

The burden of firearm injuries at two district level Emergency Centres in Cape Town, South Africa: a descriptive analysis.

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This study is in partial fulfilment of the requirements for the degree Masters of Medicine in the Faculty of Health Sciences at the University of Cape Town

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Abbreviations

CHC	Community Health Centre
COCT	City of Cape Town
DALY	Disability Adjusted Life Years
EC	Emergency Centre
EMS	Emergency Medical Service (pre-hospital service)
GBD	Global Burden of Disease
HEC	Heideveld Emergency Centre
MPH	Mitchells Plain Hospital
PHC	Primary Health Care
SATS	South African Triage Scale
TEWS	Triage Early Warning Score
WHO	World Health Organisation
YLD	Years Lived with Disability
YLL	Years of Life Lost

PART A: Literature Review

The literature review broadly describes the global firearm injury burden and then more narrowly focuses on the South African firearm mortality burden, discussing it within the context of the high proportion of interpersonal violence. Thereafter the literature is reviewed in the context of non-fatal firearm injuries and this is followed by a closer review and discussion of predominantly the international literature as it provides insight in certain aspects of firearm assault and injury that may be beneficial in the South African context.

Aims and objectives

To review the international and South African literature regarding firearm injuries and the burden in terms of mortality and that placed on health services for non-fatal injury.

Search strategy

A search on the Pubmed Database was performed on the 5th September 2020 with the following search strings.

1. (Firearm) AND (South Africa) ("firearms"[MeSH Terms] OR "firearms"[All Fields] OR "firearm"[All Fields]) AND ("south africa"[MeSH Terms] OR ("south"[All Fields] AND "africa"[All Fields]) OR "south africa"[All Fields])
2. (Trauma Burden) AND (Cape Town) ("injuries"[MeSH Subheading] OR "injuries"[All Fields] OR "trauma"[All Fields] OR "wounds and injuries"[MeSH Terms] OR ("wounds"[All Fields] AND "injuries"[All Fields]) OR "wounds and injuries"[All Fields] OR "trauma s"[All Fields] OR "traumas"[All Fields]) AND ("burden"[All Fields] OR "burdened"[All Fields] OR "burdening"[All Fields] OR "burdens"[All Fields]) AND ("Cape"[All Fields] AND ("cities"[MeSH Terms] OR "cities"[All Fields] OR "town"[All Fields]))
3. (Firearm) AND (Cape Town) ("firearms"[MeSH Terms] OR "firearms"[All Fields] OR "firearm"[All Fields]) AND ("Cape"[All Fields] AND ("cities"[MeSH Terms] OR "cities"[All Fields] OR "town"[All Fields]))

4. (Firearm) AND (Burden) ("firearms"[MeSH Terms] OR "firearms"[All Fields] OR "firearm"[All Fields]) AND ("burden"[All Fields] OR "burdened"[All Fields] OR "burdening"[All Fields] OR "burdens"[All Fields])

Search results were scanned for relevance based on the title and abstract and any duplicates were removed. Articles were limited to English and international articles to those published in the last 10 years. South African articles were also limited to English and to those published in the last 20 years. The full text article was then interrogated for relevance and the reference lists of the included articles were also interrogated and further relevant studies included.

The Global burden of firearm injuries

Worldwide in 2016 an estimated 251 000 deaths (or 5.4% of all injury-related deaths) were due to firearm injuries.(1) There is wide variation between regions and even within adjacent countries as to the total burden of interpersonal violent injury mortality and the proportion of this represented by firearms. Overall, in 2016 41% of interpersonal violence deaths were due to violence by firearm, an increase of 5.7% since 2006. (1)

As described in the World report on Violence 2002, firearm injury can be categorised into unintentional and intentional. Intentional injuries are as a result of violence, which is further defined as, *"the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, that either results in or has a high likelihood of resulting in injury, death, psychological harm, maldevelopment, or deprivation."*(2) Violence is subdivided into three broad categories according to who commits the violent act: interpersonal (individual or small group), self-directed or collective violence (state or organised group).(2) Globally, an estimated 64% of firearm related deaths result from interpersonal violence. (3)

The majority of global firearm deaths occur in young men, aged 20-24 years (4) and whilst mortality data gives an idea of the magnitude of this burden, there are many more injury survivors who are left with life-long disabilities and long-term psychological effects as a result of their injuries.(4,5)

The Global Burden of Diseases, Injuries and Risk Factors study 2016, estimated that worldwide there were 1.5 million hospital admissions for interpersonal violence with a further 28 million being managed as outpatients.(6) The study also noted that in contrast to a worldwide decrease in interpersonal violence between 1990 and 2013, the Sub-Saharan Africa and Oceania regions have seen an estimated 50% increase in disability adjusted life-years (DALY), associated with increasing interpersonal violence.(6) Over 40% of interpersonal violent injury disability adjusted living years occur in the age group 15-29 years.(7) Furthermore these interpersonal violence DALY measures do not consider the possible long-term mental health consequences of this violence.(4)

Although these DALY estimates relate to all interpersonal violent injury it is likely that a significant proportion of those injuries sustained are due to firearms.

Firearm injuries in South Africa

In South Africa, injuries are the second-leading cause of loss of healthy life and interpersonal violence dominates the South African injury profile.(8) A nationally representative sample of injury-related mortality in South Africa estimated that 48.6% of all injury related deaths were intentionally inflicted and that firearms were involved in 25% of these intentionally inflicted deaths and 12% of all injury related deaths.(9) South African estimates for firearm related deaths decreased from an age standardised mortality rate of 13.1 per 100 000 in 1990 to 7.1 per 100 000 in 2016 (3), and Matzopoulos et al attribute some of this trend to the Firearms Control Act of 2000.(10,11) Further evidence to support the decline in firearm injury related deaths comes from the largely rural Transkei region of South Africa, where a review of 23 years of autopsy data (27 936 unnatural deaths) found a decline in firearm-related death, from 29 per 100 000 of the population in 1993 to 12.8 per 100 000 in 2015.(12) In 2015, 14.8% (3935) of unnatural deaths arriving at the forensic services in the Transkei region were due to firearm injuries.(12)

In the City Cape Town within the Western Cape region of South Africa, the firearm-related homicide, age standardised mortality rate decreased markedly from 52.5 per 100 000 in 2001 to 31.5 per 100 000 in 2013.(13) Over this period there was also a marked reduction in the age specific mortality rate for male firearm-related homicide in the peak age group of 20 - 24 years in City of Cape Town suburbs of Khayelitsha, Klipfontein and Mitchells Plain.(13)

However, since 2013 there has been a 7.8% year on year increase in murders in the Western Cape region (2013 – 2542 murders; 2019 – 3974 murders), and although in 2016 the reported murder rate for the Western Cape was 51.7 per 100 000 people, communities such as Philippi East, in the Cape Town metropole, recorded a murder rate of 247 per 100 000 people.(14) This is 40 times the estimated global murder rate of 6.1 per 100 000 people.(15) The South African National Department of Health provided statistics for the number of bodies arriving at state mortuaries by province in the period 2010 to 2015. Significantly in the Western Cape in 2015, firearm-injured bodies outnumbered motor vehicle accident and stabbing injured bodies.(16)

Research within the health sector does provide sporadic and very localised data points as to the non-fatal injury burden, but there is no formal surveillance data of non-fatal injuries generally(17), or specifically documenting the significant number of non-fatal firearm injuries within the Western Cape and the City of Cape Town.

In South Africa, the National Injury Mortality Surveillance System (NIMSS) has an important role in monitoring and reporting injury mortality(8). Although it has been argued that because of the limitations in the NIMSS dataset, that the South African Police statistics regarding firearm mortality ought to be accepted as reflective of reality(18), it is likely that a many non-fatal firearm injuries are not reported to the police and so non-fatal firearm police statistics are likely not an accurate reflection.

More to the point, as Ward et al point out, *“many injuries do not result in death, and until a comprehensive injury surveillance system is established, part of the picture will be missing.”*(19) They also suggest that, *“the health system can provide surveillance systems that assess the extent of violence, which are crucial to monitor interventions and to determine their efficacy.”*(19) . A survey of

hospital superintendents in 1999 estimated that 1.5 million cases of trauma were seen at secondary and tertiary level hospitals annually and that more than half of these were from violent injuries.(20) Regular and consistent health service data can be used to supplement the available mortality data to achieve a better appreciation of the burden.(19)

A District Health Information System (DHIS) has been in operation nationally since 2000, relying on information officers at facilities on a weekly basis to manually capture the required data variables from paper-based registries at healthcare facilities.(21) There are no clear estimates as to what the current firearm injury numbers presenting to facilities are, but a 2005 study estimated that 127 000 firearm injured patients present to South African healthcare facilities per annum.(22)

In 2012, a 3-month pilot of additional trauma related variables were added to the DHIS in the KwaZulu-Natal (KZN) region and in June 2012 these variables formally adopted in KZN.(21) The KZN data from April 2013 to March 2014 was presented in 2016 by Lutge et al. and whilst the authors do highlight deficiencies around the completeness and quality of the data, the review indicated that 27% (197 219) of all hospital emergency centre visits (N = 723 142) were as a result of trauma with 45% of this trauma intentional. Firearm injuries constituted 2% (3562) of all trauma and 0.5% of the total presentations and 2.4% of all hospital admissions in KZN were trauma related. As the authors note the DHIS is not a trauma registry, but that it does manage to collect data that helps quantify the burden of trauma in the region. They also mention that, *“there is no comparative system in the rest of the country at this time to compare these results with.”*(21)

A pilot study at a district hospital in Cape Town attempted to implement a reporting system for South Africa's National Non-fatal Injury Surveillance System (NANFISS). Significant challenges were faced, concluding that the intervention was not sustainable. They highlighted the *“lack of institutionalisation and local investment”*, particularly in oversight, training, and instituting protocols. They also comment that *“data collection was regarded as research and conducted ad hoc”*.(23)

In South Africa, and Cape Town specifically, there is limited healthcare research available to inform hospitals, local government and civil society of the impact of firearm injuries that goes beyond mortality data. Most of the available research describing the local burden of non-fatal firearm injuries has been conducted at tertiary hospitals.

In Groote Schuur Hospital, a tertiary trauma centre in Cape Town, over a 16-month period (2010-11) Schuurman et al. documented 378 firearm injuries, with 90% of those injured male, accounting for 4.5% of all trauma admissions and 12.9% of all intentional injuries.(24) They also specifically highlighted an *“association between violence, young males, substance use, and weekends.”* (24) This timing of injury presentation, after hours and at weekends, is repeated again and again through the literature.(24–28) This has implications for unit resourcing and system planning.

