

**TITLE: THE EPIDEMIOLOGY OF OCULAR INJURIES AMONG PATIENTS PRESENTING TO PROVINCIAL HOSPITALS IN KWAZULU-NATAL, SOUTH AFRICA.**

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## ABSTRACT

**Purpose:** Ocular injuries are increasingly becoming the permanent cause of visual blindness (Mufti et al, 2004). Most of the previous studies in this area are done in countries outside the African context. A limited number of general surveys in ocular trauma appear in the ophthalmic literature in South Africa. The purpose of this study was to provide epidemiological data on ocular injuries among patients utilising the provincial hospitals eye services in KwaZulu-Natal, South Africa.

**Methods:** A quantitative retrospective study design was carried out by collecting data on 660 patient's record cards with ocular injuries presenting to four selected provincial eye care clinics for a four year period (January 2005-December 2008). Using a data sheet devised for capturing of the information, the following data was retrieved: (i) demographics details, (ii) place of trauma (iii) nature of trauma, (iv) type of injury, (v) management and (vi) visual outcomes following primary eye care. All patients who presented to the eye clinics with ocular injuries within the specified four years, both genders, all race groups and all age groups were included in the study.

**Results:** There were 440 patients' records reviewed at rural hospitals and 220 at urban hospitals. Males were more likely than females to have ever experienced an eye injury (72.3% versus 27.7%, respectively) and urban males were more likely than rural males to incur an eye injury (79.1% versus 68.9%, respectively). The Black population has a higher prevalence of ocular injuries than other race groups: Blacks 93.8% followed by Indians 3.9%, Coloureds 2% and the least in Whites 0.3%. Over one-third of all the patients were between 21 and 30 years old with second highest percentage of patients being in the age category of 31 to 40 years. A significant percentage of patients were children (13.8%) up to the age of 12 years. Open globe injuries were more frequent (56.2%) than closed globe injuries (43.8%). Blunt trauma/contusion was the most frequent type of injury (35.2%). More than half of patients (50.9%) had associated ocular signs with the predominance of haemorrhages (15.9%). The majority of the patients presenting with ocular signs had incurred blunt trauma (54%). Only 3.5% of all injuries were bilateral and 96.5% were unilateral.

Solid objects were responsible for more than half of the injuries (54.4%) occurring either in the home or at work, followed by assaults (24.3%) and chemical burns (6.2%). Three percent of patients' records (n=17) had substance (alcohol) abuse documented. The home accounted for the majority of the eye injuries (60.6%) followed by the social environment (15.2%), workplace or industry (13.6%), commercial workplace and agriculture had the same number of injuries (4.1%) and sports or leisure facilities (2.4%). The home remained the single most frequent place for an injury to occur across all age groups, highest in the 21 to 30 age group (26.8%, n=107) followed by 21.3% (n=85) in the 0 to 12 age group. Thirty patients (4.5%) required surgical intervention at initial presentation. Three hundred and forty patients (51.5%) returned for follow up examination. Only 9 (9.2%) patients with initial poor vision (<6/60) achieved 6/12 or better visual acuity after treatment. In 17 (38.6%) patients, visual acuity remained the same as initial visual acuity (6/15-6/60) and got worse in 5 (7.8%) patients (<6/60). Twenty six (59.1%) patients achieved between 6/15-6/60 vision after presenting with poor vision and 59 (92.2%) remained with poor vision after treatment.

**Conclusion:** Ocular trauma is a relatively common problem in the province of KwaZulu-Natal, occurring most frequently in young adults and males warranting presentation to the eye casualty department for treatment. Ocular trauma is usually unilateral, but can also be bilateral and this remains a significant major public health problem. People engaged in agriculture, in industry, in the home, in the social environment, in sports and people living in rural communities are at highest risk. This warrants specific, targeted, prevention measures to be put in place to minimize the incidence of visually damaging trauma.

**Keywords:** epidemiology, ocular trauma, urban, rural, endophthalmitis, eye protection, occupational health and safety, prevention.

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# CHAPTER ONE

## INTRODUCTION

Ocular trauma is a significant cause of unilateral blindness and visual impairment all over the world although sufficient data about its epidemiology or associated visual outcome in rural Africa is not available (Abraham et al, 1999). A review by Albataenah et al (2009) suggested that at least half a million people worldwide have unilateral loss of vision from ocular trauma. Furthermore, among patients who present to an eye casualty department, approximately half do so because of ocular trauma (Desai et al, 1996). Ocular injuries are inevitable because new hazards constantly arise in everyday life, but by identifying the underlying factors in their etiology, it may be possible to devise effective strategies for reducing the incidence of visually damaging trauma (Negrel and Thylefors, 1998). Major ocular trauma is of particular importance as it has a high risk of threatening vision. Even minor eye injuries can result in visual impairment and time lost from work. Ocular injuries remain a significant global health problem, hence previous reports reveal that with little population based data available on the risk factors, nature and circumstances, ocular trauma remains a public health issue (Negrel and Thylefors, 1998).

The spectrum of ocular injuries ranges from very mild, non-sight threatening to long lasting effects with a possibility to result in blindness which may present special challenges to patients with their daily activities or normal functioning in their environment (Steiner and Peterson, 1992). There are numerous underlying causes of ocular injuries that may occur with the majority of injuries reported being minor which affects the superficial surface of the eye such as corneal abrasions or corneal foreign bodies (MacEwen, 1989). Serious eye injuries involving the orbit (closed globe injuries) or intraocular structures (open globe injuries) are usually classified into those caused by blunt objects, burns, lacerations, large sharp objects (penetrating trauma), and small flying particles known as intra ocular foreign bodies (MacEwen, 1989; Juthani and Bruce, 2007). The force and mechanism of the causative agent determines the extent

and type of damage sustained by a traumatized eye. Penetrating injuries are known to carry a poorer prognosis than contusional injuries whether due to large or small objects (Chiapella and Rosenthal, 1985).

Throughout life there is a risk of being visually impaired from ocular trauma, but the true incidence of accidents involving the eyes remains unknown (Negrel and Thylefors, 1998). The major risk factors for ocular trauma include age, gender, socioeconomic status and lifestyle (Chiapella and Rosenthal, 1985). There is no segment of society that escapes the risk of eye injury but the victims primarily at risk are the young (Klein and Sears, 1992). Ophthalmic trauma is responsible for up to one third of cases of vision loss in the early years of life and is the leading cause of acquired unilateral blindness in childhood (Nelson et al, 1989; Cariello et al, 2007). Most injured children have good visual acuity before injury, but after trauma many of the injuries lead to permanent visual loss. Pediatric hospitalization resulting from ocular trauma corresponds to a significant amblyopic inductor factor among children (Nelson et al, 1989). The prevalence of eye trauma is more common among males than females and this is already apparent from childhood (Thylefors, 1992; Chiapella and Rosenthal, 1985). Even in industries where a greater proportion of females are employed than males, a higher significant incidence rate is seen among male employees (Islam et al, 2000). Previous reports have indicated that ocular trauma victims are predominantly the active middle-aged male population (Klein and Sears, 1992; Negrel and Thylefors, 1998), hence visual loss imposes an enduring burden on the affected individual having significant social, psychological, economic and financial implications to the healthcare provider (Steiner and Peterson, 1992).

The site where the injury occurs is related to the environmental hazards present (Negrel and Thylefors, 1998). Eye injuries occur in the workplace, in the home, on the sports field or on the battlefield; through exposure to chemicals, lasers or heat from expansion of industrial production without adequate safety precautions (Cassen, 1997). The workplace is the most common setting for the occurrence of ocular trauma and on the other hand, the home also remains an important setting for ocular trauma to occur (Chiapella and Rosenthal, 1985). Reports from previous studies have identified the

work-place as the commonest place to have an eye injury amongst adults (Murillo-Lopez et al, 2002; Ngo and Leo, 2008; Merle et al, 2008). This finding was supported by a study conducted by Gyasi et al (2007) which showed that most of the injuries occurred in agriculture. Islam et al (2000) and Mackiewicz et al (2005) reported a higher incidence rate in the agriculture, fisheries and forestry industries than manufacturing and construction sectors. In agricultural societies, injuries sustained were superficial and often led to rapidly progressing corneal ulceration and blindness (Thylefors, 1992). A greater number of injuries occur in the workplace and this relates to the development of the environment of geographical location. The lower working class is associated with situations where it is more likely to experience ocular trauma (Negrel and Thylefors, 1998; Chiapella and Rosenthal, 1985). The main causes of injuries in rural poor communities are agricultural practices whereas in more developed communities, industrial activities are more likely to be responsible for the injury (Gyasi et al, 2007).

In developing countries, ocular injuries are not only more common but also more severe in nature and apart from causing pain and misery, ocular trauma has enormous social consequences (Negrel and Thylefors, 1998). Late presentation at the hospital, post traumatic infection, lack of appropriate facilities and skilled personnel to manage the eyes may lead to poor visual outcomes. Although it is difficult to estimate the overall cost to society from the impact of ocular trauma; loss of income, cost of rehabilitation services and the need for medical attention draining upon health resources makes strengthening and implementing preventive measures a priority (Negrel and Thylefors, 1998). It is therefore not surprising that interest in the epidemiology of ocular injuries has grown over the past few years due to an increased awareness of the significant impact that ocular injuries have on long term visual disability and the economics of health care especially in developing countries (Thylefors, 1992).

# CHAPTER TWO

## LITERATURE REVIEW: OCULAR INJURIES

### 2.1 INTRODUCTION

Ocular injuries are divided into open globe and closed globe injuries, however, there may be an overlap in their classification based on the causative agent or inflicting object involved. An open globe injury involves a full thickness wound (an injury penetrating into the globe) of the corneoscleral wall which may result from penetrating or blunt eye trauma. Open globe injuries include lacerations which are then divided into penetrating injuries, perforating injuries and intraocular foreign bodies (Figure 1). Closed globe injuries are commonly due to blunt trauma whereby the corneoscleral wall of the globe remains intact (a partial thickness corneal wound) however, intraocular damage may be present. They are divided into burns, blunt trauma/contusions and lamellar lacerations. Ruptures are caused by blunt objects with the actual wound being produced by an inside-out mechanism. If the inflicting object is blunt, it can result in either a contusion or a rupture (open globe) (Kuhn et al, 1996; Juthani and Bruce, 2007; Kuhn and Pieramici, 2002; Schrader, 2004).

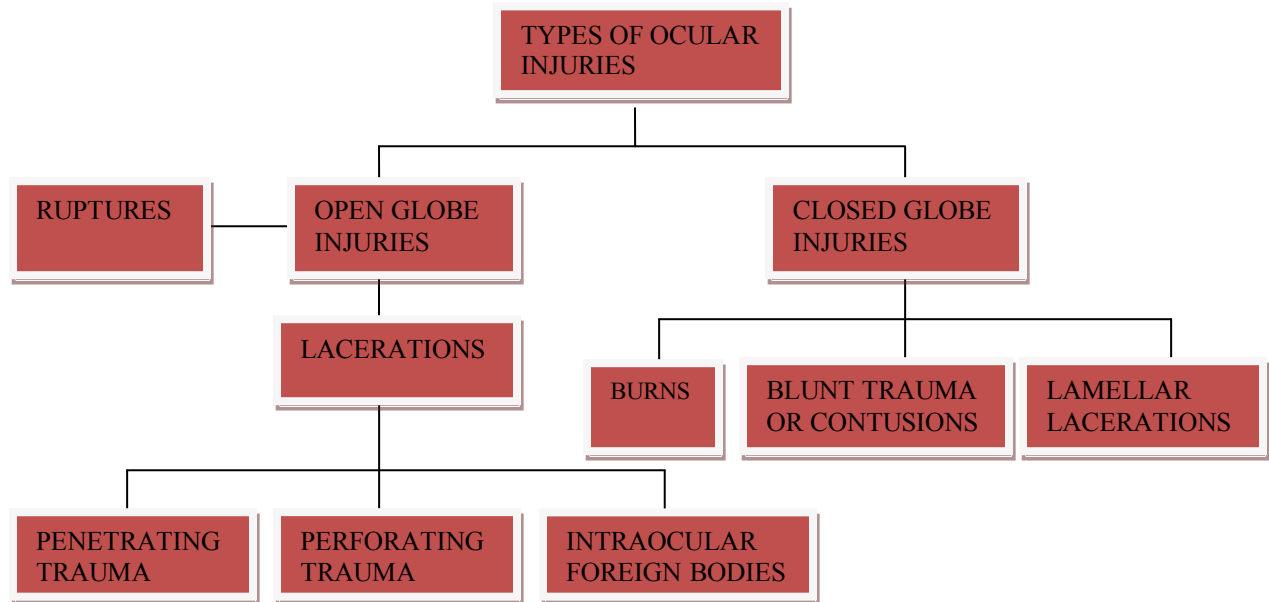


Figure 1: Standardized classification of ocular trauma using the Birmingham Eye Trauma Terminology (BETT) classification (Kuhn et al, 1996).

Open and closed globe injuries are further described in terms of zones, elaborating on which structure of the eye the wound involves and to what extent it is. For open globe injuries a zone I wound involves the cornea, a zone II wound extends into the anterior 5mm of the sclera and a zone III wound involves the sclera extending more than 5mm from limbus. In the case of closed globe injuries, a zone I wound involve only the conjunctiva, sclera or cornea, a zone II injury includes the anterior chamber including the lens and zonules and a zone III injury involves posterior structures including the vitreous, retina, optic nerve, choroid and ciliary body (Kuhn et al, 1996; Schrader, 2004).

In the past, there was no existence of a standardized classification of injuries despite the growth of interest in the publication of studies on eye injuries. However, recent studies approve the existence of the new classification which has provided better diagnoses and management of these injuries by eye health practitioners (Kuhn et al, 1996; Schrader, 2004; Pieramici et al, 1996).

## **2.2 OPEN GLOBE INJURIES**

### **2.2.1 Lacerations**

“A laceration is a full thickness wound of the eye wall, usually caused by a sharp object. The wound occurs at the impact site by an outside-in mechanism. The classification is based on whether an intra ocular foreign body or an exit wound is also present” (Kuhn et al, 1996: 399). Occasionally, an exit wound may be created by the object while remaining partially intraocular (Kuhn et al, 1996).

#### **2.2.1.1 Causes**

Lacerations to the eyelids and the conjunctiva commonly occur from sharp objects but can also occur from a fall (McGowan et al, 2006). Most corneoscleral lacerations are caused by glass from shattered spectacles and broken windows. Lacerations to the cornea and the sclera are very serious and are frequently associated with blunt trauma of flying objects (McGowan et al, 2006; MacGwin et al, 2005).

#### **2.2.1.2 Clinical features**

Corneal lacerations frequently result in prolapse of the iris with distortion of the pupil. Hyphaema is often present reducing vision in the affected eye (Coakes and Sellers, 1995). Lacerations may occur in one of two ways: i) lacerations without prolapse of tissue when the eyeball has been penetrated anteriorly but without prolapse of the intra-ocular contents; and ii) lacerations with prolapse when a small portion of iris prolapses through a wound, or uveal tissue has been injured. Corneal lacerations can involve the iris and crystalline lens forming a cataract whereby management depends on the duration and extent of the incarceration (Kanski, 2003, Coakes and Sellers, 1995).



### 2.2.1.3 Management

Ocular lacerations are treated in different ways depending on whether or not there is tissue prolapse. If the wound is extensive and loss of intra-ocular contents has been great enough that the prognosis for useful function is hopeless, enucleation/evisceration is indicated as a primary surgical procedure (Rahman et al, 2006; Barr, 1983; Sanders, 1975; Naidu, 2006). However, when the wound is clean without tissue prolapse and free from contamination, it can usually be repaired by direct interrupted sutures and can often heal spontaneously with the aid of an eye pad while administering a topical antibiotic and controlling the patient's pain with oral analgesics. The patient needs to be referred to the nearest ophthalmologist for surgical repair as soon as possible to restore the anatomy or structural integrity of the globe irrespective of the extent of the injury and the initial visual acuity. If a delay in specialist care is anticipated, a systemic oral antibiotic and tetanus prophylaxis should be administered.

### 2.2.1.4 Prognosis

Corneal lacerations due to sharp objects have a better prognosis compared to blunt trauma injuries (McGowan et al, 2006). At presentation it is often difficult to assess the visual prognosis and this may lead to the vast majority of injuries requiring primary repair. A badly injured eye with little possibility of restoring visual potential has very poor prognosis and the visual outcome does not improve even after performing several procedures. However, often an open globe injury with good visual potential will achieve optimal visual acuity after only about two procedures (Patockova et al, 2010; McGowan et al, 2006; Rahman et al, 2006). Higher rates of enucleation or evisceration in blunt injuries are associated with the presence of retinal detachment, relative afferent papillary defect, lid laceration, initial visual acuity worse than 6/60 and absence of red retinal reflex. Therefore, it is reassuring that most injuries caused by sharp objects have a fairly good prognosis (Patockova et al, 2010; McGowan et al, 2006; Rahman et al, 2006; Barr, 1983; Naidu, 2006).

## **2.2.2 Penetrating trauma/Perforating trauma**

A penetrating trauma is a single full thickness wound laceration caused by a sharp object without an exit wound whereas a perforating injury has two full thickness lacerations, an entrance and exit wound caused by the same agent (Kanski, 2003; Kuhn et al, 1996). It may be associated with prolapse of the internal contents of the eye (MacGwin et al, 2005). The extent of damage depends on the site of ocular penetration and the momentum of the object at the time of impact (Kanski, 2003; MacGwin et al, 2005).

### **2.2.2.1 Causes**

Penetrating or perforating trauma can occur following an assault, domestic accidents and sports. The globe integrity is disrupted by a full-thickness entry wound whereby the eye is pierced by sharp objects such as needles, sticks, pencils, knives, arrows, pens, glass and any object with sharp edges; or by a high-velocity missile such as a piece of metal. The extent of the injury is determined by the size of the object, its speed at the time of impact and its composition. Sharp objects such as a knife cause a well defined laceration of the globe. However, the extent of damage caused by a flying object is determined by its kinetic energy (MacGwin et al, 2005; Parver et al, 1993).

### **2.2.2.2 Clinical features**

Wounds affecting only the cornea may not penetrate the anterior segment structures, but may self seal and are less likely to cause visual morbidity, whereas more complex corneal wounds require a healing process which may result in scarring which itself may be visually disabling (Parver et al, 1993). Localized or a diffuse lenticular opacity occurs as result from trauma in the anterior segment involving the anterior capsule of the lens. Development of vitreo-retinal traction and scarring occurring after a period from posterior wounds serves as an important factor contributing to the development of complex retinal detachment (MacGwin et al, 2005; Parver et al, 1993).

### 2.2.2.3 Management

An accurate surgical repositioning of the injured eye is indicated as soon as possible in order to restore normal anatomy while maintaining and controlling the intraocular pressure within normal limits and preventing or controlling infection at the same time (Adhikary et al, 1976; Coakes and Sellers, 1995; MacGwin et al, 2005). Eucleation of eyes may be as a result of infection, vitreous abscess, anterior synechiae, cataract and tractional retinal detachment. Further operation might be needed among these complications during the follow-up period (Adhikary et al, 1976). Penetrating injuries require immediate careful attention; an accurate case history to determine how the injury occurred and then prompt surgical repair to prevent functional loss. The major objectives in the management are to relieve pain, preserve or restore vision and to achieve good cosmetic results. The eye should be covered gently with a sterile gauze or eye pad and protective shield but no pressure should be applied (MacGwin et al, 2005). The risk of intraocular infection is often low but prophylactic antibiotics are routinely prescribed (Coakes and Sellers, 1995). In any penetrating injury of the globe it is a wise precaution to take X-rays to exclude a retained foreign body (Coakes and Sellers, 1995). Metallic intraocular foreign bodies can be removed with a magnet at the time of suturing of corneal and scleral lacerations.

A penetrating injury of one eye may result in a sympathizing inflammatory reaction in the fellow non-injured eye at any time from 2 weeks to years later which is an autoimmune disease whereby uveal pigment is released into the bloodstream causing antibodies to be produced resulting in severe uveitis in both the injured and non-injured eye (Coakes and Sellers, 1995). Risk factors are minimized by removing the injured eye within 2 weeks if there is no chance of saving useful vision and if the injured eye remains inflamed (Coakes and Sellers, 1995). The management principles of penetrating ocular injury in children and adults does not differ, but among children difficulty can be encountered during examination and continuing therapy when the child is failing to cooperate. Amblyopia can cause further complications in the treatment of a child (Thompson et al, 2002).

#### 2.2.2.4 Prognosis

Complications may arise as a result of globe lesions which may depend on the seriousness according to the time occurrence, method of management and correct assessment (Adhikary et al, 1976; Mackiewicz et al, 2005). In spite of the new microsurgical techniques, the prognosis of penetrating eye injuries in many cases is still quite poor and dependent mostly on the severity (Mackiewicz et al, 2005; Smith et al, 2002; Thompson et al, 2002).

### **2.2.3 Intra-ocular foreign bodies**

An IOFB is a retained foreign object that enters the eye and may be superficial or deeply embedded causing an entrance laceration. An IOFB injury is technically a penetrating injury, but due to different clinical implications it is grouped differently because of the treatment modality, timing and rate of endophthalmitis. They are rather variable in presentation, outcome, and prognosis (Imrie et al, 2008). There are several factors that determine the final resting place and damage caused by an IOFB which include the size, the shape and the momentum of the object at the time of impact, as well as the site of ocular penetration. Once in the eye, the foreign body may lodge in any of the structures it encounters and may be located anywhere from the anterior chamber to the retina (Kanski, 2003; Imrie et al, 2008).

#### 2.2.3.1 Causes

Intra-ocular foreign body injuries are often due to hammering and metal from grinding equipment or drills that penetrates into the eye. An IOFB may traumatize the eye mechanically, introduce infection or exert other toxic effects on the intraocular structures which may result in inflammation of these structures but the risk of infection is relatively low unless the eye is penetrated by vegetable material (Coakes and Sellers, 1995). Commonly injured structures include the cornea, the lens and the retina (Imrie et al, 2008).

### 2.2.3.2 Clinical features

Retained metallic foreign bodies, especially those containing iron and copper give rise to a serious chemical reaction within the eye (Coakes and Sellers, 1995). Siderosis involves dissociation of the iron resulting in the deposition of iron in the intraocular epithelial structures including the lens epithelium and retina. Resultant toxic effects include anterior capsular cataract consisting of radial iron deposits on the anterior lens capsule, reddish brown staining of the iris, secondary glaucoma due to trabecular damage and pigmentary retinopathy the last of which has profound effects on vision (Kanski, 2003; Coakes and Sellers, 1995). Chalcosis can also result which is due to an intraocular foreign body with a high copper content causing a violet endophthalmitis like appearance on the descemet membrane, vitreous and internal limiting membrane of the retina often with progression to phthisis bulbi (Kanski, 2003; Coakes and Sellers, 1995). Foreign bodies penetrating to the posterior segment may remain suspended in the vitreous or may form a retinal tear or bleeding after striking the retina (Kanski, 2003; Szijsártó et al, 2008; Mackiewicz et al, 2005; Smith et al, 2002).

### 2.2.3.3 Management

Initial management, including an accurate case history is vital to determine the origin of the foreign body and it may be helpful for a patient to bring along any causative objects. During the ophthalmic examination special attention is paid to any possible sites of wound entry or exit. Topical fluorescein might be helpful to identify the wound entry and location of the foreign body (Kanski, 2003). One effective method appears to be prophylactic chorioretinectomy if the IOFB has caused a deep impact involving the choroid. This procedure reduces the risk of post injury proliferative vitreoretinopathy and the initial damage caused at the time of impact. Planning of surgical intervention involves ruling out the risks of endophthalmitis and subsequent scarring as possible complications (Kuhn and Cooke, 2005). Topical corticosteroids are used to minimize the inflammation and then the IOFB in the anterior chamber is typically removed through a paracentesis but not through the original wound. The IOFB removal is

performed 90°-180° from where it is located. Vitrectomy is indicated for posterior segment IOFBs unless tissue damage is minimal. (Kuhn and Cooke, 2005).

For the actual removal, the best tool to extract a deeply embedded metallic IOFB is a strong intraocular magnet (Kuhn and Cooke, 2005) while superficial IOFBs can be removed under slit- lamp visualization using a sterile 26-gauge needle (Kanski, 2003). Non-magnetic foreign bodies are removed mechanically with the aid of fine forceps (Coakes and Sellers, 1995). Primary enucleation should be performed only for very severe injuries with no prospect of retention of vision and when it is impossible to repair the sclera (Coakes and Sellers, 1995; Kanski, 2003).

#### 2.2.3.4 Prognosis

The prognosis after IOFB removal is associated with the nature of the injury e.g. in the event of blunt trauma, particularly when due to a firearm accident, the prognosis is poor. Advanced techniques for vitreous surgery and instrumentation for IOFB removal under controlled circumstances have brought hope for better results and management of these injuries (Szijártó et al, 2008; Roy et al, 2007). Intra-ocular foreign body characteristics, particularly size is often the determinant of visual outcome. The risk of visual outcome is multiplied by a factor of 1.21 with every 1mm increase in the size of the IOFB. Clinical data at presentation also play a vital role in the prognosis e.g. deficit of the afferent pupil reflex, prolapse of intraocular tissue, lens injury, poor visual acuity and post-operative retinal detachment (Roy et al, 2007; Szijártó et al, 2008).

#### 2.2.4 Ruptures

Globe rupture is a full-thickness wound of the eye wall as a result of contusion or of penetrating trauma on the orbit. It results in compression of the globe along the anterior-posterior axis resulting in an increase of intraocular pressure to an extent that the sclera tears. Ruptures from blunt trauma occur at the thinnest site of the sclera where the intraocular muscles insert, at the limbus, at the site of previous intraocular surgery and occasionally occurs around the optic nerve. Direct perforation of the globe may be due to sharp objects or those traveling at high velocity. Small foreign bodies

may remain within the globe after penetration (Patoockova et al, 2010; Doyle, 2009; McGowan et al, 2006; Rahman et al, 2006).

#### 2.2.4.1 Causes

The most common causes of a ruptured globe include blowout fracture of the orbit, sports injuries, occupational injuries, an object thrown from a power tool and an altercation (Doyle, 2009; Rahman et al, 2006).

#### 2.2.4.2 Clinical features

The most common symptoms of a ruptured globe include severe eye pain and loss of vision. Additional symptoms of a ruptured globe may include facial swelling, bruising around the eye, double vision, an abnormal pupil, bleeding inside the eye, eye redness and inability to gaze upward with the eye. The uvea, the retina, or the vitreous may prolapse through the wound (Rahman et al, 2006; McGowan et al, 2006; Doyle, 2009).

#### 2.2.4.3 Management

A detailed thorough case history must be obtained regarding the mechanism and circumstance of injury from the onset. The possibility of a subdural haemorrhage secondary to fall must be assessed when associated with an extraocular injury. During the assessment of all penetrating and blunt orbital traumas involving objects travelling at high speed, ruling out the possibility of globe rupture should be done first. Examination of the most frequent sites of rupture in the posterior segment is not easily visualized in the presence of superficial injuries. Very small superficial wounds sometimes are difficult to visualize, therefore sharp foreign bodies can enter the eye through these wounds. Protecting the injured eye should be a priority and the ruptured globe should be assessed systematically. Applying too much pressure on the injured eye can cause further damage, therefore should be avoided to prevent potential extrusion of intraocular contents. Young children usually fail to cooperate when trying to evaluate the extent of intraocular injury, however assessment can be carried out with the assistance of an ophthalmologist under conscious sedation. Treatment may include an eye shield,

antibiotics, narcotic pain medications, medications for nausea and vomiting, tetanus immunization and surgery to repair the globe for anterior ruptures by interrupted sutures. If the wound has been extensive and the loss of intra-ocular contents has been great enough that the prognosis for useful function is hopeless, enucleation/evisceration is indicated as a primary surgical procedure (Rahman et al, 2006; Barr, 1983; Sanders, 1975).

A high frequency of permanent visual loss is associated with damage to the posterior segment even though the anatomical position of the globe within the orbit protects the eye from being injured in many situations. Possible complications may involve deep structures of the eye such as infections, delayed postoperative or exogenous endophthalmitis. Within hours endophthalmitis may present after globe rupture or as with fungal organisms depending on the organism involved and the infection may appear weeks later. Maximizing functional outcome is essential with prompt recognition and ophthalmologic intervention. Cases of globe rupture require prompt management by an ophthalmologist (Patochkova et al, 2010; McGowan et al, 2006; Rahman et al, 2006).

#### 2.2.4.4 Prognosis

Until appropriate surgical treatment, the time from injury and the extent of injury determines the visual outcome. Patients should not be given a false impression about their visual outcome until a complete evaluation is done on the patient especially after an operation. The factors that aids with the prediction of excellent visual outcome (20/60 or better) include initial visual acuity of 20/200 or better, wound length of 10 mm or less, anterior wound location inserting to the plane of the 4 rectii muscles and sharp mechanism of injury. Predictors of poor vision include initial visual acuity of light perception or no light perception, greater than 10 mm wound length and wounds from blunt or missile objects extending posterior to the rectii muscles insertion planes. A high frequency of visual impairment is as a result of globe rupture and injury to posterior segment, but with development of advanced diagnostic techniques, surgical approaches



and rehabilitation, the visual outcome can be improved in many eyes (Patockova et al, 2010; McGowan et al, 2006; Doyle, 2009).

## **2.3 CLOSED GLOBE INJURIES**

Closed globe injuries also occur in everyday life caused by a variety of objects in any environment. However the outcomes and the standard of management following a severe closed globe injury has not been well established especially when associated with vitreous hemorrhages, hence they continue to pose a threat to vision in later stages of injury especially with blunt traumas.

### **2.3.1 Burns**

Burns to the eye are most often as a result of being in contact with strong acids or alkalis which are amongst the most urgent of ophthalmic emergencies. They are classified by the causative agents involved as either chemical injuries i.e. acid or alkali or radiant energy injuries i.e. thermal or ultraviolet. "In particular, the severity of a chemical burn relates to the solution pH, contact duration, solution penetrability and solution quantity" (Kanski, 2003: 678). Chemical injuries range in severity from trivial to potentially blinding (Kanski, 2003; Coakes and Sellers, 1995). Thermal burns are injuries from radiant energy usually resulting from contact with hot gases, hot liquids, or molten metals (Kanski, 2003; Coakes and Sellers, 1995).

#### **2.3.1.1 Causes**

The majority of these injuries are industrial (caustic solutions and solvents), agricultural (fertilizers and pesticides) and the remainder at home which can cause complete ocular destruction. Many alkali household products such as drain and floor cleaners should be kept out of the reach of children and be used with extreme caution (Kanski, 2003; Coakes and Sellers, 1995). The most commonly involved alkalis are ammonia, sodium hydroxide and lime while the commonest implicated acids are hydrochloric, sulphuric,

chromic and acetic acid (Kanski, 2003; Coakes and Sellers, 1995). Thermal injuries are as a result of being in contact with hot substances such as curling irons, hot curlers, cigarettes and hot liquids.

#### 2.3.1.2 Clinical features

Alkalis, in particular, cause severe injuries by penetrating the tissues and damaging cells rapidly. Burns primarily damage tissues by coagulating and denaturing cellular proteins and through secondary vascular ischemic damage (Kuckelkorn et al, 2002). Acid injuries tend to be nonprogressive and superficial. Mild burns usually recover fully even though they result in the loss of the corneal and conjunctival epithelium. Severe burns cause ischaemic damage to the limbal area affecting the vital epithelial stem for subsequent epithelialisation (Wagoner, 1997). After the injury, re-epithelialisation commences, although this may be prevented or hampered by either loss of epithelial stem cells in the limbal region or persistent inflammation. Excessive collagenase activity occurs in the absence of re-epithelialisation leading to progressive corneal thinning and ultimately to perforation of the eye. Visual reduction may be as a result of vascularisation and corneal opacification, tear and mucin deficiencies, necrotic peripheral retinopathy, collagen shrinkage and cataract formation even after epithelialisation has occurred (Kuckelkorn et al, 2002; Wagoner, 1997). Thermal necrosis and penetration can occur from thermal burns however, in thermal burns cell death is limited to the superficial epithelium, whereas ultraviolet burns often have a delayed pain effect and result in punctate keratitis.

#### 2.3.1.3 Management

In ideal situations, in an eyewash or shower station the affected eye should be irrigated as soon as possible with sterile saline solution to normalize the pH. Further damage to the eye can be reduced by using physiologically balanced solutions for irrigation (Wagoner, 1997). To facilitate cooperation a topical anesthetic is applied prior to irrigation or a lid speculum is used as to obtain the best irrigation patients eyelids must be opened as wide as possible. Initiating copious irrigation at the earliest possible time

plays a vital role on the visual outcome. To minimize the damage after a chemical injury, any available neutral fluid can be used to irrigate the eyes immediately for ten minutes (e.g. water). Following irrigation, presenting to an ophthalmologist is mandatory for a thorough examination (Wagoner, 1997; Kanski, 2003; Ikeda et al, 2006). If an acid burn is suspected, a base should not be used for irrigation in an effort to neutralize the acid. A suitable choice is saline with bicarbonate or lactated ringer balanced solution (Kuckelkorn, et al 2002; Ikeda et al, 2006).

