

Implementation of the Montreal Heat Response Plan During the 2010 Heat Wave

Karine Price, MSc,¹ Stéphane Perron, MD, MSc, FRCPC,² Norman King, MSc¹

ABSTRACT

OBJECTIVES: The objective of this paper is to describe Montreal's heat response plan and its application during the July 2010 heat wave.

PARTICIPANTS AND SETTING: The Montreal heat response plan is designed to ensure the surveillance of weather and health indicators during the summer season and to coordinate actions to be undertaken during this period to reduce morbidity and mortality due to heat, particularly when weather thresholds are reached or an increase in health indicators is observed. It was developed to coordinate and apply intervention measures on the Island of Montreal and has been in effect since 2004.

INTERVENTION: In the beginning of July 2010, Montreal experienced a heat wave that lasted 5 days. During this period, health indicators such as total mortality, prehospital emergency transports, calls to the health information line and hospital admissions were monitored by the Montreal public health surveillance system. The decision to implement emergency interventions and actions performed by regional and local public health and municipal partners (intervention level) was made following attainment of a predetermined weather threshold and increases in health indicators. The significant increase in daily observed mortality from all causes and in particular people dying at home or in the community prompted the Director of public health to conduct a chart review of all people deceased from July 5 to July 11, 2010 to determine cause of death and underlying health conditions.

OUTCOME: During the heat wave, there were 304 reported deaths from all causes in Montreal residents, of which 106 were probably or possibly heat-related. Major underlying health conditions in heat-related deaths included cardiovascular problems and mental health illness. Furthermore, in the case of people with mental illness who died during the heat wave, the chart review revealed that many were contacted 24 hours prior to their death by health care professionals, family members, neighbours or friends.

CONCLUSION: Following the 2010 heat wave, the Montreal heat response plan and heat surveillance system were updated to include initiatives to better communicate preventive measures to the vulnerable populations and to intervene earlier during a heat wave.

KEY WORDS: Extreme heat; surveillance system; heat-related mortality

La traduction du résumé se trouve à la fin de l'article.

Can J Public Health 2013;104(2):e96-e100.

Extreme heat episodes result in significant morbidity, especially in northern latitudes or areas influenced by more temperate climates.^{1,2} A recent meta-analysis showed that both environmental factors, such as the absence of air conditioning, and population risk factors, such as having cardiovascular or psychiatric co-morbidities, increase the probability of heat-related deaths.³ Following the European heat wave of 2003, 15,000 excess deaths were reported in 12 European countries during the first week of August and approximately 24,000 during the second week.^{4,5} This event prompted many countries to initiate or reinforce heat health watch warning systems to avoid high levels of excess mortality.^{6,7} To counter the effect of extreme heat, the Montreal public health department has developed a heat response plan in collaboration with the regional and local public health network and municipal partners. This plan has been in effect since 2004. Its development was prompted by the large increase in mortality following the 2003 heat wave in Europe. Although preventive measures following Environment Canada's heat warnings have been issued to the population since 1994 and a communication campaign was initiated in 2002, the Montreal health department heat plan was undertaken by public health authorities to describe actions under different alert levels with local partners. Indeed, although the heat response plan is addressed to the public health network, public health actions are

coordinated with municipal and civil security partners. Health and weather surveillance is an important component of the plan, both for immediate intervention and for updating the plan. These indicators serve as a basis for determination of different levels of action during the summer period. The main objective of the Montreal heat response plan (MHRP) is to reduce heat-related mortality and morbidity. In order to attain this objective, the plan must clearly identify and coordinate actions to be undertaken under different alert levels by partners at the regional public health and municipal level. The MHRP also serves as a guide for the health and social services network (e.g., hospitals or health and social services centres) to develop their own local heat plan for the people they serve. The following paper presents a brief overview of the Montreal heat response plan and its implementation in Montreal during the July 2010 heat wave, which was the first time the *Intervention level* was

Author Affiliations

1. Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal, Montréal, QC
2. Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal; Université de Montréal, département de médecine sociale et préventive, Montréal, QC

Correspondence: Karine Price, Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal, 1301, rue Sherbrooke Est, Montréal, QC H2L 1M3, Tel: 514-528-2400, Fax: 514-528-2459, E-mail: kprice@santepub-mtl.qc.ca

Conflict of Interest: None to declare.

