

**TERRORIST BOMB EXPLOSION IN NAIROBI
KENYA 7TH AUGUST 1998.**

**AN ANALYSIS OF SOFT TISSUE AND OTHER INJURIES
SUSTAINED AND THEIR MANAGEMENT.**


**A DISSERTATION SUBMITTED IN PART FULFILLMENT
FOR THE DEGREE OF MASTER OF MEDICINE
(SURGERY), UNIVERSITY OF NAIROBI.**

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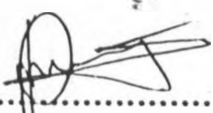
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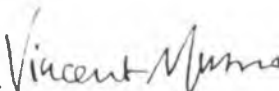
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DEDICATION:

To:

All those victims of the August 7th 1998 bomb blast.

My wife Godliver and our children Aulaar and Joan, and my parents Dr. Nick Adung'o and Mrs. Mary Adung'o.

No amount of words can adequately express my deep sense of gratitude to all of you for your endless patience, tolerance and encouragement.

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I am particularly grateful to Dr. Aref Isma'1 who stimulated my interest in this study.

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LIST OF ABBREVIATIONS:

AAR:	African Air Rescue.
AFM:	Armed forces memorial hospital.
AHC:	Avenue Health care.
AIS:	Abbreviated injury scale.
AKH:	Aga Khan Hospital.
ATL:	Anti-tension line.
BJS:	British journal of Surgery.
BSA:	Body surface area.
Db:	Decibel.
GNH:	Guru Nanak hospital.
HMC:	Hurlingham Medicare center.
ICRC:	International Committee of the Red Cross.
K.E:	Kinetic energy.
KNH:	Kenyatta National hospital.
MMH:	Mater hospital.
MPS:	MP Shah hospital.
MSB:	Masaba hospital.
NH:	Nairobi hospital.
NI:	Not indicated.
RSTL:	Relaxed skin tension line.
TNT:	Trinitrotoluene.
ZSR:	Z-plasty scar revision.

THE AUGUST 7TH 1998 BOMB BLAST IN NAIROBI: SOFT TISSUE AND OTHER INJURIES; MANAGEMENT AT KENYATTA NATIONAL HOSPITAL.

SUMMARY:

Terrorist bombings are ugly acts of the modern world that are usually politically motivated. The explosives used range from home made devices to conventional explosives such as grenades and bombs, with materials such as nails, radioactive and toxic substances added to the explosive devices sometimes. On 7th August 1998, Nairobi was the victim of a terrorist attack targeted at the American embassy. The dual explosion injured non-suspecting civilians as well as rescuers. This retrospective study has analyzed the effects and injuries due to this bombing. All patients treated at Kenyatta Hospital for blast related injuries that met the inclusion and exclusion criteria were included in the study. Data was collected in a questionnaire and entered into Microsoft excel and SPSS data sheets for analysis. An estimated 5000 people were injured in the bombing, while 213 died at the site. 1471 were treated at Kenyatta National hospital for bomb blast related injuries. 54.5% were male, 71.6% were between 20 and 40 years old.

Flying debris and shrapnel caused most of the injuries. The injured sustained mainly soft tissue injuries that were treated on an out patient basis. The regional distribution of soft tissue injury suggests the protective role of clothing and headgear. Scars; keloids and hypertrophic scars, were the commonest complication following these injuries. Scar management formed the bulk of work during the reconstruction period. Patients were admitted mainly for injuries that required surgery in main theatre, head injury was the main cause of in-patient hospital deaths. Though skeletal injuries were uncommon, most of the fractures seen involved long bones.

Effective management of a disaster of this magnitude requires inter-departmental cooperation. Triage should start at the site of accident, and the casualties rapidly transported to medical care institutions. In hospitals, a disaster management team, whose responsibility is to rapidly mobilize human and material resources, is essential.

RATIONALE OF STUDY

Terrorist activity is an ugly fact of modern life and is widely distributed the world over. Acts of terrorism have intensified during the last four decades.

The chief weapons used are the bullet and the bomb. The bombs used are sometimes wrapped up with metal nails to increase the effect and severity of secondary blast injury. Bombing incidents are prone to be highly variable concerning scene setting, victim population and the explosive charge properties thus a comparative analysis of injuries in different bombing incidents may be biased.

Nairobi was a victim of the worst terrorist attack in her lifetime on August 7th 1998. This attack targeted at the American Embassy in Nairobi was calculated to inflict as much injury as possible to innocent civilians; as in most terrorist acts.

It resulted in the largest number of fatalities (213) in any terrorist act in Kenya.

Because terrorist attacks are politically or ideologically instigated, we cannot conclude that such will be the last such attack as many a time the political expectations of the terrorist are not met.

The number of casualties all arriving at the same time presented an unfamiliar problem to the accident and emergency departments as well as individual physicians in all medical institutions.

Although the incident was handled satisfactorily, we as a Nation were unprepared for a disaster of this magnitude.

This study aims to serve as an audit of the events surroundings this type of disaster and so provide a guide in spelling out protocols for disaster management and medical preparedness for accidents of this magnitude.

Aims and objectives.*Broad objectives;*

- Determine the number, age and gender of people injured during the Aug 7th terrorist bomb explosion in Nairobi, and the type of injuries sustained.
- To provide an epidemiological description of physical injuries and fatalities in the people treated in Kenyatta Hospital for bomb blast related injuries.
- Compare the Nairobi experience with that of other cities, which have experienced similar attacks.

Specific objectives;

- Analyze the type and anatomic distribution of injuries sustained by the blast victims treated at Kenyatta national hospital.
- Determine the distribution of these injuries in relation to gender.
- Analyze the type and anatomical distribution of skin and soft tissue injuries sustained, and the treatment offered.
- Determine the complications following soft tissue injury and the relationship to gender and race.

LITERATURE REVIEW.

Background and Epidemiology.

Terrorist bombings have become more common and account for much death, non-fatal injuries and destruction of property.^{1,5,7} From 1969 to 1983, 220 terrorist bombings killed 463 people and injured 2894 worldwide (Sue Mallone et al⁴, Frykberg E.R et al⁵). Sue Mallone et al⁴ reported 6 deaths, 1000 injuries and \$575.3 million in property damage following the bombing of the World trade center in New York City.

Terrorist bombing campaigns change constantly in response to policy changes and also owing to counter-measures by the security forces (Styles 1972 BJS Vol. 65 No 8 Aug 1978).

Dan Leibovici and co-workers⁷ report the incidents to be highly variable in scene settings, victim populations and explosive charge properties, including weight and chemical structure. Styles¹ attributes this variability to the policy changes terrorists respond against and countermeasures by security forces.

It is noted that nails are added to some bombs to increase secondary injury⁷, while it is suspected that others attach radioactive substances and other toxic materials that may cause inhalation injury.⁹

Some terrorists set up dual explosions to injure both civilians and non-suspecting rescuers.

Because of the variability of terrorist bombings, Leibovici and co-workers⁷ conclude a comparative analysis of injuries inflicted in different bombing incidents is likely to be biased.

MECHANISM OF EXPLOSIVE BLAST INJURY.

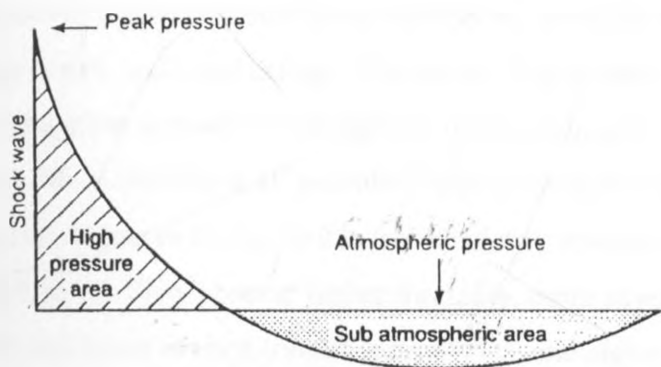
The blast wave is described to have 3 features: *a positive phase, the negative phase and a blast wind (mass movement of air).*^{4,7,14}

During the positive phase, the blast wave rapidly rises in pressure in relation to the explosion. The rise above ambient pressures (overpressure) propagates radially at velocities of 2000 to 8000 meters per second, exerting extreme force on objects and

humans on its path and reflects off solid objects at 2 to 9 times the initial pressure. An overpressure of $1.7 \times 10^3 \text{ N/m}^2$ may result in short duration wind velocities of up to 200 km per hour. The blast wave losses its pressure and velocity exponentially with distance from the explosion. In confined spaces, the dissipation of this pressure is slower.⁷

In the negative phase (vacuum phase), which lasts 10 times longer than the positive phase, pressure drops below ambient pressure (underpressure). This sucks debris into new areas e.g. pulling out windows.

Figure 1: Pressure changes during blasts.



Pressure changes that occur as a result of a bomb explosion. A blast produces two pressure changes: a high pressure shock wave, followed by a sub-atmospheric (suction) phase. Injuries are mainly due to the initial shock wave but are aggravated by the sub-atmospheric phase.

The blast wind is generated when the expanding gases of the explosion displace large volumes of air at high velocities. The blast wind may cause total disintegration of the body, and at lesser levels traumatic amputation. A person standing behind a large object may be shielded from blast wind, but not from the blast wave, which comes earlier.¹⁴ The blast wave then resolves with a return to ambient pressure.

Terrorist bombings show a consistent pattern of injury and death. The majority of injuries are subcritical injuries that require hospitalization or minor wounds that can be treated in an outpatient setting.⁴

The mechanisms and determinants of physical injury depend on type and size of the blast, the site of explosion; open air versus closed space, effects of environmental pressure changes and conditions caused by blast pressure and blast winds, and the proximity of the individual to the blast.^{1,4,7,9}

In air the intensity of the blast wave falls off very rapidly with distance. In water, which is denser than air, the blast waves travel more rapidly.^{9,14} Blast injuries in water are therefore more severe for a given distance than in air. Higher mortality and more severe injuries are also seen in large TNT equivalent explosions, confined space explosions and where there is collapse of buildings or other structure.^{4,7,9,14}

Cooper et al⁷ have shown that in confined space explosions, pressure waves are reflected from objects such as doors, walls and ceiling. This causes a quasistatic overpressure whose intensity and duration depends on the volume of the contained space and degree of venting of the space. Dan Leibovici et al⁷ postulates that prolonged exposure to this overpressure in contained spaces is responsible for the higher severity of blast injury in contained space explosions. They observe higher mortality, more severe injuries (higher injury severity score and lower revised trauma score)^{12,13,14} and higher incidence of primary blast injury. Lavonas⁹ also notes that victims standing next to walls, or other solid objects are likely to suffer more severe injuries from reflected blast wave.

Dan Leibovici and colleagues⁷ in a comparative study of injuries in open-space versus closed-space bombings found increased severity of injuries seen in survivors of closed space bombings. The primary blast injury in the confined space bombing victims they noted was predominantly severe pulmonary injury rather than perforated tympanic membranes. Though there was no difference in the incidence of penetrating trauma, traumatic amputations and burns in the two groups, those in the confined space explosion suffered burns of larger surface area, and more severe secondary blast injury (Waterworth and Carr, Leibovici).^{3,7}

While Waterworth and Carr³ divided bomb injury into three main groups; due to a) the blast effect e.g. blast lung and ruptured tympanic membrane, b) the flash such as burns to

the exposed part of the body, c) shrapnel which may cause a wide range of injuries, blast injuries are traditionally divided into three groups: *primary* blast injuries due to direct impact on tissues of variations in environmental pressure. As the front of pressure travels from one medium to another of less density, fragmentation of tissue occurs. Organs with fluid-air interfaces are particularly susceptible to damage by blast waves¹⁴; *secondary* blast injury due to flying debris set in motion by the blast wind, ground shock or by gravity (fragmentation). The wounding capacity of missiles set off by the explosion depends on the kinetic energy at impact. From this formula: $K.E = \frac{1}{2} \text{mass} \cdot \text{velocity}^2$, the impact velocity is the most important determinant of wounding capacity²². On being struck by a missile e.g. a bullet, living tissues are transformed into secondary missiles, which are thrown away from the passage largely in a radial direction. This produces a short-lived temporary cavity in which pressures of up to 10,000kPa may occur for 5-10 minutes (Harvey et al)²². The cavitation is pulsatile and the size of the temporary cavity is related to the elasticity of tissues (Hopkins & Marshal 1967)²². Air and contaminants are sucked into the cavity behind the missile, and then the track seals off. The pressure effect within the tissues damages tissue beyond the missile track. Tissue death and contamination favor bacterial colonization especially by anaerobes such as *Clostridium. feichii*. Unlike what is wrongly thought, heat generated from the missile is insufficient to sterilize tissues (Thoresby & Darlow 1967; Hopkins & Marshal 1967), but may cause damage to susceptible tissues particularly blood vessels (Gerwig et al 1966)²²; *tertiary* blast injury occurs due to propulsion of the body as a whole (De Condole, Lavonas).^{1,9} In addition, *miscellaneous* blast related injuries caused by the explosion include toxic inhalations (carbon monoxide and cyanide) and exposures, radiation exposure and chemical or secondary thermal burns, and the collapse of structures and buildings.

