs may be confused with asthma. Edema proximal to the endotracheal tube tends to push the tube backwards hence the many re-intubations especially in babies (Demling, 2005).

2.7.2 Long term complications

Polyps can be formed when there is excessive granulation (fibrous connective tissue that forms after the fibrin clot) during the healing process. Polyps typically heal within 6 months after injury but use of corticosteroids enhances the healing process (Maybaurer et al, 2009). However, in severe cases where polyps form in small airways, they can lead to a syndrome similar to bronchiolitis obliterans. This leads to scaring and inflammation and can decrease lung function to around 20% leading to respiratory failure and death. A rare long-term complication of inhalation injury is reactive airway dysfunction, a form of asthma that is irritant-induced (Palmieri, 2009).

2.8 DIAGNOSIS AND TREATMENT OF INHALATION INJURY

Indicators for possible airway injury include: 1) Burns occurring in an enclosed space; 2) Burns of the face or neck; 3) Singed nasal hairs; 4) Hoarseness, cough, stridor, high pitched voice; 5) Sooty or bloody sputum; 6) Labored breathing; 7) Hypoxemia; 8) Erythema and blistering of oral or pharyngeal mucosa (Nugen & Herndon, 2008).

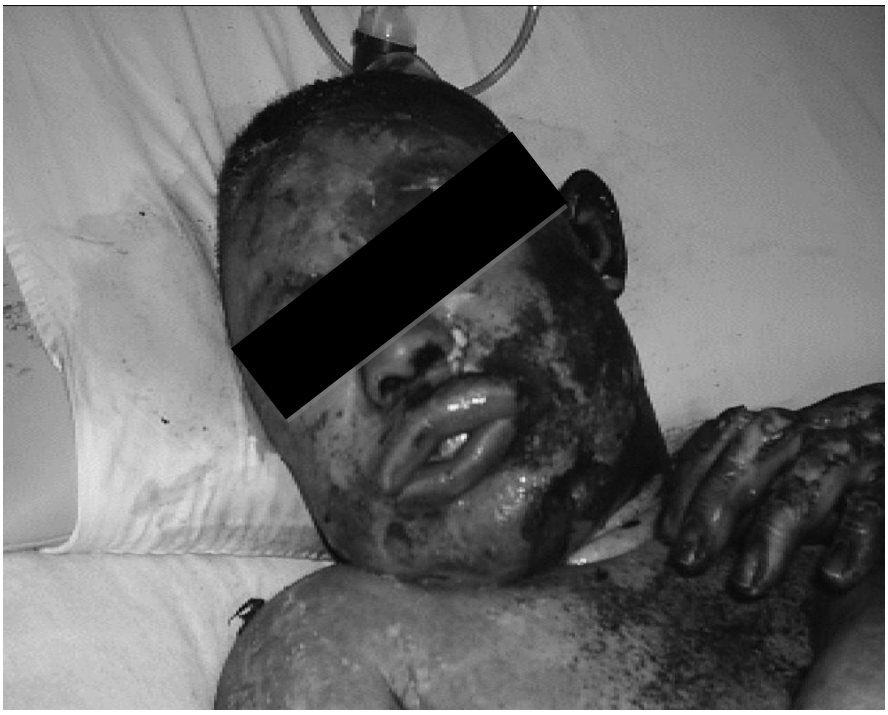
Diagnosis of upper airway inhalation injury includes oral burns, swollen tongue and mucosa, edematous supraglottis, infraglottis and cord. Erythema is demonstrated through laryngoscopy and hoarseness of voice is the first sign.

Diagnosis of lower airway inhalation injury includes monitoring of arterial blood gases, carboxyhemoglobin levels and fibreoptic bronchoscopy. Bronchoscopy findings include visible airway edema, inflammation, necrosis, or soot. Fiberoptic bronchoscopy provides direct information about the entire respiratory system (Nugen & Herndon, 2008). In addition to its diagnostic functions, bronchoscopy is useful in lung therapy determining the severity of

inhalation injury. Woodson (2009) used bronchoscopy to grade the inhalation injury: The indicators listed above are present in all grades but;

- Grade I: Has no laryngeal oedema
- Grade II: Minimal laryngeal oedema and erythema
- Grade III: Slight tracheal mucosal oedema and erythema
- Grade IV: Moderate tracheal mucosal oedema and erythema
- Grade V: Severe tracheal oedema and erythema

<u>Deep facial burns, patient entraped in burning enclosed space: Soot around mouth, patient drowsy, face and lip oedema</u>



Source: google pictures

The initial degree of injury is usually underestimated from chest x-ray, as the injury is confined mainly to the airways.

2.8.1 Carbon monoxide toxicity:

Clinical manifestations of carbon monoxide intoxication are tabled below.

Extracted from Polaski & Suzanne (2010).

% Hgb level of COHgb intoxication	Symptoms
0-5	Normal values
5-10	Impaired visual acuity
11-20	Headache, confusion, flushing
21-30	Nausea, impaired dexterity, disorientation, fatigue
31-40	Vomiting, dizziness, syncope, combativeness
41-50	Tachycardia, tachypnoea,
More than 50	Coma, shock, cardiopulmonary arrest, death

To reduce carboxyhaemoglobin levels as soon as possible, high-flow 100% humidified oxygen should be administered immediately via facemask or hyperbaric chamber treatment.

2.8.2 Cyanide toxicity:

Plasma cyanide levels are difficult to obtain, so treatment is based on history, source of fire suspicion and unexplained metabolic acidosis not corrected by fluids and oxygen. Treatment for cyanide poisoning is usually cardiopulmonary support hoping that the liver enzyme rhodenase will clear it from the circulation. In severe cases where one is reasonably sure of the diagnosis (cyanide blood levels), sodium nitrate (300mg IV over 10minutes) is administered or thiosulfate. They bind to cyanide forming thiocyanate which is then excreted through kidney. Sodium nitrate oxidizes hemoglobin to methemoglobin as a side effect and should be used cautiously if a must (Pham &Gibran, 2007).

In contrast to these antidotes, hydroxocobalamin (vitamin B12), actively binds cyanide by forming cyanocobalamin, which is directly excreted through kidney. In case of intoxication

with 1mg cyanide, hydroxocobalamin (50mg/kg) is recommended (Polaski & Suzanne, 2010). It averts methemoglobin production and can be used even in the preclinical setting.

2.9 AIRWAY EDEMA TREATMENT

The patient's head should be elevated to minimize facial and airway oedema (Pitts et al, 2008). Aerosolized adrenaline or corticosteroids may be beneficial to reduce upper airway oedema, but there is no conclusive evidence of their efficacy.

In the case of bronchospasm, nebulized beta 2-agonists, improves respiratory efficiency by decreasing airflow resistance and peak airway pressures. In addition, beta2-agonists have anti-inflammatory properties and help decrease inflammatory mediators such as histamine, leukotrienes and tumour necrosis factor (Demling, 2005). Finally, beta2-agonists improve airspace fluid clearance and stimulate mucosal repair.

According to Toon et al (2010), nebulizing children with massive burns and inhalation injury using heparin and N-acetylcysteine for the first 7 days decreases incidences of re-intubation, progressive pulmonary failure, atelectasis, and hence mortality.

Miller et al (2009) in his study also confirmed reduction in lung-injury after smoke inhalat ion when he administered nebulized heparin and the mucolytic N-acetylcysteine to a group of patients.

Many drugs have proven effective in reducing the injury to the lung parenchyma in animal models, but only a few are in clinical use. These include heparin, N-acetylcysteine and inhaled albuterol.

2.10 INDICATIONS FOR INTUBATION IN INHALATION INJURY

Early intubation may be required if stridor, hoarse voice, chest retraction or respiratory distress is present; but risk for rapid development of airway oedema should be considered for prophylaxis intubation. However, endotracheal intubation at the injury scene risks patients to

oesophageal intubation, aspiration, barotrauma and even laryngeal trauma. It should be avoided unless by professional experts (Pitts et al, 2008).

Deep burns to the face and neck call for early intubation due to anticipated upper airway obstruction. Aim is to ensure airway patency when edema of the tongue and glottis sets in. Mechanical ventilation assisted mode is indicated for all patients with lower airway inhalation injury. Purpose is to enhance gaseous exchange while maintaining adequate ventilation without much patient's effort. Management of lung injury due to smoke inhalation is mainly supportive, using mechanical ventilation, humidification and aggressive airway toileting (Traber et al, 2007). Low tidal volume ventilation with associated permissive hypercapnia has effectively reduced ventilator-induced lung injury and PEEP is a choice application in patients with ARDS (Toon et al, 2010).

2.11 RESTORING HEMODYNAMICS AND INHALATION INJURY

Inhalation injury adds 10 % to the burnt total body surface area and should be included in the calculation of fluid for replacement therapy. Loss of plasma volume is rapid after a burn injury as fluid collects in the burn tissue. Patients with very severe deep burns develop massive systemic edema and re-absorption is dependent on the depth of injury (Greenhalgh as cited in Brunner & Saddarth, 2010). Partial thickness injury resolves more quickly due to a more functional lymphatic system and increased perfusion compared to deep burns. Early fluid resuscitation is required for burns exceeding 15% TBSA in adult and 10% TBSA in children because low extra-cellular fluid volume enhances plugging of secretions along the airway thus increasing risk of chest infections and obstruction (Brunner & Suddarth, 2010). .

Patient should have at least one large bore intravenous catheter or CVP catheter for intravenous fluids and possible cardiopulmonary resuscitation. Body weight (Kgs) should be estimated and Parklands formula used to estimate amount of fluid to be replaced: (4ml x

weight x TBSA %). Half the amount is given within eight hours from the time of burn and the remaining half within the next sixteen hours (Williams, 2008).

Children receive maintenance fluid in addition, at an hourly rate of 4ml/kg for the first 10kg of body weight plus; 2ml/kg for the second 10kg of body weight plus; 1ml/kg for >20kg of body weight (Williams, 2008).

Excessive fluid administration increases edema formation in both burned and unburned tissues. As a result, pressure on small blood vessels and nerves in the distal extremities cause obstruction to blood flow and consequent ischemia. This complication is similar to compartment syndrome and may also cause pulmonary edema (Brunner & Saddarth, 2010). During burn shock, hyponatremia is present as water shifts from intravascular to interstitial spaces despite sodium reabsorption by the kidney. Hyperkaleamia results from the direct cell injury which releases large amounts of cellular potassium. Hypokaleamia may occur later following fluid shifts and potassium moving back into the cells (Ignatavicious & Linda, 2013).

3.0 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 STUDY DESIGN

This research was a descriptive longitudinal study with both qualitative and quantitative components. Data was collected prospectively assessing clinical management and patients' response to the interventions on inhalation injury. Each patient was followed up for as long as he lived up to four weeks and data collection took three months.

3.2 STUDY AREA

This research was conducted in Burns Unit, Kenyatta National Hospital (KNH). KNH is a government hospital situated in Nairobi, and the only prime referral center for both private and other government hospitals. KNH was established in 1901 and offers training and research ground to Kenya medical training college, Nairobi University, CDC Kemri and also participates in national health planning. KNH serves a population of three million and it is situated between Ngong road, Mbagathi road and the Hospital road. To explain the common causes of burns, KNH is surrounded by four slums namely, Kibera, Mukuru kwa Njenga, Mathare and Lungalunga. Poverty forces people to encroach on oil pipelines as is the case of Sinai fire disaster, while congestion in housing increase risk of babies falling into hot water or tea. Out of the 45 wards, KNH houses the only referral burns critical care unit for severe or major burns including inhalation injuries. Burns unit serves an average of 490 such patients a year but during fire disasters, an emergency ward is opened to help cope with high numbers of victims (Mugambi, 2012). Burns unit has a maximum bed capacity of 22 patients and mainly receives severely burnt patients from other hospitals or disaster sites. Burns unit admits an average of 39 new patients per month and it has an inbuilt surgical theater to facilitate timely debridement, escharotomies and skin grafting. Burns unit has previously been used by other hospitals like Moi referral, Gertrude's and Nakuru hospitals to bench

mark for quality burns management thus qualifying findings in this research to be generalizable. Being a referral and ISO certified hospital, KNH is expected to comply with quality international standards including management of inhalation burns and the researcher hoped to identify any non- conformities through this research as areas of improvement.

3.3 STUDY POPULATION

The study population incorporated both male and female patients of all ages admitted with inhalation injury in burns unit, among patients with major burns. Key informants included care givers, both doctors and nurses.

3.4 SAMPLING PROCEDURE

Sampling is a process of obtaining information about the entire population by examining only a part of it (Kothari, 2004). From December 2012 to November 2013, Burns unit admitted 473 new patients and the ward has a capacity of 22 patients. On average of 20 inpatients, 493 patients pass through burns unit annually and according to Herndon (2007), 60% of all burns cases have inhalation injury. This implies that 296.4 patients had inhalation injury during that year. Since this study takes three months, the average estimated population attended to in burns unit is 137 patients.

Non probability or convenient sampling technique was applied in selecting participants since population is small. All patients with inhalation injury, confirmed or suspected diagnosis qualified to be included in this study. This included patients with facial burns, neck burns and full thickness anterior chest wall burns. Patients found in the ward at the time of study and those admitted later for three months were recruited to participate in this research.

For key informants, purposeful sampling incorporated both doctors and nurses,

who have been working in burns unit for at least three years and happened to be in the ward during data collection. This is mainly because their experience is worth valuable input to this study. 17(89.5%; n=19) nurses and 3 (100%) doctors participated. Ward administrators included Ward in-charge, ACN, HOU, AD Specialized surgery and SAD General Surgery; based on their responsibilities and roles.

