STUDY OF PAEDIATRIC THERMAL BURNS:
PRESENTATION, CAUSES AND MANAGEMENT AS SEEN IN
KENYATTA NATIONAL HOSPITAL

A DISSERTATION SUBMITTED AS PART FULFILMENT FOR THE DEGREE
OF MASTER OF MEDICINE IN SURGERY OF THE UNIVERSITY OF
NAIROBI

BY

DR. MUNG’ARA G. MBURU
(MB.ChB - Nairobi)
DECLARATION

I certify that this dissertation is my original work and has not been presented for a degree in any other university

Signed............................................ Date............................................
Dr. Mung'ara G. Mburu
MB.ChB (Nairobi)

This dissertation has been submitted for examination with my approval as a university supervisor

Signed............................................ Date............................................
Dr. J. K. Wanjeri
MB.ChB, MMed (Surg), IPTM (Tel Aviv)
Lecturer,
Department of Surgery,
University of Nairobi.
ACKNOWLEDGEMENTS

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My thanks also go to the department of surgery and Kenyatta National Hospital ethical and research committee for facilitating this research.

I am grateful to all the patients and their relatives who participated in this study and without whose co-operation the study would not have succeeded.
DEDICATION

To my parents, Margaret and Peter Mburu, for their sacrifices, patience, hope, understanding and love.

To my wife Judy and daughter Wambui for their steadfast support, love and encouragement.
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SUMMARY

A prospective study of 101 paediatric burn patients aged 3 weeks to 12 years was carried out at Kenyatta National Hospital’s (KNH) Ward 4D, Burns Unit and Intensive Care Unit (ICU) to assess the demographic pattern and common complications.

Methodology: Patients were recruited over a 3 month and 1 week period between 26/8/2003 and 2/12/2003, according to set criteria. Each patient was followed till either discharge or for a minimum of 4 weeks for the 8 patients still in the ward at the time of conclusion of study. Data was entered into a questionnaire and analysed.

Results: 71.3% of all patients were aged less than 3 years with a mean age of 34.45 months. Pre-school children were 71.3% and males accounted for 55.4%, with a male to female ratio of 1.24:1. Many of the patients came from families living in single rooms (53.5%) and most of the immediate care takers of the children had formal education (96%).

Most of the patients’ relatives (35.7%) earned between Kshs. 4000-6000 per month. Scalds accounted for the majority of the burns or 69.3% with open flame accounting for 26.7%. 93.1% of the burns occurred at home around early morning and evening; and splash burns are the commonest form of scald burns seen in this hospital.

Patients with suspected inhalation injuries were 10.9%.

The commonest complication encountered was burn wound infection accounting for 71.3% of all patients admitted and 3 patients (3%) died over the study period.

Only thirty seven patients (36.6%) underwent skin grafting. No early tangenital excision and skin grafting was done.

All 101 patients (100%) were put on analgesics and 98% on topical and/or systemic antibiotics.

Conclusion: Thermal burns in children commonly occurs at home, with majority sustaining splash injuries. Improving the social economic status of the people can prevent them and adherence to the building code can greatly reduce the incidence of paediatric burns.
INTRODUCTION

Burns are the most devastating of injuries and the burn patients may suffer from complications for the rest of their lives. In spite of recent developments in burn care, we still see high mortality and significant morbidity in terms of burn complications and functional, social and psychological impairment (1,2).

Burn patients are a major problem in developing countries and indeed constitute a worldwide problem. Burns in children continue to be a problem in Kenya is related to the wide spread use of kerosene stoves in cooking, domestic electric appliances, use of chemicals in the home, large families with many children, the widespread social habits of preparing tea at ground level, and the low standards of living and associated poor housing. Children are at high risk because of their natural curiosity, their mode of reaction, their natural impulsiveness and their lack of experience and calculation (2).

The care of children is dependent upon others as they cannot take care of themselves. Burns at home constitute the majority of burn injuries in children, scalding being the commonest cause. Burns in children are a difficult medical and surgical problem, as children can receive deep burns even when exposed to high temperature liquids for just a few seconds (2).

Prevention of burns is an important public health aspect in the management of burns. Most centres concentrate in therapy other than prevention, however education is the main plank in burn prevention. Once etiological factors are known, e.g. fire and fire causing
material, children and parents should be advised against careless handling of these materials.

The purpose of this study was to identify the epidemiological features of burn injuries affecting children in our population, which may be preventable by implementing preventive measures and by the education of parents.

The study was undertaken at Kenyatta National Hospital which is the largest institution handling the largest number of burn patients in Kenya at any given time. The hospital is one of the two referral hospitals in Kenya and is the teaching hospital for the University of Nairobi.
LITERATURE REVIEW

DEFINITION:

Burns are wounds caused by the application of heat, cold or caustic chemicals to the skin. When heat is applied to the skin the depth of injury is proportional to the temperature applied, duration of contact and the thickness of the skin \(^{(1)}\).

Thermal burns are caused by scald, flame, flash or contact \(^{(2,3,4,5,6,7)}\).

- **Scald burns**: are usually from hot liquids e.g. water, hot oil or grease. Hot water scalds are the commonest and water at 60°C causes deep dermal or full thickness burns in 3 seconds; at 69°C the same burns occur at 1 second \(^{(8)}\). Exposed areas tend to be burned less deeply than areas covered with thin clothing. Clothing retains the heat and keeps the liquid in contact with the skin for a longer period. Scald burns are either immersion or splash. Immersion burns are always deep, severe burns. Scald burns from grease, or hot oil are usually deep dermal or full thickness burns. Cooking oil and grease may be in the range of 205°C.

- **Flame burns**: Occurs mostly due to house fires, ignition of clothing from stoves and candles. It also results from the improper use of flammable liquids; automobile accidents and arsonist fires. Patients mostly get full thickness burns.

- **Flash burns**: Are caused by explosion of natural gas, gasoline and other flammable liquids. They cause intense heat for a very brief time. Unless clothing ignites, it acts as a protection against flash burns. Generally,
distribution is over all exposed skin with the deepest part being the one facing the source of ignition.

- **Contact burns**: These burns result from contact with hot metals, plastic, glass or hot coal. They are limited in extent but are invariably very deep. They are common in industrial and automobile accidents after victims come into contact with hot engine parts. Toddlers who touch or fall against irons, ovens and wood-burning stoves with outstretched hands are likely to suffer deep burns of the palms.
EPIDEMIOLOGY

In Kenya Okonjo\(^9\) reported an average admission of 150 patients per year at KNH in the period between 1980 to 1988 with mortality of 36%. Earlier Wokabi\(^10\) reported a mortality rate of 14.7%. In USA 2.3 million thermal injuries occur every year and account for about 90% of all burns. Of these 100,000 require hospital admission and of these 5-6000 die. Those that survive need post discharge rehabilitation, reconstruction and re-adaptation to everyday life in society. The severer the burns, the more prolonged the morbidity\(^11\).

Those most at risk are the very young, the old, very unlucky and very careless.

Hot liquid scalds cause many burns, 50% of these occur in children and mostly occur in the kitchen.\(^10\)

Organisation of burn care\(^11\)

The organisation of burn care involves a multidisciplinary team approach for both inpatients and outpatients. This includes attending/resident physician, nursing staff, the nutritionist, physio and occupational therapists, psychologists, social workers and case managers. There is follow up after discharge of a patient from a burn care centre, and weekly conferences are invaluable in assessing current patient care and developing care plans for subsequent therapy.
**Initial triage and management.**

Thermally injured patients, like all other trauma victims, should be evaluated systematically.

Major priorities must be maintenance of airway, effective ventilation and support of the systemic circulation.\(^{(1,12,13)}\)

Endotracheal intubation is performed liberally on patients who have suffered severe burns or where there is any question of an inhalation injury or an upper airway burn. Oral or nasotracheal intubation is preferred to tracheostomy because tracheostomy has higher incidence of complications\(^{(1,12,13)}\).

