The Injury Experience Observed in Two Emergency Departments in Kingston, Ontario During 'Ice Storm 98'

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ABSTRACT

Objectives: 1) To describe patterns of unintentional injury presenting for emergency medical care in Kingston, Ontario following the ice storm in January 1998; and 2) to provide recommendations for prevention during such situations.

Methods: Unintentional injuries related to the ice storm that presented at the two emergency departments in Kingston, Ontario were identified and described.

Results: A total of 254 injuries were identified. Injuries peaked the day following the onset of the ice storm and again 4-6 days following the storm. Common sources of injury included slips and falls on the ice (56%), activities related to clearing brush or trees (15%), and unintentional carbon monoxide poisonings (9%).

Conclusions: While the number of injuries that presented during the storm and its aftermath was not unusual, the distribution of injuries by type did reflect the irregular nature of environmental conditions. This analysis provides useful information for public officials to use reviewing disaster plans and to generate recommendations for managing future occurrences.

ABRÉGÉ

Objectifs : 1) Décrire les types de blessures accidentelles que le service d'urgence de Kingston, en Ontario, a dû soigner à la suite de la tempête de verglas de janvier 1998; et 2) faire des recommandations pour prévenir ces différents types de blessures.

Méthodes : Identification et description des types de blessures accidentelles soignés dans les deux services d'urgence de Kingston, en Ontario.

Résultats : On a identifié un total de 254 blessures. On a constaté le plus grand nombre de blessures le lendemain suivant le début de la tempête et de nouveau 4 à 6 jours après la fin de la tempête. Les causes les plus communes des blessures étaient des glissades et des chutes sur la glace (56 %), des activités en rapport avec le dégagement des branches ou des arbres (15 %) et des empoisonnements accidentels au monoxide de carbone (9 %).

Conclusion : Si le nombre de blessures survenues pendant la tempête et après n'était pas inhabituel, la ventilation de ces blessures en fonction de leur type traduisait la nature inhabituelle des conditions de l'environnement. Cette analyse apporte des données utiles aux responsables de la santé publique qui pourront les utiliser lors de leurs examens des plans prévus en cas de catastrophe et en tirer des recommandations pour gérer de futures situations semblables.

During January of 1998, Eastern Ontario and Quebec in Canada were struck by one of the most devastating ice storms in recent memory.[1] The ice storm hit Kingston and Area on January 7, 1998 and on January 9 a state of emergency was called. Almost 80% of Kingston was left without power, with outages lasting from several hours to several weeks. Numerous institutions and businesses in the area were closed including two universities, colleges, schools, the local airport and many private companies. The two area hospitals suspended elective surgery and outpatient clinics. Nine emergency shelters were set up. Because of the substantial impact to the area, the community qualified for financial relief from the federal government as well as emergency assistance from the military.

The economic costs of this storm in Canada may never be fully determined, but early estimates suggested that it led to property losses in the billions of dollars, and that the storm inconvenienced the lives of millions of people residing in Ontario and Quebec.[2] What may be overlooked in these statistics is that the ice storm undoubtedly had a major impact on population health. Epidemiologic surveillance following a disaster such as this is an important and responsible activity that can generate objective information that may be used by health care providers, emergency providers and the public at large in preparing for future disasters.[3]

The objectives of this study were to: 1) describe patterns of unintentional injury caused by the ice storm that presented for emergency medical care in Kingston, Ontario, and 2) identify those patterns of injury that are amenable to prevention, so that efforts to prevent injuries during future storms might be guided by past experience.

The CHIRPP Program in Kingston

The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) is an emergency room-based computerized injury surveillance program operated in sentinel, Canadian hospitals. Both hospitals with emergency departments in Kingston (Kingston General and Hotel Dieu Hospital) participate in this program. In Kingston, a nurse coordinator abstracts data from medical charts to provide information about the nature of the injury and its treatment for all individuals (100%) presenting to the emergency department or admitted to hospital. In addition, the patient or an accompanying adult is asked to provide a description of the circumstances of the injury, and this is obtained in 85% of cases (K. Bowes, Nurse Coordinator, Kingston and Region Injury Surveillance Program, personal communication, 1998).