3.5 SAMPLE SIZE CALCULATION

The sample size will be calculated using the sample size calculator for prevalence studies formula where population is known or finite (Daniel, 1999).

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

Where: n = sample size with finite population

N = Population size. (The estimated population size of burns patients attended to in burns unit on monthly basis as from December 2012 to November 2013 is

474/12= 39.5 x 3months =117. 117+ 20 already in the ward = 137 patients.

Z = Statistical level of confidence (The standard normal deviation as the required confidence level = 1.96)

P = Estimated prevalence. Previous studies have shown that 60% of all burn patients have inhalation injury. Thus, p= 0.6

d = Level of precision set at 5%. Thus d = 0.05

Therefore: $n = \frac{137 \times 1.96^2 \times 0.4 \times 0.6}{(0.05^2 \times 136) + (1.96^2 \times 0.4 \times o.6)}$

n = 121.7/1.244 = 82.8; = 83 patients

3.6 STUDY VARIABLES

3.6.1 Dependent variables

- Patent airway during burn shock period (1st one week)
- Adequate lung compliance
- Adequate tissue oxygenation both centrally and peripherally
- Adequate tissue perfusion both centrally and peripherally
- Healing of parenchyma cells; absence of chest infection

3.6.2 Independent variables

- Maintenance of patent airway
- Treatment of the lung tissue injury
- Hyperbaric patient oxygenation
- Effect of administered medications
- Fluid and electrolyte replacement therapy

3.6.3 Intervening variables

- Cause of inhalation injury and duration of contact
- Pathophysiological effect of inhalation injury
- Degree of inhalation injury
- Premorbid conditions prior to the burns
- Other injuries sustained during burns process

3.6.4 0utcome variables

- Lung compliance evidenced by lung volumes
- Spontaneous breathing of the patient at normal rate
- Non toxic chemical levels in the blood
- Adequate tissue perfusion, both centrally and peripherally
- Normal arterial blood gases

3.7 INCLUSION AND EXCLUSION CRITERIA

3.7.1 Inclusion criteria

- Patients with inhalation burns confirmed or suspected.
- Patients with inhalation burns admitted in acute room or ICU.
- Patients with inhalation injury who consent to participate in this study.
- Key informants who will consent to participate and have been working in burns unit for at least three years.

3.7.2 Exclusion criteria

- Patients with inhalation injury who decline to consent for participation.
- Patients with inhalation injury whose guardian/ surrogate decline to consent for participation.
- Patients with inhalation injury who will die on arrival to the unit.
- Key informants who have worked in burns unit for at least three years and decline to consent for participation.

3.8 RESEARCH INSTRUMENTS

Research instruments included a checklist of variables which was used to assess clinical interventions and patients' response to the care given. A self administered structured questionnaire was filled by care givers to collect in-depth information on factors that influence the management of inhalation injury and an interview guide for ward administrators. The patients' checklist was adopted from a study conducted in Turkey from Burns treatment center of Ankara Numune training and research hospital. This tool was adjusted to fit the objectives of this study by adding and subtracting a few items. The tool was found fit because it was used to conduct a study on the "management of inhalation injury and respiratory complications in burns intensive care unit". Their protocol of care was in an ICU

set up; but since there are no studies on inhalation injury conducted in developing countries, this tool was found useful.

The questionnaire for care givers was formatted so as to capture both positive and negative influencing factors in the management of inhalation injury, plus preferred areas of improvement. The check list for patients' care included some of the confounders which may also contribute to high mortality in burns patients despite interventions for inhalation injury.

3.9 PILOT STUDY

Piloting of the research checklists and the key informants questionnaire was conducted at Aga Khan University hospital since they also manage patients with severe and inhalation burns and the conditions of care are almost similar to that of burns unit KNH. Likewise the same research tools were presented to my research supervisors for validity evaluation and approval. The purpose was to reduce errors, biases and ambiguity. After piloting, any question needing revision, modification or even found unnecessary was appropriately amended before going to the field. This helped the researcher to evaluate the instrument and facilitate data accuracy. Piloting also increased reliability of the instruments and research findings.

3.10 ETHICAL CONSIDERATION

Before conducting the study, the researcher presented three copies of the research proposal to the KNH/U.O.N Ethical and Research committee seeking approval for the study. A copy of the same proposal will be presented to the Ministry of higher education for research approval. Once approved, the researcher proceeded to collecting data. Patient had to be stabilized and pain control measures effected. The researcher then reassured relatives for quality care; and after self introduction, the study topic was introduced to the participants, including guardians or surrogates for intubated and unconscious patients. The researcher elaborated the aim of

study, its process and participants expectations. Respondents were assured of confidentiality and anonymity maintenance in all research instruments. The researcher clarified that there will be no payments for participation as a measure to minimize bias. Option to withdraw was availed to those who would wish to discontinue for whatever reasons. The researcher then requested the participants to sign the consent form for voluntary participation. Appointed guardians or surrogates for intubated and unconscious patients responded on behalf of individual patients. Instruments were serialized using numbers and all data collected including signed consent forms were kept by the researcher for safe custodian and confidentiality. Research checklist data was mainly monitory, to assess the care, thus posing minimal risks to the participants. No harm or pain or exploitive investigations was realized on participants in relation to this research. Patients and surrogates were allowed to share views concerning their care as study progressed. In conclusion, findings of this study will be shared with the relevant stakeholders through organized forums for utilization but will also be published in a recognized journal for reference.

3.11 DATA COLLECTION METHODS

The researcher went physically to the area sampled for research. Self introduction was done, letter of research approval presented and the purpose of study explained. Since data was to be obtained through assessment of clinical interventions, details on expected data was not elaborated hoping to capture practice as it was. Patients were recruited to this study on arrival to the ward after they had been stabilized and pain control measures effected. After recruitment, evaluation of care from time arrived in the hospital was done. Consecutive data intervals were conducted daily for the first one week, then on fourteenth day, twenty first day and twenty eighth day for the next three weeks. Assurance for confidentiality was done to all participants in order to encourage them participate without fear (Mugenda and Mugenda, 2003).Researcher obtained informed consent from the participants and introduced her

research assistants. Instruments were serialized as participants were being recruited to the study and a collecting log prepared to ensure that all checklists and questionnaires were returned and kept in safe custody before the commencement of data analysis. Checklists' data was obtained from patients, relatives, care givers and medical records.

Two critical care graduate nurses were recruited and trained for two days as research assistants. The choice of the research assistants was based on their previous research knowledge and skills in critical care nursing. Research assistants were trained on how to administer questionnaires to the care givers, diagnose inhalation burns, estimate the depth of inhalation burns, ideal management of inhalation burns, common complications of inhalation burns, interviewing skills and charting of the checklists. Each participant was followed up for a maximum of four weeks within which, death or clinical status of the patient marked the end point of data collection.

Interview schedules took 30minutes on average and were conducted by the researcher on appointment with individual administrators. Permission to tape discussion was obtained from the interviewee on the day of interview. The researcher facilitated as well as supervised the rest of the research process. In case of fire disaster during the study period, the researcher was to undertake the data collection during the night shift but there was none. Review of more literature available on the subject continued.

3.12 DATA ANALYSIS AND PRESENTATION

The data collected was edited for accuracy, uniformity, consistency and completeness. Quantitative methods of data analyses were done using SPSS program version 20.0 from the computer while content analysis was done using theme categorization and tallying. For qualitative data, common responses were identified and classified into themes. Presentation of quantitative data was done using frequency tables, pie charts, histograms and polygons;

while qualitative data was classified into themes and used to complement or fill gaps in the quantitative data. Finally, descriptive statistics such as percentages, median, mean standard deviation and statistical inferences such as t-tests, p-values, Odds ratio and chi squares were used to draw conclusions. Logistic regression was applied to determine the most significant intervention in mortality prevention.

3.13 LIMITATIONS OF STUDY

It is very rare to have a patient with isolated inhalation injury, but this study did not include management of cutaneous burns since it would have been too broad for a single research. This may affect the conclusion of the findings in that, major burns (70% and above) have detrimental homeostatic effects on all body organs leading to compartment syndrome; respiratory system included. This effect was considered during discussion as an outlier effect since only 3 (3.4%) patients had such major cutaneous burns; but further research on fluid replacement, anaemia in burns patients and wound care would be necessary.

Sample size was realized based on findings of previous studies but incase this research does not realize the expected sample size; the researcher might have to increase period of study.

CHAPTER FOUR: RESULTS OF THE STUDY

4.0 INTRODUCTION

The study involved males **46 (54.8%)** and females **38(45.2%)** aged between one month and 99 years. Majority **29 (34.5%)** of the respondents were aged less than 10 years.**22 (26.2%)** were aged from 21 to 30 years with mean age SD of **20.98 (19.3)** years.

More than half **49 (58.3%)** the population had neck burns with **34 (69.4%)** indicating 1% neck burns and **15 (30.6%)** 2% neck.

Median (IQR) of hours arrived at the hospital post-burns was reported to be 6(7) hours. The mean (SD) cutaneous burns percentage was **32.5(20.1)** with minimum of 4% and maximum of 88% reported. The median (IQR) clerking hours done post arrival was found to be **1(1.5)** hours.

4.1 SOCIAL DEMOGRAPHICS

4.1.1 Gender

Characteristics	Number	Percentage
Male	46	54.8
Female	38	45.2

4.1.2 Age of participants

Majority of the patients who sustained inhalation injury aged within 1 - 10 years **29 (34.5%)** followed by those within 21 and 30 years **22 (26.2%)** where population was 84. Within 31 to 40 years was average **12 (14.3%)** and beyond there the numbers decline. Only **2 (2.4%)** elderly patients were admitted with inhalation bur. The missing **5 (6.0%)** were children below one year of age but none was weeks or days old.

Table 1: Patients age in years

		Number of patients	Percent
Months		5	6
	1 - 10 yrs	29	34.5
	11 - 20 yrs	5	6.0
	21 - 30 yrs	22	26.2
Years	31 - 40 yrs	12	14.3
	41 - 50 yrs	8	9.5
	51 - 60 yrs	1	1.2
	91 - 100 yrs	2	2.4
Total		**84**	**100.0**

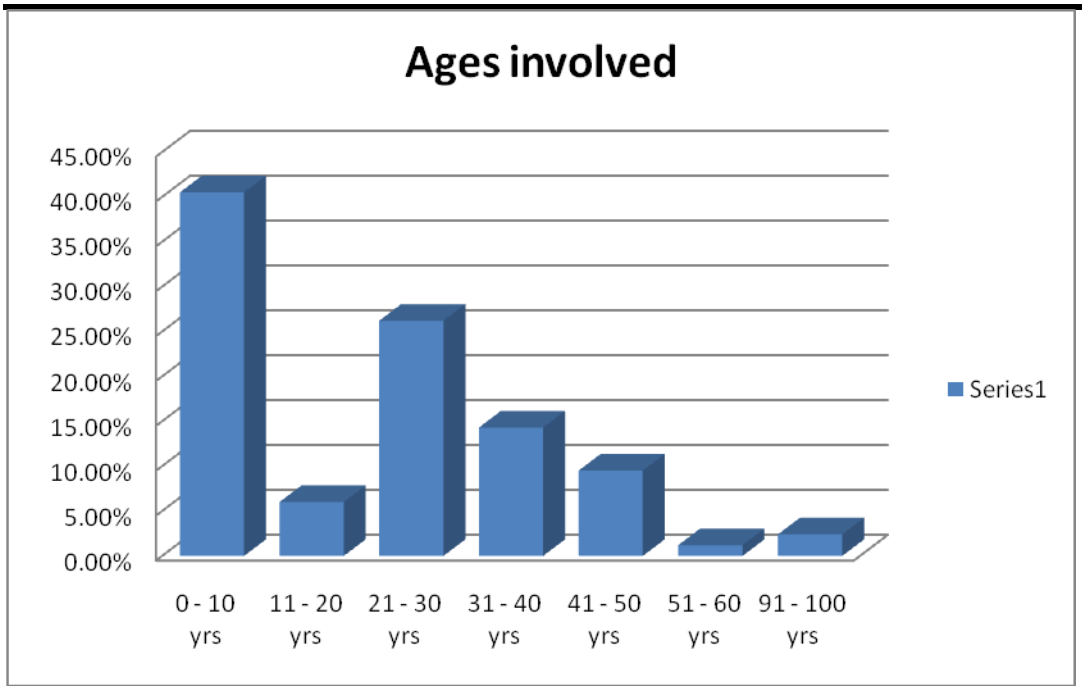


Figure 1: Ages differences in inhalation injury

4.1.3 Facial burns

Table 2: Facial burns surface area

Facial burns (%)	0	1	2	3	4	5	6	7	8	9	Total
Frequency	15	1	1	1	12	3	2	7	3	39	84
Valid percentage (%)	17.9	1.2	1.2	1.2	14.3	3.6	2.4	8.3	3.6	46.4	100

Figure 2 below shows the percentage facial burns reported.Out of 84 patients,majority **39 (46.4%)** had 9% facial burns which is full face, followed by **12(14.3%)** who had 4% of facial burns. **64.3%** were burnt more than half the face. **15 (17.9%)** did not have facial burns although they had signs of inhalation burns.