With Tucker and Alan Lettin report few but severe injuries after detonation of a bomb in an confined space at the Tower of London.⁶ The bomb containing 4.5 kg of explosives was placed near the wooden carriage of a 2500kg bronze canon, in a room measuring 68ft long, 28ft wide and 20ft high. The injuries seen were caused by blast wave, secondary injuries by stones, and wood and metal fragments from the destroyed canon and tertiary injury when the patients got thrown onto the floor.

Out of 37 people injured, 19 required admission. 27% of them had severe multiple injuries, and there was one mortality.

Luckerman 1941; Wilson and Turnbridge 1943; White 1966; Leibovici 1996, noted primary blast injury to be unique to the specific explosions. They and other authors noted gas-containing organs were predominantly affected in the following order ear, the lungs and the gastrointestinal tract.^{1,7,8,9,14}

Like Leibovici and his colleagues⁷ report eardrum rupture to occur at pressures as low as 70psi, and most pulmonary damage to occur at pressures of 70psi. Intestinal injury they reported occurred at higher pressures. Exposure to pressure levels of 80psi or above is considered lethal to 50% of cases.

INJURIES & CLINICAL FEATURES.

Primary blast injury.

There are no specific signs to enable the early and effective diagnoses of primary blast injuries. Measurements of specific blood parameters would be useful but to date, those that are readily available (serum enzymes, blood urea nitrogen, leukocyte count and hemoglobin concentration) are not useful.

Recent experimental data indicate that measurements of prostanoids (prostacyclin, thromboxane, prostaglandin F₂, prostaglandin M) may be useful in the early diagnosis of primary blast injury in victims of explosion with blast-fragment combined injury.⁸

Ilja Cernak et al⁸ in a study of victims of explosive munitions in the Yugoslav war observed that the mean circulating concentrations of thromboxane B₂, 6-keto-prostaglandin F_{1a} and sulfidopeptide leukotrienes in the 5 days after injury are elevated, but not significantly raised in patients with non-blast injury.

They conclude that measurement of prostanoid ratios is useful in diagnosing and prognosticating blast injury.

a). *Ear injury.*

Information regarding the effects of blast on the ear is scanty, but Kerr and Byrne 1975 detected 60 tympanic membrane perforations following a bomb explosion in a restaurant.¹ 49 healed on conservative management but 9 had significant sensorineural deafness (bilateral sensorineural loss of 40Db or greater for speech frequencies). Eardrum perforations were the commonest primary blast ear injury.

Blasts may also cause dislocation of the ossicles or damage to the inner ear.¹⁴ Inner ear injuries may lead to permanent deafness.

Waterworth and Carr (1974)³ in a study of 82 patients treated after confined space explosions found 9 out of 19 inpatients and 7 outpatients with perforated tympanic membranes, in 5 cases bilateral. A further 6 patients had tinnitus without a perforation being recorded. However it is important to note that perforated tympanic membrane can give rise to little symptoms and therefore go unnoticed unless careful examination of the ear is done.

After the Tower of London explosion, 22 patients sustained ear injuries, with eardrum perforations being common (16), and varying degrees of sensorineural damage, seen after audiography (21). Healing on conservative management occurred in 50%, while tympanoplasties were performed on the remaining with good results. By the time of writing their report, only two people had complete recovery from sensorineural injury (with Tucker, Alan Lettin⁶).

In a study of the Oklahoma City bombing, Sue Mallone et al⁴ report 78 persons (37% of survivors) with auditory damage. The commonest injury being; hearing loss 31 (11 sensorineural, 1 conductive, 1 mixed type, 18 unspecified); followed by bilateral or unilateral tympanic membrane perforation (22); acoustic trauma (13); tinnitus, vestibular dysfunction, and otalgia (12).

b). Lung injury.

A blast wave may cause rapid inward movement of the chest wall leading to pulmonary bruising (blast lung) with no untoward effect if minor.¹⁴

Studies by Hadden & Rutherford¹; Waterworth & Carr³; Tucker & Lettin⁶ find blast lung to be rare (less than 1%). Hill 1977¹ on the contrary found primary blast injury in 45% of the dead patients from the bombing campaign. It was not necessarily the cause of death.

Dan Leibovici et al⁷ attribute the rarity of primary blast injury in terrorist campaigns in contrast with military casualties to the smaller explosive charges, and home made devices used in civilian terrorist bombings.

Blast lung phenomenon, occurs very early following blast exposure, and is characterized by dyspnoea and a frothy blood stained pulmonary exudate and frequently pneumothoraces if severe.^{9, 14} It may occur in combination with or mimic other conditions such as aspiration pneumonia, fat embolism syndrome, fluid overload and infection¹.

The diagnosis of blast lung is difficult, but measurement of serum prostaglandin levels may be useful (Ibolja et al).⁸

Minor bruising may be difficult to diagnose, even on radiographs, while in major bruising, chest radiographs may show lung contusion in the early stages, and later an opaque, fluffy appearance around the hilum of each lung as pulmonary edema sets in. Blood gas analysis will show arterial hypoxia and raised pCO₂.¹⁴ The severity of this is used as a guide in determining the need for assisted ventilation

In spite of its presumed rarity in civilian violence^{1, 3, 6, 7} blast lung is a leading cause of mortality in military explosions. The management involves taking serial chest radiographs, administration of oxygen, assisted ventilation if required, and the avoidance of over-transfusion of fluids, which aggravate edema. Steroids may be required if toxic

gases have been inhaled. Underwater seal chest drainage for accumulated fluid or air must always be considered.^{9, 14}

c). *Gastrointestinal tract injuries.*

Primary blast injury to the gastrointestinal tract is rare in civilian explosions (Hadden)¹, most gut injuries follow penetrating trauma. It may occur though in underwater explosions (Huller and Bazini 1970)^{1, 14} and confined space bombings (Leibovici).⁷ The abdominal injuries seen are mainly perforated gut or tense pneumoperitonium; possibly from thoracic leaks.

Clinically, a patient with bowel injury will have increasing abdominal pain, signs of peritonitis and often pneumoperitoneum.¹⁴ Urgent laparotomy is indicated.

Physical injuries.

Most of the injuries seen in terrorist bombings are due to secondary and tertiary blast effects and involve mainly the head & neck, despite having a smaller cross sectional area compared with other regions of the body.^{1, 4} Soft tissue injuries; lacerations, contusions and puncture wounds are the most prevalent, followed by musculoskeletal injuries.⁴

Wounds can be classified as **a) *closed wounds*** such as contusion/bruise; haematoma; **b) *Open wounds*** such as puncture wounds; abrasions/ friction burns; lacerations, **c) *Complex wounds*** such as crush/avulsion wounds; internal organ injury; war/gunshot injuries, **d) *injuries to special tissues*** such as fat; muscle; bone; nerves; artery or veins.

Hadden W.A. et al¹ studied the body in four regions (arms, leg, head and neck and trunk), and like Hill (1977)⁴, noted the head and neck as the most frequently injured region despite having a smaller cross-sectional area. The trunk and to a lesser extent the legs are injured less frequently than their surface area would lead one to expect.^{1, 4} Sue Mallone and her colleagues⁴ found the most common location of injuries from the Oklahoma city bombing in order of prevalence as; the extremities (74%), head and neck (48%), face (45%) and chest (35%).

Hadden found more men than women to have sustained head lacerations, but the pattern was reversed for the legs suggesting that women's headgear and the trousers men wear

are protective. The distribution of these injuries emphasizes the protective effect of clothing and hence the recommendation of helmets with full-face visors and well-padded clothing to the limbs to protect all peoples at risk from explosions.

Keith Tucker and Alan Lettin⁶ report 17 patients with multiple extensive contaminated wounds containing wood, splinters, stone, metal and clothing following the Tower of London bomb explosion. Some small wounds were only obvious after scrubbing of superficial debris while some small areas of discoloration were the entry points of surprisingly large pieces of debris. Management of these wounds involved thorough wash with cetrimide; excision of devitalized tissue and removal of all debris then delayed primary closure from day 5 to 10, in line with traditional & International Committee of the Red Cross (ICRC) principles of management of missile wounds.^{10, 32} Bowyer on the other hand, based on research on animal models and experience from the Afghan war suggest a non-operative approach to the treatment of lightly contaminated small fragment wounds affecting the soft tissues.^{10, 11} This is by a) cleaning the wound with antiseptic solution and application of dressing, b) administration of tetanus toxoid vaccine, c) administration of antibiotics, in their case benzyl penicillin injection 6 hourly for 24 hours then penicillin V tablets for 5 days.

Severe wound sepsis occurs if primary closure is attempted on large contaminated wounds. This may necessitate surgical debridement, and delayed wound closure or skin grafting.^{6, 10, 11}

Soft tissue injuries being the commonest after blasts, scars and their management present a large workload in reconstruction procedures for victims of blast.

A scar is defined, as the residual visible mark of a wound.³³ Every wound that penetrates the papillary dermis leaves a scar.²³ A wound becomes a scar following epithelialization. In the early stages the epithelium is thin and easily damaged by abrasion.³³ The scar is raised, red and hard, due to high vascularity (proliferative phase of healing).^{15, 23, 33} As time progresses (6-12 months), the scar **matures**; becoming pale, flat and soft,¹⁵ with the epithelium getting stronger.³³ There is a decrease in vascularity and reduction of excess

collagen.²³ The clinical criteria of scar maturation therefore are fading and softening, with an associated improvement in appearance.²³

The final appearance of a scar is more influenced by how it was inflicted than how it was sutured (Parsons 1977),²³ but the most important single factor in scar prognosis is the orientation of the wound in relation to the normal lines of skin tension. The lines of skin tension are generally at right angles to the direction of underlying muscle pull. The more nearly the line of wound closure parallels the relaxed skin tension line of 'Borges', the more satisfactory the scar will be.²³

Lines of tension are due to the orderly arrangement of dermal fibro-elastic connective tissue. Cleavage lines, (lines of tension) are first observed in a 28mm fetus, but in most cases do not appear until the fetus is 50mm.²⁵ The cleavage lines in the fetus undergo alterations with growth, these being influenced by the rate of proportional growth and principal direction of growth of certain structures in the body.

Classification of scars. (Adapted from Bailey & Love).

a). Linear scars.

Linear wounds give rise to thin linear scars, however this can undergo stretching, hypertrophy, atrophy or keloid formation.

- **Stretching:** the scar widens e.g. in back scars.^{15,33} This is due to skin tension pulling on a scar (Albert Borges).^{16,27} The greater the skin tension pulling at right angles to a scar, the worse the scar.^{16,17,23} Skin tension is high in; most facial scars; scars that do not follow the relaxed skin tension lines (RSTL); scars resulting from loss of the integuments by avulsion, slough, excision, or burns; and scars in younger people (Albert Borges).^{16,23} Scars near joints tend to widen and become hypertrophic because of tension with motion.²³ Immobilization will facilitate initial healing, but as the scar matures it will still tend to stretch as splinting is discontinued.
- **Hypertrophy:** the scar is raised above the surface and therefore palpable. It is common in children and adolescents^{15,33} and is more likely to occur following wound infection.¹⁵ Unsightly hypertrophic scars are likely to occur over the

sternum and deltoid muscle, where the mobility of the shoulder joint produces tension in all directions. The pendulum effect of the breast in females further adds pull to scars of the sternum.²³ Hypertrophy is characterized by excessive scar tissue within the confines of the original wound,^{15, 18} and tend to regress spontaneously.^{17, 27} In histological sections, a definite margin is seen between hypertrophic scar and normal dermis.¹⁸

- **Atrophic scar formation.** The depressed scar usually follows loss of subcutaneous tissue¹⁵ or healing by secondary intention²⁷ when they may also be adherent to deep underlying structures. Depressed scars occur most frequently over a soft understructure such as the cheek; maturation and shrinkage of collagen in the scar causes it to be pulled inward toward the subcutaneous fat.²⁷
- **Keloid formation:** there is an extreme overgrowth of scar tissue; beyond the confines of the original wound.^{15, 18, 19, 27} Histological sections of keloid show no definite margin between the scar and normal dermis,¹⁸ While still continuing to extend laterally, after many years, keloid scars ultimately regress centrally.¹⁸ Keloids are common in many Afro-Caribbean's, and do not occur before puberty.^{15, 18, 19} The sites mainly affected are ear lobes, pre-sternum, the nape, beard area, scalp & fore head, and shoulder (Marks 1998, Tanga 1990).^{15, 17, 18, 19}
- **Contracture formation.** Contraction of scars occurs in both length and depth.¹⁵ A linear scar is more likely to contract if it is at right angles to relaxed skin tension lines.^{15, 16, 17} Fixation of skin to underlying tissues aggravates the effects of fibrosis and contracture.¹⁵ Such scars crossing a concavity e.g. a joint may tighten to form a bridle, limiting joint movements.
- **Trap-door scar deformity.** The trap-door effect of scars is a biophysical phenomenon by which those linear scars which have the shape of a letter U, C, or V tend to become depressed and the tissue circumscribed by its tendency to bulge.³⁰ It has also been called a horseshoe, curved, arched, or semicircular scar

deformity. It is commonly associated with industrial and automobile accidents. The scars are frequently secondary to bevel-edge deep lacerations produced by glass cuts on the face involving not only the skin, but also the deeper muscular layer.

