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The ice storm in eastern Canada January 1998

KAMEDO 74

KAMEDO is a Disaster Medicine Study Organization that is part of the Unit for Emergency Preparedness of the Swedish National Board of Health and Welfare. KAMEDO's main task is to send observers to disaster areas to collect information and then study the medical, psychological, and social impact of disasters and war, as well as rescue and health care systems.

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Foreword

Sweden's geographical location is one reason that the country has been spared major natural disasters. Most reports from KAMEDO have instead shed light on disasters or major incidents caused by human beings, as those experiences could contribute important lessons for Swedish disaster preparedness.

Natural disasters seem usually to have such force and intensity that human beings in many cases have little or no chance to affect their course and effects. To the extent the disaster can be foreseen, we can act to ensure our safety. In other cases, climatic changes and especially weather and wind can be so difficult to predict that protecting ourselves against the forces of nature is nearly impossible, which was essentially what happened to the inhabitants of southern Québec and eastern Ontario, Canada and northern New York State in the United States in early January 1998. An extreme warm front from the south collided with an Arctic cold front and on January 6th and for several days thereafter caused ice accretion whose like had never been seen before. The ice covered everything and its weight eventually broke down the entire power supply grid for three million people when the crisis reached its zenith. This happened in a country that is much like Sweden in terms of climate and where the energy supply is almost entirely dependent on electricity. For many, the wait to get their electricity back was very long.

Aimed at increasing our understanding of how Québec managed this extreme situation, technically and medically, KAMEDO dispatched Louis Riddez, surgeon and scientific secretary of KAMEDO, and Uno Dellgar, M Sc Civil Engineering, technical consultant in the field of risk, safety and security, to Canada.

This report details the course and consequences of the natural disaster. It also describes the actions of political leaders, the power company, rescue services, the health care system, the police, and the military during the disaster.

In addition to field trips to the areas affected by the disaster, the factual basis for this report was acquired by means of reports, periodicals, and newspapers, but first and foremost through a large number of interviews with managers, engineers, and rescue and medical personnel involved.

The authors are solely responsible for the information and opinions given in the report.

The information is intended to shed light on the difficulties and special circumstances that may arise in similar situations and how they were resolved in Canada. We hope that this will create opportunities to improve our own preparedness for a similar, serious situation.

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Summary and conclusions

Recent years have seen increasing discussion of global warming and the recurring weather phenomenon that has been christened El Niño or La Niña. El Niño, caused by warm currents formed in the Pacific Ocean that move towards the coasts every six to eight years, has been assigned primary blame for causing the frequent natural disasters experienced around the globe in recent years, especially in 1997 and 1998, and the natural disaster, the ice storm, described in this report.

Canada and more specifically Québec had previously experienced brief periods of freezing rain, but starting on January 4th 1998, the region experienced several days of almost non-stop fall of such rain. The freezing rain caused a thick accretion of ice at ground level. In the hardest-hit regions, the thickness of the ice was measured at more than 100 mm at ground level and the ice accretion on overhead power lines had an estimated radius of up to 40-50 mm, nearly doubling the weight of the lines. Wind also caused movement in the power lines that caused the large pylons to break apart.

The power supply system broke down successively in a few days and on January 9th an estimated 1.4 million households, or almost three million people, were without power. Most inhabitants and government authorities had initial difficulty predicting the gravity of the situation. People expected the weather to return to normal and for the power cut to be short-lived. For that reason, the provincial government never declared the situation a disaster, which later had legal consequences, e.g., with respect to insurance claims. Unprepared, many people had to wait several weeks before their power could be restored, and that during the worst of the winter season.

The ensuing situation demonstrated the pronounced degree to which we are dependent upon electrical power. Essential infrastructures such as production, storage, and distribution of energy and heating, hospitals and other health care providers, production of food and drinkable water, telecommunications and data transmission, transport of people and goods, and the banking and finance system were affected. The provincial government's disaster committee and Hydro Québec, the power company involved, were thus compelled at an early stage to prioritize the infrastructures for which power needed to be restored first. Health care institutions were first on the priority list, followed in descending order by rescue services and communications centres, emergency shelters for people forced to leave their homes, and other units engaged in some type of humanitarian or social activity.

Impact on households, health, and medical care

The disrupted power supply nearly paralysed most essential systems that are needed in a modern home. A huge need for petrol- or diesel-powered generators quickly arose. The provincial government appointed a coordination centre that worked around the clock to prioritize, coordinate, distribute, and supervise the function of the generators. Nevertheless, the need was greater than the allotment and theft of generators occurred even though crime otherwise dropped during the period. Other sources of energy such as wood could be used, however, not least because of the large number of fallen trees that needed to be removed.

Despite these supplemental sources of energy, many people could not remain in their homes and depending on the region 25-56 percent of the population were forced to move. The majority were able to move in with relatives or friends, but about 4-5 percent of the population, or some 140,000 people, spent at least one night in one of the 454 emergency shelters that the central disaster organization was forced to open. A number of problems arose in the shelters, however, where people complained about poor sanitary conditions, hardships for people with disabilities and senior citizens, and a certain amount of promiscuity, particularly early in the period.

The hospitals and small health care structures were assigned top priority when it came to restoring normal power supply. Even before the crisis, however, the hospitals were equipped with emergency generators to enable the provision of emergency medical care. As a result, the emergency medical care system functioned adequately even in regions where power supply was disrupted for an extended period. In order to secure emergency care provision, other activities were cut to a minimum; elective surgeries were cancelled and certain examinations and treatments that require electricity were postponed. At some hospitals, employees and their families were invited to live at the hospital during the crisis in order to better ensure staff availability. This was necessary especially in the hardest-hit regions, where a larger than normal number of patients sought care at the hospitals. The greatest increase was among patients seeking care for trauma caused directly or indirectly by the weather. The number of upper respiratory infections and cardiac symptoms also increased. Misapplication of petrol- or diesel-driven generators also caused a sharp rise in the number of cases of carbon monoxide poisoning. Of those cases, six people died and fifty required hyperbaric oxygen treatment.

In contrast to the large acute care hospitals, certain long-term care facilities and district and private medical centres were without power for several days, in part because they had no built-in emergency generators. In isolated cases, patients had to be transferred to other hospitals or emergency shelters. Personnel from closed medical centres could be utilized to a certain extent to provide medical care in shelters, but some underutilization of primary care resources was recorded.

There was an enormous load on prehospital medical care during the period. The need for ambulance transports rose markedly, as in addition to ordinary hospital transports, ambulances were also used to transport people to shelters and to transport medical supplies. Road conditions were bad and telephone and radio communications were poor or out of order. As a result, coordination of transports failed and military transport had to be brought in. Some exhaustion among ambulance personnel was recorded.

Water supply during the crisis was at risk of being affected by non-functioning water pumps and water purification plants. About a hundred communities were affected, but only for a few hours at the worst as power supply could be re-established using emergency generators connected to the plants. No health problems due to contaminated water were reported.

