

ADVANCES

Penetrating trauma in Ontario emergency departments: a population-based study

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ABSTRACT

Background: There is a paucity of population-based research on health service utilization related to penetrating trauma in Canada, even though such trauma can result in serious injury or death, and gunshot wounds have been labelled the “the new public health issue.” Complete epidemiologic data, including emergency department (ED) visits and hospitalizations, for penetrating trauma is not available. The objective of this paper is to describe the epidemiology of ED visits for firearm-related and knife-related penetrating trauma in one Canadian province.

Methods: All EDs in the province of Ontario (pop. approx. 12 400 000 at the time of the study) submit data on ED visits to the National Ambulatory Care Reporting System. This database includes patients’ demographic information (i.e., age, sex and geographic area of residence), the reason for the visit, disposition (i.e., admitted to hospital or sent home), and other diagnostic information. For visits related to injuries, the cause of injury is also reported (e-codes according to the *Canadian Enhancement to the International Statistical Classification of Diseases and Related Health Problems*, 10th rev [ICD-10-CA]). All patients seen in Ontario EDs for an injury related to a firearm, knife, or sharp object, were included in our study.

Results: Of the 1.2 million ED visits in 2002–03 for trauma in Ontario, 40 240 (3.4%) patients were treated for injuries relating to penetrating trauma. Most patients were male, and most were 15–24 years of age. Penetrating trauma was frequently a result of knives or sharp objects (39 654 visits or 98.5%); only 1.5% ($n = 586$) of these injuries were caused by firearms. Of those hospitalized, 151 were related to firearms and 1455 were related to knives/ sharp objects.

Conclusions: Analyzing administrative data provides an estimate of the impact of penetrating trauma on a population, thereby providing prevention programs with data upon which to design their strategies. Evidence-based prevention strategies are needed to reduce the burden of penetrating trauma. Monitoring ED and hospitalization data over time will help to assess trends and provide evidence for the effectiveness of such strategies.

Key words: injury; trauma; firearms; sharp objects

RÉSUMÉ

Contexte : Il existe très peu de recherches basées sur une population concernant l’utilisation des

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services de santé pour le traitement de traumatismes pénétrants au Canada, même si de tels traumatismes peuvent entraîner de graves blessures ou même la mort et si les blessures par balle ont été qualifiées du «nouveau problème de santé publique». Des données épidémiologiques exhaustives concernant les traumatismes pénétrants, incluant les visites au service d'urgence et les hospitalisations ne sont pas disponibles. Le présent article a pour but de décrire l'épidémiologie des visites à l'urgence pour des traumatismes pénétrants causés par des armes à feu et des couteaux dans une province canadienne.

Méthodes : Tous les services d'urgence de la province de l'Ontario (pop. 12 400 000 au moment de l'étude) soumettent des données concernant les visites à l'urgence au Système national d'information sur les soins ambulatoires. Cette base de données comprend les données démographiques au sujet des patients (p. ex. âge, sexe et région géographique de résidence), la raison de la visite, le devenir (p. ex. hospitalisation ou renvoi à la maison) et d'autres renseignements diagnostiques. Pour les visites pour des blessures, la cause de la blessure était également signalée (codes selon la *Classification statistique internationale des maladies et des problèmes de santé connexes*, 10^e éd. rév. [CIM]). Tous les patients vus dans les services d'urgence de l'Ontario pour une blessure causée par une arme à feu, un couteau ou un objet tranchant furent inclus dans notre étude.

Résultats : Parmi 1,2 million de patients reçus aux services d'urgence en 2002–2003 pour des traumatismes en Ontario, 40 240 (3,4 %) furent traités pour des blessures causées par un traumatisme pénétrant. La plupart des patients étaient des hommes et étaient âgés entre 15 et 24 ans. Les traumatismes pénétrants étaient souvent causés par des couteaux ou des objets tranchants (39 654 visites ou 98,5 %); seulement 1,5 % ($n = 586$) de ces blessures étaient causées par des armes à feu. Parmi les patients hospitalisés, 151 avaient subi une blessure par arme à feu et 1 455 avaient été blessés par un couteau ou un objet tranchant.