Hyper-trophic scars and keloids contain excess fibronectin, disorganized collagen bundles and whorls of collagen instead of discrete bundle formation.^{15, 19} The rate of collagen synthesis in keloid and hypertrophic scars is higher, compared with normal scars and normal skin respectively (Diegelman and his colleagues 1979).¹⁸

The development of these lesions is thought to be due to hypoxia following microvascular occlusion due to endothelial hyperplasia, and proliferation of perivascular myofibroblasts (Marks, Kisher).^{15, 19}

Although keloids are clinically different from hypertrophic scars, there is often a gray area between both pathologies where the differential diagnoses becomes difficult.¹⁹

Khan (1988)¹⁹ has outlined the following distinguishing features:

Keloid scars.

Not confined to wound
Thick glassy collagen
Muroid matrix
Remains elevated

Hypertrophic scars.

Limited to area of injury
Fewer thick collagen fibers
Scanty muroid matrix
Flattens spontaneously with time

b). Area scars.

Burns, deep abrasions or skin loss may result in an area of scar tissue following healing.

Area scars have a different texture from surrounding skin with a thickened fibrotic neodermis and a thin epithelium with no adnexal structures (hair follicles & sweat glands). There may be hypo- or hyper pigmentation of the skin. Contraction may occur in every dimension with pluckering of surrounding skin and limitation of joint movements.^{15, 33}

Management of Scars.

Patients, their relatives and peers may perceive visible scars as stigmata of violence, disease or deformity. Careful consideration should therefore be taken to avoid unfavorable scars whenever elective scar revision or other surgery is planned or primary repair of injuries is being carried out.²⁴ To prevent unfavorable scarring, the general principles of wound repair, such as control of bleeders, conservative debridement, reconstruction of the deep layers, elimination of dead space, suturing of skin borders without overlapping and with exact leveling of the surface, and use of adequate suture material and dressings must be strictly adhered to.²⁴ Whenever possible a scar should be closed in such a manner as to run parallel with the relaxed skin tension lines.

The expectations of patients wanting to undergo scar revision are usually exaggerated.³³ Careful counseling, and thorough scar analyses are required before considering scar revision. Judgment as to selection of patients, the proper timing of the procedures, and the correct therapy will make considerable difference in regard to the satisfaction of the patient and the surgeon,²⁶ and the prognosis as to improvement.²⁷

A surgeon should choose that revision technique that will accomplish the greatest improvement in attaining the main objectives that will improve a particular scar.

To achieve this, the scar has to be examined in all its facets.

The main objectives of scar revision are to improve the scar's direction, to divide the scar into smaller components, and to achieve a leveling effect.²⁷ Other objectives include improving the condition of the wound, halve the depth and surface of the scar, as well as camouflage it and create elasticity (Borges 1977).

The indications for scar revision include:

- Limitation of function by contracture formation.
- Irritation or pain. Pain may be due to involvement of nerves in deep scar tissue or adherence of scar to neuroma.^{15, 27}
- Unsightly appearance; hyper-trophic or atrophic scars, dirt-ingrained scars, broad scars, and keloids. Disfigurement however is not absolute but exists in the eye of the beholder and the mind of the sufferer.²⁷ Patients with such scars should be thoroughly counseled on benefits and outcome of scar revision if it shall be necessary.

Non-surgical treatment of scars;

- Intralesional injections; Triamcinolone
Cortisone
B-aminoprionitrite;
Colchicine.
- Pressure dressings.
Intralesional corticosteroid injections combined with pressure dressings, reduces hypertrophic scars by inhibiting inflammatory fibroplasias and increasing collagenolytic activity.¹⁵ Three to four injections of triamcinolone into the lesion every 3 to 4 weeks apart is adequate.¹⁵ Mistaken injection of surrounding normal tissue causes subcutaneous tissue atrophy and hypo pigmentation.
Cortisone injections result in widening of the scar as it flattens.
- Radiation therapy: 500 to 600 rads delivered in two or three divided doses within several days of excision controls keloid formation.¹⁵
- Other modes of treatment, similar to those used in keloid treatment have been practiced with varying result. They are discussed in the non-pharmacological treatment of keloids.

Surgical treatment of scars:

Albert Borges¹⁶ advocates for scar revision at two to three months after injury. At this time, the depth of the wound is healed sufficiently, tissue swelling has cleared, and circulation is adequate. This saves the patient from the anguish of disfigurement while waiting for scar maturation before revision. Borges¹⁶ also notes that improvement from revising a young scar is much greater and obvious to the patient than that obtained from revising an old mature scar.

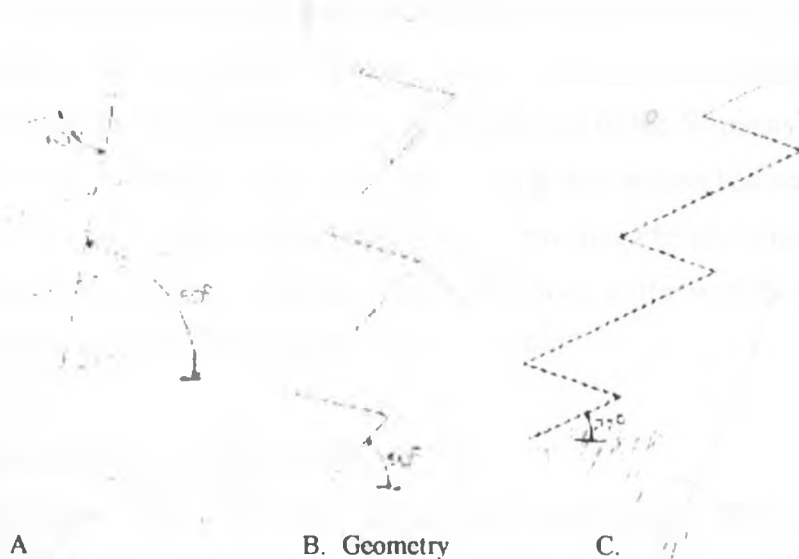
For unsatisfactory scars that closely follow relaxed skin tension lines, **fusiform scar revision** (simple elliptical excision and closure)¹⁶ is indicated, but is inadequate for wide and hypertrophic scars.

Linear anti-tension line scars are best revised by **Z-plastic scar revision**.^{16, 27}

The basic technical principles of Z-plasty are: (1) Diagonals should always fall on the scar. (2) The diagonal and limbs of each Z-plasty should always be of equal length. On

the face, 1 to 1.5 cm is the size most frequently used. Scars resulting from larger Z-plastics are usually more noticeable. (3) In multiple Z-plasty, segments should not be smaller than 1 cm because of its tendency to result in a series of bumps and furrows. The limbs should be as close to the RSTL (*relaxed skin tension line*) as possible but never 60° from the diagonal. ²⁷

Figure 2: Geometry of Z-plasty.



A. Z-plasty revision to vertical or almost vertical scar. Diagonal of every Z should fall over the scar and its length should be equal to that of the limbs. Limbs should be as close to the RSTL as possible but not greater than 60° . B and C, geometrically the direction of all segments has improved. On the live skin, improvement is even better.

The intersecting units of normal tissue brought by the Z-plasty flaps in correcting linear scars act as yielding structures which allow for a more normal repair of the elastic skin net by fragmenting the parasitic effect of the scar collagen band. ²⁸

Z-plasty is indicated for:

- 1) Anti-tension line scars on eyelids, lips, nasolabial folds and all other parts of the body.
- 2) Depressed scars including trap-door deformity.
- 3) Areas with multiple scarring.

Z-plastic scar revision is not recommended for scars that closely follow the relaxed skin tension lines, and many wide and/or hypertrophic scars in regions of high tension.

W-plasty is recommended for revising vertical or almost vertical scars. The technical points to note when performing a W-plasty are (1) the base of the last triangle at each end should be at right angle to the scar, (2) the tip of corresponding angles should also be in a line at right angles with the scar, (3) the angles should be approximately 55° - 60° (4) the length of the segments on the body of the W-plasty varies between 5 and 7 mm, depending on the size and the location of the scar (5) when the segments are 6 to 7 mm in length, they should be made shorter towards the end of the W-plasty to prevent the formation of dog ears or the production of a long anti tension line scar.²⁷ The only disadvantage of W-plasty is that width of the tissue must be given in the revision of scar. This makes it unsuitable for certain areas of the body as the vermilion border, the alar rim, and the eyelids and above the eyebrow.²⁹

Beneficial effects of Z-plasty (Borges).^{16, 27}

1. *Improvement of the scar's direction in relation to the RSTL.*
2. *Division of the scar into smaller components; reducing the bowstring tension effect of long scars.*
3. *Leveling effect; ZSR (Z-plasty scar revision) raises depressed scars on convex areas and lowers raised linear scars on concave areas, producing a better leveling effect than W-plasty can achieve.*
4. *Halving in depth and surface: the postoperative scars of the three revision techniques achieve halving in depth to a minimal degree in the FSR, but to a much greater degree in W-plasty and even more in the Z-plasty. Zigzag scars have greater cohesiveness than straight scars, so they do not tend to widen as much as straight scars.*
5. *Camouflaging effect; after ZSR, there is mingling of scarred and normal skin; concealing the scar.*
6. *Accordion-like elasticity; ZSR, changes an inelastic contracted, long linear ATL scar into a zigzag pattern with an accordion like elasticity.*

Correction of *trap door deformed scars* depends on the size of the scar. When there are multiple trap-door scars in close proximity e.g. following shattered windscreen injuries, the treatment of choice is dermabrasion or dermoplaning. If the small trap-doors are few, and separated from one another, fusiform scar revision is recommended, planned to have the scar run parallel with the resting skin tension lines. For the larger scars, multiple procedures will correct the deformity.³⁰

Treatment of keloids:

Keloids have remained an enigma of plastic surgery (Pierce, 1979)¹⁹; with no sound biological basis on which to plan their treatment for they are ill understood. To date, no single method or combination of modalities has been 100% effective, with different authors reporting varying results (Shepherd and Drawber).¹⁹:

The aim of treatment should be directed at excision of the lesion (Salasche and Grabski, 1983; Sharma, 1980; Harvey-Kemble, 1988)¹⁹, and preventing recurrence.

To reduce recurrence rates, intralesional surgical excision may be supported by peri-operative radiotherapy (Ollstein et al, 1981; Enhamre and Hammar, 1983), or depot steroid (triamcinolone) injections (Shons and Press, 1983).¹⁹

Enhamre and Hammar (1983)¹⁹ report a cure rate of 88% after following up patients treated by excision and radiotherapy for up to 9 years. Ollstein et al (1981)¹⁹ on the other hand report a recurrence rate of 21% per lesion, with a mean follow up of two years.

Shons and Press (1983)¹⁹ practiced intra-marginal excision and post-excision injection of triamcinolone (3-4 injections, each at 4 weekly intervals). Out of 20 patients, only 1 had a recurrence (5%).

The non-surgical management of keloids can be broadly classified into two groups:

physical, and pharmacological methods:

Physical methods:

- Radiotherapy (superficial X-ray therapy; Hoffman, 1982¹⁹). It has a risk of predisposing to, tumor (Hoffman, 1982).¹⁹ Malaker et al (1976)¹⁹ describe use of interstitial post-excision irradiation using radioactive iridium-192 wires buried in

to the wounds. They record a recurrence rate of 16%, with no radiation related complications.

- Strontium 90 beta rays (Deeka et al, 1987).
- Ultrasound (Walker, 1983).
- Cryotherapy (Muti and Ponzio, 1983; Cirne de Castro et al, 1986). Shepherd and Dawber (1982) used portable liquid nitrogen spray on keloid scars with poor results. They concluded keloid response to cryotherapy is poor.
- Pressure garment (Brent, 1978; Mercer and Studd, 1983).
- Laser therapy (Abergel et al, 1984; Henderson et al, 1984; Kantor et al, 1985).

Pharmacological methods.

- Steroids e.g. triamcinolone, used alone (Sharma, 1980) or in combination (Ceilley and Babin, 1979).¹⁹
- Penicillamine (Mayou, 1981)
- Retinoic acid (Janssen de Limpens, 1980)
- Dextran sulphate (Chui et al, 1987)
- Madecassol (Bosse et al, 1979)
- Systemic chemotherapy (Murray et al, 1981)

All the above except steroids have been used with limited and varying degrees of success.

