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QUAD BIKE INJURIES AND INJURY PREVENTION OPPORTUNITIES

by

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Submitted to the University of Cape Town

In partial fulfillment of the requirements for the degree M Phil EM

Faculty of Health Sciences

UNIVERSITY OF CAPE TOWN

Submitted: 5 February 2009

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Declaration

I,, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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List of abbreviations

AMID	Association of motorcycle importers and distributors
ATV	All terrain vehicle
EC	Emergency Centre
eNaTIS	National Traffic Information System

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CHAPTER 1

INTRODUCTION

Anecdotally, there has been a recent increase in the number of patients presenting to Emergency Centres (ECs) with quad bike (also known as quadbike or all terrain vehicle) related injuries. According to the Association of Motorcycle Importers and Distributors (AMID), there was an increase in overall quad bike sales amongst their South African members of approximately 51.1% during the first 4 months of 2005 when compared to the same time during 2004¹. The same source states that the combined sales figures amongst AMID members came to approximately 6123 new units from January to April 2005. Although there has been a general increase in sales over the last five years, sales have declined recently. Sales for the first 6 months of 2008 only reached 4502² compared to 7088 during the same time in 2007³. AMID attributes this decline to the fact that quad bikes in South Africa are largely luxury items used for recreational purposes⁴ and not for work and the global financial climate during 2008 has led to a decrease in public spending on non-essential items. The quad bike market consists of 3 segments, namely: recreational, utility and child-specific quad bikes. AMID represents 9 different motorcycle manufacturers in the South African market (Suzuki, Yamaha, Kymco, Ducati, Kawasaki, Polaris, Harley-Davidson, BMW and KTM).

According to information from the National Traffic Information System (eNaTIS) approximately 320 330 motorcycles (consisting of motorcycles, quadrucycles and tricycles) were registered in South Africa on 31 July 2008⁵. This added up to 3.86% of the total number of self-propelled (all vehicles except human-powered and animal-drawn vehicles like bicycles and donkey carts) vehicles registered in South Africa at that time. Separate registration statistics for quad bikes alone are unavailable. It is important to realize that, since quad bikes are supposed to only be used off-road, they are usually not registered with the Department of Transport. The registration is made even more difficult by the large and informal second hand market. Lack of manpower and the vast areas of private land where these vehicles are used would make enforcing registration in South Africa an almost impossible undertaking.

The Road Traffic Management Corporation currently compiles data regarding all fatal road accidents in South Africa. Quad bike accidents and fatalities are however currently grouped with two-wheeled and three-wheeled motorcycles, under the general category of motorcycle accidents and fatalities. This is evident in the Road Traffic Report of the Road Traffic Management Corporation of March 2008⁶. This report states the number of vehicles involved in fatal crashes in South Africa between 1 April 2007 and 31 March 2008. The total number of motorised vehicles involved in such accidents was 14 877. Vehicles were subdivided as motorcars, minibuses, minibus taxis, buses, motorcycles, light delivery vehicles, trucks and other/unknown. Quad bike related fatalities were included in either the motorcycle or the "other" division. According to their data 305 motorcycles were involved in fatal crashes during this period. The unknown or other vehicle division consisted of 1398 vehicles. Data relating to quad bike accidents in South Africa are therefore hard to come by. In the USA data specifically related to ATV accidents have been recorded in trauma registries for many years instead of simply stating that injuries was caused by a motor vehicle accident. The US Consumer Product Safety Commission's National Electronic Injury Surveillance System also record data on accidents and injuries specifically related to ATV's.

In April 2007 an article appeared in the Afrikaans Sunday newspaper the *Rapport* regarding the death of a 9 year old boy who sustained fatal injuries in an accident on his 200cc quad bike⁷. A further article regarding the dangers of quad biking appeared in the same newspaper in August of the same year⁸. The article named 7 people who were killed in quad bike related accidents during the preceding 15 months (excluding the child mentioned in the previous article). The *Daily News* also reported on a 24 year old man killed in a quad bike accident⁹. In this case the person was riding his quad bike on a public road after dark and was not wearing a helmet at the time of the accident. Two more deaths were reported on in the *Rapport*¹⁰. In this case two boys aged 11 and 13 years old were riding on a quad bike together unsupervised and collided with a car on a busy public road. These are just some of the examples of quad bike related deaths in South Africa in the last two years.

According to the South African road safety agency, Arrive Alive¹¹, 5791 all terrain vehicle (ATV) related deaths have been reported in the United States of America (USA) since 1982. Of these victims 1846 were younger than 16 and 778 were under the age of 12. According to the same source, more than 500 000 children were injured by quad bikes between 1982 and 2002. Of even greater concern is that the number of injuries and deaths have been climbing every year since 1997. During 2002 alone, 113 900 injuries and 357 deaths were recorded in the USA. These data alone should serve as encouragement to South African quad bike users and dealers to create a climate of “safety first” while the market is still expanding.

One of the preventative safety measures mentioned is a kill switch. When attached to the rider’s wrist via an armband it automatically switches off the quad bike’s engine in the event that the rider’s hands come off the handlebars. A similar safety mechanism has been widely used by jetski and powerboat users for many years to ensure that their machines stop when the rider or skipper falls off. Although there is no hard evidence that kill switches decrease the incidence or severity of injuries sustained by quad bike riders it has been very effective in stopping runaway boats and jetskis from causing injury. Normal two-wheeled motorcycles will fall over and stop when the rider falls off, but like speedboats, four-wheeled quad bikes can keep going long distances before they run out of momentum or encounter a solid obstacle. This mechanism is not currently fitted as standard equipment on all quad bikes, but is an optional after-market feature. It must, however, be fitted to a quad bike participating in officially organised races.

Arrive Alive currently publishes the following guidelines for the safe use of quad bikes^{12,13}. Included in these guidelines are the following:

- Riders should not use alcohol before or during riding.
- If possible, riders should attend a quad school to learn basic riding techniques.
- Riders should wear protective kit, at least a SABS-approved helmet, but preferably also boots and a chest protector.
- Each rider should be aware of his/her personal limitations.