Information management during the crisis was managed by individual municipalities with some assistance from the Ministry of the Interior. According to the province's disaster plans, it was essential to inform the public about current events, risks, channels of communication, and which actions should be taken by individuals and which were the government's responsibility. Although there were substantial differences among municipalities, it proved that information in general was often impeded by limited resources, which frequently had an impact on official administrations as well. Some information was provided via television, which could be seen only by those with power. The radio could probably have been used to a greater extent. Much of the information that circulated among the public was mixed with rumour, usually leading to inaccurate information.

Conclusions

- Power and telephone supply have become such general utilities and so reliable that we normally simply expect them to be there. In recent years, information technology has gained equal standing. This trend has created a dependency that has become a new vulnerability. A hundred years ago, people would not have been affected in the same way or to the same extent by a similar weather situation.

- Preparedness that enables better prevention of various kinds of disruptions in energy and communications systems must be developed in pace with technical progress. For instance, the same concern about the Y2K bug in our computer systems could have been transferred to many other structures essential to society. Security systems must in all likelihood be continually redesigned for every essential infrastructure.

- The acute care system in Québec was able to adequately adapt to the higher patient load. Offering food, lodging, and heating to hospital personnel and their families was a good solution for securing the workforce. Even though the power cuts were protracted for certain hospitals, essential acute examinations, treatments, and operations could be performed. Expansion with several emergency generators could improve the situation in cases of extended power cuts and in that case allow health care facilities to continue operating almost as usual.

- The ice storm had a significant impact on the acute care system, in that the affected population substantially changed their risk behaviour. A higher number of deaths and serious injuries occurred when people tried to remove the ice accretion from buildings, especially roofs. A considerable rise in the number of carbon monoxide intoxications was also recoded, which were caused by improper use of new sources of energy, usually without ventilation. Even though the authorities swiftly spread information aimed at preventing certain health risks, they did not manage to reach everyone. In the future, they intend to improve warning texts, e.g., on various kinds of generators. The lack of heating in many homes did not keep some of the population from remaining in their homes, but six people died of hypothermia.

- In future, the primary care system in Québec should be able to play a larger role than it did during this disaster and therewith provide more relief to the hospitals. Extra generators should be installed even at smaller health care facilities, such as district and private medical centres. The district medical centres, for which power was restored early on, could effectively relieve the pressure on the acute care hospitals during the period and many doctors in private practice were also, at least to a certain extent, able to see patients at the district medical centres.

- During the crisis, the home health care system had difficulty identifying and visiting all of the people who were at special risk. Many home health care patients were assisted mainly by relatives or friends, who took them to the hospital. There is an urgent need to reinforce primary care resources in Québec in order to better identify, locate, and help these patients as needed. Cooperation between the health care system and social services agencies must also be improved.

- The ambulance service proved to have difficulty following established disaster plans during the crisis and those involved should participate more often in disaster preparedness exercises. There is also a need to find reserve communications systems when the ordinary phone network is broken down or overloaded.

- In the opinion of the public, regular and adequate information is one of the most important tasks for which government agencies should be responsible. Despite some understanding for the fact that it was difficult to gain an overview of the situation and to disseminate what information there was, many people experienced stress because they could not predict how their situations were going to evolve. Many people in the immigrant population were poorly informed due to language barriers.

- Effective disaster preparedness requires continual work at the legislative and executive levels. It is essential that the government agencies concerned make themselves aware of all old and new risks to which a society may be exposed and that this knowledge is to a certain extent communicated to the population. Disaster plans prepared according to that principle must be regularly revised, but first and foremost they must be linked to recurring exercises to enable adequate compliance. During the ice storm, several weaknesses were revealed in the province of Québec's disaster preparedness, but when official measures no longer sufficed, ordinary people demonstrated great capacity to resolve difficulties on their own, as well as a heightened sense of solidarity.

Canada and the province of Québec

Geography and climate

Canada is five times larger in area than Europe but had a population of only 30 million as of 1996. The country, much of which is sparsely populated, is divided into ten provinces and two large northern territories. Canada was officially a colony of the British Commonwealth until 1948 and is still a constitutional monarchy, but the British queen is represented only by a "Governor General" in parliament, who has no power.

The country is divided into several large provinces. The province of Québec, the hardest-hit during the disaster, has a population of approximately five million, the majority of whose native language is French. There has been a long-standing conflict between segments of the French and English speaking populations that has yet to be fully resolved.

Like the other Canadian states, the province of Québec is governed by a provincially elected government that is responsible for the province's educational system, legal administration, civil rights system, natural resources, and social and health care systems. The latter two are similar in many respects to those we have in Sweden.

In a country as large as Canada, the climate varies considerably from coast to coast. The regions affected by the ice storm have essentially a mainland climate where the winters are often cold and snowy and the summers hot and humid. Some people claim that the climate is changing, which could explain the unusual weather that created heavy ice accretion over large parts of the country for several days.

Extreme weather situation knocked out the power supply

The extreme weather started when a slow-moving warm front travelled from Texas towards the northeastern United States and eastern Canada. At the same time, a cold front was moving in front of a high pressure system from the Arctic towards the same area. When the two air masses collided, the warm air was pushed up and over the cold air. Snow fell that melted in the warm air, but cooled again in the underlying cold air and fell to the ground as freezing rain. The winds were relatively weak and the weather situation did not change for some days.

The freezing rain started falling on January 6th 1998, a Tuesday, and continued for most of the rest of the week, including Friday. The temperature of the air near the ground hovered around zero for the first few days. The temperature rose on Saturday and the rain stopped. A cold front began moving in over the area on Saturday evening. The amounts of precipitation varied locally, but there is talk of 35 mm of precipitation in the first 24 hours. Within the course of a week, an ice coating up to 100 mm thick built up. The power lines, which were not designed to withstand such a thick layer of ice, successively collapsed.

At the height of the crisis, some 1.4 million households, or three million people, in southern Québec and eastern Ontario were without power. Northern New York State in the United States was also affected, but not to the same extent and mainly in rural areas.

The hardest-hit area was the Montérégie region south of Montreal where 300,000 people were without power for an entire month.

New vulnerability

There has been speculation over what caused this extreme weather situation. Some point the finger at El Niño, i.e., effects of temporarily changed current conditions in the Pacific Ocean. Others believe that the greenhouse effect and global warming are significant.

A similar weather situation occurred in the area twelve years earlier. About 25 mm of precipitation fell in the form of freezing rain, but stopped after the first 24 hours. The history of Canada does not go very far back in time and neither do its weather statistics, but it is believed that precipitation similar to that of January 1998 can occur at the most once a century on average, over a long period of time.

That which is unique about the 1998 ice storm may perhaps stem primarily from modern society's having taken on new vulnerabilities in recent decades. We are much more dependent on electrical power nowadays. People of a century ago would not have been affected in the same way or to the same extent by a similar weather situation.