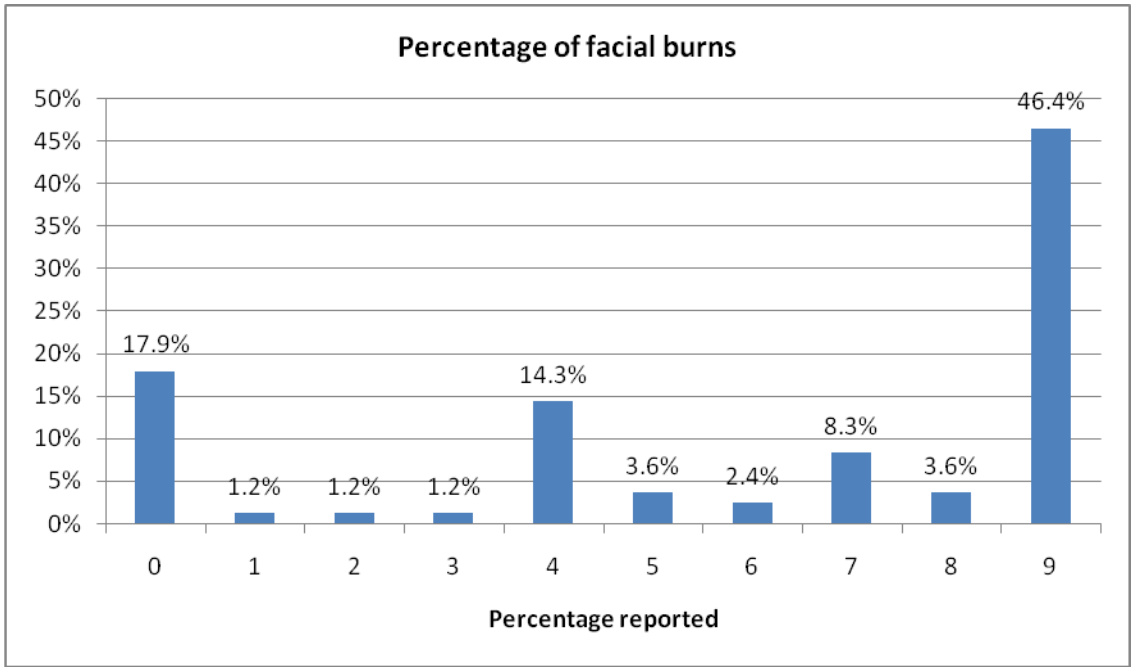


Figure 2: Percentage distribution of facial burns

4.2 PREMORBID CONDITIONS

Table 3: Premorbid Conditions

Condition	Frequency	Percentage
Epilepsy	4	4.7
Alcoholism	6	7.1
Drug addiction	2	2.4
Asthma	1	1.2
PTSD	3	3.6
Gravid	2	2.4
None	65	77.4
Cerebral palsy	1	1.2

Table 3 displays various premorbid conditions. There were **65 (77.4%)** participants with no pre-existing conditions while **6 (7.1%)** were reportedly alcoholic prior to burns.**4 (4.7%)** had epilepsy while **3 (3.4%)** had PTSD. **2 (2.4%)** were expectant and one who had cerebral palsy also had epilepsy.

4.3 OTHER INJURIES SUSTAINED.

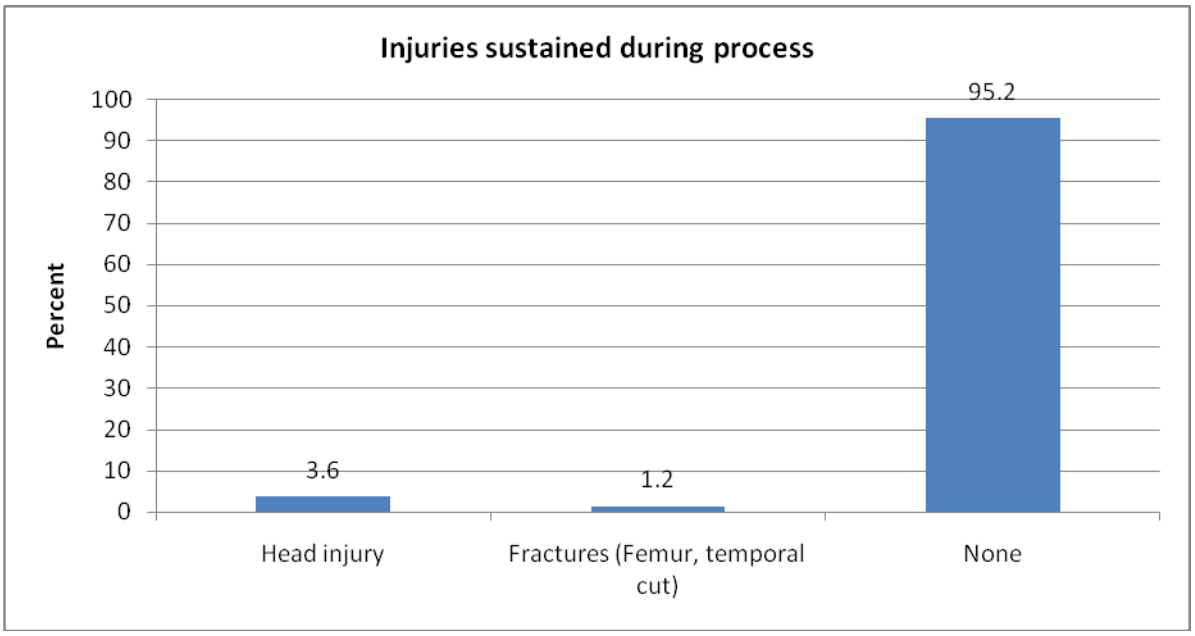


Figure 3: Other injuries sustained during burn process

The injury sustained during the process is shown in figure 3 above. No injuries during burn process were reported in **80 (95.2%),** with only **3 (3.6%)** indicating head injury while **1 (1.2%)** respondents sustained fractures (femur/temporal cut).

4.4 DURATION TO HOSPITAL POST BURNS

Table 4: Hours arrived in hospital after burns

	Number of patients	Percent	Valid Percent
0 -8 hrs	50	59.5	60.2
9 - 17 hrs	18	21.4	21.7
18 - 26 hrs	13	15.5	15.7
45 - 53 hrs	2	2.4	2.4
Total	**83**	**98.8**	**100.0**
Missing	1	1.2	
Total	**84**	**100.0**	

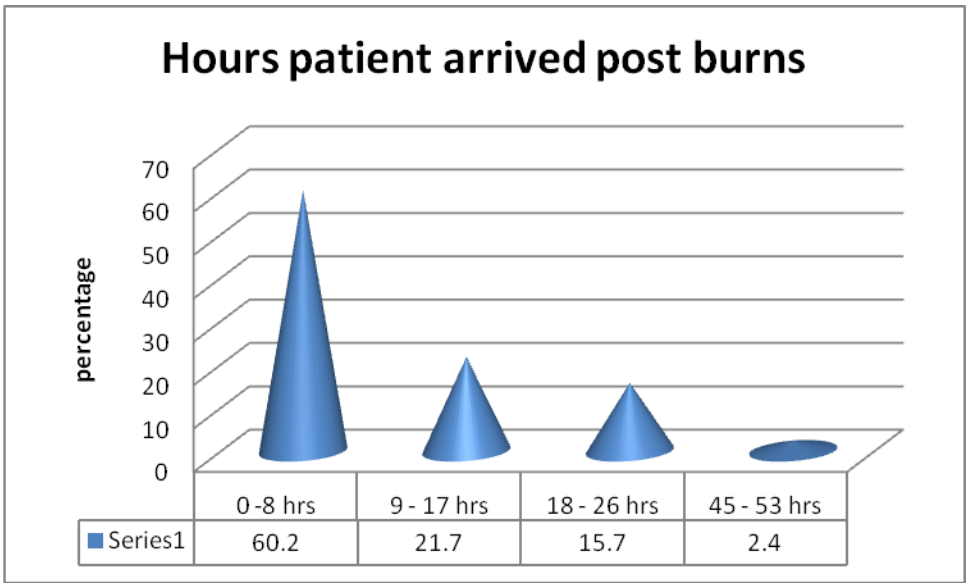


Figure 4: Duration to hospital post burns

Table 4 and figure 4 shows that majority **50 (60.2%)** out of 84 patients arrived in the hospital within eight hours after burns while **18 (21.7%)** arrived after within 12 hours after burns. **13 (15.7%)** arrived in the hospital within 24 hours after burns and only **2(2.4%)** arrived within 48 hours after burns.

4.5 DURATION TO CLERKING POST ARRIVAL

Table 5: Hours clerking done post arrival

	Hours	Number of patients	Percent	Valid Percent
	0 - 2 hrs	62	73.8	75.6
	3 - 5 hrs	15	17.9	18.3
	6 - 8 hrs	2	2.4	2.4
	9 - 11 hrs	3	3.6	3.7
	Total	**82**	**97.6**	**100.0**
	Missing	2	2.4	
Total		**84**	**100.0**	

Table 5 shows that **62 (75.6%)** were clerked within two hours after arrival to the hospital while **15 (18.3%)** others out of 84 were reviewed between 3 and 5 hours post arrival. **5 (6.1%)** were clerked after 6 hours of waiting and in **2 (2.4%)** participants, time of clerking could not be determined.

4.6: INTUBATION

4.6.1 Intubation		
Yes	38	45.3
No	46	54.7
Median (IQR) hours intubated post clerking	1(4)	

4.6.2 DURATION TO INTUBATION AFTER CLERKING

Table 6: Hours Intubation was done after clerking (n=38)

Hours	Number of patients	Percentage (%)
0-2	26	68.4
3-5	4	10.5
6-8	6	15.8
9-11	1	2.6
15-17	1	2.6

Among the patients who were intubated, **26(68.4%)** were intubated within two hours after they were clerked by plastic surgeon. **4 (10.5%)** had intubation 3-5 hours later while **6 (15.8%)** waited for 6-8 hours after clerking. **1(2.6%)** was intubated nine hours later and **1 (2.6%)** 17 hours as an emergency. Figure 5 below compares the hours of action after arrival to the hospital.

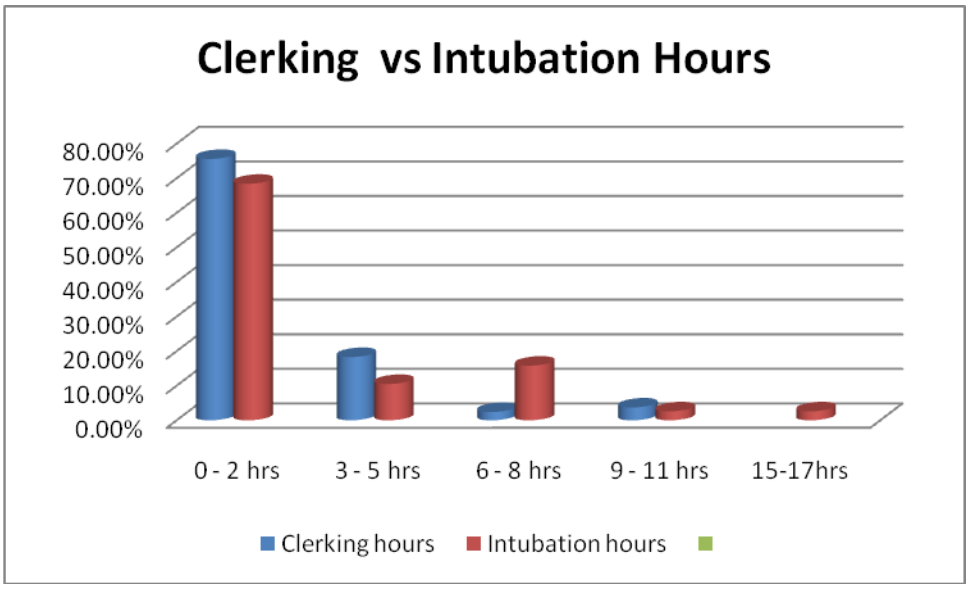


Figure 5: Comparing clerking with intubation timings post arrival.

4.7 INHALATION INJURY ASSESSMENT.

Table 7: Inhalation injury

Parameter	**Number of patients**	**Percentage**
4.7.1 Method of diagnosis		
History of Incidence	84	100
Presenting signs and symptoms	81	96.4
Chest X-ray	7	8.3
ECG	2	2.3
Bronchoscopy	0	0
4.7.2 Cause of burns		
Stove explosion	13	15.5
Burning house	17	20.2

Steam inhalation	25	29.7
Gas explosion	5	6.0
Mob justice	5	6.0
Kerosine/Petrol suicide	7	8.2
Open fire	4	4.7
Others		
Acid burns	1	1.2
Bomb blast	1	1.2
Koroboi	2	2.6
Flash burns	4	4.7
4.7.3 Grade of inhalation injury		
Grade 1	1	1.2
Grade 2	6	7.3
Grade 3	4	4.7
Grade 4	4	4.7
Grade 5	6	7.3
Not done	63	75.0

In table 7 above, the method of diagnosis was based majorly on history of incidence in all population **84 (100%).** This was combined with visible clinical features in **81(96.4%)** of the sampled population and **7 (8.3%)** had chest X-ray done.

Steam inhalation demonstrated the highest cause of inhalation burns **25 (29.8%)** followed by burning house **17 (20.2%)** while **13 (15.5%)** were involved in stove explosion. Gas explosion and mob justice accounted for **5 (6.o %)** patients each. **7(8.3%)** participants had self inflicted burns in attempted suicide where kerosene was used while **4(4.7%)** others fell on open fire face front during a fit episode.

Findings on grading indicated grading of inhalation injury not done in **63 (75%)** patients.