- Riders should keep safe following distances and be aware of other riders, children and animals.
- Riders must be aware of changing road and weather conditions.
- Riders should keep drinking water and avoid dehydration.
- Riders should keep a first aid kit with them and if possible attend a first aid course.

There is some published evidence on the specific injury patterns and characteristics of patients injured by ATV's internationally, but none of these studies were done in South Africa. If there has been a real increase in attendances at ECs in South Africa following quad bike accidents, it is important to understand the patterns of injuries that the attending physician may expect to see. Furthermore, by understanding the nature of the injuries and the population affected, one may design injury reduction strategies around this. These could include advertising campaigns and legislation for the general public and event organisers on quad bike use and safety equipment. Such data could also influence the future design of quad bikes and protective clothing.

CHAPTER 2

AIM

The primary aim of this study was to determine the specific injuries caused by quad bike accidents presenting at a private hospital setting within a largely rural population.

In order to achieve this aim, this study had the following objectives:

1. Describe the demographics of the injured population;
2. Determine the detail surrounding the events leading to injuries;
3. Describe the specific injuries seen in these patients

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CHAPTER 3

LITERATURE REVIEW

A literature review was undertaken using the following databases, which were accessed via the Pubmed platform:

Medline 1966 – present

Pre-medicine

Embase 1982 – present

In addition, databases of South African universities were searched along with the research website, www.sharingpoint.net, for unpublished research papers. All searches were repeated on the Google Scholar, google.com and yahoo.com websites.

Search terms included “quad bike”, “ATV”, “All Terrain Vehicle” and “quadbike”. The word “injury” was added and searches repeated.

Reference lists of retrieved articles were scrutinized for further relevant papers. The search was last repeated on 23 December 2008.

Thirty relevant articles were retrieved from the medical press.

CHAPTER 4

METHODOLOGY

i) Study design

This was a prospective study undertaken at the 24 hour Emergency Centre of a private hospital in the northern suburbs of Cape Town.

Permission was obtained from the head of the EC. Information relating to the study was posted at the EC and an educational session was undertaken at the start of the study to ensure that patients were appropriately identified and that data were collected correctly by doctors. This educational session was repeated regularly throughout the study.

ii) Selection of subjects

All patients who were drivers of quad bikes or passengers on quad bikes or bystanders injured by quad bikes and presented to the trial centre could be included in this study.

All patients not specifically injured by quad bikes were excluded.

Only patients willing to give informed consent for their participation in this study were included in this study.

iii) Collection of data

Data were collected using an anonymous questionnaire (Appendix A). No data collection took place without the patient's informed consent. After reading through the participant information leaflet (Appendix B), patients were given the opportunity to ask further questions to their attending medical staff and could then agree or decline further participation in this study. The information leaflet stated clearly to patients that agreeing or declining participation would not

affect their medical management. Neither the names of the patient, the hospital, or the attending doctor were recorded.

The participating EC has a high patient turnover and by limiting the questions on the questionnaire it was hoped that the extra workload on participating colleagues would be manageable. However, doctors were expected to answer as thoroughly as possible. As the questionnaires were completely anonymous it was impossible to contact patients or doctors at a later stage to complete unfinished questions.

Doctors were specifically asked not to allow data gathering to interfere with optimal patient care.

The principal investigator personally collected completed questionnaires from the participating EC where they were stored in a provided folder.

Signed patient consent forms were stored in a separate folder and not with completed questionnaires or in the patient's hospital folder. Again, this was to protect patients' privacy.

Data were collected for 16 months from 1 December 2006 until 31 March 2008.

iv) Outcomes measured

- The total number of male and female patients and the numbers in each age group seen with quad bike related injuries during the 16 month study period at our trial centre.
- The ages, mean age and different age groups of patients seen with quad bike related injuries.
- The number of accidents that occurred during organised races, recreational riding or occupational use.

- The number of injured patients that were wearing specific protective clothing (i.e. helmet, shoulder protection, motorcycling boots, etc.) at the time of their accidents.
- The total number of patients that had any formal training in quad bike handling prior to their accidents.
- The number of injured persons that were drivers, passengers or bystanders/ pedestrians.
- The specific injuries seen in these patients injured by quad bikes.

v) Data analysis

The data were stored on a Microsoft Excel database. Basic descriptive statistics, including mean and range, were analysed where appropriate.

vi) Ethics

This study adhered to the Declaration of Helsinki 2000.¹⁴

This study was completely anonymous. No space was allocated on the questionnaire for the names or addresses of the patients, the attending doctors or the EC involved. Doctors were instructed not to leave any patient identification data on the data collection sheets.

Doctors and patients took part out of free will, having given informed consent.

Participating doctors were not allowed to let the data collection process interfere with optimal patient care.

In this study no recommendations were made for the management of specific injuries.

The Research Ethics Committee of the Health Sciences Faculty of the University of Cape Town approved this project. (REC REF: 382/2006)

vii) Conflicts of interest

The author and clinical supervisors have no conflict of interest to declare.

viii) Funding

All costs for this study (excluding registration fees with the University of Cape Town for the MPhil EM degree) were borne by the principal investigator. This consisted of fuel, stationary, phone charges, printing costs, and statistician consultation fees.

The Durbanville Medi-Clinic private hospital contributed 50% of the principle investigator's registration fees for the MPhil EM degree with the University of Cape Town during 2006 and 2007. They did not however influence or recommend his choice of research topic.

CHAPTER 5

RESULTS

i) Total number of Emergency Centre patients

According to electronic records a total of 40 329 patients were seen at the EC in the 16 month period from 1 December 2006 until 31 March 2008. Of these 5649 (14%) were trauma cases and of these trauma cases 345 (6.1%) were as a result of motor vehicle accidents. Of the motor vehicle accident patients, 54 (15.6%) were recorded as having sustained quad bike related injuries. Daily EC records were hand searched by the principal investigator to ensure that no potential cases were excluded from the trial. No patient refused consent for their entry into this trial.

ii) Demographics

The group consisted of 38 males (70%) and 16 females. No quad bike injuries were excluded from the study. The youngest patient was a two year old male quad bike driver, while the oldest patient injured was a 57 year old female driver. The mean age of injured patients was 27.1 years. Fourteen patients (25.9%) were aged 13 or younger and would therefore be cared for in paediatric wards. Fifteen of the 54 patients (28%) were aged 10 to 15 years old (seven females). The highest number of patients [23 (42.6%)], were aged between 30 and 45 years old; 19 of the patients in this subgroup were male. The demographics are further outlined in figure 1.