Chronology

The ice storm day-by-day

- Sunday, January 4th 1998. An extreme weather type occurred, hitting parts of eastern Canada first. A slow-moving warm front that had moved from Texas up towards the northeastern United States and eastern Canada met a high pressure system of cold air from the Arctic. When the air masses collided, the warm air was pushed up and over the cold air. The snow that fell melted in the warm air and fell to the ground as freezing rain. Several schools and motorways in the earliest hit regions were forced to close and the ice storm claimed its first life after a traffic accident.

- Monday, January 5th. The same weather phenomenon continued to cause additional fall of freezing rain, which increased the ice layer.

- Tuesday, January 6th. The storm reached the province of Québec. A thick layer of ice formed on everything including the large overhead power lines from the north. Power lines that might normally weigh 30 tons doubled in weight and the pylons holding up the ice-covered lines broke apart. The same happened to many phone lines. The power was knocked out to some 750,000 households in Québec and 60,000 in eastern Ontario. One death from carbon monoxide poisoning was reported in Montreal and the first shelters that could offer heating, light, and food were opened in the city.

- Wednesday January 7th. Freezing rain continued to fall and schools, universities, and shops had to be closed in Montreal. More than a million people in the province of Québec were without power, along with thousands of households in Ontario.

- January 8th. The storm worsened and a severe need arose to acquire generators for energy supply. The power company that supplies the city of Montreal (Hydro Québec) requested assistance and the Canadian Armed Forces sent troops to Montreal to help. Some radio stations in the affected areas were without power and unable to broadcast.

- Friday January 9th. An estimated three million people were without power. A state of emergency was declared in twenty regions in the province. The ice storm was assessed as the largest disaster to ever hit Canada. The prime minister of Québec requested more military assistance from the federal government on what was later judged the worst day of the crisis. The power grid in the city of Québec was near collapse. During the day, however, and with tremendous effort, the power was restored to about two thirds of those affected in the province. Meanwhile, freezing rain continued to fall and new shelters had to be opened for people who were still without power.

- Saturday January 10th. The temperature rose slightly and power was restored to additional households.

- Sunday January 11th. About 900,000 people in the province of Québec still had no power and Hydro Québec estimated that it would take another two weeks before all subscribers in the hardest-hit areas could get their power back. At the same time, the cold – despite a short-lived rise in temperature on Saturday – had become a severe problem for many.

- Monday, January 12th. The police and the military went door-to-door to pick up people who had not yet elected to leave their cold, unheated homes. The fluctuating temperature had in some areas dropped to minus 20° C, so there was a distinct risk of general hypothermia in people who remained in their homes. At the same time, the material damage was vast. In Ottawa, damage was estimated at as high as CAD 500 million.

- Tuesday January 13th. The military was granted the same rights as the local police, including the power to arrest looters in the storm-wreaked city of Québec. The strong winds combined with the cold lowered the temperature to minus 30-35° C.

- Wednesday January 14th. Power was restored to most of Montreal, but inhabitants in the most severely affected regions could still not expect to get their power back for at least another week. More than 80,000 households in Ontario still had no electricity, which also applied to many companies.

- Thursday, January 15th. Some 450,000 subscribers still had no power. The cold weather continued and the authorities had to continue the forced evacuation of people who had yet to leave their homes. In some areas, there were shortages of fresh water and food. The federal government presented an aid plan. Companies could resume normal operations.

- Sunday, January 18th. About 500,000 people still had no electricity. In rural areas, farmers had paid dearly while waiting for power. A large percentage of cattle stock had not survived the cold and cows could be milked only with great difficulty due to infections. Milk and other agricultural products had been destroyed.

- Tuesday, January 20th. Schools resumed classes for the first time since the crisis began. Power restrictions on companies in Montreal were lifted and they once again were able to consume power outside the hours of 9 a.m. to 4 p.m. The estimated number of fatalities due to the ice storm was 28.

- Thursday, January 22nd. Power supply was functioning in large parts of Montreal, but the regions south of the city were still not reconnected to the power grid. Some 400,000 people in Québec were still without power. Hydro-Québec promised to invest CAD 650 million to improve the power grid.

- Tuesday, January 27th. At least 150,000 individuals south of Montreal were still without power and Hydro-Québec's proved unable to meet its schedule. Exhausted repair personnel who had been pushed to the utmost for several weeks got help from new personnel who came in from Canada's western provinces of Manitoba and British Columbia, as well as the United States.

- Friday, February 6th. After slightly more than a month, Hydro-Québec had finally restored power to all subscribers.

- Wednesday, February 12th. Freezing rain fell again, causing a new, but this time short-lived, power cut for 13,000 subscribers south of Montreal.

Disaster preparedness in Québec

The Department of Civil Security
Within the ministry responsible for public security in Québec there is a unit called the Department of Civil Security and Prevention (*La Direction générale de la sécurité et de la prevention*). The unit has about 80 employees and works with an annual budget of about CAD four million (1996–1997).

There has also been a committee (le Comité de Sécurité Civile du Québec) since 1988 that is responsible for coordination between the ministries and organizations involved in civil security planning. Resources from the various ministries are collected in an organization called "*l'Organisation de Sécurité Civile du Québec*". This organization is responsible for mobilizing all available resources when a major disaster occurs.

Disaster preparedness in the province of Québec is based largely on the principle that each individual municipality should play a separate and critical role before, during, and after a disaster.

This means that each municipality is responsible for preventive efforts related to local disaster risks. Accordingly, the municipalities are required to develop various kinds of disaster plans. When a disaster occurs, the plans are set in motion and the municipality is obliged to initiate actions to save as many lives and important structures as possible. After the disaster, the municipality ensures that measures are taken for rebuilding. Municipalities are also required to analyse the causes of the disaster and to attempt to prevent repetition of the problems.

At a higher regional level, there is a "*Comité Régional de la Sécurité Civile*", a committee that takes regional responsibility during a disaster to ensure that municipalities are provided the requisite support. This committee is responsible for ensuring that coordination exists among all parties involved and that a coordination centre exists for the purpose.

Finally, the Committee for Civil Security (*"Comité de Sécurité Civile du Québec")* acts at the highest level. Its task is to assist the provincial government in constructing a provincial disaster plan. When a disaster occurs, the committee is transformed into a disaster organization called the "*Organisation de Sécurité Civile du Québec*" which is then responsible for coordinating all activity at the provincial level.

Analysis of disaster preparedness during the ice storm

As described above, the province of Québec had clearly defined plans at the provincial, regional, and municipal levels to follow in the event of a disaster. During the ice storm, however, it proved very early on that many of the clearly defined measures that should have been taken were neglected. First and foremost, four critical points were clearly ignored.