Figure 6: Causes of burns

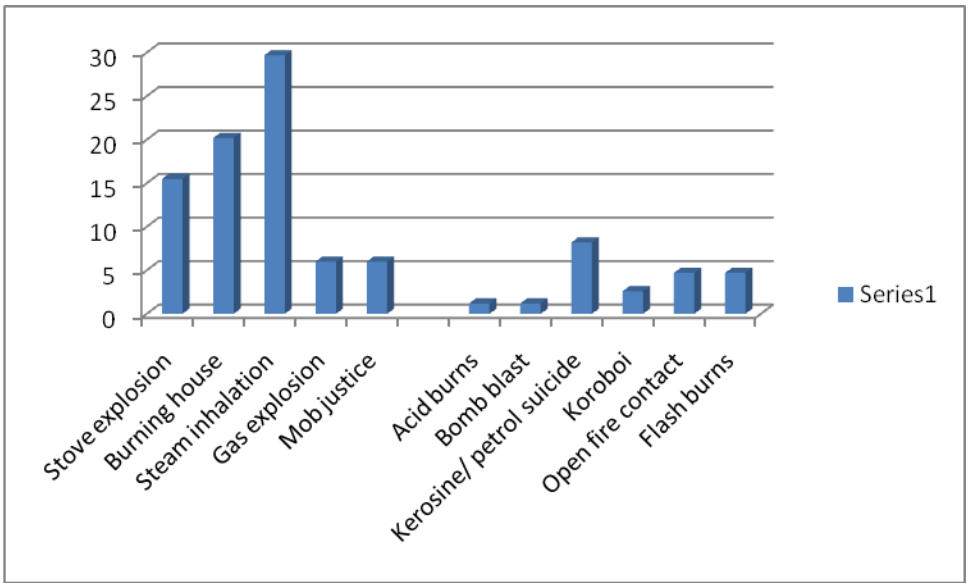


Table 8: Relationship between Age and Causes of burns

Age	Stove	Burning hse	Steam inhal	Gas exp	Mobjusti	Other	Total
< 10	2	3	24(70.6%)	0	0	5	**34**
11-20	0	2	0	1	1	1	**5**
21-30	7(31.8%)	5	1	0	2	7(31.8%)*	**22**
31-40	1	4	0	4(33%)	2	1	**12**
41-50	3	0	0	0	0	5	**8**
>50	0	3(100%)	0	0	0	0	**3**
Total	**13(15.5%)**	**17(20.2%)**	**25(29.7%)**	**5(6.0%)**	**5(6.0%)**	**19(22.6%)**	**84**

*Suicidal.

Table 8 shows the commonest cause of burns below 10 years and the highest across all ages as steam inhalation **24(70.6%);** and this is different compared to the developed countries where smoke inhalation is the major cause of inhalation injury. The commonest cause among ages 21-30, reports stove explosion **7(31.8%)** and suicidal attempts **7(31.8%)** in others, while the elderly sustain burns mainly from burning houses **3(100%).** This information is useful in burns prevention education among age groups and future research.

4.8 VENTILATORY INTERVENTION

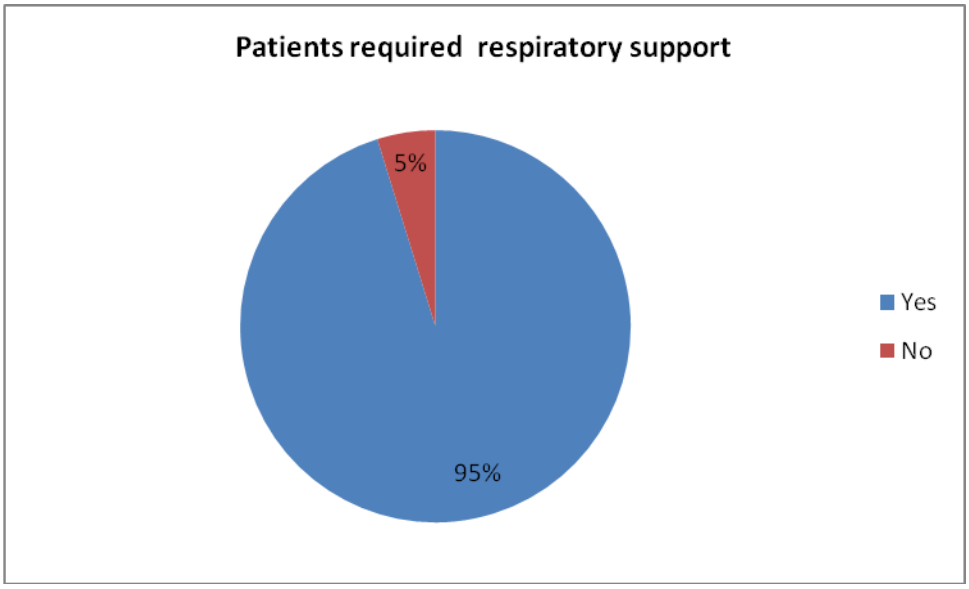


Figure 7: Respiratory support

Majority (95%; n=79) required respiratory support

4.8.1 Airway maintenance

Table 9: Airway maintenance

Day	Evd intu	Proph intu	Planned extub	Acc extu	Re intub	Emer intub
1	30	3	0	6	1	5 + 1
2			1	5	3	3
3			1	5	1	1
4			3	0	0	0
5			4	0	1	0
6			0	0	2	2
7			1	0	0	0
Total	30	3	10	16	8	12

Table 9 shows **38 (45.2%)** participants were intubated on day one, **5 (13.1%; n=38)** of which were emergencies and **3 (7.9%; n=38)** prophylactic. **30(78.9%; n=38)** participants had clinical signs of respiratory distress hence evidenced intubation. Within the same day **6 (15.8%)** had accidental extubations and only **1 (2.6%)** was re-intubated as an emergency.

Day two had **5 (13.1%)** accidental extubations and **3 (7.9%)** re-intubations. Two participants were re-intubated twice on day 1 and day 2 respectively.

For the first three days, there were **16 (42.1%;n=38)** accidental extubations and **5 (13.1%)** re-intubations. Majority of planned extubations were on day five **4 (10.5%)** followed by day four, but **2 (5.3%)** had to be re-intubated. Only **2 (5.3%)** had planned extubations by day three and all re-intubations were emergencies. The longest intubation time was seven days **1(2.6%).**

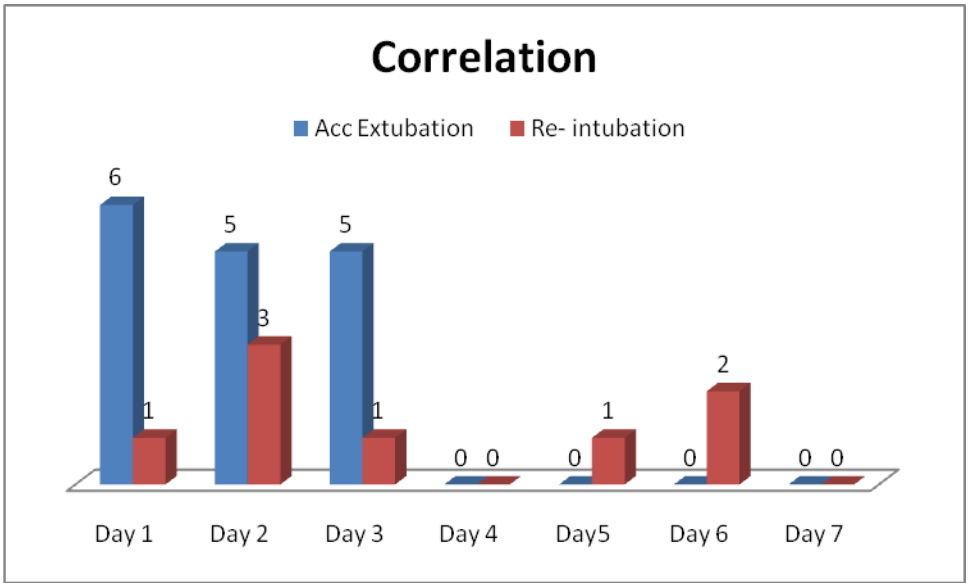


Figure 8: Extubation vs Re-intubation

4.9 OXYGENATION:

4.9.1 Commencement of oxygen.

Out of 84 participants, **9 (10.7%)** were put on mechanical ventilation on the first day while **25 (29.7%)** used thermovent for oxygenation. **18 (21.4%)** were oxygenated using oxygen mask while **32 (38.1%)** participants were put on room air without additional oxygen. Although **38(45.2%)** were intubated at A&E, only **34(40.5%)** arrived in the ward with the

endotracheal tube insitu. Table 10 and figure 9 below demonstrates how patients were oxygenated.

Table 10: Oxygenation commencement wk1

Day	MVent	Oxyge msk	Room air	Thermvt
1	9(10.7%)	18 (21.4%)	32 (38.1%)	25 (29.8%)
2	3	7	1	2
3	1	4	1	1
4	0	2	2	1
5	1	2	7	1
6	1(Reconect)	0	4	0
7	0	1	1	0
Total	15	34	48	30

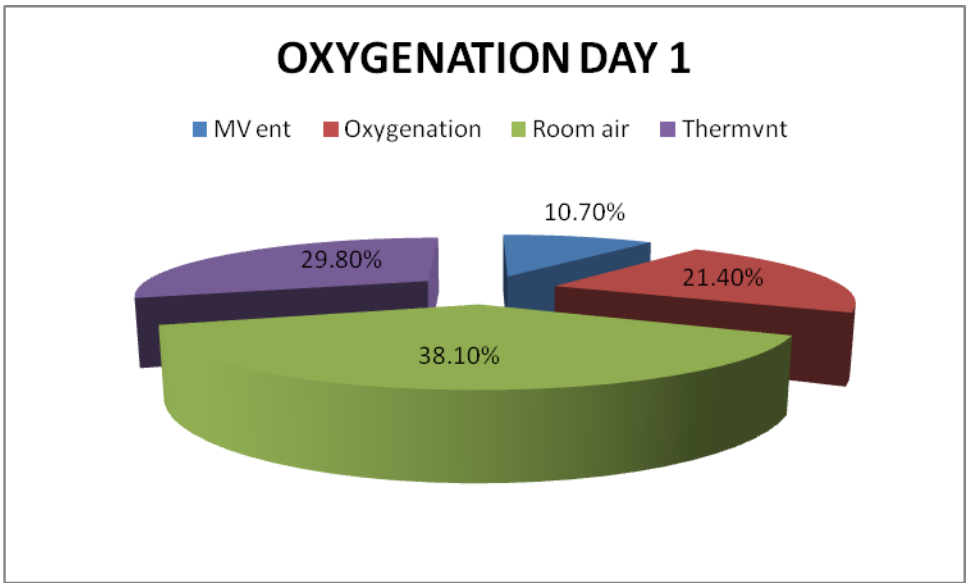


Figure 9: Oxygenation of patients

4.9.2: Duration of oxygenation.

Table 11 below shows that out of the 13 patients put on mechanical ventilation, 4 (30.7%) were ventilated for only one day while **4 (30.7%)** used ventilator for two days. **11 (13.1%)** participants out of 84 were on room air three days after which they either were intubated or

put on oxygen. **2 (2.4%)** on oxygen by mask and only **2(2.4%)** who remained on thermovent for the seven days.

Table 11: Duration of oxygenation during wk 1

	Mec vent	Oxygen mask	Room air	Thermovent
1 day	6	5	1	5
2 days	5	4	6	7
3 days	2	9	11	6
4 days	0	7	4	6
5 days	1	5	5	4
6 days	0	2	4	0
7 days	0	2	17	2
Total	14	34	48	30

From the findings patients were oxygenated variably despite all having inhalation injury and response from nurses tried to explain some challenges encountered. Nurses response on factors influencing patients' oxygenation is illustrated in table 12 below and included delayed intubation **15(88.2%; n=17),** self extubation **11(64.7%;n=17),** accessibility of mechanical ventilators **15(88.2%)** and sedation inconsistency **(10(58.8%)**.

Table 12: Factors influencing oxygenation.

Parameter	**Number of nurses (n=17)**	**Percent (%)**
Delayed intubation post burns	15	88.2
Some patients self extubation	11	64.7
Limited access to mechanical ventilation for patients in respiratory distress	15	88.2
Difficult maintaining continuous sedation for intubated patientss	10	58.8
Lack of resident anesthetist	1	5.9

4.10 LUNG TREATMENT:

4.10.1: Nurses response towards lung treatment and smoke removal.

Nurses responses on removal of smoke from lungs majored on dry endotracheal **7 (41.2%)** and wet endotracheal **4(23.5%)** suctions while **5 (29.4%)** nurses said smoke is never removed. Figure 10 below illustrates this finding.

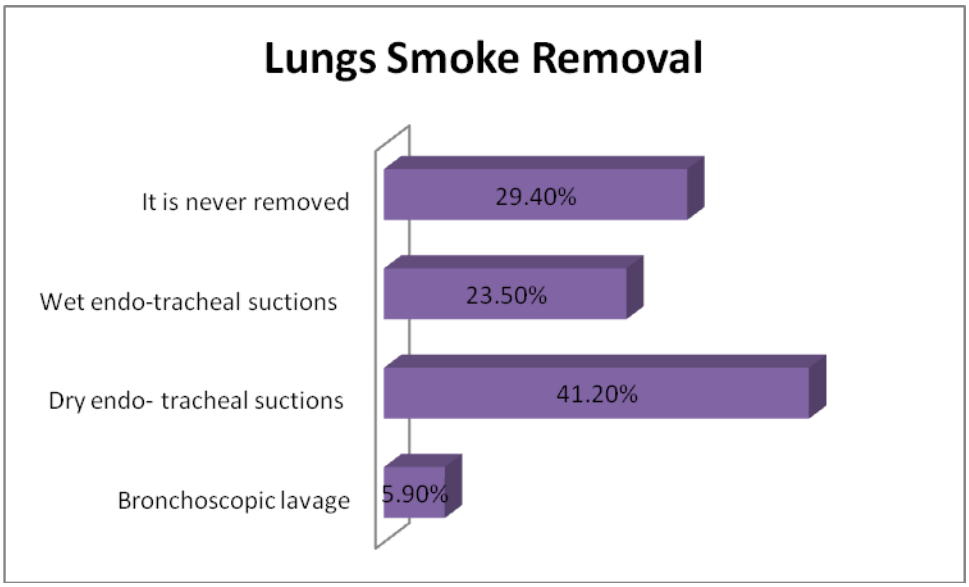


Figure 10: Smoke removal

4.10.2: Practice of lung treatment

Out of the 84 participants **29 (34.5%)** had tracheal lavage done on day1 and **2 (2.4%)** had steroid inhaler as well as bronchodilator administered. In **9 (10.7%)** participants this was done for only one day while **9 (10.7%)** others had tracheal lavage for two days. **32 (38.1%)** of the patients had tracheal lavage for lung treatment for the first one week and **23 (71.8%; n=32)** had chest physiotherapy to enhance cough expectoration. **12(14.3%)** participants were put on steroids (dexamethasone and budicort) while **8 (9.5%)** were put on bronchodilator (ventolin / atrovent). Tracheal lavage had an influence to mortality, statistically significant with a p-value of 0.0001 in bi-variate statistical test.