History of circumstances of injuries is valuable. History of inhalation injury, pre-existing medical conditions, medications taken and allergies are important\(^{(13)}\).

A patient should be completely undressed and all body surfaces exposed.

Associated injuries e.g. blunt or penetrating trauma, closed head injury, pneumothorax or other thoracic trauma, spinal injuries intra-abdominal injuries (That is ruptured viscus, haemoperitoneum, retroperitoneal haemorrhage), pelvic and long bone fractures and significant blood loss should be looked for and assessed. These injuries may cause death more rapidly than will the burn itself\(^{(1,11,13)}\).

X-rays of the cervical spine, pelvic, and chest should be taken. This will help in evaluation of possible blunt trauma. Before transfer adequate ventilation should be maintained and any constricting eschar released\(^{(14)}\).
EMERGENCY TREATMENT OF INHALATION INJURIES

Inhalation injury is the major determinant of mortality in burn injuries. Treatment is nonspecific and supportive only. Early intubation and monitoring of arterial blood gases including carboxy haemoglobin must be done and 100% oxygen administered (11, 13, 15, 16).

ESCHAROTOMY

Circumferential burns to limbs with eschar formation lead to compartment syndrome and or distal ischaemia with necrosis. In the extremities, pulses in the fingers and toes can be assessed using Doppler apparatus or gauge 16 needle prick, where a bright red drop of blood is a fairly reliable sign of adequate perfusion to distal digits. Slow or absent bleeding, or oxygen perfusion of <95% suggests diminished or absent arterial inflow and is an indication for emergency escharotomy.

Circumferential burns to the chest lead to reduced chest expansion and hence respiratory distress. Bilateral chest escharotomy along the anterior axillary lines is done using electrocautery or scalpel to incise the full length and depth of the eschar. Bleeding is controlled by direct pressure or topical haemostatic agents (11, 14).
Pre-transfer management (initial management) (1,15,27)

1. Intravenous line access + fluids 24 hour
2. Catheterization
3. Maintain output of urine at 30 to 50 cc/hour in adult or 0.5-1cc/kg/hour in children
4. Nasogastric tube for burns more than 20% of body surface area to relieve paralytic ileus
5. Analgesics and sedatives – Intravenous only
6. Tetanus toxoid
7. Keep warm and monitor patients core temperature
8. Cover burn wound with clean sterile dressing

SELECTING PATIENTS FOR OUTPATIENT BURN CARE (11,14,26)

There must be no question of airway compromise.

The wound must be less than 10% of body surface area so that fluid resuscitation is unnecessary and the patient must be able to take adequate fluids by mouth.

The patient and their families must have the resources (including socio-economic) to support an outpatient care plan.

The caregivers must be able to understand and follow the wound care and pain control plans as instructed in the clinic.

Outpatient care is contraindicated if there is any suspicion of child abuse regardless of injury severity.
CLASSIFICATION OF BURNS BASED ON DEPTH

Burns depth is defined based on the depth of coagulation necrosis into epidermis and dermis (recognizing that the anatomical depth may change with wound conversion\(^9,13,17\)).

- **SUPERFICIAL BURNS (1\(^{st}\) degree)** - Involves the entire epidermis to the basement membrane. Rapid re-epithelialization occurs in 3-6 days because a large number of epithelial cells remain with a good blood supply; there is a very small zone of injury or stasis beneath the burn wound. It is commonly caused by Ultra violet light and a very short flash of flame exposure, it appears dry and red, and blanches with pressure and leaves no scarring on healing.

- **SUPERFICIAL PARTIAL THICKNESS BURN (2\(^{nd}\) degree superficial)** - It is commonly caused by scald (spill or splash) and short splash; appears as blisters, moist red and weeping; blanches with pressure. It is usually painful, heals from 7 to 14 Days. Scarring is unusual and there are potential pigment changes. It involves the whole of the epidermis up to middle third of dermis.

- **DEEP PARTIAL THICKNESS BURN (2\(^{nd}\) degree deep)** - Involves the entire epidermis and 2/3 of the dermis leaving very little epidermal cells and dermis to regenerate. It is commonly caused by scald, flame, chemical, oil and grease. Appears as blisters which are easily unroofed; wet or waxy dry; variable colour (Patchy to cheesy white to red) and doesn't blanch with pressure. There is
perception of pressure only and healing takes more than 21 days with severe scarring and risk of contractures.

FULL THICKNESS BURN (3\textsuperscript{rd} degree); - Both layers of the skin are completely destroyed leaving no cells to heal except for the fibroblast for scar formation. Scald, flame, steam, oil, grease, chemicals and high voltage of electricity cause it. Skin appears waxy white to leathery, grey to charred and black, dry and inelastic, it doesn't blanch with pressure. Sensation is only by deep pressure. It never heals if it affects more than 2\% of the total body surface area and has a high risk of contracture and scarring, they require excision and grafting.
EXTENT OF BURNS \(^{(1,5)}\)

The extent of a burn is expressed as the total percentage of Total Body Surface Area (TBSA) affected by the injury. Accurate estimation of a burn is essential to guide management. In paediatrics we use Lund and Browder methods/charts, which covers all age groups (see table below) \(^{(1,9)}\).

<table>
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<tr>
<th>Area</th>
<th>Birth to 1 year</th>
<th>1-4 years</th>
<th>5-9 years</th>
<th>10-14 years</th>
<th>15 years</th>
<th>Adult</th>
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<td>Ant. trunk</td>
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In adults, Wallaces' rule of nine is used as shown in the table below

<table>
<thead>
<tr>
<th>Each upper limb</th>
<th>9%</th>
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<td>Anterior trunk</td>
<td>18%</td>
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<tr>
<td>Posterior trunk</td>
<td>18%</td>
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<tr>
<td>Head and neck</td>
<td>9%</td>
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<tr>
<td>Perineum</td>
<td>1%</td>
</tr>
<tr>
<td>Each lower limb</td>
<td>18%</td>
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GRADING SYSTEM FOR BURN SEVERITY AND DISPOSITION OF PATIENTS BY AMERICAN BURN ASSOCIATION: (9,17,18.)

- **MINOR BURN;** - These are burns less than 15% total burn surface area in adult or less than 10% total burn surface area in young or old and less than 2% full thickness burn; disposition is outpatient management.

- **MODERATE BURNS;** - The criteria is;
  - 15 - 25 % total body surface area burnt in adult.
  - 10 - 15% total body surface area burnt in young or old.
  - 2 - 5 % total body surface area full thickness burn
  - Suspected inhalation injury
  - Concomitant medical problem predisposing the patient to infection eg. Diabetes and sickle cell disease.
  - Circumferential burns

The disposition of moderate burn is hospital admission.

- **MAJOR OR SEVERE BURNS;** - The criteria is;
  - More than 25 % total body surface area burnt in adult
  - More than 15% total body surface area burnt in young and old
  - More than 5% full thickness burns.
  - High Voltage burn.
  - Known inhalation injury.
- Any significant burn to face, eyes, ears, genitalia or joints, significant associated injuries e.g., fractures and other major trauma.

Disposition is referral to burn centre.

- INHALATION BURNS

Inhalation burns lead to pulmonary insufficiency and is responsible for more than 75% of fire-related deaths. Because of progressive oedema, patients should be intubated at initial management. Physical findings that raise concern about inhalation injuries include, coughing, wheezing, dyspnoea, facial burns sooty mucus and laryngeal oedema (16,19,20).

Fibre-optic bronchoscopy or xenon ventilation-perfusion scanning results are more accurate in making early diagnosis of inhalation injury; and either of the above should be performed if the diagnosis of injury is in doubt (16,19,20).