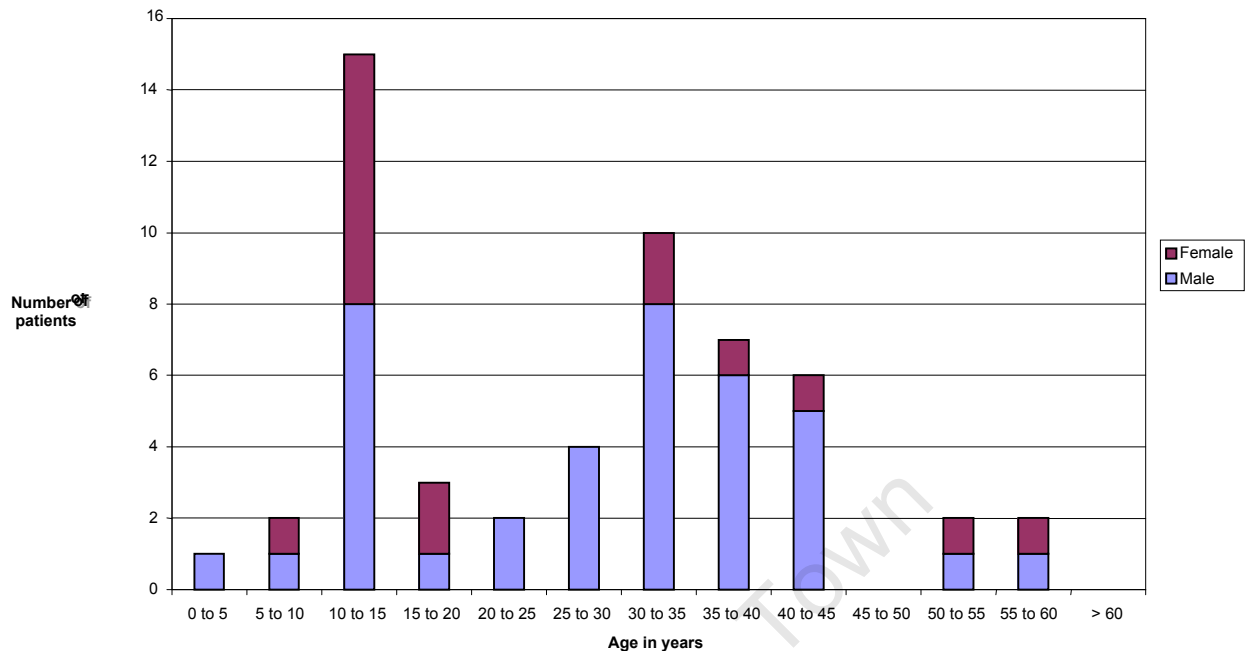


Figure 1: Demographics of patients injured by quad bikes (n=54)

iii) Accident circumstances

Fifty (93%) of the patients seen were drivers; four were passengers. No bystander injuries were recorded. A total of 20 patients (37%) were not wearing any protective clothing at the time of their accidents. The use of protective clothing is further detailed in table one on page 17.

Only 24 (44%) quad bikes were definitely equipped with kill switches while 27 (50%) were definitely not. Three drivers were unsure about the presence of such equipment on their bikes. Of all the patients seen, only two (4%) were injured while using their quad bikes for work, while nine (17%) were injured during an organised racing event. Most of the patients (79%) were injured while using their quad bikes for purely recreational purposes. Only eight (16%) of the 54 drivers stated that they had received any prior formal instructor-led training on quad bike riding.

Type of protective clothing	Number of patients
No protective clothing at all	20
Helmets	34
Goggles	26
Gloves	26
Motorcycling boots	19
Motorcycling shirt	17
Motorcycling trousers	16
Shoulder harness	16
Lower back support	12
Neck brace	2

Table 1: Use of protective clothing by 54 riders

iv) Injuries sustained

A wide variety of injuries were recorded, ranging from minor bruising of hands to splenic rupture. A total of 109 different injuries were recorded amongst the 54 patients (figure 1).

The total of 16 head injuries included three patients with concussion, nine with lacerations and four with bruises or abrasions. Only two neck injuries were recorded, both of which were minor soft tissue injuries. The only spinal column injury sustained by a patient in this study was a compression fracture of the fifth thoracic vertebra.

Seven back injuries were recorded comprising four lower back sprains, one middle back sprain and two abrasions. The only pelvic injury was a patients with bruising in his left gluteus region. See table two on page 18 for further detail.

Part of body injured	Number of injuries to body part
Arms	40
Legs	24
Head	16
Chest	14
Back	7
Abdomen	4
Neck	2
Spinal column	1
Pelvis	1

Table 2: Anatomical distribution of injuries

There were 14 chest injuries. These comprised of eight patients with bruises, three with rib fractures and three with abrasions. Abdominal injuries totalled four (three bruised left flanks and one ruptured spleen).

The body parts most frequently injured were the arms. There were 40 such injuries, equally distributed between the left and right arms. These included 13 fractures, eight ligament or muscle sprains, 13 soft tissue bruises and six abrasions.

There were 24 leg injuries. Interestingly, only five of these injuries were on the patients' left legs. There was one fracture and three ligament or muscle sprains, eight soft tissue bruises, two abrasions, one toenail avulsion and nine lacerations.

v) **Hospital admission and final disposition**

Hospital admission was necessary for 18 (33%) patients of which one person required treatment in the intensive care unit. All other admissions were to general surgical and orthopaedic wards. Reasons for admission are detailed in figure 2.