Alas, all the mentioned pharmacological preparations are not without side effects; steroids may cause atrophy of surrounding tissues,^{15, 19} while their systemic responses (Dziewulski et al, 1988)¹⁹ may reactivate quiescent pulmonary tuberculosis (Amene, 1983).¹⁹

Adhesive zinc tapes (Soderberg et al, 1982) and silicone gels (Perkins et al, 1983; Quinn et al, 1985) have been claimed to reduce keloid and hypertrophic scar, and also to prevent keloid recurrence, while acrylic splints or stents (Hurtado and Crowther, 1985; Pierce, 1986) are thought to exert a pressure effect on the scars, so reducing their size.

It is not clear how zinc tapes work, but Soderberg et al (1982)¹⁹, studied the use of zinc tapes on hypertrophic scars and keloids. Their study showed encouraging results.

Y. Sawada and K. Sone (1990)²⁰ report very good result on the use of silicone cream occlusive dressing for the treatment of hypertrophic scars and keloids. Scar improvement is better when silicone cream/occlusive dressings are used (Sawada and Sone) than when silicone cream is used alone.

Sawada and Sone (1990) suggest that occlusion and hydration are the principal modes of action of both silicone cream, and silicone cream/occlusion dressing methods. The occlusion ensures contact of silicone with the scars especially if they have rough surfaces.

Datubo-Brown and Blight (1990)²¹ suggest the effectiveness of boa constrictor fat in the treatment of keloids as practiced in African traditional medicine. Their experiments on fibroblast tissue cultures demonstrated significant inhibition of fibroblast proliferation. This effect is thought to be due to the fatty acid content of the snake oil.

Burns.

The tremendous heat from hot gases generated by the explosion causes *flash* burns. They are typically superficial but may be extensive (5-70% BSA) and affect exposed areas such as the face, neck hands and the calves in females.^{1,4,7} The exposed surface area may be increased when the blast wave blows off baggy clothes and trousers. It is important to note the severity of burn is inversely proportional to the distance from detonation.

Ignition of clothing and inflammable gases cause *secondary* burns, which may be deep.^{1,3,4,6} This may require skin grafting.

Typically flash burns rarely affect the orbit, notwithstanding the exposed face and eyelids. This was attributed to the rapid closure of the eyelids in response to flash.^{1,3}

Fractures dislocations and sprains.

These occur as a result of secondary and tertiary blast effects.

Large fragments of metals from the bomb itself, blast driven wood, concrete or glass may cause serious fractures and soft tissue loss. The size and velocity of the fragment, as well as the anatomic site injured determine the severity of these injuries (Waterworth and Carr³).

Hadden et al¹ saw the following fractures in their study; pectoral girdle, humerus, radius & ulna, hand, pelvic girdle, femur, tibia & fibula, ankle foot, ribs and vertebrae. These were predominantly compound.

60 survivors from the Oklahoma City bombing sustained fractures and sprains.⁴ 37% had multiple fractures. The most common sites of fractures and dislocations were extremities (lower limbs 40%, upper limbs 38%, face and neck 37% and back chest or pelvis 25%). Sue Mallone et al⁴ also reported one patient with spinal injury with transient symptoms.

Keith and Allan⁶ found fractures of the extremities as the most common with up to 50% of them compound. The compound fractures may be associated with extensive tissue destruction and vascular injury, necessitating limb amputation.

Traumatic amputations.

These awesome injuries, probably the most dramatic serious consequences of explosions are seen in people in close proximity to the detonation. Although they may result from penetration by large fragments, in most cases they are due to the direct effects of the shock waves.⁷ The waves are coupled to the limb and run along bones, creating powerful shearing forces that run in a coaxial direction relative to the bone. They cause comminuted fractures, and with the disruption soft tissues complete the amputation.

Hadden et al¹ reported 20 patients (1.3% of all patients and 8% of inpatients in their series) had traumatic amputation. 4 of them died (20%). Seven patients sustained bilateral above-knee amputations and one of this in addition lost an arm. Six patients had unilateral above knee amputations, 2 of who had below knee amputation on the other side. They report amputations of the arm in 2 patients, the hand in 1 and the fingers in 4. In the patient with an amputated hand, the other hand was left permanently defective following injury.

There was no patient who sustained traumatic amputation in the Oklahoma City bombing. One had a leg amputated to extricate him from the building rubble.⁴

Head injuries.

Hadden et al¹ reported 11 patients with skull fractures 9 of which were compound. Six of these were concussed and 3 sustained brain laceration, one of who died. 28 other patients were concussed but had no skull fracture.

Compound head injury is also reported in 2 patients after the Tower of London bomb explosion⁶. One of them died while the other had comminuted fracture of the occipital and parietal bones associated with minor concussion and cortical blindness. The patient recovered, with resolution of the cortical blindness after debridement and wound closure and conservative management of the neurologic problem.

80 survivors from the Oklahoma bombing sustained head injury, 44% were hospitalized. 8 had severe head injury (AIS head 4 or 5), 4 of them had open skull fractures, 2 had subdural haematomas, and 2 depressed skull fractures. Among 72 patients with mild or moderate head injury (AIS head 1, 2 or 3), 33 had concussions while 25 had closed injuries.

Vascular and nerve injury.

David Caro and Miles Irving² reported 3 patients to have had major vascular injury due to shrapnel following the Old Bailey explosion in 1973. Two of these cases following exploration of the entry and exit wounds in the thighs were noted to have extensive tissue distraction and in-driven clothing. Lacerations and contusions of the femoral artery seen were repaired by segmental resection and end-to-end anastomosis with a saphenous vein graft with good results. The third patient had a brachial artery laceration, which was repaired with a saphenous vein patch. They note the brachial artery injury to be the only one diagnosed pre-operatively (absent radial pulse), while the others were diagnosed intra-operatively.

Hadden et al¹ reported one patient with a 4-mm tear of the popliteal artery and a 20-mm tear of the accompanying vein, both of which were sutured. The same patient had partial division of the popliteal nerve, which was also sutured.

They report three other patients with damage to major lower limb nerves: 1 to the sciatic nerve and 2 in the lower leg. Two radial nerves were damaged in the upper arm and 1 median nerve in the wrist. Recovery after conservative management was complete in all except in the sciatic nerve, which only partially recovered.

Severe and potentially fatal vascular injuries are reported by Sue et al⁴ due to the Oklahoma bombing. They report 5 patients with carotid artery or jugular vein laceration, 3 of them also had severed nerves or tendons in the extremities. 11 patients had severed nerves, ligaments or tendons and 3 had facial or popliteal artery lacerations

Visceral injuries.

Blunt and penetrating injuries mainly affecting the orbit, thorax and abdomen are encountered.

Waterworth and Carr³ report one case of severe penetration to the orbit and two corneal abrasions.

In one of the patients they studied, a metal fragment traversed the lungs and penetrated the thoracic aorta. This led to death.

Sue et al⁴ report 4 life threatening visceral injuries following the Federal building bombing: 1 partial bowel transection, 2 patients with lacerated spleens (1 also had a ruptured kidney), and 1 with a lacerated liver. Thoracic injuries were common in their series; acute respiratory distress syndrome in 4, pneumothorax in 6 (4 closed, 1 open and 1 haemopneumothorax), 3 with pulmonary contusion.

Keith and Alan⁶ also report penetrating injuries of the abdomen caused by various objects propagated by the blast wave. They report 2 cases, in 1 a 45cm sliver of wood penetrated from the left flank to enter the cortex of the left kidney. Fortunately after surgery, his kidney function was preserved. The other patient had a laceration of the liver.

Leibovici⁷ reports splenic rupture in 5 patients involved in closed space bombings compared with 1 from open space bombings. The injuries were possibly due to tertiary effects that caused blunt abdominal trauma.

Sue Mallone and her colleagues⁴ report ocular injuries in 59 patients (29% of the survivors). The most frequent injuries were corneal or scleral abrasions (15) and lacerations, contusions or foreign body in the eye (6), 9 patients had ruptured globes (4 had retinal detachment), 1 other had detached retina.

Keith and Alan⁶ also found corneal abrasion to be the most common ocular injury after the Tower of London explosion. Out of 4 patients with eye injuries, 3 had corneal abrasions, which healed well after conservative management. The other patient had laceration of the left cornea and multiple intra-ocular and intra-corneal foreign bodies. The foreign bodies were removed and the corneal laceration sutured. He completely lost vision in one eye while in the other eye he developed traumatic cataract.

METHODOLOGY

Study Design

This is a retrospective, descriptive epidemiological study of patients treated at Kenyatta National Hospital for physical injury sustained during the bomb blast. All patients meeting the inclusion and exclusion criteria were included in the study.

Physical injury in the study is defined as any blunt or penetrating trauma, primary blast injury including thermal or inhalation burns and tympanic membrane rupture.

Data was gathered from hospital medical records and from records of the rehabilitation team coordinated by Kenyatta National Hospital in conjunction with the United States Agency for International Development and the African Medical and Research Foundation.

Patients in the study had details of their sex, age at the time of injury, the anatomic site and type of injury sustained, the primary management received, follow-up procedures performed or recommended and the medical outcome of the injuries. This was extracted through a pro-forma questionnaire.

Raw data was tabulated appropriately to address the questionnaire.

The data was entered into Microsoft Excel spreadsheets and analyzed statistically both in descriptive and analytical manners, with the aid of Microsoft SPSS software. It was presented in tables, pie charts, histograms and bar graphs.

Inclusion and exclusion criteria.

A case patient in this study is defined as one who sustained physical injury incurred during the blast or while escaping.

All patients injured in the blast and treated at Kenyatta National Hospital during the emergency or rehabilitation periods were included in the study.

The emergency period for patients presenting with injuries runs seven days, from the day of blast 7th August 1998- 13th August 1998.

The rehabilitation period runs from 6 months after the blast to date.

I defined physical injury as any blunt or penetrating trauma or blast related injury, including thermal burns, inhalation injury and tympanic membrane rupture.

People injured during the search and rescue process were excluded from the study.

Study limitations.

Some patients involved in the bomb blast were treated at other medical institutions other than Kenyatta National Hospital and did not present themselves for the rehabilitation program. The details of their injuries are therefore not available in the KNH database.

The study population therefore will not have 100% of those injured following the August 7th bombing of the American embassy in Nairobi.

It is also noted that a few patients with none bomb blast related injuries may have escaped the thorough screening process and presented themselves for treatment so that they could take advantage of the free services rendered, and the financial compensation that was distributed to bomb victims.

Their numbers are small and are unlikely to be significant.

Ethical considerations.

In this retrospective study, data was obtained from the medical records of all patients treated for bomb blast injuries. The information obtained was handled in a manner to ensure privacy and confidentiality. The patient's consent was not sought, as this is a retrospective study.

Strategies for ensuring confidentiality.

- Limiting access to the research data and storing data in locked file cabinets.
- Coding data to hide the identity of patients, and ensuring the individual subjects cannot be identified when the findings are published.
- Destroying questionnaires and datasheets after completion of the study.

RESULTS:

Medical records of patients who were treated at Kenyatta National Hospital for bomb blast related injuries were reviewed, and the information entered into a questionnaire. The data was then entered into Microsoft excel and SPSS software and was analyzed using the same. Some of the records were incomplete, regarding information such as description of injury, and details regarding how the injury was caused.

A total of 1471 persons injured during the August 1998 bomb blast were treated at the Kenyatta Hospital, 646 within the first 24 hours after the blast, the remaining (825) during the screening and reconstruction period (Table 1). There was a predominance of males 801 (54.5%), compared with females 669 (45.5%); similar to the gender profile of Nairobi province where 53.83% of the population is male and 46.13% is female.³⁴ The gender was not indicated in 1 person's records (Table 2).