At Tygerberg Hospital, another tertiary referral centre in Cape Town, a study examining the cost involved with care, included 128 firearm injured patients admitted for more than 12 hours.(29) Eighty-seven percent of those with firearm injuries were male, with an average age of 28 years and most presenting on weekends and between 7pm and 7am. With many of those injured shot more than once, they determined that 59% of patients had firearm wounds to their torso, 16% to the head and neck, and 76% extremity injuries (arms and legs). They attempted to determine the cost of care but were unfortunately limited by not being able to include the pharmaceutical, laboratory or staff salary

costs. Despite these significant excluded costs, the average minimum inpatient cost per day in 2006 was ZAR2 832 (\$US385), and with the average length of stay at 5.8 days, the minimum cost per patient was determined at ZAR15 598 (\$US2 230).(29) Adjusting for South African inflation and at a current currency conversion the minimum cost would be ZAR6 113 (\$US428) per day.

Multiple other South African studies look at certain specifics of non-fatal firearm injuries at tertiary hospitals. Martin et al. looked at the burden of firearm injuries on orthopaedic healthcare resources(30) and Kong et al. at the spectrum of injuries related to the use of firearms in car hijacking(31) and civilian cerebral injuries(32).

The healthcare burden of non-fatal firearm injuries

There is currently no South African injury surveillance system in place. Very little information is available to describe the distribution and details of the burden faced by healthcare services dealing with firearm injuries. Most studies at a district level document the trauma burden within the total disease burden(25,26,33,34) or document the trauma burden, in type of trauma and number on these district services(24,27) or prehospital services(35).

To motivate for a change to what and how data is captured and provide surveillance of injury type and other characteristics, Govender et al. in 2010 piloted a simple trauma surveillance tool at a primary healthcare emergency centre in Cape Town.(36) It was found that 70% of trauma cases that presented were due to violent injury and 47% of trauma patients were suspected of being alcohol intoxicated. Of these potentially intoxicated and injured patients, 87% had injuries due to interpersonal violence. The authors also note that the 2-week data collection period included the last weekend of the month, when many people are paid, and that this may have influenced the proportion and type of trauma seen.(36) It is unclear as to whether there have been any further sustained attempts at surveillance at this primary care facility or similar facilities in the region.

In a two-year (2016/17) retrospective chart review, Aspelund et al. evaluated trauma scoring systems in firearm injuries at a district level hospital in Cape Town.(28) They analysed 331 out of 405 patients who presented with firearm injuries to determine which trauma scoring system most accurately predicted mortality. Most firearm-injured patients presented on the weekend, with 96% of them male and 56% aged 18-29 years. The majority of firearm injuries were to the extremities, with most deaths due to abdominal injuries and the highest risk of death in those with injuries to the neck. The study found that none of the trauma scores were superior in predicting mortality, although they were limited by the low number of deaths, which was their primary outcome.(28)

International literature, focusing on the hospital burden of firearm injuries, almost universally conclude by emphasizing the significant burden that firearm injuries place on healthcare resources.

In a cohort of 308 children and adolescents (<18 years), who had sustained gunshot wounds, presenting to three trauma centres in Colorado USA, 52% of those injured required an operation, 21% received at least one unit of blood and 7% required a massive transfusion (defined as >40ml/kg of blood products).(37) There was a readmission rate for complications at 30 days of 11.6% and 14% of

those injured followed up with psychiatric services at one year. After controlling for multiple factors, those associated with a higher cost of care were shotgun injury and the need for explorative laparotomy. The researchers emphasized the *“immense burden of disease”* and long-term sequelae.(37)

A single centre cross-sectional study of firearm injured patients presenting to a Level I trauma centre in St Louis, USA documented 1226 firearm injuries over a 2-year period (July 2014-June 2016).(38) The trauma centre sees in excess of 95 000 patients per year and so this 1226 is approximately 0.65% of all patients seen and equates to 613 firearm injuries per year during the period. 88% were male, with median age of 26 years and 48% of patients had prior contact with the health care system for traumatic injury before their index firearm injury. Within the study period, of those surviving to discharge, 3% returned with another firearm injury within the next year. The authors note that this is likely an underestimate as data from other hospitals was not available. 47% of the patients were discharged from the ED, with 22% transferred to the operating theatre, 18% to the ward and 7% to the ICU. 4% of patients died in the ED with a further 3% dying in either the ICU or operating theatre. In what is a repetitive theme across studies the authors conclude, *“ED visits for traumatic injury represent an opportunity to provide social work, case work, and counselling-based interventions to help disrupt the cycle of violence in high- risk individuals.”* (38)

In contrast to such high numbers of firearm injuries, research at a London major trauma centre over a seven-year period (January 2010 - December 2016) identified, a total of 182 firearm injured patients.(39) Even with such relatively low numbers, the authors conclude that firearm *“injuries place a significant burden on hospital resources.”* The 182 injuries were out of a total of 939 331 emergency admissions, equating to 0.019% of admissions and just 26 firearm injuries per year. Males comprised 97.8% and the median age was 22 years. Sixty-seven percent required specialist operative intervention and 61% suffered only superficial or musculoskeletal injury. Of the 182, thirty-five (24%) were admitted to ICU and ten (5.5%) patients died. Disposition from the emergency department to theatre and ICU were 17% and 8.8% respectively. (39)

The two tertiary level trauma centres in Cape Town, Groote Schuur and Tygerberg Hospitals are not located in areas with the highest firearm incidence.(40) Their referral district level facilities have limited radiological and surgical support, with no onsite blood bank and no high acuity or intensive care wards. Patients presenting to a district level service that require a higher level of care are transferred to the above tertiary facilities. This strategy is supported by Renson et al who investigated the mortality related to interfacility transfer of firearm injured patients from the National Trauma Data Bank in the United States of America (USA).(41) They compared the outcomes of 62 227 patients, of which 10 968 were transferred to a higher level of care. In their analysis the relative risk of mortality for transferred patients was lower than those not transferred (risk ratio [RR] 0.81, 95% confidence interval [CI] 0.70 to 0.95, $p = 0.011$), suggesting that transfer to a higher level of care outweighs the potential harm of transfer.(41)

To ensure that firearm injured patients are managed at facilities that can deal with the injuries sustained, early and appropriate transfer to these facilities is necessary. Prehospital services are well positioned to make such decisions, but when patients arrive at facilities that are not capacitated for managing firearm injuries, then interfacility transfer to a higher level of care may be necessary. This is likely more apparent in the South African context where the resources necessary to manage

moderate to severe injuries are often concentrated at distant tertiary facilities. Establishing clear evidence-based prehospital triage guidelines and optimising early interfacility transfer of those requiring urgent surgical intervention may improve outcomes.

Newgard et al. used USA and Canadian EMS data to compare severe firearm, stabbing, assault, or motor vehicle collision injury mechanisms, by event characteristics, location, timing, and outcome and their primary sample of 2079 persons included 506 (24.3%) patients injured by firearm.(42) They completed a geospatial analysis, describing it as unique, as it linked EMS pick up location to home address on the hospital record. They found that 53.9% of stabbings and 49.2% of firearm injuries occurred within 1.6km of the patients' home address. Seventy percent of firearm injuries occurred between 16h00 and 4h00 with a similar finding for stabbing and assault. The researchers concluded that severe firearm and stabbing injuries often occur at home or within the same neighbourhood and that the firearm injured patients had more significant serious anatomic injury, required more resources in their care and had the highest mortality when compared to the other injury mechanisms.(48)

It is highly likely that in Cape Town many of those sustaining interpersonal violent injury, and firearm injury specifically, are injured near home. With surgical resources located in facilities often distant to the injury location, facilities located near areas with a high incidence of firearm injury need to have the resources available to assess, stabilise and manage or transfer when necessary. Considering this, there is an argument to direct resources towards EMS and to local district hospitals where many of these patients may present and give clear guidance as to their management either at the presenting facility or facilitate early transfer to a tertiary centre.

Future direction for South African firearm injury related research and intervention

There is very limited research in other high incidence countries that goes beyond just describing the injury pattern, mortality, or short-term burden of disease, and whilst this may be of interest, it has little value in understanding the impact of firearm injuries on society and healthcare resources in South Africa and where resources should be deployed to reduce the burden and mitigate effects.

Recognising South Africa's competing interests for limited resources, further local research is necessary to inform relevant public health and policy makers of the resources required in managing the burden of firearm injury as part of the larger violent injury burden. For the agenda of firearm injuries to compete with other interests, a 'clear picture' is required of the impact that firearm injuries have on healthcare resources and society. This may provide support for further high-value research into other aspects of firearm injury neglected in the local evidence base.

Unfortunately, there is no local research available detailing the rate of violent injury recidivism; short-, medium- or long-term mortality after surviving violent injury; the physical or mental health sequelae following a violent injury; or the investigation into any primary intervention that reduces the number

of violent injuries or secondary strategies that may alter the effects of a violent injury on those that present at any level of the health service.

Although the healthcare resources that the majority of South Africans access are comparatively different to that in the international literature, this literature provides some insight that may be beneficial in the South African context. Most of this research originates from the United States of America (USA) where the firearm age standardised mortality rate is 12.0 per 100 000.(3) Despite this research originating out of the USA, the country also lacks a national surveillance system for non-fatal firearm injuries. When looking at the association of firearm laws with firearm outcomes in children and adolescents, Zeoli et al noted that the lack of such a surveillance system hampers research specifically looking at policy effects and that it is not clear as to which strategies, beyond limiting access to firearms, are most effective at reducing occurrence or impact of firearm injury.(43)

International research into firearm injury includes: the firearm injury burden; the factors associated with recidivism, the progression from non-firearm assault to firearm assault; the increased subsequent risk of violent death after surviving a violent injury; some aspects of the long term physical and mental health consequences; and policies that may reduce the burden of injury.

Even in resource rich countries many aspects of firearm injury research have been neglected. As Ranney et al. point out in their scoping review of the evidence regarding the prevention of behavioural and physical health sequelae in youth, most studies (45%) focused on mass shootings that account for <1% of youth firearm deaths in the USA, and that only 16% of studies looked at firearm assault, which contribute to 53% of youth firearm deaths.(44) The authors also note the lack of evidence as to the best practice in preventing negative behavioural and mental health consequences, with often little evaluation of mental health beyond PTSD.(44) Ngo et al. after reviewing primary prevention strategies in the USA between 1985 and 2018, lament the fact that there is a lack of evidence-based programmes that reduce the morbidity and mortality due to firearm injuries amongst the youth.(45)

Despite the above concerns voiced by researchers, the evidence available does generate several themes relating to risk factors for firearm injury, mortality, morbidity and recidivism.