Virtually all injuries to the catchment population of 130,000 residents (City of Kingston, parts of Frontenac, Lennox and Addington, and Leeds and Grenville Counties) requiring emergency department or in-hospital care for injuries present to these two emergency departments. Kingston General Hospital is one of the few level I trauma centres in Eastern

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TABLE I
Agent of Injury, by Day

Date (January)	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Day of week	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	
Temp.: max.	0.5	0.5	2.5	3.5	-3.0	4.0	4.0	-12.0	-10.0	-7.5	-8.0	-4.5	-3.0	
min	-3.0	-2.0	-3.0	0.5	-8.0	-12.0	-7.0	-14.0	-13.5	-13.5	-10.0	-9.5	-9.0	
Precipitation	FR	FR	FR	R	-	FR	S	-	S	-	S	S	S	
(cm)	2.8	1.6	0.7	0.1	-	0.4	1.2	-	16.0	-	1.0	2.0	1.6	
Agent														
Ice	15	12	5	3	4	23	14	15	19	14	9	5	8	146
Clean-up of trees	-	7	3	3	8	2	5	3	2	1	4	1	-	39
Carbon monoxide	-	1	3	-	8	9	-	-	1	-	-	-	-	22
Motor vehicle collision	3	2	-	-	-	-	4	-	-	1	1	-	-	11
Darkness (due to power outage)	-	3	2	1	4	-	-	-	-	-	-	-	-	10
Fire	-	1	1	3	1	1	-	1	-	-	-	-	-	8
Other / Unknown	-	2	1	-	3	5	1	3	2	-	-	1	-	18
Total	18	28	15	10	28	40	24	22	24	16	14	7	8	254

FR-freezing rain; R-rain; S-snow

TABLE II
Nature of Injury, by Day

Date (January)	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Day of week	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	
Precipitation	FR	FR	FR	R	-	FR	S	-	S	-	S	S	S	
(cm)	2.8	1.6	0.7	0.1	-	0.4	1.2	-	16.0	-	1.0	2.0	1.6	
Nature of Injury														
Superficial (e.g., bruise, abrasion)	10	8	5	2	4	6	11	4	13	5	8	2	-	78
Fracture / Dislocation	3	6	-	2	6	10	2	7	5	5	-	1	1	48
Open wound	-	7	4	1	5	2	4	2	3	2	2	1	4	37
Sprain / Strain	3	1	2	1	1	4	3	4	1	2	2	1	-	25
Poisoning	-	1	3	1	8	10	-	-	1	-	-	-	-	24
Head injury / Concussion	1	1	-	-	1	3	3	2	1	1	1	2	3	19
Eye injury	-	3	-	1	2	2	1	1	-	1	1	-	-	12
Other / Unknown	1	1	1	2	1	3	-	2	-	-	-	-	-	11
Total	18	28	15	10	28	40	24	22	24	16	14	7	8	254

FR-freezing rain; R-rain; S-snow

Ontario, and the only such centre serving our area. We consider the data to be population-based for severe (but non-fatal) trauma, and population-based in a limited way for less serious injuries, as these may seek medical care from other sources.[4] Deaths that occur outside of the hospital setting are not captured by the CHIRPP system.