TABLE 1: INSTITUTIONS WHERE PERSONS WERE FIRST SEEN

	PLACE (Abrev.)	FREQUENCY	PERCENTAGE
African Air Rescue clinics	AAR	10	0.68%
Armed Forces Memorial Hosp	AFM	41	2.79%
Aga Khan Hospital	AKH	85	5.78%
Avenue Hospital	AHC	17	1.16%
Guru Nanak Hospital	GNH	24	1.63%
Hurlingham hospital	HMC	19	1.29%
Kenyatta National Hospital	KNH	646	43.92%
Mater Hospital	MMH	124	8.43%
MP Shah Hospital	MPS	35	2.38%
Masaba Hospital	MSB	46	3.13%
Nairobi Hospital	NH	145	9.86%
Other	OTHER	251	17.06%
Not indicated	NI	28	1.90%
	TOTAL	1471	100.00%

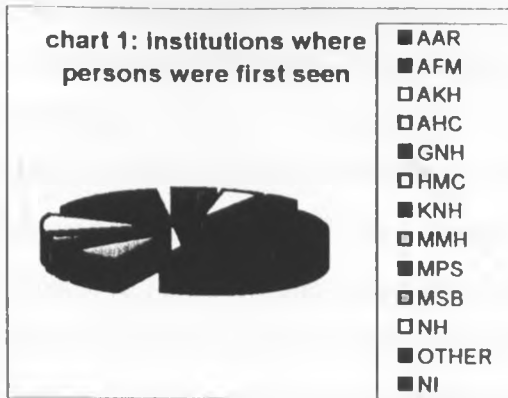
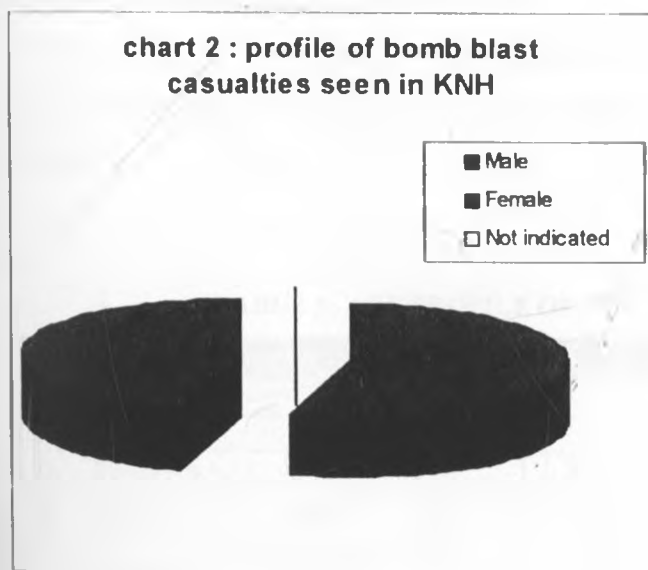


TABLE 2: SEX PROFILE OF BOMB BLAST CASUALTIES SEEN IN KNH

	FREQUENCY	PERCENTAGE
Male	801	54.5%
Female	669	45.5%
Not indicated	1	0.1%
Total	1471	100.0%



The 825 (56.08%) persons first seen during the screening and reconstruction period were first seen at various medical facilities, 251 (17.06%) by private practitioners and health centers, and 145 (9.86%) in the Nairobi Hospital, 124 (8.43%) at Mater Hospital and 85 (5.78%) at the Aga Khan Hospital.

The remaining were seen at the other major hospitals in Nairobi, including Masaba, Armed Forces Memorial, Guru Nanak, Avenue Hospital and African Air Rescue clinics (Table 1).

58.54% of the survivors were first seen in Kenyatta National Hospital and the hospitals around it. It is noteworthy that among the private hospitals, Nairobi Hospital; which is closest to KNH saw the most patients, followed by the church owned Mater hospital. Considering that most of the injured were transported to hospitals in private cars and public transport vehicles (matatus), this distribution seemed to be determined by the status of KNH as a public hospital and its close proximity to the accident site.³⁵ The route map to KNH and the hospitals around it was more direct compared with the other hospitals where one had to drive through heavy traffic in the central business district.³⁶

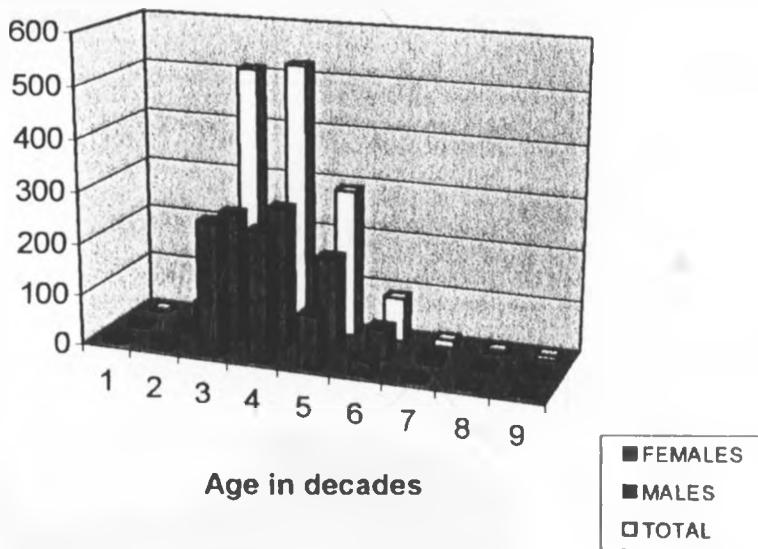
The age profile of the injured differed from that of Nairobi province in that the extremities of age were under represented,³⁷ an observation that may be obvious considering that the bomb blast occurred in a commercial area where most of the population comprises the working class.

71.6% of the survivors were between 20 and 40 years old, and 20% between 40 and 50 years old. Only 2.3% of the patients were below 20years, and 7.4% above 50 years (Table 3).

TABLE 3: AGE PROFILE OF THE STUDY GROUP.

RANGE	FEMALES	MALES	TOTAL	% FEMALES	% MALES	% TOTAL
1). 1-9yrs	3	2	5	0.4%	0.2%	0.3%
2). 10-19yrs	14	15	29	2.1%	1.9%	2.0%
3). 20-29yrs	259	250	509	38.7%	31.2%	35.3%
4). 30-39yrs	253	270	523	37.8%	33.7%	36.3%
5). 40-49yrs	104	184	288	15.5%	23.0%	20.0%
6). 50-59yrs	29	58	87	4.3%	7.2%	6.0%
7). 60-69yrs	3	11	14	0.4%	1.4%	1.0%
8). 70-79yrs	1	5	6	0.1%	0.6%	0.4%
9). Not specified	3	6	9	0.4%	0.7%	0.6%
Total	669	801	1470	100.0%	100.0%	100.0%

chart 3 : bar graph of age profile of the study group



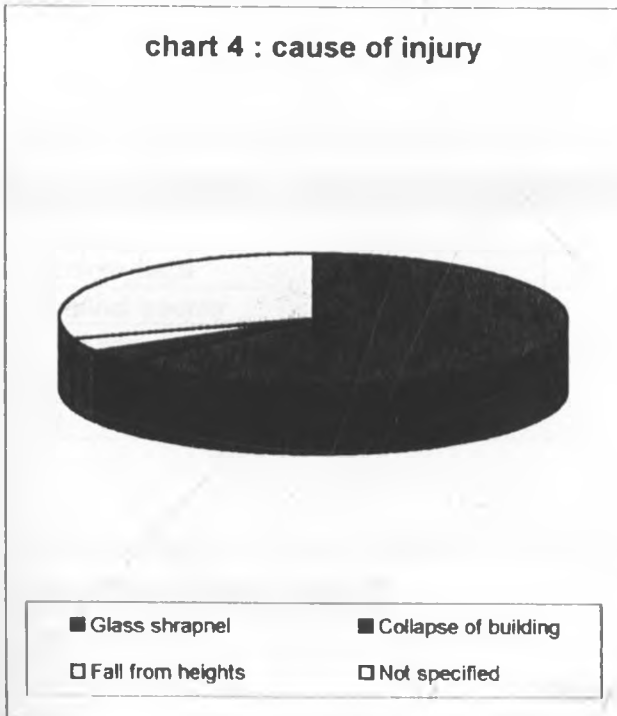
The age distribution for males and females was similar except in the 5th decade where out of 288 persons in total, 184 (63.8%) were male and 104 (36.2%) were female (Table 3). There was also a big discrepancy in the 6th and 7th decades where 3 times as many males were injured compared with females.

During screening for injuries sustained during the blast, survivors were interviewed on how they sustained their injuries. Though subjective, and unreliable^{1,4} 63% indicated their injuries were caused by glass or shrapnel, followed by falls in 3.5%, and building collapse 3.2%. In 30.2% of the cases; the cause of injury was not indicated (Table 4).

TABLE 4: CAUSE OF INJURIES

	FREQUENCY	
Glass shrapnel	987	63.0%
Collapse of building	52	3.3%
Fall from heights	55	3.5%
Not specified	473	30.2%
Total	1567	100.0%

chart 4 : cause of injury



NONFATAL INJURIES.

646 persons were seen at Kenyatta National Hospital within the first 24 hours of the blast. Of these, 111 (17.2%) were admitted, while the remaining were treated and discharged (Table 5). Similarity is drawn with the Belfast¹ and Oklahoma⁴ bombings where 14% and 16% of the victims were admitted respectively.

TABLE 5: OUTCOME OF PATIENTS SEEN ON THE DAY OF THE BLAST

OUT COME	NUMBER	%
ADMITTED	111	17.2%
TREATED & DISCHARGED	535	82.8%
TOTAL	646	100.0%

Of those admitted in KNH, 14 were to intensive care, while the remaining 97 were admitted to the emergency ward (Table 6a& b).

TABLE 6a: REASON FOR ADMISSION TO THE GENERAL WARD

Eye injury	18
Musculoskeletal	16
Abdominal trauma	2
Severe hemorrhage	6
Others	55
Total	97

TABLE 6b: REASON FOR ADMISSION TO THE ICU

INJURIES	FREQUENCY
HEAD INJURY	12
CHEST TRAUMA	2
TOTAL	14

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The criteria for admission was not clear, though the main reasons for admission were; eye injury requiring surgical intervention or slit lamp examination¹⁸, musculoskeletal injuries requiring surgery 16, anemia following hemorrhage from external wounds 6, other causes 55 (Table 6a).

Of those admitted to intensive care, 12 had head injury, while the other 2 had chest injuries requiring assisted ventilation (Table 6b). 7 of the patients admitted with head injury died, 2 of them within 4 hours of admission (Table 7).

The two persons admitted with chest injuries survived. No patient was diagnosed with blast lung, possibly because of the difficulty in diagnosing it.⁸ Because post-mortems

were not performed on all those who died at the site, it is unclear how much chest injury could have contributed to mortality.

7 of the patients with head injury had intracranial bleeds, 4 of them associated with compound depressed skull fracture. 1 of these patients had foreign bodies embedded in the brain substance. They all underwent surgery; the postoperative mortality was 3.

2 out of 3 patients with severe head injury with no intra cranial bleed died.

TABLE 7: OUTCOME OF PATIENTS WITH HEAD INJURY

	OPEN/ DEPRESSED FRACTURE	LINEAR FRACTURE	NO FRACTURE	TOTAL	SURVIVED	MORTALITY
Intracranial bleed	4	1	2	7	4	3
No intracranial bleed	0	2	1	3	1	2
Unknown	2	0	0	2	0	2
Total	6	3	3	12	5	7

The remaining 535 people seen had lacerations and cuts of various sizes and locations in the body.

332 had the wounds cleaned and sutured immediately, under local anesthesia (Table 8); 162 persons had wounds that did not require suturing. These were cleaned with antiseptic and dressed. They were advised to have the wounds dressed in a facility near their residence.

10 patients had wounds that were grossly contaminated with dust, pieces of clothing and glass fragments. The skin was cleaned with detergent antiseptic (savlon), before exploration under local anesthesia. All foreign material, dead and contaminated tissue was removed, then the wound was lightly packed and inspected after 3-5 days.

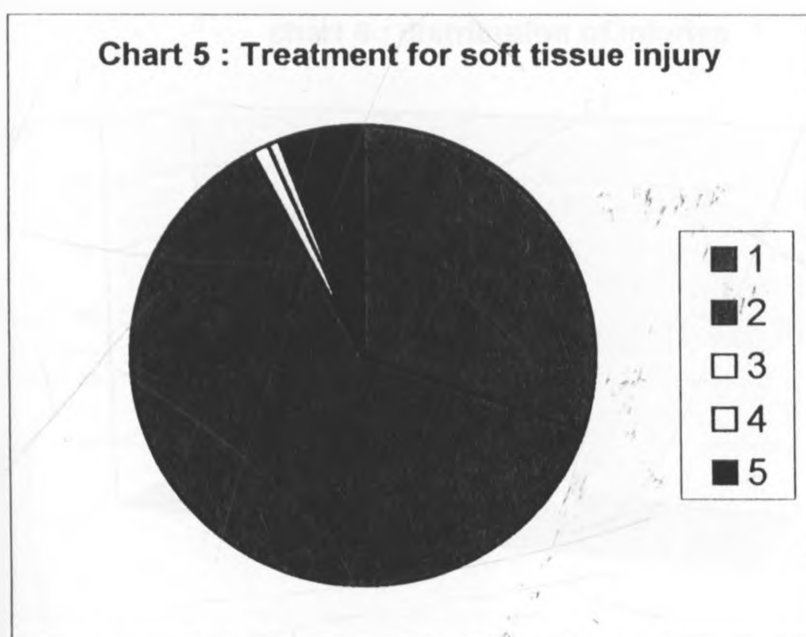
5 were sutured between the 5th and 7th day (delayed primary suturing) while the remaining 5 were sutured later (secondary suturing). No wound required skin grafting.

The patients also received tetanus prophylaxis and oral antibiotics. The antibiotic prescribed was either ampiclox or ampicillin.