Table 13: Lung treatment commencement

Day	Tracheal Lavage	Chest Physio	Steroid inhaler	Bronchodilator
1	29	14	2	3
2	3	9	1	2
3	0	0	0	0
4	2	0	1	1
5	0	1	0	0
6	1	0	1	1
7	0	0	1	1

Table 14: Duration of lung treatment

	Tracheal lavage	Chest Physio	Steroid inhaler	Bronchodilator
1day	12	4	2	2
2days	9	4	2	2
3days	6	7	0	2
4days	6	2	0	0
5days	0	1	0	1
6days	1	4	0	0
7days	1	1	1	1

4.11 SYSTEMIC THERAPY

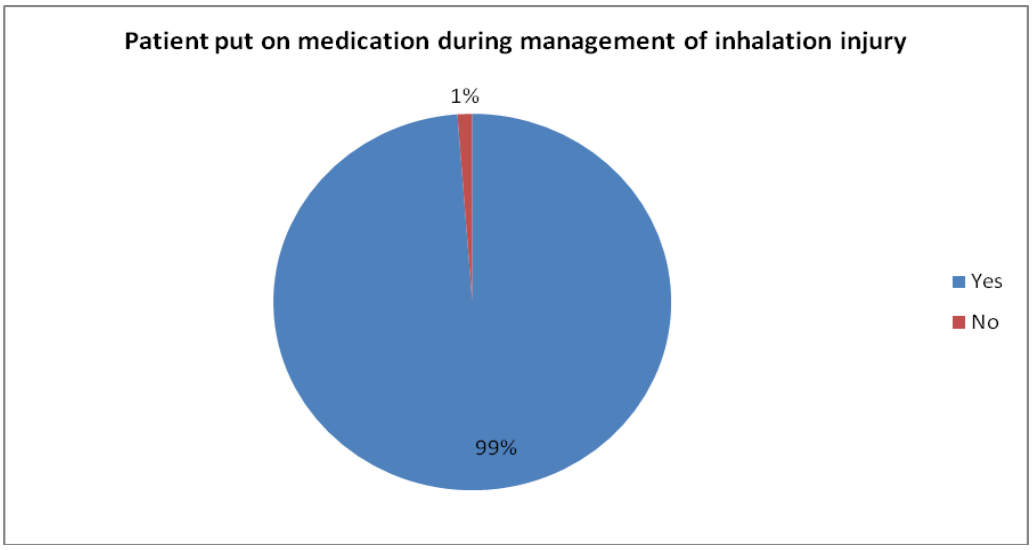


Figure 11: Medication during management of inhalation injury

It was confirmed that 99% were put on systemic medication during the management of inhalation injury.

Table 15: Medication used

Medication	Number of participants	Percentage (%)
Antibiotics (Prophylaxis)	51	60.7
Antibiotic (EVB)	1	1.2
Steroids	7	8.3
Nsaids	77	91.6
Opiods	62	73.8
Sedatives	23	27.4
Antipyretics	22	26.2
Anti epileptics	2	2.3
Eye antibiotics	1	1.2
Haloperidol	1	1.2

Table 14 above shows the type of medication used by the respondents. **77(91.6%)** reported using Nsaids, **62(73.8%)** used Opioids while **51(60.7%)** indicated using prophylactic antibiotics. **23 (27.4%)** patients had sedative prescribed and **22 (26.2%)** used antipyretics. Few patients **7 (8.3%)** used steroids during their care.

4.12 RESPIRATORY DISTRESS

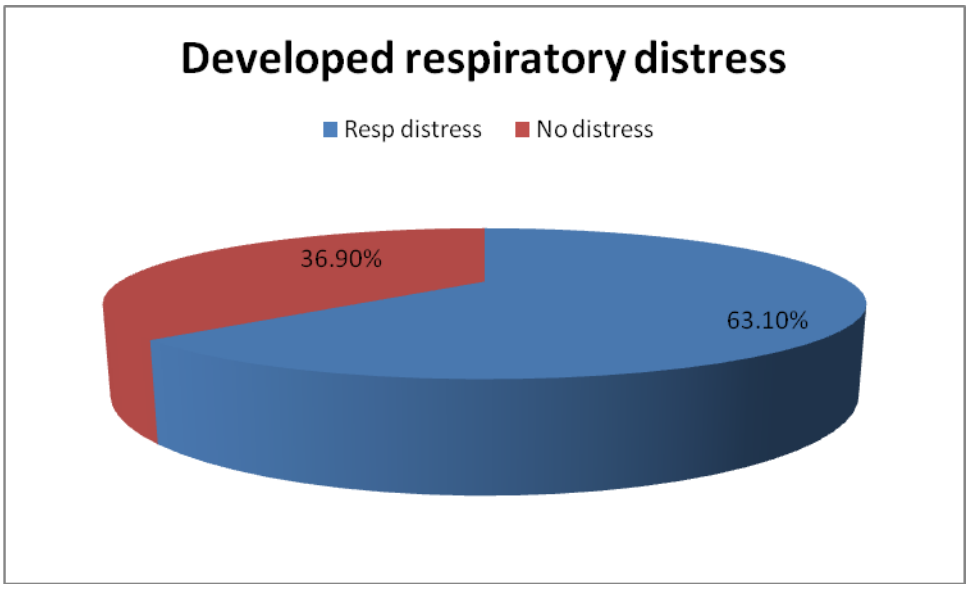


Figure 12: Respiratory distress

Of the sampled respondents, **53 (63.1%)** patients developed respiratory distress during the management process as shown in figure 12 above.

4.12.1 Causes of respiratory distress

Table 16 below demonstrates the causes of respiratory distress during the four weeks of care. Out of the sampled 84 participants, **56 (66.6%)** patients presented with facial edema, the first risk sign for upper airway obstruction. However, **15 (17.8%; n=84)** patients had facial edema but did not develop respiratory distress. Of those who developed respiratory distress **12(22.7%; n=53)** did not have facial edema.

Table 16: Causes of respiratory distress

Combined causes	**Week 1**	**Week 2**	**Week 3**	**Week 4**
Upper airway obstruction (edema)	41	-	-	-
Bronchospasms	3	2	1	1
Tracheal stenosis	-	-	3	-
Pneumonia/ Alveolitis	27	7	2	-
Atelectasis	-	-	-	-
Others, specify	1	1	-	-

Out of the **53(63.1%)** who developed respiratory distress, **41 (77.3%)** was due to upper airway obstruction and facial edema was evident. Of the 77.3%, **21 (51%;n=41)** also had signs of chest inflammation captured as either pneumonia or alveolitis. **6 (11.3%; n=53)** did not have airway edema but developed respiratory distress possibly due to chest inflammation related to inhalation of toxic chemicals or hot steam. Other patients developed respiratory distress after one week **6 (11.3%)** and **4 (7.5%)** among them developed respiratory distress during the second week. Other causes included stridor post extubation second week, uraemia and anaemia post abortion.

4.13 PATIENT'S OUTCOME

Table 17 below demonstrates patient's outcome within and up to four weeks of care.

More than half **44 (52.4%)** indicated ABGA not done while **32.1% (27**) had deranged results.**15.5% (13)** of patients had normal arterial blood gas results. Ability to breathe spontaneously were noted in **56 (66.7%)** patients out of 84 with **28 (33.3%)** abruptly becoming dyspnoeic which led to either resuscitation, oxygen by mask or quiet death .

Lung volumes were not determined in any of the patients; reportedly not a routine practice in the unit.

Mortality was reported in **47% (39)** of the respondents with median (IQR) day of post admission death of 5(6) days. Of the **53% (45)** who survived, **42.2% (19)** were discharged to another ward, **28.9% (13)** still in the ward while **28.9% (13)** went home. The median (IQR) day of discharge was 8.5(9) days.

Table 17: Outcome of patients within and up to four weeks

Clinical status	Number	Percentage (%)
4.13.1 Alveoli gaseous exchange restored (ABGA)		
Normal	13	15.5
Abnormal	27	32.1
Not done	44	52.4
4.13.2 Able to breathe spontaneously (RR)		
Yes	56	66.7
Dyspnoeic	28	33.3
Able to maintain adequate lung volumes	Not done	
4.13.3 Mortality		
Yes	39	47
No	45	53
Total	84	100
4.13.4 Discharge		
Home	13	28.9
Another ward	19	42.2
Still in ward	13	28.9
Median (IQR) day of discharge	8.5(9)	

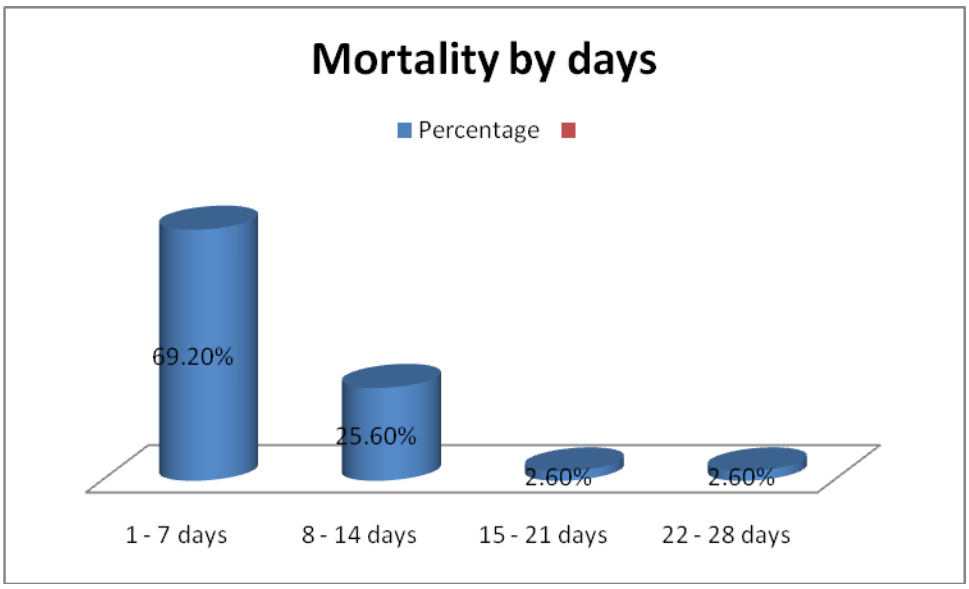


Figure 13: Mortality by Days

Table 18: Specific day of death post admission

	Number of patients	Percent (%)
1 - 7 days	27	69.2
8 - 14 days	10	25.6
15 - 21 days	1	2.6
22 - 28 days	1	2.6
Total	**39**	**100**

Figure13 above illustrates mortality by days. Out of the 39 patients who died, **27 (69.2%)** died during the first week. **10 (25.6%)** died during the second week making a total of (**94.8%; n=39).** only **2 (5.2 %)** patients died during third and fourth week respectively. From the sampled population, **37 (45%; n=84)** died within the first two weeks. Figure 14 below shows mortality by cause of burns

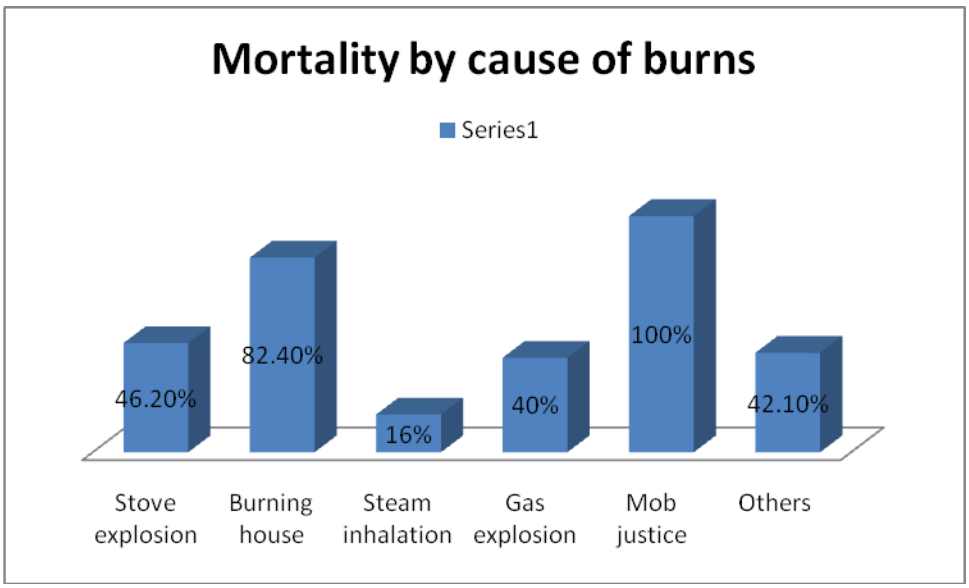


Figure 14: Mortality by cause of burns

4.14 ATTRIBUTES TO MORTALITY

Nurses attributed mortality to the factors shown in figure15 below.