Acute chemical injuries are graded to plan an appropriate subsequent treatment and afford an indication of likely ultimate prognosis (Kanski, 2003; Ikeda et al, 2006). Grading is performed on the basis of limbal ischaemia severity and corneal clarity. Mild injuries are treated with short course topical steroids, cycloplegics and prophylactic antibiotics for about seven days. The main aims for treatment of more severe burns are to reduce inflammation, prevent corneal ulceration and promote epithelial regeneration (Kanski, 2003). The eye should be patched to establish a conducive environment for re-epithelialization. Emergent ophthalmologic consultation is mandatory for any vision threatening injury be it a serious thermal burn or any alkali chemical globe exposure (Ikeda et al, 2006). Early surgery and conservative anti-inflammatory therapy may be necessary to vascularize the limbus, restore the limbal cell population, re-establish the fornices, mucous membrane grafts and correction of eyelid deformities. A procedure known as tenoplasty prevents anterior segment necrosis by re-establishing limbal vascularity and the conjunctival surface in most severe burns (Kuckelkorn et al 2002; Ikeda et al, 2006).

#### 2.3.1.4 Prognosis

A better understanding of the physiology of the corneal epithelium over the last decade has markedly improved the prognosis of serious forms of ocular burns (Khodabukus and Tallouzi, 2009; Fish and Davidson, 2010). Surgical techniques aimed at restoring the destroyed limbal stem cells have also improved the prognosis of severe corneal burns. Prevention, particularly in industry is essential in order to decrease the incidence of burns (Khodabukus and Tallouzi, 2009). On the other hand long term follow up is mandatory to promote the healing process and for providing the best possible

opportunity for visual rehabilitation whenever necessary (Khodabukus and Tallouzi 2009). Advancements in reconstruction of the ocular surface and pathophysiological understanding of a chemical injury or radiant energy has provided hope for patients who would have poor prognosis (Fish and Davidson, 2010).

### **2.3.2 Blunt trauma/ Lamella lacerations**

Blunt trauma refers to a direct blow or a type of physical trauma to the eye and surrounding tissues caused by the impact of an object. Damage may occur to anterior segment structures including the eyelid, conjunctiva, sclera, cornea, iris and lens; and posterior segment structures including the retina and optic nerve resulting in significant visual loss (Viestenz and KÜchle, 2005). It includes contusions and lamellar laceration of the globe. A contusional injury has no (full thickness) wound. The injury is either due to choroidal rupture (direct delivery of the object) or angle recession (changes in the shape of the globe). Lamellar laceration is a partial thickness wound of the eyewall caused by a sharp object. Both structural and functional damage to the eye can be as a result of blunt trauma (Viestenz and KÜchle, 2005).

#### **2.3.2.1 Causes**

The most common cause of blunt trauma is the eye being struck with a finger, fist, racket, tennis ball, or other solid object. At the moment of impact sudden compression and indentation of the globe occurs producing damage to the eye (Viestenz and KÜchle, 2005).

#### **2.3.2.2 Clinical features**

Blood occupying the inferior part of anterior chamber is often observed, a condition referred to as a hyphaema (MacGwin et al, 2005). Normally damage to the crystalline lens forms a cataract preventing light from reaching the retina, or it may no longer be able to focus clear images due to displacement within the eye (MacGwin et al, 2005). Blunt trauma can damage the retina as well. The presence of a tear in the retina leading to large retinal detachment may result in reduced vision whenever the area on the retina responsible for clear vision is affected (Kaushik and Sukhija, 2006). In some

instances, sudden effects may not be evident until months or years later after the injury occurs such as a cataract, retinal detachment, or glaucoma and all of these may result in visual loss (MacGwin et al, 2005).

#### 2.3.2.3 Management

Any hyphema present should be examined by an ophthalmologist as soon as possible to encourage the blood to settle which usually involves bed rest with the head of the bed elevated. Atropine may be given to dilate the pupil and corticosteroids to reduce inflammation within the eye. Further injury can be prevented with the use of a protective shield taped over the eye. Patients with blunt eye trauma should be under steady observation by an ophthalmologist to handle late complications such as proliferative vitreoretinopathy which is a condition that generally results from chronic retinal detachment or retinal surgery and severe ocular trauma (Viestenz and Kuchle, 2005). Prompt surgical repair is required for retinal detachments to prevent or to minimize serious visual loss. Follow-up care must be continuous to preserve vision after an injury by monitoring the intraocular pressure at least once daily for the first few days because if the pressure is elevated it may result in secondary open-angle glaucoma (Kaushik and Sukhija, 2006).

#### 2.3.2.4 Prognosis

After initial injury the risk duration for certain complications remains unknown, however, as a result of retinal surgery, severe ocular trauma and chronic retinal detachment, proliferative vitreoretinopathy is one possible complication. Poor visual outcome is expected during vitreoretinal surface traction created by proliferative membranes, causing further complications and visual loss even though the nidus for proliferation is unclear (Waters et al, 2008).

## **2.4 FACTORS AFFECTING PROGNOSIS OF OCULAR INJURIES**

The extent of damage to the eye is a prognostic factor used to predict the final visual outcome. Open globe injuries have demonstrated prognostic significance in anatomic and physiological variables or characteristics on presentation to injuries and associated with the type or mechanism of injury. The presence of an afferent pupillary defect, wound length (4mm or longer), combined anterior and posterior segment injuries, lenticular injury, vitreous haemorrhage, intraocular foreign bodies, scleral wounds, retinal detachment, vitreoretinal traction and endophthalmitis were all found to have poor prognoses (Bejiga, 2001; Gyasi et al, 2007; MacGwin et al, 2005). Multiple surgeries are often required in the case of retinal detachment following posterior open globe injuries and the visual outcome is usually poor, if not the eventual enucleation of the eye (Arroyo et al, 2003; Bejiga, 2001; Gyasi et al, 2007; MacGwin et al, 2005). The final visual outcome is dependent on the predictive value of the initial visual acuity of the traumatized eye as indicated by previous reports (Bejiga, 2001; MacGwin et al, 2005). Favourable prognosis is associated with initial visual acuity of 5/200 (1.5/60) or better. The anatomy and function of the eye can be restored to its pre-injury state by seeking proper management at an early stage (Gyasi et al, 2007). Several sub-specialists are often required for rehabilitation of the injured eye. Ultrasonography and radiography are diagnostic instruments that need to be readily available with trained personnel for management of these injuries (Bejiga, 2001; Gyasi et al, 2007; MacGwin et al, 2005; Arroyo et al, 2003).

## **2.5 PROTECTIVE DEVICES**

A protective device/equipment generally can be used to protect the wearer's face, in addition to the eyes, from a variety of hazards e.g. particles, light, heat, wind blast, sea spray or some type of ball or puck used in sports (Cockerhem, 1983; Wyman, 2000). Protective devices are divided into two types depending on their function i) "a primary protector is a device which may be worn in conjunction with a secondary protector or alone e.g. goggles, they may be used in conjunction with the other protectors or used

alone and ii) a secondary protector is a device which shall be worn or used only in conjunction with a primary protector” (Wyman, 2000: 271) e.g. face shields made of polycarbonate will stop low-velocity projectiles, windblown dust, sand and will afford some protection against a direct blow to the eye (Cockerhem, 1983; Wyman, 2000).

Protective eyewear must meet the following requirements efficiently: (i) tailored to specific purposes (different designs), (ii) resistant against major impact as well as scratching, (iii) held by a proper frame that does not let go or break, (iv) offer side as well as frontal protection without interfering with the field of view, (v) designed to prevent fogging, (vi) readily available and affordable (Kuhn, 2008; Rosenfield and Logan, 2009; Wyman, 2000). The conditions or nature under which people are working requires its wearing or use for their personal protection to minimize the risk of an eye injury and the type of work done is also the determiner of what kind of device is suitable for that working environment (Ballal, 1997; Rosenfield and Logan, 2009; Wyman, 2000).

## **2.5.1 Primary protective devices**

### **2.5.1.1 Goggles**

Goggles are a protective device intended to fit the face immediately surrounding the eyes. To shield the eyes each goggle is designed for specific hazards e.g. infectious fluids, chemicals or water from striking the eyes and from impact. Goggles protect the facial area immediately surrounding the eyes and the eye sockets. Some goggles fit over corrective lenses (Wyman, 2000). In addition, goggles also incorporate prescription spectacles with side shields and protective lenses that meet the requirements for protection against work place hazards while also correcting vision. Goggles are divided into two main varieties, impact resistant and splash resistant goggles. Vents can be classified into four main types; gas-proof (for protection against harmful vapours), non-vented (for protection against fumes and vapours), indirect (permits the passage of air but not liquid) and direct (allows the dissipation of humidity and heat) (Wyman, 2000).

#### 2.5.1.2 Box type goggles

Box type goggles have a one piece lens made of cellulose acetate, polycarbonate or toughened glass and the housing is made of PVC (polyvinyl chloride) which gives a good fit around the brows and cheeks. They are light weight with good ventilation and create no obstruction of vision. It is possible to wear prescription spectacles underneath but comfort can be affected. Prescription spectacles or laser goggles incorporate high optical density filter materials or reflective coatings to reduce potential harm from laser radiation and have no possible adjustment across the bridge (Rosenfield and Logan, 2009; Wyman, 2000).

#### 2.5.1.3 Wire gauze goggles

These are made from wire gauze which has very good impact resistance but are rarely used because they impair vision and give no protection against splashes of molten metal (Rosenfield and Logan, 2009; Wyman, 2000). Wire gauze is sometimes found as part of a face shield into which lenses are fitted. The housing is generally made of polyvinyl chloride (PVC). They sometimes have adjustable nasal fittings and if the rims have screws the lenses can be replaced or exchanged for another type of lens e.g. tinted or impact resistant. Some cup-type goggles also have large bridge aprons to protect the nose however, they have some disadvantages. Ventilation is often poor which causes lenses to mist up when worn over prescription spectacles. If ventilation holes are present they must be screened to prevent penetration and blockage by dust or chemicals (Rosenfield and Logan, 2009). Goggles with a hard cup are sometimes uncomfortable to use and the frequently wide separation of the lenses which obscure the sides can obstruct central and peripheral vision (Rosenfield and Logan, 2009).

#### 2.5.1.4 Safety glasses

The level of protection provided by eye glasses designed for ordinary wear is not necessarily sufficient to protect against work place hazards (Wyman, 2000). When



choosing eye protection for workers special care must be taken for workers who wear glasses with corrective lenses. This includes comfortable fitting goggles worn over corrective spectacles without altering the alignment (Wyman, 2000; Rosenfield and Logan, 2009). Protection for contact lens wearers is also vital because they are also exposed to the potential of an eye injury. Protective eyewear provided to workers may also incorporate corrective spectacles. Safety spectacles made of safety frames constructed of plastic or metal can be fitted with either plain or corrective impact resistant lenses for protection (Wyman, 2000; Rosenfield and Logan, 2009).

## **2.5.2 Secondary protective devices**

### **2.5.2.1 Face shields**

Face shields are devices provided to shield the wearer's face from certain hazards, or portions thereof, in addition to the eyes (Rosenfield and Logan, 2009). They are secondary protectors and are used only in conjunction with primary protectors. Head band supported visors that cover the face and neck are used to provide protection from chemical splashes, flying particles and molten metals. One major advantage is that they can be easily worn over prescription glasses or other types of protection if necessary. They do not obstruct the field of view. Either polycarbonate or cellulose acetate is used to produce the shield (Rosenfield and Logan, 2009; Wyman, 2000). They can be hand held such as welding screens which have filters like an ocular tinted window. The main function of face shields is the provision of protection in occupations such as the security industry, cricket and motorcycling. It is recommended that the use of goggles in combination with face shields or safety glasses to protect against impact hazards is emphasized because face shields do not provide the necessary protection from impact hazards for workers (Rosenfield and Logan, 2009; Wyman, 2000).

### **2.5.2.2 Side shield**

A side shield is a device attached to the front of the frame, providing angular protection from impact hazards because of its design, but does not offer full protection against

chemical splashes. Wire mesh or plastic is used to make side shields. Eyecup type shields provide the best protection (Wyman, 2000).

### 2.5.2.3 Helmets and visors

A protective headgear made of hard material to resist blows include safety helmets, armor visors, firefighter's helmets and batting helmet. They are commonly worn during specific conditions such as a welding helmet which is a shielding device that filters intense light and radiant energy with the use of special absorptive lenses produced during welding operations (Rosenfield and Logan, 2009). The entire face and neck are protected from intense radiation and spatter. Harmful radiation can be prevented from reaching the eyes by the use of an ocular containing a filter. Filters are designed in such a way that it can be flipped up to expose the impact resistant clear lens which is used during grinding and chipping operations (Rosenfield and Logan, 2009; Wyman, 2000). In superior versions the window is fitted with a polarizing cell which darkens to welding densities as soon as the arc is struck. There is a tendency for the helmets to mist over but this can be eliminated by the inclusion of respiratory equipment, a feature essential where the gases from welding rods are toxic (Rosenfield and Logan, 2009; Wyman, 2000).

### 2.5.3 Eye protectors for sport

Brands of sport goggles for eye protection vary significantly either in their capacity to protect the eyes and the way they fit (Washington et al, 2004). Strong recommendations have been made by the American Academy of Pediatrics and Ophthalmology about the use of eye protection in all sporting activities where the risk of an eye injury exists. For functionally monocular athletes whose practitioners recommend eye protection after eye surgery or trauma, protective eyewear should be mandatory (Washington et al, 2004). In the United Kingdom, flying and motor sports have regulations for participants and eye protection is mandatory in ice hockey, horse racing and squash (Napier et al, 1996). Flying objects are not the only hazard. During

participation in close contact sports, eye injuries from pokes, jabs by fingers and elbows can also contribute to ocular injuries (Napier et al, 1996; Vinger, 1980). Properly fitting sport goggles are mandatory to the individual wearer to avoid purchasing a larger goggle than required at that present moment so that the youngster has "room to grow" particularly in children (Washington et al, 2004). An appropriate selection of a protection device can be done with the assistance of an athletic trainer, optometrist, optician, physician and ophthalmologist, bearing in mind that the device should fit well and provides the maximum amount of protection. Furthermore, assistance can also be enhanced with having seminars whereby an athlete can be taught on which device is suitable for that particular sport they participate in (Washington et al, 2004; Napier et al, 1996; Vinger, 1980).

#### **2.5.4 Protection in the Home**

The home has long been recognized as an important location for eye injuries to occur which may warrant admission to hospital depending on the severity (McEwen 1989, Chattopadhyay et al, 2010; Luff et al, 1993). According to a study done by Luff et al (1993) in the United States (US), 125,000 of eye injuries that occur each year are caused by household products. Many of these injuries are caused by projects and activities such as home repairs, yard work, cleaning and cooking (Chattopadhyay et al, 2010; Thompson et al, 2002). Furthermore, for all activities performed bystanders also face significant risk and should also take the necessary precautions against eye injuries, for instance, children who watch their parents perform routine chores in and around the home. Bystanders should leave the area or wear eye protection where the chore is being performed. A pair of approved protective eyewear in every household is recommended by the American Academy of Ophthalmology and the American Society of Ocular Trauma to be worn when doing projects or activities that could create a risk for an eye injury (Luff et al, 1993; Thompson et al, 2002). It is important to properly protect your eyes when using chemicals or tools that may present a hazard especially after experiencing some vision loss. Even if the eye injury appears minor presenting to an ophthalmologist or to the emergency room immediately is mandatory because delaying medical attention can result in permanent visual loss or blindness (Luff et al, 1993).

## 2.6 CONCLUSION

Broadly, ocular injuries are classified into open globe and closed globe injuries, according to the causative agent and nature of the injury. Injuries due to sharp objects have a better prognosis than blunt injuries and this also depends on the severity of the injury. The eye is subject to experience minor injury (superficial) affecting anterior structures and severe injuries involving the posterior segment with the possibility of resulting in visual impairment or blindness. Treatment of these types of injuries differs because of severity and potential complications that can arise. Prompt attendance at the clinic for surgery is mandatory for injuries requiring primary repair and those with no potential to achieve useful vision are enucleated or eviscerated. Protective devices are also classified into different categories designed specifically for workplace hazards and these devices can be used in conjunction with other devices at the same time to provide maximum protection. The potential for an injury exists in any environment even where protective eyewear is recommended, whether it is occupation, sports related or at home. Protective gear that is uncomfortable to use or limits activities performed is often avoided by the wearer (Crebolder and Sloan, 2004; Ngo and Leo, 2008). Hence need for an increase in the use of eye protection that fits well and provides maximum amount of protection is clearly indicated in injuries in the work place and recreational settings (Crebolder and Sloan, 2004; Ngo and Leo, 2008). The home has been also identified as a risk environment for injury; therefore every household is required to have at least one protective device to use whenever doing house chores, inside or outside the home.

## CHAPTER THREE

### LITERATURE REVIEW: EPIDEMIOLOGY OF OCULAR INJURIES

#### 3.1 Epidemiology

Globally, an estimate of approximately 1.6 million cases of blindness, 19 million cases of unilateral blindness and 2.3 million cases of low vision have been reported which are all due to eye injuries (Negrel and Thylefors, 1998). The incidence of penetrating eye injury in Australia was reported as 3.7 per 100 000 of the population (Smith et al, 2002). Furthermore, Smith et al (2002) revealed that the estimated incidence rate of eye injuries ranged from 8.2 to 13.0 per 1000 population showing an overall decline in ocular injuries. Annually, in Scotland 10% of the people lose useful sight in the injured eye with a reported cumulative incidence of 8.14 per 100 000 of the population requiring hospital admission (Bhogal et al, 2007). In the United States, an estimate of 6.98 per 1000 population was reported among subjects who had an eye injury warranting presentation to an emergency room, private physician's office, inpatient or outpatient facility. A population based study by Gupta et al (2004) in an urban slum population in India reported an annual incidence of 9.75 injuries per 1000 adults significant enough to require treatment. A review by Karamen et al (2004) showed that the annual incidence of adult patients requiring hospitalization because of ocular trauma was 23.9 per 100,000 inhabitants of the Split-Dalmatian County, Croatia. This was far greater than the incidence reported in Australia (15.2 per 100,000) or Great Britain (8.14 per 100,000) partly because the majority of rural areas and islands have no ophthalmological service and these patients had to be hospitalized (Karamen et al, 2004).

Eye injuries in Africa have their own characteristic features regarding their causes, seriousness and management (Gyasi et al, 2007). Hospital-based studies conducted at the upper east region of Ghana show that 5% to 16% of all ophthalmic admissions to eye hospitals/units are related to ocular trauma (Gyasi et al, 2007; Adala, 1983). A

study done in Addis Ababa, Ethiopia revealed that about 5% of all ocular trauma cases were as a result of severe trauma such as intraocular foreign bodies, ruptured globe, orbital or facial fractures and hyphaema (Adala, 1983). Lack of access to preventive health care at all levels in developing countries certainly has worsened the situation. It is therefore of concern that in rural areas where the necessary services are scarce more injuries (80%) are reported (Adala, 1983; Gyasi et al, 2007; Bejiga, 2001).

### **3.2 Age**

In all age groups the risk of an eye injury is inevitable, but the victims primarily at risk are those in the active years of life. The young are said to be more at risk to eye injuries because of their immaturity, tendency to imitate adults' behavior or observe adult activities without evaluating the risks. Paediatric injuries in general account for between 20% and 50% of all cases of ocular trauma often due to sharp or blunt objects which contribute to non-congenital unilateral blindness (Thompson et al, 2002; Luff et al, 1993; Oum et al, 2004; Patel and Morgan, 1991). A similar survey by Poon et al (1998) found that 20% to 29% of corneal transplants in children in Hong Kong followed ocular trauma. Wagoner and Kenyon (1990) reported that children are involved in 23% to 34% of all penetrating eye injuries.

A survey by Grieshaber and Stegmann (2005) among South African children showed that most children (66%) sustained injuries during play, 55% of penetrating eye injuries were reported to have occurred to children all under the age of 6 years at home and most injuries occurred when there was no parental supervision (85%). Impact with a sharp object was the commonest mechanism of injury (46%), sticks, wire, and glass accounted for half of all causative agents resulting in an eye injury (48%).

Childhood ocular injuries reported by pediatric eye injury-related hospitalizations in the United States estimated an annual incidence of 15.2 per 100 000 of ocular trauma among children (Teilsch and Parver, 1990; Serrano et al, 2003). Furthermore, Teilsch and Parver, (1990) reported that one-third of all serious eye injuries occur in children,

25% result in monocular blindness, 10% result in enucleation which is four times more common in boys than girls and the most common injury was due to sharp objects. Levy (2007) also estimated an incidence of about 80% of all pediatric ocular injuries to involve the external ocular tissues. Glynn et al (1988) showed that the occurrence of serious ocular trauma is bimodal in relation to age, with the maximum incidence in young adults and a second peak in the elderly. However, Wagoner and Kenyon (1990) estimated that 35% of eye injuries occur in individuals less than 17 years of age. On the other hand recreational sports in the United States tend to lead to the most severe injuries in children between the ages of 4 and 15 years (Jones, 1993). This can be due to the fact that children often have poor stereopsis therefore judging the position of a flying object may be difficult (Jones, 1993).

The working class population often tends to be in the young to middle age groups hence it may be expected that this group may be vulnerable to industrialized related ocular injuries. A survey by Katz and Tielsch (1993) showed the highest incidence rate of total ocular trauma found in Baltimore Maryland to be among non-white men aged 25 to 69 years. Young people working in factories and laboratories constituted two-thirds of the patients experiencing eye injury due to the nature of the chemical agents they work with. Almost 36% suffered severe (Grade III/IV) injuries and 42.1% suffered bilateral injuries (Saini and Sharma, 1993).

### **3.3 Race**

Black people seem to be more at risk from ocular trauma than whites (Katz and Tielsch, 1993; Wong and Tielsch, 1999). A population based survey by Katz and Tielsch (1993) in a multiracial urban setting in Baltimore Maryland showed that there was a higher prevalence of eye injuries in non-whites especially blunt eye injuries. Wong and Tielsch (1999) estimated the prevalence of ocular injuries among black men to be 21.2 per 1000, or 3.7 times the rate for white men. The incidence of any medically treated injury was 1.9 per 1000 per year among whites and 4.4 per 1000 among blacks aged 45 years and older (Katz and Tielsch, 1993; Wong and Tielsch, 1999). Ethnicity and age had

also been cited among subjects with ocular injuries. Proportionately more injuries occurred between 10 and 19 years of age among blacks than whites, but more injuries occurred above the age 60 years for whites than blacks (Katz and Tielsch, 1993).

Even the visual consequences of the injuries are more severe among blacks hence changes may be observed in the risk of ocular trauma over time in this race group. There was a higher rate of hospitalized ocular trauma among non-whites than whites and the length of hospital stay was also shown to be longer for non-whites with a 40% to 60% higher risk compared to whites between the ages of 25 and 65 years (Katz and Tielsch, 1993; Wong and Tielsch, 1999). Visual loss from trauma was due to corneal and lens damage; 20 % corneal based among whites and 10% in blacks, lens based in 53% of whites and 43% of blacks. Rates of vision loss due to retinal damage were 13% among whites and 17% among blacks (Katz and Tielsch, 1993; Wong and Tielsch, 1999). Black men were three times more likely to have visual impairment from ocular trauma than white men whereas black women had higher rates of visual impairment than white women (between 30% and 90%) depending on the severity of vision loss (Wong and Tielsch, 1999). There were two cases of visual loss due to optic atrophy among blacks and none among whites while the proportion of visual loss due to secondary glaucoma was equal among whites and blacks (Katz and Tielsch, 1993).

### **3.4 Gender**

In general, males are frequently reported to be more at risk to have an eye injury than females despite severity and this is already apparent from childhood (Smith et al, 2002; Pieramici et al, 1996). A greater proportion of male workers are employed in higher risk occupations than female workers (Madden et al, 2002; Koo et al, 2005). It was estimated that there are 3.1 penetrating eye injuries per 100,000 person-years in the United States (Landen et al, 1990) with 78–80% of these injuries occurring in males (Landen et al, 1990; Smith et al, 2002). Most studies to date have shown a remarkable predilection of young males for penetrating injury with the proportion of males ranging from 80% to 85% and mean/median ages ranging from 27 to 38 years (Smith et al,



2002; Pieramici et al, 1996; Parver et al, 1993; Schein et al, 1988). Population and hospital based studies also indicate a large preponderance of injuries affecting males (Glynn et al, 1988; Vernon, 1983).

There are profound social implications on affected individuals regarding the lost productivity by middle age young men and the requirement of caring facilities and rehabilitation for the elderly. Ngo and Leo (2008) concluded that young non-resident males (95.7%) sustained work-related injuries warranting presentation at the emergency service level in Singapore. Madden et al (2002) showed that rural men (42.1%) experienced more injuries compared to urban men (30.5%) and women (9.9%) were less likely than males (34.2%) to have ever experienced an eye injury. The potential for severe visual loss is always present among young men while playing sports even though most injuries are minor and good visual recovery can be achieved (Barr et al, 2000). Koo et al (2005) reported on occupational and recreational preferences wherein most globe rupture injuries (78.6%) and penetrating injuries (69.9%) were to be experienced by men, whereas women presented more often with blunt globe rupture (68.1%). A survey conducted at a tertiary hospital serving rural Dodoma, Tanzania revealed that of those presenting for treatment, 69% were males and a third of the injuries occurred in those less than the age 20 (Abraham et al, 1999). Researchers have thus suggested that future prevention of injury should be more based or focused on this target group of rural young men (Ngo and Leo, 2008; MacGwin et al, 2005).

### **3.5 Workplace injuries**

The socioeconomic status in developing countries can be determined by the working environment or the domestic setting. People who live and work in remote areas are more at risk than those of the better-off social classes (Madden et al, 2002). Ocular trauma causing permanent or temporary visual disability may approach 70,000 each year in the US while in the workplace an estimated 1000 ocular injuries occur each day and most are preventable (Islam et al, 2000). The annual incidence rate of work-related ocular injuries was 567 per 100,000 employees in the US (3699 injuries among 652,956

employees). Data released by the National Institute for Occupational Safety and Health estimated that 900,000 occupational eye injuries occurred and were caused mostly by ocular foreign bodies, 84% of which were minor (Islam et al, 2000). The workers compensation claims have been reported to account for between 5.0% and 6.1% from ocular injuries in Singapore (Ngo and Leo, 2008; Merle et al, 2008).

Farming is the main cause of ocular injuries in rural poor communities whereas in urban communities, industrial activities are more likely to be the cause of injury (Gyasi et al, 2007; Ballal, 1997). Gyasi et al (2007) reported a higher prevalence of ocular trauma (19.6%), among unskilled, semi-skilled workers and lower socioeconomic classes, such as laborers which was consistent with previous reports in India. Krishnaiah et al (2006) reported that the overall age and gender adjusted prevalence of history of eye injuries in rural population of India was 7.5%.

A higher prevalence of eye injuries in patients with lower levels of education and patients under the influence of alcohol has been reported (Katz and Tielsch, 1993; Dannenberg et al, 1992). Furthermore, a report by Singh et al (2005) categorized 36.9% of patients as rural who had unilateral ocular involvement and 23.7% as illiterate. (Younger age, rural setting, illiteracy, presence of foreign body and lens disruption correlated with the development of endophthalmitis (Singh et al, 2005). Therefore, Singh et al (2005) concluded that young students, labourers and factory workers are the ones that require the most attention. The possibility of ocular trauma has also been found to be higher in newly established factories, especially small scale industries in developing countries due to poor working conditions, long hours at work and poor organization with regards to safety (Edema et al, 2009).

### **3.6 Environment and etiology**

Ocular injuries can occur anywhere from the home to the workplace (industry, agriculture) and on the sports field.

### 3.6.1 *The home*

The home has long been recognized as an important location for various types of injury and accidents. The home accounts for more than 50% of all accidents in all age groups and was identified as the commonest location for an injury (Luff et al, 1993). Activities in the home carried out by patients above the age of 65 years are the commonest cause of ocular injuries warranting admission and hence they account for 75% of hospitalized eye injuries in this group with falls being responsible for 43.3% of these injuries (Saeed et al, 2010). Similar findings were reported by Desai et al (1996) in Scotland, where 60% of the injuries were sustained in the home in this age group and falls (44%) were also noted to be the commonest cause eye injuries in this age group. “For the 0–15 years, 65 years and over age groups the home was reported to be the single most frequent place of injury (30.2%) at all hospital admissions for ocular trauma in Scotland” (Bhogal et al, 2007: 72). Over a one year period 428 patients were admitted in hospital and the most frequent cause of injury (13.9%) were tools at home (Bhogal et al, 2007). Thompson et al (2002) also found in Australia that 58% of perforating injuries occurred in the home while injuries at school were infrequent (1%).

The use of domestic tools or machinery and falls among the elderly are the most commonly identifiable causes of injury in the home (Desai et al, 1996). Injuries occurring in the domestic setting among children and women are of no lesser magnitude, but such cases are probably underreported. Even though injuries at the workplace in some places are more common, those in a domestic environment are equally severe (Chattopadhyay et al, 2010). Male predominance is more marked in injuries sustained in a domestic setting while on the other hand household products are increasingly reported to pose a threat to the eye in the home (Luff et al, 1993). Domestic utensils and other potentially dangerous home objects need to be identified to be able to reinforce attention and awareness in the home as cited by other studies of ocular trauma (Luff et al, 1993; Thompson et al, 2002, Desai et al, 1996).

### *3.6.2 Rural versus urban trends*

A greater percentage of the indigenous population lives in rural settlements in most developing countries, particularly in remote areas (Madden et al, 2002). In general, people in rural areas experience lower access to health care services and yet are found to incur greater levels of ocular injuries than their urban counterparts (Madden et al, 2002). This can be contributed to higher levels of socioeconomic disadvantage experienced in rural areas than urban counterparts. Studies performed in Australia have estimated the annual incidence of all injuries greater in urban areas than in rural areas (11.8 per 100,000 in rural settings and 15.2 per 100,000 in urban settings, respectively) (Smith et al, 2002; Karamen et al, 2004). However, Madden et al (2002) estimated a higher incidence of eye injuries among rural participants (25.1%) than their urban counterparts (19.4%) in Australia. Evidence provided suggests that eye health in rural areas is worse for some conditions (Madden et al, 2002). Salvatore et al (2008) showed that work related eye injuries were more frequent in rural areas rather than urban areas (66% vs. 34% respectively) due to the greater number of intra-ocular foreign bodies found in rural areas in Italy which suggest the need for better monitoring of rural occupational injuries. A greater proportion of eye injuries in rural areas may be ascribed to the comparatively high rates of eye injuries in the agricultural and mining industries. A study from Malawi constituting of a large rural population showed that more than half of the injuries were associated with domestic pursuits or occurred at home, 6.3% resulted from industrial accidents and 21% of the eye injuries were incurred in fights (Ilsar et al, 1982). Gupta et al (2004) reported that a rural population of 4.5% had a higher prevalence as compared to an urban one (3.97%). Mackiewicz et al (2005) in a similar study among a rural population reported a higher rate of unilateral blindness compared to all penetrating injures (40%) treated in the hospital of Lublin, Poland.

### *3.6.3 Agriculture*

In agriculture high risks of eye injuries still exist due to the fact that farming in rural areas is still a family business hence preventive measures are often insufficient or absent. During paid work in agriculture the incidence of eye injuries is about four times

as high as in industry due to the fact that in agriculture there is a great range of possible eye hazards when a worker undertakes different tasks during the course of the day and measures to protect the eyes cannot be readily applied (Mackiewicz et al, 2005). Khatry et al (2004: 456) estimated “the annual incidence of eye injuries in agriculture to be 3.46 per 10 000 people which was higher than in industry (1.9 per 10.000 people) but lower than in construction (5.28 per 10 000 people)”. Saari and Aine (1984) found that the blindness rate was 21.9% after analyzing all kinds of eye injuries in agriculture (superficial, blunt and penetrating) in Finland.

Among agricultural workers vegetation substances such as twigs and branches caused most eye injuries. Comparable findings by Abraham et al (1999) showed that 67% of the cases were caused by a stick and after treatment most patients had poor visual acuity in the affected eye. In Malawi, 80% of the working population engages in agriculture and live in rural areas, but findings reveal that only 1.5% of the injuries were related to agriculture (Ilsar et al, 1982). This finding may be attributable to the fact that eye injuries occurring in the fields are often too minor to warrant admission to hospital and the low level of farm mechanization in Malawi (Ilsar et al, 1982). According to a study by Canavan et al (1980) in Ireland, only 4% of the total eye injuries resulted from agricultural pursuits which seemed a low figure for a hospital situated in a community with a large rural population. A contrasting report showing high numbers of serious eye injuries during agricultural pursuits in Ireland, a developed country, compared to a developing country with less farm mechanization was produced by Ilsar et al (1982). Farm mechanization in the agriculture industry has led to a corresponding reduction in the number of workers employed in agriculture which would have resulted in greater number of injuries (Canavan et al, 1980).

#### *3.6.4 Industry*

Occupational accidents occur in the manufacturing sector worldwide in most rapidly expanding economies (Ballal, 1997). In the past, more than 70% of all serious eye injuries occurred in the workplace without the lack of knowledge of protective devices

especially in heavy industry in Glasgow, Scotland (Garrow, 1923). Work related eye trauma vary worldwide from reports of 70% in the United Kingdom to 38.9% in Taiwan, 32.8% in Greece, 19.6% in Scotland, 14.3% in the United States, 1.25 per 1,000 population in Hong Kong and the annual incidence of work-related eye injuries in Singapore accounted for 8% of all occupational injuries (Ngo and Leo, 2008; Merle et al, 2008). Ngo and Leo (2008) in a study in Singapore found that 56.4% of all eye injuries were work-related, 54.1% of patients were injured on industrial premises.