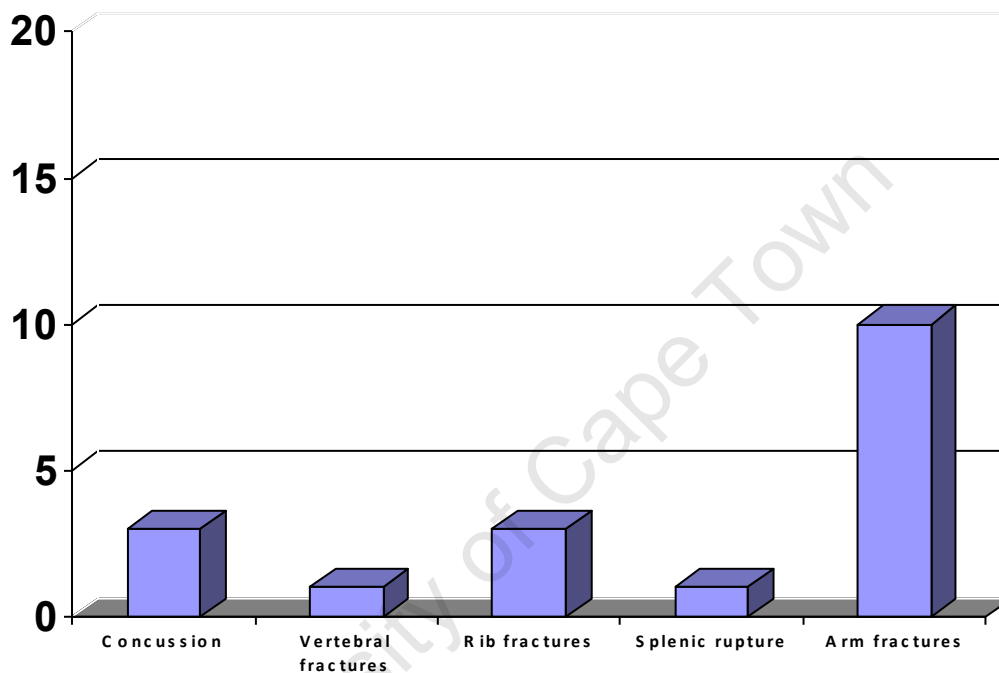


Figure 2: Reasons for hospital admission (n=18)

The four patients who sustained head injuries were admitted for neurological observation only. The patient who was admitted due to a vertebral fracture was admitted for analgesia and bedrest while a back support brace was being made. The patients admitted with rib fractures are those who required parenteral analgesia. The patients with splenic rupture required an emergency splenectomy. The patients who were admitted due to arm fractures all needed closed reduction or open reduction and fixation of their fractures under general anaesthesia.

All patients were discharged home from hospital. There were no fatalities and no-one needed to be transferred to other hospitals or rehabilitation centres before final discharge home.

CHAPTER 6

DISCUSSION

i) Findings

Although patients injured in quad bike related events only made up 54 of the total 40 329 (0.001%) patients seen at this EC during the 16 month period, a much better perspective of this number is reflected by the fact that it made up 15.6% of motor vehicle accident victims seen. On average 0.78 quad bike injured patients were seen per week over this period (one patient every nine days). A total of 18 patients were admitted to hospital with only one patient requiring ICU admission. Injuries that led to patient admission were arm fractures(10), head injuries(3), rib fractures(3), a vertebral fracture and one patient sustained splenic rupture.

Most of the injured patients (70%) were males. There are also two age related peaks. Fifteen of the 54 patients (28%) were aged between 10 and 15 years old (8 males). Twenty two (41%) of patients were between 30 and 45 years old (19 males). The reasons for the higher number of injuries in these two groups are unclear, but it certainly suggests that injury prevention strategies should be aimed at riders and in these two age groups. Injury prevention and rider education should also be more focussed on male riders.

Most (93%) of the patients were drivers of quad bikes. As stated earlier quad bikes in the study community are mainly used for recreational purposes and therefore it was not surprising that only two patients were seen after sustaining work related ATV injuries. Nine (17%) of the patients treated were injured during organised races. It is unclear what the ratio of racing versus recreational quad bikers is, but 4.8 times more recreational users were treated. During races, quad bikers ride at far greater speeds than usually achieved by recreational riders, but far more safety measures are in place. Riders are more experienced and must have had instruction on racing. Riders are obligated to wear all the safety equipment to be able to compete in a race. These include full-face helmets, goggles, shoulder and chest protectors,

motorcycle shirts and trousers with protective padding, neck and lower back braces and motorcycle gloves and boots. (However, only two of the nine riders injured in races however stated that they were wearing a neck brace.) Racing quad bikes must also be fitted with kill switches and a frame to prevent riders' feet from getting pulled under the quad bike's rear wheels if they come off the foot stays. Tracks are also specifically marked out for these races to ensure that they are clear of other traffic and dangerous unexpected obstacles like closed farm gates and fences.

A very large percentage of our population still do not even use basic safety equipment. Twenty patients (37%) were not wearing any protective clothing at the time of their accidents. The most commonly used safety gear was helmets and these were used by 34 (63%) riders. Goggles and gloves were used by 25 (46%) riders. Other safety gear was used by less than 34% of injured riders. At least half the accidents occurred with quad bikes not equipped with kill switches. The extent to which these mechanisms prevent injury is still unclear at this point. Proper driver training is unfortunately currently the exception rather than the rule. Only 16% of our study group stated that they had received proper instructor-led training prior to their accidents.

There is certainly huge room for improvement in the general safety behaviour of our study community and this should form a central part of any future injury prevention campaigns.

The primary aim of this study was to describe the specific injuries caused by quad bike accidents in a suburban private hospital with a large rural and farming community as part of its drainage area. Our data show that these patients sustained mostly soft tissue injuries such as lacerations, bruises, abrasions and sprains. Arm injuries were the most common and accounted for 36.7% of injuries sustained. Arm fractures also accounted for 55.6% of hospital admissions. Left and right arms were involved equally. The same could not be said for leg injuries which are also common (22% of total injuries), but 19 of the 24 leg injuries were recorded on the right leg. This could be explained by a recent study by Brandenburg et al¹⁵ which found right-sided rollovers to be a very common mechanism of injury when riders are

travelling on flat or uneven surfaces. Right-sided rollovers also happen more frequently with children than with adults. The reason for this is currently unclear, but it could be related to the lighter weight of children in general compared to adults. This will limit their ability to counter balance heavy quad bikes when they lean into corners at speed. Sixteen (of 109 injuries) head injuries were sustained (remember that this number includes soft tissue injuries involving the face and scalp). No serious head injuries were recorded with the worst cases being three patients who were kept in hospital overnight for neurological observation following mild head injury or concussion. Fourteen (of 109 injuries) chest injuries were tended to. Only one serious visceral injury (splenic rupture) was recorded.

ii) Available literature

When non-scientific internet search engines were screened using the search phrase “quad bike injuries” on 16 June 2008, 601 000 links were found using www.yahoo.com and 139 000 links using www.google.com for South African sites alone. Such a high number of related internet reports certainly suggest that quad bike injuries are a common occurrence at present.