Table 1. Alert and Mobilization Levels in the Montreal Heat Response Plan*

Alert Level	Some of the Actions Undertaken by the Montreal Public Health Department and Partners During the 2010 Heat Wave
Normal In effect Sept. 15 to May 15	<ul style="list-style-type: none"> Preparation and application of education campaign Updating of heat response plan
Seasonal Watch In effect May 15 to Sept. 15	<ul style="list-style-type: none"> Press release and distribution of educational material for the population via health and social services centres and other distribution platforms Advisories transmitted to Info-Santé and to the Health and Social Services Agency for release in the health care network Monitoring of the health surveillance screen Preparation for further levels
Active Watch In effect following a heat warning by Environment Canada (forecast of temperatures $\geq 30^{\circ}\text{C}$ and Humidex ≥ 40)	<ul style="list-style-type: none"> Transfer of heat advisory to partners Advisories to the public via different media on preventive measures Monitoring of the health surveillance screen and weather conditions Intensification of surveillance and application of preventive measures by health care facilities
Alert In effect following a forecast of 3 consecutive days with average maximal temperatures $\geq 33^{\circ}\text{C}$ and average minimal temperatures $\geq 20^{\circ}\text{C}$	<ul style="list-style-type: none"> Monitoring of the health surveillance screen and weather conditions Advisories emitted to surrounding regional public health departments, the Agency and the Ministry of Health Advisories to health care facilities by the Agency via the Civil security advising committee Preparation for intervention
Intervention In effect when temperature thresholds have been attained or sanitary indicators are above normal levels	<ul style="list-style-type: none"> Mobilization and application of intervention measures by municipal, regional and local public health partners. These actions can include information in the media, call for awareness issued to health care professionals, surveillance of dehydration symptoms in patients, extension of pool opening hours, opening of air-conditioned shelters, door-to-door campaign by municipal partners to identify people suffering from heat and in need of assistance Monitoring of the health surveillance screen and weather conditions

* A detailed description of actions performed by the Montreal public health department and partners at the municipal, regional and local public health levels is available in Annexe 1 of the "Report of the Public Health Director on the 2010 Montreal heat wave"⁸ (see Supplemental Appendix B).

reached.⁸ Results of the surveillance activities and ensuing actions are also presented.

The Montreal heat plan

Target Population and Setting

The MHRP covers the Island of Montreal. It comprises five levels which define different actions to be taken, namely the *Normal level*, *Seasonal watch*, *Active watch*, *Alert level* and *Intervention level* (Table 1). The attainment of these levels is determined through surveillance of weather and health indicators. The weather threshold upon which emergency interventions take place was determined following analysis of all-cause mortality during different heat wave episodes spanning a 20-year period from 1984 to 2004.⁹ The weather threshold was based on a 60% increase in all-cause mortality. This threshold corresponds to a weighted average maximum temperature of $\geq 33^{\circ}\text{C}$ over 3 days and a weighted average minimum temperature of $\geq 20^{\circ}\text{C}$ over 3 days.¹⁰ The surveillance of health and weather indicators is ensured by the Montreal public health surveillance team on a daily basis as part of an existing surveillance system developed by the Montreal public health department.¹¹ Mortality data are accessed daily from hospital statistics. Health indicators include total mortality (death occurring at home or in the community, long-term health care and hospital mortality), number of prehospital emergency transports (Urgences-santé), calls to the health information line (Info-Santé) and hospital admissions. The surveillance system automatically brings attention to these indicators when they increase above expected baseline values. However, it is important to note that the increases in health indicators are also evaluated subjectively using information from the field. At the *Active watch* level, following a heat warning by Environment Canada (forecast of temperatures $\geq 30^{\circ}\text{C}$ and Humidex ≥ 40), the system automatically transmits a heat warning to various partners. At the *Alert level*, following a forecast reaching or exceeding the aforementioned threshold temperatures, daily conference calls are scheduled between the public health network and partners at the municipal and civil security level. The onset of emergency inter-

Table 2. Underlying Health Conditions in Heat-related Deaths from July 6 to 11, 2010 in Montreal, Canada