Lamellar lacerations were the most frequent type of ocular injury in the construction industry with 71.3% cases of superficial corneal foreign body associated with welding, grinding, cutting, metal, hammering and drilling and 60% were injured by high-speed machinery involving grinding activities and hacking (Ngo and Leo, 2008). A survey done in Portugal showed a 29.6% prevalence of intraocular foreign bodies which was more frequent when working with metallic objects (50%) (Falcão et al, 2010). The incidence of endophthalmitis was 5.7% with a trend for a higher risk with IOFBs (Falcão et al, 2010). Dhir et al (1984) in India reported that the use of a hammer and chisel was responsible for intraocular foreign bodies in 61.11% patients followed by working on power driven machines and tools (24.44%). The other modes of injury were dynamite blast, gun shots and glass bottles. Murillo-Lopez et al (2002) also revealed that work related injuries were often as a result of IOFBs. The IOFB composition was metal in 79%, wood in 9.7%, stone in 7% and glass in 4.3% (Murillo-Lopez et al, 2002). Therefore investigators concluded that work-related trauma is more associated with IOFBs and subsequent presentation to an emergency department for evaluation is fundamental (Falcão et al, 2010, Murillo-Lopez et al, 2002). According to Kanski (2003) two-thirds of accidental burns occur at work. In support of that view, Saini and Sharma (1993) reported that 80% of the chemical injuries in the work place in Finland were as a result of acids and alkalis.

### *3.6.5 Sports and leisure*

Worldwide sport related eye injuries represent an important eye health hazard (Napier et al, 1996; Jones, 1993). Sport and leisure activities have become the main source of serious ocular trauma and being responsible for most cases of hospitalized eye trauma

(MacEwen 1989; Jones, 1993). Sports in relation to eye injuries can be classified as low risk, high risk and very high risk. Eye injuries occurring among school aged children in the United States are often sports-related (Jones, 1993; Napier et al, 1996). “About one-third of the injuries result from sports out of the 1.6 to 2.4 million Americans who sustain eye injuries each year with an estimate of about 40,000 patients becoming legally blind in the injured eye” (Napier et al, 1996: 229). Blunt trauma, penetrating injuries and radiation injuries from sunlight are common types of eye injuries during sports (Napier et al, 1996; Jones, 1993; MacEwen 1989; Dasgupta et al, 1990).

The mechanisms by which they occur may be classified into five groups: “ball contact; racquet or bat contact; body contact; foreign body; and falling over” (MacEwen, 1987: 701). In organized and recreational sports in the US, basketball has the highest prevalence (20%) of ocular injuries followed by baseball (8%) (Jones, 1993). In Scotland 50% of the sport injuries reported were caused by football which was responsible for patients attending a Glasgow eye casualty unit (Barr et al, 2000). This was related to the large numbers participating and popularity of the sport. This was supported by Canavan et al (1980) in Ireland where adult sports accounted for 4-8% of ocular injuries, 28% in football and 17% in squash. Sports-related eye injuries are preventable with adequate safety precautions undertaken or in place and the prevention of these injuries can result in potential economic savings (Napier et al, 1996; Jones, 1993).

### *3.6.6 Road accidents*

Dramatic increases in the proportion and absolute number of traffic fatalities have been witnessed in South Africa, despite the efforts made by local road safety organizations and research institutes (road traffic management corporation) to decrease them (Van Schoor et al, 2001). A recent research report published by the RTMC puts the statistics of road accidents at 8% in South Africa (National department of transport, 2008). In Scotland, 3.4% of the eye injuries were as result of traffic accidents and the decline was observed because of the introduction of legislation for compulsory wearing of seat belt in 1993 (Desai et al, 1996). Motor vehicles were the third most common cause of injury (9.1%) in Australia after wire injury during fencing and hammering (Madden et al, 2002).

This is comparable to a report from Korea, where 8% of eye injuries were also a result of traffic accidents (Oum et al, 2004). Keightley (1983) reported that the most devastating injury to the victim was a laceration to the eye due to a shattered windscreen. This can result to cosmetic and severe visual disability. In support, Vernon and Yorston (1984) indicated that all patients who were wearing seat belts during time of accident were injured by flying glass (66%). A study from Ogun state, Nigeria, reported that only 24% of the drivers and 8% front seat passengers were wearing seat belts at the time of the injury (Ajibode et al, 2009). The most common injury was lid injury (90.6%) followed laceration (34.4%). Subconjunctival haemorrhages (85.2%) were the most common associated ocular sign of the anterior segment (Ajibode et al, 2009). These accidents do not only result in bodily harm, but also increases the mortality rate, therefore legislation to enforce the use of sit belt and all cars to have laminated windscreens appears paramount (National department of transport, 2008).

### **3.7 Ocular site of injury (anterior versus posterior)**

All ocular structures are vulnerable to injury, but the site often depends on the cause and mechanism of ocular injury. The anterior segment of the eye consists of the cornea, conjunctiva, trabecular meshwork, anterior chamber, iris, and crystalline lens. The anterior segment is vulnerable to direct trauma. Transient or permanent visual loss may occur due to numerous sequelae of blunt anterior segment trauma (Cockerham, 1983). A survey conducted in a large urban metropolitan eye hospital found that hyphaema was the most common injury among patients admitted with ocular trauma and was present in 25% of the ocular trauma cases. Severe injury was present in 5% of the patients evaluated over a 6-month period such as hyphaema, intraocular foreign body (IOFB), open globe and orbital/facial fracture (Cockerham, 1983). Depending on the population studied secondary haemorrhage (rebleeding) may complicate hyphaema occurring in 3.5% to 38% of patients (Cockerham, 1983). Rebleeding associated with initial hyphaema size, grade II or higher, occupying more than one third of the anterior chamber area has been reported to range from 18-27%, although correlation with the initial hyphaema size has not been done by other investigators (Cockerham, 1983;



McKinney et al, 1973). Hyphaema (gross) has been followed by an approximate 70% occurrence of anterior chamber angle recession and a 7% occurrence of glaucoma. A higher risk of secondary haemorrhage exists among black patients of African descent as suggested by other studies (Cockerham, 1983; MacEwen, 1989). A rise above 25 mmHg in intraocular pressure (IOP) occurs in 25% of patients with hyphaema. Fortunately young patients having hyphaema with healthy optic nerves can withstand moderate rises in IOP without glaucomatous damage (Cockerham, 1983).

A survey conducted by Dhir et al (1984) on IOFBs revealed that the wound of entry of a foreign body was corneal in 67.02% of cases, 25.53% scleral and 7.45% corneoscleral. Thirteen of the 94 eyes (13.83%) had intra-ocular infection and were excised. Five patients who presented late (one month to two years) and had a retained iron foreign body had signs of siderosis bulbi (Dhir et al, 1984).

Muga and Maul (1978) in a study in Chile found that the crystalline lens was injured in 69.15% of the eyes and 45.74% of eyes had uveitis at the time of presentation. During perforating injuries of the anterior segment of the eye 30% of lens damage is present (Muga and Maul, 1978). It has not been established whether the cataractous lens should be removed during initial corneal laceration repair or at a later stage when the eye has recovered fully (Muga and Maul, 1978).

A survey done at a tertiary hospital in Belfast by Canavan and Archer (1982) showed that 37.3% of eyes had iris (37%) or papillary abnormalities after contusional eye injuries. Papillary margin tears were the most common producing a focal or sectorial defect when the sphincter muscle was involved. Anterior chamber angle recession occurred in 80-85% of subjects which was the commonest complication, 24.5% of cataract or lens dislocation was attributable to trauma, resulting in stationary and localized lens opacities not associated with significant loss of vision (Canavan and Archer, 1982). Corneal opacities masked perforating injuries and functional corneal sequelae were rare. The complications of angle recession by hyphaema following ocular contusion varied from 20% to 94% (Canavan and Archer, 1982; Mooney, 1972).

During and after the first week of injury the appearance of the recessed angle changed dramatically becoming more difficult to identify as time passed (Canavan and Archer, 1982; Mooney, 1972). Permanent unilateral or bilateral visual impairment may occur due to extensive damage from chemical injuries to the anterior segment and the ocular surface epithelium (Wagoner, 1997).

Posterior ocular structures include the retina, choroid and optic nerve (Cockerham, 1983). Non-penetrating or blunt ocular trauma and orbital trauma may cause a variety of posterior segment abnormalities. Blunt ocular trauma may cause damage to the retina (commotio retinae), retinal pigment epithelium (retinal pigment epithelial edema), choroid (choroidal rupture) and optic nerve (optic nerve evulsion) alone or in combination. Traumatic macular holes and retinal detachment or dialysis may also occur after blunt ocular trauma (Williams et al, 1990; Dadgostar et al, 2008). Injuries confined to the posterior segment are comparatively uncommon, comprising only 16% of the whole series (Eagling, 1976). Two factors lead to vitreous fibrosis viz. vitreous haemorrhage and vitreous incarceration in the wound (Eagling, 1976). A high percentage of patients with injuries confined to the posterior segment achieve good standard of vision initially, but a significant number of patients lose all useful vision at a later stage several weeks after injury due to the development of a tractional retinal detachment (Eagling, 1976).

In the absence of anterior segment lesions, finding significant lesions of the fundus is not common. In the uncommon situation when force is applied directly to the overlying sclera the posterior segment can be damaged, although blunt injuries may also damage the posterior pole of the eye (Canavan and Archer, 1982). Retinal detachment after blunt trauma may develop as a result of retinal dialysis, flap tears, or giant retinal tears through rapid compression-decompression forces that result in transient anteroposterior shortening and equatorial elongation of the globe (Dadgostar et al, 2008). Rhegmatogenous retinal detachment trauma is the most common cause of retinal detachment in children and may play a role in approximately 10% of retinal detachments overall (Dadgostar et al, 2008). It is estimated that 70% of haemorrhagic posterior vitreous detachments may have an associated retinal tear and this association

is likely even greater in the specific setting of trauma (Dadgostar et al, 2008). Peripheral tears can also occur as a result of trauma induced vitreous detachment (Dadgostar et al, 2008).

Clinically the predictor of visual outcome is the location of a posterior wound. Irreversible damage to the optic nerve and retina can occur following a posterior segment injury even after the structural integrity of the globe has been repaired and thus carries a poor visual prognosis (Dadgostar et al, 2008; Canavan and Archer, 1982). This view is supported by Wai Man and Steel (2010) who found in their review of open globe injuries that poor visual outcome was associated with posterior wound location. Post traumatic endophthalmitis diagnosis was made in 20.5% cases of open globe injuries. Singh et al (2005) reported a higher incidence of open globe injuries (41.44%) than closed globe injuries (26.4%) and intraocular foreign body was present in 31.16% of the open globe injuries. Associated or an isolated finding of a vitreous haemorrhage was present in 34.8% of the eyes (Singh et al, 2005).

The worst outcome is often seen in the combined anterior and posterior segment injuries, with 60% of this group losing all useful vision (Eagling, 1976; Gyasi et al, 2007; MacGwin et al, 2005). The early visual assessment in these patients showed that three quarters of these injured eyes were damaged beyond repair indicated by the absence of light perception prior to repair, or by the rapid loss of light projection after repair. The finding of retinal prolapse at operation was also a very bad prognostic sign (Eagling, 1976; Meier, 2010). In these patients, an expulsive suprachoroidal haemorrhage had occurred, resulting in retinal disorganization (Eagling, 1976). Of concern is the finding that paediatric open globe injuries (29%-47%) involve both anterior and posterior segments of the eye (Meier, 2010). Furthermore, childrens' eyes have unique characteristics and therefore require special attention during treatment of combined anterior and posterior segment injuries hence there is a pronounced tendency for scar formation, development of amblyopia as well as proliferation adherence of the posterior vitreous (Meier, 2010).

### **3.8 Epidemiology of the types of injuries**

Blunt and penetrating injuries are equally common, with lifetime prevalence“s of 52.7 per 1000 and 56.3 per 1000 respectively (Katz and Tielsch, 1993). Blunt ocular trauma is more common among males than females and has a higher prevalence in young age groups (Katz and Tielsch, 1993). Work environment and recreational activities that put eyes at risk for trauma also increase the prevalence of injuries (Roy et al, 2007; Dadgostar et al, 2008). It is estimated that there are 3.1 penetrating eye injuries per 100,000 person-years in the United States and an Australian review cited an incidence of 3.6 per 100 000 person per year (Smith et al, 2002; Rahman et al, 2006). Intraocular foreign bodies are encountered in 18% to 41% of cases that involve open globe trauma (Roy et al, 2007). Hammering is the most frequent predisposing activity accounting for 60% to 80% of cases or from injuries caused by machines and among these metallic IOFBs, 55% to 80% are magnetic (Roy et al, 2007; Dadgostar et al, 2008). Ocular or thermal burns account for 7.7%-18% of ocular trauma and are one of the most frequently reported causes of eye injuries (Merle et al, 2008). The local incidence of this possibly devastating injury is unknown but accounts for 11.1% of all ocular injury in Benin City, Nigeria and 7-9.9% in other parts of the world (Adepoju et al, 2007). Alkali burns are twice as common as acid burns since alkalis are widely used at home and in industry (Kanski, 2003). Males and young adults have the highest risk for ocular chemical burns as most of the burns occur at work and in domestic situations as mentioned previously (Merle et al, 2008).

### **3.9 Prognosis**

Provision of an early examination, diagnosis and repair greatly improves the visual prognosis. However, factors such as socioeconomic, geographical location, culture and system of health care may keep the patient from receiving specialized attention timeously consequently hampering the visual prognosis (Serrano et al, 2003; MacGwin et al, 2005; Arroyo et al, 2003). A presentation of a hospital-based study in Ghana by Gyasi et al (2007) revealed that at initial assessment 89.5% of patients who had ocular

injury had visual impairment (VA<6/18). Out of these 10.5% patients had their vision recorded as normal (6/6 to 6/18) at presentation while 74.4% were considered blind (VA<3/60) in the injured eye. At discharge, the number of blind cases had fallen to 54.2% and visual impairment to 69.3%. Eighteen cases (20.9%) were either eviscerated or enucleated due to badly lacerated eyes or ruptured globe (Gyasi et al, 2007). To access eye care services in some parts of Ghana most of the patients studied had to travel great distances. At discharge 54.2% of injured eyes were blind compared to 74.4% on admission (Gyasi et al, 2007). The inability to manage some of the complications associated with eye injuries resulted in the lack of improvement in some of the cases. Inadequacy of equipment and vitreo-retinal corneal expertise to manage some of these complications might have also contributed adversely (Gyasi et al, 2007).

A review by Bejiga (2001) showed that failure to manage the complications of injury threatening the posterior segment such as vitreous haemorrhage or retinal detachment, resulted in about two thirds of patients remaining blind in the injured eye. This was due to an inability to manage vision by the vitreo-retinal surgeon and lack of trained personnel in corneal transplantation. Bejiga (2001) revealed that 89.7% of patients were reported blind before surgery as opposed to 76.6% after surgery to the injured eye in Ethiopia. Cariello et al (2007) reported that 48.3% of patients seeking medical assistance had to wait for more than 24 hours. Presumably this delay can worsen the prognosis. Forty-eight percent of the children had sought other services without ophthalmologic assistance initially in general hospitals which could also have contributed to the delay of instituting adequate measures (Cariello et al, 2007). The average length of time between trauma and attendance to a health center in Mexico was 6.92 days (range 3 hours to 63 days) with 28% receiving ophthalmologic care elsewhere prior to admission and 72% receiving attention only at the center (Murillo-Lopez et al, 2002).

A prospective study done in India by Singh et al (2005) among patients with ocular injuries referred to a tertiary eye hospital revealed an incidence of 17.4% of intraocular foreign bodies and 11.3% of retinal detachment respectively. Furthermore, open globe

injuries were more often associated with the development of retinal detachment with delayed presentation instead of being more often associated with endophthalmitis (Singh et al 2005). About 75% of patients presented 1 week after injury with zone I open globe injuries. There was no eye with closed globe injury that developed endophthalmitis whereas 20.5% of the open globe injuries were diagnosed with post-traumatic endophthalmitis. This complication was more common in illiterate younger patients from rural backgrounds and worsened the prognosis (Singh et al, 2005).

Bhogal et al (2007) in Manchester found that more than half of the open globe injuries (12%) required enucleation of the injured eye with less than 6/15 visual acuity. A study done in Sydney, Australia showed the overall outcome after treatment to be 36% of patients attaining visual acuities of 6/12 or better, however, 31% had acuities of worse than 6/60 (Thompson et al, 2002). The causes of injury included work-related accidents (13.7%) and home-related accidents (37%). Final visual acuity in patients that had IOFB injuries was equal to or better than 20/40 in 26%, 20/50 to 20/200 in 15%, less than 20/200 in 35% and no light perception in 24% (Murillo-Lopez et al, 2002). Most authors reported that at least 10% of subjects achieve useful vision (6/24-6/60) and 25% achieved good vision between 6/6 and 6/18 after treatment (Dhir et al, 1984; Morris et al, 1987; Murillo-Lopez et al, 2002).

The time of presentation for treatment is expected to influence the prognosis. Grieshaber and Stegmann (2005) revealed that within 24 hours after injury only 25% of injured patients presented to the hospital; the younger the patient and the more severe the injury sustained the earlier was the presentation at the clinic. Most patients (51%) regained 20/40 or better visual acuity and 71% regained best-corrected visual acuity (Snellen equivalent) of 20/200 or better. Dhir et al (1984) found that the time interval between infliction of injury and reporting ranged from few hours to two years, 60% of the patients presented within one week and another 18.88% within one month of trauma.

Identified indicators of poor visual outcome were mixed corneoscleral type wounding, wound size greater than 11 mm in length, and involvement of the lens and posterior

segment in the injury (Grieshaber and Stegmann, 2005; Murillo-Lopez et al, 2002). Rebleeding of eyes have been associated with poorer prognoses, although other investigators suggest that retinal abnormalities especially, may account for this observed tendency associated with ocular injuries (Cockerham, 1983; MacEwen, 1989). Retinal detachment (16.7%), endophthalmitis (14.2%), intraocular haemorrhage (12%), hypotony (2.7%) and cataract (2.7%) were reported as the main complications of ocular injuries and 1.3% of them required evisceration in Mexico (Murillo-Lopez et al, 2002).

Dhir et al (1984) listed some of the possible effects of late presentation to hospitals following an IOFB injury in India, where foreign body removal attempt failed because the IOFB was suspected to be impacted (7.7%) even through pars plana and corneoscleral tears. Furthermore, removal was not attempted in ten out of 75 eyes with magnetic foreign bodies because of intra-ocular infection. Vitreous haemorrhage was present in two eyes following foreign body removal and ten eyes (15.38%) developed retinal detachment at a later stage (Dhir et al, 1984).

### **3.10 Protective devices**

Besides the great strides made in recent years in the development of protective devices especially the use of safety goggles, the incidence of eye injuries remains high in the work place, in sports and at home in the United Kingdom (Dasgupta et al, 1990). Ocular trauma in particular has not decreased despite the work practice policy and legislation of strict guidelines on mandatory wear of protective eye devices for workplace safety (Ngo and Leo, 2008). A retrospective study conducted by Ngo and Leo (2008) at a tertiary hospital in Singapore showed that 34% of patient claimed that they were not provided with any protective device while 44.7 % were non-compliant even when provided with protective eyewear. Voon et al (2001) reported similar findings and found that 43.7% had not used protective eyewear at the time of injury even after it being made available and 34.6% had not been provided with any. Woo and Sundar (2006) also found that 32% reported that none had been issued and 38.7% had been issued protective devices but had not used them. Furthermore, Ballal (1997)

reported that more than a third of the subjects were not wearing eye protection at the time of injury and 76.6% of accidents were as a result of projectile foreign bodies.

A study done in South Africa amongst welders by Sithole et al (2009) showed that a large percentage of the welders (89%) reported wearing protective devices when welding and the most common protective devices used by the welders were helmets (57%), goggles (22%), and face shields (15%). Six percent used inefficient protective devices such as sunglasses. Sixty one percent reported occasional exposure to welding flashes when not wearing any eye protection. Although the majority of the welders wore protective devices while welding, a few did not always use such devices while others used sunglasses for protection. Therefore, Sithole et al (2009) concluded that eye protection practices amongst the welders appeared to be inadequate to avoid hazards associated with welding.

A review by Meallet (1994) showed that the setting in which an injury occurs has a marked impact on the severity and the prognosis for visual recovery. Interestingly, the vast majority (approximately 90%) of eye injuries occur in settings where protective eyewear can have a major impact (e.g. workplace and sports activities). In fact, in many of these settings, eyewear is mandated but is not being worn at the time of injury (Meallet, 1994; Woo and Sundar, 2006) and it is estimated that up to 90% of eye injuries could be prevented if protective eyewear were worn in these settings (Meallet, 1994; Cockerhem, 1983). Desai et al (1996) reported 74 cases where protective eyewear was ascertained to have been applicable from the subjects, with less than half of these (47%) being aware of any risk of injury associated with the activity they were pursuing. When applicable, protective eye wear was available for only 48.6% of patients, with only a fifth (19.4%) of them wearing it.

In the US, a Bureau of Labor Statistics (BLS) by Lombardi et al (2009) estimated that 60% of those experiencing a work related eye injury were either wearing the wrong type or not wearing protective eyewear at the time of injury. The emergent theme in the study was the age of the worker, where young participants were reported to be less



likely to use personal protective eyewear and were less likely to perceive the risk of eye injury due to lack of experience of the employee (Lombardi et al, 2009).

Various reasons exist for the non-compliance of wearing protective devices. Fogging, scratching and somatic issues such as headache or nausea proved to be significant factors related to the non-use of personal protective eyewear (Lombardi et al, 2009; Meallet, 1994). The main risks of being injured were due to cheap quality of personal protective eyewear, lack of enforcement or low management priority, laziness to put them on, rushing around, invincibility, lack of awareness of hazards and doing a low risk task (Lombardi et al, 2009; Meallet, 1994). Specifically, other factors related to eyewear were inconvenience, cost, inappropriateness for the task and interference with prescription glasses. Recent estimates released by National Health Interview Survey (NHIS) suggest that in the U.S. 29.3% adults perform duties that could result to an eye injury and among them, while only 32.1% engaging in such activities wore eye protection (Lombardi et al, 2009). Crebolder and Sloan (2004) in Canada showed that in a combat military environment eye gear restrict soldiers' activities resulting in routine failure to wear protective goggles, yet they face the possibility of being injured through exposure to fragmentation, handling of ammunitions, flying debris and equipment which represents an extremely high risk arena for an ocular injury. Complaints have been raised against wearing lenses for protection such as they tend to fog up impairing the wearer's vision. New developments suggest that an anti-fog coating is applied to the lens to reduce fog accumulation hence safety gear must provide adequate protection while being unobstructive and comfortable (Crebolder and Sloan 2004; Lombardi et al, 2009; Vasu et al, 2001).

Accidents can occur anywhere and anytime, but through training, education and safety measures undertaken they can be prevented or controlled. At each level, attitudes toward safety should be looked at and analyzed whether it is occupation related, sports related or at home (Ngo and Leo, 2008; Ballal, 1997; Capão Filipe, 2004). Strict compliance with the use of well fitted, durable, protective eyewear with good visibility can result in these injuries being largely prevented (Lombardi et al, 2009; Ngo and Leo, 2008; Vasu et al, 2001). The unnecessary loss of workdays can be greatly reduced by

reinforcing the strict implementation of occupational eye safety programmes and review of eyewear designs (Ngo and Leo, 2008; Ballal, 1997). The objective should be to allow workers to learn from the mistakes of others rather than from their own (Ballal, 1997).

The responsibility of workplace safety lies upon managers, supervisors and workers. Non-compliance among workers over the last few years, the high rate of not issuing protective eye devices by employers and the lack of change reflect that the current guidelines as set down by the Factories Act (1981) are not being implemented properly (Ngo and Leo, 2008; Capão Filipe, 2004; Ballal, 1997). The South African Occupational Health and Safety (OHS) Act No 85 of 1993 drawn up in consultation with trade unions and employers is the main act which deals with all aspects of health and safety in the workplace placing responsibility for the provision of safe working conditions upon the employer and compels the employee to act responsibly. Customers must also be informed about any potential dangers of product use by the manufacturer or supplier. Therefore, it is of paramount importance for any employee for example in the chemical industry to be aware of potential hazards in order to protect themselves and their fellow employees at all times in the workplace. A suitable protective device can be recommended after determining the concentration and physical nature of the substance being handled. Face shields and goggles can be used for eye protection, but a full face shield is appropriate as it also protects the skin. Employees wearing spectacles are advised to wear eye shields with side shields over spectacles for maximum protection.

The South African OHS Act requires the availability of eye wash facilities at all times. Workers must make sure that they know how they operate them and where they are. Act No 181 of 1993 stipulates that; “no employer or user shall permit welding operations to be undertaken, unless: i) the person operating the equipment has been fully instructed in the safe operation and use of such equipment and in the hazards which may arise from its use; ii) effective protection is provided and used for the eyes and where necessary, for the face and body of persons performing such operations, as well as against heat, incandescent or flying particles and dangerous radiations; iii) the workplace is effectively partitioned off where practical and where not practical, all the other persons exposed to the hazards are warned and provided with suitable protective

equipment” (South African Occupational Health and Safety, 2005). Both acts, however, do not include details of the specific types of devices for different types of welding operations and the chemical industry.

The need for an increase in the use of eye protection is clearly indicated by the prevalence of eye injury in the work place, in the home and in the recreational settings. However, most protective gear have restrictions resulting in reluctance of an individual to use a protective device when carrying out risky duties.

### **3.11 Socioeconomic implications**

The nature and circumstances of ocular injury differ from country to country because it is related to differing levels of industrialization, safety standards at work place, access to health services and sociological peculiarities unique to each country (Gupta, 2009). In developing countries activities such as carpentry, agriculture, chiseling and hammering are responsible for many eye injuries. This pattern of distribution, with the majority of cases involving young and working groups, highlights the socio-economic burden of injury in these communities (Ngo and Leo, 2008; MacGwin et al, 2005). Fortunately only 2-3% of all eye injuries require hospital admission (Wagoner and Kenyon, 1990) and it is this small minority of cases that have attracted most attention and interest with regard to management and outcome. Visual impairment in the active years of life will be particularly devastating on the affected individuals, having social implications regarding loss of productivity, delaying rehabilitation and hence resulting in serious vocational and economic consequences. In developing countries eye injuries remain a cause for concern; more eye injuries occur without access to adequate caring facilities yet the patients are the least able to afford costs resulting from these injuries (Negrel and Thylefors, 1998).

### **3.12. AIM AND OBJECTIVES**

#### **3.12.1 AIM**

The aim of this study was to provide epidemiological data on ocular injuries among patients utilising the provincial hospitals eye services in Kwazulu-Natal.

#### **3.12.2 OBJECTIVES**

The objectives of this study were to:

- (i) investigate the demographic factors related to ocular injuries.
- (ii) assess the aetiology of ocular injuries.
- (iii) assess the visual outcome of ocular injuries.

#### **3.1.13 Conclusion**

The eye remains a high risk organ for work related accidents resulting in industrial blindness despite efforts made for primary prevention. On the other hand domestic accidents are also inevitable and appear to be equally severe as work related ocular injuries. The rate of monocular blindness among the rural population appears to be higher due to exposure in risky environments especially during farming activities, but on the other hand prevention of the eye injuries in industry is more controlled although eye injuries still occur. In developing countries the types or modes of injury are not necessarily similar as a result of relations to different occupations and cultures. Opportunities exist for high risk behavior in industrialized countries and urban societies leading to ocular trauma. Participation in sport has become more popular in all age groups and this has increased the risk of an eye injury without adequate protection. Despite eye protection and reflexes, the eye is still vulnerable to injury especially in sports that involve a small ball. The final functional outcomes are not satisfactory despite the high quality of surgical service after eye trauma and secondary surgical procedures during follow up with patients continuing to lose eyes through enucleation or evisceration. Lack of proper eye care facilities, human resources (skilled personnel in hospitals) unawareness of manual workers and poor education has played a vital role in poor visual outcomes of eye injuries. With so much evidence at hand about these

disabling injuries, this definitely indicates that there is an urgent need to step up safety precautions for prevention. The epidemiology of ocular injuries in the province of KZN has not been studied previously and no data could be found in the literature. Therefore, the study was conducted to provide epidemiological data on ocular injuries among patients utilising the provincial hospitals eye services in KwaZulu-Natal province, South Africa.

# CHAPTER FOUR

## METHODOLOGY

### 4.1 Introduction

Some of the causes and potential hazards that lead to eye injuries are simply beyond human control. However, through research better targeted prevention strategies can be developed in keeping these injuries minimal. This chapter presents an overview of the methodology employed in the current study.

### 4.2 Research Design

This study used a quantitative retrospective study design. Analysis was based on a review of case records of patients with ocular injuries who had presented to provincial hospital eye clinics. A retrospective study uses existing data that has been recorded for reasons other than research. In health care these are often called “chart reviews” because the data source is the medical record. Many times investigators view retrospective studies as “quick and dirty” because the data are quickly gleaned from existing records to answer a question (Gearing et al, 2006). It enables or allows the researcher to focus on the study question, determine an appropriate sample size, clarify the hypothesis, and identify feasibility issues for a prospective study. Following up cases i.e. prospective study tends to be time consuming. The advantages of conducting chart reviews include a relatively inexpensive ability to research the rich readily accessible existing data; easier access to conditions where there is a long latency between exposure and disease and allowing the study of rare occurrences. In addition, because diseased individuals have already been identified, retrospective studies are particularly useful in investigating manifestation diseases of low incidence (Gearing et al, 2006).

### **4.3 Study population**

The study population comprised of all files of patients who presented at the eye clinics during the period of January 2005 – December 2008 in provincial hospitals in KwaZulu-Natal. Only provincial hospitals were included in this study as according to the literature review, patients with lower level of education (illiterate) and labourers in whom ocular injuries tend to be more prevalent, would more likely present to a public hospital than private hospital (Gyasi et al, 2007; Singh et al, 2005, Katz and Tielsch,1993). This study is targeted at that sector of the population.

### **4.4 Sample and Sampling procedure**

A list of all provincial hospitals was obtained from the website of the KwaZulu-Natal Health Department. It was noted that only 18 out of a total of 71 hospitals offer eye services. Only hospitals within 80km of the Durban City Centre were selected due to easier accessibility as shown on the map (Appendix C). The hospitals were categorised on the list as either urban or rural and assigned numbers. Thereafter 2 urban and 2 rural hospitals were selected randomly with the use of a table of random numbers. The hospitals selected were as follows:

#### 4.4.1 Urban hospitals:

##### *(i) Edendale Hospital*

Edendale hospital situated in Pietermaritzburg is a regional and district level hospital fully recognized for post-graduate teaching in all major disciplines in the uMgungundlovu district. The hospital serves a population of over a million. The eye clinic conducts almost all types of anterior segment and posterior segment surgery except for retinal detachment for which patients are referred to Greys referral hospital instead. On average about 7 operations are done per day including cataract surgery, trabeculectomy, squint correction and trauma (all types of eye trauma repair). There are only 3 ophthalmologists who work on a full time basis, one optometrist who is

employed on a part time basis and about three full time ophthalmic nurses. An average of about 60 patients present to the clinic each day including children of different races but dominated by Blacks. The inpatient ward has 35 beds; 30 beds for adults and 5 for children. Ward rounds are conducted 2 to 3 times daily to ensure quality of service in the management of in-ward patients. Each day an average of about 8 patients are admitted and about 4 discharges are made. Statistics revealed that 21% (2421) of all the patients that presented to the hospital had to undergo eye surgery for the year 2008/2009. For the year 2009/2010, the number of patients who had to undergo eye surgery dropped to 12% (n=1378). Among all operations done in the hospital per surgical ward the eye clinic was among the highest with 76.28% for the year 2009/2010 with an average of 5.25 days length of stay for surgery.

*(ii) Addington Hospital*

Addington hospital situated in Durban is a regional and district level hospital in the Ethekewini district. The hospital serves a population of approximately 1.5 million in Durban central and North. The eye clinic conducts almost all types of anterior segment and posterior segment surgery except for retinal detachment for which patients are referred to Inkosi Albert Luthuli referral hospital. On average about 7 operations are done per day, including cataract surgery, trabeculectomy, squint correction and trauma (all types of eye trauma repair). There are only 2 qualified ophthalmologists who work on a full time basis, 2 registrars, an optometrist who is employed full time and about 2 ophthalmic nurses. An average of about 80 patients present to the clinic each day including follow up patients of all races, but dominated by Blacks. The inpatient ward has only 11 beds; 7 beds for adults and 4 for children which has been found to be insufficient because most patients admitted are kept in other wards instead of the eye ward. Ward rounds are conducted once daily in the management of inpatients. No statistics were provided by the eye clinic in this hospital with respect to the number of operations done and admissions of patients presenting to the eye clinic.



#### 4.4.2 Rural hospitals:

##### *(i) Prince Mshiyeni Memorial Hospital*

Prince Mshiyeni Memorial is a regional hospital at Umlazi in the eThekweni district that serves the surrounding area, up to and including part of the Eastern Cape. The statistics estimate the population to be approximately 2 million that is being served by the hospital. The hospital offers health services to the community at regional and district levels and has 17 clinics attached. The eye clinic conducts only minor anterior segment surgeries e.g. cataract surgery, conjunctival mass, foreign body removal and suturing. Patients are referred to St. Aidan's hospital for further assessment. The number of operations done per day is not specified and it depends on availability of the cataract surgeon. There is no ophthalmologist to attend to patients instead they are treated by a trained medical practitioner who works on full a time basis with one optometrist who is employed full time and one ophthalmic nurse. The number of patients seen per day depends on the appointment date and the number of patients referred from Eastern Cape including children of different races, but dominated by Blacks. There is no inpatient ward belonging to the eye clinic instead patients are admitted in a general ward where there are 18 beds allocated to the eye clinic; 11 beds for males and 7 beds for females while children are admitted in a pediatric ward. Each day an average of about 8 patients are admitted especially for cataract surgery and they are discharged on the third day irrespective of any post operation complications due to the lack of space to keep the patients and insufficient staff to look after the patients. Patients with complications are then referred to St. Aidan's hospital for further assessment. Statistics revealed that 2.2% (334) of all the patients that presented to the hospital for the year 2009 had to undergo eye surgery and of these 4% (614) presented with ocular trauma. For the year 2010, the number of patients who had to undergo eye surgery dropped to 1.5% (n= 231) with 3.89% (603) patients presenting with ocular trauma.