Firearm injury has been shown by several studies to be a risk factor for subsequent mortality. In a paediatric population (0-16 years) in California, an inspection of death registration data revealed that assault by any means (firearm or non-firearm) was an independent risk factor for long term mortality.(46)

In another study also from California, Fahimi et al. aimed to calculate the 5-year mortality, after surviving to hospital discharge, following a firearm injury.(47) The risk of death following firearm injury, motor vehicle collision or assault without firearm over the following five years was calculated to be higher in those who sustained a firearm injury. Homicide was the cause of death in 79.2% of firearm injured patients who died after surviving their initial injury. The researchers concluded that in their population *“firearm injury exposure is an important predictor of death within 5 years and most pronounced in the first year after injury”*.(47)

Rowhani-Rahbar et al. compared the risk for subsequent violent injury, death, or crime perpetration among patients with a firearm related hospitalisation (FRH), to those hospitalised for non-injury reasons and the general population in Washington, USA.(48) In their population the researchers

found that patients with an index FRH were 30 (CI: 14.9 to 61.0) times more likely to have a subsequent FRH and 7.3 (CI: 2.4 to 22.9) times more likely to die of a firearm-related death when compared to the general population.(48)

In their paper titled the Long-term Functional, Psychological, Emotional, and Social Outcomes in Survivors of Firearm Injuries, Vella et al noted that although there is research in the USA detailing the mortality and costs attributed to firearm injuries, there is a paucity of data as to the long-term outcomes for those who survive.(49) In their research they telephonically contacted a cohort of firearm injury survivors at a median of 5.4 years post their initial injury. The responses were scored on eight PROMIS (Patient-Reported Outcomes Measurement Information System) instruments and found a decrease in employment, increased combined alcohol and substance use, and mean scores below the population norm for Global Physical Health ($P < 0.001$), Global Mental Health ($P = 0.03$), and Physical Function ($P < 0.001$). Furthermore 48.6% of those contacted screened positive for probable PTSD. Although the cohort of those contacted was relatively small (183) they concluded that: *“Survivors of GSWs may have negative outcomes for years after injury. These findings suggest that early identification and initiation of long-term longitudinal care is paramount.”* (49)

Data describing recidivism and escalating violence is also available from the USA. A prospective cohort of youth aged 14-24 with a recent history of drug use who presented following an assault were compared to a proportionally sampled group of drug-using non-assaulted youth.(50) The high-risk youth, presenting to urban emergency departments for assault, had elevated rates of subsequent firearm violence. Predictors of subsequent firearm violence include male gender (RR = 1.51), assault-injury (RR = 1.35), firearm possession (RR = 1.23), attitudes that favour retaliation (RR = 1.03), Post Traumatic Stress Disorder (RR = 1.39), and a drug use disorder (RR = 1.22). The researchers advised that, *“Interventions at an index visit addressing substance use, mental health needs, retaliatory attitudes, and firearm possession may help decrease firearm violence among urban youth.”*(50)

Looking at the transition into and out of firearm assault among drug using youth, predictors have also been identified. Those predictors with an increased hazard ratio of transition into firearm assault were non-firearm peer violence (HR = 2.31; 95% CI 1.28-4.21) and firearm victimisation (HR = 2.57; 95% CI 1.31-5.04).(51) Further to this, delinquent peer association, that is non-firearm violence and substance use, hastened transition into firearm assault (HR = 1.19; 95% CI 1.00-1.40) and slowed transitions out of firearm assault (HR = 0.84; 95% CI 0.72-1.00) The authors conclude that *“programs focusing on peer influence and social norms may be effective in reducing the rate of transition”*. Attitudes favouring retaliation also hastened the transition into firearm assault. The authors suggest that to prevent firearm assault initiation, services should focus on those who *“report firearm violence victimisation.”*(51)

In the article Trauma Recidivism and Mortality Following Violent Injuries in Young Adults, Kao et al. reported an injury recidivism rate of 24.9% in those who sustained a violent injury over a 7-year period (2009-2015).(52) 14.9% had two trauma admissions and 8% had greater than three. Of subsequent injury admissions, 37% of recidivists presented with non-violent injuries and 13.8% were related to a suicide attempt or suicidal ideation. They additionally found that patients living in areas below the median income were more likely to return with a second traumatic injury. Once again, the authors similarly conclude that, *“improved medical, psychological, and social collaborative treatment of these high-risk patients is needed to interrupt the cycle of violent injury.”* (52)

The high rates of recidivism for violent injury and progression from non-firearm assault to firearm assault may well be mirrored in South African communities. The factors influencing this progression are also likely similar in the context of Cape Town, where a proportion of this violent injury and firearm violence is gang-related and potentially drug-related too. As Goldstick et al. indicated those who are victims of firearm violence may transition into firearm assault themselves and that delinquent peer association (non-firearm violence and substance use) and attitudes favouring retaliation also hasten this transition(51). These features are likely present in the local gang-culture and attitudes of retaliation are also seen in the retributive justice often favoured in some of the affected communities.

In Cape Town there is certainly the potential for hospital-based interventions or strategies to be put in place that attempt to alter this trajectory. Most studies recommend a multipronged approach, including strategies related to injury prevention and better follow-up for these patients.(37)

Should we choose not to intervene we must accept that as de Anda et al. express, "*Violence begets violence.*"(38)

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PART B: Manuscript in article format for submission to Injury Journal

The burden of firearm injuries at two district level Emergency Centres in Cape Town, South Africa: a descriptive analysis.

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Abstract

Introduction

Firearm injuries account for an increasingly significant portion of violence related trauma experienced in South Africa. The related burden on district level emergency care, surgical and inpatient services is poorly described. This research aims to provide epidemiological and health service data on patients sustaining firearm injuries presenting at Mitchells Plain Hospital and Heideveld Emergency Centre. The research also assesses the association of the Triage Early Warning Score with anatomical location of injury, the need for surgical intervention and mortality. A geographical analysis of incident location with respect to home address has also been undertaken.

Methods

All patients who presented to these emergency centres with a firearm injury over a 12-month period (1 Jan 2019 – 31 Dec 2019) were eligible for inclusion in a retrospective chart review.

Results

Seven-hundred-and-seventy-six firearm injuries were analysed with those injured having a mean age of 27 years and 91% of those injured male. Sixty-seven percent of patients self-presented and there were 18 deaths in the emergency centre and a further 23 as an inpatient. The Triage Early Warning Score and Shock Index both showed statistical significance when comparing those not surviving to hospital discharge against those that did survive ($p < 0.01$).

Discussion

Firearm injuries represented 5.7% of all trauma seen at these two facilities and likely form a higher proportion of the injury profile than at other district services in the City of Cape Town. Although a significant number of those injured are transferred out to tertiary centres that are better capacitated to manage these injuries, many remain at district level for their care.

Conclusion

Firearm injuries, the immediate surgical needs of those injured and the long-term consequence of those injuries pose a significant burden on limited healthcare resources. Multi-sectoral action, supported by evidence-based primary and secondary preventative strategies, is required to reduce this intentional injury burden, and mitigate the effects.

Highlights

- 776 firearm injuries representing 5.7% of all trauma seen
- 28.6% of those injured required transfer out to a higher level of care
- 112 of those admitted at Mitchells Plain required theatre
- The Triage Early Warning Score and Shock Index were statistically significant for those not surviving to discharge

Introduction

Worldwide in 2016 an estimate of 251 000 deaths or 5.4% of all injury-related deaths were due to firearm injuries, with 41% of interpersonal violence deaths due to violence by firearm, a 5.7% increase from 2006 levels.(1) In 2016 there were an estimated 1.5 million hospital admissions for interpersonal violence, with a further 28 million managed as outpatients. Whilst there has been a global decrease in interpersonal violence between 1990 and 2013, the Sub-Saharan and Oceania regions have seen an estimated 50% increase in interpersonal violence disability adjusted life-years (DALY).(2)

In South Africa, injuries are the second-leading cause of loss of healthy life, and interpersonal violence dominates the South African injury profile (3). An estimated 49% of all injury related deaths in South Africa are intentional and firearms are involved in a quarter of these deaths.(4) Between 1990 and 2016 the South African firearm age-standardised death rate declined from 13.1 to 7.1 per 100 000 (1,5), with some of this decline attributable to the Firearms Control Act of 2000.(4,6) Since 2013 there has been a 7.8% year on year increase in murders in the Western Cape region of South Africa with communities such as Philippi East, in the Cape Town metropole, recording a murder rate of 247 per 100 000 people(7). This is more than 40 times the estimated global murder rate of 6.2 per 100 000 people.(8)

In 2015 firearm-injured bodies outnumbered motor vehicle accident and stabbing injured bodies arriving at mortuaries in the Western Cape region of South Africa(9), and of those murdered in the Western Cape in 2018/2019, 46% died as a result of a firearm injury.(10) The South African National Injury Mortality Surveillance System (NIMSS) has an important role in monitoring and reporting injury mortality(3), but as Ward et al, point out, *“many injuries do not result in death, and until a comprehensive injury surveillance system is established, part of the picture will be missing.”* They also suggest that, *“the health system can provide surveillance systems that assess the extent of violence, which are crucial to monitor interventions and to determine their efficacy.”*(11)

An attempt at implementing South Africa's National Non-fatal Injury Surveillance System (NANFISS), at a district hospital in Cape Town concluded that it was not sustainable(12). Beyond mortality data and without adequate injury surveillance, the available firearm injury literature is further limited in scope and depth. Hospital specific studies document the total trauma burden within the total disease burden(13–16) or document the trauma burden (17,18), or those presenting to prehospital services.(19) Patients that are referred on to higher levels of care are often incompletely documented as there is little co-ordinated research between facilities. Specific firearm injury data is largely limited to tertiary hospital services(17,20–23), with some of these having limited scope.

This study aims to provide evidence as the burden of this injury profile and the outcomes of those injured at these district facilities.

Methods

Study design

This is a descriptive study following a retrospective chart review describing the injury burden related to firearm injuries at two district level facilities in the Cape Town metropole.