	Place of Death	
	Community or Emergency	Long-term Health Care Facilities
Total Number of Deaths	93	12*
Age (Average)	71.7	83.9
Underlying Health Condition†	Number of Cases	Number of Cases
Cardiovascular/cerebrovascular problems		
Coronary artery disease	13	8
Cardiac insufficiency	14	3
Cerebral vascular accident	4	2
Cardiovascular risk factors		
Diabetes	27	4
Hypertension	43	6
Mental health illness		
Schizophrenia	13	1
Alcoholism/drug addiction	13	0
Depression	1	0
Bipolarity	3	0
Dementia	3	7
Cancer	12	0
Asthma/COPD	14	1
Renal insufficiency	7	0

* One death occurred in a hospital and results are not shown here.

† Information on all underlying health conditions was present in 77 cases. Numerous health conditions can be present in one individual.

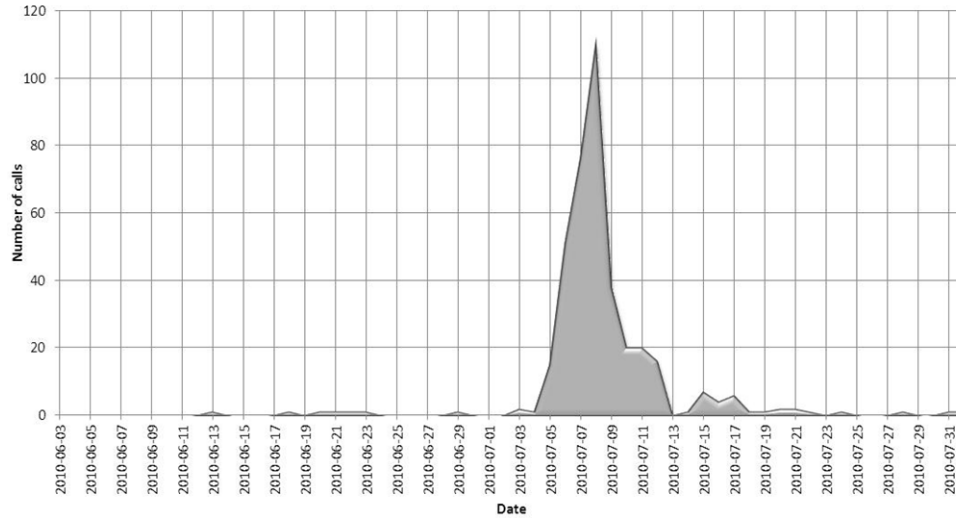
ventions (*Intervention level*) takes place when these predetermined temperature levels have been attained or are forecast to be attained and health indicators are above normal levels.

Public Health Intervention During the Extreme Heat Event of July 2010

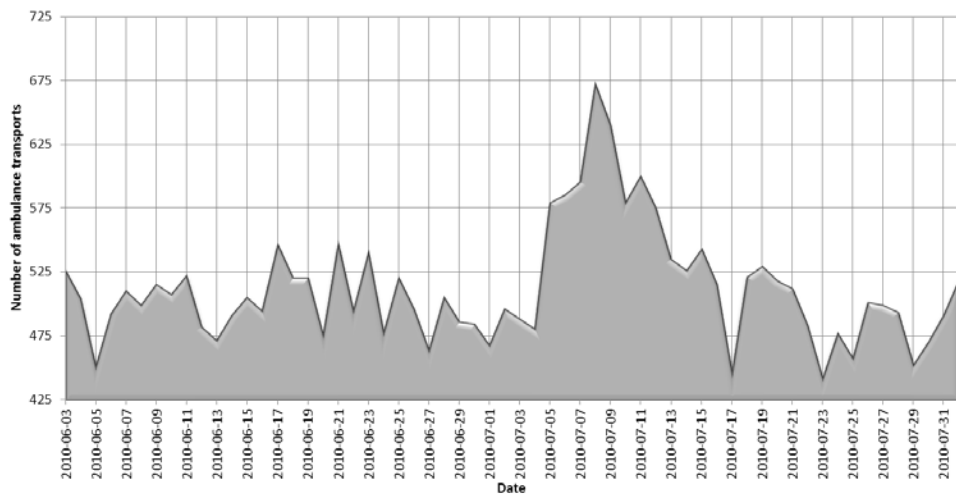
In the beginning of July 2010, Montreal experienced a heat wave that lasted 5 days, with a mean maximum temperature above 33°C , while minimum temperatures stayed above 20°C for 9 days. During the heat wave, temperature as well as health indicators were tracked daily by the Montreal public health surveillance team. In addition, further information on prehospital emergency transport and deaths occurring in the community were obtained on a daily basis through Urgences-santé. Following the onset of the *Intervention level*, many