*(ii) Stanger Hospital*

Stanger hospital is a regional and district hospital located in KwaDukuza in the ILembe health district. The hospital serves a population of about 600 000 from the ILembe district. The eye clinic conducts almost all types of anterior segment surgery e.g. extra capsular cataract extraction, microscopic intra ocular lens implant, glaucoma surgery, all types of eye trauma repair and posterior surgery except for retinal detachment for which patients are referred to St. Aidan's hospital. The inpatient ward has 12 beds; 8 beds for females and 4 for males. Ward rounds are conducted 2 to 3 times daily to ensure quality service in the management of inpatients. On average about 5 operations are done per day, this includes cataract surgery, trabeculectomy, squint correction and trauma (all types of eye trauma repair). There is no consultant ophthalmologist instead patients are treated by a cataract surgeon and three trained medical practitioners who work on full time basis with one optometrist who is employed full time and two ophthalmic nurses. The inpatient ward has 35 beds; 30 beds for adults and 5 for children. This is the only hospital that is dominated by more than one race, Indian and Blacks. No statistics were provided by the eye clinic in this hospital with respect to the number of operations done and admissions of patients presenting to the eye clinic.

A probability ratio of 2:1 was determined in consultation with the faculty statistician to come up with the number of medical records of patients with ocular injuries to be reviewed comparing rural hospitals versus urban hospitals as it is proven by previous studies done that rural clinics had higher prevalence of ocular injuries (Salvatore et al (2008; Madden et al, 2002). Therefore, a total of 660 record cards were reviewed, 220 in each rural hospital and 110 in each urban hospital. All record cards for the specified period that were complete with respect to the required information were selected and assigned numbers then randomly selected using a set of random numbers that was generated for the sample.

#### **4.5 Data gathering instruments**

A data sheet/form (Appendix A) was devised for capturing of the information. Cases were analyzed with respect to: (i) demographics details, (ii) place of trauma (iii) nature of trauma, (iv) type of injury, (v) management and (vi) visual outcomes following primary eye care.

#### **4.6 Procedure for data collection**

On reaching each hospital, patient record cards were gathered by looking for diagnoses in the patients' register. A list was compiled for all patients diagnosed with ocular injuries using inpatient and outpatient numbers on the patients' register. Files were then selected from the file cabinets with the assistance of administration clerks. The files were reviewed on the hospital premises to avoid misplacement of the record cards.

#### **4.7 Ethical and legal consideration**

The proposal for this study was approved by the Biomedical Research and Ethics Committee of the University of KwaZulu-Natal (HSS/0095/10M). Permission was sought from the hospital superintendent and the Department of Health of KwaZulu-Natal (Appendix B) to view hospital records before the commencement of the study. All the information gathered was kept confidential and no subject was identified by name. The department was informed that findings would enable the planning and provision of eye health care, identify population groups at risk and guide health and safety strategies for the prevention of ocular injuries. All patients who presented to the hospital with ocular injuries within the specified four years, both genders, all race groups, all age groups were included in the study. The raw data was captured directly to the Statistical Package for Social Sciences (SPSS) and the computer in which captured data was saved was password protected and accessed only by the researcher.

#### **4.8 Data analysis**

Descriptive statistics using the SPSS (version 18) and Microsoft Excel 2007 statistical packages were used to analyze the data in consultation with the faculty statistician. Chi square test, Fisher's exact test and McNemar-Bowker test were used as appropriate. Statistical significance was set at a 95% confidence interval and all P-values less than 0.05 were considered statistically significant.

#### **4.9 Problems experienced**

On reaching each hospital, a simpler way to access patients' records cards was going through patients register, however in one of the hospitals the patients' registers were nowhere to be found for the specified four years. This constituted to a delay in data collection because the researcher had to go through all the records cards to check whether the patient presented with an ocular injury or not.

#### **4.10 Conclusion**

Overall, conducting this research was fulfilling. Most of the eye clinic staff were supportive and encouraging.

# CHAPTER FIVE

## RESULTS

A total of 660 records of patients who had sustained ocular injuries (over a four year period) were reviewed. Out of these, 440 patients' records were reviewed at rural hospitals and 220 at urban hospitals.

### 5.1 DEMOGRAPHICS

#### 5.1.1 Gender

There were 477 (72.3%) male patients and 183 (27.7%) female patients in total (Figure 1).

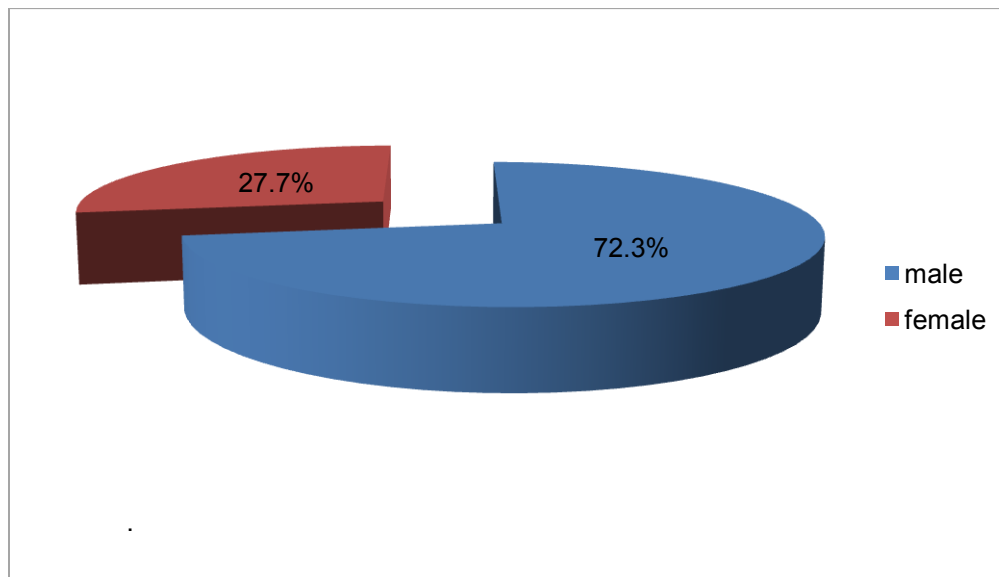


Figure1. Gender distribution of the total sample

Out of these, 303 (68.9%) males and 137 (31.1%) females presented at rural hospitals whereas 174 (79.1%) males and 46 (20.9%) female patients presented at urban hospitals (Figure 2).

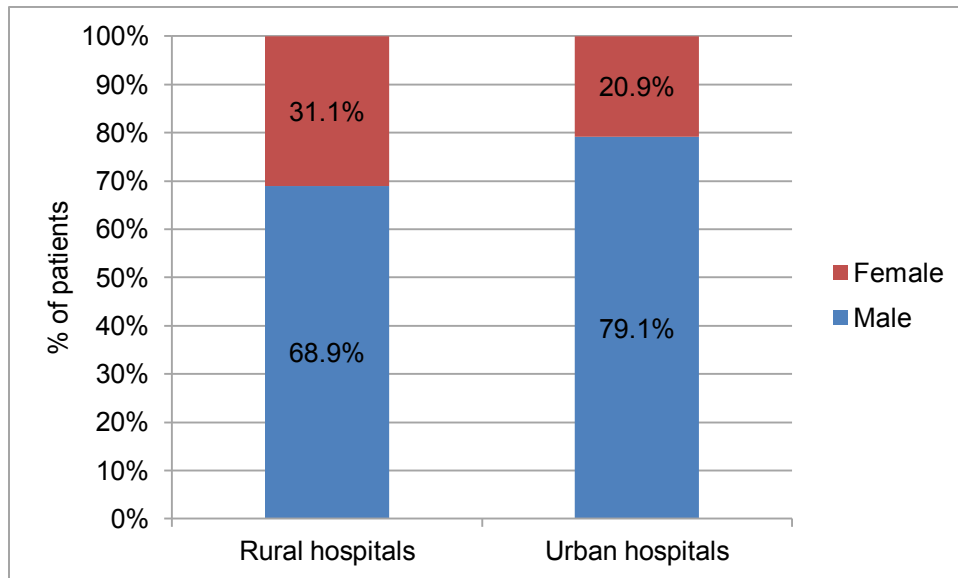


Figure 2. Gender distribution of patients (rural versus urban hospitals)

### 5.1.2 Age

For the entire sample the average age was 29 years  $\pm$ 16.82 years ranging from 1- 89 years. The distribution of the subjects into age categories is shown in Figure 3.

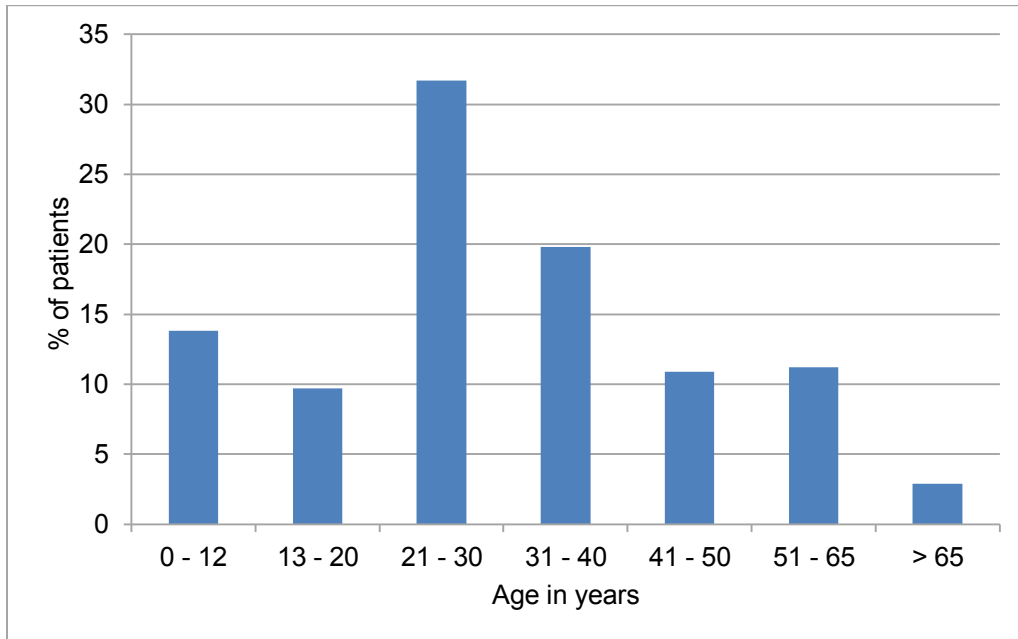


Figure 3. Age distribution of the total sample

Almost one-third of all the patients (31.7%) were between 21 and 30 years old with the second highest percentage of patients (19.8%) being in the age category of 31- 40 years. A significant percentage of patients (13.8%) were children up to the age of 12 years. Only a small percentage of patients (2.9%) were older than 65 years.

Figure 4 below shows the age distribution of patients presenting to rural hospitals compared to the presentation at urban hospitals.

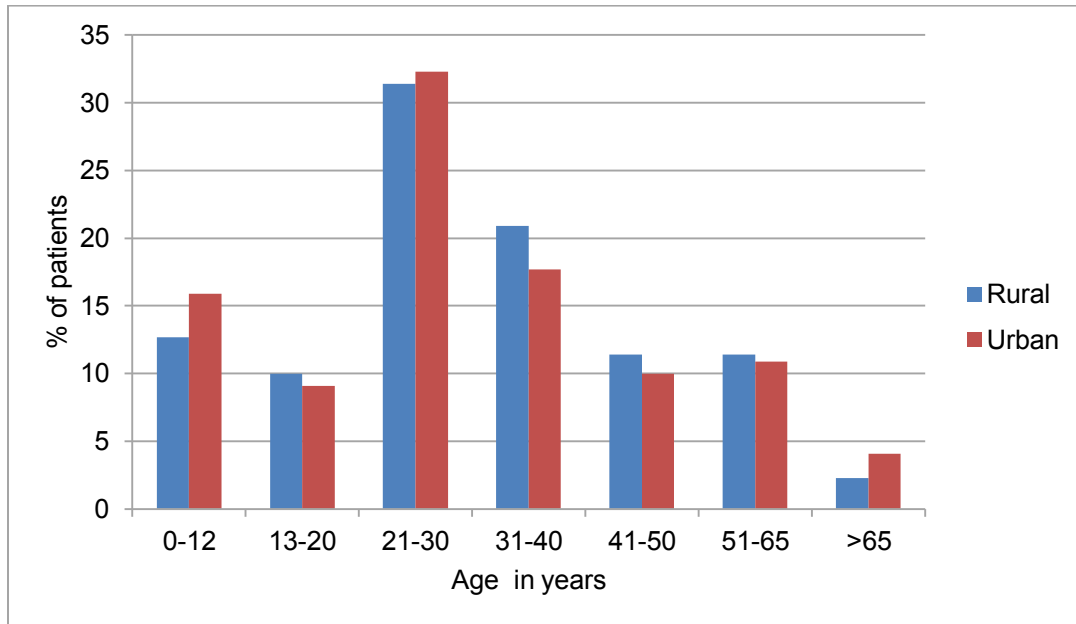


Figure 4. Age distribution (rural versus urban hospitals)

The highest percentage of patients (31.4%) with ocular injury presenting to rural hospitals were between 21 and 30 years. This was similar to the presentation at urban hospitals with the greatest percentage of patients with ocular injuries (32.3%) also being between 21 to 30 years. A higher percentage of patients were found to be in the 31 to 40 age category at both rural and urban hospitals (20.9% versus 17.7%, respectively). At both rural and urban hospitals, patients were found to be in the 0 to 12 year age category (12.7% versus 15.9%, respectively). Patients over 65 years of age were very few at both rural and urban hospitals (2.3% versus 4.1%, respectively).



### 5.1.3 Race

In the overall sample, the majority of the patients were Blacks (93.8%, n=619) followed by Indians (3.9%, n=26), Coloureds (2%, n=13) and lastly Whites (0.3%, n=2) as is illustrated in Figure 5 below.

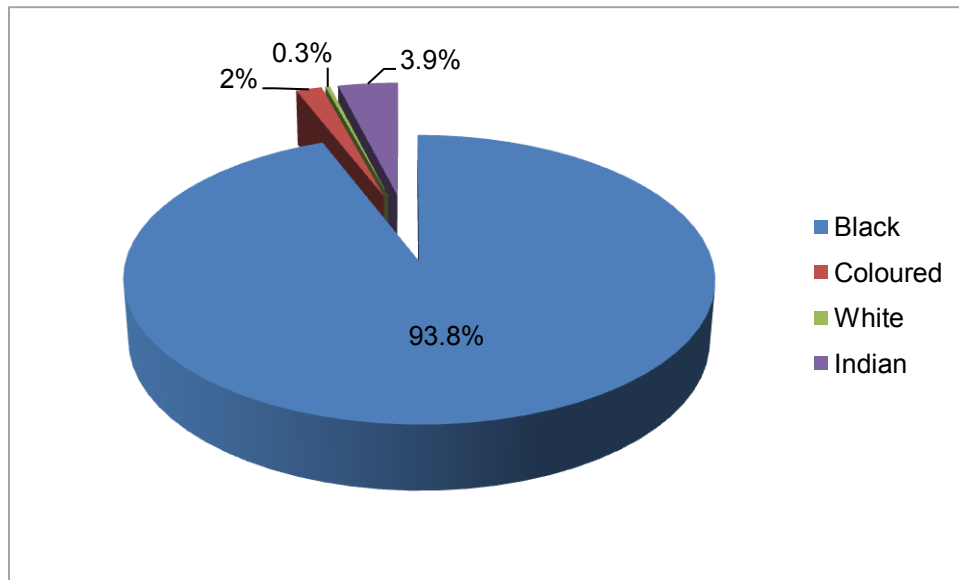


Figure 5. Sample distribution by race in the total sample

At the rural hospitals, the sample comprised of 430 (97.7%) Blacks, 4 (0.9%) Coloureds, 6 (1.4%) Indian. No Whites presented with ocular injuries to rural hospitals. In comparison there were 189 (85.9%) Blacks, 9 (4.1%) Coloureds, 20 (9.1%) Indian and 2 (0.9%) Whites who presented with ocular injuries to urban hospitals as is illustrated in Figure 6.

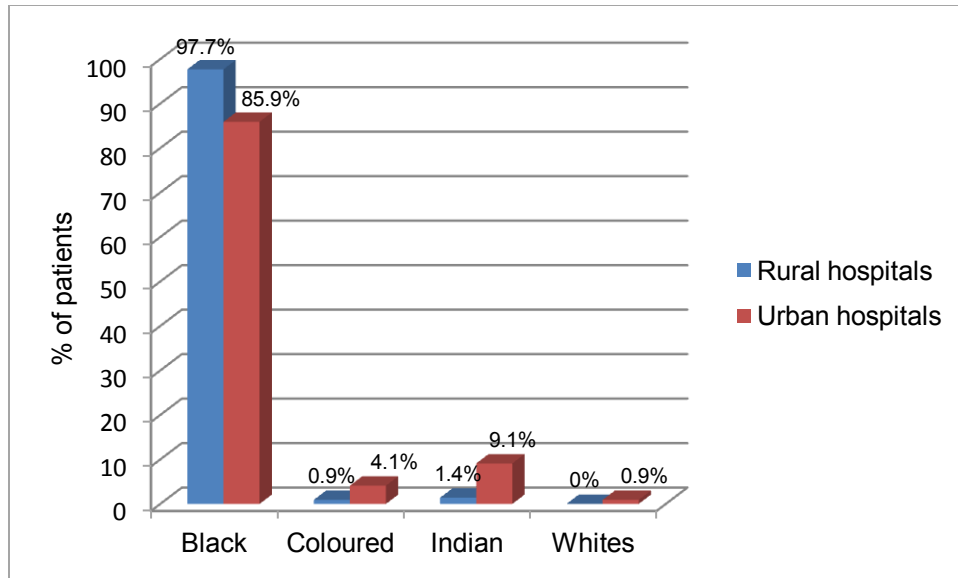


Figure 6. Race distribution (rural versus urban hospitals)

## 5.2 OCULAR INJURIES

### 5.2.1 Type of injury

The Birmingham Eye Trauma Terminology (BETT) was used to classify the main types of ocular trauma into open globe and closed globe injuries. There was a higher percentage of open globe injuries (56.2%) incurred compared to closed globe injuries (43.8%). The injuries are further subdivided into types as is illustrated in Table 1 below.

Table 1. Showing the type of injuries in order of decreasing frequency for the overall sample

Type of injury	Percentage of patients
Blunt trauma (closed globe)	35.2 (n= 232)
IOFBs (open globe)	25.8 (n= 170)
Lacerations (open globe)	20.2 (n= 133)
Penetrating trauma (open globe)	10.3 (n= 68)
Burns (closed globe)	8.6 (n= 57)
Total	100 (n= 660)

Blunt trauma/contusion was the most frequent type of injury (35.2%) and the least frequent type of injury was burns (8.6%).

Table 2 below shows the types of injuries for patients presenting to rural hospitals compared to the presentation at urban hospitals.

Table 2. Showing the types of injuries in percentages at rural and urban hospitals

Type of injury	Rural hospital (% of patients)	Urban hospital (% of patients)
Blunt trauma	36.4 (n= 160)	32.7 (n= 72)
IOFBs	29.5 (n= 130)	18.2 (n= 40)
Lacerations	18.2 (n= 80)	24.1 (n= 53)
Penetrating	8.4 (n= 37)	14.1 (n= 31)
Burns	7.5 (n= 33)	10.9 (n= 24)
Total	100 (n= 440)	100 (n= 220)

A similar trend was observed with respect to the frequency of the types of injury at rural and urban hospitals. Blunt trauma was the most frequent type of injury at both rural (36.4%) and urban (32.7%) hospitals. The least frequent type of injury at both rural and urban hospitals was burns (7.5% vs. 10.9%, respectively). The one difference noted was that there were more lacerations observed at urban hospitals (24.1%) than at rural hospitals (18.2%) and more IOFBs observed at rural hospitals (29.5%) than at urban hospitals (18.2%).

### 5.2.1.1 Type of injury versus age of patients

Table 3. Showing the type of injury (row % (n)) in relation to the age of the patients in the overall sample

	0-12	13-20	21-30	31-40	41-50	51-65	>65	All types
Type of injury								
Blunt trauma	9.5(n=22)	12.1(n=28)	30.6(n=71)	19(n=44)	11.6(n=27)	12.9(n=30)	4.3(n=10)	100(n=232)
Penetrating	16.2(n=11)	4.4(n=3)	27.9(n=19)	23.5(n=16)	10.3(n=7)	11.8(n=8)	5.9(n=4)	100(n=68)
IOFBs	13.5(n=23)	7.6(n=13)	32.9(n=56)	22.4(n=38)	10.6(n=18)	10.6(n=18)	2.4(n=4)	100(n=170)
Lacerations	19.5(n=26)	12(n=16)	29.3(n=39)	17.3(n=23)	9.8(n=13)	11.3(n=15)	0.8(n=1)	100(n=133)
Burns	15.8(n=9)	7(n=4)	42.1(n=24)	17.5(n=10)	12.3(n=7)	5.3(n=3)	-	100(n=57)
Total	13.8(n=91)	9.7(n=64)	31.7(n=209)	19.8(n=131)	10.9(n=72)	11.2(n=74)	2.9(n=19)	100(n=660)

In the overall sample, blunt trauma was found to be the most frequent type of ocular injury in all age categories from 13 years to over the age of 65 years. In the age category 0 to 12 years, lacerations (28.6%, n=26/91) was the most frequent type of ocular injury. Each type of injury occurred most frequently in the 21 to 30 age group. Not surprisingly, therefore, the 21 to 30 age group suffered the most number of injuries in the overall sample (31.7%, n=209).

At rural hospitals the 21 to 30 age group suffered the most number of injuries (31.4%, n=134). This was similar to what was observed at urban hospitals in the 21 to 30 age category (32.3%, n=71). Furthermore at both rural and urban hospitals each type of injury also occurred most frequently in the 21 to 30 age group. In the age category of 0 to 12 years lacerations occurred more frequently at rural hospitals than at urban hospitals (21.3% vs. 17%, respectively). Furthermore, at urban hospitals lacerations and IOFBs had an equal number of cases in the age category of 0 to 12 years (25.7%, n=9/35).

### 5.2.1.2 Type of injury versus gender of the patients

Figure 7 below shows the type of injury in relation to the gender of the patients.

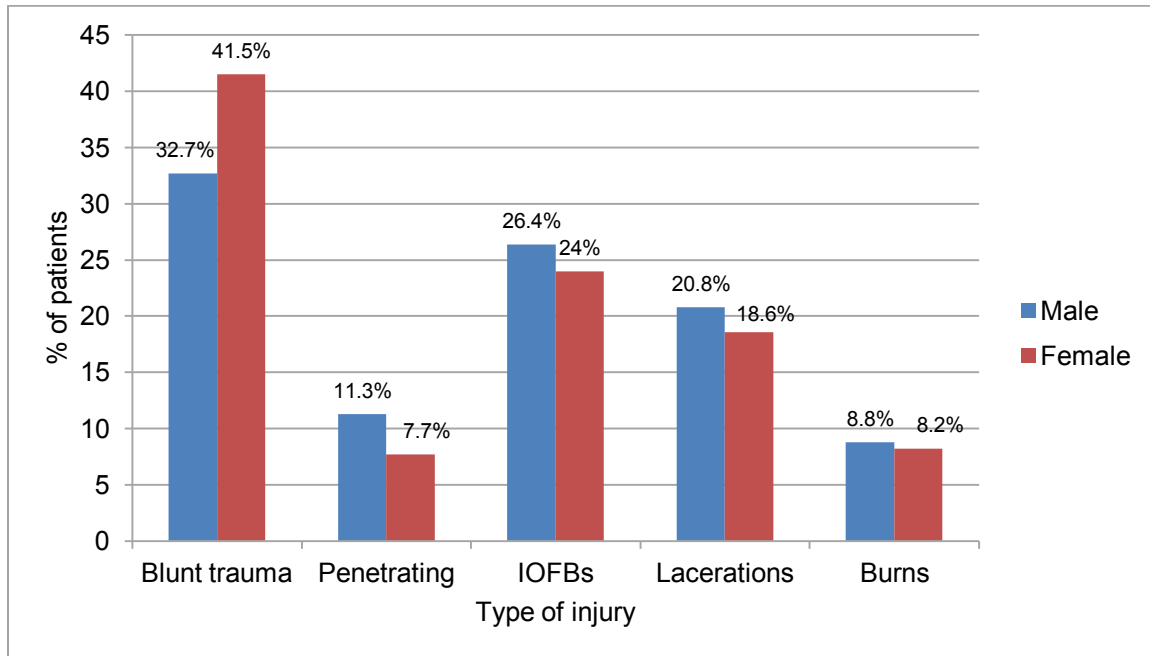


Figure 7. Type of injury in relation to the gender of patients

In the overall sample for each type of injury there appears to be an excess of males except for blunt trauma (41.5% vs. 32.7% of females vs. males, respectively).

A similar trend for blunt trauma was observed at both rural (33.7% vs. 42.3% for males vs. females, respectively) and urban hospitals (31% vs. 39.1% for males and females, respectively). At rural hospitals, there were an equal number of males (18.2%) and females (18.2%) who had lacerations. At rural hospitals burns were more frequent among females compared to males (13% vs. 10.3% respectively). This is illustrated in Figure 8 below.

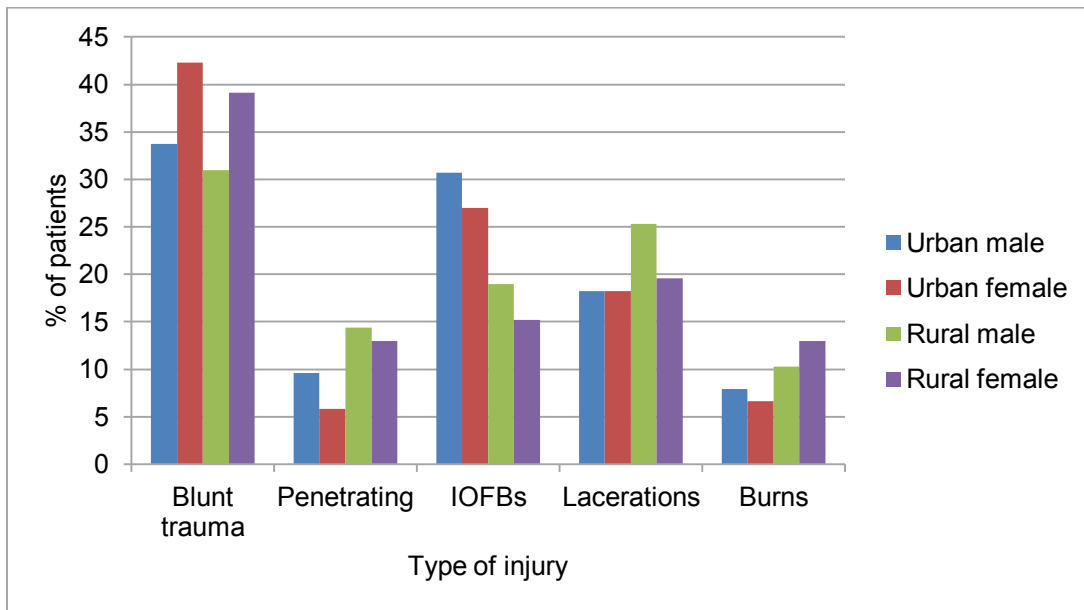


Figure 8. Type of injury in relation to the gender of the patients (rural versus urban hospitals)

## 5.2.2 Ocular signs

After diagnosing the type of injury, just about half of the patients (50.9%, n= 335) in the overall sample had associated ocular signs which ranged from hyphaema to raised intraocular pressure (IOP) as is illustrated in Table 4 below.

Table 4. Showing associated ocular signs in the overall sample

Ocular sign	Percentage of patients
Hyphaema	8.6 (n= 57)
Orbital fracture	1.8 (n= 12)
Haemorrhages	15.9 (n= 105)
Endophthalmitis	1.7 (n= 11)
Tobacco dust cells	0.8 (n= 5)
Traumatic uveitis	1.7 (n= 54)
Corneal scarring/opacity	6.5 (n= 43)
Corneal laceration	4.1 (n= 27)
Elevated IOP	3.2 (n= 21)
No ocular signs	49.2 (n=325)
Total	100 (n= 660)

The most frequent associated ocular sign was haemorrhages (15.9%) followed by hyphaema (8.6%). The least frequent associated ocular sign was tobacco dust cells (0.8%).

Table 5 below shows the frequency of ocular signs for patients presenting to rural hospitals compared to the presentation at urban hospitals.

Table 5. Showing ocular signs (column % (n)) in rural vs. urban hospitals

Ocular sign	Rural hospital	Urban hospital
	% of patients	% of patients
Hyphaema	8 (n=35)	10 (n=22)
Orbital fracture	0.9 (n=4)	3.6 (n=8)
Haemorrhages	17.5 (n=77)	12.7 (n=28)
Endophthalmitis	0.9 (n=4)	3.2 (n=7)
Tobacco dust cells	-	2.3 (n=5)
Traumatic uveitis	10 (n=44)	4.5 (n=10)
Corneal scarring/opacity	4.5 (n=20)	10.5 (n=23)
Corneal laceration	2.7 (n=12)	6.8 (n=15)
Elevated intra ocular pressure	2.3 (n=10)	5 (n=11)
No ocular signs	53.2 (n=234)	41.4 (n=91)
Total	100 (n=440)	100 (n=220)

A lower percentage of patients with associated ocular signs was noted at rural hospitals (46.8%) compared to 58.6% of patients who exhibited associated ocular signs at urban hospitals. A higher percentage of patients with haemorrhages (17.5%) and traumatic uveitis (10%) was observed at rural hospitals compared to at urban hospitals (12.7% and 4.5% for haemorrhages and traumatic uveitis, respectively). The remaining ocular signs were more frequent at urban hospitals. The ocular signs were further analyzed according to the type of injury they were associated with (Table 6).



### 5.2.2.1 Associated ocular signs versus the type of injury

Table 6. Associated ocular signs (column % (n)) in relation to type of injury

Type of injury	Hyp	OF	Haems	Endo	TD cells	TU	CSO	CL	Raised IOP	All types
Blunt trauma	75.4(43)	83.3(10)	57.1(60)	-	20(1)	46.3(25)	16.3(7)	70.4(19)	76.2(16)	54(181)
Penetrating	5.3(3)	-	8.6(9)	9.1 (1)	60(3)	7.4(4)	14(6)	22.2(6)	-	9.6(32)
IOFBs	10.5(6)	8.3(1)	14.3(15)	63.6 (7)	20(1)	31.5(17)	11.6(5)	3.7(1)	23.8(5)	17.3(58)
Lacerations	7(4)	8.3(1)	20(21)	27.3(3)	-	11.1(6)	30.2(13)	3.7(1)	-	14.6(49)
Burns	1.8(1)	-	-	-	-	3.7(2)	27.9(12)	-	-	4.5(15)
Total	100(57)	100(12)	100 (105)	100 (11)	100(5)	100(54)	100(43)	100(27)	100(21)	100(335)

Hyp=hyphaema, OF= orbital fracture, Haems= haemorrhages, Endo= endophthalmitis, TD cell= tobacco dust cells, TU= traumatic uveitis, CSO= corneal scarring/opacity, CL= corneal laceration, IOP= intra ocular pressure, IOFBs= intra ocular foreign bodies.

The majority (54%) of the patients presenting with associated ocular signs had incurred blunt trauma. Endophthalmitis was the only sign that did not present in cases of blunt trauma. Hyphaema (75.4%), orbital fracture (83.3%), haemorrhages (57.1%) and traumatic uveitis (46.3%) were most frequently observed in patients who had incurred blunt trauma. Corneal scarring/opacities were mostly associated with cases of lacerations (30.2%) followed by ocular burns (27.9%). Burns had the least number of associated ocular signs. Tobacco dust cells were not associated with lacerations and burns. Raised IOP was present in cases of blunt trauma and intra ocular foreign bodies. Orbital fracture was not associated with penetrating injury and burns. With the exception of ocular burns, corneal lacerations were associated with all other types of injuries.

Table 7 below shows the types of injuries in relation to ocular signs for patients presenting to rural hospitals.