1. The provincial government never officially declared the ice storm a disaster. At a later stage, the omission caused legal problems, e.g., with respect to insurance claims.
2. The Committee for Civil Security, whose tasks included disaster planning and which would normally be transformed into an ”*Organisation de Sécurité Civile du Québec (OSCQ)*” or “disaster organization” was essentially replaced by an inter-ministerial secretariat made up of 14 ministers, i.e., two thirds of the council of ministers. The government gave the secretariat considerably more freedom to act than the original disaster organization, whose activities were thus significantly subordinated.
3. At the municipal level, the disaster plans prepared in advance proved to be of little value, as they were seldom followed. In many municipalities, disaster preparedness exercises had never been done. In the most severely affected region of Montérégie, it was very difficult to coordinate disaster relief efforts in nearly half of municipalities with fewer than 10,000 inhabitants. Support from the regional level was also criticized. Many municipalities were left to manage their problems using available resources.

4. In the eyes of many, it was instead the people’s solidarity, struggle to survive, and ability to overcome difficult situations that saved the day. The investigatory commission (*La Commission scientifique et technique chargée d’analyser les événements relatifs à la tempête de verglas* or the Nicolet Commission) that reviewed the effects of the ice storm declared “An explicit willingness on the part of the government of Québec will be required in future to change the current attitude of indifference and disorganized mobilization in the face of disaster”.

The Commission recommends that the provincial government attempt to achieve three objectives

1. Creation of a sort of “tradition of civil security” in the province. At present, there is a certain culture with respect to traffic safety, health care, and prevention of occupational injuries. Something similar should be created for potential disasters.

2. Definition of a proper system for civil security. Such a civil security system should lead to the drafting of plans for risk management and management of various disasters, as well as plans for maintaining the system itself. The establishment of such a civil security system would entail working with a concept that deals with “normalized risk”. This entails becoming fully aware of all risks that can disrupt the normal function of society – risks that are becoming ever more diversified and credible by reason of the rapid advance of technology. This raising of awareness also normalizes that which must be done in every kind of disaster.

3. Regrouping of government functions and structures that are directly affected when a disaster occurs. In each type of disaster, the first to act must be the affected municipality and its population, but there must be a direct connection with other municipalities, districts, and regions in the vicinity. Government agencies must be able to swiftly reorganize activities in order to coordinate these major actions. The

differences between a state administration in normal circumstances and the administration that must act in a disaster must be as little as possible. In disaster mode, it must be possible to make decisions in a simpler fashion and easier to delegate tasks and allocate responsibility.

Essential social structures in the province of Québec and problems caused by the ice storm

Power supply

Hydro Québec is the power grid owner and electricity supplier for the affected areas in the state of Québec. The power company produces hydroelectric power in the northern parts of the province and Newfoundland and buys also energy from the state of New York in the United States.

Power is transmitted via high voltage lines of 735 to 765 kV to the more densely populated areas in the southern part of the province of Québec, including Montreal. Electrical power from New York is transmitted directly to the Montreal area.

Hydro Québec's power grid has a total line length of almost 100,000 km.

The high voltage lines are designed to withstand ice accretion of 45-55 mm in Zone 1, which includes the Saint Laurent valley, and accretion of 35-45 mm in Zone 2, which includes the rest of the territory.

Power lines closer to densely populated areas, with voltages of 120 kV or lower, are designed to withstand ice accretion of 28-38 mm.

One reason that that Montreal area was hit especially hard compared to e.g. Ottawa is that the local power grid in the state of Québec has a high percentage of overhead lines, while underground power lines are more common in Ontario. Overhead lines are not usually seen in central Montreal, but are common in the large residential and industrial areas.

The Nicolet Commission has recommended that the power grid in the state of Québec should successively increase the percentage of underground lines in the local network.

The power grid had been rebuilt by the first of February (temporarily or permanently) and connected so that the lines marked in green in the diagram were up and running.

Water supply

The power cut during the ice storm affected the water supply in two ways. First, water pumps that ran on electricity stopped working, and second, the electrically powered systems at water purification plants did not work.

Water supply could be secured for many households, however, through electricity supplied by privately owned petrol-driven generators.

At the municipal level, the disrupted power supply affected water filtration and purification of waste water in about a hundred municipalities. The water supply for fire fighting was also affected. The provision of power could, however, be rapidly reinstated using emergency generators connected to the plants.

The city of Montreal, which collects raw water from the Saint Laurent River, had no emergency power. On Friday, January 9th, the city was close to being without water when two water purification plants stopped working. At the direct request of the mayor, Hydro Québec put priority on quickly re-establishing power there, at which the company succeeded. Even though the power cut lasted for only a few hours, water pressure dropped significantly in many neighbourhoods. During the power cut, the city issued a warning that "there is risk of water contamination and all water should be boiled". When there is a shortage and pressure in the pipelines is weak or non-existent, leaky sewerage systems can infect the water. Standing water in the pipelines can also become unfit for human consumption after a while, even if nothing from the outside is affecting it. The primary reason for providing that information to the public was to prevent stockpiling. If many people stockpile water, it automatically makes the shortage a fact. If instead of announcing a shortage the message is that water must be boiled, consumption will decline drastically, which is what indeed happened. The warning was cancelled two days later. No immediate health problems due to contaminated water were reported.

Electricity and heating - solutions

Heating is supplied in Montreal mainly with electricity and oil. There are no significant district heating systems. Supply is individual or, in central districts of the city and in exceptional cases, in small groups of buildings. Newer buildings in the city have a larger percentage of heating supply using electricity. Housing consists to a large extent of single-family houses, many of which have wood-burning stoves or other means of heating with wood.

The disrupted power supply knocked out most essential systems needed in modern homes, including heating. Very quickly, a huge need to acquire petrol- or diesel-powered electric generators arose. Early on, the provincial government had to deploy resources to coordinate the needs. This was accomplished via the Department of Civil Security, which opened a coordination centre where fifty people with specialist expertise worked around the clock to inform the public on how to use the emergency generators. Human resources from various government departments were also allocated to acquire and distribute the generators. About twenty Hydro Québec employees worked full-time inspecting temporary power generation installations for safety and compatibility with imported systems.

Large, private sector companies also helped enable the relative rapid acquisition of more than 1,200 extra generators with total output of 110 megawatts.

Distribution, repair, and maintenance of the generators were to be performed in the following order of priority:

1. Health care facilities
2. Rescue services and communications centres
3. Shelters for victims of the disaster and other units engaged in some type of humanitarian or social activities

Later investigations have shown that seven percent of the population already had some kind of extra generator before the crisis. During the ice storm, ten percent of the affected population used a generator, of which slightly less than one third used a generator lent to them through the provincial initiative.

A large number of small power generators were acquired from elsewhere in North America. The devices were used by farmers and private individuals. The generator was placed in a garage, on the balcony, etc., and run for a few hours, and then handed over to the next person in need. Operational problems with the generators arose because they were not always designed for extended operation and could neither be run or maintained correctly.

Misapplication led to a number of cases of carbon monoxide poisoning, e.g., because the generator was placed on the balcony with the window opened slightly to make room for the cord, allowing emissions to enter the home. No accidents due to incorrect electrical connection were reported.