TABLE 8: TREATMENT GIVEN AT KNH FOR PATIENTS WHO SUSTAINED SOFT TISSUE INJURY

TREATMENT	FREQUENCY
1). Cleaned & dressed	162
2). Cleaning & primary stitching	332
3). Cleaned, dressed then delayed primary suturing	5
4). Cleaned, dressed & secondary suturing	5
5). Not specified	31
Total	535

Chart 5 : Treatment for soft tissue injury

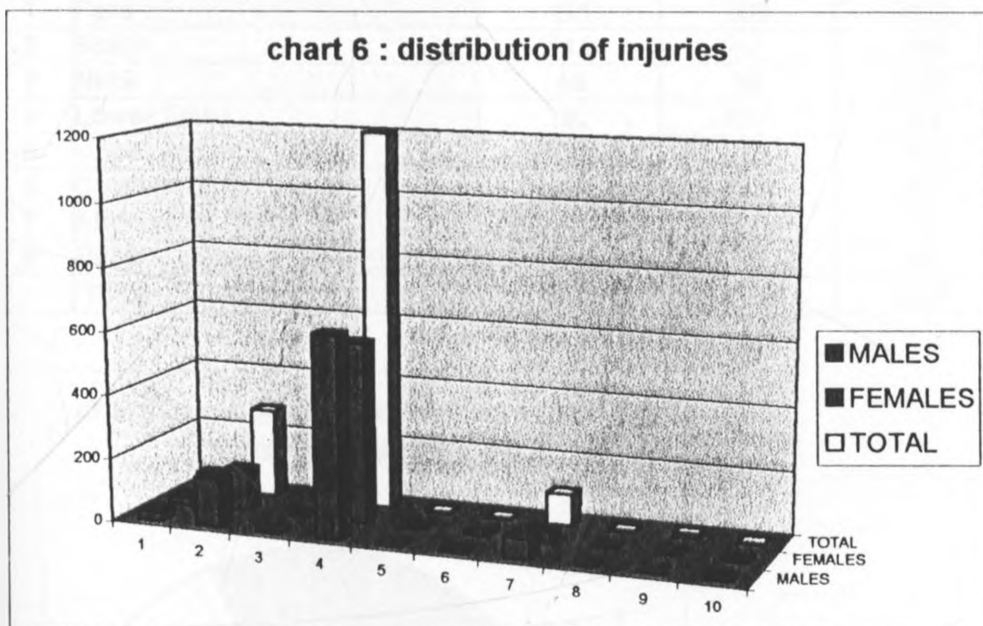


Like in other terrorist bombings^{1,4}, soft tissue injuries (lacerations, abrasions, contusions and puncture wounds) were the most common injury (72.8%) in the 1464 survivors, followed by eye (17%) and musculoskeletal (6.1%) injuries consecutively (Table 9). Ear injuries were seen in only 3% of the survivors.

TABLE 9: DISTRIBUTION OF INJURIES

SITE OF INJURY	MALES	FEMALES	TOTAL	% TOTAL
Ear	27	23	50	3.0%
Eye	150	129	279	17.0%
Nose	0	2	2	0.1%
Soft tissue injury	630	567	1197	72.8%
Abdominal injury	1	1	2	0.1%
Chest injury	2	1	3	0.2%
Injury to bone	64	34	98	6.0%
Blood vessel injury	1	0	1	0.1%
Nerve injury	3	8	11	0.7%
Spine	1	1	2	0.1%
Total	879	766	1645	100.0%

chart 6 : distribution of injuries



Among the 1197 persons with soft tissue injury, the most common location was the extremities (40.2%). In spite of the small body surface area they occupy, soft tissue injury of the face and the scalp occurred in 38.9% (Table 10) of the survivors.

The severity of soft tissue injury was not indicated. Some patients had injuries at more than one location. Hadden et al¹ and Sue Mallone⁴ also noted a predominance of extremity injuries following terrorist bombings.

More males sustained injury to the face (425) and scalp (112), compared with females (388 & 57) respectively (Table 10). Conversely, more females (327) had lower limb soft

tissue injury compared with their male (192) counterparts. The occurrence of soft tissue injury to the trunk was similar in both sexes.

The upper limb, chest, abdomen and back were affected in relatively equal proportions in both sexes.

The distribution of this injuries in relation to the regions of the body suggested the protective value; of trousers in men to the lower limbs, and headgear in females to the head.^{1,4}

TABLE 10: REGIONAL DISTRIBUTION OF SOFT TISSUE INJURIES

	SITE	MALE	FEMALE	TOTAL	% Of Total
1	Face	425	388	813	32.2%
2	Scalp	112	57	169	6.7%
3	Neck	48	98	146	5.8%
4	Lower limbs	192	327	519	20.6%
5	Upper limbs	239	255	494	19.6%
6	Chest	103	114	217	8.6%
7	Abdominal wall	47	27	74	2.9%
8	Back	51	38	89	3.5%
	Total	1217	1304	2521	100.0%

chart 7a : regional distribution of soft tissue injuries

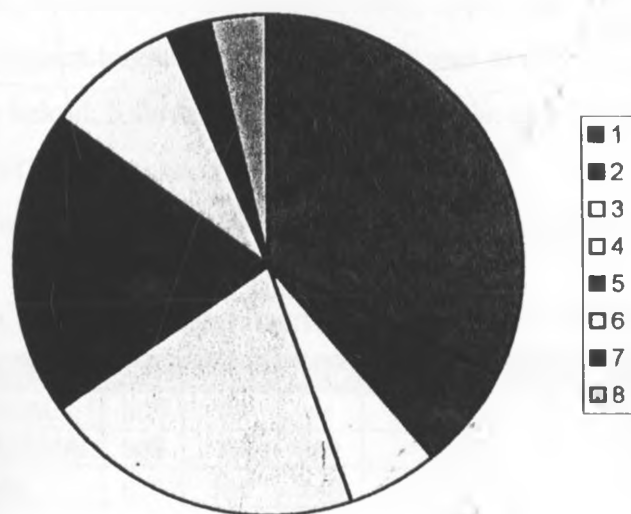
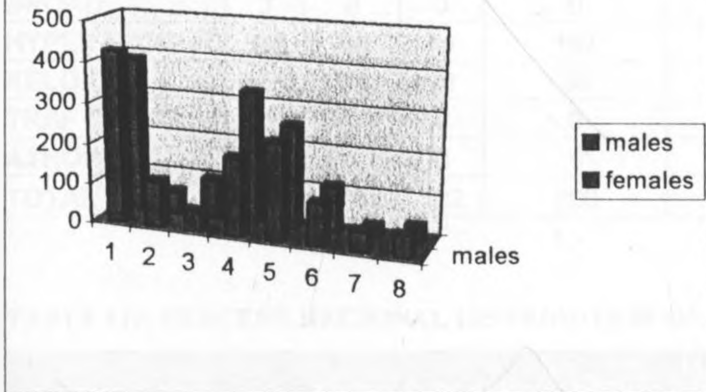


chart 7b : sex difference in regional distribution of soft tissue injury



Abnormal scars as a consequence of soft tissue injury occurred in 69.8% of the survivors who sustained neck injuries and 62% of those who had soft tissue injury to the head (Table 11b). The back, abdomen and upper limbs had less than 40% of the survivors with soft tissue injury developing abnormal scars.

For all sites, hypertrophic scars accounted for more than 66% of the abnormal scars, followed by keloid, accounting for 19% to 33%.

The highest occurrence of hypertrophic scars was in the scalp (81%) and lower limbs (81%), followed by the face (75.8%), upper limbs (77%) and back (75%) (Table 11b).

The highest tendency to form keloids was in the chest where 32.8% of the abnormal scars were keloid, followed by the neck (27.5%), abdomen (26.7%), back (25%) and upper limbs (22.5%) respectively.

The scalp and face accounted for the lowest occurrence of keloid.

TABLE 11a: REGIONAL DISTRIBUTION OF ALL SCARS

	FACE	SCALP	NECK	LOWER LIMBS	UPPER LIMBS	CHEST	ABDOMEN	BACK
NORMAL	308	90	44	319	290	101	44	57
ABNORMAL	505	79	102	200	204	116	30	32
TOTAL	813	169	146	519	494	217	74	89

TABLE 11b: REGIONAL DISTRIBUTION OF ABNORMAL SCARS

	FACE	SCALP	NECK	LOWER LIMBS	UPPER LIMBS	CHEST	ABDOMEN	BACK
BROAD	3	0	0	0	1	1	0	0
HYPERTROPHIC	383	64	74	162	157	77	22	24
KELOID	111	14	28	38	46	38	8	8
TRAP DOOR	7	0	0	0	0	0	0	0
ATROPHIC	1	1	0	0	0	0	0	0
TOTAL	505	79	102	200	204	116	30	32

TABLE 11c: PERCENT REGIONAL DISTRIBUTION OF ABNORMAL SCARS

	FACE	SCALP	NECK	LOWER LIMBS	UPPER LIMBS	CHEST	ABDOMEN	BACK
BROAD	0.6%	0.0%	0.0%	0.0%	0.5%	0.9%	0.0%	0.0%
HYPERTROPHIC	75.8%	81.0%	72.5%	81.0%	77.0%	66.4%	73.3%	75.0%
KELOID	22.0%	17.7%	27.5%	19.0%	22.5%	32.8%	26.7%	25.0%
TRAP DOOR	1.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
ATROPHIC	0.2%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

The treatment given for hypertrophic scars at various sites was varied, but the majority of patients had excision of scar alone (Table 12). Scars were mainly revised for cosmetic reasons.

Out of 430 people with hypertrophic scars on the face, 52.1% had excision only, and only 20.2% had excision followed by radiotherapy: 10.9% had Z-plasty.

64 patients with hypertrophic scars on the scalp were mainly treated by steroid injections (31.3%), excision (29.7%) and pressure garments (21.9%).

37.8% of the people with hypertrophic scars in the neck (Table 12) had Z-plasty scar revision, 27% excision followed by radiotherapy and 21.6% excision alone.

Most of the patients (60.5%) with hypertrophic scars in the lower limbs were left alone, while (24.1%) were put on pressure garments.

39.5% of the 157 patients with hypertrophic scars in the upper limbs had them excised, while 28.7% were given pressure garments.

81.9% of the 77 patients with hypertrophic scars on the chest had excision of the scars, 44% of these were followed up with steroid injections and 31.7% radiotherapy.

Most of the hypertrophic scars on the back (33.3%) and the abdomen (36.4%) were left alone while 25% and 36.4% respectively were excised and injected with steroid.

The method of scar revision was as varied as the surgeons who operated on the patients. Suffice to note; general and orthopedic Surgeons carried some of the operations out.

TABLE 12a: TREATMENT OF HYPERTROPHIC SCARS

	FACE	SCALP	NECK	LOWER LIMB		CHEST	ABDOMEN	BACK
EXCISION ONLY	224	19	16	22	62	20	0	6
EXCI. AND RAD.	87	0	20	0	24	28	0	0
EXCI. AND STEROID	20	2	6	3	2	15	8	6
STEROID ONLY	0	20	2	0	0	6	6	4
PRESSURE GARMENT	48	14	0	39	45	0	0	0
LEFT ALONE	4	6	2	98	24	8	8	8
Z-PLASTY	47	3	28	0	0	0	0	0
TOTAL	430	64	74	162	157	77	22	24

TABLE 12b: % TREATMENT OF HYPERTROPHIC SCARS

	FACE	SCALP	NECK	LOWER LIMB	UPPER LIMB	CHEST	ABDOMEN	BACK
EXCISION ONLY	52.1%	29.7%	21.6%	13.6%	39.5%	26.0%	0.0%	25.0%
EXCI. AND RAD.	20.2%	0.0%	27.0%	0.0%	15.3%	36.4%	0.0%	0.0%
EXCI. AND STEROID	4.7%	3.1%	8.1%	1.9%	1.3%	19.5%	36.4%	25.0%
STEROID ONLY	0.0%	31.3%	2.7%	0.0%	0.0%	7.8%	27.3%	16.7%
PRESSURE GARMENT	11.2%	21.9%	0.0%	24.1%	28.7%	0.0%	0.0%	0.0%
LEFT ALONE	0.9%	9.4%	2.7%	60.5%	15.3%	10.4%	36.4%	33.3%
Z-PLASTY	10.9%	4.7%	37.8%	0.0%	0.0%	0.0%	0.0%	0.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

All the patients with keloid scars on the face (111) had them excised. 93.7% also had radiotherapy, and the remaining (6.3%) received steroid injections (Table 13b), in keeping with the common practice in KNH.

Excision and radiotherapy was performed for most of the keloids at other sites; scalp (50%), neck (64.3%), chest (68.4%), upper limb (65.2%) and lower limb (47.4%) respectively.

75% of the patients with keloids on the back and abdomen had excision only, while 25% were left alone. 36.8% of the 28 patients with keloid in the lower limb were left alone.