Table 7. Showing the type of injury (column % (n)) in relation to associated ocular signs at rural hospitals

Type of injury	Hyp	OF	Haems	Endo	TD cells	TU	CSO	CL	Raised IOP	All types
Blunt trauma	62.9(22)	50(2)	61(47)	-	-	52.3(23)	25(5)	91.7(11)	70(7)	56.5(117)
Penetrating	5.7(2)	-	2.6(2)	-	-	2.3(1)	15(3)	-	-	4.3(9)
IOFBs	17.1(6)	25(1)	15.6(12)	50(2)	-	31.8(14)	25(5)	-	30(3)	20.8(43)
Lacerations	11.4(4)	25(1)	20.8(16)	50(2)	-	13.6(6)	10(2)	8.3(1)	-	15.5(32)
Burns	2.9(1)	-	-	-	-	-	25(5)	-	-	2.9(6)
Total	100(35)	100(4)	100(77)	100(4)	-	100(44)	100(20)	100(12)	100(10)	100(207)

Hyp=hyphaema, OF= orbital fracture, Haems= haemorrhages, Endo= endophthalmitis, TD cell= tobacco dust cells, TU= traumatic uveitis, CSO= corneal scarring/opacity, CL= corneal laceration, IOP= intra ocular pressure, IOFBs= intra ocular foreign bodies.

At rural hospitals the majority of the patients who presented with associated ocular signs had incurred blunt trauma (56.5%). The most frequent ocular sign associated with blunt trauma was haemorrhages (40.2%, n=47/117) followed by hyphaema (18.8%, n=22/117). Tobacco dust cells were the only associated ocular sign that did not present in all types of injuries. Endophthalmitis was only associated with IOFBs and lacerations. Corneal scarring/opacities had an equal number of cases from blunt trauma, IOFBs and ocular burns (25%, n=5). Corneal laceration was only observed in cases of blunt trauma and IOFBs.

Table 8 below shows the types of injuries in relation to ocular signs for patients presenting to urban hospitals.

Table 8. Showing type of injury (column % (n)) in relation to associated ocular signs at urban hospitals

	Hyp	OF	Haems	Endo	TD cells	TU	CSO	CL	Raised IOP	All types
Type of injury										
Blunt trauma	95.5(21)	100(8)	46.4(13)	-	20(1)	20(2)	8.7(2)	53.3(8)	81.8(9)	49.6(64)
Penetrating	4.5(1)	-	25(7)	14.3(1)	60(3)	30(3)	13(3)	40(6)	-	18.6(24)
IOFBs	-	-	10.7(3)	71.4(5)	20(1)	30(3)	-	6.7(1)	18.2(2)	11.6(15)
Lacerations	-	-	17.9(5)	14.3(1)	-	-	47.8(11)	-	-	13.2(17)
Burns	-	-	-	-	-	20(2)	30.4(7)	-	-	7(9)
Total	100(22)	100(8)	100(28)	100(7)	100(5)	100(10)	100(23)	100(15)	100(11)	100(129)

Hyp=hyphaema, OF= orbital fracture, Haems= haemorrhages, Endo= endophthalmitis, TD cell= tobacco dust cells, TU= traumatic uveitis, CSO= corneal scarring/opacity, CL= corneal laceration, IOP= intra ocular pressure, IOFBs= intra ocular foreign bodies.

At urban hospitals, the majority of the patients who presented with associated ocular signs had also incurred blunt trauma (49.6%). The most frequent ocular sign associated with blunt trauma at urban hospitals was hyphaema (32.8%, n=21/64) followed by haemorrhages (20.3%, n=13/64). The majority of the patients with corneal scarring /opacities had incurred lacerations (47.8%, n=11/23). Tobacco dust cells did not present in cases of lacerations and burns. With the exception of IOFB cases, corneal scarring/ opacities was associated with all the types of injuries. Orbital fracture was only present in cases of blunt trauma.

At rural hospitals, there were an equal number of patients with endophthalmitis (50%) following an IOFB injury and lacerations. At urban hospitals, there were more patients with endophthalmitis following an IOFB injury compared to lacerations (71.4% vs. 14.3%, respectively). Patients with burns had the least number of associated ocular signs at both rural and urban hospitals (2.9% vs. 7%, respectively). At both rural and urban hospitals, raised IOP was only associated with cases of blunt trauma and IOFBs. Traumatic uveitis did not present in cases of ocular burns at rural hospitals compared to urban hospitals where traumatic uveitis did not present in cases of lacerations.

### 5.2.3 Laterality

In the overall sample unilateral ocular injuries occurred in 637 patients (96.5%) and only 23 patients (3.5%) had incurred bilateral injuries. The majority of the bilateral injuries were due to burns following chemical splashes (65.2%, n=15) followed by blunt trauma (26.1%, n=6). None of the penetrating injuries occurred bilaterally. Blunt trauma resulted in the highest percent of unilateral injuries (35.5%) followed by IOFBs (26.5%) and then lacerations (20.7%). This is illustrated in Table 9.

Table 9. Type of injury (column % (n)) in relation to laterality of ocular injury in the overall sample

Type of injury	Bilateral	Unilateral	Total
Blunt trauma	26.1 (n=6)	35.5 (n=226)	35.2 (n=232)
Penetrating	-	10.7 (n=68)	10.3 (n=68)
IOFBs	4.3 (n=1)	26.5 (n=169)	25.8 (n=170)
Lacerations	4.3 (n=1)	20.7 (n=132)	20.2 (n=133)
Burns	65.2 (n=15)	6.6 (n=42)	8.6 (n=57)
Total	100 (n=23)	100 (n=637)	100 (n=660)

More bilateral injuries were encountered at urban hospitals than at rural hospitals (5.5% vs. 2.5%, respectively). Unilateral injuries were more frequent than bilateral injuries at both rural and urban hospitals (97.5% vs. 94.5%, respectively). At rural hospitals, there were 2(18.18%) bilateral blunt trauma cases and only 1(8.33%) unilateral blunt trauma case at urban hospitals as a result of alcohol abuse.

Burns tended to present bilaterally while blunt trauma and IOFB injuries tended to be more unilateral and this association between the type of injury and laterality was found to be significant ( $p=0.000$ ; Fisher's exact test). Furthermore, an association was also found at both rural and urban hospitals ( $p=0.000$ ; Fisher's exact test) between the type of injury and laterality. Bilateral injuries were more frequent at urban hospitals compared to rural hospitals as a result from burns (37.5% vs. 18.2 %, respectively) and blunt trauma (2.8% vs. 2.5%, respectively).

### 5.3 PLACE OF INJURY

Figure 9 shows the places of injury in the overall sample.

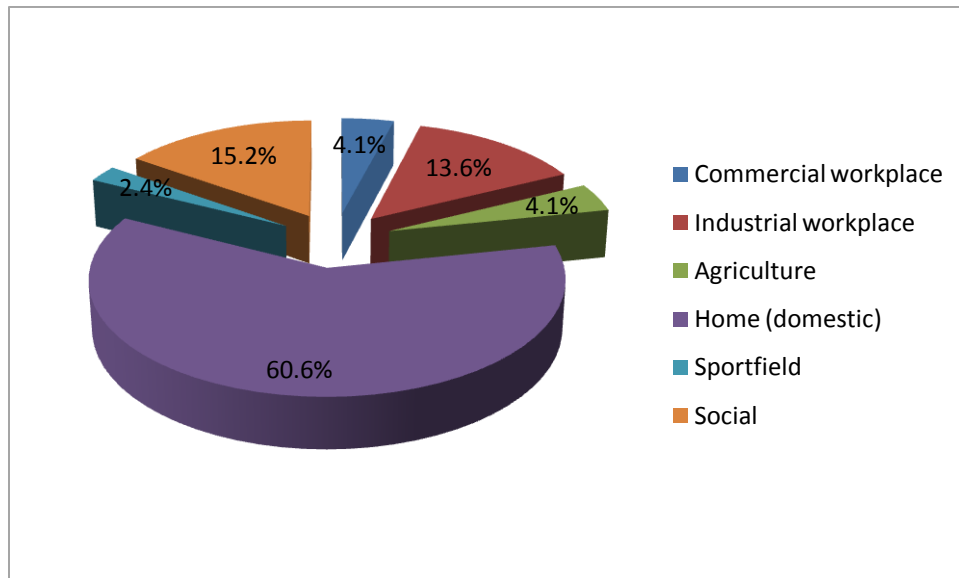


Figure 9. Place of injury of the overall sample

The highest percentage of patients (60.6%) experienced ocular trauma in the home. Very few (2.4%) were sports related.

Table 10 below shows the relative frequency distribution of place of injury for the overall sample, for rural hospitals compared to urban hospitals.

Table 10. Showing the overall frequency distribution of the place of injury in relation to rural versus urban hospitals (column % (n))

Place of injury	Rural hospitals	Urban hospitals	Total
Home (domestic)	54.5 (n=240)	72.2 (n=160)	60.6 (n=400)
Social environment	19.1 (n=84)	7.3 (n=16)	15.2 (n=100)
Commercial workplace	3.9 (n=17)	4.5 (n=10)	4.1 (n=27)
Industry	15.7 (n=69)	9.5 (n=21)	13.6 (n=90)
Agriculture	4.5 (n=20)	3.2 (n=7)	4.1 (n=27)
Sports	2.3 (n=10)	2.7 (n=6)	2.4 (n=16)
Total	100 (440)	100 (220)	100 (660)

Injuries incurred in the home were frequent at both rural and urban hospitals (54.5% vs. 72.2% respectively). A significant percent of injuries also occurred in the social environment at both rural and urban hospitals (19.1% vs. 7.3%, respectively) and in the industrial workplace (15.7% vs. 9.5%, respectively).

### 5.3.1 Place of injury versus ages of the patients

Table 11 below summarizes the places of injury in relation to age for the overall sample.

Table 11. Place of injury (column % (n)) in relation to age of the patient

	Comm. wk	Agric	Indus.	Home	Sports	Social	All types
Age (y)							
0-12	-	3.7 (1)	-	21.5 (86)	12.5 (2)	2 (2)	13.8 (91)
13-20	3.7 (1)	11.1 (3)	5.7 (5)	10.8 (43)	12.5 (2)	11 (11)	9.7 (64)
21-30	40.7 (11)	14.8 (4)	39 (35)	26.8 (107)	37.5 (6)	46 (46)	31.7 (209)
31-40	25.9 (7)	25.9 (7)	30 (27)	16.3 (65)	6.3 (1)	24 (24)	19.8 (131)
41-50	11.1 (3)	22.2 (6)	15.6 (14)	9 (36)	12.5 (2)	11 (11)	10.9 (72)
51-65	14.8 (4)	14.8 (4)	6.7 (6)	12.5 (50)	18.8 (3)	7 (7)	11.2 (74)
>65	3.7 (1)	7.4 (2)	2.2 (2)	3.5 (14)	-	-	2.9 (19)
Total	100 (27)	100 (27)	100 (90)	100 (400)	100 (16)	100 (100)	100 (660)

Comm. wk. = commercial workplace, Agric. = Agriculture, Indus. = Industrial workplace

The home appeared to be the most common place of injury for all age groups, with the highest number of injuries in the home being in the 21 to 30 age group (26.8%, n=107) followed by 0 to 12 age group (21.5%, n=86). With the exception of agriculture, the majority of ocular injuries incurred at all places of injury were in the 21 to 30 age group. The place of injury was found to be significantly different for all age groups in the overall sample ( $p=0.000$ , Fisher's exact test). However the association was found to be insignificant at both rural ( $p=0.032$ , Fisher's exact test) and urban hospitals ( $p=0.073$ , Fisher's exact test). Ocular injuries also occurred in the social environment and in the industrial work place in the age categories between 21 to 30 years (46% and 39%, respectively) and 31 to 40 years (24% and 30%, respectively). Sport related injuries were also found to be significant in the 21 to 30 age group (37.5%).

There were more injuries at urban hospitals compared to rural hospitals in the home (30% vs. 24.6%, respectively) and in industry (47.6% vs. 36.2%, respectively) for the age group between 21 to 30 years. However, rural hospitals had a higher percentage of ocular injuries incurred in the social environment than urban hospitals for the age group between 21 to 30 years (46% vs. 43.8%, respectively). The age group between 0 to 12 years had an equal number of injuries in the home at both rural and urban hospitals (21.3% vs. 21.3%, respectively). A higher percentage of injuries in the agricultural setting were observed for the age group between 31 to 40 years (30%) at rural hospitals while at urban hospitals the 41 to 50 age group (28.6%) had a higher percentage of ocular injuries in this setting.

### 5.3.2 Place of injury versus gender of the patients

Table 12 below summarizes the places of injury in relation to gender of the patients for the overall sample.

Table 12. Place of injury (column % (n)) in relation to gender of the patients

	Comm. wk	Agric	Indus.	Home	Sports	Social	All types
Gender							
Male	74.1 (20)	70.4 (19)	85.6 (77)	68.5 (274)	81.3 (13)	74 (74)	72.3 (477)
Female	25.9 (7)	29.6 (8)	14.4 (13)	31.5 (126)	18.8 (3)	26 (26)	27.7 (183)
Total	100 (27)	100 (27)	100 (90)	100 (400)	100 (16)	100 (100)	100 (660)

Comm. wk. = commercial workplace, Agric. = Agriculture, Indus. = Industrial workplace.

The majority of injuries incurred at all places of injury were in males. The most common place of injury for both males (57.4%, n=274/477) and females (68.9%, n=126/183) was in the home.



At rural hospitals males experienced more injuries than females (68.9% vs. 31.1%, respectively). This was similar to what was observed at urban hospitals where injuries were also more frequent among males than females (79.1% vs. 20.9%, respectively). Home related injuries were more frequent among males than females at rural hospitals (62.5% vs. 37.5%, respectively). This was similar at urban hospitals where males were also found to experience more injuries than females in the home (77.5% vs. 22.5%, respectively). At rural hospitals there were more males presenting with ocular injuries incurred in the industrial workplace than at urban hospitals (13.2% vs. 8.6%, respectively). This was also similar among females at rural and urban hospitals (2.5% vs. 0.9%, respectively). The frequent place of injury for both males and females was in the home. The association between place of trauma and gender was found to be insignificant at both rural ( $p=0.017$ ; Pearson's chi-square test) and urban hospitals ( $p=0.472$ ; Fisher's exact test).

### 5.3.3 Place of injury versus race of the patients

Table 13 below summarizes the sites of ocular injury in relation to race for the overall sample.

Table 13. Place of injury (column % (n)) in relation to race of the patients

	Comm. wk	Agric	Indus.	Home	Sports	Social	All types
<b>Race</b>							
African	92.6 (25)	100 (27)	96.7 (87)	93 (372)	93.8 (15)	93 (93)	93.8 (619)
White	-	-	1.1 (1)	0.3 (1)	-	-	0.3 (2)
Coloured	3.7 (1)	-	1.1 (1)	1.8 (7)	6.3 (1)	3 (3)	2 (13)
Indian	3.7 (1)	-	1.1 (1)	5.0 (20)	-	4 (4)	3.9 (26)
Total	100 (27)	100 (27)	100 (90)	100 (400)	100 (16)	100 (100)	100 (660)

Comm. wk. = commercial workplace, Agric. = Agriculture, Indus. = Industrial workplace.

The majority of the patients that presented to the selected public hospitals with ocular injury were Black. A higher percentage of ocular injuries was observed among Black patients in the home (60.1%, n=372/619) followed by the social environment (15%, n=93/619) and in industry (14.1%, n=87/619). Coloureds and Indians also incurred ocular injuries in the home (53.8%, n=7/13 and 76.9%, n=20/26, respectively). Race was insignificantly associated with place of trauma ( $p=0.577$ ; Fisher's exact test) and at both rural ( $p=0.380$ ; Fisher's exact test) and urban hospitals ( $p=0.698$ ; Fisher's exact test).

The majority of the patients with ocular injuries presenting at both rural and urban hospitals were Black (65.2% vs. 28.6%, respectively). At rural hospitals, the Black population sustained more injuries in the home (54.7%) followed by the social environment (18.6%). At urban hospitals, Blacks also sustained majority of the injuries in the home (72.5%). Indians, Coloureds and Whites had an equal number of ocular injuries in the industrial workplace at urban hospitals (4.8%) while none of the Indian, Coloured and White patients at rural hospitals had industrial related injuries. Indians incurred more ocular injuries at urban hospitals than at rural hospitals in the social environment (12.5% vs. 2.4%, respectively) and in the home (10% vs. 1.7%, respectively). Coloureds also incurred sport related injuries (16.7%) at urban hospitals while none of the Coloured patients who presented at rural hospitals had sport related injuries.

#### **5.4 CAUSE OF INJURY**

In reviewing the main causes of ocular trauma, solid objects e.g. metal pipes, planks, coffee mugs, metal rods, pellet guns, stones, wood from chopping, piece of tile, broken glass, scissors, screw drivers etc. were responsible for more than half of the injuries (54.4%, n=359/660) occurring either in the home or at work. This was followed by assault which was responsible for 24.3% (n=160/660) of the injuries including sport related injuries such as karate. Chemical ocular burns accounted for 6.2% (n=41/660)

of the injuries (domestic or work related) with acid burns (2.7%, n=18) being more common than alkali burns (1.1%, n=7). For the remaining burns the cause was not specified (2.4%, n=16). Thermal burns accounted for 1.8% (n=12) of injuries and ultraviolet burns for only 0.2% (n=1). Metal from grinding equipment or drills accounted for 5% (n=33), shattered glass 4.4% (n=29), falls 2.1% (n=14), hammering 0.9% (n=6) and ball accounted for 0.6% (n=4) of the injuries. This is illustrated in Figure 10 below.

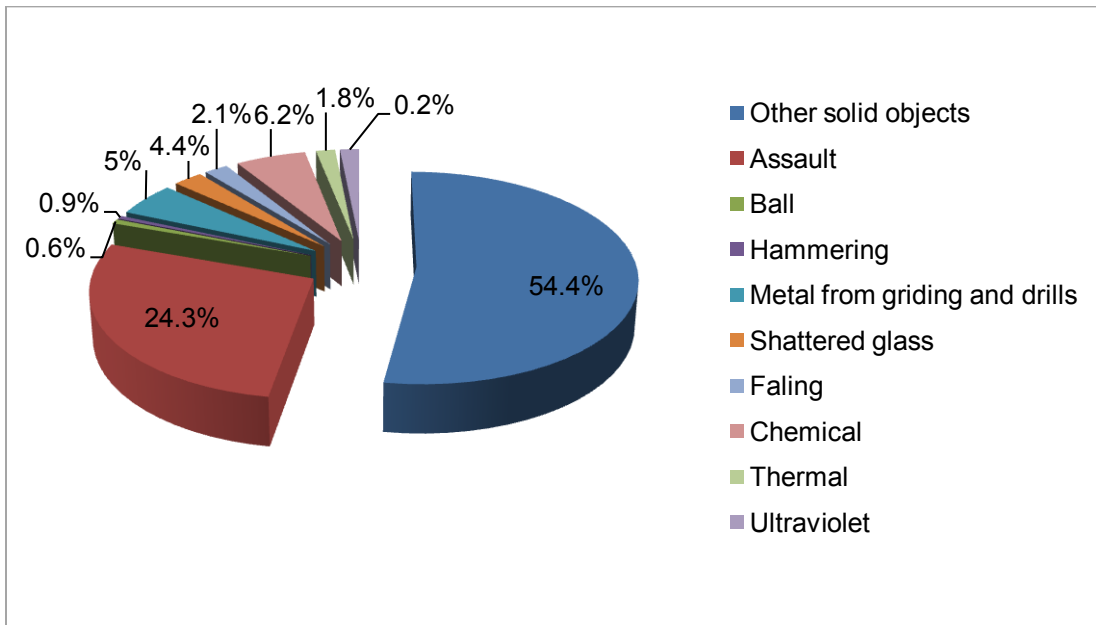


Figure 10. Causes of injuries in the overall sample

Even though the ocular injuries were caused by a variety of agents in any environment, other solid objects appeared to be the more frequent cause at both rural and urban hospitals (53.4% vs. 56.4%, respectively). At rural hospitals, assaults were more frequent (28.2%) compared to urban hospitals (16.4%). On the other hand, at urban hospitals, chemical burns and other solid objects causing injuries were more frequent (5.9% vs. 6.8% for chemical burns and 53.4% vs. 56.6% for other solid object at rural vs. urban hospitals, respectively) as illustrated in Figure 11 below.

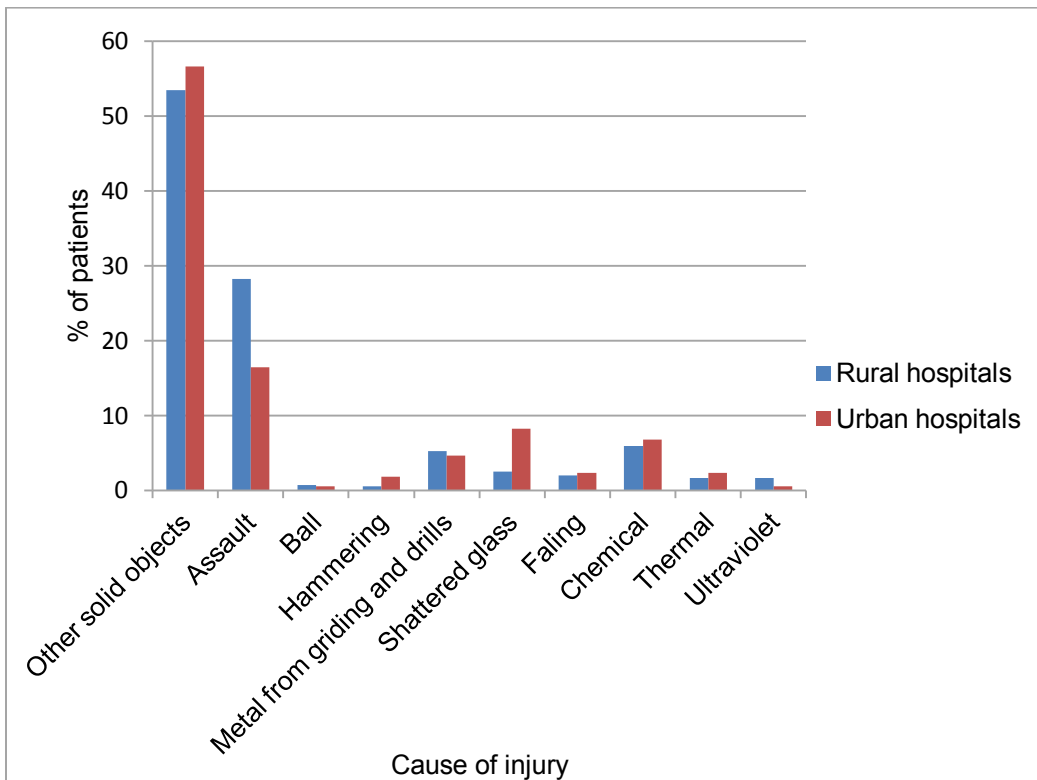


Figure 11. Causes of injuries (rural versus urban hospitals)

### 5.4.1 Cause of injury versus the age of the patients

Table 14 below summarizes the causes of injury in relation to age for the entire sample.

Table 14. Cause of injury (column % (n)) in relation to the age of the patients

	Ass	Ball	Other	Ham	MGD	SG	Falls	Chem.	Therm.	UV	All types
Age (y)											
0-12	6.9(11)	25(1)	17(61)	-	-	6.9(2)	50(7)	14.6(6)	25(3)	-	13.8(91)
13-20	11.3(18)	25(1)	10(36)	-	-	20.7(6)	-	7.3(3)	-	-	9.7(64)
21-30	37.3(60)	25(1)	26.5(95)	83.3(5)	36.4(12)	31(9)	35.7(5)	39(16)	50(6)	-	31.7(209)
31-40	26.1(42)	25(1)	16.4(59)	-	39.4(13)	20.7(6)	-	19.5(8)	16.7(2)	-	19.8(131)
41-50	6.3(10)	-	12.8(46)	16.7(1)	12.1(4)	10.3(3)	7.1(1)	14.6(6)	8.3(1)	-	10.9(72)
51-65	10.6(17)	-	13.1(47)	-	9.1(3)	10.3(3)	7.1(1)	4.9(2)	-	100(1)	11.2(74)
>65	1.9(3)	-	4.2 (15)	-	3(1)	-	-	-	-	-	2.9(19)
Total	100(161)	100(4)	100(359)	100(6)	33(100)	100(29)	100(14)	100(41)	100(12)	100(1)	100(660)

Ass= assault, other= other solid objects, Ham= hammering, MGD= metal from grinding material or drill, SG= shattered glass, Chem = chemical, Therm. = thermal, UV= ultraviolet

In the overall sample, patients that experienced the most number of injuries irrespective of the cause were those in the age category of 21 to 30 years (31.7%). In all age groups the majority of injuries were due to other solid objects. Each cause of injury was also more prevalent in the 21 to 30 age group. Ocular injuries due to falls were more common in the 0 to 12 age category compared to the 51 to 65 age group (50% vs. 7.1%, respectively). The causes of injury were more industrial related in patients between the ages of 21 to 40 years. The causes of injuries appear to be more frequent in the middle age groups and this association between cause of injury and age group was found to be significant ( $p=0.000$ ; Fisher's exact test) in the overall sample, however at both rural ( $p=0.0448$ ; Fisher's exact test) and urban hospitals ( $p=0.135$ ; Fisher's exact test) no significant association was found. The younger age group from 0 to 12 years was not an exception to acquire an injury through assault (12.1%,  $n=11/91$ ) and neither was the age group of over 65 years of age (15.8%,  $n=3/19$ ).

Other solid objects were the most frequent cause of injury appearing in excess in all age groups at both rural and urban hospitals (53.4% vs. 56.4%, respectively) followed by assaults (28.2% vs. 16.8%, respectively). At rural hospitals, chemical injuries were more frequent in the 21 to 30 age group (7.2%). This was similar to what was found at urban hospitals where chemical injuries were also found to be more frequent in the 21 to 30 age group (8.4%). At urban hospitals, shattered glass, chemical burns, falls and thermal burns had an equal number of injuries (5.7%) in the 0 to 12 age group. At rural hospitals, ocular injury due to falls and chemical injuries were more frequent in the 0 to 12 age group (8.9% and 7.1%, respectively).

#### 5.4.2 Cause of injury versus the gender of patients

Table 15 below summarizes the causes of ocular injury in relation to gender in the overall sample.

Table 15. Cause of injury (column % (n)) in relation to gender of the patients

	Ass	Ball	Other	Ham	MGD	SG	Falls	Chem.	Therm.	UV	All types
Gender											
Male	70.8(114)	100(4)	69.9(251)	100(6)	93.9(31)	79.3(23)	57.1(8)	73.2(30)	83.3(10)	-	72.3(477)
Female	29.2(47)	-	30.1(108)	-	6.1(2)	20.7(6)	42.9(6)	26.8(11)	16.7(2)	100(1)	27.7(183)
Total	100(161)	100(4)	100(359)	100(6)	100(33)	100(29)	100(14)	100(41)	100(12)	100(1)	100(660)

Ass= assault, other= other solid objects, Ham= hammering, MGD= metal from grinding material or drill, SG= shattered glass, Chem = chemical, Therm. = thermal, UV= ultraviolet

Other solid objects were the most frequent cause of injury among male patients (69.9%). Female patients also experienced more injuries caused by solid objects (30.1%). Ocular injuries due to assaults were more likely to occur in males than females (70.8% vs. 29.2%, respectively). Ultraviolet burns were only incurred by female patients (0.5%). However, no significant correlation was found between the type of injury and gender in the overall sample ( $p=0.012$ ; Pearson's chi-square test) as well as

for rural ( $p=0.065$ ; Fisher's exact test) and urban hospitals ( $p=0.042$ ; Fisher's exact test).

At rural hospitals, injuries from falls were more frequent among females than males (3.6% vs.1.3%, respectively). This was different to what was observed at urban hospitals where injuries from falls were more frequent among males than females (7.5% vs. 4.3%, respectively). At urban hospitals, female patients presented with ultraviolet burns (2.2%) while none of the male patients presented with ultraviolet burns. At urban hospitals, thermal burns were incurred by both males and females (1.4% and 0.9%, respectively). However, at rural hospitals male patients (2.3%) incurred thermal burns while none of the female patients had incurred thermal burns.

#### 5.4.3 Cause of injury versus the race of patients

Table 16 shows the race of patients in relation to the cause of injury.

Table 16. Cause of injury (column % (n)) in relation to race of the patients

	Ass	Ball	Other	Ham	MGD	SG	Falls	Chem.	Therm.	UV	All types
Race											
Black	95(153)	100(4)	93.6(336)	100(6)	100(33)	89.7(26)	100(14)	90.2(37)	75(9)	100 (1)	93.8(619)
White	-	-	0.3 (1)	-	-	-	-	2.4(1)	-	-	0.3(2)
Coloured	1.2(2)	-	2.8(10)	-	-	-	-	2.4 (1)	-	-	2(13)
Indian	3.7(6)	-	3.3(12)	-	-	10.3(3)	-	4.9(2)	25(3)	-	3.9(26)
Total	100(161)	100(4)	100(359)	100(6)	100(33)	100(29)	100(14)	100(41)	100(12)	100(1)	100(660)

Ass= assault, other= other solid objects, Ham= hammering, MGD= metal from grinding material or drill, SG= shattered glass, Chem = chemical, Therm. = thermal, UV= ultraviolet

Ocular injuries due to all causes listed in Table 12 occurred in Black patients. However, only assault, other solid objects, chemicals and thermal burns were observed in all the other races. White patients did not present with ocular injuries due to assault. There was no significant association found between cause of injury and race for the overall sample ( $p=0.566$ ; Fisher's exact test).

At both rural and urban hospitals, the causes of ocular injuries were common among Blacks. The most common cause of injury among people of Indian ethnicity at urban hospitals was thermal burns (15%, n=3/20) while none of the Indian patients who presented at rural hospitals had thermal burns. Coloureds had more injuries due to other solid objects at urban hospitals than at rural hospitals (5.6% vs. 1.3%, respectively). The main cause of injury among White patients was chemical burns (6.7%) at urban hospitals only. No association was found between cause of injury and race at rural (p=1.000; Fisher's exact test) or at urban hospitals (p=0.314; Fisher's exact test).

#### 5.4.4 Cause of injury versus the place of injury

Table 17 below summarizes the causes and places of ocular injury in the overall sample.

Table 17. Cause of injury (column % (n)) in relation to place of injury

Cause of injury	Comm. wk	Agric	Indus.	Home	Sports	Social	Total
assault	3.7 (1)	3.7 (1)	-	21.8 (87)	12.5 (2)	70 (70)	24.4 (161)
ball	-	-	1.1 (1)	-	18.8 (3)	-	0.6 (4)
other	55.6 (15)	88.9 (24)	41.1 (37)	61.8 (247)	68.8 (11)	25 (25)	54.4 (359)
hammering	3.7 (1)	-	-	1.3 (5)	-	-	0.9 (6)
MGD	22.2 (6)	3.7 (1)	24.4 (22)	1 (4)	-	-	5 (33)
SG	3.7 (1)	-	6.7 (6)	4.8 (19)	-	3 (3)	4.4 (29)
falling	-	-	-	3 (12)	-	2 (2)	2.1 (14)
chemical	11.1 (3)	3.7 (1)	21.1 (19)	4.5 (18)	-	-	6.2 (41)
thermal	-	-	5.6 (5)	1.8 (7)	-	-	1.8 (12)
ultraviolet	-	-	-	0.3 (1)	-	-	0.2 (1)
Total	100 (27)	100 (27)	100 (90)	100 (400)	100 (16)	100 (100)	660 (100)

Comm. wk. = commercial workplace, Agric. = Agriculture, Indus. = Industrial workplace

Injuries from other solid objects were the most frequent cause of injury across all possible places of ocular trauma. Assaults accounted for 21.8% (n=87) of ocular injury incurred in the home followed by injury from shattered glass 4.8% (n=19) and then



chemical burns 4.5% (n=18). Filings of metal from grinding equipment or drills and chemical injuries were also found to be frequent in the industrial workplace (24.4% and 21.1%, respectively).

Table 18 below shows the cause of injury in relation to place of injury at rural hospitals.

Table 18. Cause of injury (column % (n)) in relation to place of injury at rural hospitals

	Comm. wk	Agric	Indus.	Home	Sports	Social	Total
<b>Cause of injury</b>							
assault	5.9 (1)	5 (1)	-	25 (60)	20 (2)	71.4 (60)	28.2 (124)
ball	-	-	1.4 (1)	-	20 (2)	-	0.7 (3)
other	70.6 (12)	85 (17)	43.5 (3)	62.5 (150)	60 (6)	23.8 (20)	53.4 (235)
hammering	-	-	-	0.8 (2)	-	-	0.5 (2)
MGD	17.6 (3)	5 (1)	21.7 (15)	1.7 (4)	-	-	5.2 (23)
SG	-	-	5.8 (4)	1.7 (4)	-	3.6 (3)	2.5 (11)
falling	-	-	-	3.3 (8)	-	1.2 (1)	2 (9)
chemical	5.9 (1)	5 (1)	20.3 (14)	4.2 (10)	-	-	5.9 (26)
thermal	-	-	7.2 (5)	0.8 (2)	-	-	1.6 (7)
Total	100 (17)	100 (20)	100 (69)	100 (240)	100 (10)	100 (84)	100 (440)

Table 19 below shows the cause of injury in relation to place of injury at urban hospitals.