Study setting

Mitchells Plain Hospital (MPH) is a large district level hospital about 30 kilometres from Cape Town and the nearest trauma centre and tertiary hospital. It has around 300 beds and serves a population of approximately 600 000. Sixty-two percent of Mitchells Plains' population is younger than 29 years of age with 48% of households living below the poverty line and only 43% of the working age population employed.(24) The reported violent crime rate is 1930/100 000 people (24) and MPH drains the Mitchells Plain sub-sections as well as Philippi, that has a murder rate of 247 per 100 000 people.(7)

Heideveld Hospital (HEC) is an emergency centre and a short-stay admission ward in Heideveld, approximately 20km from Cape Town. Communities adjacent to Heideveld have deeply entrenched gangs and much of the violent crime is related to inter-gang warfare and control of the local drug trade.(10) The MPH and HEC emergency centres

are district level services, with a management team including four specialist emergency physicians, seeing a combined total of 68 000 patients per annum – approximately 60% being of high acuity.

Patients seen at the MPH Emergency Centre, depending on the level of care required, may be admitted to MPH or be referred to the tertiary hospital. MPH has operating theatres and during office hours has onsite two fulltime general surgery consultants and one anaesthetic consultant. Outside of office hours a medical officer or registrar manages cases with a consultant on call from home. MPH has no after-hours CT scan service, nor does it have a high-acuity or intensive care unit. As there is no surgical support service or advanced radiology onsite, patients at HEC with trauma requiring admission or operative care are referred to either MPH or the tertiary hospital. Neither facility has an on-site blood bank, with only limited O-positive and negative packed red cells and Freeze-Dried Plasma immediately available for transfusion.

Study participants

Convenience sampling was used to include all patients who presented to these emergency centres with a firearm injury over a 12-month period (1 Jan 2019 – 31 Dec 2019). Down referrals from a tertiary centre, duplicated cases, non-powdered gunshot wounds, cases with incomplete data or incorrect icd-10 coding data were excluded from the sample.

Data collection and content management

The data collection procedure involved two phases. The first phase comprised of exporting demographic, triage and Emergency Centre process data for all patients with firearm injuries from the HECTIS (Hospital and Emergency Centre Tracking Information System) registry by performing an ICD-10 search (X93-95, W32-34, X72-74) or triage descriptor (Gun, GSW, GWS).

Phase 2 involved the collection of clinical details from the Electronic Content Management system (ECM) database at MPH, or by scrutinising patient folders at HEC.

MPH and HEC utilise an electronic patient tracking and registration system called HECTIS. It was designed to streamline and track patient processes in the emergency centre, by collecting patient process times, triage scores, ICD-10 diagnosis assigned at disposition and disposition plans. The data is stored electronically in an off-site Oracle database version 12.1.0.2.0 (Oracle Corp., USA).

ECM and patient folder data were collected to separate spreadsheets, then combined for analysis. Age categories >18 year were selected as per standard WHO guidelines with adolescents 13-17 year. The childhood age group was divided 0-5 and 6-12.

Incident location and home address, where available, were retrieved from ECM to allow geospatial analysis.

Statistical analysis

Descriptive statistics are used to describe the demographics and clinical details of patients. Categorical data is presented as frequency counts and proportions and non-random associations are assessed with the Chi² test. The Shapiro-Wilk test was applied to determine the age category distribution from the mean. Weekends were defined as Saturday and Sunday, after hours care between 16h and 8h and time data presented as h:mm. Data was analysed with SPSS Statistics Version 26.0 (IBM Corp. 2019. Armonk, NY: IBM Corp.) and geospatial analysis, using ArcGIS® software by Esri, presented as a heatmap. Distributions of other variables are presented as two-way tables or bar charts and continuous variables as medians and their interquartile range.

Ethical considerations

This study was performed without any patient involvement and patient care was in no way affected. A waiver of consent was granted by the University of Cape Town Human Research Ethics Committee (UCT HREC 044/2020). Facility approval was granted via the National Health Research Database (WC_202002_029).

Results

MPH and HEC emergency centres attended to a total of 49 577 and 18 051 emergency visits respectively during the study period, of which 9 629 (19%) and 4 035 (22%) were trauma related. Of the trauma related presentations, 565 (5.9%) and 286 (7.1%) were because of firearm injuries respectively and therefore eligible for inclusion. Of these 851 presentations after removing duplicates, repeat presentations, cases with no notes, incorrectly coded firearm and non-powdered gunshot injuries and cases missed or lost in the data collection process, the final sample for analysis included 776 firearm injured patients – 501 from MPH and 275 from HEC.

Table 1: Demographical and arrival details of all patients with firearm injuries (n=776)

	n (column%)	Mitchells Plain Hospital		Heideveld Hospital		Total	
		n=501	%	n=275	%	n=776	%
Gender	Male	455	90.8%	251	91.3%	706	91.0%
	Female	46	9.2%	24	8.7%	70	9.0%
Age categories (years)	0-5	4	0.8%	2	0.7%	6	0.8%
	6-12	8	1.6%	4	1.5%	12	1.5%
	13-17	35	7.0%	29	10.6%	64	8.3%
	18-25	154	30.7%	93	33.9%	247	31.9%
	26-35	182	36.3%	97	35.4%	279	36.0%
	36-45	77	15.4%	32	11.7%	109	14.1%
	46-55	32	6.4%	14	5.1%	46	5.9%
	56-65	8	1.6%	2	0.7%	10	1.3%
	>65	1	0.2%	1	0.4%	2	0.3%
Arrival Type	PHC referral via EMS*	58	11.6%	6	2.2%	64	8.2%
	PHC referral with own transport*	1	0.2%	0	0.0%	1	0.1%
	Metro EMS from scene	152	30.3%	23	8.4%	175	22.6%
	Private EMS from scene	2	0.4%	1	0.4%	3	0.4%
	SAPS**	7	1.4%	5	1.8%	12	1.5%
	Self-presenter	280	55.9%	240	87.3%	520	67.0%
	Other	1	0.2%	0	0.0%	1	0.4%
Transported via EMS	From PHC	58	27.4%	6	20.0%	64	26.4%
	From scene	154	72.6%	24	80.0%	178	73.6%

Percentages may not add up to 100% because of rounding

*PHC Primary health care; EMS Emergency Medical Services

**South African Police Service

Demographics and process data

The age distribution was skewed to the right with a Shapiro-Wilk $p < 0.001$. Table 1 indicates that 91% (714) were male and the median age of those injured was 27 years (IQR 21-34). Eleven percent (89) were less than 18 years old with 2.3% (18) under the age of 13. Sixty-seven percent (520) of patients made their own way to hospital with 31.2% (242) arriving by ambulance, either from the incident or transferred from a community health centre.

Seventy-four percent (581) presented outside of normal working hours or at weekends with presentations on weekends accounting for 43.2% (340) of all presentations (figure 1). There was no temporal increase related to public holidays above the median of 2 (IQR 3) firearm injuries per day. The maximum at MPH on an individual day was 14 and 6 at HEC. The median emergency centre process times were arrival to triage 0:16 (IQR 0:31), triage to consultation 1:03 (IQR 3:09) and arrival to exit 8:00 (IQR 8:48). Figure 2 shows the 2019 monthly distribution.