The Arrive Alive website¹⁶ does suggest commonly sustained injuries to be fractures of wrists, forearms and ankles, while the most dangerous injuries are identified as spinal injuries, blunt or penetrating head, chest and abdominal injuries and pelvic fractures, but this is based on unpublished data.

There have been several publications in medical literature relating to quad bike injuries recently. Some of these articles do contain data relating to the types of injuries sustained, the demographic detail of the injured patients or the use of protective equipment by quad bikers.

Smith et al¹⁷ published a retrospective review of ATV related injuries between 1995 and 2003 at two level-one trauma centres in the USA. They found that 75% (compared to 70% in our study group) of their patients were male and the mean age of patients were 23 years. This is slightly younger but similar to the mean age of 27 years of our study population.

Severe injuries (Injury Severity Score ≥ 12) caused by quad bikes and treated at Dalhousie University Hospital in Canada were documented by Sibley et al¹⁸ over a five year period. They found that 92% of patients were males and 64% were between 16 and 34 years old (compared to 35% in our group). Central nervous system injuries comprised 39% of all major injuries. A very alarming finding was that only 16% of patients were wearing helmets at the time of their accidents (compared to 63% in our group). In the oldest article reviewed for our study Krane et al¹⁹ documented detail regarding 23 patients attending the Guthrie Medical Centre (rural level-two trauma centre) in Pennsylvania in the USA over 30 months (ending August 1986). Of the patients treated, 78% did not wear helmets. Their patients also sustained more serious injuries than we documented with two deaths, two cord transections with permanent disability and one below-knee amputation recorded. They recorded 11 cases of renal contusion while no such a case was documented in our study. The importance of helmet use is emphasized by a report of the Centers for Disease Control and Prevention in the USA in 1999²⁰. They found that about two thirds of ATV related deaths were from head and neck injuries. Consistent helmet use should therefore greatly reduce ATV related deaths. James et al²¹ did a comprehensive review of an estimated 58 254 patients treated at 1004 community hospitals in the USA between 2000 and 2004. Their results, published online in December 2007, state that 80% of patients tended to were men (compared to 70% in our small sample group) and 30% of patients were younger than 18 (compared to 35% in our group). Nine percent of patients recorded in this large review were passengers (compared to seven percent in our group). Contrary to our findings, they recorded more lower limb fractures compared to upper limb fractures. Fractures made up a total of 37% of all injuries in their study (22% being lower limb fractures). Data regarding 707 injuries were collected by Balthrop et al²² on patients seen at a level-one trauma centre in the USA between 1998 and 2003. They again showed that most patients were male (85%) and only 14.5% of patients were wearing helmets. Of the total number of injuries recorded, 45.1% were fractures. In their study, 26% of fractures were spinal fractures. This is probably not a true reflection of the incidence of fractures sustained by quad bike riders in general, but rather reflects the severity

of patients triaged and transferred to a level one trauma centre in the USA. Similar to our data they recorded more upper than lower limb fractures.

Several researchers have looked specifically at the impact that increased ATV use has on the paediatric population. Research by Cvijanovich et al²³ shows that the injury rate per 100 registered ATV's is significantly higher for children than adults (3.41 vs 1.71). Shults et al²⁴ reviewed an estimated 108 724 children up to and including 15 years old treated at hospitals in the USA between 2001 and 2003. Similar to our findings males between 11 and 15 years old made up 52% (compared to 44% in our group) of ATV related EC visits by children up to 15 years old. They state that children up to five years old are more likely to sustain facial injuries and older children are more likely to sustain lower trunk and lower limb injuries. Fractures were once again the most common diagnosis and were the reason for 45% of hospitalizations.

An 11 year review by Kute et al²⁵ of recreational ATV accident related injuries at a level one paediatric trauma centre in Kentucky, USA, once again confirmed low helmet usage. Only 16% of the patients they treated were wearing helmets at the time of sustaining their injuries. Fractures were the most common injuries sustained. Most fractures in their study involved the lower limbs 32.4% (66 of 204 fractures), while upper limb fractures and skull/facial fractures each made up 25% (51 of 204) of fractures seen. Of the 238 patients they admitted, 43 required intensive care unit admission. The injury severity in this study was significantly worse than those seen at our trial centre. This most likely reflects the severity of injuries sustained by patients that are transferred to level one trauma centres in the USA and not all injuries sustained by ATV riders in the USA.

We did not find specific review articles regarding cause of death during quad bike accidents, but the articles that did mention fatalities found that most are due to head injuries²⁶.

Deladisma et al²⁷ reviewed 6308 cases in the USA between 1989 and 2003 and found age older than 60 to be an independent predictor of mortality among ATV trauma patients. The oldest patient we treated was 57 years old.

According to Gabbe et al²⁸ quad bikes caused only one death out of 48 caused by recreational activities in Victoria, Australia, between July 2001 and June 2003. Most deaths in their study were due to drowning. Palmer et al^{29,30} mentions quad bike riding as one of the causes of occupational whole body vibration injuries. In South Africa however a very small percentage of quad bikes are used for occupational purposes. Most owners in South Africa buy quad bikes for informal recreational use. In the South African context forklifts, earthmoving and farming equipment and pneumatic drilling equipment are more likely to cause this type of injury.