Conclusions : L'analyse des données administratives offre une estimation de l'impact des traumatismes pénétrants chez une population, et par le fait même, fournit des données aux programmes de prévention sur lesquelles fonder leurs stratégies. Des stratégies de prévention fondées sur des preuves sont nécessaires afin de diminuer le fardeau des traumatismes pénétrants. La surveillance des données sur les visites aux services d'urgence et les hospitalisations permettra au fil du temps d'évaluer les tendances et d'offrir des preuves quant à l'efficacité de telles stratégies.

Background

Penetrating trauma results in high morbidity and mortality in many countries. An estimated 229 000 people die from firearm-related deaths around the world each year.¹ In the United States, much research has been conducted to determine the burden and costs of this type of injury. In 2000 there were an estimated 16 765 victims in the US who were killed by firearms and a further 776 deaths from unintentional firearm injuries.² For each death there are many more hospitalizations and ED visits. For example, one US study estimated that there were 64 200 ED visits in 1 year for gunshot wounds alone.³ In New Mexico, researchers reported similar rates of knife-related and stabbing-related hospitalizations.⁴ Although the rate of firearm-related injuries and deaths has traditionally been lower in Canada, the costs to the victim and the health care system are substantial in both countries.^{5,6}

Penetrating trauma related to gunshot wounds has been dubbed “the new public health issue” in Canada.⁷ Among young adults (15–24 years) firearms were the third leading cause of death in 1990.^{8,9} The overall mortality rate from

gunshot wounds in Canada has declined since 1979, when it was 10.6 per 100 000 for Canadian men; in 2002 the rate had dropped to 4.9 per 100 000.¹⁰ In 1991, the health care costs associated with gunshot wounds in Canada were estimated to be \$63 million.¹¹ Despite the costs to victims, their families and the health care system, and despite the fact that many of these injuries can be prevented, there has been little published regarding ED visits for penetrating trauma. Gaining an understanding of the epidemiology and the magnitude of health services use for all kinds of penetrating trauma in Canada is an important step in prevention. The goal of this study is to describe the epidemiology of penetrating-trauma-related visits to Ontario EDs. This includes comparing gun-related injuries to injuries associated with knives and sharp objects, and presenting population-based rates by gender, age, acuity, intent and admission rates.

Methods

All EDs in the province of Ontario (pop. 12 400 000) submit abstracted data on ED visits to the National Ambula-

tory Care Reporting System (NACRS), maintained by the Canadian Institute for Health Information. This database includes urban, suburban and rural hospital EDs in the province, as well as pediatric, tertiary care and community hospitals. In all, 180 hospitals are required to submit data, including demographic information about the patient (i.e., age, sex, geographic area of residence), the reasons for the visit (i.e., external causes of injury codes according to the *Canadian Enhancement to the International Statistical Classification of Diseases and Related Problems*, 10th rev [ICD-10-CA]), where the patient went after leaving the ED (i.e., either admitted to hospital or sent home) and other diagnostic information. Our study included patients with an ICD-10-CA code related to contact with knife, sword or dagger, and firearm injuries, including those classified as unintentional/unknown intent, intentional, and self-inflicted injuries. Table 1 includes the codes selected for this study and the description provided by the ICD-10-CA.

All patients seen in Ontario EDs between Apr. 1, 2002, and Mar. 31, 2003, for an injury related to a firearm, knife, or sharp object, (i.e., classified with the codes mentioned above) were included in our study. Using the *Canadian Emergency Department Triage and Acuity Scale* (CTAS),¹² acuity of injuries were categorized as Level I (Resuscitation), II (Emergent), III (Urgent), IV (Less Urgent) and V (Non Urgent). Data are presented as rates per 100 000 population (based on population estimates from Statistics Canada 2001 census.¹³ The rates were calculated by using the number of ED visits in that category as the numerator, and the relevant population (i.e., all Ontario, specific age groups, or gender) as the denominator. Data were analyzed using SAS software.