Patients with the risk of inhalation injury should be checked for carbon monoxide poisoning. Arterial carboxyhemoglobin level of greater than 25% tends to indicate carbon monoxide exposure, and is treated by oxygen (16,19,20).
INDICATIONS FOR ADMISSION.

The criterion according to the American Burn Association are\(^{(1,11,17)}\):

- 2\(^{nd}\) and 3\(^{rd}\) degree burns more than 10 % of body surface area in patient less than 10 years and more than 50 Years.
- 2\(^{nd}\) and 3\(^{rd}\) degree burns more than 20 % body surface area in other groups.
- 2\(^{nd}\) and 3\(^{rd}\) degree burns with serious threat of functional or cosmetic impairment that includes the face, hands, feet, genitalia, perineum and major joints.
- 3\(^{rd}\) degree burns more than 5 % body surface area in any age group.
- Electrical burns including lightning injuries.
- Chemical burns with serious threat of function or cosmetic impairment.
- All inhalation burn injuries.
- Circumferential burns of the limbs.
- Burn injury in patients with pre-existing medical disorders that could complicate management, prolong recovery or affect mortality.
- Any burn with concomitant trauma e.g. fracture bones in which the injury poses the greatest risk of morbidity or mortality.
- Referring centre without qualified personnel or equipment for the care of children.
PHYSIOLOGIC RESPONSE TO BURN INJURY:
Burns patients with or without inhalation injury commonly manifest an inflammatory process involving the entire organism (The SIRS – Systemic Inflammatory Response Syndrome). Most common cause of SIRS is burn sepsis.

A. **BURN SHOCK**

Hypovolemic shock and tissue trauma result in formation and release of local and systemic mediators which produce an increase in vascular permeability or an increase in microvascular hydrostatic pressures.

1. Most mediators act to increase permeability by altering venular membranes integrity.

2. Early burn edema lasting from minutes to an hour is attributed to mediators such as histamine, bradykinin and vasoactive amines, products of platelet activation and the complement cascade of hormones, prostaglandins and leukotrienes.

3. Serotonin is released immediately upon post burn platelet aggregation and acts directly to increase pulmonary vascular resistance and indirectly to amplify the vasoconstrictive effects of non-epithelial histamine, angiotensin II and prostaglandin.

4. Bradykinin increases vascular permeability primarily in the venule

5. Platelet activation factor is released after burn injury and increases capillary permeability.

6. The reduction of cardiac output after burn injury is the result of
hypovolemic and cellular shock, increased systemic vascular resistance due to sympathetic stimulation and hypovolaemia with release of catecholamines vasopressin, angiotensin II and neuropeptide Y.

7. After successful resuscitation, cardiac output normalizes after 19-24 hours and increases to supernormal levels during the wound healing phase of burn management

**B. METABOLIC RESPONSE TO BURN INJURY:**

1. **Hypermetabolism**

   Resting energy expenditure (REE) after burn injury can be as much as 100% above predictions based on standard tables for size, age, sex and weight. This is due to increased heat loss from burn wound and increased B-adrenergic stimulation. Radiant heat loss is increased from the burn wound secondary to high blood flow. Glycolysis, glycogenolysis and proteolysis are increased and proteins are excreted primarily in urine as urea. Contributing to the progressive depletion of body protein stores, protein intake of over 1g/kg/day has been recommended for thermally injured patients.

2. **Neuroendocrine-media response**

   Catecholamines are the major endocrine mediators of hypermetabolic response in thermally injured patients. Pharmacologic blockade of beta receptors diminishes the intensity of post burn hypermetabolism although this is not applied clinically.
C. IMMUNE RESPONSE TO BURN INJURY

After injury a number of cytokines are induced rapidly, which include Tumour Necrosis Factor (TNF), interleukin –1 (IL-1) and interleukin-6 (IL-6). TNF-α is detectable early in the period of burn shock. The maximum level of TNF-α throughout the course is of prognostic significance. The physiological effects of TNF are indistinguishable from endotoxin, hence the induction of TNF have been held responsible for the clinical effects of endotoxaemia. There is up-regulation of local production of IL-1 and IL-6 in inflammatory sites, inducing polymorphonuclear chemo-atraction.

1. For arachidonic acid cascade; the major product after thermal injury is prostaglandin E₂ (PGE₂); produced by macrophages and partially mediated by endotoxin; PGE₂ exerts its immunosuppressive effect primarily by inhibition of lymphocyte IL-2 production and T-cell activation and down regulation of IL-6.

2. Cell-mediated immunity is impaired after burn injury. These include documented delays in allograft rejection and impairment in mitogenic and anogenic responsiveness of lymphocytes.

3. The macrophage, B-cell and neutrophils functions are impaired following burns. These leads to the appearance of bacteraemia and pneumonia.

4. For hormonal immunity, after burn injury, there is a marked diminution of total serum IgG concentration and all subclasses. Levels return to normal between 10-14 days post burn and extremely low levels of IgG on admission are predictive of a poor prognosis. The low levels are due to combination of leakage through the burn wounds, protein catabolism and relative diminution in synthesis.
of IgG, IgM and IgA levels are relatively unaffected. The classical and the alternative complement pathways are depleted.

**MANAGEMENT OF BURNS:**

**Emergency care**

1. Care at the scene of injury is very important. Once flames are extinguished, initial attention is directed to the airway. Any patient rescued from burning or exposed to a smoky fire should be placed on 100% oxygen by tight-fitting mask if there is any suspicion of smoke inhalation. If the patient is unconscious and there is presence of trained personnel, endotracheal intubation should be done and connected to 100% oxygen source.

2. After securing the airway, intravenous access is gotten and fluids started if available, the patient is then rapidly examined for associated injuries. The patient is kept warm, flat and nil per oral. For transport, the patient is wrapped in a clean sheet and blanket. Before or during transport, constricting clothing and jewellery should be removed from body parts.

3. Small scalding burns are treated with immediate application of cool Water.

4. Once the patient arrives in hospital or emergency room, as with any form of trauma, ABC protocol of airway, breathing, circulation then overall assessment of the patient is done.
**Fluid resuscitation in emergency room**

Resuscitation begins by starting intravenous Ringer's lactate solution, Foley's catheter is inserted and urine output monitored hourly.

Tetanus prophylaxis is given and gastric decompression is done by nasogastric tube.

Pain control by intravenous route during shock period is initiated using morphine or pethidine and psychosocial care is begun immediately. After the above is done, the burn wound assessment is given attention. The size of the burn is calculated to establish the proper level of fluid resuscitation, wounds are wrapped in a clean sterile dressing and patient kept warm until he/she arrives at the definitive care centre.

**Transport and transfer protocols**

The transfer should be from physician to physician and contact should be established as soon as the patient arrives in the emergency room of the initial hospital.

The mode of transport depends on vehicle availability, local terrain, weather and the distance involved. For distance less than 80km, ambulance is usually satisfactory. Helicopter is usually preferred when distance is between 80-240km. Distance more than 240km, fixed wing aircrafts are most satisfactory. Any patient transported by air must have a nasogastric tube inserted and be placed in a dependent position since nausea and vomiting inevitably result during the flight.
20

**Fluid management.**

The necessity for fluid resuscitation have been appreciated for over a century ago but the magnitude of fluid loss was not apparent until studies of Frank Underhill of victims of theatre fire in 1921 and in 1952 Evans developed a burn surface area to weight formula.\(^\text{19}\)

Fluid changes that occur in burns, affect the volume in each compartment, with intracellular and interstitial volumes increasing at the expense of plasma volume and blood volume.

The primary goal of fluid resuscitation is to replace fluid sequestered as a result of thermal injury. Crystalloids are the fluids commonly used especially Ringer's lactate.