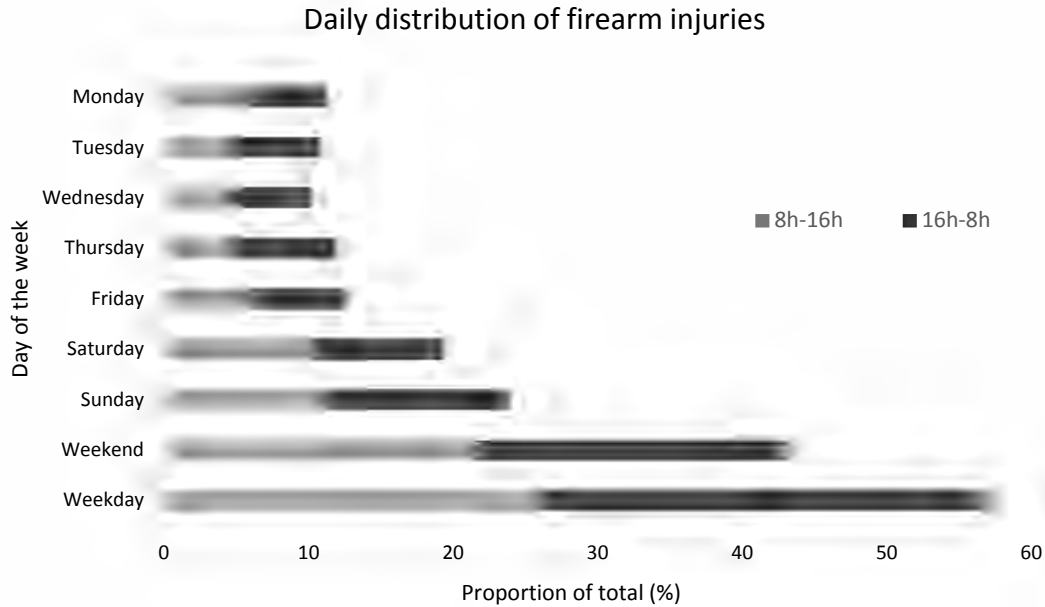


Figure 1: Daily distribution of firearm injuries per day of the week

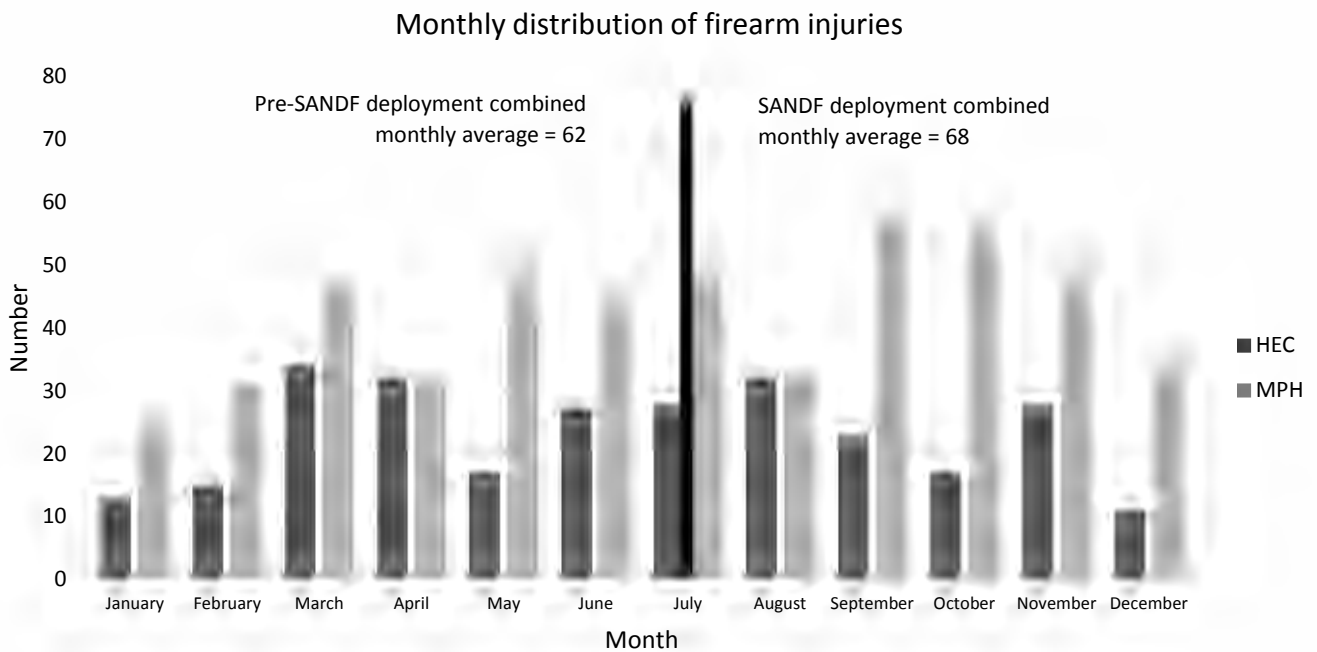


Figure 2: Monthly distribution of firearm injuries in relation to SANDF deployment on the 17th of July 2019

Geospatial data

The home suburb or subplace was determined for 593 patients, generating the heatmap in the figure 3. There were 52 records available where the distance between the home address and incident location could be accurately recorded from ambulance record on ECM. Including those injured at home, the median incident distance from home was less than 1km.

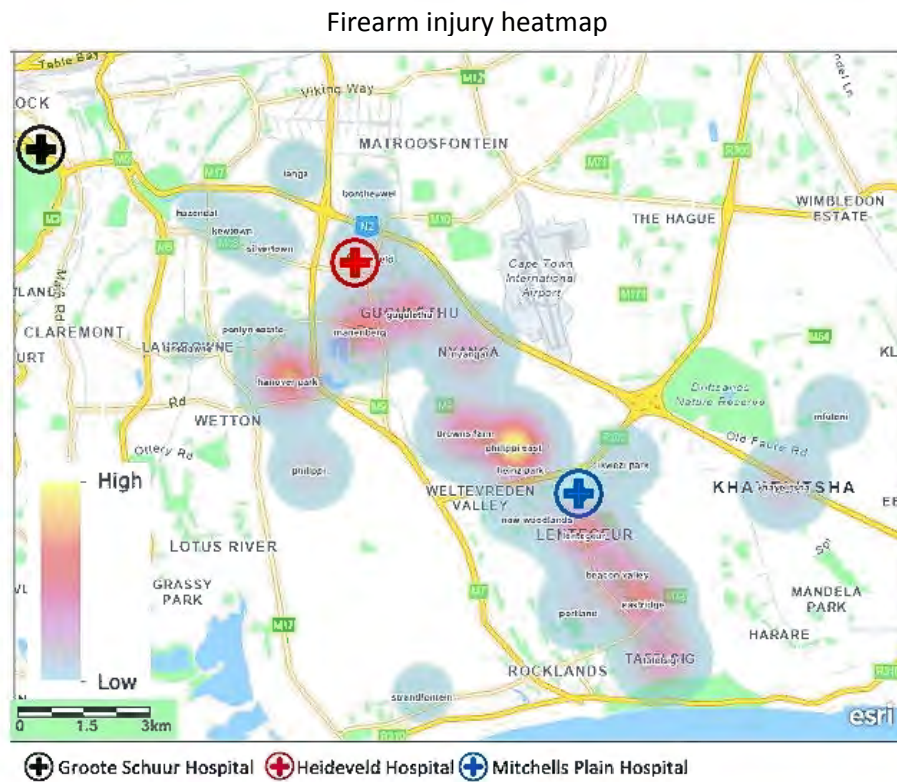


Figure 3: Firearm injury heatmap by home suburb or subplace (n=593)

Clinical and outcome data

In determining the anatomical wound location (Table 2), 595 (483 MPH, 112 HEC) records out of the 776 patients were included (see limitations). Of these 595 patients, 30.4% sustained more than one firearm injury, with 13.7% sustaining a head or neck injury, 22.4% a chest, 21.5% an abdominal and 66.9% an extremity injury.

Two percent (18) of patients died in the EC and of those that survived to EC disposition (749), 41.6% (313) were discharged home, 29.7% (224) were transferred out and 22.2% (167) admitted to a ward at MPH. In total 55.3% (417) required an admission to hospital beyond their EC care or following transfer to the tertiary centre trauma unit. Four percent (30) of patients required an admission to ICU. Over a third of the MPH patients were referred to surgery and almost one in five to orthopaedics. Only theatre details of those patients managed at MPH were available to the research team and 49 patients, representing 9.5% of those patients that presented to MPH EC went directly from the EC to theatre. A total of 112 patients at MPH required at least one theatre visit. Of those admitted to MPH, 1 died in the ward and 3 in theatre. There were a further 19 deaths at referral facilities. Total deaths were 41 or 5.3% of all patients who arrived alive and almost a third of those admitted to ICU died (Table 3).

Except for RED triage colour category where the proportion was similar, the Triage Early Warning Score (TEWS) and South African Triage Scale (SATS) colour categories showed marked variation in the proportion categorised to each colour code (Table 3). GREEN and YELLOW accounted for 18% of those triaged by SATS and 64% of TEWS triage categories. Despite this variation there were no deaths in those triaged in these less urgent categories by TEWS. The TEWS and SATS RED categories were statistically significant for those patients not surviving to discharge ($p < 0.005$), whereas the inverse i.e. patients surviving to discharge was significant for the SATS ORANGE category ($p < 0.005$). The TEWS numeric score and the Shock Index (SI – heart rate divided by systolic blood pressure) were both also statistically significant for those not surviving to discharge ($p < 0.005$).

Table 2: Comparison of triage characteristics, anatomical injury location, and emergency centre disposition (n=776)

		Mitchells Plain Hospital		Heideveld Hospital		Totals	
n (column%)		n=501	%	n=275	%	n=776	%
SATS Category*	Green	4	0.8%	7 A	2.5%	11	1.4%
	Yellow	70	14.0%	60 A	21.8%	130	16.8%
	Orange	350	69.9%	174	63.3%	524	67.5%
	Red	77	15.4%	34	12.4%	111	14.3%
AVPU	Unresponsive	24	4.8%	11	4.0%	35	4.5%
	Pain	7	1.4%	6	2.2%	13	1.7%
	Voice	15	3.0%	4	1.5%	19	2.5%
	Alert	455	90.8%	252	92.3%	707	91.3%
Mobility	Normal for age ^s	10	2.0%	5	1.8%	15	1.9%
	Stretcher/Immobile	268 B	53.5%	60	21.8%	328	42.3%
	Unable to move as normal ^s	0	0.0%	1	0.4%	1	0.1%
	Unable to walk as normal ¹	2	0.4%	1	0.4%	3	0.4%
	Walking	131	26.1%	92	33.5%	223	28.7%
	Walking Aid	23	4.6%	13	4.7%	36	4.6%
	With help	67	13.4%	103	37.5%	170	21.9%
TEWS Category**	Red	74	14.8%	31	11.3%	105	13.5%
	Orange	115	23.0%	58	21.1%	173	22.3%
	Yellow	199	39.7%	123	44.7%	322	41.5%
	Green	113	22.6%	63	22.9%	176	22.7%
Firearm injury location ¹	Head	69	13.8%	13	11.6%	82	13.7%
	Chest	107	22.2%	26	23.2%	133	22.4%
	Abdomen	106	22.0%	22	19.6%	128	21.5%
	Extremities	321	70.5%	77	68.8%	398	66.9%
	Multiple	145	30.1%	36	32.1%	181	30.4%
Hospital outcome ²	MPH Surgical consult	190	38.4%	2	0.7%	192	24.7%
	MPH Orthopaedic consult	91	18.4%	4	1.5%	95	12.2%
	Transferred to tertiary	105	21.2%	114	41.9%	219	28.6%
	Theatre MPH	109	22.0%	3	1.1%	112	14.4%
	ICU	25	5.1%	5	1.8%	30	3.9%
	Died total	28	5.7%	13	4.8%	41	5.3%
	Died in EC	10	2.0%	8	2.9%	18	2.3%
	Died in ward at MPH	1	0.2%	0	0.0%	1	0.1%
	Died in theatre at MPH	3	0.6%	0	0.0%	3	0.4%
	Died at tertiary facility	14	2.8%	5	1.8%	19	2.5%

Percentages may not add up to 100% because of rounding

*South African Triage Scale; **TEWS Triage Early Warning Score

§Paediatric metrics

¹Firearm injury location: MPH n=483 and HEC n=112 for Total n=595 (see limitations)

²Hospital outcome: MPH n=495 and HEC n=272 for Total n=767 (see limitations)

A statistically significantly higher proportion at HEC than at MPH (p<0.05)

B statistically significantly higher proportion at MPH than at HEC (p<0.05)

Table 3: A summary of factors impacting survival in patients with firearm injuries (n=767)