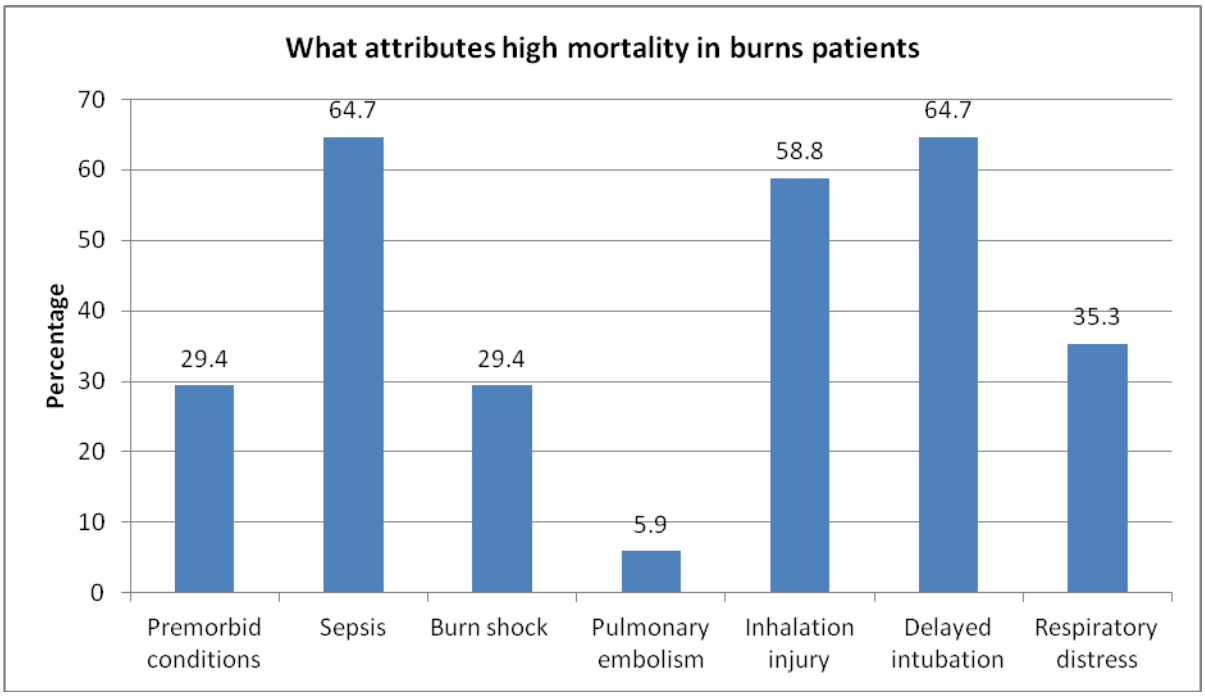


Figure 15: Attributes of mortality.

Figure 15 shows nurses attributing high mortality to sepsis **11(64.7%)** delayed intubation **11(64.7%)** and inhalation injury **10 (58.8%)** while the doctors attribute sudden deaths to tracheal stenosis in qualitative data.

Table 19: Specific day of discharge

Parameter	Number of patients	Percent (%)
1 - 7 days	12	26.7
8 - 14 days	14	31.1
15 - 21 days	5	11.1
22 - 28 days	1	2.2
Still in ward	13	28.9
Total	**45(53%)**	**100.0**

Table 19 above shows majority **14(16.7%; n=84)** of the respondents discharged during the second week while **12 (14.3%)** were discharged to other wards during the first week. Those discharged during the third and fourth week are few **5 (6.0%)** and usually the very sick who survive week one and two.

4.15 PROFESSIONAL EXPERTISE

Figure 16 above shows that **8(47.1%; n=17)** of nurses have no special skill to manage inhalation injury while **5 (29.4%)** are trained on general burns management. **5(29.4%)** are ACLS trained without special attention to burnt airway while **3 (17.6%)** are critical care nurses where patients have an intact airway.

4.16 COMPLICATIONS

Out of 84 participants, **49 (58.3%)** had complications at least one or more of the complications listed in table 20 below. Majority **14(28.5%)** had metabolic acidosis while **13 (26.5%)** had hypoxemia followed by hypokaleamia **7(14.3%). 6(12.2%)** patients had pneumonia confirmed either through chest X- ray or auscultation. **3 (6.1%)** developed tracheal stenosis while **2 (4.1%)** had stridor. Unexpected deaths were **7 (14.3%)** and only

5(10.2%) patients had respiratory acidosis. Out of 16 complications, **7 (43.7%)** were due to inhalation injury. Figure 17 below illustrates the complications related to inhalation injury.

Table 20: Complications

Complications	Number (n= 49)	Percentage (%)
AKI	6	12.2
Pneumonia	6	12.2
Hyperkalemia	6	12.2
Metabolic acidosis	14	28.6
Hypoxemia	13	26.5
Albuminemia	1	2.0
Anaemia	3	6.1
Stridor	2	4.0
Septicaemia	3	6.1
Tracheal stenosis	3	6.1
Hyponatremia	6	12.2
Hypokalemia	7	14.3
Sudden death	7	14.3
Respiratory acidosis	5	10.2
Metabolic alkalosis	1	2.0
Asthma like	1	2.0

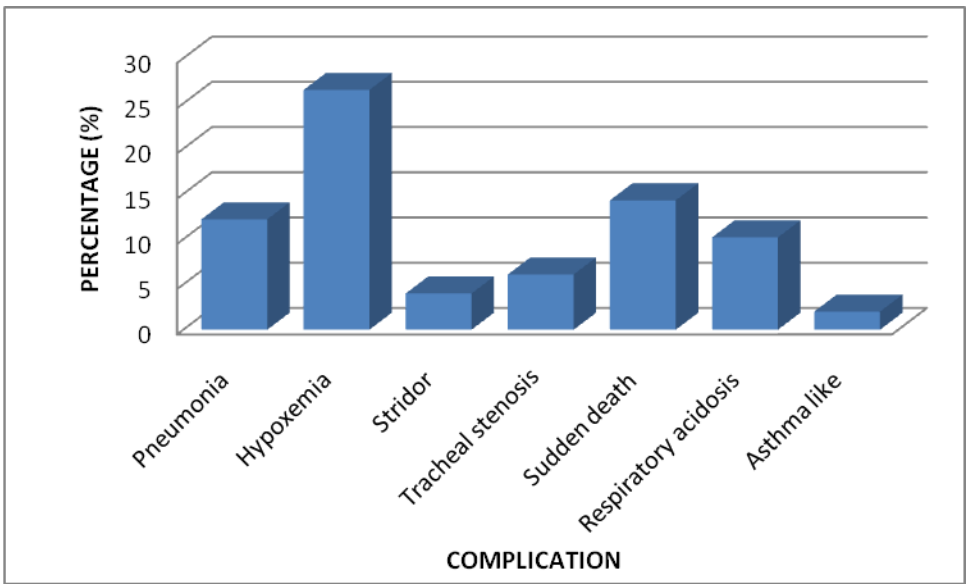


Figure 17: Complications related to Inhalational injury

4.17 INFERENTIAL STATISTICS

Table 21: Crosstabulations

Variable	Mortality		Chi-square	P-value
	Yes	No		
Age in years				
0-10	9(26.5%)	25(73.5%)	10.56	0.061
11-20	3(60%)	2(40%)		
21-30	12(57.1%)	9(42.9%)		
31-40	7(58.3%)	5(41.7%)		
41-50	6(75%)	2(25%)		
>50	2(66.7%)	1(33.3%)		
Intubated post-clerking				
Yes	32(84.2%)	6(15.8%)	38.83	**0.0001****
No	7(15.2%)	39(84.8%)		
Hours intubated post-burns				
≤6	4(80%)	1(20%)	5.48	0.242
>6 to ≤12	14(82.4%)	3(17.6%)		
>12 to ≤18	10(100%)	0		
>18 to ≤24	2(50%)	2(50%)		
>24	2(66.7%)	1(33.3%)		
Cause of burns				
Stove explosion	6(46.2%)	7(53.8%)	24.14	**0.0001****
Burning house	14(82.4%)	3(17.7%)		
Steam inhalation	4(16%)	21(84%)		
Gas explosion	2(40%)	3(60%)		
Mob justice	5(100%)	0		
Others	8(42.1%)	11(57.9%)		
Inhalation				
Steam	4(16%)	21(84%)	13.25	**0.0001****
Smoke	35(59.3%)	24(40.7%)		
Steroids				
Yes	2(28.6%)	5(71.4%)	0.979	0.322
No	37(48%)	40(52%)		
Tracheal lavage				
Yes	25(83.3%)	5(16.7%)	14.58	**0.0001****
No	10(34.5%)	19(65.5%)		
Respiratory distress				
Yes	39(73.6%)	14(26.4%)	42.58	**0.0001****
No	0	31(100%)		

5ABGA				
Normal	1(7.7%)	12(92.3%)		
Abnormal	26(96.3%)	1(3.7%)	41.33	**0.0001****
Not done	12(27.3%)	32(72.7%)		

4.15.1 Logistic regression of mortality

Variables	Odds Ratio	Std. Err.	z	P	95% Conf. Interval	
					Lower	Upper
Age	1.03	0.03	1.03	0.30	0.97	1.10
Intubated	2.36	4.23	0.48	0.63	0.07	79.42
Causes of burns						
Steam inhalation						
Stove explosion	5.29	8.79	1.00	0.32	0.20	137.37
Burning house	43.00	73.94	2.19	**0.03****	1.48	1250.83
Gas explosion	1.21	2.66	0.09	0.93	0.02	90.04
Others	1.70	2.77	0.33	0.74	0.07	41.13
Tracheal lavage	53.56	127.38	1.67	0.09	0.51	5664.62
Oxygenation	0.37	0.42	-0.87	0.38	0.04	3.47
ABGA						
Normal						
Abnormal	4762.38	12466.44	3.24	**0.00****	28.16	805387.50
Not done	251.31	575.01	2.42	**0.02****	2.84	22275.11

4.15.2 Bivariate analysis

	Pneumonia		Chi- square	P-value
Antibiotic prophylaxis	Yes	No		
Yes	25(49%)	26(51%)		
No	8 (24.2%)	25(75.8)	7.516	**0.02****

** *indicates significant at P<0.05*

CHAPTER FIVE: DISCUSSION

5.1 DISCUSSION

This study involved 84 participants who were admitted in burns unit, KNH due to inhalation injury during the months of April, May and June 2014. Open flame burns had the highest prevalence of (64.3%) while steam inhalation had (29.7%) Others included chemical burns and flash burns. Smoke inhalation was responsible for (89.7%) mortality consistent with Toon et al,(2010) finding. In comparison, (64.8%;n=54) of burn patients who had smoke inhalation died compared to(13.3%;n=30) of those without smoke inhalation.

All age groups and gender are at risk of inhalation injury and this is consistent with Pitts et al (2008) report that burns can affect all ages, gender and social economic levels. Burning house was the most frequent cause of inhalation injury across all ages while steam inhalation had higher frequency among those aged 10years and below. Being prevalent cause of burns within this age bracket, steam inhalation (head immersion or spill) reflects home accidents and is relevant in burns prevention. Stove explosion and kerosine suicide featured more among those aged 21-30 years with equal occurrence of 7(8.3%) mainly due to mismanaging stove, domestic quarrels or love affair conflicts.Open flame burns accounted for 64.3% of inhalation injury which is higher above Miller et al (2008) report which showed 40% prevalence.

The study findings showed that majority 50 (59.5%) of the patients arrived in the hospital within eight hours post burns. Eight hours is adequate duration for any chemical to destroy body cells; but if appropriate resuscitation was done at the scene of injury, these patients are likely to survive depending on time clerking and intubation is done. Oxygen by mask can be administered to reduce effect of carbon monoxide and hydroxocobalamin to combat cyanide effect. Arrival to the hospital is confounded by many factors.

After arrival to hospital, majority (73.8%) were clerked within two hours of waiting time and this is a bit too long for an intoxicated patient. However (6.1 %) participants waited for more than 6 hours before clerking and this can be a contributing factor to high mortality. Qualitative data attributed this to inefficiencies in mobilizing resources and poor attitude among clinicians.

Quite often, intubation follows clinical observations and patient may require intubation immediately except where patient comes in already intubated. However, some patients wait even longer. In this study, a few participants had to wait for 6 more hours after clerking before intubation. Findings revealed majority 26(68.4%; n=38) were intubated within 2 hours post clerking although time lapse was different considering the time of burn which might be significant in determining patient's outcome. Intubation alone was not statistically significant [p-value > 0.05(0.63)] thus supporting hypothesis. Among the patients 53 (63.1%) who developed respiratory distress, 41 (77.3%) was due to upper airway obstruction and severity depended on the extent of obstruction. This might explain why some patients with facial edema survived even without intubation. Since grading of inhalation injury is not routinely done, these patients would require very close monitoring to enable timely intubations where prophylactic intubation was not done.

Despite intubation, other parameters seemed to influence the outcome of patients with inhalation injury, and premorbid conditions were presumed confounders. However, this study findings did not show evidenced effect of premorbid conditions although some conditions predisposed participants to sustaining burns as is the case of epilepsy 4(4.7%) and alcoholism/drugs 8(9.5%). This implies that effective management of epilepsy and alcoholism would help reduce incidents of burns.