METHODS

The study period spanned from January 7, 1998 at 12 noon (start of the ice storm) through Monday, January 19, 1998 at 2 p.m. (lifting of the state of emergency in Kingston). All cases of unintentional injury presenting for treatment at the two emergency departments during this time were identified shortly after they occurred. Emergency charts and the CHIRPP records for each injury were reviewed. A determination was made as to whether each injury was caused, in whole or in part, by the ice storm or its aftermath. This included injuries due to: wind, snow, lightning, falling debris, disruption of power lines, loss of power, loss of communication, loss of access to usual medical care or support services, restoration or clean-up activities, and hazardous road conditions.[5] Injuries that were not caused by the ice storm (or it was doubtful) were excluded. Weather information, including daily temperatures and precipitation, was obtained from Environment Canada.[1]

The analyses of these data were descriptive and employed univariate statistics (frequencies, cross-tabulations). All cases were described by: age and sex; agent of injury (e.g., ice, motor vehicle collision); nature (e.g., fracture, abrasion); treatment and disposition; day of presentation and the prevailing weather conditions. They were also coded for severity according to the 1990 revision of the Abbreviated Injury Scale (AIS).[6]

RESULTS

Overall

There were a total of 669 injuries that presented to the two Kingston emergency departments during the 13-day period beginning the day of the storm. Two hundred and fifty-four (38%) of these injuries (to 252 different people) directly resulted from the storm or its aftermath. The total number of injuries (669) was slightly lower than the number (692) seen during the same time period of the previous year (January 7-19, 1997).

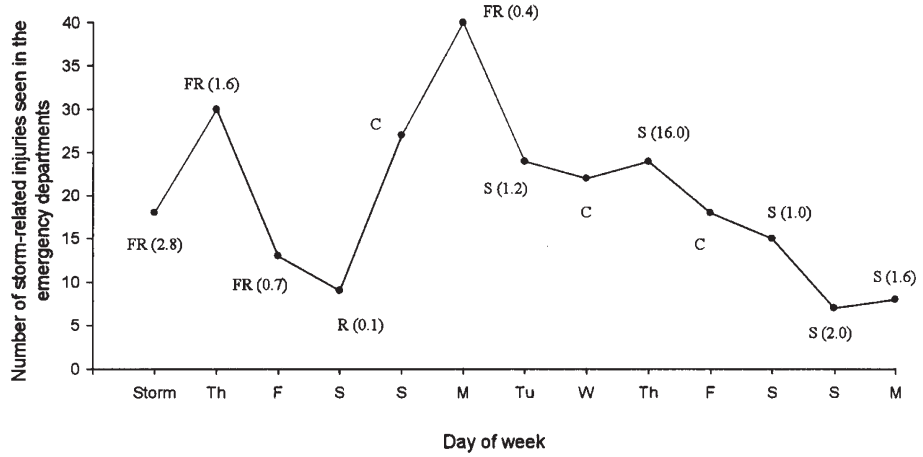
Injury severity

Of the 254 cases, 131 (52%) were classified as injuries with minor severity according to the Abbreviated Injury Score (AIS score 1), 64 (25%) with moderate severity (AIS score 2), and 28 (11%) with serious severity (AIS score 3 or greater). 31 cases could not be assigned an abbreviated injury score because of insufficient information on the medical record. No deaths were identified, although two fatalities attributable to the ice storm occurred out-of-hospital during the same time period (one from carbon monoxide poisoning, one from severe burns).

TABLE III
Disposition, by Day

Date (January)	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Day of week	Wed	Thurs	Fri	Sat	Sun	Mon	Tues	Wed	Thurs	Fri	Sat	Sun	Mon	
Precipitation (cm)	FR 2.8	FR 1.6	FR 0.7	R 0.1	- -	FR 0.4	S 1.2	- -	S 16.0	- -	S 1.0	S 2.0	S 1.6	
Disposition														
Left without being seen	1	-	-	-	-	2	-	1	-	-	-	-	-	4
Advice only	-	2	-	-	2	4	1	-	4	3	1	2	-	19
Treated, follow-up as required	13	14	12	5	14	21	17	6	11	7	10	3	2	135
Treated, follow-up required	4	9	3	3	9	12	5	13	9	4	2	2	5	80
Admitted to hospital	-	3	-	1	2	1	-	2	-	-	1	-	-	10
Transferred to other hospital	-	-	-	-	2	-	1	-	-	2	-	-	1	6
Total	18	28	15	9	29	40	24	22	24	16	14	7	8	254

FR-freezing rain; R-rain; S-snow



FR-freezing rain; R-rain; S-snow; C-clear; (total precipitation in cm)

Figure 1. Total number of storm-related injuries presenting to the emergency departments in Kingston (January 7-19), by day of the week

Time of presentation

The number of storm-related injuries peaked the day following the storm and again five days after the storm (Figure 1).