Despite the intensive efforts devoted to acquiring generators, the need was still greater than the allocation. As a result, there were some thefts of generators, although crime otherwise dropped during the period.

"Firewood Front" of fallen trees

The demand for firewood rose markedly during the first week of the ice storm, especially in the most severely affected area, Montérégie. On January 11th 1998, the central disaster organization set up a "firewood front" to coordinate the provision of firewood to those in need. Several centres for firewood production were rapidly established; not least importantly, large quantities of wood could be harvested from the very large number of fallen trees caused by ice accretion. All told, "Operation Firewood" cost CAD 5-6 million.

Despite massive efforts to restore power supply by various means, an astounding three million people were without power when the crisis reached its zenith. The power cut made it impossible for many people to maintain adequate warmth in their homes to remain under acceptable conditions, but a very large percentage of the population nevertheless elected to stay at home as long as possible. A limited survey of the public was carried out in the Montérégie area, which asked people how cold it would have to get

before they would have to abandon their homes. The 3,685 people asked responded as shown on the table below.

Limit	*Number*	*Percentage*
At least +15° C	1,276	35
+10-14° C	752	20
+5-9° C	520	14
Below +5° C	628	17
Don't know	505	14
Did not answer	4	0
Total	3,685	100

The public's acceptable temperatures for staying overnight in the home

Evaluations have shown that 25%-56% of the population, depending on the region, were forced to leave their homes. Most (96.4 %) were able to use their personal resources to get help from relatives, friends, and neighbours for temporary housing, or relocate to a vacation home. Many people crowded together and there were as many as 20-30 people in a single private home. On the other hand, some people chose to stay home once they were given the opportunity to obtain adequate meals, e.g., at emergency shelters.

Shelters for the homeless

Arranging temporary housing for the segment of the population that could no longer remain in their homes became top priority for the central disaster organization "*Organisation de Sécurité Civile du Québec*". During the period, 454 emergency shelters were set up around the various municipalities, with a total capacity of 130,000 beds. Utilization of the shelters reached its height on January 17th, when a total of 17,800 people were housed. An estimated 4-5 percent of the population, or 140,000 people, spent at least one night in a shelter. Several thousand more used the facilities to gain access to hot meals, showers, and toilets.

Problems in emergency shelters

Especially at the beginning of the period, problems arose in some shelters (especially in Montérégie, the most severely affected region) with promiscuity and normal health and hygiene. Several shelters had difficulty offering acceptable opportunities for normal hygiene, food, and place to rest. Tensions arose frequently among the people forced into the shelters, especially after a few days when sanitary problems could no longer be resolved fast enough. Many people complained that once they were housed in a shelter they were abandoned to their fate, but for many people who normally lived alone and were suddenly being properly cared for, it felt hard to return later to their lonely homes. Taking care of the large number of people with pets was a particular problem. For sanitary reasons, they were not allowed to take their animals with them. But when many refused to leave their pets, the authorities were forced to open various pet facilities adjacent to the shelters.

The sudden need to be able to offer temporary housing to a large number of people also meant that there were no arrangements for people with disabilities in most shelters. In some cases, people with disabilities were transferred to special shelters. It was particularly difficult to take care of patients who had been transferred from long-term care facilities.

Health care structures in Québec

The health care system and social services in Québec are built on a complex group of a total of 600 municipal or private (accredited by the province) institutions for the public, almost 1,000 health care facilities, and more than 2,300 municipal health units. About 10 percent of the active labour force in the province works within one of these. The costs for health care and social services correspond to about one third of the total budget for the province, amounting to about CAD 13 billion in 1997-98.

Ultimate responsibility for health care in Québec rests with the provincial government's Ministry of Health, which issues general guidelines for how the health care system and social services should be managed and evaluates the extent to which objectives have been met. The Ministry of Health also monitors the fair allocation of available resources among the various regions of the province. Its mandate also extends to responsibility for coordinating education and research, training managerial staff to manage the health care system's finances and human and material resources. The ministry is also in charge of inter-regional coordination of provincial service functions and for programmes and initiatives aimed at securing public health.

The province of Québec is divided into several regions, each of which has a "*régie régionale*" (equivalent to a Swedish county council) that is responsible for ensuring compliance with Ministry of Health guidelines. Their mandate consists of adapting regional service functions to prevailing demographic, geographical, cultural, and socioeconomic conditions. Each *régie régionale* thus has separate financial responsibility and is the unit that allocates financial resources to the various health care and social service institutions. In addition, it is meant to ensure the maintenance of public health and to promote cooperation among the various health care units in order to achieve optimum efficiency.

In order to exercise its health care mandate, each *régie régionale* has several health care units with which to work, which may be described as follows, in somewhat simplified terms:

- *Centre local de service communautaires* = district medical centres
- *Centre hospitalier* = hospitals of various level and specialities
- *Centre de réadaptation* = rehabilitation units of various kinds depending on the type of injury, etc.
- *Centre d'hébergement et des soins de longue durée* = long-term care facilities
- *Centre de protection de l'enfance et de la jeunesse* = child and youth homes

In addition, there are municipal units in charge of various programmes and initiatives such as:

- Aid and preventive measures for certain needy individuals
- Aid for people to assert their rights within the health and social care systems
- Aid for people to improve their life situations
- Aid for people with special needs of recent onset

In recent years, the regional health care structures have had to adapt to changes very similar to those we have seen within the Swedish health care system. Factors such as an increased number of elderly citizens, fewer hospital beds, a higher percentage of day surgery, increased home health care, and fewer mentally ill individuals in institutions have also affected the health care system in Québec.

Disaster preparedness in the health care system

Each régie régionale is also responsible for the region's preparedness for major incidents or disasters. It is obliged to devise full-coverage disaster preparedness along with the responsible individuals from the provincial Department of the Environment and Agriculture, the poison information centre (*Centre antipoison, et Centre de Toxicologie du Québec*), and the provincial public health laboratory (*Laboratoire de santé publique du Québec*).

The impact of the ice storm on the overall health care system in Québec

The ice storm had a pronounced impact on the overall health care system in Québec, but the effects varied considerably from region to region, largely dependent on the duration of the power cut. Accordingly, this section begins with a short, general overview of the impact on health care in the entire province, after which certain problems in the hardest-hit region, Montérégie, are studied. The Montérégie region is located in the area known as "the ice triangle", in much of which the power cut lasted for several weeks.

Montérégie is a sub-region of the province of Québec corresponding to an area of 10,000 km^2 and with a population of 1.3 million. There are 19 large district medical centres, 35 long-term care units, 10 acute care hospitals (of which one, Charles Le Moyne, is affiliated with a university), and 7 rehabilitation centres in the region. Some 25,000 people work within the health care sector. The prehospital medical care system has 16 ambulance companies with about 500 paramedics under contract. About 500 volunteers also work within the various sectors.