Results

Out of the 4 921 085 ED visits captured in the NACRS data, 1 211 500 were for injury-related causes, and 40 240 (3.3%) of those were coded as penetrating trauma injuries, which resulted in an annual ED visit rate for penetrating trauma of 324.5 per 100 000 population. Twenty-six thousand visits (65%) were made by males (466.2/100 000), and 14 240 by females (244.1/100 000). Most penetrating trauma in the ED is a result of knives or sharp objects (39 654 visits, or 98%), with firearms implicated in only 586 visits. The injury rate for firearm-related injuries was 4.7 per 100 000, versus 319.8 per 100 000 for knives/sharp-object-related injuries. The majority of ED visits for penetrating trauma were classified as unintentional or intent unknown.

Table 2 depicts the epidemiology of penetrating trauma

for both firearm-related injuries and injuries from knives/sharp objects by ED visit rates, gender, age group, intent, triage score and hospitalization. Age is associated with the incidence of penetrating trauma. The 15–24-year age group had the highest rate of ED visits for both firearms and knives/sharp objects (14.9 for firearms and 673.5 for knives). The injury rates in this age group were more than twice as high as the corresponding rate among adults 25–64 years (4.2 and 355.8 for firearms and knives, respectively).

Both types of penetrating trauma can be associated with high-acuity injuries. The frequency distribution of penetrating trauma by CTAS score is presented in Table 2. Knives were less likely to result in high-acuity (CTAS Level I or II) injuries than were firearms (1234/39 654 [3.1%] v. 234/586 [39.9%]); however, the number of high-acuity knife-related injuries was more than 5 times greater than those related to firearms ($n = 1234$ v. $n = 234$). Hospi-

Table 1. Canadian Enhancement to the International Statistical Classification of Diseases and Related Health Problems, 10th rev (ICD-10-CA) codes and descriptions for penetrating trauma

Code	Description
W26	Contact with knife, sword or dagger
Y28	Contact with sharp object, undetermined intent
W 32	Handgun discharge
W33	Rifle, shotgun, and other firearm discharge
W34	Discharge from other and unspecified firearms (includes airgun, BB gun, gunshot wound not otherwise specified (NOS), shot NOS, Very pistol*)
Y22	Handgun discharge, undermined intent
Y23	Rifle, shotgun, and other firearm discharge, undetermined intent
Y24	Discharge from other and unspecified firearms, undetermined intent (includes airgun, BB gun, gunshot wound NOS, shot NOS, Very pistol*)
X99	Assault by sharp object
X93	Assault by handgun discharge
X94	Assault by rifle, shotgun, and other firearm discharge
X95	Assault by discharge from other and unspecified firearms (includes airgun, BB gun, gunshot wound NOS, shot NOS, Very pistol*)
X72	Intentional self-harm by handgun discharge
X73	Intentional self-harm by rifle, shotgun, and other firearm discharge
X74	Intentional self-harm by discharge from other and unspecified firearms (includes airgun, BB gun, gunshot wound NOS, shot NOS, Very pistol*)
X78	Intentional self-harm by sharp object

*Very pistol = pistol used for firing signal flares

tal admission is a fairly common outcome, with 151 over the study period for firearm-related injuries, and a corresponding 1455 admissions for injuries due to knives or sharp objects, an almost 10-fold difference. However, firearm-related injuries were more likely to result in admission (151/586 [25.7%]) than were knife-related injuries (1455/39 654 [3.7%]). The overall number of deaths in hospital caused by knives ($n = 26$) and guns ($n = 30$) were similar even though the case-fatality rate in hospital was much higher for firearm-related injuries (5%) than for knives/sharp-objects-related injuries (0.06%).

Discussion

In 2002–03, penetrating trauma in Ontario was responsible for about 3% of all ED visits for trauma, with more than 40 000 ED visits resulting from guns, knives and other sharp objects. The overall firearm-related injury rate of 4.7

per 100 000 is significantly lower than the estimated corresponding value reported by some states in the US (e.g., 34.3 in New Mexico and 30.9 in Massachusetts^{4,14}); however, it is of concern in Canada nonetheless.³ Our data reinforce an earlier article by Chapdelaine and colleagues⁸ suggesting that penetrating trauma is most common among males and young people. Although about 10% of these ED visits are classified as intentional (assault or self-harm), the majority are coded as unintentional or of unknown intent. This percentage demonstrates a markedly different pattern from mortality data, where suicides make up about four-fifths of all firearm-related deaths in Canada.¹⁰