Figure 1. Variation of health indicators from June 3 to July 31, 2010

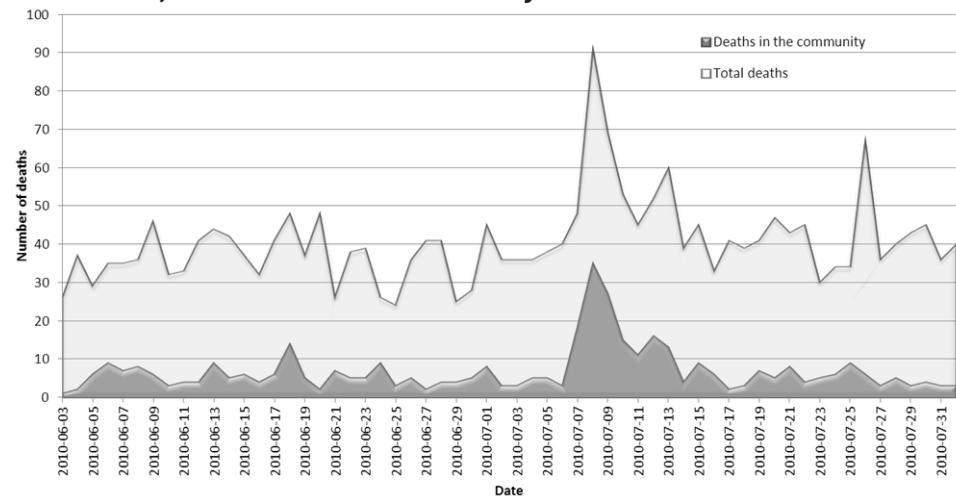
A. Number of calls to Info-Santé



B. Ambulance transports



C. Total number of deaths (hospitals, community and long-term health care facilities) and deaths in the community⁸



actions were performed by municipal, regional and local public health partners. These actions are wide-ranging (mass media communication, involvement of local health departments in order to

identify vulnerable individuals, opening of air-conditioned shelters, extension of pool opening hours, etc.).⁸ Interventions also involve hospitals and long-term care, pre-hospital emergency care, boroughs and cities in the island of Montreal, police and fire departments (see Table 1 for more details).

Following the heat wave, there was an excess in daily observed mortality from all causes, particularly in the community. As part of our surveillance efforts, the Director of public health conducted a chart review of all people deceased from July 5 to July 11, 2010, a period that spanned the heat wave. Individual evaluation of 304 records was performed, according to contribution of heat and place of death (community, long-term health care facility, hospitals). The chart review was not part of the actions initially described in the heat plan, but was prompted by the excess mortality and was part of the Director of public health's surveillance mandate.

OUTCOME

Health indicators during the heat wave

Between July 5 and July 11, 2010, there was a noted increase in the number of calls to Info-Santé regarding oppressive heat (Figure 1A), and a clear increase in prehospital emergency transports and total and community deaths (Figure 1B and 1C). However, emergency room visits did not increase during this period. Prehospital transportation and Info-Santé calls were the first indicators to vary with increases from baseline detected as early as July 5. Deaths in the community and total deaths increased only as of July 7. Other indicators, such as deaths in hospitals, deaths in the emergency wards and deaths in long-term care, did not show any clear patterns.⁸

Chart review

As presented in Table 2, of the 304 deaths from all causes in Montreal residents, 106 were probably or possibly heat-related. In order to quantify the contribution of heat, the medical team at the Montreal public health department developed a medical chart extraction form (see Supplemental Appendix A), based on information in the

literature provided in case-control studies.^{12,13} From this chart extraction form, the mortality cases were divided into three categories based on contribution of heat to the death: probable heat-

related cases, possible heat-related cases and improbable heat-related cases. For the community deaths, data were extracted from the death certificate, the prehospital intervention report and attestation of death performed by the medical team of Urgences-santé. For long-term care and hospitals, medical records were consulted on site or faxed and data were extracted from them. Results were tabulated according to risk factors derived from the literature.