Table 19. Cause of injury (column % (n)) in relation to place of injury at urban hospitals

	Comm. wk	Agric	Indus.	Home	Sports	Social	Total
<b>Cause of injury</b>							
assault	-	-	-	16.9 (27)	-	62.5 (10)	16.8 (37)
ball	-	-	-	-	16.7 (1)	-	0.5 (1)
other	30 (3)	100 (7)	33.3 (7)	60.6 (97)	83.3 (5)	31.3 (5)	56.4 (124)
hammering	10 (1)	-	-	1.9 (3)	-	-	1.8 (4)
MGD	30 (3)	-	33.3 (7)	-	-	-	4.5 (10)
SG	10 (1)	-	9.5 (2)	9.4 (15)	-	-	8.2 (18)
falling	-	-	-	2.5 (4)	-	6.3 (1)	2.3 (5)
chemical	20 (2)	-	23.8 (5)	5 (8)	-	-	6.8 (15)
thermal	-	-	-	3.1 (5)	-	-	2.3 (5)
ultraviolet	-	-	-	0.6 (1)	-	-	0.5 (1)
Total	100 (10)	100 (7)	100 (21)	100 (160)	100 (6)	100 (16)	100 (220)

At both rural and urban hospitals, injuries were more likely to be caused by other solid objects (53.4% vs. 56.4%, respectively). The majority of the ocular injuries caused by solid objects were more common in the home. The cause of injury was significantly related to the site of injury ( $p=0.000$ ; Fisher's exact test) at both rural and urban hospitals ( $p=0.000$ ; Fisher's exact test). At rural hospitals, an equal number of injuries (48.4%,  $n=60/124$ ) due to assaults had occurred in the social environment and in the home. This was different to what was found at urban hospitals where injuries due to assaults were more frequent in the home compared to in the social environment (73% vs. 27%, respectively).

#### 5.4.5 Alcohol abuse

Only 2.6% ( $n=17/660$ ) of patients had evidence of alcohol abuse on presentation to hospital with an ocular injury. At rural hospitals, there were 12 (2.7%) cases of alcohol use documented compared to a slightly smaller number at urban hospitals (2.3%,  $n=5$ ).

### 5.5. TREATMENT

On presentation 630 (95.5%) patients received medication as a form of treatment for their injuries and in the remaining 30 patients (4.5%) surgical management was required. At both rural hospitals and urban hospitals the majority of the patients were treated with medication (98.6% vs. 89.1%, respectively). Only a few patients required surgery at rural and urban hospitals (1.4% vs. 10.9%, respectively) on initial presentation. Table 20 shows the treatment strategy on the patients at initial presentation to the hospital in relation to the type of injury.

Table 20. The treatment (column % (n)) strategy on patients at initial presentation to the hospital in relation to the type of injury

Type of injury	Medication	Surgery	Total
Blunt trauma	35.7 (n=225)	23.3 (n=7)	35.2 (n=232)
Penetrating	9 (n=57)	36.7 (n=11)	10.3 (n=68)
IOFBs	26.7 (n=168)	6.7 (n=2)	25.8 (n=170)
Lacerations	19.5 (n=123)	33.3 (n=10)	20.2 (n=133)
Burns	9 (n=57)	-	8.6 (n=57)
Total	100 (n=630)	100 (n=30)	100 (n=660)

For the overall sample, the majority of the patients who required medication as the first line of treatment had ocular injuries due to blunt trauma (35.7%). The majority of patients who required surgery had incurred ocular injury following penetrating injury (36.7%).

### 5.5.1 Treatment strategy versus type of injury at rural and urban hospitals

Table 21 shows the treatment strategy on patients at initial presentation to hospital in relation to the type of injury at rural and urban hospitals.

Table 21. The treatment strategy (column % (n)) on patients at initial presentation to the hospital in relation to the type of injury at rural and urban hospitals

Type of injury	Rural hospitals			Urban hospitals		
	Medication	Surgery	Total	Medication	Surgery	Total
Blunt trauma	36.4(n=158)	33.3(n=2)	36.4(n=160)	34.2(n=67)	20.8(n=5)	32.7(n=72)
Penetrating	7.8(n=34)	50(n=3)	8.4(n=37)	11.7(n=23)	33.3(n=8)	14.1(n=31)
IOFBs	30(n=130)	-	29.5(130)	19.4(n=38)	8.3(n=2)	18.2(n=40)
Lacerations	18.2(n=79)	16.7(n=1)	18.2(n=80)	22.4(n=44)	37.5(n=9)	24.1(n=53)
Burns	7.6(n=33)	-	7.5(n=33)	12.2(n=24)	-	10.9(n=24)
Total	100(n=434)	100(n=6)	100(n=440)	100(n=196)	100 (n=24)	100 (n=220)

The majority of the patients presenting with ocular injuries required medication as first line of treatment at rural and urban hospitals. At both rural and urban hospitals the majority of the patients with blunt trauma were treated with medication on initial presentation (98.8%, n=158/160 vs. 93.1%, n=67/72, respectively). At rural hospitals,

surgery was more frequently performed on patients with penetrating trauma (50%) than any other type of ocular injury. This was different to what was observed at urban hospitals where surgery was marginally more frequently required on patients that had lacerations (37.5%).

Medication was also frequently used for IOFBs at rural hospitals (30%) while at urban hospitals, lacerations were frequently treated with medication (22.4%). None of the ocular injuries due to burns required surgery at initial presentation at both rural and urban hospitals.

Out of the overall sample reviewed, 150 (22.7%) patients required surgical intervention, 30 (4.5%) patients required surgical intervention at initial presentation and 120 (18.2%) patients had to undergo surgery at a later stage during their follow up period. Corneal repair/graft was performed in 62 (9.4%) patients, followed by traumatic cataract removal (6.2%, n=41), suturing (5.2%, n=34), segment reconstruction (1.1%, n=7) and retinal surgery/vitreotomy (0.9%, n=6).

Some patients had repeated surgical procedures; single operation in 131 (19.8%) patients and double in 19 (2.9%) patients. Lacerations were significantly related to the type of surgery/operation in patients requiring surgical intervention ( $p=0.000$ ; Fisher's exact test) and at both rural and urban hospitals ( $p=0.000$ ; Fisher's exact test). At both rural and urban hospitals single operation (15.2% vs. 31.4%, respectively) and repeated (2% vs. 4.5%, respectively) procedures were performed.

Table 22 below shows the type of surgery performed at rural versus urban hospitals.

Table 22. The type of surgery (column % (n)) performed at rural vs. urban hospitals

Type of surgery	Rural hospitals	Urban hospitals
Corneal repair/graft	31.6 (n=24)	51.4 (n=38)
Segment reconstruction	1.3 (n=1)	8.1 (n=6)
Retina surgery/vitreotomy	2.6 (n=2)	5.4 (n=4)
Traumatic cataract removal	38.2 (n=29)	16.2 (n=12)
Suturing	26.3 (n=20)	18.9 (n=14)
Total	100 (n=76)	100 (n=74)

Out of the total number of surgeries performed at urban hospitals, 51.4% were corneal repair/graft. At rural hospitals, the most frequent type of surgery performed was traumatic cataract removal (38.2%).

### 5.5.2 Type of surgery versus the age of patients

Table 23 shows the type of surgery in relation to age distribution for patients who had to undergo surgical intervention.

Table 23. The type of surgery (row % (n)) in relation to age distribution of patients who had to undergo surgical intervention

	0-12	13-20	21-30	31-40	41-50	51-65	>65	Total
Type of surgery								
Corneal repair/graft	19.4 (12)	14.5 (9)	25.8 (16)	16.1 (10)	11.3 (7)	6.5 (4)	6.5 (4)	100 (62)
Segment reconstruction	-	14.3 (1)	85.7 (6)	-	-	-	-	100 (7)
Retinal surgery/vitreotomy	-	-	16.7 (1)	33.3 (2)	16.7 (1)	33.3 (2)	-	100 (6)
Traumatic cataract removal	9.8 (4)	7.3 (3)	17.1 (7)	12.2 (5)	9.8 (4)	31.7 (13)	12.2 (5)	100 (41)
Suturing	11.8 (4)	2.9 (1)	52.9 (18)	23.5 (8)	2.9 (1)	5.9 (2)	-	100 (34)
Total	13.3 (20)	9.3 (14)	32 (48)	16.7 (25)	8.7 (13)	14 (21)	6 (9)	100 (150)

The 21 to 30 age group required the most number of surgical procedures (32%) followed by the 31 to 40 age group (16.7%). In the 21 to 30 age group the most frequently required procedure was suturing (37.5%, n=18/48) followed by corneal repair/graft (33.3%, n=16/48). Segment reconstruction was also more likely to be

performed in the 21 to 30 age group (12.5%, n=6/48). The 51 to 65 age group required traumatic cataract removal most often (61.9%, n=13/21). Corneal repair/graft was also often performed in the 0 to 12 age group (19.4%). The 31 to 40 and the 51 to 65 age groups had an equal number of retinal surgery/vitreotomy performed (33.3%, n=2).

At rural hospitals, the 21 to 30 age group had the most number of surgical procedures performed (28.9%). This was similar to what was found at urban hospitals where the 21 to 30 age group also had the most number of surgical procedures performed (35.1%). The one difference noted was that suturing was more often performed in the 21 to 30 age group at rural hospitals (55% vs. 50% at rural vs. urban hospital, respectively) compared to urban hospitals where corneal repair/grafts were often performed (26.3% vs. 25% at urban vs. rural hospital, respectively). Traumatic cataract removal was frequently performed at rural hospitals in the 51 to 65 age group (37.9%) compared to urban hospitals where traumatic cataract removal was frequently performed in the 21 to 30 age group (25%).

### 5.5.3 Type of surgery versus the gender of the patients

Of the total number of patients that required surgical intervention the majority were male (76%, n=114) and 24% (n=36) of the patients were female. Based on the type of surgery required, corneal repair/graft (75.8%) was frequently performed on male patients followed by traumatic cataract removal (68.3%). Retinal surgery/vitreotomy was the least frequent procedure that was required by male patients (5.3%, n=6) while none of the female patients had retinal surgery/vitreotomy performed on them.

At both rural and urban hospitals male patients were more likely to undergo corneal repair/graft (32.7% vs. 49.2%, respectively). At rural hospitals, a higher percentage of male patients underwent traumatic cataract removal (36.4%). This was different to what was observed at urban hospitals where most male patients had sutures performed on them (20.3%). Female patients were more likely to have traumatic cataract removal at rural hospitals than at urban hospitals (42.9% vs. 26.7%, respectively).

In the overall sample, patients who presented with poor vision (<6/60) were more likely to require surgical intervention (67.8%). Similarly at rural and urban hospitals, patients who presented with poor vision (<6/60) were more likely to undergo surgical intervention (70.5% vs. 64.9%, respectively). At rural hospitals, traumatic cataract removal was frequently performed on patients with visual acuity of less than 6/60 (88.9%). This was different to what was observed at urban hospitals where corneal repair/grfts were frequently performed on patients with poor vision (<6/60) (69.2%).

#### 5.5.4 Type of injury versus type of surgery

Table 24 summarizes the type of injury in relation to the type of surgery for patients who had to undergo surgical intervention.

Table 24. Type of injury (column % (n)) in relation to type of surgery for patients who had to undergo surgical intervention at initial presentation and during subsequent visits

	Corneal repair/graft	Segment reconstruction	Retinal surgery/vitreotomy	Traumatic cataract removal	Suturing	All types
Type of injury						
Blunt trauma	12.9 (8)	71.4 (5)	50 (3)	68.3 (28)	23.5 (8)	34.7 (52)
Penetrating	17.7 (11)	-	50 (3)	19.5 (8)	17.6 (6)	18.7 (28)
IOFBs	4.8 (3)	14.3 (1)	-	7.3 (3)	2.9 (1)	5.3 (8)
Lacerations	54.8 (34)	14.3 (1)	-	4.9 (2)	55.9 (19)	37.3 (56)
Burns	9.7 (6)	-	-	-	-	4 (6)
Total	100 (62)	100 (7)	100 (6)	100 (41)	100 (34)	100 (150)

The type/nature of surgery performed depended on the type of injury incurred by the patients. Irrespective of the type/nature of surgery performed, patients who incurred lacerations were most likely to undergo surgical intervention (37.3%) followed by patient with blunt trauma (34.7%). Blunt trauma accounted for 68.3% (n=28/41) of traumatic cataract removals while lacerations accounted for 54.8% (n=34/62) of corneal repair/grfts and 55.9% (n=19/34) of sutures. Penetrating injury accounted for 17.7% (n=11/62) of corneal repair/grfts and 19.5% (n=8/41) of traumatic cataract removals. Burns only required corneal repair or graft.

Table 25 below shows the type of injury in relation to type of surgery for patients who had to undergo surgical intervention at rural hospitals.

Table 25. The type of injury (row % (n)) in relation to type of surgery for patients who had to undergo surgical intervention at rural hospitals

	Corneal repair/graft	Segment reconstruction	Retinal surgery/vitrectomy	Traumatic cataract removal	Suturing	All types
Type of injury						
Blunt trauma	14.3 (5)	2.9 (1)	5.7 (2)	62.9 (22)	14.3 (5)	100 (35)
Penetrating	20 (2)	-	-	30 (3)	50 (5)	100 (10)
IOFBs	40 (2)	-	-	40 (2)	20 (1)	100 (5)
Lacerations	56 (14)	-	-	8 (2)	36 (9)	100 (25)
Burns	100 (1)	-	-	-	-	100 (1)
Total	31.6 (24)	1.3(1)	2.6 (2)	38.2 (29)	26.3 (20)	100 (76)

Table 26 below shows the type of injury in relation to type of surgery for patients who had to undergo surgical intervention at urban hospitals.

Table 26. The type of injury (row % (n)) in relation to type of surgery for patients who had to undergo surgical intervention at urban hospitals

	Corneal repair/graft	Segment reconstruction	Retinal surgery/vitrectomy	Traumatic cataract removal	Suturing	All types
Type of injury						
Blunt trauma	17.6 (3)	23.5 (4)	5.9 (1)	35.3 (6)	17.6 (3)	100 (17)
Penetrating	50 (9)	-	16.7 (3)	27.8 (5)	5.6 (1)	100 (18)
IOFBs	33.3 (1)	33.3 (1)	-	33.3 (1)	-	100 (3)
Lacerations	64.5 (20)	3.2 (1)	-	-	32.3 (10)	100 (31)
Burns	100 (5)	-	-	-	-	100 (5)
Total	51.4 (37)	6.9 (5)	5.6 (4)	16.7 (12)	19.4 (14)	100 (74)

At both rural and urban hospitals the majority of the patients with blunt trauma (62.9% vs. 35.3%, respectively) had traumatic cataract removal. Burns required only corneal repair/graft at both rural and urban hospitals. Corneal repair/graft was the most common type of surgery followed by lacerations at both urban and rural hospitals (64.5% and 56%, respectively).



## 5.6 FOLLOW UP

In the overall sample, 340/660 (51.5%) patients returned for follow up treatment while 320 (48.5%) did not. At rural hospitals 41.5% (n=182) returned for follow up and 58.5% (n=257) did not return. This was different to urban hospitals where 71.8% (158) returned for follow up examination and 28.2% (n=62) did not return.

The likelihood of patients returning for follow up may have been dependant on the type of injury as is illustrated in Table 27 below.

Table 27. Type of injury (column % (n)) in relation to follow up and non- follow up

	Follow up	Non – follow up	Total
Type of injury			
Blunt trauma	38.5 (n=131)	31.6 (n=100)	35.2 (n=232)
Penetrating	14.7 (n=50)	5.6 (n=18)	10.3 (n=68)
IOFBs	14.5 (n=50)	37.6 (n=120)	25.8 (n=170)
Lacerations	23.8 (n=81)	16.3 (n=52)	20.2 (n=133)
Burns	8.2 (n=28)	9.1 (n=29)	8.6 (n=57)
Total	100 (n=340)	100 (n=320)	100 (n=660)

Of the overall sample, patients with ocular injuries were likely to require or return for follow up examination (51.5%, n=340/660). Follow up examination was more frequently observed in patients who had incurred blunt trauma (38.5%, n=131) followed by patients with lacerations (23.8%, n=81/133). Many patients who had incurred ocular burns returned for follow up examination (49%, n=28/57). Non-follow up was mostly observed among patients who had incurred an IOFB injury (37.6%, n=120).

At rural and urban hospitals, follow up was more frequently observed in patients who had incurred blunt trauma (50% vs. 70.8%, respectively). At rural hospitals, the majority of the patients with lacerations and IOFBs did not return for follow up examination (52.5% vs. 47.5%, respectively). This was different to what was found at urban hospitals where patients with lacerations and IOFBs were most likely to return for follow up examination (81.1% vs. 55%, respectively).

### 5.6.1 Follow up versus visual acuity

Presentation to the hospital and to the ophthalmologist following ocular injury ranged from 1 day to 5 days (median =2 days) for patients with good visual acuity (6/12 or better) and 1 to 9 days (median =3 days) for patients with poor visual acuity (<6/60). In the overall sample 22.6% (n=53) of patients with 6/6 or better returned for follow up examination, 55.6% (n=70) of patients with 6/15 to 6/60 visual acuity, and 79.8% (n=154) of patients with less than 6/60 visual acuity.

The association between follow up and final visual acuity was found to be insignificant ( $p= 0.039$ ; Fisher's exact test) for the overall sample as well as for rural ( $p= 0.915$ ; Fisher's exact test) and urban hospitals ( $p=0.035$ ; Fisher's exact test). At both rural and urban hospitals patients who had poor vision (<6/60) were likely to return for follow up examination (73.5% vs. 88.8%, respectively). Urban hospitals had a higher percentage of patients returning for follow up with good vision (6/12 or better) when compared to rural hospitals (47.2% vs. 18.2 %, respectively).

## 5.7 ADMITTED AND NON-ADMITTED CASES

There were 169 (25.6%) admissions made for the overall sample. Of the 169 admitted patients, 108 (72%) underwent surgical intervention. Forty three (28.7%) of the admitted patients required corneal repair/grafts, 34 (22.7%) traumatic cataract removals, 20 (13.3%) sutures, 6 (4%) segment reconstruction and 5 (3.3%) retinal surgery/vitreotomy. Non- admission was seen more frequently at rural hospitals than at urban hospitals (79.5% vs. 64.1%, respectively).

### 5.7.1 Cause of injury versus patient admission

Table 28 below shows the cause of injury in relation to patient admission.

Table 28. Cause of injury (column % (n)) in relation to patient admission

	Patient admission		Total
	Yes	No	
assault	27.8 (n=47)	23.2 (n=114)	24.4 (n=161)
ball	-	0.8 (n=4)	0.6 (n=4)
other solid object	57.4 (n=97)	53.4 (n=262)	54.4 (n=359)
hammering	1.2 (n=2)	0.8 (n=4)	0.9 (n=6)
metal from grinding equipment or drills	1.2 (n=2)	6.3 (n=31)	5 (n=33)
shattered glass	6.5 (n=11)	3.7 (n=18)	4.4 (n=29)
falling	1.8 (n=3)	2.2 (n=11)	2.1 (n=14)
chemical	3.6 (n=6)	7.1 (n=35)	6.2 (n=41)
thermal	0.6 (n=1)	2.2 (n=11)	1.8 (n=12)
Ultraviolet	-	0.2 (n=1)	0.2 (n=1)
Total	100 (n=169)	100 (n=491)	100 (n=660)

Of the 169 hospital admissions, the majority of the patients (57.4%) had incurred an injury with a solid object. At rural hospitals, more admissions were made following injury with solid objects (58.9%) followed by assaults (33.3%). This was similar to what was observed at urban hospitals where patients were frequently admitted following injuries from solid objects and assaults (55.7% and 21.5%, respectively).

### 5.7.2 Patient admission versus type of surgery

Patient admission was frequently observed in patients who had incurred blunt trauma and lacerations. Patients who required sutures (45.2%) and corneal repair/graft (33.3%) were less likely to be admitted. There appeared to be more admissions made at urban hospitals than at rural hospitals (35.9 % vs. 20.5%, respectively). This association between the type of injury and patient admission was found to be significant

(p=0.000; Pearson's chi square test) as well as for both rural (p=0.000; Pearson's chi square test) and urban hospitals (p=0.005; Pearson's chi square test).

### 5.7.3 Patient admission versus age of the patients

Table 29 below shows patient admission in relation to age of the patients.

Table 29. Patient admission (column % (n)) in relation to age of the patients

	Admission	Non-Admission	Total
Age (years)			
0 - 12	9.5 (16)	15.3 (75)	13.8 (91)
13 - 20	10.1 (17)	9.6 (47)	9.7 (64)
21 - 30	32.5 (55)	31.4 (154)	31.7 (209)
31 - 40	17.8 (30)	20.6 (101)	19.8 (131)
41- 50	11.2 (19)	10.8 (53)	10.9 (72)
51- 65	14.8 (25)	10 (49)	11.2 (74)
> 65	4.1 (7)	2.9 (19)	2.9 (19)
Total	100 (169)	100 (491)	100 (660)

Of the injuries necessitating admission, a higher percentage occurred in the 21 to 30 age group (32.5%, n= 55) followed by the 31 to 40 age group (17.8%, n=30). A significant percentage occurred in the 0 to 12 year age group (9.5%, n=16). This was similar at rural and urban hospitals where the 21 to 30 age group had the highest percentage (30% vs. 35.4%, respectively) for patient admission. However, at rural hospitals there was a higher percentage of admissions in the 51 to 65 age group (21.1%) compared to 7.6% of this age group requiring admission at urban hospitals. At urban hospitals, the 0 to 12 age group had a higher percentage of patient admissions than at rural hospitals (11.4% vs. 7.8%, respectively).

#### 5.7.4 Patient admission versus gender of the patients

Of the total number of patients admitted the majority (77.5%) were male (Table 30).

Table 30. Patient admission (column % (n)) in relation to gender

	Admission	Non-Admission	Total
Gender			
Male	77.5 (n=131)	70.5 (n=346)	72.3 (n=477)
Female	22.5 (n=38)	29.5 (n=145)	27.7 (n=183)
Total	100 (n=169)	100 (n=491)	100 (n=660)

The majority of the patients admitted at both rural and urban hospitals were male (73.3% vs. 82.3%, respectively). However, more females required admission at urban hospitals than at rural hospitals (30.4% vs. 17.5%, respectively).

#### 5.7.5 Patient admission versus initial visual acuity

Table 31 below shows patient admission in relation initial visual acuity.

Table 31. Patient admission (column % (n)) in relation to initial visual acuity

	Patient admission		Total
	Yes	No	
Initial visual acuity			
6/12 or better	5.1 (n=7)	54.4 (n=227)	42.3 (n=234)
6/15-6/60	19.9 (n=27)	23.7 (n=99)	22.8 (n=126)
<6/60	75 (n=102)	21.8 (n=91)	34.9 (n=193)
Total	100 (n=136)	100 (n=417)	100 (n=553)

Seventy five percent of the patients who required admission had initial visual acuity of less than 6/60. Only 5.1% of the patients who required admission had visual acuity of 6/12 or better. This was similar at both rural and urban hospitals where patients with poor visual acuity (<6/60) were also more likely to be admitted (53.1% vs. 52.5%, respectively). However, rural hospitals had fewer patients admitted for patients with 6/6

or better and 6/15- 6/60 vision when compared to urban hospitals (3.9% vs. 6.7% and 17.1% vs. 23.3%, respectively).

#### 5.7.6 Patient admission versus place of injury

Of the 169 patients who required admission, 58.6% had been injured at home, 20.1% in the workplace, 20.1% in the social environment and 1.2% during sports. Rural hospitals had more patients who incurred ocular injuries compared to urban hospitals in the social environment (28.9% vs. 10.1%, respectively) and in industry (12.2% vs. 7.6%, respectively) warranting patient admission. Urban hospitals had more patients who incurred domestic accidents requiring hospital admission compared to rural hospitals (35% vs. 17.9%, respectively).

#### 5.7.7 Patient admission versus type of injury

For the overall sample, admission to hospital was mostly required following blunt trauma (40.2%, n=68) followed by lacerations (26.6%, n=45), penetrating injuries (19.5%, n=33), IOFBs (7.7%, n=13) and burns (5.9%, n=10). At both rural and urban hospitals, admissions were frequent for patients with blunt trauma (46.7% vs. 32.9%, respectively). At urban hospitals, admissions were more frequent for patients with penetrating injuries than at rural hospitals (51.6% vs. 45.9%, respectively).

### 5.8 VISUAL OUTCOME

On initial presentation, 234 (42.2%) patients had unaided visual acuity of 6/12 or better, 126 (22.8%) had visual acuity of 6/15 – 6/60 and 193 (34.9%) had visual acuity of less than 6/60 (Table 32). In 107 (16.2%) patients visual acuity was not recorded. Twelve (1.8%) patients required enucleation/evisceration. Enucleation/ eviscerations were required at both rural and urban hospitals (0.9% vs. 3.6%, respectively).

Table 32 below shows the unaided initial visual acuity and final visual acuity at both rural and urban hospitals.

Table 32. Shows initial visual acuity and final visual acuity (column % (n)) at both rural and urban hospitals

Visual acuity	Initial visual acuity			Resultant visual acuity		
	Overall	Rural	Urban	Overall	Rural	Urban
6/12 or better	42.3 (234)	51.2 (198)	21.7 (36)	46.7 (100)	42.7 (53)	52.2 (47)
6/15-6/60	22.8 (126)	19.6 (76)	30.1 (50)	20.6 (44)	19.4 (24)	22.2 (20)
<6/60	34.9 (193)	29.2 (113)	48.2 (80)	32.7 (70)	37.9 (47)	25.6 (23)
Total	100 (553)	100 (387)	100 (166)	100 (214)	100 (124)	100 (90)

In the overall sample, the resultant visual acuity showed an improvement for patients who presented with good vision following treatment (Table 32). Urban hospitals had more patients presenting with visual acuity of less than 6/60 (48.2%), hence a few (25.6%) remained at this level following treatment. Urban hospitals had more patients presenting with visual acuity of between 6/15-6/60 (30%) than at rural hospitals (19.6%). Rural hospitals had more patients (51.2%) with good vision (6/12 or better) on presentation, however there was a slight decline on the visual outcome after treatment as only 42.7% had 6/12 or better visual acuity.

Table 33 below shows initial visual acuity in relation to final visual acuity.

Table 33. Shows initial visual acuity (column % (n)) in relation to final visual acuity. Visual acuity grouped according to a study by Patel, 1989.

Recorded initial V/A	Recorded final V/A			
	6/12 or better	6/15 – 6/60	<6/60	Total
6/12 or better	51 (50)	2.3 (1)	-	24.8 (51)
6/15 – 6/60	39.8 (39)	38.6 (17)	7.8 (5)	29.6 (61)
<6/60	9.2 (9)	56.1 (26)	92.2 (59)	45.6 (94)
Total	100 (98)	100 (44)	100 (64)	100 (96)

On presentation, 83.8% (n=553) of patients' visual acuities were recorded. Out of these 50 (51%) patients with initial visual acuity of 6/12 or better remained with the same level of visual acuity. Approximately 40% of the patients initially presented with visual acuity of 6/15 to 6/60 were able to achieve 6/6 or better after treatment. Only 9 (9.2%) with initial poor vision (<6/60) achieved 6/12 or better visual acuity after treatment. Only 1 (2.3%) patient presenting with 6/12 or better had vision reduced (6/15-6/60) and none had poor visual acuity. In 17 (38.6%) patients, visual acuity remained (6/15-6/60) the same as initial visual acuity and got worse in 5 (7.8%) patients (<6/60). Twenty six (59.1%) achieved between 6/15-6/60 vision after presenting with poor vision and 59 (92.2%) remained with poor vision after treatment. However, more patients had their eyes enucleated/eviscerated at a later stage (2.7%, n=18). This was observed at both rural and urban hospitals, however rural hospitals had a higher percentage of patients who required enucleation during their subsequent visits (3.4% vs. 1.4%, respectively).

### 5.8.1 Type of injury versus visual outcome

The type of injury in relation to visual outcome is illustrated in Table 34 below.

Table 34. Type of injury (column % (n)) in relation to visual outcome

	6/12 or better	6/15 – 6/60	<6/60	All types
<b>Type of injury</b>				
Blunt trauma	25 (25)	34.1 (15)	42.9 (30)	32.7 (70)
Penetrating	7 (7)	9.1 (4)	22.9 (16)	12.6 (27)
IOFBs	26 (26)	25 (11)	7.1 (5)	19.6 (42)
Lacerations	24 (24)	25 (11)	21.4 (15)	23.4 (15)
Burns	18 (18)	6.8 (3)	5.7 (4)	11.7 (25)
Total	100 (100)	100 (44)	100 (70)	100 (214)

Visual acuity grouped according to a study by Patel, 1989

In the overall sample, the majority of the patients who had poor visual outcome (<6/60) had incurred blunt trauma (42.9%). Patients who had good visual outcome (6/12 or better) had incurred IOFB injury (26%).



The type of injury in relation to visual outcome at rural hospitals is illustrated in Table 35 below.

Table 35. Type of injury (row % (n)) in relation to visual outcome at rural hospitals

	Rural hospitals					
Type of injury	Blunt trauma	Penetrating	IOFB	Lacerations	Burns	Total
Visual acuity						
6/12 or better	34(18)	3.8(2)	26.4(14)	18.9(10)	17(9)	100(53)
6/15-6/60	41.7(10)	4.2(1)	25(6)	25(6)	4.2(1)	100(24)
<6/60	48.9(23)	23.4(11)	6.4(3)	19.1(9)	2.1(1)	100(47)
Total	41.1(51)	11.3(14)	18.5(23)	20.2(25)	11(8.9)	100(124)

Table 36 shows the type of injury in relation to visual outcome at urban hospitals.

Table 36. Type of injury (row % (n)) in relation to visual outcome at urban hospitals

	Urban hospitals					
Type of injury	Blunt trauma	Penetrating	IOFB	Lacerations	Burns	Total
Visual acuity						
6/12 or better	14.9(7)	10.6(5)	25.5(12)	29.8(14)	19.1(9)	100(47)
6/15-6/60	25(5)	15(3)	25(5)	25(5)	10(2)	100(20)
<6/60	30.4(7)	21.7(5)	8.7(2)	26.1(6)	13(3)	100(23)
Total	21.1(19)	14.4(13)	21.1(19)	27.8(25)	15.6(14)	100(90)

For rural hospitals, 48.9% patients with blunt trauma and 23.4% of patients with penetrating trauma had poor vision (<6/60) after treatment. This was similar for urban hospitals where 30.4% of patients who had blunt trauma and 21.7% of patients with penetrating trauma had poor visual outcome i.e. <6/60. At both rural and urban hospitals the majority of the patients that had IOFBs (26.4% vs. 25.5%, respectively) lacerations (18.9% vs. 29.8%, respectively) and burns (17 vs. 19.1%, respectively) had good visual outcome. There was a significant association between final visual acuity and type of injury ( $p=0.000$ ; Pearson Chi-Square test) even for rural hospitals ( $p=0.002$ ;

Fisher's exact test), however no significant association between final visual acuity and type of injury was found for urban hospitals ( $p=0.514$ ; Fisher's exact test).

The data collated have been illustrated in the results showing the pattern of ocular trauma in patients presenting for treatment at the chosen eye clinics.

# CHAPTER SIX

## DISCUSSION

### 6.1 INTRODUCTION

This retrospective study has provided data on the pattern of minor and severe ocular injuries among patients presenting to public health care facilities (eye clinics) following ocular trauma for treatment by a consultant ophthalmologist or an ophthalmic nurse.

### 6.2 GENDER

More males appeared to have experienced an eye injury compared to females as 72.3% of the total sample were males compared to only 27.7% who were females. Similar trends were reported for the gender distribution of patients by Madden et al (2002) in Australia (34.2% vs. 9.9% in males vs. females, respectively). Males are more at risk to experience an eye injury possibly because a greater proportion of males are employed in high risk occupations than females (Madden et al, 2002; Koo et al, 2005). Focus on prevention in this target group therefore remains a priority.

Similar trends of gender distribution of patients presenting with ocular injuries were observed at both rural and urban hospitals as there were more male patients than females. There were more males presenting to urban hospitals (79.1%) with ocular injuries than males presenting at rural hospitals (68.9%). This is in contrast to a report by Madden et al (2002) in Australia for male presentation at rural and urban hospitals (42.1% vs. 30.5% rural males vs. urban males, respectively). This can be related to urbanized males seeking job prospects in South Africa. In addition, males from rural areas relocate to urban areas to search for employment. The comparatively high rates of eye injuries in the mining and agricultural industries may explain the higher rates of eye injuries in rural men in Australia. Evaluating the risks and educating the community about occupational injuries thus appears paramount.

### 6.3 AGE

The majority of the patients experiencing ocular trauma were between the ages of 21 and 40 years. This is similar to the findings of other studies (Smith et al, 2002; Pieramici et al, 1996; Parver et al, 1993; Schein et al, 1988; Wong and Tielsch, 1999). A possible reason for the trend observed is that this is the age group most likely to be employed in industry or agriculture which are high risk areas for ocular trauma (Saini and Sharma, 1993; Ilsar et al, 1982). At both rural and urban hospitals ocular trauma also occurred more frequently in patients between 21 and 40 years. This is in agreement with a report by Gyasi et al (2007) in the upper East region of Ghana where 82% of the patients experiencing ocular trauma were between the ages of 20 and 30 years. The working class population often tends to be in the young middle age groups hence it may be expected that this group may be vulnerable to occupational injuries. The loss of productivity in the active years of life can also result in profound social and economic implications which would need urgent attention.

Of concern was the finding that a significant percentage of patients incurring ocular injuries were children up to the age of 12 years. This is critical because their vision is still developing at that age (Jones, 1993). If not treated there could be negative implications on their future including studying, employment and subsequently independence later on in life can be compromised. At both rural and urban hospitals, children under the age of 12 years were also found to be incurring ocular injuries, however, more often at urban hospitals. These childhood ocular injuries are often incurred while at play. Therefore, efforts to increase eye health awareness in this target group should include parents and children to prevent blindness due to ocular injuries.