There are various formulas for estimating adult and paediatric burn patient resuscitation fluid needs. For adults, the most commonly used is the Parkland formula which is 4mls/kg/% burns in which \(\frac{1}{2}\) is given during first 8 hours and a similar amount in the next 16 and 24 hours respectively. Paediatric fluid requirement is slightly more than in adults and there are several formulas for estimation. On average, fluid requirement averages 5.8ml/kg/% BSA in Cincinnati Burn unit.

Fluid intake should be titrated against urine output; central venous pressure, blood pressure and pulse rate.
Management of moderate and severe burns

After initial quick history and physical examination, initial resuscitative measures are taken, that is airway, breathing and circulation. Give oxygen to all patients, intubate if there is airway respiratory or neurological compromise. Intubation is also indicated with deep fascial burns and inhalation injury documented by bronchoscopy or laryngoscopy. Put large bore IV cannula and start fluid resuscitation as shock is common in burns exceeding 10% BSA\(^{(17)}\).

Wound care

Sterile technique should be observed. Remove all clothing and cover or irrigate with cool saline, but be careful to avoid hypothermia. Debride dead material and ruptured vesicles; blisters should be left intact unless at flexor areas. Apply antimicrobial cream with a fine mesh absorbent dressing (no dressing to face and perineal burns) \(^{(11,15,18)}\).

Antibiotics creams used are:

- 1% silver sulfadiazine is the preferred first line preventive agent for eschar formation but not as ongoing treatment for deep burns (can cause thrombocytopenia, leukopaenia and rash).
- Neosporin or bacitracin are excellent for facial burns (non toxic to eyes) but should not be used on large areas.
- Mafenide acetate, penetrates eschar well but is painful during application and causes bicarbonate wasting.
Surgical management includes escharotomy, escharectomy, skin grafting and release of contractures.

**COMPLICATIONS:**

A. *Early and intermediate*

1. **Respiratory**
   
   - The incidence of pulmonary complications associated with burn injury is approximately 22% and mortality of this group is in order of 80%\(^{(26)}\). Early complications result from upper airway obstruction by oedema, bronchospasm and inhalation of toxic vapours.
   
   - As airway oedema subsides over 3-4 days after the injury, increased mucous production along with reduced ciliary activity combine to increase the risk of infection.
   
   - Detaching debris from small airway lead to obstruction and add to the shunt fraction.
   
   - Positive end expiratory pressure and continuous positive ambulatory pressure helps to keep airways patent and wheezing is treated with nebulized bronchodilators such as salbutamol.
   
   - Adult respiratory distress syndrome may develop in major burns possibly due to mediators released from the burn or resulting from inhalation injury damaging the pulmonary capillary-endothelial membrane
   
   - Thrombo-embolic phenomena is common in major burns patients due to multiple canulations, multiple operations, immobility for long periods and massive fluid shifts\(^{(28)}\).
2. **Cardiovascular.**
   - Hypovolaemia is the commonest complication due to shift in fluid distribution; its avoided by careful fluid replacement.
   - In the first few hours after a major burn injury, the myocardium is depressed by factors released into the plasma\(^9\) and vasculature loses it integrity. This is managed by ionotropes.
   - Ischaemia of extremities following circumferential burns which compromise blood supply is prevented by doing early escharotomy.
   - Complication following vascular cannulation such as endocarditis, phlebitis and septicaemia from infected catheters.

3. **Endocrine**
   - Impaired glucose tolerance is a common feature due to raised levels of catecholamines and cortisol.
   - Adrenal insufficiency occurs in some patients with severe shock due to hypovolaemia or sepsis.
4. **Haematological**\(^{(23)}\)

- Both hyper-coagulability and hypocoagulability are seen in patients who have sustained major burns.
- Anaemia is due to thermal damage to red blood cells and repeated operations, gastrointestinal bleeding, bone marrow suppression due to infection and toxins, decreased erythropoiesis, repeated blood sampling and frequent wound dressing. Transfusion may be necessary to keep the haemotocrit above 0.3 and ensure adequate oxygen transport\(^{(23)}\).
- Depression of both cellular and humoral immunity occurs following burns and leads to increased susceptibility to infection\(^{(23)}\).

5. **Gastrointestinal tract**

- Paralytic ileus due to electrolyte imbalance particularly hypokalaemia,
- Acalculus cholecystitis\(^{(24)}\) occurs due to dehydration, prolonged ileus, sepsis, blood transfusion, decreased tissue oxygenation\(^{(7)}\) and superior mesenteric artery syndrome.
- Pancreatitits may occur due to hypoperfusion vascular changes, decreased gut motility or part of a sepsis syndrome
- Gastric and duodenal ulceration occurs in over 20% of burned patients. Its prevented by H-2 receptor antagonists e.g. Intravenous ranitidine 0.125 mg/kg/hr infusion\(^{(17)}\).
Liver dysfunction occurs in burned patients with the highest incidence being in those with largest burn surface areas. Hepatocellular injury results in raised transaminases, alkaline phosphatase and bilirubin levels.

6. Renal, fluid and electrolytes.

- Acute renal failure occurs following hypovolaemia, with acute tubular necrosis, haemoglobinuria and myoglobinuria. Its reduced by prevention of hypovolaemia and maintenance of adequate urine output.
- Electrolyte imbalance can occur in the immediate resuscitation period as large volume of fluids are given or later if parenteral nutrition is required or gastrointestinal complications supervene.
- Hyponatraemia and hyperkalaemia is seen if fluid is lost into the gut. Hypocalcaemia, hypophosphataemia and hypermagnesaemia are the consequences of major burn injury.
- Trace elements including zinc are depleted in major burns.
B. Late complications

Occur and are related to scar formation, they include:

a. Hypertrophic scar formation which develops in deep 2nd burns and 3rd degree burns that are allowed to heal by secondary intentions. They are prevented by early excision of eschar and grafting.

b. Keloid formation, are treated by excision and primary closure with steroid injections or radiotherapy for broad based keloids.

c. Itching is common on healed scars and early intervention is important. Lotions and medications such as antihistamines may be used to treat the area.

d. Open wounds resulting in pain and scarring managed by wound care and debridement and skin grafts.

e. Painful scars when they occur are managed by silicon gel sheets, placed underneath compression garments, massage and medication such as steroids to relieve pain. For very painful scar, surgical removal is indicated.

f. Contractures result from the scarring and eventual narrowing of burned area resulting in loss of range of motion. This may be prevented by physiotherapy.

g. Generalised peripheral neuropathy may occur during the first few weeks post-injury. This condition may manifest itself as pain, numbness, tingling, swelling or blushing in the upper and/or lower extremities. It is
diagnosed by electromyography, muscle testing or nerve conduction studies. It is treated by physiotherapy and splinting to prevent contractures.

h. Heterotopic ossification is a condition where new bone forms in the connective tissues and muscles surrounding joints. It is diagnosed by x-ray and physiotherapy and occupational therapy may assist in recovery by increasing range of motion as much as possible. Splinting may also be recommended. If treatment is unsuccessful, surgery may be required, followed by therapy.

i. Marjolin’s ulcers may develop even up to 20 years post burn and lead to malignant degeneration with squamous cell carcinoma as the most common tumour and is managed by wide excision and skin grafting.

j. Other late complications that may follow include osteomyelitis, scoliosis, reflex sympathetic dystrophy and sleep disturbances.
STUDY JUSTIFICATION

Having been exposed to the extent of burn problem in children who are managed at KNH burn wards I realised how difficult, expensive and traumatizing it is to the child during treatment. I also realised that burns are the most common cause of trauma at home that can best be managed by prevention. With the rapid industrialisation and population increase in our city, the multiplicity of types of burn injuries is bound to increase. I also noticed that no prospective study had been carried out for paediatric thermal burns for comparison with other centres. Hence this gave me the challenge to try and find out the epidemiology of paediatric thermal burns with the aim of coming up with ways of preventing them.
OBJECTIVES OF THE STUDY

Main objective:
Presentation, causes and management of thermal burns in paediatrics age group as seen at Kenyatta National Hospital.