A particular panorama of injuries could be observed throughout the province. First, there were injuries inflicted in connection with improper use of generators, open fires, and tea lights, which led to burn injuries and/or carbon monoxide poisoning. Second, there were injuries caused by people taking great risks aimed at removing ice accretion that threatened to destroy houses and other property. People also suffered frostbite and several cases of hypothermia were observed. A higher number of respiratory infections and isolated cases of food poisoning after eating spoilt food were also seen during the period.

An estimated 30 deaths were directly caused by the ice storm during the period of January 6th to March 17th 1998. The causes of death are outlined in the following table.

Table 1. Causes of death during the ice storm in absolute numbers

Region	**Falls from roof**	**Burns**	**CO poisoning**	**Hypothermia**	**Other injuries**
Centre-du-Québec	1	0	0	1	0
Estrie	0	0	0	0	0
Chaudière-Appalaches	0	0	0	0	1 [1)]
Montréal	0	2	0	2	1 [2)]
Outaouais	0	0	1	0	0
Laval	0	1	0	0	0
Lanaudière	1	0	0	0	0
Laurentides	1	0	0	0	0
Montérégie	1	7	5	2	3 [3, 4, 5)]
Total number	**4**	**10**	**6**	**5**	**5**
Median age	55	53	76	72	53
Range	35-75	10-93	67-82	46-90	30-68
Number of males	4	5	3	1	4
Number of females	0	5	3	4	1

1) Crushed by falling ice
2) Killed by a snow-blower

3) Decapitated by a power line
4) Head injury
5) Fall when de-icing a power line

In addition to the deaths described above, which were directly connected to the effects of the ice storm, Montérégie also noted an increase in the number of dead from 733 to 924 during the period, corresponding to a 22 percent increase compared with the same period in the preceding year. The increase was judged to be partially caused by a 58 percent increase in pulmonary disease and a 23 percent increase in cardiovascular disease. Similar changes were not recorded in other regions that were less severely affected by the ice storm.

Special medical problems

Carbon monoxide poisoning
During the first 24 hours of the ice storm, the régie régionale in the various regions issued bulletins on the risky behaviours that people should avoid, especially the risk of carbon monoxide poisoning. Warnings were issued to all available media concerning the risks of using certain heating systems indoors, but a sharp increase in the number of intoxications was nevertheless recorded. Some were of a less serious nature and could be treated locally with oxygen alone. All patients who presented symptoms of more serious intoxication were transported to Sacré-Coeur de Montréal, the only hospital in the province that can offer hyperbaric oxygen treatment. Fifty cases of carbon monoxide intoxication were treated with hyperbaric oxygen between January 7th and January 28th. Most of the patients (62%) were from Montérégie. The most common causes, in descending order, were: petrol- or diesel-powered electric generators, barbecues, and propane cookers. In response, new safety regulations have been introduced for various types of petrol- or diesel-powered generators, heating, and cooking systems, as the risks of using these devices in closed rooms seem to be unclear to many.

Visits to emergency departments and hospital admissions

In follow-up interviews, it emerged that about 14 percent of the population felt the need to seek medical care due to the ice storm, but in all likelihood the widespread power cut and the extreme weather conditions impeded their opportunities to do so. Data from Montérégie showed that 5 percent of the families interviewed after the crisis stated that they needed to seek medical attention for someone in the family but could not. The most common reasons given were that bad road conditions or that medical centres were closed.

Number of visits to hospital emergency departments
There was a general increase in the number of visits to hospital emergency departments between January 6th and March 3rd 1998, but there were regional differences. The increase in Montérégie was 15 percent compared with the preceding year, and it was particularly noticeable for patients arriving by ambulance. This might be because the roads were icy and the risks of driving their own cars were too great. The most common reasons for seeking care in a hospital were, in descending order: accidents (trauma) and poisonings (26%), respiratory illnesses (24%), diseases of the intestinal tract (22%), endocrinal disorders (19%), infections (16%), and cardiovascular diseases (8%).

Compared with the year before, there was a 38 percent increase in the number of infectious diseases, while respiratory illnesses and accidents/poisoning cases rose by about 20 percent.

There were differences between the sexes. The commonest causes of hospital admissions among men were cardiovascular disease, chronic obstructive pulmonary disease, pneumonia and influenza, and head injuries and fractures. Women were admitted most often for diverse pulmonary diseases and infections. In the months immediately after the ice storm, the number of patients admitted remained clearly higher than in past years.

Functional capacity of hospitals

The acute care hospitals could generally provide necessary medical care during the crisis. Power and water cuts occurred but emergency equipment and compensatory measures of various kinds were relatively adequate, in any case for the larger hospitals in Montreal.

The hospitals were given top priority in all contexts, from restoration of power and provision of fuel to transport and services.

As the power cut lasted the longest in the Montérégie area, conditions in the hospitals there were the most problematic, but they never had to be evacuated. There was, however, some spontaneous evacuation, primarily from elder care facilities. Some people picked up their elderly relatives and drove them home or to another place where they could be kept warm.

A general description of conditions at a few representative hospitals follows.

Hospital Royal Victoria and Hôpital Général de Montréal

Hospital Royal Victoria and Hôpital Général de Montréal are located in central Montreal and are under joint management. Like most other acute care hospitals, they are owned by the state. The hospitals are of significant size, play an important role in the city, and are affiliated with a university. The catchment area covers the entire Montreal area.

Power supply to the hospitals

The hospitals, like the rest of central Montreal, lost power about 24 hours after the power grid began breaking down. This gave the hospitals forewarning and they were able to commence preparations for an expected power cut. Information about what was happening, starting in the areas surrounding the city, came mainly via radio and TV.

The hospitals were totally without external power supply for about twelve hours, which was a relatively short time compared to many other power customers. During those hours, restrictions were imposed on the usage of electricity.

Each hospital has three generators, each with an output of 900 kW. The output specification probably refers to short-term operation. The system is built so that the devices can each back up the other and any one device can feed a prioritized section of the hospital. The generators begin operating automatically if external power supply fails.

If all three devices were running at the same time, the combined output would correspond to about 80 percent of hospital's needs (probably the maximum hourly output), but the system was not built for all devices to run and distribute power simultaneously to the majority of the hospital. Instead, only the most important functions were supplied, e.g., the surgical department, while a system of "rotating blackouts" was otherwise applied, in which e.g. the laundry had power in the morning and the kitchen somewhat later, etc.

Tests were carried out with one generator in the current system against actual load weekly at seven o'clock every Thursday morning at Hôpital Général de Montréal, but the doctors at Hospital Royal Victoria did not accept that idea and tests could not be performed as regularly there.

Redesign of the systems had been planned, which will enable simultaneous power supply to most areas of the hospitals in future, at least during brief power cuts. The systems will be constructed so that lower priority supply areas will be automatically disconnected if the generators should become overloaded for any reason. High priority sections will be small enough to be supplied by a single generator. During the crisis, there was a high level of service with respect to personnel and parts for repair and maintenance of the emergency system for electricity.