Very few patients (2.9%) over the age of 65 years incurred ocular injuries. A possible reason could be that elderly patients over the age of 65 years are less likely to present to hospitals for treatment following an injury. Khatry et al (2004) highlighted that access to health care may change with age and socioeconomic factors may have a role. Furthermore, it could also be assumed that the lower prevalence of injuries in this age

group may be due to lower survival of those with ocular injuries in comparison to the general population (Dandona et al, 2000). Seeking medical attention following an eye injury in this age group should be encouraged. Desai et al (1996) in Scotland reported that 60% of the patients over the age of 65 years had incurred ocular injuries which is high compared to the current study. At both rural and urban hospitals, a few elderly patients over the age of 65 years incurred ocular injuries. Most probably at this stage most people in this age group are unlikely to be active and most are retired from work therefore, the lesser the exposure to occupational hazards the lower the risks.

## **6.4 RACE**

It was found in the current study that the majority of patients who sustained ocular injuries were Black. Similar findings were reported by Katz and Tielsch (1993) and Wong and Tielsch (1999) in a multiracial urban setting in Baltimore Maryland. Blacks represent the majority of the working class and are therefore more vulnerable to these injuries in industry and agriculture (Wong and Tielsch, 1999). People of Indian ethnicity had twice the risk of incurring an eye injury in relation to Coloureds and Whites. Whites were the least likely to experience an eye injury and only presented at urban hospitals. Racial differences may be attributable to variations in occupation hence Whites represent the better socioeconomic class, therefore the majority would be employed as work place managers (Wong and Tielsch, 1999). Information gathered from Statistics South Africa (2011) indicates a greater number of Blacks employed in industry, agriculture and construction compared to the other race groups which could be another reason for having more Blacks that experienced ocular injuries.

## **6.5 OCULAR INJURIES**

### **6.5.1 Type of injury**

In the present study there was a greater proportion of open globe injuries (56.2%) compared to closed globe injuries (43.8%), with a predominance of blunt

trauma/contusions. This corresponds to the findings by Singh et al (2005) in North India who reported 41.4% of open globe injuries and 26.4% of closed globe injuries. Blunt trauma in most cases ranged from minimal contusions to extensive disruption of the globe. This observed tendency may be as a result of more exposure to blunt objects in any environment (MacEwen, 1989). The need for awareness of danger from these objects remains a priority to be considered when planning for the prevention of these injuries. Blunt trauma was the most common type of injury at both rural and urban hospitals (36.4% versus 32.7%, respectively). A significant number of blunt trauma occurred during wood chopping and gathering of wood at rural areas as some of these places still use wood for preparing their meals and to heat their houses.

It was therefore not surprising that intra ocular foreign bodies were also more common at rural hospitals than at urban hospitals (29.5% versus 18%, respectively). Intra ocular foreign bodies have been found to be the most common causative agents of ocular injuries found at rural hospitals in agreement with the report by Salvatore et al (2008) in Italy (66% versus 34%, rural areas vs. urban areas, respectively) although a lower percentage was found in the current study. It is assumed that a greater proportion of patients presenting to rural hospitals were exposed to potentially dangerous situations and hence experienced an eye injury compared to at urban hospitals. Many cases of IOFBs were associated with the use of a hammer, metal from grinding equipment or drilling and shattered glass. In agreement, Ngo and Leo (2008) found that 71.3% of cases associated with IOFBs were as a result from welding, grinding, hammering cutting metal and drilling in Singapore. This was concluded to be due to carelessness and unawareness among workers when carrying out these duties (Dandona et al, 2000). Monitoring these situations and encouraging the use of eye protection can play a vital role for minimizing the occurrence of these injuries.

The majority of the patients who experienced blunt trauma were between the ages of 21 and 30 years. This is consistent with previous reports (Teilsch and Parver, 1990; Oum et al, 2004; Klein and Sears, 1992; Negrel and Thylefors, 1998). A possible reason for the observed trend is that this age group could be exposed to more injuries in the

workplace, in sports and in the social environment consisting of different causative agents. Statistics South Africa (2011) reported that approximately 10% of the total population is made up of the 21 to 30 age group. At both rural and urban hospitals ocular burns were also frequent in the 21 to 30 age group. In agreement, Saini and Shama (1993) reported that young people working in laboratories and factories constituted two-thirds of the patients experiencing injuries from chemical agents they work with and emphasized the use of eyewear being mandatory when performing their duties. The younger age group (0-12 years) experiences more lacerations and IOFBs than blunt trauma which contributes to non-congenital unilateral blindness. The findings among the 0 to 12 years age group in the current study agree with previous reports (Thompson et al, 2002; Luff et al, 1993; Oum et al, 2004; Patel and Morgan, 1991). Children cannot be fully responsible for their actions, therefore more injuries occur in this age group. Educating parents in preparing a safer environment for children, the safety of playing toys in urban areas and sticks and stones in rural areas is advisable. Patients over the age of 65 years experienced all types of injuries, however blunt trauma was the most frequent type in this age group.

Males are more at risk for ocular injuries than females particularly between the ages of 21 to 30 years as reported by previous studies (Smith et al, 2002; Pieramici et al, 1996; Parver et al, 1993; Schein et al, 1988). This trend may be due to the fact that males are more exposed to risky environments than females (Thompson et al, 2002). Due to more exposure, all the types of eye injuries were mostly incurred by males except for blunt trauma which was common among females in agreement to a report from Baltimore, Maryland and Massachusetts USA (Katz and Tielsch, 1993; Wong and Tielsch, 1999; Koo et al, 2005). The reason given was that projectile objects cause the majority of open globe injuries among males compared to females which are incurred either at work or during home improvement projects (Wong and Tielsch, 1999). Females on the other hand, are more vulnerable to injuries from domestic violence which in most instances result in blunt trauma. The Statistics in South Africa of violence against women stands at 49% at the current moment because statistics generally underestimates the extent of domestic violence (Violence Against Women in South

Africa, 1999). This is as a result that woman may not reveal if they are abused in fear of further abuse and other people reactions. Mobilization and campaigns in the media to raise awareness to address violence against women can be effective in reducing the assault related eye injuries (Violence Against Women in South Africa, 1999). Furthermore, findings at both rural and urban hospitals show a similar trend among males versus females for blunt trauma.

### 6.5.2 Ocular signs

The majority of the patients experienced haemorrhages (15.9%) as an associated ocular sign following injury. Singh et al (2005) reported an associated or isolated finding of haemorrhages present among 8.6% of patients which is lower compared to findings of the current study. This observation could be due to the difference of the causes of injury in the report by Singh et al (2005) compared to the current study e.g. arrows, gun shots, blast injuries and the mechanism of injury. Hyphaema (8.6%) was also present as an associated ocular sign in accordance with the findings by Cockerham (1983). The ocular signs relate more to the anterior segment and the possible reason for their presentation and frequency could be that the anterior segment of the eye is more vulnerable to the direct mechanism of injury. It was also evident that some of the patients had more than one classification of injury or more than one type of major lesion existing in one eye e.g. blunt trauma and laceration. IIsar et al (1982) reported similar findings in Malawi. This is dependent on the causative agent involved during the time of injury (solid objects) because the site where the injury occurs is related to the environmental hazards present (Negrel and Thylefors, 1998). Therefore, awareness of these dangerous objects (solid objects) should be emphasised.

Corneal opacities or scarring were also found to be common in agreement with a report in Korea (Oum et al, 2004) although higher (50.1%) compared to findings of the current study (6.5%). This difference may be explained by the larger sample size used in the Korean study and safety practices in South Africa may differ from Asian countries. The nature and circumstances of injury may differ from one country to the next which may



be related to the levels of industrialization, safety standards and access to health services (Gupta 2009; Oum et al, 2004). Many patients presented with haemorrhages and traumatic uveitis (panuveitis) at both rural and urban hospitals. Associated ocular signs after diagnoses more often were found at urban hospitals compared to rural hospitals with the predominance of haemorrhages (conjunctival and vitreous). It is possible that associated ocular signs were not being diagnosed due to lack of facilities at rural hospitals. The evidence suggests that eye health in rural areas still needs to be improved by acquiring more eye care practitioners.

The majority of the ocular signs were associated with blunt trauma and the remainder were seen mostly with IOFBs, lacerations and penetrating trauma. This is in accordance with other studies (Canavan and Archer, 1982; Cockerham, 1983; MacEwen, 1987; Mooney, 1972). The anterior segment is more vulnerable to direct trauma, however blunt injuries may also have an effect on the posterior segment (Cockerham, 1983; Dadgostar et al, 2008; Williams et al, 1990). The literature reveals that endophthalmitis complicates approximately 5% of cases following trauma (Thompson et al, 2002; Falcao et al, 2010; Wai Man and Steel, 2010). However, only 11 (1.7%) patients had endophthalmitis as an associated ocular sign in the present study. At both rural and urban hospitals the majority of the patients presenting with endophthalmitis had an IOFB injury. Urban hospitals had a higher percentage of cases of endophthalmitis than rural hospitals which is in contrast to what was found by Singh et al (2005), who reported that patients from rural background were more likely to develop endophthalmitis following ocular trauma. The difference may be due to the difference in the mechanism of injury, different treatment modalities and under diagnoses at rural hospitals. Therefore, if this is the case it emphasizes that the lack of equipment and skills for the diagnoses of ocular injuries remains a serious problem. The need to focus more on rural hospitals to improve health services to the public thus appears paramount.

Hyphaema, orbital fracture and raised IOP was often associated with blunt trauma. This trend is similar to a report by Cockerham (1983) who reported that 25% of patients with

hyphaema had a rise in intraocular pressure above 25 mmHg. Furthermore, the complication of angle recession by hyphaema following blunt trauma varies from 20% to 94% (Canavan and Archer, 1982; Mooney, 1972). Direct trauma to the trabecular meshwork or clogging of the meshwork by blood cells and their by products can result in the rise in IOP. Hence when the eye is struck, a sudden dynamic shift may occur stretching limbal vessels and displacing the iris, resulting in a tear to the ciliary body and iris shearing blood vessels which are responsible for the formation of a hyphaema. Orbital fracture involves either the thin inferior or medial (lamina papyracea) orbital walls often sparing the orbital rim (Cockerham, 1983; MacEwen, 1989). At both rural and urban hospitals hyphaema was also most often associated with blunt trauma, however higher at urban hospitals. Therefore, a systematic approach in diagnosing and treating these injuries is advisable for achieving good results.

### 6.5.3 Laterality

Unilateral injuries occurred more often than bilateral injuries. This is similar to previous reports from Scotland and Poland (Desai et al, 1996; Mackewicz et al, 2005). This was found to be dependent on the causative agent involved at the time of injury. In addition, the majority of the injuries are blunt/contusional which is often unilateral. Injuries due to chemical burns or splashes often caused bilateral injuries. In the present study, only 3.5% of patients incurred bilateral injuries which was similar to reports from other countries where the number of patients with bilateral injuries varied from 0.3% to 27% (Negrel and Thylefors, 1998). Furthermore, other studies revealed prevalences of 10.6%, 1.1%, 4.44% and 42.1% for bilaterally injured patients (Khatry et al, 2004; Serrano et al, 2003; MacEwen, 1987; Teilsch and Parver, 1990; Bejiga, 2001; Saini and Sharma, 1993). Frequent causes of bilateral injuries were paint, battery acid, petrol/diesel from generators and sand in the present study.

The occurrence of unilateral injuries at rural hospitals was higher compared to urban hospitals, however urban hospitals had more bilateral injuries. This trend may be due to the fact that in an urban setting there are more laboratories or industries where

chemicals are being used more often than in a rural setting. Therefore, bilateral eye injuries are encountered following an explosion or a splash projected on the face at short distance. Extensive damage to the anterior segment and ocular surface epithelium from chemical injuries may result in permanent unilateral or bilateral blindness. Therefore, during use of these chemicals eye protection should be mandatory and awareness by employees and employers cannot be over emphasized. On the other hand blunt trauma caused the majority of unilateral injuries in agreement with a report in Scotland (Desai et al, 1996). A similar trend was also observed for blunt trauma at both rural and urban hospitals, however, higher at urban hospitals.

## **6.6 PLACE OF INJURY**

It has been established in most studies that the home remains an important place for ocular injuries (Luff et al, 1993; MacEwen, 1989; Desai et al, 1996; Thompson et al, 2002; Chattopadhyay et al, 2010). Findings of the current study agree with what other studies have found. Injuries occurring in the domestic setting are probably underreported and the lack of knowledge about potential hazards in the home is obvious (Chattopadhyay et al, 2010). This was also evident at both rural and urban hospitals where more injuries were incurred in the home compared to other sites, however more common at urban hospitals. The outdoor environment/social environment was also reported by Negrel and Thylefors (1998) as a common place for ocular trauma, in agreement with the current study. Injuries incurred in the social environment were found more often at rural hospitals than at urban hospitals. Potential hazards are readily available in the outdoor environment and the occurrence of most injuries is inevitable (Negrel and Thylefors, 1998). Emphasis on awareness when in these environments can play an important role in decreasing the incidence of ocular injuries.

Sport related injuries were rare (2.4%) falling within the range (2-3%) according to previous studies (MacEwen, 1989; Cariello et al, 2007). However, karate also contributed to the statistics wherein patients were either kicked on the eye or the eye struck by feet. Soccer, cricket and rugby were the most common sporting activities

contributing to sport related injuries in the current study. In the United States and United Kingdom, sports related injuries are caused by different sporting activities which depend on the popularity of the sport e.g. football, baseball, basketball (Napier et al, 1996; Jones, 1993; MacEwen, 1989; MacEwen et al, 1999; Dasgupta et al, 1990). This could be caused by unintentional and intentional injuries during participation in sport. Sport related injuries were more frequent at urban hospitals than at rural hospitals. These sporting activities i.e. soccer, rugby and cricket have massive participation and are often played in urban communities. Furthermore, people living in urban areas are exposed to a variety of sporting activities due to availability of sport facilities which is not the case in rural areas.

Universally, males are reported to experience more ocular injuries in agreement to the current study. This may be because they participate in dangerous hobbies or sports (MacEwen, 1987; MacEwen et al, 1999). In every sporting activity, fair play should be encouraged and disciplinary actions for transgressors be put in place in order to minimize these injuries. Injuries in sport occurred most frequently amongst young males (2.7%) and a few in females (1.6%) with good visual outcome. Barr et al (2000) reported that in sport in the United Kingdom, the potential for severe vision loss is always present among young men even though most are minor with good visual recovery. Therefore, with adequate safety practices put in place, sport related injuries can be prevented.

The findings of the current study indicate that the majority of ocular injuries occurring in the home. However, previous reports indicate that the majority of ocular injuries occurring in industry (Chattopadhyay et al, 2010; Thompson et al 2002; Ngo and Leo, 2008; Lombardi et al, 2009). This trend is observed in developing countries in the manufacturing sector due to the lack of knowledge of protective devices in industry or non-compliance among workers (Ballal, 1997; Ngo and Leo, 2008; Merle et al, 2008). Other contributing factors are poor organization as regards to safety and poor working conditions (Edema et al, 2009). Therefore, strict compliance needs to be reinforced by workplace managers during working hours. Most investigators reported IOFBs as the

main cause of ocular trauma in industry more commonly found in rural areas (Falcão et al, 2010, Murillo-Lopez et al, 2002; Dhir et al, 1984). This is in agreement with the findings of the current study. Salvatore et al (2008) reported that a greater number of intra ocular foreign bodies are found in rural areas which may be due to agricultural practices and mining industry with a lack of monitoring of rural occupational injuries. Grinding was also a cause of injury in the home and in the workplace as a result of not issuing or using eye protection. Educating employees and employers about the prevention of the loss of sight can go a long way in promoting industrial safety and eye health. At rural hospitals, there were only 2 (5%) cases of assault in the workplace while urban hospitals had none. This depends on workers' behaviour in the workplace.

Farming has also been reported as a site of ocular injuries. Chopping grass and sugar cane harvesting, increases the risks of acquiring an injury (Ilsar et al, 1982; Canavan et al, 1980). In the current study, the high risk of injury in rural areas can be due to the fact that agriculture is often practiced in an unsafe environment without safety precautions being undertaken due to unawareness of workers doing manual labour. The current study found that 4.1% of the ocular injuries were incurred during agricultural pursuits. In Finland, Saari and Aine (1984) analyzed all kinds of eye injuries in agriculture and found that 21.9% of all injuries were farm related. Furthermore, reports from Ireland and Malawi showed a 4% and 1.5% prevalence respectively of the total eye injuries resulting from agricultural pursuits which seemed low for such a large rural population (Canavan et al, 1980; Ilsar et al, 1982). An overview of these injuries, initially considered to be superficial, may progress to a more long lasting effect such as recurrent corneal erosion/ulcers which needs close monitoring until the healing process (Steiner and Peterson, 1992). Injuries from agriculture were more common at rural hospitals than at urban hospitals as would be expected. Domestic animals also caused ocular injuries e.g. during horse riding and during milking of cows as found in previous reports from Ireland, Malawi and Scotland (Canavan et al, 1980; Ilsar et al, 1982; Garrow, 1923). In poor rural communities farming is often practised and therefore has been cited as one of the main sites of ocular injuries. Improving working conditions can help minimize these injuries (Mackiewicz et al, 2005).

A high risk of injury is evident among the 0 to 12 and the 21 to 30 age groups in the home. In agreement to the current study, Bhogal et al (2007) and Desai et al (1996) in Scotland found an increasing frequency with age as a risk factor for experiencing serious ocular trauma in the home. The setting seems to be the predictor for most eye injuries to occur. At both rural hospitals and urban hospitals ocular trauma occurred more frequently in the home in patients between 21 and 30 years and 0 to 12 years. Urban hospitals had a greater percentage of ocular injuries incurred in the home for the 21 and 30 age group compared to rural hospitals and an equal number of patients in the 0 to 12 age group. Reinforcement of the need for caution when dealing with potential dangerous home objects or domestic utensils needs to be emphasized.

Different objects have been identified to cause a disproportionate amount of serious eye injury among children. In agreement with the current study, reports from South Africa and Manchester revealed that ocular injuries were more frequent in children less than 6 years of age (Grieshaber and Stegmann, 2005; Patel, 1989). Therefore, parental supervision during play is advisable. Patients experiencing sport related injuries were infrequent in the middle age groups. Reports from the USA, Scotland and Ireland are different to the findings of the current study (Jones 1993; Barr et al, 2000; Canavan et al, 1980). Reasons cited may be due to limited to a variety of sporting activities compared to these European countries.

In India women and children are reported to be more at risk for ocular injuries in the home (Chattopadhyay et al, 2010). However, in contrast to that, the current study found that males are more at risk to ocular injuries from performing home improvement projects and children while at play. A significant number of injuries among children were as a result from playing without parental supervision with items such as piece of wood, pellet guns, fireworks, knives, glass bottles, scissors and pens. Accidents among children are more likely to occur in the home because children spend the majority of their time at home. This is similar to reports from Lesotho and Brazil (Gordon and Mokete, 1982; Cariello et al, 2007), hence ocular injuries caused by these objects should be prevented by preparing a safer environment for children and supervision.

The potential for an injury exists mostly for an active child in the home, therefore parental awareness of safety measures to ensure reduction of these injuries appears paramount. Males and children were at high risk to incur ocular injuries in the home was also evident at both rural and urban hospitals. Males in industry in rural areas experienced more injuries compared to urban males in agreement with a report from Australia (Madden et al, 2002). A possible reason for this is that in rural industry most of the work is done manually compared to their counterparts where a greater volume of work is done by machines. It could also be due to the lack of supply of protective devices (Gupta et al, 2004; Singh et al, 2005; Edema et al, 2009).

In Baltimore, Maryland, Blacks had a higher rate of injuries in all places cited for ocular trauma compared to other race groups, in agreement to the current study (Katz and Tielsch, 1993; Wong and Tielsch, 1999). The difference can be work related, assault related and sport related among the racial groups. There was not much difference in the presentation to rural and urban hospitals for Black people due to similar exposure to injuries. People of Indian ethnicity had frequent injuries in the home (5%) while Coloureds had more ocular injuries during sport (6.3%). In industry, Indians, Whites and Coloureds had an equal number of injuries at urban hospitals and none in rural hospitals had none.

## **6.7 CAUSE OF INJURY**

A solid object found in any environment can cause or can be used to cause an injury. Other causes of eye injuries in domestic and social environments included blunt objects, fists, metal pipe, planks, coffee mugs, metal rods, pellet guns, stones, shambok, bricks, pencils, fireworks, bones from chops, splinters of wood from chopping, elastic bands; sharp objects, wire injury, pieces of tile, broken glass, knives, nails, scissors, screw driver, burns, acidic floor cleaner, burning rubber, soft drink explosion, gas cylinder explosion, hot cooking oil, detergents such as jeyes fluid, jik etc. IIsar et al (1982) and Grieshaber and Stegmann (2005) reported some of these causative agents in Malawi and in South Africa, respectively. According to previous reports solid objects pose a

threat to the eye (Luff et al, 1993; Thompson et al, 2002; Desai et al, 1996; Murillo-Lopez et al, 2002). In the present study solid objects were responsible for 54.4% of the ocular injuries. Solid objects causing injuries appeared to be more common at urban hospitals compared to rural hospitals. Exposure to dangerous objects in any environment can pose a threat to the eye, therefore awareness of potential hazards must be emphasized.

Solid objects were found across all places cited for ocular trauma according to previous reports in agreement with the current study (Luff et al, 1993; Thompson et al, 2002; Desai et al, 1996; Murillo-Lopez et al, 2002). Solid objects were also found to have contributed the most injuries at both rural and urban hospitals. As mentioned previously, that any solid object has a potential of causing an injury, therefore precautions must be undertaken at all times. Chores in the home e.g. digging can result in the soil particles causing harm to the eye according to Garrow (1923) in agreement to the current study. Shattered glass was also responsible for many injuries in the home, however, a higher percentage was observed at urban hospitals than at rural hospitals. Prevention measures have focused on other areas of trauma besides the home and the social environment, therefore these areas still remain a priority (Luff et al, 1993). It is also advisable that every household should have a pair of approved protective eyewear and it is vital to note that bystanders are also at risk especially young children (Thompson et al, 2002; Luff et al, 1993).

Metal from grinding equipment or drills and chemical burns were frequent causes of injury in industry in the current study. This is in agreement with previous studies (Ngo and Leo, 2008; Merle et al, 2008). This is mostly seen in expanding economies in the manufacturing sector (Edema et al, 2009). Therefore, this shows that the barriers to the use of protective devices still remain in the industrial sector.

Assaults were also found to contribute to eye injuries in the present study (24.3%). Assaults resulting in ocular injuries were distributed over the whole range of the types of injuries. These injuries are inevitable which are contributed to by many factors



especially in the social environment and does not only result in serious ocular trauma but is also life threatening in the event of body trauma. Although machinery in industry and tools in the home are still the major causes of moderate to severe eye injuries, according to the findings of the current study assaults (21.6%) were more frequent in the home. They have increasingly become a major cause of serious ocular trauma in the home and social environment as reported by Desai et al (1996) in Scotland (21.8% assault cases). Assaults in the social environment and in the home were more frequent at rural hospitals compared to urban hospitals. Identifying solid objects mostly used during assaults or any activity in the environment remains vital for reducing ocular damaging trauma. In agreement, Shein et al (1988), IIsar et al (1982) and Garrow (1923) also found that assaults were becoming a major cause of ocular injuries. Assaults were more frequent at rural hospitals than at urban hospitals. Sharp objects used during assault were reported in most cases resulting in perforation, endophthalmitis, afferent pupillary defect and raised intra ocular pressure depending on the causative agent involved.

The majority of the patients experiencing ocular trauma through assault were between the ages of 21 and 30 years attributable possibly to social activities that most middle age groups engage in. This trend is similar to the findings of other studies (Desai et al, 1996; Oum et al, 2004, Wong and Tielsch, 1999). Ocular injuries due to assault often occurred in the middle age groups at both rural and urban hospitals. The younger age group (0-12 years) and the age group of 65 years and over also experienced injuries through assault. During physical play children incur ocular injuries through assault without parental supervision. Physical abuse from parents cannot be ruled out also resulting in ocular trauma e.g. use of glass, fists and broom sticks. This is consistent with the findings among children in Lesotho where 60% of the injuries were self inflicted while 40% resulted from assaults (Gordon and Mokete, 1982).

Identifiable causes of injury among the elderly were solid objects used during assault. Identifying potential hazards is crucial for the prevention of these injuries. Therefore, awareness campaigns through media e.g. television, radio etc especially on assaults

can be effective to the audience. The middle age groups are vulnerable to chemical injuries and metal from grinding equipment or drills in agreement with previous reports (Saini and Sharma, 1993; Ngo and Leo, 2008; Pieramici et al, 1996). This trend may be because most patients in the middle age groups are employed in industries where they perform these tasks in everyday life. In support, Lombardi et al (2009) found that young people were less likely to use eye protection or perceive the risk of eye injury due to lack of experience. Furthermore, injuries due to hammering were infrequent at both rural and urban hospitals. Loss of productivity can be expected as a consequence of ocular injury especially in the middle age groups because the majority of the patients work in places where they are vulnerable to ocular injuries.

Chemical burns (6.2%) and thermal burns (1.8%) were also responsible for causing ocular injuries as in accordance with recent studies where the range varied between 7.7%-18% although a lower percentage was found in the current study (MacEwen, 1989; Kuckelkorn et al, 2002; Merle et al, 2008; Adepoju et al, 2007). This may be attributable to different safety practices from one country to the next in chemical industries. The scope for improvement and the use of eye protection especially in the workplace appears paramount. Urban hospitals had more chemical burns than rural hospitals. In rural areas jik which is often used in place of chlorine as the common water purifier and which is also a domestic disinfection solution, was reported as one of the chemicals resulting in ocular injuries. Most household products especially the ones for cleaning also pose a treat to the eye in agreement to a report by Luff et al (1993).

In the current study it could not be determined as to whether the injury was due to an acid or a base as the pH was not specified in most cases. In those cases where the pH was specified acid burns were found to be more frequent than alkali burns in the present study which is comparable to reports from Scandinavian countries (Kuckelkorn et al, 2002). Kanski (2003) reported that alkali burns are twice as common as acid burns since alkalis are widely used in the home. This can be due to a lack of information provided by the supplier to customers informing them about potential hazards associated with the use of the product.

In the present study the frequent causes of chemical injuries were tyre lubricant, splash by thinners and gun powder which contains dangerous chemicals. These have been proven to be dangerous to the eye as it can cause mild to severe chemical burns, however in the present study patients incurred self limiting burns. Kuckelkorn et al (2002) and Wagoner (1997) reported that most burns were trivial and did not result in any long lasting effects although some had the potential to result in permanent unilateral and bilateral visual impairment, in agreement to the current study. In cases where eye protection should have been applicable, it seems that barriers of its use still remain which include discomfort, forgetfulness or not citing its importance (Crebolder and Sloan, 2004; Ngo and Leo, 2008).

Ocular injuries due to falls were infrequent (2.1%), but predominant in 0 to 12 age group followed by 21 to 30 age group. This is in disagreement with other studies from Scotland and Ireland where ocular injuries due to falls were predominant among the elderly (44% and 43.3%, respectively) (Saeed et al, 2010; Desai et al, 1996). At rural hospitals falls were predominant among the 0 to 12 year age group while at urban hospitals falls were predominant in the 21 to 30 age group. Children at this stage are very active without evaluating the risks. Therefore, parental supervision during play is very important.

Males were observed to have twice or more higher rates of ocular injuries from solid objects and assaults compared to females in agreement to previous reports (Ngo and Leo, 2008; Desai et al, 1996; IIsar et al, 1982; Dhir et al, 1984). This may be because males work in environments that pose more risk for ocular injuries. Therefore, preventive strategies must be based on this target group. Similarly, males were more at risk to experience ocular injury at urban hospitals than females. This cause is mostly confined to males therefore can be assumed that this may be related to the differences in occupation between the genders.

Each cause of injury was more frequent among the Black population compared to the other race groups which is in agreement to previous studies (Katz and Tielch, 1993;

Wong and Tielsch, 1999). The only race group that did not present with cases of assaults was White patients. This can be related to the differences in occupations, social and sporting activities among the racial groups (Wong and, Tielsch, 1999). Monitoring and evaluating the risks when performing these duties can help minimize these injuries. The Indian population was often vulnerable to ocular injuries caused by solid objects. Similarly, the Black population was more likely to sustain injuries than the other race groups at rural and urban hospitals suggesting racial differences in exposure to high risk injury settings. Coloureds on the other hand experienced more ocular injuries from solid objects at urban hospitals than at rural hospitals while Whites sustained chemical burns and presented at urban hospitals. Furthermore, thermal burns were only experienced by the Indian population at urban hospitals. Therefore, proper planning and increasing funding to build more health institutions/facilities could make the situation better.

During agricultural pursuits, ocular injuries from solid objects e.g. thorns, rake and grass occurred frequently in agreement to a report in Tanzania (Abraham et al, 1999). Agricultural pursuits are mostly carried out manually without evaluating the risks while there is also greater exposure to potential hazards during working hours. The use of eye protection and awareness among employees can help alleviate these problems. Similarly, industrial accidents and agricultural accidents were more frequent at rural hospitals than at urban hospitals. This is consistent with agricultural pursuits which are the main cause of ocular trauma in rural poor communities, however, in contrast to industrial pursuits which are assumed to be common in urban communities (Ballal, 1997, Gyasi et al, 2007). Ball contact was responsible for sport related injuries. However, the size of the ball in different sporting activities has roused particular interest. The football has been previously considered to rarely cause damage to the eye because it is too large to enter the orbital aperture in comparison to other sporting activities that use small size balls e.g. squash ball (MacEwen, 1989). MacEwen (1989) reported that in most sporting activities that involve the use of a ball, ocular injuries are most likely to occur irrespective of the size of the ball and this was consistent with the classification of mechanisms of injuries incurred in sports (MacEwen, 1989).

Dannenberg et al (1992), Smith et al (2002) and Vasu et al (2001) also documented the rate of alcohol/drug usage (52%, 35% and 68.4%, respectively) suggesting that alcohol has an indirect aetiological profound effect on ocular injuries. However, only 2.6% (n=17) of patients had alcohol use documented on the patients' records in the current study, with rural hospitals having a higher number of patients compared to urban hospitals. The alcohol usage was difficult to quantify because of the retrospective nature of the study and formal testing would have been impossible. Therefore, periodic monitoring of the levels of alcohol and counseling of patients can minimize the alcohol related injuries. This is because patients who are intoxicated have poor judgment impaired by the alcohol or exhibit greater risk taking behavior (Dannenberg et al, 1992)

## **6.8 TREATMENT**

The majority of the patients were treated with medication rather than surgery. This is consistent with previous studies (Cariello et al, 2007; Serrano et al, 2003; Vasu et al, 2001; Oum et al, 2004). Medication was found to be the more frequent method of treatment because more patients in the current study incurred closed globe rather than open globe injuries which in most instances would have required surgical intervention. Furthermore, most IOFB cases were often managed with medications even though classified as open globe injuries. Other possibilities are that most of the injuries incurred did not require surgical intervention, there was a lack of experts to perform some of the complicated procedures, delayed presentation to hospitals resulting to a self sealing injury and phthisis bulbi (Gyasi et al, 2007). At both rural and urban hospitals, medication was mostly used as the form of treatment however, rural hospitals used medication more often when compared to urban hospitals. In agreement, the protocol of practice for the eye specialist requires that an open globe injury should be repaired as soon as possible and closure of a penetrating injury or rupture must be attempted even for a disrupted globe (Schrader, 2004). At rural hospitals patients with penetrating injuries often required surgical intervention compared to urban hospitals

where lacerations were often surgically managed. The only type of injury that did not require surgical intervention at presentation to hospital was burns.

Corneal repair/graft and traumatic cataract removal were often performed which is consistent with the findings of previous reports (Muga and Maul, 1978; Khatry et al, 2004). This can be as a result of the availability of eye specialists that are highly trained to perform corneal repair/graft and traumatic cataract removal. Corneal repair/graft was frequently performed at urban hospitals compared to rural hospitals which may probably be due to inadequacy of equipment and corneal experts at rural hospitals. However, traumatic cataract removal and suturing are commonly performed at rural hospitals due to the availability of cataract surgeons to perform these procedures.

Some eye injuries required more than one type of surgery (2.9%) e.g. corneal repair, lens extraction, IOFB extractions etc which is in agreement with reports from Colombia (49.2%) and Korea (9.6%) (Serrano et al, 2003; Oum et al, 2004). Quality of health care offered may differ, hence this can also be dependent on the severity of the injury and clinical protocol used. Performing repeated procedures does not change the outcome, however the outcome is dependent on the mechanism of injury and eyes with less severe trauma can also require repeated procedures (Rahman et al, 2006). Repeated procedures were most likely to be performed at urban hospitals compared to rural hospitals, and single operation was also twice more likely to be performed at urban hospitals. Inadequacy of equipment and expert surgeons at rural hospitals may have contributed immensely to the delay of performing the relevant required surgery on patients. Penetrating trauma and blunt traumas were found to be the most common types of injury that required repeated surgical procedures for corneal repair/graft and traumatic cataract removal in agreement to previous reports (Oum et al, 2004; Patel and Morgan, 1991). Corneal repair/graft was done first then lens extraction after corneal healing. Muga and Maul (1978) mentioned in their review that it had not been established whether to repair the eye and extract lens at the same time of repair or wait until the healing process is complete. Ophthalmic trauma is difficult to manage and may vary from one country to the next depending on the available surgical and clinical skills to treat serious eye injuries (Desai et al, 1996).