		Survival to hospital discharge				P value	
		No		Yes			
		n (row%)	n=41 (5.4%)	n=726 (94.6%)			
Sex	Male	36	5.2%	661	94.8%	0.483	
	Female	5	7.1%	65	92.9%		
Age Category	0-5	1	16.7%	5	83.3%	0.025	
	6-12	1	8.3%	11	91.7%		
	13-17	2	3.2%	60	96.8%		
	18-25	14	5.7%	231	94.3%		
	26-35	11	4.0%	267	96.0%		
	36-45	8	7.6%	97	92.4%		
	46-55	1	2.2%	45	97.8%		
	56-65	3 B	30.0%	7	70.0%		
	>65	0	0.0%	2	100.0%		
SATS Category*	Green	0	0.0%	11	100.0%	<0.005	
	Yellow	0	0.0%	130	100.0%		
	Orange	10	1.9%	514 A	98.1%		
	Red	31 B	30.4%	71	69.6%		
TEWS Category**	Red	31 B	32.3%	65	67.7%	<0.005	
	Orange	10	5.8%	163	94.2%		
	Yellow	0	0.0%	322	100.0%		
	Green	0	0.0%	176	100.0%		
TEWS Score: median (IQR)		8 (4)		4 (2)		<0.005	
Shock Index: median (IQR)		0.92 (0.47)		0.72 (0.18)		<0.005	
Firearm injury location	Head	Yes	8 B	9.8%	74	90.2%	0.031
		No	22	4.2%	502 A	95.8%	
	Chest	Yes	11 B	8.3%	122	91.7%	<0.005
		No	9	2.0%	452 A	98.0%	
	Abdomen	Yes	12 B	9.4%	116	90.6%	<0.005
		No	8	1.7%	458 A	98.3%	
	Extremities	Yes	9	2.3%	389 A	97.7%	0.027
		No	10 B	5.9%	159	94.1%	
Multiple	Yes	11 B	6.1%	170	93.9%	0.015	
	No	9	2.2%	404 A	97.8%		
Theatre at MPH	Yes	9 B	8.0%	103	92.0%	<0.005	
	No	9	2.4%	368A	97.6%		
Admission to tertiary ICU	Yes	9B	30.0%	21	70.0%	<0.005	
	No	9	1.9%	455 A	98.1%		

Percentages may not add up to 100% because of rounding

*South African Triage Scale; **TEWS Triage Early Warning Score

§ Mann-Whitney U; IQR Interquartile range

A statistically significantly higher proportion than corresponding *No Survival to hospital discharge* category ($p < 0.05$)

B statistically significantly higher proportion than corresponding *Yes Survival to hospital discharge* category ($p < 0.05$)

Discussion

There is a paucity of data regarding non-fatal firearm injuries in the City of Cape Town and South Africa in general. Whilst Mitchells Plain Hospital and the Heideveld Emergency Centre have high levels of interpersonal violence presenting at their emergency centres, the extent of firearm violence as a proportion of this was unknown. This research provides some insight into this burden.

The majority of those injured were male (91%) between the ages of 18 and 35 years (67.8%) and these figures are consistent with data from other facilities in Cape Town(17,25).

With 67% of the patients self-presenting and a further 8.3% referred in from a Community Health Centre (CHC), the nearest Emergency Centre or CHC is where most of this care begins. Firearm injuries may form a larger portion of the total EC burden at facilities like MPH and HEC than elsewhere in the City of Cape Town(13,14,25).

The location data is in line with international research suggesting that most firearm injuries occur in the same suburb in which the injured person lives (26). Figure 3 shows the heatmap by home suburb or subplace, reflecting the violence in these communities. This is mirrored in the mortality rates for these areas (10).

The timing of injury presentation after hours and at weekends is again repeated in this dataset and has implication for resource allocation.

On the 17th July 2019 the South African Defence Force was deployed to assist South African Police Service reduce the high incidence of drug related crime and violence. Figure 2 indicates that this had little effect on the number of firearm injuries presenting to these facilities, with the combined monthly average higher post deployment. The deployment of the army as a temporising measure is unlikely to have long-term impact on violent crime associated with gangsterism and drugs(27).

To reduce mortality and morbidity, triage prioritises care to those presenting who require it urgently. The South African Triage Scale (SATS) (28) was developed locally and is used by all facilities in Cape Town. An initial Triage Early Warning Score (TEWS) is incorporated into a final SATS triage colour determination. The TEWS component was as sensitive for mortality as the full SATS for those triaged ORANGE or RED. This has implications in busy Emergency Centres where a firearm injured patient may be prioritised (using SATS) over other patients who have a similar TEWS. The suggestion being that firearm injured patients with a GREEN or YELLOW by TEWS are at a potentially lower risk of dying.

Further evidence that a simple physiology-based score is potentially accurate in identifying those at a higher risk, is that the Shock Index was statistically significant, when comparing those who survived to hospital discharge and those who died ($p < 0.01$). A Shock Index (SI) > 0.9 has been shown to be predictive of those requiring massive transfusion(29) although a cut-off of >0.8 may be more sensitive.(30) In this series those not surviving to discharge had a median SI of 0.92 (IQR 0.47) whereas the median was 0.72 (IQR 0.18) for those surviving to discharge.

The high proportion of transfers out is partly a result of HEC not having surgical services, but even when removing HEC from this data, more than 1 in 5 MPH patients were transferred out to a tertiary service. It is perhaps important to note that, interfacility transfer to higher level of service with improved care, potentially outweighs the potential harm of transfer (31). This may hold true for these patients transferred to a better capacitated tertiary service.

Whilst capturing the data there were multiple instances of patients being transferred from MPH Emergency Centre to a tertiary facility, as the surgical team was frequently occupied in theatre with another patient. There are likely other capacity constraints at MPH such as no advanced radiology after hours and the lack of an onsite blood bank, that may be reflected in the high number of interfacility transfers and/or potentially worse outcomes when compared to a tertiary service.

Limitations

The EMS incident location was only retrievable on ECM for 52 patients, limiting the final analysis of distance of incident from the home address.

There were 27 patients transferred to the police mortuary from the EC with their original folder. No copies of these folders were found either by physical review or scanned to ECM. As a result, none of these 27 patients were included in the firearm wound location data and where this anatomical information was not available from the Heideveld folder review, these folders were also excluded in determining the anatomical injuries. The combination of these, account for the 595 out of 776 analysed in the firearm wound location. This still provides a large dataset but excludes 27 deaths from the anatomical wound location analysis.

Although these folders were excluded from the firearm wound anatomical data, HECTIS provided the triage data regarding TEWS and SATS and so these folders were still included in the dataset as the outcome for these folders was still available. Where HECTIS data had no vital signs (n=9) these patients were determined to have been dead on arrival and were excluded from analysis, those with vital signs on HECTIS were included as having arrived alive (n=767). Mortality data and length of stay were available for all included folders and theatre data only available for those admitted to MPH. As a result, the theatre data for the 194 patients admitted at tertiary facilities was not reported and limits the completeness of the dataset and further analysis. This is particularly true for HEC patients where 41.9% were transferred out to a tertiary centre. The need for advanced radiology at either MPH or tertiary centre, blood product use, pharmacy costs, support services such as physiotherapy, occupational therapy, and mental health whilst in hospital were also not investigated.

Including these data points would allow for the direct costs involved in managing these patients to be determined. These direct costs are likely to be substantial and combined with costing models and estimates of the indirect costs, Years Lived with Disability and Years of Life Lost due to premature mortality would establish the full impact of this injury profile. (32–34)

Conclusion

The large number of firearm injuries included in this dataset demonstrates only a portion of the firearm injury burden on hospitals in the City of Cape Town.

By their nature firearm injuries are resource intensive involving prehospital services, emergency centres and care extending to the theatre and ICU, with prolonged admissions, repeat theatre visits and at times the need for rehabilitation services well beyond the acute injury.

Adequate resource allocation to reduce the impact on those injured, whilst still fairly allocating resources across the full spectrum of disease, is complicated by the varied and often overwhelming demands being placed on district and community-based services. The significant resources allocated in managing this completely intentional trauma burden may well be better allocated elsewhere but until the firearm injury burden decreases this is unlikely to occur.

There are many unknowns – the long term sequelae for those injured in terms of loss of function, employment opportunities and mental health is unknown; those factors facilitating an escalation of violent injury in our communities; and the rate of recidivism or proportion of injuries associated with gang violence. It is unclear what practical interventions should be undertaken aimed at reducing repeat and escalating injury patterns for all violent injury and how this should be integrated into hospital services.

The international literature provides some advice, but local strategies should be developed. By reducing the number of those injured, the costs of implementing such strategies may well be recovered from the direct and measurable healthcare cost savings, without even taking into effect the benefit to society.

The full effect and cost on society of violent injury and specifically firearm injury is unmeasured, and evidence-based primary and secondary preventative strategies need to be integrated into the Government and civil society's response to this epidemic of violent injury.

Declaration of interest

The authors declare no personal or financial conflict of interest.

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PART C: ADDENDA

a. Research Protocol

RESEARCH PROPOSAL:

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The burden of firearm injuries at two district level hospitals in Cape Town, South Africa: a descriptive analysis

This study is in partial fulfilment of the MMed: Emergency Medicine degree.

Declaration

I, Luke Anthony Bush hereby declare that the work on which this 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. I authorise the University to reproduce for the purpose of research either the whole or any portion of the contents in any manner whatsoever.

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ABSTRACT

INTRODUCTION: A high proportion of violent trauma in South Africa involves firearm injuries, with significant geographical differences in this specific injury burden. Within the City of Cape Town certain communities face a disproportionate level of firearm violence. There is no non-fatal injury surveillance system and so data from healthcare facilities can potentially inform not only of the burden of this injury profile, but also be used in assessing the effectiveness of public health policy, policing and social service interventions in the affected communities.

METHODS: Epidemiological and health service data from a retrospective chart review of patients who sustained firearm injuries between 1 January and 31 December 2019 at two district level hospitals in Mitchells Plain and Heideveld will be collected. The study will be a descriptive study with secondary analysis of this data to inform of the burden of firearm injury. Included in further analysis will be geospatial mapping to determine the firearm injury density per residential area.

ETHICAL CONSIDERATIONS: Retrospective data will be collected from several existing databases, with no patient or clinician contact. This study design poses little risk to the facilities, the clinicians, the community, or the patients, other than for the safeguarding of data collected and de-identification of this data. Patients under the age of 18 will be included, as documenting this vulnerable group may have important planning and policy implications.

CONCLUSION: The proposed research will add to the evidence base with regard to those sustaining firearm injuries in a high prevalence community, and give an insight into the specific injury burden, which is of benefit to both the health facilities involved and the broader community.

INTRODUCTION

According to the South African Police Service (SAPS) crime statistics released in September 2019, 21022 people were murdered in South Africa during the 2018/2019 reporting period. The Institute for Race Relations commented that:

“On a per capita basis, this rivals numbers in places such as war-torn Syria. It is no exaggeration to say on the basis of the number of people killed each year, South Africa is facing a crisis akin to a low intensity civil war.”

Worldwide in 2016 there were an estimated 251 000 deaths due to firearm injuries, accounting for 5.4% of all injury-related deaths, and approximately 41% of all interpersonal violence related deaths were due to violence by firearm, a 5.7% increase from 2006 levels(1).

Whilst mortality data gives an idea of the magnitude of firearm injury burden, there are many more injury survivors who are left with life-long disabilities and long-term psychological effects as a consequence of their injuries(2,3).