ATVs have been mentioned in 11 original articles in the journal, *Injury Prevention* between March 1998 and December 2008. Warda et al³¹ wrote an original article in 1998 discussing ownership, access to three and four wheeled ATV's and safety behaviour by rural children in Manitoba, Canada. They found that inadequate use of protective clothing and rider training were major safety concerns. Ten years later our study still shows the same two shortcomings in injury prevention by quad bike users. The continued high incidence of injury amongst paediatric ATV users (despite educational efforts and regulations in Arkansas in the USA), prompted research by Aitken et al³² on the knowledge, practices and beliefs of children in an attempt to better plan injury prevention strategies. They recommend that safety awareness campaigns should clearly depict ATV injury risks and proper safety practices. The researchers also suggest that messages emphasising the consequences of dangerous riding would have the greatest impact on children. Ramsey et al³³ reviewed injury prevention as depicted in "General public" (G) and "Parental Guidance" (PG) rated movies between 1998 and 2002 where quad bikes and other recreational vehicles are used. The authors found that appropriate injury prevention practices were still infrequently depicted by 2002. They recommended that the entertainment industry should ensure that G and PG rated movies show proper safe ATV usage. Whether such recommendations were heeded should be the topic of a future study. ATVs are mentioned in a further seven brief reports, opinions or notes^{34,35,36,37,38,39,40} in the same journal during the same time period. All of these reports

express concern regarding the dangers of quad bike use, especially by children and the need for better safety legislation.

Results of a study published online by Rodgers GB⁴¹ in July 2002 suggests that helmet use reduces death from head injuries sustained during ATV accidents by 42% and could reduce the likelihood of nonfatal injuries involving the head by about 64%. Murphy et al⁴² found in their study on paediatric patients injured by ATVs that only four of 20 patients wearing helmets at the time of their accidents sustained head or facial injuries compared to 37 of 40 patients that did not wear helmets. The same investigators found that flipping or rolling was the most common mechanism of injury, as did Brandenburg et al (reference 15). Further investment and research into effective rollover protection devices could help to reduce ATV related injuries. One such design can be viewed on the World Intellectual Property Organization website⁴³.

No articles were retrieved from medical publications regarding the effectiveness of kill switches in reducing the incidence of injury or death during quad bike accidents.

In addition to the long list of safety equipment mentioned in our questionnaire newer designs like the BMW Motorrad neck brace system⁴⁴ are also available. The South African Bureau of Standards and AMID have urged manufacturers and importers of motorcycle helmets to submit all helmets for testing⁴⁵. All motorcycle helmets sold in South Africa should comply with SABS standard VC 8016. This 39 page document deals with all aspects of helmets' dimensions and their ability to absorb impact to protect motorcyclists. It also explains how the SABS tests new helmets.

Two articles were retrieved that compare injuries caused by ATVs to those caused by motorcycles. In a study by Acosta et al⁴⁶ the median injury severity score of patients injured by ATVs was 16 compared to 13 for those injured by motorcycles between April 2000 and November 2002. ATV injured patients had a higher incidence of head and neck injuries (56%) compared to motorcycle accident patients (30%), but the incidence of chest and abdominal

injuries were similar. Holmes et al also found that ATV injured patients had a higher incidence of maxillofacial injuries than patients injured in motorcycle crashes (32% versus 8% in their study group).

Yanchar et al⁴⁷ showed the inherent dangers of seeing powerful motorised ATV's as toys for children by comparing injury patterns and severity of injuries caused by ATV's to that caused by bicycles. Severe deep soft tissue injuries and fractures are more likely to result from ATV accidents than bicycle falls. ATV injuries are also more likely to be located in the truncal, hip, lower extremity and spine areas. This pattern is similar to that caused by motor vehicle and dirtbike accidents. Their findings highlight that, although quad bikes are often seen as toys when purchased by parents, these machines cause major injuries and have high cost implications for the Canadian healthcare system.

iii) **Limitations**

- 1.) Although we planned to involve several other hospitals in the Western Cape in this study, to increase the sample size, we failed to gain sufficient cooperation from such hospitals. This study was therefore limited by a smaller sample size which involved only the patients attending one trial centre. This did however allow for more accurate data collection and provided accurate statistics on ATV injuries at our trial hospital.
- 2.) Originally we wanted to include data from government forensic morgues (as stated in the approved research proposal). Unfortunately this proved an impossible undertaking. The current morgue delivery system in the Western Cape does not require entry of the specific type of motor vehicle accident in which the person was killed and the pathologist would not have been able to ascertain that the deceased had been involved in a from ATV accident. No deaths occurred amongst patients enrolled in our study group. Neither data regarding causes of death nor the numbers of people killed during quad bike crashes were therefore collected and no such data are currently available for South Africa. Several of the referenced studies suggest that

head injuries were the most common cause of death in their populations. Prospective data regarding quad bike related deaths in South Africa are needed and this could be the focus of a future study.

- 3.) Although three wheeled ATV's are no longer produced, several of the older studies referenced included data on both three and four wheeled ATVs and it is not possible to get data purely related to the quad bikes in these studies.

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CHAPTER 7

CONCLUSIONS

Although patients with quad bike related injuries account for a small amount of the total number of patients seen at this private emergency centre they formed a large percentage of the motor vehicle related trauma seen.

Males, especially between ages 10-15 and 30-45 are most often seen with injuries from quad bikes, both internationally and in South Africa. Most quad bikes in South Africa are used purely for recreational purposes. Most of the patients injured by quad bikes are the drivers themselves.

We were unable to collect data on causes of death from quad bike accidents in South Africa, but overseas data show that most ATV deaths in the USA are caused by head and neck injuries.

Arm injuries (left and right) were the most common injuries seen in our study. American studies reported more serious injuries in general and more serious head injuries. This might be due to the lower percentage of riders wearing helmets or due to the fact that most of these studies are run at level one trauma centres which handle serious trauma cases. There are no published data from community hospitals, which would be equivalent to our study site. The above data has shown that quad bike accidents can lead to morbidity and mortality, yet in our study only one serious visceral injury (splenic rupture) and one serious spinal injury (compression fracture) was recorded over the 16 months of our study.

Although this study was limited by a small sample size some very obvious shortcomings in the current use of quad bikes were identified.