Corneal repair/graft was frequent across all age groups, but the highest in the 21 to 30 age group. This is in agreement with a report by Oum et al (2004). Sutures were also often performed in the 21 to 30 age group and traumatic cataract removal in the 51 to 65 age groups. The 0 to 12 year age group was not an exception for corneal repair/graft (19.4%). In agreement to the current study, Poon et al (1988) in Hong Kong found that 20% to 29% of corneal transplants were done on children following ocular trauma. The disadvantages with corneal repair/grafts, even with a fairly high success rate include rejection of the new cornea, experiencing decreased vision, increased pain, increased redness of the eye and increased light sensitivity (Schrader, 2004). Therefore, experienced corneal experts are required to perform these procedures. Sutures were often performed at rural hospitals rather than at urban hospitals where corneal repair/grafts were frequently performed in the 21 to 30 age group. These patients are in their active stage of life, therefore more exposed to ocular injuries from the workplace, sports and the social environment. Furthermore, traumatic cataract removal was often done at rural hospitals in the 51 to 65 age group compared to urban hospitals where it was mostly performed in the 21 to 30 age group.

A unique feature in the epidemiology of ocular injuries is that males sustain more serious injuries thus requiring surgical intervention more often than females according to previous reports (Desai et al, 1996; Glynn et al, 1988; Bhogal et al, 2007; MacGwin et al, 2005; Katz and Tielsch, 1993; Wagoner and Kenyon, 1990). The potential for incurring severe injuries among males is thought to be related to participation in dangerous hobbies, sports and occupational exposure. In addition, all the types of injuries were more prevalent among male patients according to findings of the present study compared to female patients. Therefore, future prevention should be based more on this target group. Surgical intervention was also often performed on male patients at both rural and urban hospitals. Retinal surgery/vitrectomy was only performed on male patients. However, females required traumatic cataract removal at both rural and urban hospitals.

Irrespective of the type of injury, surgery was performed mostly on patients presenting with poor visual acuity except for sutures which were done even on patients with good

vision (6/12 or better). This is in agreement with a report in the United Kingdom (Rahman et al, 2006). Traumatic cataract removal was done frequently at rural hospitals because of the availability of the cataract surgeon. Therefore, it can be assumed that rural hospitals perform simple procedures because of inadequacy of equipment and eye specialists unlike at urban hospitals where almost all complicated procedures are done. Posterior segment injuries were not treated, especially at rural hospitals e.g. retinal detachment, macular scar, secondary glaucoma and these cases were rare because they were referred to other hospitals for further assessment. Similarly, in Malawi, vitrectomy which might have improved prognoses in patients could not be performed because of the lack of appropriate instruments (Ilsar et al, 1982). For posterior segment injuries with the possibility of restoring useful vision such as retinal detachment, more care is required during management. In India, Vasu et al (2001) reported that some of the patients requiring surgery for retinal detachment and vitreous haemorrhages could not afford the cost of the surgery. This also indicates the financial implications as a result of these injuries.

Patients who incurred lacerations were most likely to require surgical intervention irrespective of the type of surgery (37.3%). This is consistent with a report from Ghana where 20.9% of the patients with lacerated injuries had to undergo surgical intervention. This is dependent of how badly the eye was lacerated or ruptured (Gyasi et al, 2007). Patients requiring surgery following blunt trauma often required cataract removal, while penetrating trauma required retinal surgery and lacerations required corneal repair/graft and sutures. Burns only required corneal repair/graft. This is in agreement with a report from Malawi, however only patients with penetrating injuries required surgical intervention according to the report by Ilsar et al (1982). This can be attributable to the level of development of the country in terms of healthcare, experts and adequacy of equipment to perform the necessary surgical treatment. In the current study patients from rural hospitals required more traumatic cataract removal following blunt trauma while corneal repair/graft was frequently performed at urban hospitals.



## 6.9 FOLLOW UP

Just over half of the patients returned for follow up examination (51.5%). In Baltimore, Maryland, 82.1% of patients were seen over a follow up period, in agreement to the current study (Khatry et al, 2004). Severity of the injury and poor visual acuity may be possible factors forcing patients to return for follow up examination. At urban hospitals patients were more likely to return for follow up examination compared to rural hospitals. Possible reasons for this difference could be distance travelled to get assistance, negligence from patient's side, delayed referral by hospitals or clinics and travelling costs (Gyasi et al, 2007). Desai et al (1996) in Scotland, Gyasi et al (2007) in Ghana and Bejiga (2001) in Ethiopia reported that most patients (32%) who did not return for follow up had to travel great distances to seek medical attention and some were satisfied with their recovery and visual status following injury. Gyasi et al (2007), Bejiga (2001) and Adala (1983) found that areas where the availability of resources was scarce were the ones that had a large number of patients presenting with complicated cases requiring follow up examination for treatment even if the injury was initially minor. This was as a result of a delay in presenting to a health care facility or late presentation of symptoms. Decentralizing health services to rural areas therefore appears paramount.

Patients with blunt trauma and lacerations were most likely to return for follow up treatment. A similar trend was observed for follow up examination at both rural and urban hospitals. Patients with lacerations and IOFBs were more likely to return for follow up examination at urban hospitals than at rural hospitals. In certain situations without long term follow up it becomes difficult to determine the exact prognosis in these eyes especially in blunt trauma where an after effect to a distant structure after a period of time is inevitable (Gyasi et al, 2007). Information gathered indicates that patients initially present with good vision following a blunt injury, however at a later stage vision may be compromised and the long term outcome for blunt cases has not yet been fully established (Gyasi et al, 2007; MacEwen, 1989). Patients with ocular burns returned for follow up examination while patients who had incurred an IOFB injury were less likely to return for follow up examination. This could be due to the fact that in most instances

once the foreign body is removed the symptoms/signs disappear unlike for ocular burns where the physiology of the eye or the ocular surface may be compromised. In addition, the least percentage of patients with IOFBs would return for follow up examination because they had good visual outcome. Therefore, long term follow up is mandatory to promote the healing process and for providing the best possible opportunity for visual rehabilitation whenever necessary (Khodabukus and Tallouzi 2009). This was also evident at both rural and urban hospitals where patients with ocular burns returned for follow up examination.

Poor vision is an important factor that would motivate patients to attend follow up examinations. In the current study this was also the case as patients with poor visual acuity (<6/60) were more likely to return for follow up examination compared to patients with visual acuity between 6/15 and 6/60 and 6/12 or better. It is expected that patients with good visual recovery would be less likely to return for follow up examinations. At both rural and urban hospitals patients with poor vision (<6/60) were also more likely to return for follow up examination. Information gathered from the results also indicates that patients with good visual acuity were more likely to return for follow up examination at urban hospitals rather than at rural hospitals. Therefore, it can be assumed that urban hospitals provide quality healthcare and have sufficient staff to attend to these injuries compared to rural hospitals. However, health care quality is measured in terms of access to services, clinical quality and patient experience/perception which can play a vital role for patient motivation to return for follow up examination especially at rural hospitals. According to the vision 2020 guidelines, urban hospitals are close to meeting the guidelines in terms of the population served. However, rural hospitals are far from meeting the guidelines because they do not have a single consultant ophthalmologist. Therefore, improving health services at rural hospital needs to be prioritized by having adequate, appropriately utilized, competent and motivated health workers in the healthcare profession.

Patients with poor visual acuity were most likely to return for a follow up examination to the ophthalmologist. Just over half of the patients had only one follow up examination

(50.3%). Patient satisfaction following injury and traveling great distances are factors that may affect follow up (Gyasi et al, 2007; Bejjga, 2001; Desai et al, 1996). Patients who presented with poor vision (<6/60) had a longer duration of follow up examination compared to patients who presented with good vision. Morris et al (1987) in Alabama, USA reported that for every group of patients evaluated, the majority had improved acuity over the follow up period of four to eight months. This report differs from what is found in the current study because these patients had a shorter period of follow up examination compared to patients in the Alabama study. Continued follow up must be encouraged although sometimes these can be determined by quality, patient experience and perceptions as mentioned previously. The emphasis on follow up and compliance to ensure that patients do not cause preventable blindness appears paramount. Issuing of appointment cards, stressing on the importance of follow up, phoning patients to remind them about their follow up appointments and provision of transport by hospitals are key areas that can be effective in improving follow up examinations of patients.

## **6.10 ADMISSION**

In the current study it was found that only 25.6% of admissions were made. Hospital-based studies conducted in Ghana show that 5% to 16% of all ophthalmic admissions to eye hospitals/units are related to ocular injuries (Gyasi et al, 2007; Adala, 1983). Admitted patients were most likely to undergo surgical intervention (72%) especially for corneal repair/graft and traumatic cataract removal. These findings are similar to a report from Glasgow where admitted patients also required surgical intervention (MacEwen, 1989). Desai et al (1996) reported that ophthalmic services experience a significant workload from ocular trauma and most of these injuries are minor and may warrant hospital admission. More admissions were made at urban hospitals than at rural hospitals. This relies on the quality of care, availability of space and skilled personnel to attend to patients at urban hospitals because they are more prioritized compared to rural hospitals. Rural hospitals, on the other hand, do not have sufficient facilities to allow admission with less comprehensive treatment and hence poor

prognoses. Furthermore, rural patients travel long distances to attend health care facilities, therefore admission of patients would be an advantage because these would cut the traveling costs while at the same time patients are kept under observation with the aim of achieving better visual outcome.

Injuries from solid objects were commonly cited as common causes of ocular trauma warranting patient admission for treatment in accordance to MacEwen (1989) in Glasgow. These injuries can be incurred at any site of injury, therefore identifying these objects for public awareness remains a priority. Similarly, at both rural and urban hospitals admissions were made for injuries from solid objects and assaults.

The age group between 21 and 30 years incurred more injuries that necessitated admission followed by the 31 to 40 age group. In agreement, Oum et al (2004) in Korea reported that the age group between 10 and 39 was more likely to be hospitalized following an ocular injury. The types of injury were more prevalent among the 21 to 30 age group compared to the other age groups that necessitate hospital admission according to findings of the present study. Furthermore, as mentioned previously that the middle age group are more at risk to experience an ocular injury either in the home or at work. Children up to the age of 12 years also experience injuries requiring hospital admission. This is in accordance to findings in Glasgow where children up to the age of 10 years also experienced ocular injuries requiring hospital admission (MacEwen, 1989; Bhogal et al, 2007). Increased awareness especially in the home where serious eye injuries can occur among the young is paramount.

More admissions were made for the 21 to 30 age group at both rural and urban hospitals, however, there were more admissions made at urban hospitals. The types of injuries were similar at both rural and urban hospitals. However, of concern was that more types of injury were found at rural hospitals yet rural hospitals had the least number of admissions compared to urban hospitals. Again this may be as a result of insufficient staff and eye specialists to attend to ocular injured patients at rural hospitals. Other possibilities are easier access to health services at urban areas compared to rural

areas and patients could have been referred from rural hospital to urban hospital for admission. At urban hospitals, the 0 to 12 age group was admitted more often compared to at rural hospitals.

The majority of the patients that required admission were males which is similar to the findings of other studies (Desai et al, 1996; Glynn et al, 1988; Bhogal et al, 2007; MacGwin et al, 2005; Katz and Tielsch, 1993; Wagoner and Kenyon, 1990). As mentioned in previous reports males are not only at risk, but also have greater duration of exposure to potential hazards that can result in a more serious injury compared to females. Injury prevention should be based on this target group in future. At urban hospitals more female admissions were made than at rural hospitals. The present study found that in one of the rural hospitals there was no inpatient ward belonging to the eye clinic instead patient were admitted in a general ward. Patients who had cataract surgery were discharged on the third day irrespective of any post operation complications due to the lack of space to keep the patients and insufficient staff to look after the patients. This confirms that rural hospitals experience more heavy workloads while they do not have the basic health care facilities.

Patients' admissions were dependent on the visual acuity at presentation, the poorer the visual acuity the greater the chances of being admitted. This is in agreement with previous studies (Desai et al, 1996; Ngo and Leo, 2008). The severity of the injury has been found to correlate with poor visual acuity and this may imply a posterior segment involvement (Dadgoster et al, 2008; Canavan and Archer, 1982). A similar trend for patients with poor visual acuity requiring admission was observed at both rural and urban hospitals. Patients with good visual acuity (6/12 or better) and 6/15 to 6/60 were likely to be admitted at urban hospitals but not likely at rural hospitals. This could be because at rural hospitals the resources or facilities are not able to accommodate all patients requiring admission.

Injuries that were incurred at home frequently required admission to hospital. In agreement with the current study, Saeed et al (2010) and Bhogal et al (2007) found that

domestic activities were responsible for warranting hospital admission. Injuries occurring in the workplace still warrant patients' admissions from carrying out industrial and agricultural duties (20.1%). Ngo and Leo (2008) reported that only 5% of the patients requiring hospital admission had incurred industrial related injuries. Furthermore, in agriculture, MacEwen (1989) found a small minority of injuries (0.4%) that were serious enough to require patient's admission to hospital. This may be attributable to the fact that eye injuries occurring in fields are often too minor to require hospital admission (Ilsar et al, 1982). Occupational safety through the use of eye protection must be encouraged. Domestic accidents requiring admission were more frequently at urban hospitals. This was an interesting finding for domestic accidents at urban hospitals as it is assumed that there is an increase of home awareness in urban areas rather than in rural areas (Madden et al, 2002). Rural hospitals on the other hand had more occupational injuries requiring admission. Reasons given for having more occupational injuries at rural hospitals included working in an uncontrolled environment, lack of farm mechanization, long duration of working hours and unawareness by employees (Mackiewicz et al, 2005). A few sports related injuries required hospital admission (1.2%) in the current study. This is similar to a report from the United States (MacEwen, 1989; Jones, 1993; Napier et al, 1996). With adequate safety precautions put in place, sport related injuries can be prevented.

In the current study it was found that patients who incurred blunt trauma were most likely to require hospital admission followed by lacerations and penetrating injuries. Katz and Tielch (1993) reported that blunt trauma and penetrating injuries were equally common and often require hospitals admission which is in agreement to findings of the current study. Possible reasons are that penetrating injuries require immediate careful attention followed by prompt surgical repair to prevent functional loss. Furthermore, it is advisable that patients with blunt eye trauma should be kept under steady observation by an ophthalmologist to handle late complications. Awareness of danger from these objects is advisable. Urban hospitals had more admissions compared to rural hospitals. This may be attributable to the fact that there could be a shortage of ophthalmologists at rural hospitals as well as an inadequacy of supply of equipment to assess and diagnose

these injuries compared to that at urban hospitals. As the demand for ophthalmic services increases the situation could become much worse especially at rural hospitals.

### **6.11 VISUAL OUTCOME**

The majority of the patients were able to achieve good vision (6/12 or better) following treatment yet a large percentage (32.7%) were left with poor vision (<6/60). However, in some patients visual acuity was not recorded and other patients had to undergo enucleation/evisceration. Most children under the age of 10 years presenting to these eye clinics did not have visual acuity recorded which may have been influenced by the severity of injury and age of patient i.e. an uncooperative child. Khattry et al (2004) also reported that visual acuity was not attempted in patients aged 5 years and younger.

Patients who initially presented with poor vision (<6/60) at urban hospitals (25.6%) had better visual outcome compared to patients at rural hospitals (37.9%) where there was a decline in visual outcomes. Other studies revealed a 10% useful vision and 25% good vision achievement after treatment (Dhir et al, 1984; Murillo-Lopez et al, 2002; Morris et al, 1987). Early management and diagnosis of most injuries improves the prognosis because many injuries present acutely (Arroyo et al, 2003; MacGwin et al, 2005). This may be explained by the quality of care at urban hospitals. Recruitment of more healthcare staff especially at rural hospitals to facilitate the provision of 24-hour services will help reduce the long queues, reduce the referrals to higher levels of care and improve access to the community with accompanied lower costs per visit and travel costs for patients. This will facilitate early management and thereby reduce complications that can lead to poor visual outcome (Bejiga, 2001; Gyasi et al, 2007). Rural hospitals had a greater percentage of patients presenting with 6/15 to 6/60 vision than at urban hospitals which could be as a result of patients negligence or late presentation of symptoms. Some of the patients at rural hospitals had poor visual outcome after treatment even after they had presented with good visual acuity (6/12 or better). This may be as a result of late presentation to hospital and patients' satisfaction with their visual status following injury.

The majority of the patients who presented with good visual acuity (6/12 or better) remained the same. A significant improvement was observed for patients with initial visual acuity between 6/15-6/60 who were able to achieve 6/12 or better following treatment. There was a slight improvement in 9.2% of patients who initially presented with poor vision (<6/60). In 5 (7.8%) patients vision got worse while in 17 (38.6%) patients vision remained the same level after presenting with visual acuity of 6/15-6/60. Only one patient had reduced vision after presenting with good vision (6/12 or better). There was no change in 59 patients (92.2%) and in 26 (59.1%) patients vision improved to between 6/15 and 6/60 after presenting with poor vision (<6/60). This is different to a report by Gyasi et al (2007) where out of 89.5% after initial assessment, 10.5% patients had their vision recorded as normal (6/6-6/18) while 74% were considered blind (VA<3/60). Furthermore, the present study had a higher percentage of patients presenting with good vision. Schrader (2004) found that about 5% of all registered patients with no light perception regained at least some ambulatory vision after reviewing the United States Eye Injury Register. This is in agreement with the current study. This observed trend can be as a result of the different geographical locations where the causes of ocular injuries may differ depending on the environmental exposure or where most people live, lack of facilities and specialists to provide quality healthcare (Serrano et al, 2003; Arroyo et al, 2003; MacGwin et al, 2005).

A significant number of patients had to undergo enucleation/evisceration (1.8%) on presentation or at a later stage (2.7%). This corresponds to findings reported in Malawi (13.2%) and Manchester (12%) where patients also required enucleation/evisceration (Ilsar et al, 1982; Patel, 1989). The difference in the smaller number of patients requiring enucleation/evisceration in the current study may be as the causative agents involved during the time of injury and health standards may have differed. Enucleation/evisceration is performed on patients with no chance of achieving any degree of useful vision (disorganized eyes) and to reduce the risk of sympathetic ophthalmia, however, some patients with vision may also undergo enucleation/evisceration eventually (Rahman et al, 2006; Oum et al, 2004; Schrader, 2004). A contrasting report from Germany concluded that any injured eye at risk of



sympathetic ophthalmia should not be enucleated/eviscerated, but be maintained under steady observation (Schrader, 2004). The standard practice for ophthalmologists worldwide states that primary repair should be performed to restore the eye to its pre-state regardless of initial visual acuity and extent of injury. Failure to repair the eye enucleation/evisceration is indicated (Rahman et al, 2006; Schrader, 2004).

At both rural and urban hospitals enucleations/eviscerations were performed at initial presentation or at a later stage. However, more enucleations/evisceration were done at initial presentation at urban hospitals and more at a later stage at rural hospitals leaving a question of rendering quality healthcare at rural hospitals. In some instances, primary repair involved specialists other than ophthalmologists like in the case of severe burns (plastic surgeon) and severe orbital fracture (maxillofacial surgeon). Delay in performing enucleation/evisceration on a severely damaged eye with no prognosis restricts allied specialists to repair maxillofacial associated injuries for fear of interfering with the damaged globe and cosmesis (Rahman et al, 2006). Therefore, it can be assumed that the improvement of microsurgical techniques can improve the functional visual outcome (Schrader, 2004). This needs to be considered at rural hospitals.

Blunt trauma was found to have poor visual outcome (<6/60) following treatment. Intra ocular foreign bodies and lacerations had good visual outcomes, however, a poor outcome was also observed with certain cases of lacerations. In the United Kingdom, Rahman et al (2006) reported that sharp injuries were associated with good visual outcome compared to blunt mechanisms, in agreement with findings of the current study. Therefore, it can be assumed that the causative agents involved and the mechanism of injury may be similar irrespective of the different geographic locations (Serrano et al, 2003).

At both rural and urban hospitals, patients who incurred blunt trauma and penetrating trauma had poor visual outcome while patients who incurred burns, lacerations and IOFBs had good visual outcome. However, patients at rural hospitals had poor visual outcomes after treatment compared to those at urban hospitals. This may be

attributable to inadequacy of equipment even though expected to render quality health care at all times.

Devising strategies to encourage more doctors to see the need to specialize in ophthalmology, optometrists to realize their roles they can play in the public sector and training of more ophthalmic nurses for primary management of these injuries especially in remote areas where services are scarce appears paramount. A number of training programmes such as rural registrar programme for ophthalmologists can be established. Continuous optometric education in rural areas has been a problem which is a major issue that needs to be addressed by the Health Professions Council of South Africa (HPCSA) in conjunction with South African Optometrist Association (SAOA). Even though these programmes may appear costly, but they can be effective to the rural audience and if all these programmes are already in place, the only thing would be to devise strategies on how to keep them sustainable and effective.

## **6.12 SUMMARY AND CONCLUSION**

The main findings of the current study are that ocular trauma is more prevalent in the home and it is a common cause that would warrant patient presentation to the eye casualty department. The majority of the ocular injuries were contusional/blunt. Ocular injuries were more frequent in males and in the middle age groups and also among children which is a cause for concern. A significant number of ocular injuries occur in the workplace, the social environment and in sports. In addition, a few cases of the ocular injuries incurred require hospital admission.

# CHAPTER SEVEN

## CONCLUSION, LIMITATIONS AND RECOMMENDATIONS

### 7. 1 CONCLUSION

Males appear to be more at risk than females of experiencing an ocular injury. Urban males are more at risk compared to rural males. The majority of victims are the young in the active years of life due to exposure in occupations. Patients between 21 and 40 years are the most vulnerable to ocular injuries. An excessive amount of serious ocular injuries occur among children. Ocular trauma is less frequent among the elderly patients. Blacks are the most vulnerable race group to ocular injuries compared to other race groups. The majority of the injuries are contusional with fewer IOFBs and lacerations. Intraocular foreign bodies pose a threat to the eye especially at rural environments. Grinding, drilling and hammering are common tasks performed when an eye injury occurs. The 21 to 30 age group appears to incur more blunt injuries. Children often incur lacerations and IOFB injuries.

Males are at high risk to experience open globe injuries when compared to females. The majority of the injuries were associated with haemorrhages. More than one lesion can exist in one type of injury. Associated ocular signs appeared to be common at urban hospitals. The majority of the contusional injuries were associated with hyphaema, orbital fracture and raised IOP. A considerable proportion of IOFB cases had endophthalmitis. Ocular trauma is predominantly unilateral and localized to the eye, however, can be bilateral especially when it is due to a chemical splash. Any solid object has the potential of causing an eye injury. Blunt objects, sharp objects, burns and detergents are the common causes of eye injuries. Assault has increasingly become one of the main causes of ocular injuries hence it is difficult to determine the causes and circumstances. Chemicals pose a threat to the eye irrespective of the etiological concentration of the chemical (acid or base). Assault related injuries occur in

all age groups. The risk of ocular injuries from solid objects exists at all places that ocular trauma can occur at. Children appeared to incur more injuries from falls than elderly patients. Being intoxicated increases the risk of incurring an ocular injury.

The home remains the common place for ocular trauma. Domestic accidents are often incurred by the 0 to 12 and 21 to 30 age groups. Males and children are more at risk in the home to experience an ocular injury. Sport related injuries are infrequent, however, higher at urban hospitals. Males are more vulnerable to sport related injuries. Sport related injuries are frequent in the 21 to 30 age group. Work related injuries remain an important problem and most involve IOFBs. Agricultural practice still exposes the eye to potential hazards especially at rural areas. Industrial related injuries are common among rural males. The Black population is more at risk across all places of ocular trauma.

Medication was commonly used as first line of treatment at initial presentation. Blunt trauma/contusions and IOFBs are mostly treated with medication while lacerations and penetrating injuries require surgical intervention. Corneal repair/graft and traumatic cataract removal are the more commonly performed surgical procedures. Some eye injuries require repeated surgical procedures for treatment especially following penetrating trauma and blunt trauma. Multiple surgical procedures are often performed in the 21 to 30 age group. Most injuries incurred by males require surgical intervention. Surgery is more likely to be performed on males compared to females. Blunt trauma often requires traumatic cataract removal while lacerations require corneal repair/graft. Suturing and traumatic cataract removals are procedures often performed at rural hospitals. The majority of the patients do return for follow up examination. Patients with blunt trauma and lacerations are more likely to return for follow up examination. In the majority of the patients who returned for follow up, the visual acuity remained the same and follow up did not impact significantly on final visual acuity.

A few cases of the injuries sustained require hospital admission. The majority of the admitted patients require surgical intervention. Accidents due to solid objects and

assault cause a significant number of ocular injuries requiring hospital admission. A disproportionate amount of serious eye injuries occur among the middle age groups and children warranting hospital admission. Males are twice as likely to be admitted following ocular trauma compared to females. The majority of the patients who present with poor visual acuity are more likely to be admitted. Domestic accidents and occupational accidents account for the majority of injuries that warrant patient admission. Most cases of blunt trauma and penetrating trauma usually require admission. The majority of the ocular trauma cases at urban hospitals had better visual outcome compared to rural hospitals. It is reassuring that presenting to the eye clinic may improve the prognoses, however, in some cases it may remain poor. Patients who presented with good vision had good visual outcome. Enucleation/evisceration is preferred for patients with severe injuries (disorganized eyes). Blunt mechanisms have poor visual outcome while sharp injuries have good prognoses in this respect.

Results of the current study show that ocular trauma is a relatively common problem in the province of KwaZulu- Natal, occurring most frequently among children, young adults and males warranting presentation to the eye casualty department for treatment. Another challenge is the shortage of staff at rural hospitals. Changes in the mechanism of ocular trauma and preventive measures are effective to ameliorate the visual outcome. The scope for improvement of the use and design of eye protection especially in the workplace appears paramount.

The lack of provision of statistics in some of the hospitals has a setback for research purposes. This can provide information on whether the number of injured patients is increasing, stable or decreasing. It can also help identify if the outcomes of treatment with new developments and equipment put in place yields better results and to encourage timeous delivery of high quality health services. Duties are carried out differently in each hospital and this leaves a question of rendering quality services to the public at all times, however this can be attributable to lack of human resource (skilled personnel), lack of equipment or lack of commitment among health workers.

The Vision 20/20 ideology tried to set goals that by the year 2020 there should be at least 2 ophthalmologists per million of the population and 4 optometrists in a population of 1 million which seems to be quite a nightmare to achieve especially in developing countries (National Department of Health, 2002). A province having a population of approximately 10 million with only 18 hospitals rendering eye services is not adequate and not forgetting that some of the primary health care clinics do not offer tertiary services where you would expect to find most specialists in eye care. Health and safety education and awareness campaigns through media on ocular injuries can make a difference in our communities at large and should be directed to the unrecognized locations for ocular trauma.

## 7.2 LIMITATIONS

The limitations of this study included:

- 7.2.1 The epidemiology of eye injuries is dynamic not static therefore, this may cause difficulty in the interpretation of the results of a retrospective study. The study is limited by its retrospective nature, recording bias thus it is likely that many of the results are actually underestimates of the incidence of most of these clinical measures and findings.
- 7.2.2 There was a limitation in respect of the last recorded visual acuity in the hospital medical record and sometimes even the initial visual acuity although all hospitals providing ophthalmic services use of the same record card.
- 7.2.3 Most of the hospitals were receiving patients from primary health care clinics, therefore the possibility of missing out superficial injuries was inevitable and it is more likely that results from this study represent mostly severe injuries underestimating the true prevalence of these injuries. There was inconsistency in the time taken to seek eye care, and in recording the time of injury. Superficial foreign body trauma may be underestimated because most practitioners remove foreign bodies without making a full registration.
- 7.2.4 The socioeconomic status is most likely related to the lifestyle differences, where the lower socioeconomic class is most likely to present to a public facility which currently constitutes of mostly the Black population. This does not give the exact estimate on prevalence of ocular trauma in the province because patients presenting to a private facility were not included and thus the severity of injuries and management in these facilities remains unknown.

7.2.5 There is a possibility that the most severely injured patients' records were among the ones that were excluded in the study because patients were referred after admission containing not much information. The major disadvantage for patient records with severe trauma is that most of these patients have no follow up as they are referred for further assessment to referral hospitals.

### **7.3 RECOMMENDATIONS**

Based on the limitations and findings of this study the following recommendations are made:

7.3.1 A prospective study on patients with ocular trauma should be carried out.

7.3.2 A community based survey should be conducted to get a true prevalence because not all patients present to hospital for treatment due to many reasons. It appears that there is still scope for improvement of the design and use of eye protection, especially in small scale industry, agriculture and in sports.

7.3.3 Large surveys, preferably on a national basis, may provide sufficient data to increase public awareness and so expedite the appropriate measures.

7.3.4 Health service demand is also increased by the disease burden emanating from relatively high poverty levels and unemployment. This can be as a result of lack of knowledge or compliance among employees. A national collaborative register could be established in order to provide a South African population based data on ocular injuries to ascertain if these injuries are increasing or decreasing and that will make it easier to identify the causes in order to put in place the necessary precaution and preventive strategies. The recording of data can be standardized to eliminate cases whereby some information is missing unless in the case of a minor or a severely injured patient.



7.3.5 More surveys need to be carried out in rural areas to determine the population at risk and the possibility of preventing these injuries.

7.3.6 Training in eye care for nurses in primary health care clinics to be able to identify and refer ocular injuries appropriately.

Ocular trauma has been called the “neglected epidemic of modern society” by the National American Academy of Sciences (Schmidt et al, 2007:202). Therefore, having more population based data would appear useful as vision loss due to trauma is potentially preventable.

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# **APPENDICES**

## **APPENDIX A**

### **Data collection form**

#### **DEMOGRAPHICS**

Age

Gender

1- Male

2- Female

Race

1- Black

2- Coloured

3- White

4- Indian

#### **CAUSE OF INJURY**

1- Assault (Blow (Fist)

2- Ball

3- Other solid object

4- Hammering

5- Metal from grinding equipment or drills

6- Shattered glass

7- Falling

8- Chemical

9- Thermal

10-Ultraviolet



### **TYPE OF INJURY**

- 1- Blunt trauma
- 2- Penetrating
- 3- IOFBs
- 4- Lacerations
- 5- Burns

### **PLACE OF TRAUMA**

- 1- Commercial workplace
- 2- Industrial workplace
- 3- Agriculture
- 4- Home (Domestic)
- 5- Sport field
- 6- Social (Sheeben)

### **TREATMENT STRATEGY AT INITIAL PRESENTATION**

- 1- Medication
- 2- Surgery

### **FOLLOW UP**

- 1- Yes
- 2- No

### **INITIAL V/A AND FINAL V/A**

- 1- 6/6
- 2- 6/9
- 3- 6/12
- 4- 6/15
- 5- 6/18
- 6- 6/24
- 7- 6/36
- 8- 6/60
- 9- <6/60
- 10-Finger Counting
- 11-Light Perception
- 12-No Light Perception
- 13-Enucleation/Evisceration
- 14-V/As not recorded (Initial v/a) and did not return for follow up ( Final v/a)

### **PROCEDURES FOLLOWED FOR TREATMENT**

- Duration of presentation after trauma
- Duration of presentation to the ophthalmologist
- Number of operations

### **TYPE/NATURE OF SURGERY**

- 1- Corneal repair/graft
- 2- Segment reconstruction
- 3- Retina surgery/vitrectomy
- 4- Traumatic cataract removal
- 5- Suturing

**ANY EVIDENCE ON THE NOTES ON ALCOHOL USE**

1- Yes

2- No

**ASSOCIATED OCULAR SIGNS AFTER DIAGNOSIS**

Associated with hypheama

1- Yes

2- no

Associated with orbital fracture

1- yes

2- no

Associated with haemorrhages

1- yes

2- no

Associated with endophthalmitis

1- Yes

2- no

Associated with tobacco dust cells

1- yes

2- no

Associated with traumatic uveitis

1- yes

2- no

Associated with corneal scaring

1- yes

2- no

Associated with lacerations

1- yes

2- no

Associated with elevated IOP

1- yes

2- no

**CHEMICAL**

1- acid

2- alkaline

## APPENDIX B

### Letter to the hospital superintendent

PRIVATE BAG X54001  
DURBAN  
4000  
SOUTH AFRICA  
TEL: (031) 260-7111

**University of  
KwaZulu-Natal**



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DISCIPLINE OF OPTOMETRY  
FACULTY OF HEALTH SCIENCES  
WESTVILLE CAMPUS

Tel: +27 (0) 31 260 7352  
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### THE HOSPITAL SUPERINTENDENT

Dear Sir/Madam

Re: Permission to view Hospital Records of patients with Ocular Injuries in the eye clinic.

I am a Masters student in optometry at the University of KwaZulu-Natal Westville. I am currently pursuing a research study entitled: „The epidemiology of ocular injuries among patients presenting to provincial hospitals in Kwazulu-Natal, South Africa“.

The study will be a retrospective case review of medical records over a 4-year period (January 2005- December 2008) whereby provincial hospitals in Kwazulu-Natal providing eye services will be identified. Cases will be analyzed with respect to: (i) demographics, (ii) place of trauma, (iii) nature of trauma, (iv) type of injury (v) management and (vi) visual outcomes following primary repair.

The findings of this study will be used to inform the planning and provision of eye health care, population groups at risk, health and safety strategies for the prevention of ocular injuries.

I am therefore hereby requesting permission to view hospital records of ocular injured patients visiting your hospital at the eye clinic.

I assure the Hospital Management that the records will be kept confidential at all times and they will be reviewed by me only within the hospital premises. For further information you can contact my supervisor;

Dr R. Hansraj

Email: [hansraj@ukzn.ac.za](mailto:hansraj@ukzn.ac.za)

Tel: 031 260 7352

Thanking you in advance for your cooperation.

Yours faithfully

Velibanti Sukati (205500993)

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Discipline of Optometry

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## APPENDIX C