TABLE 13a: TREATMENT OF KELOIDS

	FACE	SCALP	NECK	LOWER LIMB	UPPER LIMB	CHEST	ABDOMEN	BACK
EXCIS. & RAD.	104	7	18	18	30	26	0	0
EXCIS AND STEROID	7	1	5	4	4	5	6	6
EXCIS. ONLY	0	4	2	2	10	3	0	0
LEFT ALONE	0	2	3	14	2	4	2	2
TOTAL	111	14	28	38	46	38	8	8

TABLE 13b: PERCENTAGE TREATMENT OF KELOIDS

	FACE	SCALP	NECK	LOWER LIMB	UPPER LIMB	CHEST	ABDOMEN	BACK
EXCIS. & RAD.	93.7%	50.0%	64.3%	47.4%	65.2%	68.4%	0.0%	0.0%
EXCIS AND STEROID	6.3%	7.1%	17.9%	10.5%	8.7%	13.2%	75.0%	75.0%
EXCIS. ONLY	0.0%	28.6%	7.1%	5.3%	21.7%	7.9%	0.0%	0.0%
LEFT ALONE	0.0%	14.3%	10.7%	36.8%	4.3%	10.5%	25.0%	25.0%
TOTAL	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

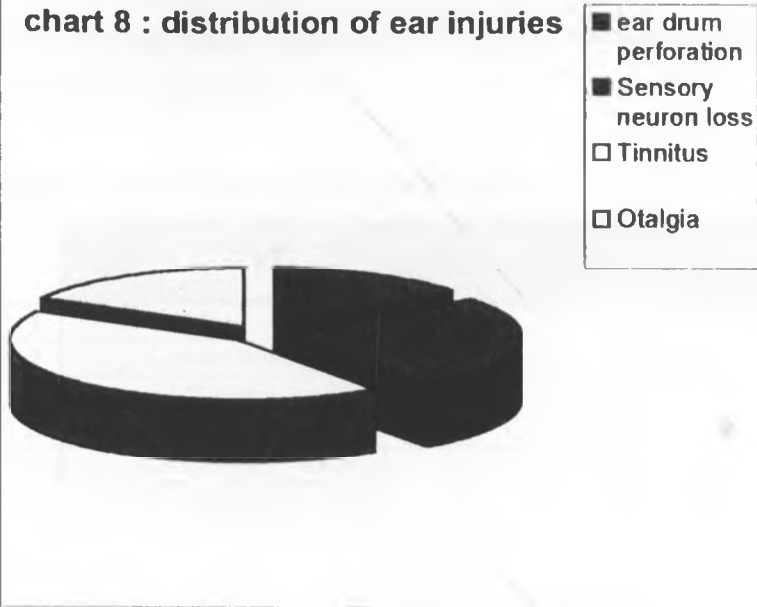
Only 50 (3%) survivors sustained auditory damage (Table 9), in a total of 70 ears (Table 14). As observed by Kerr & Byrne¹; Waterworth & Carr³; and Keith & Allan⁶; auditory injury following blasts is often under diagnosed because of the difficulty in performing auditory examination on such a large number of patients. More over patients often have more severe or visible injuries, and so tend to ignore the ears until they experience persistent hearing loss.

The mechanism of injury to the ear was difficult to establish, as the diagnosis was often made late.

The commonest diagnosis was tinnitus (30 ears), followed by sensory neuron hearing loss of varying severity (18 ears), and undiagnosed otalgia (12 ears). There were 10 eardrum perforations.

TABLE 14: DISTRIBUTION OF EAR INJURIES

	FREQUENCY
Ear drum perforation	10
Sensory neuron loss	18
Tinnitus	30
Otalgia	12
Total	70

chart 8 : distribution of ear injuries

Only 3 survivors sustained chest injuries (Table.9). 1 sustained blunt trauma causing multiple rib fractures, lung contusion and haemopneumothorax (Table15). He was admitted into intensive care for assisted ventilation and underwater seal drainage. He fully recovered.

One person sustained a penetrating injury to the chest with torn diaphragm and a pneumothorax. The diaphragmatic tear was successfully repaired at thoracotomy. He recovered after 5 days of underwater seal drainage. The remaining survivor had respiratory difficulty following blunt trauma, with no radiological evidence of intrathoracic pathology. He recovered fully after treatment with bronchodilators, expectorants and analgesics.

2 survivors had abdominal wall hematomas following blunt trauma to the abdomen. None required a laparotomy. They both recovered fully after analgesics and bed rest.

A total of 97 survivors sustained fractures; 46.4% of these involved the lower limb and 44.3% involved the upper limb (Table 15). There was only one patient with spinal injury associated with a burst fracture of the 1st lumbar vertebrae. 6 patients sustained skull fractures.

Most of the upper limb fractures involved bones of the fingers (44.19%), followed by fractures of the radius and ulna (32.56%) and fractures of the humerus (20.93%) respectively (Table16).

TABLE 15: DISTRIBUTION OF FRACTURES

	REGION	CLOSED FRACTURE	OPEN FRACTURE	TOTAL	% Total FRACTURES
1	Upper limb	25	18	43	44.3%
2	Lower limb	42	3	45	46.4%
3	Spine	1	0	1	1.0%
4	Pelvis	2	0	2	2.1%
5	Skull	3	3	6	6.2%
	Total	73	24	97	100.0%

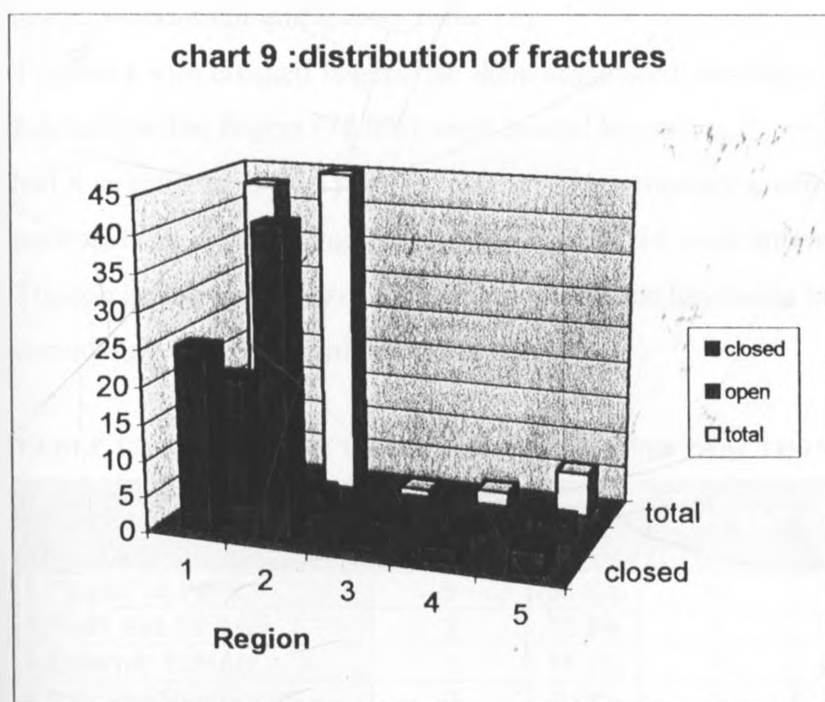


TABLE 16: DISTRIBUTION OF UPPER LIMB FRACTURES

	Bone	CLOSED FRACTURE	OPEN FRACTURE	TOTAL	% UPPER LIMB FRACTURES
1	Scapula	1	0	1	2.33%
2	Humerus	8	1	9	20.93%
3	Radius/ Ulna	14	0	14	32.56%
4	Bones of the hands & fingers	2	17	19	44.19%
	Total	25	18	43	100.00%

5 (55.6%) out of 9 patients with fractures of the humerus were treated by U-slab (Table 17), while 3 (33.3%) had open reduction and internal fixation with plates and screws. Only 1 person had intra-medullary nail fixation. 5 out of 8 of these patients ended up with fracture malunion, another 2 with non-union (at 8 months), and only 1 with osteomyelitis (Table 18).

The 2 patients with fracture non-union had transverse mid shaft fractures and so may have affected the nutrient artery. These complications compared well with the findings of Rusagara 1991.³⁸

11 out 14 (78.6%) patients with fracture radius and ulna were treated non-operatively using plaster of Paris casts, the remaining had operative fixation (Table 17). They all healed without complications (Table 18).

4 patients with crushed fingers had them amputated; the majority of survivors with fractures of the fingers (78.9%) were treated by casting. 1 person with a mangled hand had it amputated (Table 17). She developed postoperative osteomyelitis. Of the 15 patients treated by casting for fractured fingers, 14 went into malunion (Table 18).

Though important, no indication was made on the functional impairment of the fingers, considering the method of immobilization.³⁹

TABLE 17: TREATMENT GIVEN FOR UPPER LIMB FRACTURES

	HUMERUS		RADIUS & ULNA		FINGER INJURIES		CRUSHED HAND
	FREQUENCY	%	FREQUENCY	%	FREQUENCY	%	FREQUENCY
1.Plaster of Paris	5	55.6%	11	78.6%	15	78.9%	0
2.Plate and Screws	3	33.3%	2	14.3%	0	0.0%	0
3.External fixators	1	11.1%	0	0.0%	0	0.0%	0
4.Inter-medullary nail	0	0.0%	1	7.1%	0	0.0%	0
5.Amputation	0	0.0%	0	0.0%	4	21.1%	1
	9	100.0%	14	100.0%	19	100.0%	1

chart 10a : treatment given for fractures of the humerus



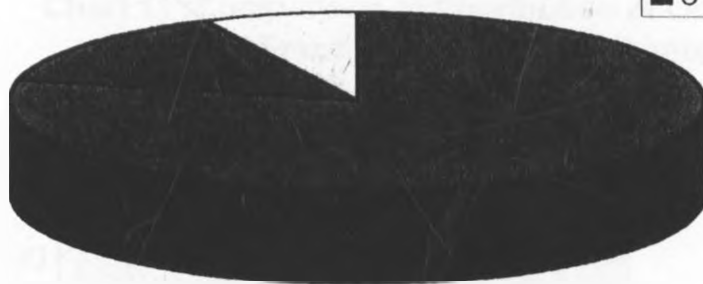
■ Plaster of Paris

■ Plate and Screws

External

□ Fixators

chart 10b : treatment given for fracture radius/ulna



■ 1

■ 2

□ 3

□ 4

■ 5

TABLE 18: COMPLICATIONS FOLLOWING TREATMENT OF UPPER LIMB FRACTURE

COMPLICATION	HUMERUS	RADIUS/ULNA	FINGER INJURIES	HAND	Total
Malunion	5	0	14	0	19
Non-union	2	0	0	0	2
Osteomyelitis	1	0	0	0	1
Total	8	0	14	0	

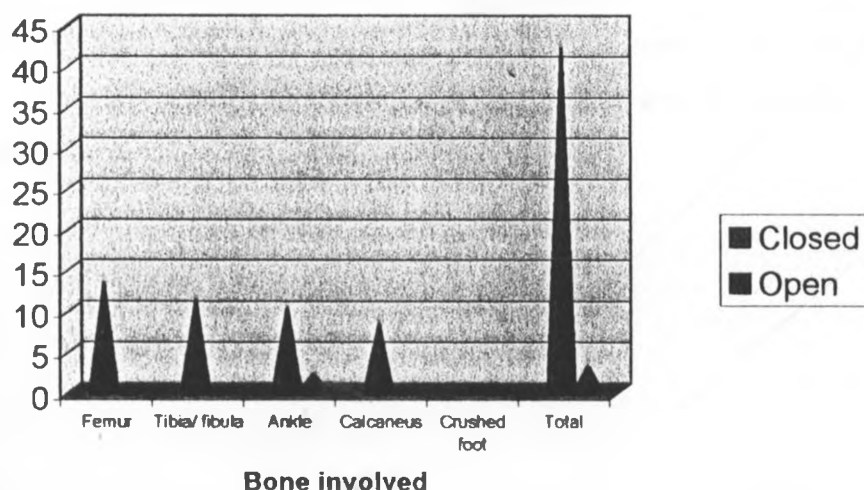
Long bone fractures of the lower limb occurred in relatively equal proportions; femur 13 (28.9%); tibia/fibula 11 (24.4%). 12 patients had ankle joint fracture/ dislocation, and 8 (17.8%) had fractures of the calcaneus's, 2 of these were bilateral fractures of the calcaneus's (Table 19).

TABLE 19: DISTRIBUTION OF LOWER LIMB FRACTURES

BONE INVOLVED	TYPE OF FRACTURES		TOTAL	% OF TOTAL
	CLOSED	OPEN		
Femur	13	0	13	28.9%
Tibia/ fibula	11	0	11	24.4%
Ankle	10	2	12	26.7%
Calcaneus	8	0	8	17.8%
Crushed foot	0	1	1	2.2%
Total	42	3	45	100.0%

8 of the survivors with fractures of the femur had traction; which translated into a long hospital stay.⁴⁰ 5 had open reduction and internal fixation; 3 using plates and screws; 2 intra-medullary nails (Table 20). The 8 fractures of the femur treated by traction not surprisingly healed with mal-union (Table 21).

Chart 11 :Comparison of Distribution of Open and Closed Fractures of the Lower Limbs



10 out of 11 fractures of the tibia/fibula were immobilized in casts; only 1 patient had open reduction and internal fixation using plates and screws. 7 out of 11 limbs with fracture tibia/fibula ended up in mal union, while 1 had non-union at 8 months. While the patient with non-union was lost to follow up none of those with mal union required surgical intervention.