Specific objectives:
1. To determine the demographic pattern and causes of thermal burns.
2. To determine the complications encountered during management.
MATERIAL AND METHODS

Study design:

This was a descriptive hospital based prospective study of patients upto 12 years. It commenced on 25 August 2003 after approval by the Kenyatta National Hospital Ethical and Research Committee on 20/8/2003 and concluded on 2/12/2003.

Patients admitted with burns underwent a full physical examination and a detailed extent of burned body surface area was documented. Baseline haemogram and urea and electrolytes were recorded and repeated where it was necessary. Also documented was treatment given and type of surgery done which basically included escharotomy, escharectomy, disarticulation/amputation and or skin grafting.

The plastic surgical team which included consultants and senior house officers decided specific and subsequent management of each patient during ward rounds and other discussions that followed. This was in line with international recognised management protocols on a case-by-case basis.

Patients were enrolled on the day of admission or the following morning and reviewed weekly till time of discharge or for a minimum of four weeks if still in the wards at the time of conclusion of the study. Eight patients were still in the ward when the study was concluded but had been followed up for more than 4 weeks.

The research was undertaken by the author with the help of one research assistant trained by the author.
Study area

The study was conducted at the Kenyatta National Hospital, the first of the two national referral hospitals in Kenya and a teaching hospital of the University of Nairobi; it was conducted in burnt patients admitted in ICU, Burns Unit and Ward 4D.

SAMPLING TECHNIQUE AND SAMPLE SIZE

The sample size was estimated using the following formula:

\[ N = \frac{Z^2 \times P \times (1-P)}{D^2} \]

Where:
- \( N \) = sample size to be determined
- \( P \) = Prevalence of thermal burns
  
  (90% thermal, 10% is electrical and chemical burns)
- \( Z \) = standard errors from the mean corresponding to 95% confidence level.
- \( D \) = Absolute precision [0.05]

\[ N = \frac{1.645 \times 0.1 \times 0.9}{(0.05)^2} = 97 \]

A total of 101 patients were recruited for the study.

Inclusion criteria

All patients admitted to Ward 4D, Burns Unit and ICU aged less than 12 years and whose relatives consented were included in the study.
Exclusion criteria

- Patients more than 12 years of age
- Patients whose parents or guardians refused to give consent

DATA COLLECTION

Data was collected on a pre-designed data collection form (appendix 2). Relevant history was taken from the parents/guardians. The files were scrutinized for the laboratory results and wound evaluation was done by the researcher and compared with independent assessment by the ward staff reflected in the files.

STUDY SHORTCOMING

The limitations were lack of standardization in clinical assessment, which was subject to individual bias.

DATA ANALYSIS

Data analysis was done using SPSS (Statistical Package for Social Sciences) version 11.0 computer software, and results presented in form of tables and figures.
ETHICAL CONSIDERATIONS AND CONFIDENTIALITY

The research proposal was submitted to the Kenyatta National Hospital Ethical and Research Committee for approval before embarking on the study. Patients were recruited after signing an informed consent form (appendix 1). This was signed after the parent/guardian read and understood the consent explanation form. All patients' information was treated with strict confidentiality and used only for the intended purpose.
RESULTS

A total of 101 Patients were seen during the period of August 2003 and November 2003.

Table 1: Age Distribution

<table>
<thead>
<tr>
<th>Age group (Years)</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>72</td>
<td>71.3</td>
</tr>
<tr>
<td>3-6</td>
<td>16</td>
<td>15.8</td>
</tr>
<tr>
<td>6-9</td>
<td>11</td>
<td>10.9</td>
</tr>
<tr>
<td>9-12</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>

The age range was from 3 weeks to 12 years with a mean age of 34.45 months.

Figure 1: Gender Distribution.

Table 2: Distribution of area of residence by Province

<table>
<thead>
<tr>
<th>Province</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nairobi</td>
<td>73</td>
<td>72.3</td>
</tr>
<tr>
<td>Central</td>
<td>22</td>
<td>21.7</td>
</tr>
<tr>
<td>Western</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rift Valley</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Eastern</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 2: Distribution by level of education of the patients

![Bar chart showing distribution by level of education](chart.png)

Majority of the patient were not in school, accounting for 71.3%, those in pre-unit and nursery accounted for 11.9% while those in primary school accounted for 15.85%.

Table 3: Distribution of education background of responsible adult at time of burn

<table>
<thead>
<tr>
<th>Education</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>No formal education</td>
<td>4</td>
<td>4.0</td>
</tr>
<tr>
<td>Primary</td>
<td>64</td>
<td>63.3</td>
</tr>
<tr>
<td>Secondary</td>
<td>31</td>
<td>30.7</td>
</tr>
<tr>
<td>College/University</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 4: Distribution by monthly income

<table>
<thead>
<tr>
<th>Income</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2001-4000</td>
<td>26</td>
<td>25.8</td>
</tr>
<tr>
<td>4001-6000</td>
<td>35</td>
<td>35.7</td>
</tr>
<tr>
<td>6001-8000</td>
<td>17</td>
<td>16.7</td>
</tr>
<tr>
<td>8001-10000</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>10001-12000</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>12001-14000</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>14001-16000</td>
<td>2</td>
<td>1.0</td>
</tr>
<tr>
<td>16001-18000</td>
<td>3</td>
<td>3.0</td>
</tr>
<tr>
<td>Undisclosed</td>
<td>8</td>
<td>7.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>101</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Note that 1 US Dollar was exchanging at a rate of Ksh 76 at the time of study.

Table 5: Distribution per size of the house

<table>
<thead>
<tr>
<th>Size of the house</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single room</td>
<td>54</td>
<td>53.5</td>
</tr>
<tr>
<td>Single room with separate kitchen</td>
<td>34</td>
<td>33.7</td>
</tr>
<tr>
<td>2 rooms with separate kitchen</td>
<td>9</td>
<td>8.9</td>
</tr>
<tr>
<td>2 or more bedrooms with separate kitchen</td>
<td>4</td>
<td>4.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>
Figure 3: Distribution of place of burn

Table 6: Distribution as per time of burn

<table>
<thead>
<tr>
<th>Time</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.01am-12.00pm</td>
<td>28</td>
<td>27.7</td>
</tr>
<tr>
<td>12.01pm-6.00pm</td>
<td>24</td>
<td>23.8</td>
</tr>
<tr>
<td>6.01pm-12.00am</td>
<td>49</td>
<td>47.5</td>
</tr>
<tr>
<td>12.01am-6.00am</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 7: Distribution by ward of admission

<table>
<thead>
<tr>
<th>Ward</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICU</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Burns unit</td>
<td>13</td>
<td>12.9</td>
</tr>
<tr>
<td>Ward 4D</td>
<td>83</td>
<td>82.1</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 8: Distribution by time taken to arrive at the hospital

<table>
<thead>
<tr>
<th>Time (hours)</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6</td>
<td>75</td>
<td>74.2</td>
</tr>
<tr>
<td>6-12</td>
<td>14</td>
<td>13.9</td>
</tr>
<tr>
<td>12-24</td>
<td>8</td>
<td>7.9</td>
</tr>
<tr>
<td>&gt; 24</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 9: Distribution of causes of burns

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalds</td>
<td>70</td>
<td>69.3</td>
</tr>
<tr>
<td>Open flame</td>
<td>27</td>
<td>26.7</td>
</tr>
<tr>
<td>Contact with object</td>
<td>4</td>
<td>4.0</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 4: Distribution of scalding Burns
Table 10: Distribution of scalding burns

<table>
<thead>
<tr>
<th>Type of scald</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splash</td>
<td>52</td>
<td>74.3</td>
</tr>
<tr>
<td>Immersion</td>
<td>18</td>
<td>25.7</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 11: Distribution of Causes of scalding