Age and sex

More males (59%) were injured than females (41%). The majority (66%) of injuries involved persons between the ages of 20 and 59. Individuals younger than 20 accounted for 15% and those older than 60 accounted for 19% of the injuries.

Agent of injury

Table I describes the agent of injury by day of the storm and its aftermath. The majority of the injuries (58%) involved ice, with most of these (97%) resulting from slips or falls on the ice and the remaining cases (3%) resulting from being hit by falling ice. The second most common agent of injury accounting for 15% of all injuries involved aspects of clearing brush or trees, such as hit by tree/branch (44%), cut by chainsaw/axe (21%), and falls from tree/ladder (18%). The third most common agent of injury (9%) was carbon monoxide from the use of generators, charcoal barbeques, propane barbeques and kerosene heaters under inadequately ventilated conditions.

Nature of injury

Table II describes the nature of injury by day following the onset of the storm. The most common injuries were superficial abrasions/lacerations (31%), fractures/dislocations (19%), and open wounds (15%). Sprains/strains (10%), poisonings (9%), and minor head injuries (6%) constituted the majority of the other injuries. More severe injuries (i.e., fractures and poisonings) relative to the soft tissue injuries peaked four to five days after the storm, during the initial clean-up phase.

Disposition

The majority (92%) of cases were seen or treated in the emergency department and discharged home. Ten individuals (4%) required admission to hospital and six individuals (2%) were transferred to another hospital for care. There were no apparent patterns in disposition seen over the 13-day period (Table III).

DISCUSSION

The rapid surveillance of health impacts following natural disasters provides accurate and timely information that can be used by health care providers and community representatives to assist in planning for future events.[3] The existence of the CHIRPP injury surveillance program allowed us to explore the impact of the ice storm on one aspect of population health. This was done in a comprehensive fashion, at no cost to the community or the institutions involved. This analysis shows how the CHIRPP system can be exploited to quickly identify important or emerging patterns of injury occurrence, and to monitor small epidemics of specific types of injury.

There were two clear temporal peaks in the occurrence of these injuries. The number of injuries peaked the day following the onset of the ice storm and again early during the week of January 12th (4-6 days following the storm) when major restoration efforts were initiated, and residents gradually began to return to regular activities. The second peak was also associated with the largest numbers of carbon monoxide poisonings observed. These patterns provide useful direction for the planning of emergency responses to future natural dis-

asters. In general, the occurrence of injuries directly related to the relative degree of exposure to ice storm hazards.

The absolute number of injuries that presented to the Kingston emergency departments during the course of the ice storm was not unusual. However, the observed decrease in the overall number of injuries is not consistent with one published report from two hospitals in Maine,[7] which showed a 47% increase in the total number of emergency visits in 1998 (2,586 visits) versus 1997 (1,758 visits) for the same time period. When limited to injuries other than carbon monoxide poisonings, they observed a 14% increase in 1998. The CHIRPP data collection system in Kingston does capture 100% of injuries presenting for emergency medical care, and the decrease observed in 1998 is valid. While the ice storm contributed to the occurrence of many injuries due to the unusual environmental conditions, it also resulted in decreases in other types of injury that occur in high numbers during normal conditions (e.g., injuries associated with organized sports).