TABLE 20: TREATMENT FOR FRACTURES OF THE LOWER LIMBS

	PLASTER		INTRAMEDULLARY		
	TRACTION	OF PARIS	PLATING	NAIL	AMPUTATION
Femur	8	0	3	2	0
Tibia/ fibula	0	10	1	0	0
Ankle	0	10	2	0	0
Calcaneus	0	8	0	0	0
Crushed foot	0	0	0	0	1

TABLE 21: COMPLICATIONS FOLLOWING TREATMENT FOR LOWER LIMB FRACTURES

	FEMUR	TIBIA/ FIBULA
Malunion	8	7
Non-union	0	1
Osteomyelitis	0	0

FATAL INJURIES.

14 patients were admitted into intensive care, 8 of them died within the first 12 hours of admission. Of those who died, 7 died from severe head injury, while one died after surgery for axillary artery injury. No deaths were reported in the patients admitted into general wards.

DISCUSSION:

Terrorist bombings are ugly acts of modern life that are widely distributed the world over. The Aug 7th bombing of the American Embassy in Nairobi; which also affected the neighboring Cooperative and Ufundi House buildings was the worst experience Kenya has so far had with terrorism. The dual explosion injured civilians and non-suspecting rescuers, living 213 dead, and many more injured at site with a massive scale of confusion.

Understanding the epidemiology of the injuries sustained, and the accompanying complications are imperative in efforts to save lives and reduce morbidity should future bombings occur.

A total of 1471 persons were seen at Kenyatta National Hospital due to injuries following the August 7th bomb blast. 56% of these were seen for the first time during the reconstruction period, having been treated at private hospitals and clinics immediately after the blast.

It affected both males and females from the most productive age group in the society (table 3), hence the major economic implications.

Most of the injured were rapidly evacuated from the site to hospitals by civilians in private and public transport vehicles, most of them landing in the public hospital. Those performing the initial evacuation did it at random as they lacked proper coordination and first aid knowledge.

Once in hospital, medical personnel who were prepared for they had been for warned readily received the survivors.

Most of the injuries sustained by the survivors were caused by glass and flying debris, and were minor soft tissue injuries that required outpatient treatment; cleaning and dressing; suturing in the casualty department or minor theatre; oral antibiotics and tetanus prophylaxis.

These injuries were commoner in exposed areas of the body, such that more males sustained soft tissue injury to the face compared with the females, whereas more females had lower limb injuries. The regional distribution of the injuries suggests the protective role of clothing and headgear.

Abnormal scar formation was the commonest complication following these injuries, with hypertrophic scars accounting for more than 66% of them.

Scar revision was performed in 80% of the hypertrophic scars on the face and scalp, as compared with less than 75% for scars on the trunk and the extremities. Most of this was fusiform scar revision (excision). The method of scar revision was varied considering that some of the physicians performing the operations were not specialists in plastic and reconstructive surgery.

Keloids accounted for less than 32% of the abnormal scars. All the keloids occurring on the face were excised and then followed up with superficial radiotherapy in 94% of the cases, the remaining 6% receiving steroid injections.

Patients were admitted mainly for injuries that required specialized examination and treatment or surgical correction in the main theatre. This included eye injuries, and extensive musculoskeletal injuries.

Skeletal injury was not common, affecting only 6% of the survivors. Most of the fractures involved the long bones of the upper and lower limbs in relatively equal proportions.

Most of these were treated conservatively with relatively good outcome.

Among those who died in hospital, 7 out of 8 died from severe head injury. All the deaths occurred within 12 hours of admission onto hospital.

CONCLUSION:

Despite the fact that explosions vary greatly in the numbers of victims they claim and the nature of injuries they inflict, several general conclusions may be drawn:

1. The majority of patients sustain minor soft tissue injuries, mainly caused by flying glass and debris and may be treated as outpatients.
2. Injuries predominantly affect the head and neck and peripheries, suggesting that clothing has a protective role.
3. Although injuries to the chest and abdominal organs are uncommon after explosions, they are associated with a high morbidity.
4. Primary blast injuries to the lungs are infrequently seen in survivors. It is possible they may be responsible for some deaths occurring before the victims arrive in hospital.
5. Scars are the most frequent complication following blast injury and so form the bulk of work during reconstruction.

Both public and private medical care delivery institutions were involved in looking after the blast victims especially in the acute stage. All health care delivery institution should therefore be well equipped and stocked to enhance preparedness in the event of similar disasters.

Apart from treating physical injuries and their associated complications, much attention should be directed to the mental health consequences for all persons directly involved in the blast, especially those with disabling, disfiguring injuries.

RECOMMENDATIONS:

Planning for a disaster presents many difficulties as most of the time it is not anticipated. The great challenge to medical personnel following disasters is the large number of patients who arrive at the hospital emergency departments at the same time. The second difficulty arises from the multidisciplinary nature of disaster planning both in and outside the hospital.

Out side hospital it involves medical services as well as the police, ambulance and fire services, and in most situations volunteers.

The police and firemen, headed by a senior officer should readily be available to control the emotionally charged atmosphere filled with terrified persons, curious spectators and people who genuinely want to help the injured. The police should also immediately clear roads to allow for rapid movement of vehicles bringing in supplies and those transporting the injured to medical institutions.

A senior medical officer and ambulance teams should be available on site to facilitate the immediate evacuation of victims bearing in mind the seriousness of their injuries. The first point of triage therefore should be the accident site.

In hospitals, a command structure (disaster management team) comprising of senior officers from the medical, nursing and administrative fields should immediately be constituted (within 10-15 minutes). This is only possible if all hospitals have people clearly responsible for these roles, who should at all times carry communication equipment.

Their responsibility is to monitor both the influx of casualties and arrival of staff, assign duties to and mobilize additional staff and resources as necessary.

The disaster plans drawn should fit into daily routines as much as possible as the more procedures depart from daily routine; the more mistakes are likely to be made.

Points of triage should be set up within the hospital; on arrival, patients should be sorted out to allow optimal utilization of resources.

The worst cases should be moved to the resuscitation room, and the less serious to cubicles. Those with minor injuries can be made to share cubicles. The casualty nurse can do the actual placement of patients in cubicles very well, while the casualty consultant allocates doctors to specific patients, cubicles or areas of the department.

A suturing area should be set up outside the emergency department.

A senior doctor should screen all admissions and requests for radiology.

A senior surgeon should decide all priorities for the operating theatre.

The importance of documentation has to be emphasized. This prevents duplication of procedures and also ensures safe management of patients both immediately following the disaster, and the reconstruction period. They are also important for audit and litigation.

Medical record personnel should ensure that all those handled have basic case records made in triplicate. One copy accompanies the patient while the other is filled at each treatment station, and there after handed over to one office where all records are consolidated and updated. The 3rd copy should be handed over to a central national authority for filing. They should all bear the patients name gender and address, a diagnosis and disposal (admission, transfer, discharge etc).

It should be mandatory that all hospitals and physicians who treat casualties from disasters file case records at the central authority.

For those being admitted it is noted whether their condition is critical, serious or fair. All procedures carried out on patients should be recorded in duplicate, one copy accompanying the patient. To ensure that all patients are recorded, the department can be organized such that only one way remains for patients to get out of the casualty department.

All the casualties admitted must be reassessed frequently to make sure no life threatening injuries are missed.

To ensure continued preparedness, each hospital should have a disaster budget, and arrange for disaster rehearsals, maybe every 2 months.

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APPENDIX:**PRO-FORMA QUESTIONNAIRE**

Study Number:

Hospital Reg No.

Name

Sex

Age

Race

1. Were the injuries fatal? If yes, go to Q 10
 - a) Was there ear injury?
 - b) Indicate which type of injury was present, by a tick.
 - i. Perforated Tympanic membrane
 - ii. Persistent loss of hearing
 - iii. Others
 - c) If perforated tympanic membrane, how was it treated?

2. Chest Trauma
 - a) Was there lung injury? Yes No
 - b) What was the cause?
 - I. Blunt chest trauma
 - II. Penetrating Chest injury
 - III. Unspecified
 - c) What was the type of lung injury? Tick as necessary.
 - i. Lung contusion and bruising on X-ray, mild to moderate dyspnoea, or Haemoptisis with minimal dyspnoea.
 - ii. Severe lung trauma, respiratory distress, or Haemo or pneumothorax
 - d) How was this injury treated? Specify whether;
 - iv. Artificial ventilation
 - v. UWSD
 - vi. Thoracotomy
 - vii. Others
 - e) Which chest complication was present?

3. Abdominal Trauma

a) Was there abdominal Injury?

b) What is the possible cause of this injury?

- I. Blunt abdominal trauma
- II. Penetrating Injury
- III. Unspecified.

c) Indicate the type of injury to any of the listed types of organs if present.

i. Intestines -Small

-Large

ii. Liver or Gall bladder

iii. Pancreas

iv. Spleen

v. Peritoneum and mesentery

vi. Kidney, bladder and ureters

vii. Blood vessels (specify)

viii. Nerves (specify)

d) How were this treated

a. Non-operative (specify)

b. Operative (specify)

e) Which complications were encountered as a result of this injury?

4. Soft Tissue Injury:

a) Did the patient sustain soft tissue injury?

b) Indicate the type and anatomical site of injury using the stated guidelines and regions of the body.

I. Head and Neck

II. Arms

III. Legs

IV. Trunk

i. Bruising/contusion or haematoma.

ii. Puncture wounds; lacerations/cuts

iii. Abrasions/friction burns;

iv. Avulsion/crush injury.

c) Indicate how these injuries were treated, using the treatment guideline below.

i. Cleaning, and then dressing with antiseptics or local antibiotics.

ii. Cleaning, debridement and then primary suturing.

iii. Cleaning, debridement and then delayed primary or secondary suturing.

iv. Other type of treatment (specify).

i) Bruising/contusion or haematoma:

- I. Head and neck
- II. Upper limb
- III. Lower limb
- IV. Trunk

ii) Puncture wounds and lacerations/cuts:

- I. Head and Neck
- II. Upper limb
- III. Lower Limb
- IV. Trunk

iii) Abrasions/friction burns:

- I. Head and neck
- II. Upper limb
- III. Lower limb
- IV. Trunk

iv) Avulsion injuries

- I. Head and neck
- II. Upper limb
- III. Lower limb
- IV. Trunk

d) Indicate the outcome of all of the above stated injuries

i) Normal scar

Site:

ii) Hypertrophic scar

Site:

iii) Keloid

Site:

iv) Contracture

Site:

c) How were the complications treated?

i) Hypertrophic scars

- I. Head and neck
- II. Upper limbs
- III. Lower limbs
- IV. Trunk

ii) Keloid

- I. Head and neck
- II. Upper limbs
- III. Lower limbs
- IV. Trunk

iii) Contracture (state site, and treatment).

Specify how the complication was dealt with.

- a) Left alone
- b) Use of steroid crème
- c) Pressure garments
- d) Excision
 - i) FSR
 - ii) Z-plasty
 - iii) Y – V plasty
 - iv) Excision and skin grafting
- f) Indicate the results of treatment

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5. Burns:

- a) Did the patient sustain burns
 - Inhalation injury
- b) What is the cause of burns
- c) Indicate the anatomical site of burns and the severity.

d) How was this treated?

e) Was skin grafting necessary? If yes, was it done?

7. Fracture and dislocation

Indicate whether there were any fractures or dislocation, describe whether compound/simple or comminuted, and treatment given.

a)

b)

c)

d)

e)

f)

Did any of this end up in a complication?

Specify:

8. Indicate whether there was any limb amputation done as treatment, and the indication.

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9. a) Which type of eye Injury was present

a)

b)

c)

b) Did the patient develop blindness? Yes No . Specify possible cause

i) Partial

ii) Complete

10. For Fatal injuries only:

a) Indicate which injuries the patient sustained

b) What was the possible cause of death?

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Ref: KNH-ERC/01/1069

28 June 2001

Dr. Ikol J. Adung'o
Dept. of Surgery
Faculty of Medicine
University of Nairobi

Dear Dr. Adung'o,

**RESEARCH PROPOSAL "TERRORIST BOMB EXPLOSION IN NAIROBI, KENYA 7 AUGUST 1998:
AN ANALYSIS OF SOFT TISSUE AND OTHER INJURIES SUSTAINED AND THEIR
MANAGEMENT"** (P929/10/2000)

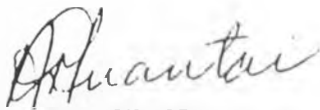
This is to inform you that the Kenyatta National Hospital Ethical and Research Committee has reviewed and approved the revised version of your above cited research proposal.

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 data base that will be consulted in future when processing related research study so as to minimize chances of study duplication.

Thank you.

Yours faithfully,


PROF. A.N. GUANTAI
SECRETARY, KNH-ERC

c.c. Prof. K.M. Bhatt,
Chairman, KNH-ERC,
Dept. of Medicine, UON.

Deputy Director (CS),
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The Chairman, Dept. of Surgery, UON

The Dean, Faculty of Medicine, UON