<table>
<thead>
<tr>
<th>Causes</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot water</td>
<td>50</td>
<td>71.3</td>
</tr>
<tr>
<td>Hot tea/porridge</td>
<td>14</td>
<td>20.0</td>
</tr>
<tr>
<td>Hot oil</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Hot milk</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Hot food</td>
<td>2</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 12: Distribution of burns as per region of body involved

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper limbs</td>
<td>72</td>
<td>71.3</td>
</tr>
<tr>
<td>Trunk</td>
<td>64</td>
<td>63.4</td>
</tr>
<tr>
<td>Head/neck</td>
<td>44</td>
<td>43.6</td>
</tr>
<tr>
<td>Lower limbs</td>
<td>44</td>
<td>44.6</td>
</tr>
</tbody>
</table>

NB: Many patients had more than one region of the body involved.
Table 13: Distribution as per special areas of body

<table>
<thead>
<tr>
<th>Area</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major joints</td>
<td>77</td>
<td>76.2</td>
</tr>
<tr>
<td>Hands</td>
<td>37</td>
<td>36.6</td>
</tr>
<tr>
<td>Face</td>
<td>36</td>
<td>35.6</td>
</tr>
<tr>
<td>Feet</td>
<td>11</td>
<td>10.9</td>
</tr>
<tr>
<td>Perineum</td>
<td>9</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Table 14: Distribution as per the percentage body surface area involved

<table>
<thead>
<tr>
<th>Body surface</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10%</td>
<td>58</td>
<td>57.4</td>
</tr>
<tr>
<td>11-15%</td>
<td>19</td>
<td>18.8</td>
</tr>
<tr>
<td>16-20%</td>
<td>10</td>
<td>9.9</td>
</tr>
<tr>
<td>21-25%</td>
<td>6</td>
<td>5.9</td>
</tr>
<tr>
<td>26-40%</td>
<td>6</td>
<td>5.9</td>
</tr>
<tr>
<td>&gt;41%</td>
<td>2</td>
<td>2.0</td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 5: Distribution according to the depth of the wound

- Full thickness: 19.8%
- Superficial burns: 5.9%
- Partial thickness: 74.3%
Figure 6: Distribution of patients with suspected inhalation injuries.

Table 15: Distribution of complications encountered

<table>
<thead>
<tr>
<th>Complication</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burn wound infection</td>
<td>72</td>
<td>71.3</td>
</tr>
<tr>
<td>Itching</td>
<td>62</td>
<td>61.4</td>
</tr>
<tr>
<td>Anaemia</td>
<td>28</td>
<td>27.7</td>
</tr>
<tr>
<td>Electrolyte imbalance</td>
<td>22</td>
<td>21.8</td>
</tr>
<tr>
<td>Hypovolaemic shock</td>
<td>13</td>
<td>12.9</td>
</tr>
<tr>
<td>Respiratory distress</td>
<td>10</td>
<td>9.9</td>
</tr>
<tr>
<td>Hypertrophic scar</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Paralytic ileus</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Death</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Table 16: Distribution of patients put on antibiotics, analgesics, warming

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotics</td>
<td>99</td>
<td>98</td>
</tr>
<tr>
<td>Analgesics</td>
<td>101</td>
<td>100</td>
</tr>
<tr>
<td>Warming</td>
<td>32</td>
<td>31.7</td>
</tr>
</tbody>
</table>
### Table 17: Distribution of surgical management by week

<table>
<thead>
<tr>
<th>Surgical management</th>
<th>wk 1</th>
<th>wk 2</th>
<th>wk 3</th>
<th>wk 4</th>
<th>wk 5</th>
<th>wk 6</th>
<th>Wk 7</th>
<th>wk 8</th>
<th>Total</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Escharotomy</td>
<td>26</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>26</td>
<td>25.7</td>
</tr>
<tr>
<td>Escharectomy</td>
<td>8</td>
<td>7</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>18</td>
<td>17.8</td>
</tr>
<tr>
<td>Debridement</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Skin Grafting</td>
<td>-</td>
<td>7</td>
<td>2</td>
<td>13</td>
<td>9</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>36.6</td>
</tr>
<tr>
<td>Amputation/disarticulation of digits</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>
DISCUSSION

There were a total of 101 patients aged between 2 weeks and 12 years with a mean age of 34.45 months admitted during the study period (table 1). 71.3% were aged under 3 years with children aged 3-6 years accounting for 15.8%, 6-9 years accounted for 10.9% and 9-10 years accounted for 2%. This is because it is thought pre-school children spend most of their wakeful time at home near fire (JHA-S.S)\(^{(28)}\). It is difficult to know the true incidence since only the severely injured were admitted and those with involvement of special areas of the body.

Males are slightly more at risk of sustaining burn injuries (55.4%) (figure 1) as opposed to females 44.6%. This is comparable with Okonjo's finding in 1989\(^{(9)}\), who noted that males accounted for 53.5% and Wanjeri's finding in 1995 (58.5%)\(^{(34)}\). It is thought that the male toddler is more clumsy and inquisitive than his female counterpart as suggested by Okonjo\(^{(9)}\) and JHS S.S.\(^{(28)}\).

Seventy two point three percent of the patients lived in Nairobi with 21.7% coming from Central Province (table 2). This is because Kenyatta National Hospital serves as both referral and local hospital for most of Nairobi residents and other areas neighbouring Nairobi due to inefficiency of most government health institutions. Only 6% were referrals from other provinces (Western 1%, Rift Valley 2% and Eastern province 3%).
Seventy one point three percent of children had not yet enrolled in school (figure 2) with those in nursery and pre unit accounting for 11.9% and primary school 15.85%.

Seventy six percent of responsible adults at time of burn had formal education. 64% had primary level education, 30.7% secondary and 2% were graduates of colleges and universities (table 3). However, 4% had no formal education. Maleche (34) had noted that upto 80% of children were left with maids most of who are primary school leavers. Any preventive education given should be made simple and easy to understand since majority of the responsible adults are primary school leavers.

The total gross monthly income for most (35.7%) of the patients’ parents fell within kshs. 4001-6000 monthly wage bracket, with 27.8% earning less than kshs. 4000. Seven point nine percent (7.9%) refused to disclose the total monthly gross income while the rest earned between Kshs 6001 to 18000 (table 4). This shows that many of the patients’ parents are low income earners and may tend to live in small overcrowded rooms where children are prone to accidents.

Fifty three point five percent of patients came from families living in single rooms with 34% living in single rooms with a separate kitchen (table 5). As the size of the house increased the incidence of burns decreased. This directly correlates with the monthly income, the higher the income the lesser the incidence of
burs. There was increased risk of injury where families lived in single rooms which served as kitchen, living room and sleeping quarters.

Ninety three point one percent (figure 3) of all the burn injuries occurred at home while the rest 6.9% occurred within the neighbourhood. This is because majority of the children are less than 3 years and spend most of the time in the house. This correlates well with other studies Forjuoh et al. (39) noted that 92% of 630 children aged 9 months to 5 years in Ghana occurred at home and Muguti (41) reported 90% of 297 children sustained burns at home in Zimbabwe’s Mpilo Hospital.

Forty seven point five percent of the children got burned late in the evening and 27.7% in the morning with 23.8% occurring in the afternoon and non reported after midnight. This could be because most burns injuries occur around the time when meals are being prepared. Forjuoh et al. (40) had similar observation in his study of 630 patients aged 0-5 years in Ashanti Ghana in 1995.

Eighty three percent of all the patients landed in ward 4D with Burns Unit having 12.9% and ICU 5%, meaning that only 17.9% came in critical condition (table 7).