Two major underlying health conditions were identified in heat-related deaths: cardiovascular problems and mental health problems. Often, numerous underlying health conditions were present in an individual. In addition, when analyzing the 32 reported community deaths for people with mental illness, many of these people lived alone, and 14 out of 21 for whom information was available were contacted 24 hours prior to their death by health care professionals, family members, neighbours or friends. The chart review also revealed that the medical files for the patients in long-term care facilities were lacking information. Hence in these settings, the extent to which heat contributed to death for these patients was more difficult to identify.

On typical summer days in Montreal, 70% of deaths from all causes occurred in hospitals, followed by 14% in the community and 16% in long-term care facilities.¹⁴ During the 2010 heat wave, 52% of deaths from all causes occurred in hospitals, while 31% occurred in the community and 17% in long-term health care facilities. For heat-related deaths during the heat wave, 93 occurred in the community (88%) and 13 occurred in long-term health care facilities and hospitals (12%).

Update of the heat response plan following the 2010 heat wave

In this paper, we highlighted the functioning of the MHRP and regional surveillance system. The observations stemming from the 2010 heat surveillance system and the chart review prompted Montreal public health and its partners to update its heat response plan and surveillance system. It was decided that the sentinel indicators would be the Info-Santé calls, prehospital transports and community deaths. The main advantage in using these indicators is that the data regarding these events are available rapidly (the next day). In addition, it was decided that during heat waves, the physician filling the attestation of death would also use a section of the chart to determine if mortality is probably, possibly or not related to heat, thus guaranteeing rapid availability of information. Major changes to the MHRP also include the onset of the *Intervention level* following two instead of three days of temperatures reaching the threshold temperatures if Environment Canada maintains its predictions of >33°C for the third day. Indeed, it was observed that increase in mortality in the community occurred a day earlier than the peak in total deaths. Furthermore, during the heat wave, total deaths occurring at home in the community were twice the normal expected value. This displacement of deaths, from hospitals to the community, has also been observed during other heat waves.¹⁵

The results of the chart review performed during the heat wave indicated that individuals over approximately 70 years of age and suffering from cardiovascular disease were at higher risk during a heat wave. Communication strategies have previously been developed for specific vulnerable populations, including seniors. However, the chart review also highlighted the important vulnerability of individuals with mental illness in Montreal and of those who

were drug- or alcohol-dependent. Individuals with mental illness who died during the heat wave were also younger, averaging approximately 60 years of age. Family, friends and professionals may have been less aware that individuals with certain mental illnesses were particularly vulnerable during a heat wave, as can be implied by the data reporting that many people with mental illness were contacted 24 hours prior to their death. It was thus decided that there would be a specific communication campaign during heat waves that targets individuals with mental illnesses (in addition to the communication campaign already in place targeting the elderly and young children). In addition, there would be further preparation work with local health and social services centres, community organizations and psychiatric hospitals to ensure that there is proper outreach to vulnerable populations, including patients with mental illness, during heat waves.

DISCUSSION

The MHRP and surveillance system as implemented have strengths and limitations. The surveillance system provides the information necessary for Montreal's public health department and its partners to decide on the levels of interventions required during the summer period and when there is a heat wave on the Montreal Island. This system is unique because the information is very timely, especially with regards to health indicators that are often available within the same day. This surveillance system is based on the daily monitoring of several health indicators that can respond rapidly during a heat wave; indeed, it is able to detect slight increases in heat-related deaths even before important increases are observed in the total number of deaths from all causes. Some systems developed elsewhere are also based on daily monitoring of indicators, such as mortality. In general, these systems, including the one developed in Montreal, aim to reduce as much as possible delays in transfer and analysis of health indicators.¹⁶⁻¹⁹ However, regarding health indicators, it is not clear if the increases in heat-related Info-Santé calls were prompted by the heat protection measures presented in the mass media campaign that was occurring simultaneously. In fact, as part of the preventive messages, the population was encouraged to contact Info-Santé for further information. The Montreal heat wave in July 2010 was extreme both in duration and intensity. It is not clear such a health outcome would occur if weather criteria were met but with shorter duration and less intensity. In addition, contrary to expectations, as can be seen from the community mortality data, there was a protracted period of community mortality (July 12th and 13th), even after most interventions were stopped because of cooler temperatures. Recent studies have proposed that the intensity and duration of a heat wave, and consequently associated mortality during this period, could be best predicted if the cumulative effect of several hot days is taken into consideration.²⁰