There were enough Uninterrupted Power Supply (UPS) devices so that control equipment for technical supply worked satisfactorily, according to information provided to the authors, but there were some problems with certain administrative computer systems.

Fuel supply for the generators was critical during the power cut. This was managed by parking a fuel tanker in the area and connecting it to the generators. The hospital was even prioritized ahead of the fire department, which sometimes came to the hospital to refuel its vehicles. The generators are air-cooled and thus not dependent on water supply.

Water supply

Both hospitals were supplied with cold water from two sources. There was a disruption at Hospital Royal Victoria but not in both systems at the same time, so the water outage at the hospital was limited to the time required to switch from one system to the other.

Due to risk of contamination, the regular water was not used for cooking or drinking at either of the two hospitals. Instead, large quantities of bottled water were purchased for drinking and food preparation. The hospitals do not have their own emergency water supplies. According to information provided to the authors, this applies generally to hospitals in Canada.

Heating supply

Both hospitals have their own heating systems, normally fuelled by natural gas but sometimes also by oil. Contracts with the gas supplier are written in such a manner that delivery of gas is not guaranteed, so the system runs on oil during certain periods. The solution probably came about for financial reasons (a cheaper gas rate if the hospital does

not require guaranteed delivery), but is also advantageous from an operational reliability point of view.

All vital components in the heating systems have emergency power supplies, which is why heating worked normally during the period. The systems produce steam that is used for heating and for autoclaves, etc.

Heating supply is to a certain extent dependent on water supply; the system loses water in various ways including leakage. The production of steam also requires some of the steam to be released, which must be replaced with water.

Personnel

A large percentage of employees had no power or heating in their own homes, which was a particular problem. Many of them actually needed to take action to care for their families and relatives, which could have jeopardized access to personnel at the hospitals. In response, the hospitals arranged lodging and meals, etc., for personnel and their families in large rooms where large numbers had to live communally. The decision to offer this solution was taken during the first 24 hours of the crisis. The extraordinary situation lasted for 8-10 days.

Hôpital Charles Le Moyne

The hospital is in the Montérégie area, but just outside the area that experienced the longest power cut. Like most other acute care hospitals, it is owned by the state.

The hospital has 475 beds (590 beds five years ago) and eight operating theatres. The hospital is orientated towards general medicine, but also has an important trauma unit. The catchment area for general medicine has a population of about half a million. Charles Le Moyne is the largest hospital in the area south of the Saint Laurent River, but is smaller than the large hospitals in central Montreal.

Power supply

The hospital experienced a brief power cut that lasted a few hours when the power grid began breaking down, but a longer outage occurred 24 hours later. The first breakdown gave the hospital a forewarning and it could begin preparations for an expected power cut of longer duration.

The hospital was entirely cut off from external power supply for about five days. Thereafter, electricity usage was restricted for a while but there were no further power cuts. The hospital was supplied from two sources, which is a common solution for hospitals in the Montreal area. It has two generators, each with 400 kW in output. The output specification probably refers to short-term operation. The system is built so that the devices can each back up the other and any one device can feed a prioritized section of the hospital. The generators begin operating automatically if external power supply fails.

The generators supplied only the functions assessed as essential, e.g., the surgical department and minimal lighting. No emergency power was used for x-ray, the laundry,

kitchen, or the majority of the ventilation system, but ventilation was connected on a rotating basis to a certain extent.

The kitchen could not prepare hot food during the crisis, but could provide cold food. The laundry was transported to an external laundry that was operational.

The operating theatres, which did have emergency power, were not used other than in exceptional cases for emergency procedures. Otherwise, all non-acute medical care was postponed. Essentially, the acute care hospital was transformed into a district medical centre during the critical days.

Tests are normally done once a week, but not against actual load (power consumption in normal operations), which cannot be performed with the current solution, as e.g., alarms will be triggered by patient ventilators that must be reset after every power cut, no matter how brief. There are not enough UPS devices.

During the days without power, there were intermittent problems with water pumps and other equipment that required manual reconnections. Expansion of the systems with a third emergency power generator has now been planned, so that it will be possible in future to supply a larger part of the hospital simultaneously, at least during brief power cuts. Additional sockets have already been installed for prioritized power in patient care rooms.

There were enough Uninterrupted Power Supply (UPS) devices so that control equipment for technical supply worked satisfactorily during the crisis, but there were some problems with certain administrative computer systems. Normal computers at office workstations within the hospital could not be used.

Fuel supply to the generators was sometimes very poor during the power cut, but the problem could be resolved through regular refilling. The generators are air-cooled and thus not dependent on water supply.

Telecommunications

The telephone system worked in all essential respects, but the mobile phone system was at times overloaded.

Water supply

There was no disruption to the water supply. The water company has its own emergency power. Raw water is taken from the Saint Laurent River. The hospital does not have its own emergency water supply, which applies generally to hospitals in Canada. Large quantities of bottled water were purchased for drinking water.

Heating supply

The hospital has its own heating system, normally fuelled by natural gas but sometimes also by oil. Contracts with the gas supplier are written, however, in the same way as for the hospitals in central Montreal and the gas supply is not guaranteed. For that reason, the

heating system runs on oil during certain periods. There is a permanent 2,000 litre oil tank for the purpose, but natural gas supply functioned normally throughout the crisis.

All vital components in the heating systems have emergency power supplies, which is why heating worked normally during the period. The system produces steam that is used for heating and for autoclaves. In normal circumstances, the steam is also used by the kitchen and the laundry.

Personnel

So that personnel could be available for work, they and their families were offered housing as described for the other hospitals. The hospital's total workforce numbers about 2,200, of whom an estimated 800 are on duty at any one time, but at most only about 150 people slept at the hospital, including some family members.

Patients

According to information given to the authors, the patient census was higher than normal. But patients who needed sophisticated treatment were transported to a hospital in Montreal for treatment and then back to Charles Le Moyne for follow-up care. Many patients could be given minor treatment at the hospital and did not need to be admitted. The hospital also made preparations for accepting additional patients from other hospitals who might need to be evacuated. Additional beds were planned for the purpose in a nearby school, but no patients from other hospitals had to be accepted. Although it was a close call at times, no hospitals had to be evacuated. The emergency power at another hospital in the area broke down, but a new 900 kW generator could be acquired in time.

Prehospital medical care

There are 149 ambulance companies, 550 ambulances, and some 3,000 paramedics in the province of Québec. Paramedic training is roughly comparable to that in Sweden. During the ice storm, ambulance transports were generally used for five kinds of tasks:

1. Evacuation of people from their homes to shelters
2. Transport of ill patients from one facility to another
3. Responses involving poisoning of various types, primarily carbon monoxide
4. Responses to fires
5. Responses to take care of injured persons who had fallen, usually from roofs

The ambulance service was under tremendous pressure, as higher demand for transports arose even as roads in certain areas were impassable. Here as well, conditions varied considerably. Transports could be managed tolerably well in certain areas, while others had to be assisted by military transports. There were also major problems with telecommunications in the areas that were the most severely affected (see below).