Seventy four point two percent (74.2%) of the patients arrived at the hospital within 6 hours after sustaining burns (table 8), 13.9% within 6-12 hours and 7.9% between 12-24 hours. 96% had arrived within 24 hours, 4% came after 24 hours and were mainly referrals from other hospitals. Forjuoh S.N. (40) reported that
68% of the patients presented within 24 hours of injury. This is because the nature of burn injury is dramatic, scaring to the relatives and associated pain to the victim will make people seek early medical help. In this study many patients came from Nairobi and its environs which are served by a fairly efficient transport system (table 2). This is important for resuscitation is likely to be done in good time.

Scalds were the commonest form of thermal injury in this study (table 9) accounting for 69.3% followed by open flame burns with 26.7% and contact with hot object accounting for 4.0%. The compares well with other studies, Muguti in his study of 297 patients in Bulawayo Zimbabwe reported that scalds accounted for 58% and open flame 15%. Forjouh reported scalds in 45%, contact burns 34% and open flame 20% in Ghana. Boukinand reported scalds in 69.1%, open flame in 15.2% all in paediatric age group. This is because most of the burns occur at home around the time when meals are being prepared (table 7) as seen earlier.

Splash burns are the commonest form of scalds accounting for 52 patients (74.3%) while 18 patients (25.7%) suffered from immersion burns (table 10). Among the causes of scalds, hot water accounted for 71.3% while hot food and other edibles including beverages accounted for 28.7% (table 11). This was comparable with Maleche's observation who reported hot water scalds to be the commonest which however in his study accounted for 48.3%.
In this study, (71.3%) patients had involvement of upper limbs, followed by trunk with 64 patients (63.4%), lower limbs and head and neck accounted for 44 patients (43.6%) each (table 12). This is expected since scalds are the commonest and children will grab the container with their hands spilling the contents onto themselves from the upper limbs, trunk and to the rest of the body.

In this study, special areas of the body involved (table 13), show that major joint involvement had most patients with 77 (76.2%) patients followed by hands 37 (36.6%) patients and face 36 (35.6%) patients respectively. Feet involvement accounted for 11 (10.9%) patients and perineum accounted for 9 (8.9%) patients. Special areas of the body have a functional and cosmetic significance that far exceeds their size and physiologic importance as noted by Robert L. Sheridan, hence the need to admit them for studied approach in their wounds management.

This study showed that the majority of children, 58 (57.4%) had burn surface area equal or less than 10% and 19 (18.8%) had 11-15%, 10 (9.9%) patients had 16-20%, 6 patients had 21-25%, 6 patients had 26-40% and 2 patients had more than 40% (table 14). The number of patients decreased as the burn surface area increased. This is opposite to what Maleche observed in his study, where he reported 34.6% of the patient to have < 10% with 65.6% having burn surface area of > 10% of the body.
In categorization of burn wound by depth, partial thickness had 74.3% of the patients followed by full thickness with 19.8% and superficial burns accounted for 5.9% (figure 5). This also contrasts with Maleche’s\(^{34}\) finding where he only reports superficial and deep burns accounting for 68.7% and 31.3% respectively.

Patients with suspected inhalation injuries accounted for 10.9% (figure 6). It is important to have a high index of suspicion for possible inhalation injuries and a relevant history sort, physical evaluation and important laboratory tests done. Zhang H. et al\(^{47}\) in his analysis of 333 cases of inhalation injuries showed an incidence of 12% (comparable with this study’s finding) and also reported high incidence of mortality due to shock and bacteraemia, 41.14% and 18.92% respectively and recommended early endotracheal intubation’s and use of antibiotics.

Table 15 shows a list of complications encountered. Burn wound infection accounted for 71.3% which is comparable to Wanjeri’s\(^{35}\) findings of 66.3%. Many patients had itching 61 (61.4%) with 28 (27.7%) developing anaemia due to burns. These findings indicate that there has not been improvement of infection control measures.

Electrolyte imbalance was reported in 22 (21.8%) patients.
Shock was reported in 13 (12.9%) patients of all patients on admission and 10 (9.9%) patients had respiratory distress. Three had developed hypertrophic scars before the study was over and one had paralytic ileus which was corrected by rehydration and correcting the electrolyte imbalance.

Death occurred in 3 patients (mortality rate of 3%) over the study period, with burn surface area of 100%, 26% and 20%. Wanjeri\(^{(35)}\) had reported a mortality rate of 10% with mortality rate increasing with increase in total burn surface area. Earlier, Okonjo\(^{(9)}\) had showed a mortality rate of 36.2% at Kenyatta National Hospital. At that time burn patients were admitted in all general surgical wards. This reduced mortality may reflect on better care of burn patients at Kenyatta National Hospital with their removal from the general surgical wards to a more skilled unit. Iregbulem\(^{(44)}\) had reported a mortality rate of 9.87% in Nigeria and Muguti\(^{(41)}\) had reported a mortality rate of 2% in Zimbabwe. Many other reports had different mortality rates; this is expected since burn centre management protocols tend to differ. It’s also not possible to predict the pattern of severity of burn injuries occurring at any given time.

Ninety eight percent of all patients admitted were put on antibiotics. All patients were put on topical, and either oral or parenteral antibiotics. All patients were put on analgesics and 31.7% of patients had warming by a heater done especially those in ICU and ward Burn’s Unit. Burn injury is a painful condition and almost all the authors referred to recommend use of analgesics. Many authors
recommend the use of topical antibiotics but use of oral and parenteral antibiotics is controversial. Many western authors recommend use of oral/systemic antibiotics when sepsis sets in. At KNH, use of oral or parenteral antibiotics is almost routine to reduce the rate of cross infection and nosocomial infections since it is not possible to nurse our patients in isolation.

There were a number of surgical procedures done as depicted in table 17, 26 patients had escharotomy done, mainly within first week of admission. These were done emergencies under nothing at the time of admission to prevent mainly ischaemia of extremities.

Eighteen (17.8%) patients had escharectomy done within the first 3 weeks. This was important so as to clear infection pockets and encourage granulation of the wound.

Skin grafting was done on 37 patients or 36.6%, the rest were managed conservatively. Many of the patients were grafted on week 4 (13 patients), none on week 1 and 7 patients on week 2.

Early tangential excision is recommended by many authors and Milo Y\(^{(43)}\) in Tel Aviv showed that early excision and skin grafting on day 5 lead to reduced morbidity and mortality, had better aesthetic results and improved motor function.

In his study of 421 patients in 1993 whom 37% were treated surgically and the
rest were treated conservatively. He also showed that those treated surgically by early tangential excision and grafting tended to have shorter stay in hospital.

Four patients had amputation and disarticulation of digits. In week 3 one patient, in week 4 two patients and in week 5 one patient. This shows that there was a determined effort for conservative management, which is important in the pediatrics age group. The procedure, was carried out only when dry gangrene ensued. It also shows that escharotomy done early are quite successful in preventing distal ischaemia and should be carried out on all circumferential burns.

Surgical debridement was carried out on 1 out of 9 patients admitted with infected burn wound.
CONCLUSIONS

- Paediatric thermal injuries are common with pre-school children less than 3 years are affected most.
- Males are affected slightly more commonly than females in the ratio of 1.2:1.
- Many adults catering for children have formal education with majority having primary school education.
- Many of the parents of affected children are grossly underpaid, live in small houses of single rooms and are of low social economic status.
- Most of the children are burned in the house they live in, around the time when meals are prepared and scalds are the commonest with hot water being the single most major cause of scalds.
- Many patients arrive at the hospital relatively early.
- Splash burns are the commonest form of scald burns in this study with the limbs being the area of the body affected most suggesting that the children actually pull the hot liquid container towards themselves.
- Special areas of the body are commonly affected hence the higher incidence of patients admitted with small areas of body surface area burned of less than 10% in our wards.
- Inhalation injuries in this study had a high incidence hence the need to take full history and a detailed physical examination cannot be
overemphasized because of the high rate of mortality associated with it if it is not detected early enough for intubation.