As previously discussed, the MHRP and heat surveillance system were updated and further actions were taken as a result of the information obtained during the July 2010 heat wave in Montreal. Lessons learned from our approach are important for any surveillance initiative regarding heat. It is hoped that better communication methods for the vulnerable populations and earlier intervention will diminish the health impact, given the observation that although contacted by health care professionals, family or friends 24 hours prior to their death, many people with mental illness unfortunately died during the heat wave. Future initiatives should

focus on better identifying the vulnerable populations and communicating preventive measures, pursuing the identification of the most valuable health indicators, as well as thoroughly evaluating the overall impact of the heat response plan and its actions on mortality reduction during heat waves. The current paper was not designed to assess whether the heat plan, as applied in 2010, was effective in reducing mortality. Future research specifically aimed at evaluating the effectiveness of the heat plan would allow one to conclude whether changes in mortality are attributable to the implementation of preventive measures in the heat plan.

REFERENCES

1. Laaidi M, Laaidi K, Besancenot JP. Temperature-related mortality in France, a comparison between regions with different climates from the perspective of global warming. *Int J Biometeorol* 2006;51(2):145-53.
2. Curriero FC, Heiner KS, Samet JM, Zeger SL, Strug L, Patz JA. Temperature and mortality in 11 cities of the Eastern United States. *Am J Epidemiol* 2002;155:80-87.
3. Bouchama A, Dehbi M, Mohamed G, Matthies F, Shoukri M, Menne B. Prognostic factors in heat wave-related deaths. A meta-analysis. *Arch Intern Med* 2007;167(20):2170-76.
4. Kosatsky T. The 2003 European heat waves. *Eurosurveillance* 2005;10(7):552.
5. Robine J-M, Cheung SLK, Le Roy S, Van Oyen H, Griffiths C, Michel J-P, Herrmann FR. Death toll exceeded 70,000 in Europe during the summer of 2003. *CR Biologies* 2008;331:171-78.
6. Pascal M, Laaidi K, Ledrans M, Baffert E, Caserio-Schönemann C, Le Tertre A, et al. France's heat health watch warning system. *Int J Biometeorol* 2006;50:144-53.
7. Kovats RS, Kristie LE. Heatwaves and public health in Europe. *Eur J Public Health* 2006;16(6):592-99.
8. Roy L-A, Price K, Pâquet M, Vida S, Sénécal G, Lefebvre L, et al. Canicule 2010 à Montréal. Rapport du directeur de santé publique. Montréal, QC : Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal, 2011.
9. Litvak E, Fortier I, Gouillou M, Jehanno A, Kosatsky T. Programme de vigie et de prévention des effets de la chaleur accablante à Montréal. Définition épidémiologique des seuils d'alerte et de mobilisation pour Montréal. Montréal : Direction de santé publique de l'Agence de la santé et des services sociaux de Montréal, 2005.
10. Martel B, Giroux J-X, Gosselin P, Chebana F, Ouarda TBMJ, Charron C. Indicateurs et seuils météorologiques pour les systèmes de veille-avertissement lors de vagues de chaleur au Québec. Institut National de Santé publique du Québec, 2010.
11. Tessier F, Plante C, Kosatsky T. The validation of a new population surveillance system that analyzes the daily mortality rates in Montreal. *Can J Public Health* 2009;100(2):153-56.
12. Kilbourne EM, Choi K, Jones TS, Thacker SB and The Field Investigation Team. Risk factors for heatstroke: A case-control study. *JAMA* 1982;247(24):3332-36.
13. Kaiser R, Hendersen AK, Kieszak S. Heat-related death and mental illness during the 1999 Cincinnati heat wave. *Am J Forensic Med Pathol* 2001;22(3):303-7.
14. Smargiassi A, Goldberg MS, Plante C, Fournier M, Baudouin Y, Kosatsky T. Variation of daily warm season mortality as a function of micro-urban heat islands. *J Epidemiol Community Health* 2009;63:659-64.
15. Fouillet A, Rey G, Laurent F, Pavillon G, Bellec S, Guihenneuc-Jouyaux C, et al. Excess mortality related to the August 2003 heat wave in France. *Int Arch Occup Environ Health* 2006;80(1):16-24.
16. Kovats RS, Ebi KL. Heatwaves and public health in Europe. *Eur J Public Health* 2006;16(6):592-99.
17. Nogueira PJ, Machado A, Rodrigues E, Nunes B, Sousa L, Jacinto M, et al. The new automated daily mortality surveillance system in Portugal. *Euro Surveill* 2010;15(13):19529.
18. Kanieff M, Rago G, Minelli G, Lamagni T, Sadicova O, Šelj B, et al. The potential for a concerted system for the rapid monitoring of excess mortality throughout Europe. *Euro Surveill* 2010;15(43):19697.
19. Michelozzi P, de' Donato FK, Bargagli AM, D'Ippoliti D, De Sario M, Marino C, et al. Surveillance of summer mortality and preparedness to reduce the health impact of heat waves in Italy. *Int J Environ Res Public Health* 2010;7(5):2256-73.
20. Fouillet A, Rey G, Jouglé E, Frayssinet P, Bessemoulin P, Hémond D. A predictive model relating daily fluctuations in summer temperatures and mortality rates. *BMC Public Health* 2007;19(7):114.