The two most important and basic current shortcomings are lack of instructor-led rider training and the fact that even basic protective gear like helmets, which have been proved to reduce morbidity and mortality in quad bike accidents, are often not used. Although the rate of helmet use by our patients was considerably better than those reported by American studies, a rate of 100% must be our goal. AMID encourages their members to adhere to these and several other safety measures in their code of conduct which is available on the internet⁴⁸. The American Medical Association is currently seeking action from federal government in the United States⁴⁹ to regulate these two aspects of safety. Enforcing these two simple steps will obviously pose a problem in the large informal second hand market. The French Commission of Consumer Safety investigated quad bike safety in depth in 2000 and again in 2006⁵⁰. They made the same two basic recommendations, but further advised the setting of specific product standards for quad bike manufacturers to adhere to. Only 17% of accidents recorded happened during organised races where drivers race at speeds far greater than achieved by the normal recreational quad bike user, but during these races the use of all protective gear (listed in table one) is compulsory, drivers are experienced and the route is especially set out for use by quad bikes.

Quad bikes should not be seen as toys for children and serious injury is much more likely to occur from quad bike accidents than those caused by bicycle. The risk of serious injury by quad bikes is greater among children than adults.

Studies in the USA have shown that quad bikes cause more serious injuries than motorcycles and also cause more head, maxillofacial and neck injuries.

Only about half the quad bikes were equipped with kill switches. The fitment of these switches as standard equipment may reduce injuries or their severity.

CHAPTER 8

RECOMMENDATIONS

Based on this small study, the following suggestions are made:

1. Sellers of quad bikes should:
 - a) Not hand over quad bikes to the purchasers before he or she has completed a proper riding course.
 - b) Ensure that buyers have the proper protective equipment available for all the intended users of the quad bike when they take ownership of it.
 - c) Guide buyers correctly regarding the appropriate size and engine power of quad bikes for the intended user.

2. Purchasers of quad bikes should:
 - a) Always at least wear a helmet when riding an ATV, but ideally all protective gear available on the market should be worn.
 - b) Always complete an instructor-led course on quad bike riding before using a quad bike unsupervised.

3. National government should:
 - a) Aim preventative strategies at the two subgroups mostly involved in accidents. These are males and females between 10 and 15 years old and males between 30 and 45 years old.
 - b) Should separate statistical data related to quad bike accidents and deaths from those related to other motorcycles to help guide specific regulations for safe quad bike use.

- c) Put regulations in place to prevent children from unsupervised quad bike use, even on private land.
 - d) Enforce current laws forbidding the use of quad bikes on public roads, pavements and parks.
4. The medical fraternity should:
- a) Aim preventative strategies at the two subgroups mostly involved in accidents. These are males and females between 10 and 15 years old and males between 30 and 45 years old.
 - b) Always expect limb injuries and especially arm fractures when they examine and treat patients with quad bike related injuries.
 - c) Be aware that head and neck injuries are the main causes of death from ATV accidents.
 - d) Establish and contribute to a larger national database on quad bike related injuries and deaths to guide future regulations and laws for safe quad bike use.
5. Manufacturers should:
- a) Support and invest in new safety designs like rollover protection devices.
 - b) Depict safe riding styles when advertising their products.

A larger prospective study on quad bike related injuries and deaths in South Africa is required to strengthen or refute these suggestions.

Word count excluding appendices: 7393.

Word count excluding references: 9087.

APPENDICES

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APPENDIX A

QUESTIONNAIRE

1. Your age _____

Questions 2 to 8: Please circle correct answer.

2. Gender Male Female

3. Were you

- A the driver of a quad bike?
- B a passenger on a quad bike?
- C a bystander hit by a quad bike?

4. If you were the driver or a passenger, did you wear any specific protective gear or clothing?

Yes No

5. If answer YES, in question 4, please circle items from list below.

- A Helmet
- B Goggles
- C Motorcycling shirt
- D Motorcycling trousers
- E Shoulder and upper back protection harness
- F Lower back protection ("kidney belt")
- G Motorcycling boots
- H Gloves
- I Other
Please specify: _____

6. Was the quad bike equipped with a kill switch (mechanism by which engine is automatically switched off if rider falls from bike)?

Yes No

7. Did the accident occur while quad bike was being used for

- A recreational purposes?
- B work (other than professional quad bike racing)?
- C an organized race?

8. If you were the driver of the quad bike, have you had any formal training from a qualified instructor prior to the accident?
- Yes No

Questions 9 and 10 must be completed by the attending doctor

9. Hospital admission? Yes No

If yes, admitted to: Normal ward High Care ICU

Please answer question 10 by circling the body part/s (head, neck, spinal column, chest, abdomen, pelvis, arms and legs) injured and the type of injury. Then, only complete further detail of involved body part. Please be as specific as possible regarding injury type (eg. not just clavicle fracture, but displaced, oblique fracture of lateral third of clavicle).

10. Please give details of all the injuries incurred by injured or deceased person. (Also please state cause of death, if known.)

DECEASED? YES NO

If yes, give primary cause of death, if known:

HEAD: Concussion Cerebral contusion Cerebral Haemorrhage

Fracture/s? Yes No

If yes, give detail:

Soft tissue or muscular injury detail (bruise, sprain, abrasion, laceration, etc):

Further detail or injury type not mentioned above:

NECK (soft tissue, not spinal column): Bruise

Sprain

Abrasion

Laceration

Further detail or injury type not mentioned above:

SPINAL COLUMN: Fracture: Yes No

If yes, give detail (vertebra/e involved and type of fracture):

Ligament injury: Yes No

If yes, what intervertebral disc space/s involved? _____

Neurological injury: Yes No

If yes, give detail

Further detail or injury type not mentioned above:

CHEST: Rib fracture/s? Yes No

If yes, give detail:

Sternum fracture? Yes No

If yes, give detail:

Soft tissue or muscular injury detail (bruise, sprain, abrasion, laceration, etc):

Pneumothorax? Yes No

If yes: Left Right
Haemothorax? Yes No

If yes: Left Right
Lung contusion? Yes No
If yes: Left Right
Pericardial tamponade? Yes No
Cardiac contusion? Yes No

Further detail or injury type not mentioned above:

ABDOMEN: Soft tissue and muscular injury detail (bruise, sprain, abrasion, laceration, etc)

Organ injury: Liver _____
 Spleen _____
 Stomach _____
 Kidney _____
 Bladder _____
 Bowel _____