In The Global Burden of Diseases (GBD), Injuries and Risk Factors study published in 2016, it was estimated that worldwide there were 1.5 million hospital admissions for interpersonal violence with a further 28 million being managed as outpatients (4).

In the United States Shaahinfar et al. found that children and adolescents injured by assault had a greater long term mortality than those injured by unintentional non-violent trauma(5); and Fahimi et al. found that in adults presenting to an emergency department and surviving to discharge, firearm injury exposure was an important predictor of death within five years and that this was most pronounced in the first year after injury(6).

In South Africa from mortuary data in 2009, Matzopoulos, Prinsloo et al. estimated that 48.6% of all injury related deaths were intentionally inflicted and that firearms were involved in 25% of these intentionally inflicted deaths (7).

Groenewald et al. found that in the City of Cape Town between 2001 and 2013, that the age standardised mortality rate (ASDMR) for firearm-related homicide decreased markedly from 52.5 to 31.5 per 100 000(8).

Since 2013 there has been a 7.8% year on year increase in murders in the Western Cape (2013 – 2542 murders; 2019 – 3974 murders), and although in 2016 the reported murder rate for the Western Cape was 51.7 per 100 000 people, communities such as Philippi East, in the Cape Town metropole, recorded a murder rate of 247 per 100 000 people(9). This is 40 times the estimated global murder rate of 6.2 per 100 000 people.

In South Africa, the National Injury Mortality Surveillance System (NIMSS) has an important role in monitoring and reporting injury mortality(10), but as Ward et al, point out, *“many injuries do not result in death, and until a comprehensive injury surveillance system is established, part of the picture will be missing.”* They also suggest that, *“the health system can provide surveillance systems that assess the extent of violence, which are crucial to monitor interventions and to determine their efficacy.”*(11)

Matzopoulos, Zavala, et al. found significant challenges in implementing a pilot project for South Africa's National Non-fatal Injury Surveillance System (NANFISS) at a hospital in Cape Town, concluding that it was not sustainable and commenting that data collection was regarded as research and conducted 'ad hoc' (12).

Health services within the Western Cape and South Africa, to quote the above, provide some 'ad hoc' evidence as to the non-fatal injury burden. There is no surveillance data of non-fatal injuries(11) generally or specifically documenting the significant non-fatal firearm injuries within the Western Cape.

There are several studies looking specifically at non-fatal firearm injuries at tertiary hospitals(13–15), but there is a paucity of studies specifically documenting firearm injuries, at district level services in South Africa(16). The majority of studies at district level document the trauma burden within the total disease burden(17–20) or document the specifics of the trauma burden on these district services(21,22) or prehospital services(23).

Until such time as an injury surveillance system is established, further research is required to better document the burden of injuries, and in communities with high levels of firearm violence, those injured by firearms.

MOTIVATION

Emergency Centres across South Africa see a disproportionate amount of violent trauma compared to many comparable countries. Many of those injured are not managed in dedicated trauma centres or tertiary hospitals, instead presenting to district level services.

A high proportion of violent trauma involves firearm injuries, with the majority likely presenting to district level services, where they are either treated at this level, or referred on to tertiary facilities.

With no non-fatal surveillance systems in place, the research from health services provides an idea as to the burden of disease within a specific geographical area. This identifies priorities for both the health services and the communities that they serve. With more and specific research, there is potential that it can also be used in assessing the effectiveness of public health policy, policing and social service interventions in the affected communities.

The proposed research aims to provide epidemiological and health service data on patients sustaining firearm injuries at two district level hospitals in a community with high levels of firearm violence.

The proposed research will add to the evidence base regarding those sustaining firearm injuries in a high prevalence community.

AIM

To describe the burden and outcomes of firearm injuries in all patients presenting to two district level emergency centres, between 1 January 2019 and 31 December 2019.

OBJECTIVES

- To investigate the burden of firearm injuries at two district health care facilities.
- To describe the demographics of all patients presenting at these facilities who sustained firearm injuries.
- To collate the process times and outcomes of all patients who sustained firearm injuries.
- To perform geospatial mapping of EMS pickup location as proxy for assault location and to assess the firearm injury density per residential area.
- To assess the association between the South African Triage Score and
 - the anatomical location of firearm injury;
 - whether patient went to theatre at district level; and
 - mortality of those patients treated at district level.

METHODS

Study design:

The study will be a descriptive study with secondary analysis. Data will be collected through a retrospective chart review.

Study setting:

Mitchells Plain Hospital emergency centre (MPH) and Heideveld Emergency Centre (HEC) are located within the Cape Town metropole, providing health services to communities with high levels of crime and violence(9).

Mitchells Plain is a township about 32km from the city of Cape Town with an estimated population of 398 650, 62% are younger than 29 years of age with 48% of households living below the poverty line and only 43% of the working age population employed(24). It is divided into 19 sub-sections and was established during the 1970's by the apartheid government to provide housing following the forced removal of Coloured people under the Group Areas Act of 1962. Approximately 90% of the population is coloured(25). The reported violent crime rate is 1930/100 000 people (24) and MPH drains the Mitchells Plain sub-sections as well as another township known as Philippi, that has a murder rate of 247 per 100 000 people(9).

HEC is located in Heideveld (population 17 388) approximately 20km from Cape Town. The Manenberg (population 52 877) and Hanover Park (population 34 625) communities adjacent to Heideveld, have deeply entrenched gangs and much of the violent crime is related to inter-gang warfare and control of the local drug trade.

MPH and HEC are district level services offering 24hr emergency centres with MPH having an operating theatre and HEC having to refer patients for further operative management. Firearm injured patients can either self-present to these services or be referred in by general practitioners or community health centres. Patients who sustain firearm injuries are managed at both facilities and depending on the severity of injury may be referred to Groote Schuur Trauma Unit (C14) for further care.

Between the two emergency centres 74 000 patients are seen per year, with an estimate of 540 firearm injuries in this time.

Study population and sampling:

The data of all patients who presented to these emergency centres with a firearm injury over a 12-month period will be reviewed (1 Jan 2019 – 31 Dec 2019).

All patients who presented to MPH and HEC during the study period will be eligible for inclusion. Incomplete records will be excluded, based on the information that is available (see data analysis section). Down referrals from a tertiary centre will also be excluded.

Data collection procedures

Data from the two facilities will be collected by data collectors who will have password controlled access to HECTIS (hospital and emergency centre tracking and information system). Each data collector will have their own password protected Microsoft Excel spreadsheet and data from HECTIS will be used to populate the spreadsheet.

Folder numbers will be collected, to provide a link to ECCR (Electronic Continuity of Care Record), ECM (Electronic Content Management system) and EMS database E-triage to collect further data as tabulated below in table 1. Outcome data will be accessed from the Clinicom database.

Demographic data and information pertaining to the burden of firearm injuries will be extracted from HECTIS, with ECCR and ECM accessed where insufficient data is available on the HECTIS database. For patients that arrive via EMS, the EMS database will be accessed to retrieve pickup location. Clinicom will be accessed to determine outcome data. This data will be added to the Microsoft Excel spreadsheet.

Table 2: Description of variables to be collected

Demographics	Arrival by	Process Data
Age Gender Address	EMS Self-transport Other Unknown GP referral CHC referral SAPS	Day Arrival time Triage time Time seen Disposition time
Injury anatomical location	Disposition Decision	South African Triage Score
Head and neck Chest Abdomen Extremities Multiple	Discharge from EC Surgical/orthopaedic referral Transfer out Died Absconded Signed 'refusal of hospital treatment'	Required theatre at district level Geographical location of injury

Data safety and monitoring

Data collectors will be required to sign a data safety confidentiality agreement and each data collector's spreadsheet will be saved in a password-protected UCT Institutional Account OneDrive® folder with access permission restricted so that the spreadsheet will only be accessible to the data collector and the primary investigator. For quality control, a set of each data collectors records will be duplicated by another data collector to ensure accuracy of the data collection process. Should this highlight errors, this would be reported on and potentially the data recaptured.

Once the data collection is complete, the data will then be combined to a single spreadsheet and folder numbers removed and stored on a separate password protected file as reference. Analysis will be performed on the complete dataset. This dataset will be shared via the abovementioned OneDrive® folder to the research supervisors and will have no patient identifiable data. Again access will remain restricted.

A copy of data will be saved to a password protected folder on the hard drive of the primary investigators desktop computer. This device is password protected and any and all files saved will be password protected.

Once the research is complete, all data will be kept in a secure, locked cupboard on a password protected hard drive at the UCT Division of Emergency Medicine for 5 years.

Data analysis plan:

As this will be a descriptive study and will not be hypothesis testing, incomplete data will be included and described up to the point where it can no longer be analysed. This will be clearly documented and described. Demographics will be presented for both missing and incomplete data, so that it can be compared to those with complete data. In those cases where the analysis of clinical data provides uncertain information, it will be presented as "unsure" and not categorised into a definitive category.

Cases will be excluded if patients' clinical data or information is missing or inaccessible. The number of missing cases will be clearly described, as well as much as possible of the relevant descriptive details. This will allow for comparison between cases and missing data. The investigators will make every effort to prevent missing data, including scrutinising hard copies of clinical notes if the information on the relevant database(s) is incomplete. A flow chart of cases and missing data/incomplete records will be presented.

The categorical data collected will be described with summary statistics and proportions or percentages. When assessing non-random associations, Fisher's exact or Chi2 tests will be used, depending on the variable characteristics (table 2).

Street and suburb data will be used to geographically plot the number of events by residential location. If sufficient data is available for those that arrive via EMS as to the geographical location of the firearm assault, then this will be captured to determine proximity to residential address. Geographical data collected will be presented in a map or graphical format. The address data will be converted to GPS co-ordinates for this purpose and no physical address data (i.e. 4 Winder Road) will be saved. The exact location of events will not be presented. Location will only be used to determine firearm injury density, within the 20 residential sub-sections that comprise the Mitchells Plain area and the suburbs that the Heideveld Emergency Centre serves. The data will also be used to describe the proximity of the geographical firearm injury location to the home address on the clinical record and this will be presented as a distance.

Central tendency and spread for normally distributed variables will be described as means and standard deviations, while medians and interquartile ranges will be used on non-normally distributed data. 95% Confidence intervals (CI) will be provided where applicable and statistical significance will be defined as $p < 0.05$.