The observation of slips and falls on the ice as the most common source of injury is not surprising or new.[5] Slips and falls on the ice were the source of many of the more severe injuries, accounting for 69% of the fractures/dislocations and 84% of the head injuries/concussions. For comparative purposes, we examined the types of injuries treated during the winter of 1996-97 (November through March). While the percentage of fractures/dislocations was comparable between the two periods, almost twice as many concussions/head injuries occurred during the ice storm and its aftermath.

Clean-up activities following a natural disaster have previously been identified as a source of an important number of injuries.[8,9] Injuries from clean-up activities primarily involved being hit by a tree or branch, falling from a tree or ladder, and being cut by a chainsaw or axe. These injuries most commonly involved the head (41%) and the upper extremities (39%). There is clearly a role for public health officials to provide education and warning regarding hazards and safety measures. The use of safety devices including protective clothing/equipment should be encouraged during clean-up activities.

We observed a cluster of unintentional carbon monoxide poisonings and have reported on this cluster in detail elsewhere.[10] During the 13-day period beginning the day of the ice storm, 22 individuals were seen in the Kingston emergency departments for unintentional carbon monoxide poisonings compared to 12 cases treated in the three-year period ending December 31, 1996. These poisonings frequently occur during power outages, due to the use of alternative methods of heating and cooking.[11-13] Again, there is a role for health officials to inform the public regarding the hazards of carbon monoxide and indoor use of gas and charcoal appliances.

CONCLUSION

This analysis highlights the value of an existing surveillance system in enabling researchers to quickly recognize patterns of injury occurrence and examine mini-epidemics. During the 13-day period beginning the day of the ice storm, there were 254 storm-related injuries that presented to the two emergency departments in Kingston, Ontario. The patterns of injury observed were clearly related to the unusual environmental conditions posed by the storm. This analysis provides useful information for public officials to review disaster plans and generate recommendations for future occurrences.

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REFERENCES

1. Environment Canada. Monthly Meteorological Summary. Ontario Climate Centre, Environment Canada.
2. Canadian Broadcasting Corporation. Reports on 'Ice Storm '98' (various). Toronto: *The National*, CBC English Television, January 1998.
3. Binder S, Sanderson LM. The role of the epidemiologist in natural disasters. *Annal Emerg Med* 1987;16:1081-83.
4. A descriptive study of childhood injuries in Kingston, Ontario, using data from a computerized injury surveillance system. *Chron Dis Can* 1996;17:21-27.
5. Geehr EC, Salluzzo R, Bosco S, et al. Emergency health impact of a severe storm. *Am J Emerg Med* 1989;7:598-604.
6. Association for the Advancement of Automotive Medicine. The Abbreviated Injury Scale, 1990 Revision. Des Plaines, IL: AAAM, 1990.
7. Holt D, Even J, Young Jr. WW, et al. Community needs assessment and morbidity surveillance following an ice storm – Maine, January 1998. *MMWR* 1998;47:351-54.
8. Glass RI, O'Hare P, Conrad JL. Health consequences of the snow disaster in Massachusetts, February 6, 1978. *Am J Public Health* 1979;69:1047-49.
9. Faich G, Rose R. Blizzard morbidity and mortality: Rhode Island, 1978. *Am J Public Health* 1979;69:1050-52.
10. Hartling L, Brison RJ, Pickett W. Cluster of unintentional carbon monoxide poisonings presenting to the emergency departments in Kingston, Ontario during "Ice Storm 98." *Can J Public Health* 1998;89(6):388-90.
11. Centers for Disease Control. Unintentional carbon monoxide poisonings following a winter storm - Washington, January 1993. *MMWR* 1993;42(6):109-11.
12. Wrenn K, Conners GP. Carbon monoxide poisoning during ice storms: A tale of two cities. *J Emerg Med* 1997;15(4):465-67.
13. Houck PM, Hampson NB. Epidemic carbon monoxide poisoning following a winter storm. *J Emerg Med* 1997;15(4):469-73.

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