Not all penetrating trauma falls within a triage category reflecting high acuity. Our data suggest that firearms cause more serious injuries on average than do knives. Overall, only 3.1% of knife-related injuries were triaged as high acuity in the ED and only 3.7% required hospital admission, compared with 39.9% and 25.7%, respectively, for firearm-related injuries. Surprisingly, 10.2% of the firearm-related injuries were classified as Non Urgent (Level V). This is likely because injuries due to BB guns and air rifles were included in the firearm-related category, and injuries due to this type of firearm may be less severe.

The injury rates found in this population-based study are lower than those reported in New Mexico. For example, the admission rate per 100 000 in our study was 1.2 and 11.7 for firearms and knives/sharp objects, respectively, compared with 34.3 and 35.1, respectively, in New Mexico.⁴ This proportion was somewhat different from that reported in Sydney, Australia, where 30% of severe penetrating trauma was due to firearms.¹⁵ However, the Australian study reported only patients with an Injury Severity Score of >15, whereas our study included all patients treated at an ED in Ontario.

Limitations

The primary limitation of our data is related to the inability to include data from patients who died without being brought to an ED. These patients are not captured within the NACRS data, thus our results probably underestimate mortality from penetrating trauma. This is likely to differ between guns and knives, with a greater proportion of shooting victims pronounced dead at the scene.

Further limitations are related to the use of administrative data. Although nosologists have standardized practices for coding the data, there is room for misclassification error. Classification of intent is particularly problematic in an ED setting. It is possible that many of the injuries coded as “intent unknown or undetermined” were, in fact, either self-inflicted or inflicted by others. This may differ system-

Table 2. Patients presenting to Ontario hospital emergency departments with penetrating trauma in 2002–03

Variable	Cause of trauma, no. of patients (and rate/100 000 pop.)	
	Guns	Knives/sharp objects
Gender		
Male	522 (9.3)	25 478 (456.9)
Female	64 (1.1)	14 176 (243.0)
Age group, yr		
0–14	72 (3.1)	3 223 (136.6)
15–24	236 (14.9)	10 722 (673.5)
25–64	254 (4.2)	23 737 (355.8)
≥65	24 (1.7)	1 972 (129.6)
CTAS Level		
I (Resuscitation)	116 (0.95)	278 (2.3)
II (Emergent)	118 (1.0)	956 (7.7)
III (Urgent)	150 (1.2)	5 741 (46.2)
IV (Less Urgent)	142 (1.1)	24 677 (199.0)
V (Non Urgent)	60 (0.5)	8 001 (64.5)
Type of injury		
Unintentional/unknown	419 (3.4)	34 960 (281.9)
Assault	46 (0.4)	2 594 (20.9)
Self-inflicted	121 (1.0)	2 100 (16.9)
ED outcome		
Admitted to hospital	151 (1.2)	1 455 (11.7)
Sent home	435 (3.6)	38 199 (316.5)
Died in hospital or DOA (and %)	30 (5.0)	26 (0.06)
Total rate (no. of visits)	4.7 ($n = 586$)	319.8 ($n = 39 654$)

CTAS = Canadian Emergency Department Triage and Acuity Scale; DOA = dead on arrival

atically between men and women, and among the different age groups. In order to try to assess this possibility, we compared the type of injury coded in the ED and in the hospitalization records, to assess the concordance. There was agreement between the ED code and the in-hospital code in 72% of unintentional/intent-unknown cases, 93% of self-inflicted cases, and 94% of assaults.

Conclusions

Analyzing administrative data provides an estimate of the impact of penetrating trauma on a population level, thereby providing prevention programs with data upon which to design their strategies. It is clear that evidence-based prevention strategies are needed to reduce the burden of penetrating trauma. As suggested by other Canadian authors, these strategies may include controlling the import and circulation of firearms, further research, and education.^{9,10} Monitoring ED and hospitalization data over time will help to assess trends and provide evidence for the effectiveness of such strategies.

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