Table 3: Data analysis plan

Objective	Outcomes	Source	Variable type	Analysis Strategy
Objective 1: Burden of firearm injuries	Total patients attended to	Hectis	Numerical discreet	Descriptive statistics with medians/averages and proportions.
	Total trauma and GSW patients seen	Hectis	Numerical discreet	
	Mode of arrival/transport	Hectis	Categorical nominal	
	Time of day (night vs day)	Hectis	Dichotomous	
	Time of week (weekend vs week day)	Hectis	Dichotomous	
Objective 2: Patient demographics	Age	Hectis	Numerical discreet	Descriptive statistics with medians/averages and proportions.
	Gender	Hectis	Dichotomous	
Objective 3: Patient outcomes and process times	Anatomical location of GSW	Hectis, ECCR, ECM	Categorical nominal	Descriptive statistics with medians/averages and proportions.
	Process times	Hectis, ECCR, ECM	Numerical continuous	
	Disposition decision/outcome	Hectis, ECCR, ECM	Categorical nominal	
Objective 4: Geospatial mapping	Geographic location of injury	Clinicom, ECM, EMS	Decimal degree (DD) or degrees and decimal minutes (DMM)	Geospatial analysis with specific software
	Geographic location of EMS pickup	Clinicom, ECM, EMS		
Objective 5: Association between the SATS and location of firearm injury; the need for theatre/ICU; mortality	South African Triage Score	Hectis	Categorical ordinal	Categorical data will be tested for non-random associations with the Fisher's exact test
	Anatomical injury location	Hectis, ECCR, ECM	Categorical nominal	
	Need for theatre, ICU	Hectis, ECCR, ECM	Dichotomous	
	Mortality	Clinicom, Hectis	Dichotomous	

ETHICAL CONSIDERATIONS

As the proposed study is collecting existing data from a database, the study design poses little risk to the facilities, the clinicians, the community, or the patients and an application for expedited ethics approval will be submitted. The application for approval to the University of Cape Town Human Research Ethics Committee (UCT HREC) will also include a request to waive informed consent.

Provincial, hospital and EMS permission to conduct the study will be applied for as soon as HREC approval is granted.

Risk to patients:

Data will be de-identified as soon as the data collection process has been completed. Folder numbers will be collected, to provide a link between the different databases. The folder numbers will be removed after the data collection process has been completed and stored on a separate password protected file as reference.

Patients under the age of 18 will be included, as the study design poses low risk to this vulnerable group. This group of patients is included as they may sustain firearm injury as bystanders or as part of gang involvement. As a vulnerable group they are an important group to document with regard to burden of disease, particularly as there are potential long term effects on both their physical and mental health and risk for repeat injury.

There is no patient contact and no direct effect on patient management.

With regard to the specifics of the data, the address information and EMS geographical data will only be used to geographically plot the number of events by area and will only be presented in a map or graphical format. The address data will be converted to decimal degree or decimal minute format for this purpose and no physical address data (i.e. 4 Winder Road) will be saved. The exact location of events will not be presented.

Risk to clinicians:

No information will be collected from or with regard to the treating clinicians.

Must outline benefits of the study otherwise the risks greatly outweigh the benefits!

Benefits

The proposed research will add to the evidence base with regard to those sustaining firearm injuries in a high prevalence community and give an insight into the firearm injury burden. This is of benefit to both the health facilities involved and the broader community.

Health Facilities:

By better understanding the injury burden the facilities will be better able to provision services and care for the specific needs applicable to their population of patients. The research will provide a reference point at these facilities to which future research and data can be compared.

Community:

It is recognised that firearm related deaths have increased in many communities in Cape Town. As there is no non-fatal injury surveillance mechanism and no mandatory reporting to police, it is likely that the true burden of firearm related injuries is not well or accurately documented. The research will provide an insight into the non-fatal injuries attributed to firearms and this may assist communities in advocating for improved social services and policing interventions.

Social Services:

Social service interventions in the affected communities would benefit from the research by better understanding the demographic of those affected by or involved in firearm violence. This is particularly relevant in those under the age of 18 where specific interventions may reduce the rate of recidivism or further involvement in retaliatory violence. Geographical data may provide insight into the areas where social service interventions would be most appropriate.

The proposed research at these facilities may provide relevant data and analysis thereof that will add to the research available to the health facilities, communities and local government to better inform

their respective decisions with regard to the significant burden of firearm injuries that these specific communities experience.

RESOURCES AND BUDGET

Hardware: desktop computer; printer

Software: Microsoft Excel; Microsoft Word; SPSS statistica 25 under licence to the University of Cape Town.

Geospatial analysis software: batchgeo (www.batchgeo.com)

Database access:

Access to Hospital and Emergency Centre Tracking & Information System (HECTIS) to identify cases;

Access to Electronic Content Management (ECM) system for clinical records;

Access to Electronic Continuity of Care Record (ECCR) system for clinical records

;Access to Clinicom for outcome information;

Access to Metro EMS eTriage database for location data

Budget:

Item	Description	Unit Cost	Total Cost
Consumables			
Materials & supplies			R 500
Printing	HREC documents		R 50
	Data collection sheet		R 250
	Manuscript		R 200
	Other		R 250
Research Travel			
Travel to sites	500km total distance	@ 130.1c/km (SARS)	R 650,50
Personnel			
Data Collectors	60 hours	@ R80/hour	R 4 800
Total			R 6750,50

TIMELINE

	Oct 19	Nov 19	Dec 19	Jan 20	Feb 20	Mar 20	Apr 20	May 20	Jun 20	Jul 20	Aug 20
EMDRC Summary	X										
EMDRC Proposal		X	X								
HREC Approval				X	X						
NHRD Approval						X					
Data Collection							X	X	x		
Data Analysis									X	x	
Final write up									X	X	X

DISSEMINATION OF FINDINGS PLAN

The research project will be converted into one publishable research paper for submission to a peer reviewed journal.

Feedback on results to the institutions and referral tertiary centre.

Feedback results to the Western Cape Provincial Violence Prevention Innovation Hub

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b. HREC approval letter



UNIVERSITY OF CAPE TOWN
Faculty of Health Sciences
Human Research Ethics Committee



Room G50- Old Main Building
 Groota Schuur Hospital
 Observatory 7925
 Telephone [021] 406 6492
 Email: hrec-enquiries@uct.ac.za
 Website: www.health.uct.ac.za/fhs/research/humanethics/forms

24 January 2020

HREC REF: 044/2020

Dr K Evans
 Division of Emergency Medicine
 c/o Vathiswa Mzamo
 F-51, OMB

Dear Dr Evans

PROJECT TITLE: THE BURDEN OF FIREARM INJURIES AT TWO DISTRICT LEVEL HOSPITALS IN CAPE TOWN, SOUTH AFRICA: A DESCRIPTIVE ANALYSIS (MMeD candidate-Dr L Bush)

Thank you for submitting your study to the Faculty of Health Sciences Human Research Ethics Committee (HREC) for review.

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

Approval is granted for one year until the 30 January 2021

Please submit a progress form, using the standardised Annual Report Form if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: www.health.uct.ac.za/fhs/research/humanethics/forms)

The HREC acknowledge that the student: - Dr Luke Bush will also be involved in this study.

Please quote the HREC REF in all your correspondence.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate Institutional approval, where necessary, before the research may occur.

Yours sincerely

PROFESSOR M BLOCKMAN
CHAIRPERSON, FHS HUMAN RESEARCH ETHICS COMMITTEE

Federal Wide Assurance Number: FWA00001637.
 Institutional Review Board (IRB) number: IRB00001938
 NHREC-registration number: REC-210208-007

HREC 044/2020sa

c. Injury Journal guide for authors



INJURY

International Journal of the Care of the Injured

AUTHOR INFORMATION PACK

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ISSN: 0020-1383

DESCRIPTION

Injury was founded in 1969 and is an international journal dealing with all aspects of **trauma care** and **accident surgery**. Our primary aim is to facilitate the exchange of ideas, techniques and information among all members of the trauma team.

Topics covered include: **trauma** systems and management; surgical procedures; epidemiological studies; surgery (of all tissues); resuscitation; biomechanics; rehabilitation; anaesthesia; radiology; basic science of local and systemic response to trauma and tissue healing.

Regular features include: original research papers; review articles; case reports; ideas and innovations detailing novel and effective solutions to surgical problems; book reviews; calendar of world-wide meetings.

Letters that comment on an article previously published in *Injury* are particularly encouraged, and the authors will be given the opportunity to respond. Please [submit](#) letters to the editor by e-mail where possible to editor@injuryjournal.com.

Authors are also welcome to submit case reports to *Injury*'s companion title, *Trauma Case Reports*.

AUDIENCE

Accident and emergency/trauma surgeons, orthopaedic surgeons, anaesthetists, intensive care specialists, nursing staff, physical therapists, radiographers, paramedics.

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Frame JD, Frame JE. Modifying integra as a regeneration template in deep tissue planes. *J Plast Reconstruct Aesthet Surg* 2006;59: 460-4.

Books

1. Book chapter

Lister GD. Skin flaps. In Green DP, editor. *Operative Hand Surgery*. 3rd ed. New York: Churchill Livingstone; 1993, p. 1741-1823.

2. Book

Book: Mathes SJ, Nahai F. *Reconstructive Surgery: principles, anatomy, and technique*. New York: Churchill Livingstone; 1997.

Website

Uebersax J. A practical guide to local dependence in latent class models.
<http://www.wiki.compuserve.com/homepages/jsuebersax/comp1ep.htm>.

Dataset

[dataset] Oguro M, Imahiro S, Saito S, Nakashizuka T. Mortality data for Japanese oak wilt disease and surrounding forest compositions, Mendeley Data, v1; 2015.
<http://dx.doi.org/10.17632/xwj96nb39f.1>.

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Reference to a book:

[3] W. Strunk Jr., E.B. White, *The Elements of Style*, fourth ed., Longman, New York, 2000.

Reference to a chapter in an edited book:

[4] G.R. Mettam, L.B. Adams, How to prepare an electronic version of your article, in: B.S. Jones, R.Z. Smith (Eds.), *Introduction to the Electronic Age, E-Publishing Inc.*, New York, 2009, pp. 281–304.

Reference to a website:

[5] Cancer Research UK, *Cancer statistics reports for the UK*. <http://www.cancerresearchuk.org/aboutcancer/statistics/cancerstatsreport/>, 2003 (accessed 13 March 2003).

Reference to a dataset:

[dataset] [6] M. Oguro, S. Imahiro, S. Saito, T. Nakashizuka, Mortality data for Japanese oak wilt disease and surrounding forest compositions, *Mendeley Data*, v1, 2015. <https://doi.org/10.17632/xwj98nb39r.1>

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