Diagnosis of inhalation injury was mainly clinical 82(97.6%) based on history of the incidence and presenting signs and symptoms. Lower airway inhalation injury was not assessed except in some patients who presented with respiratory distress (Nugen & Herndon, 2008). Almost all patients had facial burns except 15 (17.9%) and this implies that patient can have inhalation injury without necessarily having burns on the face. Since diagnosis was based on clinical features, it is therefore possible to miss diagnosis unless further investigation is conducted. Other parameters like chest X-ray were primarily used to confirm position of central lines and only 7 (8.3%) patients had this done.Although literature does not support chest X-ray to confirm inhalation injury, it can be useful incase of chest inflammation. Inhalation injuries were not routinely graded and adopting Woodson's criteria of grading inhalation injury would assist in guiding on interventions. Grading inhalation injury and determining levels of toxicity were not part of the diagnosis despite being key factors in planning interventions (Woodson,2009).

Tracheal lavage is a common practice but literature does not support its use as the ultimate intervention for lung treatment. More than half nurses reported use of saline tracheal lavage to remove smoke from the lungs while a few said smoke is never removed.This discrepancy may be due to lack of documented standardized operating procedure. In absence of bronchoscopic lavage, tracheal lavage would be useful, but only small proportion of nurses reported practicing the same. Tracheal lavage on its own was found to be significant to mortality but was not significant when subjected to logistical regression; (p-value 0.09). Other confounders seemed to influence the outcome. Toon et al (2010) and Miller et al (2009) recommends broncho alveolar toileting using heparin and N- acetylcysteine for smoke removal and as such tracheal lavage (dry or wet) is not effective to decrease lung toxicity, incidences of re-intubation, atelectasis and progressive pulmonary failure. This might explain the derraged arterial blood gas results reported in majority 23 (58.9%;n=39) of the

participants who died during the study period. Qualitative data reported lack of bronchoscopic theater as the reason for not performing broncho-alveolar lavage otherwise the doctors were willing to learn and perform.

Accidental extubations came out as common phenomena but few patients benefitted from re-intubation. For the first three days, 16(19.0%) participants had accidental extubations and those re-intubated were less than half. All re-intubations done were emergencies meaning severe respiratory distress mainly due to laryngeal edema. From qualitative data, difficulty convincing anaesthetists to intubate burns patients was commonly repeated. From the nurses' responses, protocol of care is not standardized 13 (76.5%;n=17) and this might influence decision making including whether to intubate, re-intubate or not. Best example is where Doctor 1 confessed trying to convince an anaesthetist to intubate a patient who had inhalation injury yet anaesthetist felt there was no indication for intubation. Responses from care givers showed variation of ideas although majority reported that intubated patients should be sedated as long as they needed intubation to prevent accidental extubations. Study findings showed less number of participants put on sedatives (mainly dormicum administered as bolus doses) compared to those intubated; attributing accidental extubations to in-effective sedation. Qualitative data reported lack of syringe pumps for drug titration as one of the challenges in managing inhalation injury and combined with other confounders like high nurse: patient ratio might explain the inconsistent sedation.

Mechanical ventilation practice 13(24.5%; n=53) was found inconsistent with Traber et al (2007) indications which include all patients with lower airway inhalation injury to enhance gaseous exchange while maintaining adequate ventilation. On observation, those on mechanical ventilation had settings of normal tidal volume and PEEP while Toon et al (2010) recommends low tidal volume and PEEP to reduce ventilator associated lung injury in inhalation injury and ARDS. This may be because airway management is borrowed from

critical care where airway is intact and risk for baro trauma is less. Knowledge on management of a burnt airway is necessary to the clinicians managing burns patients. Qualitative data reported lack of bronchoscopic theater as the reason for not assessing lower airway to grade inhalation injury and as such, depend on arterial blood gases to determine respiratory efficiency. On the other hand, arterial blood gas analysis is not routinely done and as a result, some patients die before they are mechanically ventilated.

Carbon monoxide poisoning is a common feature in smoke inhalation and most nurses 14 (82.3%) demonstrated knowledge on use of hyberbaric oxygen to counter effect of carbon monoxide. However, a discrepancy between knowledge and practice was observed where almost half of the participants (40.5%) were being maintained on room air first day of admission. This may be attributed to lack of a standardized operating procedure as was reported by majority key informants. Lack of a standardized protocol may contribute significantly to omissions and assumptions in decision making (Raman& Edwin,2014).

Despite use of prophylactic antibiotics on 60.7% participants, it was observed that 49% among them developed clinical signs of pneumonia / alveolitis and almost all cases were noted during the first week. Bacterial chest infections were reportedly common during the second week which suggests that the observed pneumonia must be related to inhaled smoke or steam. Attributing the pneumonic / alveolitis process to the chemical toxicity within the alveoli would therefore disqualify use of antibiotics to prevent pneumonia in patients with inhalation injury. However, bivariate analysis showed significant relationship between antibiotic prophylaxis use and pneumonia development with a (p- value of 0.02).

Among the intubated patients 32 (60.4%; n=53)) died and only 6 (11.3%) survived compared to those with respiratory distress and were not intubated 7 (13.2%; n=53) died and 8 (15.1%)

survived. This shows that risk of death is higher to those intubated and a different approach may be required to reduce the risk. If patent airway was the only problem, these patients would not die once intubated but it appears like either intubation aggrevates the problem or cause of death cannot be treated by intubation. Qualitative data hypothetically attributed cause of death to smoke related chemical toxicity, alveolar atelectasis, tracheal stenosis and alveolar steam burns which require more than intubation to treat.

Mortality was reported in 39 (47%) patients and 35 (89.7%) of them had smoke inhalation while 4 (10.3%) had steam inhalation. 35 (41.6%) of the total population died of smoke inhalation while 4 (4.7%) died of steam inhalation. Mortality was found to be the same regardless of the time of intubation and this implies that the cause of death is the same in all patients and it is not taken care of by intubation. The amount of smoke patient is exposed to determine whether he/she will survive or die and any intervention to reduce this exposure might increase chances of survival. Cyanide toxicity requires antidote (Polaski & Suzanne, 2010) but no intervention was identified in this study. Majority 27 (69.2%) of deaths occurred during the first week and arterial blood gas analysis showed 13 (15.5%; n=84) of patients with hypoxemia while at the same time 56 (66.7%) were breathing well spontaneously. This indicates a problem with either oxygen transport or exchange and may be, prolonged mechanical ventilation with alveolar wash out would have enhanced survival. Burning house as a cause of inhalation injury is statistically significant towards mortality with a p-value of 0.03 ($p<0.05$).

A number of complications often follow inhalation injury and in this study, 58.3% of the participants developed complications. Those related to inhalation injury included Pneumonia due to steam inhalation and crust formation, hypoxemia due to impaired gaseous exchange following chemical related alveolitis, respiratory acidosis due to retention of CO2 following impaired gaseous exchange while asthma-like symptoms follow spasms as trachea contracts

during healing process. Some patients are prone to development of tracheal stenosis and in this study two patients developed stridor post extubation and three had tracheal stenosis which warranted immediate re-intubations. However, this information is not supported in literature and requires more evaluation.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Diagnosis and management of inhalation injury is very critical in determining the outcome of patients with burns and early diagnosis is paramount. Clear guideline on management is very key and there is need for grading the injury. However, the practiced management of inhalation injury in burns unit is ineffective due to lack of clear protocol, delay in decision making, inconsistent sedation and that has resulted in higher mortality than internationally reported. From the finding of this study, the intubation being done is not well defined; does not tell who should be intubated and who should not. Patients are treated differently despite inhalation injury and this is not based on any written guideline. Intubation is mainly done for airway maintenance but sustaining it is a challenge. Although intubation helps to keep the airway patent, lower lung tissue injury due to smoke and related chemicals toxicity is not managed and seems responsible for many deaths regardless of the age of patient.

There is no documented protocol of managing inhalation injury thus allowing room for variable use of knowledge based on personalized reasoning. Qualitative data showed that doctors and nurses know what should be done but inadequate resources and care facilitation is a challenge.

Most of inhalation injuries were not graded and management of inhalation injury without broncho-alveolar lavage might impact negatively on the outcome of care. Current approach of care is subjective in that some nurses do saline tracheal instillations and others do not.

Some doctors recommend intubations while others disregard opinions without an objective scale. This was featured in qualitative data where plastic surgery Registrars and nurses working in burns unit commonly reported trying to convince anaesthetists to intubate burn patients. Anaesthetists feel patients should be intubated incase of obvious respiratory distress

or derranged arterial blood gases. Oxygenation of patients is not based on toxic chemical levels in the lungs or blood but on visible respiratory distress symptoms which might be evident when chemical effects cannot be reversed. Whether on oxygen or not, death and life probability is the same (p-value 0.38) thus implying a gap in the care**.** Putting patients on oxygen alone could not change the outcome implying that, chemical removal or its neutralization is very key in managing inhalation injury.

Critical care of inhalation injury should comprise broncho-alveolar lavage, high level oxygenation and respiratory support for those with respiratory difficulties guided by arterial blood gas levels and toxic chemical levels. Intubation is more traumatic to burnt airways than it is to intact airways and this could be the reason for stridor and tracheal stenosis post extubation, including majority deaths among the intubated patients.

Other related factors that influence the care of inhalation injury include lack of ventilators, drug titrating pumps, cardiac monitors, Lack of burns acute care skilled nurses, bronchoscopic theater and standardized protocol.

6.2 RECOMMENDATIONS

1. There is need for a standard operating procedure or policy on managing inhalation injury for the entire team to guide on decision making concerning patient care.
2. Further training required on the following:
    i. Nurses on pathophysiology of inhalation injury to appreciate need for oxygenating all patients with inhalation injury guided by carbon monoxide blood levels.
    ii. All clinical care providers on critical care of a burnt airway as compared to intact airway; which is the main reason for referral of burn patients from other health facilities.

3. Carbon monoxide blood level should be determined on admission for all burn patients exposed to smoke inhalation as a guide on oxygen concentration requirement on individual patients.
4. Clinicians should practice routine arterial blood gas analysis for all burns patients with respiratory distress to promote early diagnosis and early respiratory intervention.
5. All patients with smoke inhalation should be given vitamin B12 (hydroxycobalamin) to combat cyanide toxic effect and this can be done even at the scene of injury.
6. To promote critical care of patients with inhalation injury, hospital management should equip Burns unit with the following:
    i. Syringe pumps for titrating sedatives to enhance continuous sedation during intubated period to prevent accidental extubations, and improve on pain management.
    ii. Mechanical ventilators and cardiac monitors for effective respiratory support of patients with inhalation injury.
    iii. Equip Burns Theater with a fibre- optic bronchoscope to enhance grading of inhalation injury and adoption of bronchoscopic-alveolar lavage, supported in literature as the ultimate treatment for lower lung inhalation injury.

6.3 RECOMMENDATION FOR FURTHER RESEARCH

1. Challenges of managing a burnt airway.
2. Comparative study between use of bronchoscopic alveolar lavage versus tracheal lavage to compare effectiveness in reducing mortality.
3. Case- control study on use of hydroxycobalamin versus non –use to determine its effectiveness in reducing mortality.
4. Comparative study using tracheal instillations of heparin versus normal saline.

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APPENDIX A: CHECKLIST FOR PATIENTS ***SERIAL NO……***

RESEARCH ASSISTANT NO……

MANAGEMENT OF INHALATION INJURY AND ITS EFFECT ON THE OUTCOME OF PATIENTS IN BURNS UNIT KENYATTA NATIONAL HOSPITAL

Instructions:

- Please confirm that the checklist is serialized
- Please confirm that research assistant number is correct
- Use the attached inhalation grading chart for question 1.5
- Use the attached respiratory support indicators chart for questions 4.0 & 7.0
- Do not write patients' names on the checklists
- Do not share any information outside this research
- Only those who consented should participate

1.0 DERMOGRAPHIC DATA

1.1

1.Patient's bed no.	2.Sex(M/F)	3.Facial burns %age	4.Neck burns Present/absent	5.Cutaneous burns %age
		.	.	

1.2

1.Anterior trunk burns %age	2,Hours arrived in hosp post burns	3.Hours clerking done post arrival	4.Hours intubated post clerking	5.Not intubated
.				

1.3 What is the patient's age by nearest whole numbers?

1. ----------Days
2. ----------Weeks
3. ----------Months
4. ----------Years

1.4 What method of diagnosis was used to confirm inhalation injury?

1. History of incidence ☐
2. Presenting signs and symptoms ☐
3. Chest X- ray ☐
4. Bronchoscopy ☐

1.5 What was the cause of burns? Kindly tick [ ] where applicable.

1. Stove explosion ☐
2. Burning house ☐
3. Steam inhalation ☐
4. Fuel tanker explosion ☐
5. Gas explosion ☐
6. Mob justice ☐
7. Others, specify ……..

1.6 What grade was the inhalation injury?

1. Grade 1 ☐
2. Grade 2 ☐
3. Grade 3 ☐
4. Grade 4 ☐
5. Grade 5 ☐
6. Not done ☐

2.0 PREMORBID CONDITIONS

2.1 What other chronic condition did the patient have prior to burns? Please tick [ ] in the second column where appropriate.

1. Epilepsy	
2. Alcoholism	
3. Drug addiction	
4. Diabetese mellitus	
5. Peptic ulcers	
6. Kidney disease	

7. Asthma	
8. Pneumonia	
9. Heart condition (specify)	
10. Hypertension	
11. PTSD	
12. None	

3.0 INJURIES SUSTAINED DURING BURN PROCESS

3.1 What other injuries did the patient sustain while trying to safe him/her self from fire source? Kindly tick [ ] in the second column all applicable.