Received: July 18, 2012

Accepted: January 24, 2013

RÉSUMÉ

OBJECTIFS : Décrire le plan d'intervention en cas de chaleur de Montréal et son application durant la vague de chaleur de juillet 2010.

PARTICIPANTS ET LIEU : Le plan d'intervention en cas de chaleur de Montréal vise à assurer la surveillance de la météo et des indicateurs de santé durant la saison estivale et à coordonner les mesures à prendre durant cette période de l'année pour réduire la morbidité et la mortalité dues à la chaleur, surtout quand des seuils météorologiques sont atteints ou que l'on observe une hausse des indicateurs de santé. Élaboré afin de coordonner et d'appliquer les mesures d'intervention sur l'île de Montréal, le plan est en vigueur depuis 2004.

INTERVENTION : Au début de juillet 2010, Montréal a vécu une vague de chaleur pendant cinq jours. Durant cette période, le système de surveillance de la santé publique montréalais a contrôlé des indicateurs de santé (mortalité totale, transport préhospitalier d'urgence, appels à la ligne d'info-santé et hospitalisations). Il a été décidé d'instaurer des interventions et des mesures d'urgence, appliquées par les partenaires régionaux et locaux de la santé publique et les partenaires municipaux (au niveau des interventions), à l'atteinte d'un seuil météorologique déterminé accompagné d'une hausse des indicateurs de santé. L'augmentation importante de la mortalité quotidienne observée, toutes causes confondues, en particulier des gens mourant à la maison ou dans la communauté, a incité le directeur de la santé publique à procéder à l'examen des dossiers médicaux de toutes les personnes décédées entre le 5 et le 11 juillet 2010 pour déterminer la cause du décès et les troubles médicaux sous-jacents.

RÉSULTAT : Durant la vague de chaleur, 304 décès (toutes causes confondues) ont été signalés chez les résidents de Montréal, dont 106 probablement ou possiblement liés à la chaleur. Les troubles médicaux sous-jacents graves dans les décès liés à la chaleur étaient les problèmes cardiovasculaires et les maladies mentales. De plus, l'examen de dossiers médicaux des personnes atteintes de maladies mentales décédées durant la vague de chaleur a révélé que beaucoup avaient été contactées 24 heures avant leur décès par des professionnels de la santé, des parents, des voisins ou des amis.

CONCLUSION : À la suite de la vague de chaleur de 2010, le plan d'intervention en cas de chaleur et le système de surveillance de la chaleur de Montréal ont été révisés; on y a inclus des initiatives pour mieux communiquer les mesures de prévention aux populations vulnérables et pour intervenir plus tôt durant une vague de chaleur.

MOTS CLÉS : chaleur extrême; système de surveillance; mortalité due à la chaleur