- Wound sepsis, anaemia and itching were the commonest complications encountered in this study.
RECOMMENDATIONS

- Preventive health care programmes targeting the adults who take care of children should be formulated and advocated both in the media, community meetings and health institutions when mothers are attending maternal and child health care clinics. They should be made simple and easy to understand since majority of the people taking care of the children have primary school level of education.

- The building code\(^{(48)}\) should be adhered to during construction of residential houses to give families better houses with more space to live in at a time like this when more residential houses are coming up.

- Effect of escharotomy on limbs and early tangential excision and skin grafting should be studied.

- More prospective studies detailing social economic studies and specific regions with the highest incidence is recommended.

- Prospective study to show the pattern of long term complications and success of the rehabilitation is recommended.

- Training of more health personnel and organizing continuous medical education workshops on basic skills of handling burn patients and ways of propagating preventive measures.
APPENDIX 1

CONSENT EXPLANATION

My name is Dr Mung’ara G Mburu. I am carrying out a research on paediatric thermal burns. This study will enable us to know more about the causes of these burns and how we treat them here at Kenyatta National Hospital. Through this study, we will be in a better position to issue guidelines on prevention and offer better medical treatment to others who may be afflicted. All the information gathered shall be used solely for the purpose of medical research. You are under no obligation to either accept or refuse to be enrolled in this study, and your decision shall in no way affect any treatment you may receive in this hospital.

You will be enrolled upon giving consent and allocated a study number. Your patient will undergo a normal history taking, physical examination, and investigations needed. All these will be documented. The type of dressing and any surgery done will be documented. He/she will be reviewed weekly and monitored for any complication that may arise till discharge.

Your patient will be identified by a study number, which will not even appear in the final report. Apart from the normal risks any other burns patient undergoing management faces, there are no extra risks you are exposed to in this study.

Please feel free to ask any questions that may not be clear to you or may arise from my explanation above.

Sign below if you agree to have your dependant to be part of this study.

Parent or guardian consent form

I accept to participate in the research and voluntarily give the necessary information. I’m fully informed that my participation or refusal to participate shall not positively or negatively influence my current management, and the information shall be treated in confidence.

Parent/guardian’s signature..............................................................

Researcher’s signature..............................................................
APPENDIX 2

QUESTIONNAIRE

1. Serial number

2. Date of admission

3. Date of discharge/death

4. Age of the patient

5. Sex (male=1, female=2)

6. Area of residence

7. Level of education of the patient
   1=Not at school
   2=Pre unit – nursery
   3=Primary level

8. Educational background of immediate care taker
   1=Primary
   2=Secondary
   3=College
   4=University
   5=Other specify

9. Average income of parent/guardian per month

10. Type of housing
    1=Permanent
    2=Semi permanent
    3=Temporary
    4=Others specify

11. Size of house
    1=Single room
    2=Single room with separate kitchen
    3=2 rooms with separate kitchen
    4=2 or more bedrooms with separate kitchen

12. Cause of burns
    1=Open flame
    2=Hot water/food scalding
3=Frost
4=Others specify

13 For open burns
1=Kerosene stove explosion
2=Gas explosion
3=Lantern lamp explosion
4=Others specify

14. Scalding burns
1=Immersion
2=Splash burns

15. Cause of scalding
1=Hot water
2=Hot oil
3=Hot tea/ujii
4=Hot milk

16. Area of body affected
1=Trunk
2=Head and neck
3=Upper limbs
4=Lower limbs

17. Special areas of the body involved (1=yes, 2=no)
   Hands
   Feet
   Perineum
   Face
   Major joints

18. Classification of burns in percentage body surface area
1=0-10%
2=11-15%
3=16-20%
4=21-25%
5=26-40%
6=41-55%
7=≥ 56%

19. Classification according to depth
1=Superficial[1°]
2=Superficial partial thickness [2° superficial]
3=Deep partial thickness [2° deep]
<table>
<thead>
<tr>
<th>Question</th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
<th>Option 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Suspected inhalation injuries</td>
<td>Present</td>
<td>Absent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Place of burn</td>
<td>Home</td>
<td>Neighbourhood</td>
<td>Street</td>
<td>Institution e.g school</td>
</tr>
<tr>
<td>22. Time of burn</td>
<td>12.01 am-6.00 am</td>
<td>6.01 am-12.00 pm</td>
<td>12.01 pm-6.00 pm</td>
<td>6.01 pm-12.00 am</td>
</tr>
<tr>
<td>23. Ward admitted</td>
<td>ICU</td>
<td>Burns unit</td>
<td>Ward 4D</td>
<td></td>
</tr>
<tr>
<td>24. Time taken to arrive at the hospital</td>
<td>0-6 hours</td>
<td>6-12 hours</td>
<td>12-24 hours</td>
<td>24 hours</td>
</tr>
<tr>
<td>25. Fluids type</td>
<td>Ringer's lactate</td>
<td>Dextrose</td>
<td>Normal saline</td>
<td>others</td>
</tr>
<tr>
<td>26. Warming of the patient</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Analgesics</td>
<td>Yes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4=Full thickness $[3^0]$  
5= $[4^0]$
28. Antibiotics
   1 = Yes
   2 = No

29. Number of times wound dressed per day
   1 = Once
   2 = Twice
   3 = Alternate days

30. Type of dressing
    1 = Open method
    2 = Closed dressing
    3 = Others specify

31. Associated injuries (code 1 = yes, 2 = no)
    Fracture of long bones
    Haemothorax
    Ruptured viscous
    Head injury
    Other specify

32. Surgical management (code yes = 1, no = 2) week done
   a. Emergency escharotomy
   b. Escharectomy
   c. Debridement
   d. Skin grafting
   e. Others specify

If yes state the time it was done in weeks from time of admission
   1. Week 1
   2. Week 2
   3. Week 3
   4. Week 4
   5. More than 4 weeks specify

33. Complication encountered (1 = yes, 2 = no) week it occurred
    Hypovolaemic shock
    Respiratory distress
    Paralytic ileus
    Electrolyte imbalance
    Septic shock
    Renal failure
    Sepsis
    Dehydration
    Hypertrophic scar formation
Itching .....................................  
Painful scar ..........................  
Keloid ..................................  
Death ....................................  
Others specify ........................

If yes, state the week at which it occurred as in 32 above

34 Investigations done  
1 Haemogram ........................................  
2 serum Sodium ...............................  
3 serum potasium .............................  
4 urea ........................................  
5 serum creatinine ............................  

<table>
<thead>
<tr>
<th>week</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
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<td></td>
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48. The Local Government Order 1968
   Building Code 216 and 218.
Ref: KNH-ERC/01/1934

Date: 20 August 2003

Dr. Mung’ara G Mburu  
Dept. of Surgery  
Faculty of Medicine  
University of Nairobi

Dear Dr. Mung’ara,

RESEARCH PROTOCOL “PAEDIATRIC THERMAL BURNS: PRESENTATION, CAUSES AND MANAGEMENT AS SEEN IN KENYATTA NATIONAL HOSPITAL”  

This is to inform you that the Kenyatta National Hospital Ethics and Research Committee has reviewed and approved the revised version of your above cited research protocol.

On behalf of the Committee, I wish you fruitful research and look forward to receiving a summary of the research findings upon completion of the study.

This information will form part of database that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Yours sincerely,

PROF. A N GUANTAI  
SECRETARY, KNH-ERC

Cc Prof. K Bhatt, Chairperson, KNH-ERC  
The Deputy Director (C/S), KNH  
The Dean, Faculty of Medicine, UON  
The Chairman, Dept. of Surgery, UON  
CMRO  
Supervisor: Dr. J K Wanjeri, Dept. of Surgery, UON