1. Head injury	
2. Pneumothorax	
3. Heamothorax	
4. Intracerebral bleed	
5. Fractures (specify)	
6. None	

4.0 VENTILATORY INTERVENTION

4.1. Did the patient require any respiratory support? 1. Yes [ ] 2.No [ ]

4.2. If yes what was the intervention? Kindly tick [ ] in second column.

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day5**	**Day 6**	**Day 7**
1. Early intubation (EVB)							
2. Prophylactic intubation							
3. Emergency intubation							
4. Re-intubations (give reason)							
5. Mechanically ventilated							
6. Ventilatory mode							
7. PEEP							
8. NIPPV (Oxygen mask)							
9. None was provided							
10. Extubation							

5.0 LUNG TREATMENT

5.1 What interventions were given to enhance lung tissue healing? Please tick [ ] if done and explain where necessary.

	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**	**Day 6**	**Day 7**
1.Chest physiotherapy							
2.Tracheal aspiration							
3.Tracheal lavage							
4.Bronchial alveolar lavage							
5.Fibreoptic bronchoscopy							
6.Heparin nebulization							
7.Saline nebulization							
8.Bronchodilator nebulization							
9.Corticosteroid nebulization							
10.NAC nebulization							

6.0 SYSTEMIC THERAPY

6.1. Was the patient put on any medication during management of inhalation injury?

1. Yes [ ] 2. No [ ]

6.2. If yes, please tick [ ] appropriately in the second column

1.Antibiotics (Prophylaxis)	
2.Antibiotic (EVB)	
3.Steroids	
4.Nsaids	
5.Opiods	

6. Sedatives	
7. Antipyretics	
8. Others, specify	

6.3. If No, what was the reason? ----------

7.0 RESPIRATORY DISTRESS (RD)

7.1. Did the patient develop respiratory distress at any time during the management process?

1. Yes [ ] 2. No [ ]

7.2. If yes, what was the cause? Please tick [ ] where applicable.

	Week 1	**Week 2**	**Week 3**	**Week 4**
1..Upper airway obstruction (edema)				
2. Bronchospasms				
3. ARDS				
4. Tracheal stenosis				
5. Pneumonia				
6. Atelectasis				
7. Others, specify				

8.0 PATIENT'S OUTCOME AFTER FOUR WEEKS

8.1 How was the patient's clinical status after four weeks of care? Please tick [ ] in the second column and qualify your answer.

1.Alveoli gaseous exchange restored (ABGA)	
2. Able to breathe spontaneously (RR)	
3. Able to maintain adequate lung volumes	
4. Mortality (Specify day of death post admission)	
5. Complication (Specify)	

Would you like to make any comment about this study? You are welcome.

Thank you for your participation.

APPENDIX B: CARE GIVERS QUESTIONAIRE ***SERIAL NO……...***

RESEARCH ASSISTANT NO……..

MANAGEMENT OF INHALATION INJURY AND ITS EFFECT ON THE OUTCOME OF PATIENTS IN BURNS UNIT KENYATTA NATIONAL HOSPITAL

Instructions:

- Please confirm that the questionnaire is serialized
- Please confirm that research assistant number is written
- Do not write your names on the questionnaire
- All information given will be held in confidence
- Only those who consented should participate

1.0 DERMOGRAPHIC DATA: Please tick [ ] where appropriate**.**

1.1 What is your age?

1. 15 – 24 years ☐
2. 25 – 34 years ☐
3. 35 – 44 years ☐
4. 45 – 54 years ☐
5. Above 54 years ☐

1.2 For how long have you been working in burns unit?

1. 3 – 7 years ☐
2. 8 – 12 years ☐
3. 13 - 17 years ☐
4. More than 17 years ☐

1.3 What is your highest level of training?

1. Certificate level ☐
2. Diploma level ☐
3. Degree level ☐
4. Masters level ☐

2.0 PROFESSIONAL EXPERTISE

2.1 What special skill do you possess to help you manage inhalation injury?

1. Trained on burns management ☐
2. Trained on ATLS ☐
3. Trained in ACLS ☐
4. Trained on Critical Care ☐
5. No special skill ☐

2.1.1 If no special skill, how does it affect your performance in managing inhalation injury?

1. I concentrate on wound care ☐
2. I have learnt on job to manage burnt airways ☐
3. I consult specialists ☐
4. Though I work, I feel incompetent ☐

2.2 How is diagnosis of inhalation injury/burns usually made in your ward? Please tick all that applies.

1. Based on signs and symptoms ☐
2. By use of chest x-ray ☐
3. By use of bronchoscopic examination of the airways ☐
4. Based on history given ☐
5. Others, specify…….

2.3 Is there a documented protocol of managing patients with inhalation injury/burns?

1. Yes ☐ 2.No ☐

2.3.1 If No, how does this affect management of patients with inhalation injury/burns? Please tick all that applies.

1. Diagnosis depends on how the admitting doctor sees it ☐
2. Medications depend on individual doctor's reasoning ☐

3. Either doctor or anaesthetist makes decision and patient is managed ☐
4. Care givers discuss and dialog on intervention ☐
5. Once patient is intubated, the rest is routine care ☐
6. Others, specify……..

2.4 What is the average Nurse: Patient ratio in burns unit? .....

3.0 OXYGENATION

3.1 What factors influence oxygenation of patients with inhalation injury/burns in your ward? Please tick all what applies.

1. Delayed intubation post burns ☐
2. Some patients self extubation ☐
3. Limited access to mechanical ventilation for patients in respiratory distress ☐
4. Difficult maintaining continuous sedation for intubated patients ☐
5. Others, specify……...

4.0 LUNG TREATMENT

4.1 How do you remove smoke from the lungs to reduce inhalation injury?

1. Bronchoscopic lavage ☐
2. Dry endo- tracheal suctions (no instillations) ☐
3. Wet endo-tracheal suctions (with instillations) ☐
4. It is never removed ☐
5. Others, specify…….

5.0 FLUID RESUSCITATION

5.1 What factors influence fluid resuscitation for patients with inhalation injury/burns in your ward? Please tick [ ] all that applies.

1. Not all patients have big bore cannulars for adequate hydration ☐
2. Very few patients reach ward within 12 hours post burns ☐
3. Different doctors give different regimes of fluid ☐

4. Almost all patients have cutaneous burns ☐
5. Others, specify……..

6.0 PATIENTS OUTCOME

6.1 What would you attribute the high mortality (68.9%) among burns patients to?

1. Premorbid conditions ☐
2. Sepsis ☐
3. Burn shock ☐
4. Pulmonary embolism ☐
5. Inhalation injury ☐
6. Delayed intubation ☐
7. Respiratory distress ☐

7.0 KNOWLEDGE

7.1 What is your opinion about the following statements regarding management of inhalation injury? Please indicate by number on Likert scale below, on the second column.

1- Agree 2- Strongly agree 3- Average 4- Disagree 5- Strongly disagree

	Number
1.All patients with inhalation injury should be intubated	
2.All patients with suspected inhalation injury should have prophylactic intubation	
3.All patients with inhalation injury should be mechanically ventilated	
4.Only those patients with respiratory distress should be intubated	
5.All patients with smoke inhalation injury should be put on hyperbaric oxygen	
6.All patients with inhalation injury should have bronchoscopy to grade injury	
7.All patients with inhalation injury should have tracheal instillations during ETT suctions	

8.All patients with inhalation injury should have fibre-optic bronchoscopic lavage	
9.All patients with inhalation injury should be put on anti-inflammatory drugs	
10.All patients with inhalation injury should be nursed in a propped up position	
11.All intubated patients with inhalation injury should be sedated continuously	
12.Others,specify	

Would you like to recommend any area for improvement for improvement?.

Thank you for your time and participation.

APPENDIX C: KEY INFORMANTS INTERVIEW GUIDE ***SERIAL NO…….***

RESEARCHER'S SIGNATURE …….

MANAGEMENT OF INHALATION INJURY AND ITS EFFECT ON THE OUTCOME OF PATIENTS IN BURNS UNIT KENYATTA NATIONAL HOSPITAL

Instructions:

- Please confirm that the checklist is serialized
- Please confirm that the researcher has signed top right
- Do not write the names of participants on the interview guide
- All information given to be held in confidence
- Only those who consented should participate
- Obtain permission to tape record the information given

What are your strengths in managing inhalation burns as a referral hospital?	
Do you experience challenges in diagnosing inhalation injury among burns patients?	
How effective is it to manage inhalation injury with respiratory distress in your burns unit?	
How is your nurse/patient ratio? And how does it affect the care?	
How many of your nurses are specially trained in burns management?	
How many of your nurses are specially trained in critical care or ACLS?	
What challenges do you experience in terms of resources?	
How would you explain some of the challenges you've been experiencing?	
What would you recommend for improvement on management of inhalation injury?	

If you would like to make a comment about this research, please write here below

…….

Thank you for your time and participation.

APPENDIX D: CONSENT FORM FOR PARTICIPANTS

Dear Participant.

My name is Judith Mugambi, a second year post graduate student at the University of Nairobi; School of nursing sciences pursuing Master degree in Critical Care Nursing.

I intend to carry out a study on the management of inhalation injury and its effect on the outcome of patients as part of the requirements for the award of Masters Degree in Critical care nursing. The study seeks to evaluate the current management of inhalation injury, find out more about the management of inhalation injury and inform on possible solutions into mortality reduction for patients with inhalation injuries.

Participation in this study is voluntary and patient / guardian or surrogate will be required to consent by writing his name and signature at the end of this form, acknowledging that he has read and understood the information in this form.

Participants will be all patients with confirmed or suspected inhalation injuries following burns and non-probability sampling technique will be applied to allow all qualified population to participate. Each participant (patient) will be followed up for at least four weeks and data collection will continue for three months. Care givers and ward administrators will be incorporated for in-depth information.

No harm or pain will be inflicted on participants during the process, as this research is mainly an evaluation of interventions. Participants will be free to share views about their care as research progresses and should you wish to withdraw from this study at any time, you will be free to do so without any victimization or bias in the subsequent care. This study may not benefit you directly but the findings will provide relevant information that will be used to standardize care and improve survival rate for patients with inhalation injury.

All information obtained will be kept confidential and research instruments anonymous. Consent forms will be kept by the researcher under lock and key.

Your participation is highly appreciated and please note that there will be no monetary gifts for participation

In case of any question or clarification, please feel free to ask or contact the principal researcher or the secretary Ethics and Research Committee (ERC) on the following address.

i. Judith Mugambi; Cell no. 0722820671
ii. Secretary ERC, KNH/UON; P.O Box 30197 NRB or Tel no. 2726300; Ext. 44102.
iii. Director, School of nursing; P.O Box 19676 NRB or Tel no. 2726300; Ext. 43673.

I have read / been explained to the details about this research and I have understood the nature and the conditions of my participation. I have been allowed to ask any question regarding the study and I accept to sign here below as consent for voluntary participation.

Participant (Patient): Name: ……. Signature…….. Date……..

(Surrogate/Guardian):

Name: ……Relationship…….. Signature……Date…….

Researcher: Name: …….. Signature…….. Date……

<u>THANK YOU.</u>

APPENDIX E:

1. GRADING INHALATION INJURY

First verify that the patient has at least two or three signs suggestive of inhalation injury. i.e. sighed nasal hairs, sooty sputum, facial burns, swollen tongue, swollen lips, cough, hoarse voice, history of enclosed in burning house or hot liquid head immersion.

Then confirm:

- Grade I: No laryngeal oedema
- Grade II: Minimal laryngeal oedema and erythema
- Grade III: Slight tracheal mucosal oedema and erythema
- Grade IV: Moderate tracheal mucosal oedema and erythema
- Grade V: Severe tracheal oedema and erythema

2. EVIDENCE OF RESPIRATORY DISTRESS; INDICATORS FOR RESPIRATORY SUPPORT

- Horseness of voice
- Laboured breathing
- Obvious upper airway edema
- Respiratory acidosis
- Respiratory alkalosis
- Hypoxemia
- Carbon monoxide levels above 20%Hgb
- Dyspnoea
- Stridor

WORK PLAN

ACTIVITY	2013			2014							
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG
Topic Identification											
Proposal writing											
Literature Review											
Tool Structuring											
Ethical review& approval											
Pre-testing Instruments											
Instruments Revision											
Training of assistants											
Data collection											
Data processing											
Data analysis											
Report Writing											
Thesis submission											
Thesis Defense											
Findings dissemination											
Research publication											

BUDGET

ITEM	ESTIMATED COST PER UNIT	NUMBER OF UNITS	TOTAL COST
STATIONERY: Pens, Printing papers. **Cartilages, airtime, Note books**	500.00 4800.00	10 10	5000.00 48000.00
BROWSING	10.00	500	5000.00
ETHICAL APPROVAL: KNH/UON, MOHE	-	-	2000.00
TYPING : Questionnaires, Final report	10.00	200 Pages	2000.00
PHOTOCOPYING: Questionnaires, Drafts, Thesis	2.00	4000 pages	8000.00
ALLOWANCES FOR ASSISTANTS (2): Training, Field work, Transport, Lunch	1000 per day	90days	90,000.00
DATA PROCESSING & ANALYSIS: Data analyst	5000.00	1	5000.00
PROPOSAL & DRAFT THESIS BINDING	150.00	10	1500.00
THESIS FINAL BINDING	250.00	12	3000.00
SUBTOTAL			**169,500.00**
CONTIGENCY EXPENSES (10%)			16,950.00
TOTAL			**186,450.00**