During the days the ice storm was going on in Montreal itself, emergency response centres received 1,201 calls – an increase of 38 percent compared with normal circumstances. The system managed to increase its capacity by 13 percent, which corresponded to 543 responses/day. After the ice storm, a decision was taken to revise the various emergency levels in order to better differentiate between decision-making and

operational structures and, first and foremost, to ensure the provision of food, lodging, and transport for the people working within the organization.

The situation was considerably more severe in Montérégie because the power cut lasted much longer. A 60 percent increase in ambulance transports was recorded for the period of January 6th to May 2nd 1998. The ambulance companies complained that the *régie régionale* (the health care system principal) delayed too long in informing them of the gravity of the situation. They also complained about the absence of protocols and rules on the order of priority that should apply to emergency calls. They had great difficulty keeping themselves informed about road conditions, which caused serious delays, and initially had serious problems with phone and radio communications.

Many ambulance crews also complained of exhaustion. It was difficult to use the roads in many areas due to fallen trees and extreme icing. Several bridges and some roads were closed to the public due to slippery conditions, but the road tunnel under the Saint Laurent River came in very handy during the crisis.

In addition to ordinary patient transports, ambulances also performed more unusual tasks during the period, such as transport of oxygen equipment, special transports for people with disabilities, and transport of drugs and other necessities to health care units. Much of the shortfall in ambulance and transport resources was relieved by the Canadian army and ambulance units from other regions. There was some difficulty coordinating all of those transports and it was hard to comply with regional and local disaster plans.

Primary care

The primary care system in Québec is to a certain extent similar in structure to the Swedish system. It is based on GPs and nurses who usually practice in private offices or clinics or else work as general practitioners in emergency departments, larger district medical centres, or hospitals.

As the power cuts mainly affected the small, private medical centres, a larger number of patients were forced to seek care at hospitals. During the first days of the crisis, many doctors in private practice instead approached the hospitals to offer assistance, but soon found out that their services were not needed there and that it was best if they returned to their own offices as soon as possible. Many could initially work instead at the larger district medical centres, where power was restored faster than it was at small, private medical centres.

Many of the large district medical centres were also forced to close for a while. Some of the centres could be provided with power by means of generators allocated to them. Despite this, many medical centres, which were already short-staffed before the crisis, lacked adequate resources to meet the needs of the population for primary health care. First and foremost, a great need arose during the crisis for house calls and contacts of a psychosocial nature.

Identification of the most at-risk individuals

From the outset of the devastation wrought by the ice storm, the home health care system contacted the most at-risk individuals, in part via the phone and in part via home visits. All those who were registered in the home health care system were prioritized. Those who lacked permanent housing or could not manage on their own were transported to shelters, long-term care units, or acute care hospitals. Many of these patients were very difficult to manage, in part because the personnel could not always accompany them and in part because there was a lack of resources for maintaining adequate hygiene. Isolated patients proved to be unknown to the authorities and therefore did not receive the care they should have. These people were not identified and rescued until door-to-door canvassing was carried out.

Psychosocial aspects

In order to evaluate the psychosocial problems caused by the ice storm, the Institute of National Scientific Research (*Institut national de recherche scientifique*) later carried out a follow-up survey by means of 2,112 phone interviews and more in-depth personal interviews with sixty storm victims. This combination of interviews provided an opportunity to gain a clearer picture of the scope and evolution of the disaster and to evaluate public opinion of official measures. We present here the key conclusions of the study in a very abridged form.

Perceived problems of a more practical nature:

- Only a small group of victims (9%) felt the cold was a severe problem
- 34% had difficulty moving; one of the consequences of this was that 29% felt they had problems acquiring necessities
- 6% of the population left their homes upon being ordered to evacuate; this applied especially to the elderly population
- 42% felt they had difficulties combining work with chores that had to be done in the home
- Difficulties finding adequate housing during the crisis were greater for families with children than for single people
- Due to language barriers, recent immigrants had problems understanding the information provided about the help that was available to them

Difficulties for people forced to leave their homes:

- Most were anxious to be able to stay near their homes, as most chose to visit their homes daily
- Among those forced to leave their homes, 10% of those with an income of > CAD 70,000 chose to stay in a hotel
- In the hardest-hit region, 36% of those who had left their homes had been housed at 2-7 different places

The most common reasons for changing their temporary address were:

- Desire for greater comfort
- The power cut lasted longer than expected

- Stress due to conflicts with others. Problems arose concerning how daily chores should be divided, finances in shared households, child-rearing, etc. The problems were perceived as equally severe by those who received and those who provided temporary housing.

Particular stress-inducing factors were noted among those who:

- Lost their phone lines
- Lived in areas were ice accretion caused the most severe damage to the surroundings
- Were women
- Were caregivers to someone in the home

The positive psychosocial aspects may be summarized with the following points:

- A clearly heightened sense of solidarity among people in the community
- 63% felt a stronger sense of belonging to the community in which they lived
- Greater inclination to help each other in all situations, regardless of whether the people involved knew each other

Information management during the crisis

According to the provincial government's disaster plans, continual information to the public is extremely important. Such information should first and foremost deal with five important issues:

- What is happening right now?
- How great are the risks for danger in every region?
- How can I communicate with my loved ones?
- What measures are the authorities taking?
- What measures should I be taking?

Every municipality is obliged to include some kind of information to the public in its disaster plan. Advice and assistance in establishing these information centres, as well as help providing the right information, is provided by a higher authority, i.e., "*Communication-Québec*" which is part of the Ministry of the Interior. Communication between this central communications body and the smaller municipalities was often poor. Although there were substantial differences among municipalities, certain conclusions could still be drawn:

- Transfer of information to the affected population was often difficult because most municipal administrations were also affected by the ice storm.
- Many municipalities did not have the resources required to receive and then disseminate information from central sources. Many municipal disaster plans also lacked methods for reaching out with information to all concerned residents.
- The central information unit put too much emphasis on informing the public via press conferences broadcast on television and the information was often of a too-general nature. Many people felt the information did not reflect reality and that it could not meet the needs of victims.
- Information via the radio should have been used much more, as many people were totally without power but did have batteries. The power company Hydro Québec in particular provided a great deal of information about the power situation on television, which could only be followed by those whose power had been restored.
- The information disseminated among the public was often mixed with rumour. As a result, many were inaccurately informed about the situation. Many victims also complained of contradictory information about the power situation. Hydro Québec at the central level provided information to the media that later proved inconsistent with information provided by the company's local managers.

In certain areas, military personnel were sent out to knock on doors, which led to misunderstandings in a few cases. One person had got the notion that the power cut meant that Canada was at war and the individual did not feel any calmer when soldiers later appeared on the doorstep.

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