Further detail or injury type not mentioned above:

BACK (soft tissues, not spinal column): Bruise

Sprain

Abrasion

Laceration

Further detail or injury type not mentioned above:

PELVIS: Fracture/s? Yes No

If yes, give detail: _____

Detail of soft tissue injury (bruise, sprain, abrasion, laceration, etc):

Further detail or injury type not mentioned above:

ARMS (including shoulders and hands):

Left: Fracture? Yes No

If yes, give detail (bone/s involved and type of fracture):

Detail of soft tissue injury (bruise, sprain, abrasion, laceration, etc):

Right: Fracture? Yes No

If yes, give detail (bone/s involved and type of fracture):

Detail of soft tissue injury (bruise, sprain, abrasion, laceration, etc):

LEGS (including hips and feet)

Left: Fracture? Yes No
If yes, give detail (bone/s involved and type of fracture):

Detail of soft tissue injury (bruise, sprain, abrasion, laceration, etc):

Right: Fracture? Yes No
If yes, give detail (bone/s involved and type of fracture)

Detail of soft tissue injury (bruise, sprain, abrasion, laceration, etc):

ANY FURTHER INJURY DETAIL:

THANK YOU VERY MUCH FOR YOUR ASSISTANCE WITH THIS PROJECT.

PLEASE PLACE COMPLETED FORM IN THE FOLDER PROVIDED AT YOUR UNIT.

Thank you
Gys van der Westhuizen

APPENDIX B

PATIENT INFORMATION LEAFLET

QUAD BIKE INJURIES AND INJURY PREVENTION OPPORTUNITIES

Principal investigator: Dr G van der Westhuizen

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SOUTH AFRICA

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Dear Sir/Madam

I would like to enlist your help in gathering information for this study. Please take some time to read through this short information leaflet explaining the aims of this study and how you could be involved. If you have any further questions please do not hesitate to ask your attending doctor or contact me on above telephone number.

What is this project all about?

Quad bike riding has become a very popular pastime and emergency units across the country have seen an increase in serious, even fatal, injuries related to their use.

The ultimate goal of this study is to make quad biking safer, without ruining the fun. We will be determining the kind of injuries caused by quad bikes and the characteristics of the people injured. This information can hopefully be used to protect quad bike users in various ways, eg design of protective gear.

You have been asked to take part in this study because you have been involved in a quad bike accident. We will aim to question as many patients as possible in your unfortunate position until approximately the end of March 2008. All the collected information will then be analysed and used to complete my dissertation for a master's degree in emergency medicine from the joint faculties of the Universities of Cape Town and Stellenbosch.

What is your role?

Your participation only involves the answering of 8 simple questions. Your doctor will then fill in the details of the injuries you incurred to complete the questionnaire.

YOUR NAME, CONTACT DETAILS OR ANY OTHER IDENTIFIABLE INFORMATION WILL NOT BE DOCUMENTED ON THE QUESTIONNAIRE. THE COMPLETED QUESTIONNAIRE WILL NOT BE STORED WITH YOUR MEDICAL NOTES. IN THIS WAY NO ONE WILL BE ABLE TO IDENTIFY OR CONTACT YOU AT A LATER STAGE.

We make no recommendations regarding the medication or treatment you receive from the medical staff attending you. As stated above, the aim of this study is future injury prevention.

Your participation in this study is completely voluntary and you are free to withdraw from it at any stage. Your doctor will not allow this study to interfere with your optimal medical care. Your refusal to take part in this study will certainly not influence the quality of the medical care you receive.

This study has been approved by the Research Ethics Committee of the Health Sciences Faculty of the University of Cape Town.

Unfortunately you will not be paid for your participation. We do trust however that you will reap the benefits of safer quad biking in the future.

IF YOU AGREE TO PARTICIPATE, PLEASE WRITE YOUR NAME AND SIGN BELOW.

This consent form will be stored separately from your questionnaire and will not be kept in your hospital folder, to protect your confidentiality.

IF YOU DO NOT WISH TO PARTICIPATE, SIMPLY TELL THE MEDICAL STAFF AND DISCARD THIS FORM WITHOUT WRITING YOUR NAME OR SIGNING.

I _____ hereby agree to take part in the study named Quad bike injuries and injury prevention opportunities. I fully understand the information given in this leaflet. I also understand that my participation is completely voluntary and refusing or agreeing to take part in this study will not influence my optimal medical management.

Signed at _____ on _____ 200_

Signature (Patient or Legal guardian) _____

Signature of witness _____

Thank you very much for your time/participation and all of the best for a speedy recovery.

Dr Gys van der Westhuizen

APPENDIX C

ABBREVIATED CURRICULUM VITAE OF PRINCIPAL RESEARCHER

Dr Gysbert van der Westhuizen

General practitioner in full time private practice at the Emergency Centre of Durbanville Medi-Clinic since September 2004.

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Matriculated: Citrusdal High School in 1993

Tertiary education: MBChB degree from The University of Stellenbosch in December 1999.

Postgraduate: Commenced M Phil in Emergency Medicine 2006.

Certificate courses: ACLS, 2001, 2004
APLS, 2002
ATLS, 2004
Wound management, 2005
Aviation Medicine, 2006
Disaster Medicine, 2006

Work experience:

Internship: Grey's Hospital, Pietermaritzburg, KwaZulu-Natal, 2000.
Secondary referral hospital
Rotations through Internal medicine, general surgery, anaesthetics and obstetrics and gynaecology.

- Community service: Itshelejuba Hospital, near Pongola, KwaZulu-Natal, 2001.
Primary care rural hospital
- United Kingdom: Royal Devon and Exeter Hospital, Exeter, Devon 2002 – 2003.
Three star NHS academic hospital.
Worked mostly in department of medicine, rotating through general medical, gastro-enterology, oncology and elderly care wards as well as a specialist stroke unit and the Emergency Medical Unit.
- Private practice: Locum medical officer at the Emergency Centres of several Medi-Clinics (Louis Leipoldt, Constantiaberg, Durbanville and Milnerton) in the Western Cape, South Africa from January to August 2004.

University of Cape Town

APPENDIX D

CONTACT DETAILS OF CLINICAL SUPERVISORS

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