*Project Title:*
Use of 911 Ambulance Dispatch Data for the Syndromic Surveillance of Heat-Related Illness in Toronto: Summer 2007

*PI(s):*
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*Project Description:*

*Background*

The adverse effect of heat on health in urban communities is of major concern, and will likely become even more important with climate change. In Toronto, although a heat alert system based upon predicted excess mortality exists, there is currently no method for monitoring heat-related illness (HRI) in the community. As a result, there is a lack of information regarding the impact of HRI on members of the community and the urban areas that are most severely affected. There is a need to develop a surveillance method that will both indicate the incidence and distribution of HRI in Toronto so that public health interventions and policies may be appropriately developed and targeted in order to mitigate the negative health effects associated with high ambient temperatures in an urban environment.

The development of methods for monitoring syndrome-like illnesses and particularly those related to environmental health, like HRI, is a quickly developing area in epidemiological surveillance. Such systems, called syndromic surveillance systems, use pre-existing data streams (e.g. administrative, pharmacy, lab) based on disease symptoms to provide near real-time information regarding health events of interest. For syndromes like HRI, such a system has the potential to provide valuable information that can then direct a public health response.

The majority of the research on heat and human health is based on mortality data. However, mortality is an outcome which occurs later in the severe HRI pathway. Although these studies are useful for identifying risk factors for mortality from extreme heat, there is much additional knowledge that can be gained from analysing morbidity data. Calls to 911 have been suggested as a potentially useful and feasible source of morbidity data in Toronto.

There are several features of 911 medical dispatch data that make it a suitable source for syndromic surveillance systems. 911 call records include at least some information about the caller, location, and category of health complaint. Data are entered in real-time into a computerized database, with a single record created for each call. The automated nature of the system facilitates a timely and relatively simple method of transferring the data for analysis either continuously or in discrete time intervals, making it an appealing data source for near-real-time surveillance.

Despite the growing interest in this area, there has been limited formal evaluative work to date exploring the use of 911 medical dispatch data, particularly in Canada. While there has been limited research examining the effectiveness of 911 for the surveillance of heat-related illness,

including work by our research team, this has largely been conducted for academic purposes, rather than an assessment from a public health practice perspective. The aim of the current work was to test a surveillance system based on 911 data for heat-related illness prospectively over the summer of 2007 on a near-real time basis as a public health tool.

*Methods*

The main dataset was the Toronto Emergency Services (TEMS) medical dispatch database. Toronto has a single-provider EMS system where ambulance response calls are triaged by a commonly used call sorting algorithm, the Medical Priority Dispatch System (MPDS) software (Priority Dispatch Corp., Salt Lake City, UT, USA). This call-centre-based triage system is used to determine an approximation of the clinical status of the patient for whom help is required and then determine the appropriate level of EMS response in the pre-hospital setting. The MPDS software contains a series of prompted standardized questions used to assess the symptoms of the caller. The software categorizes each call into one of approximately 500 predefined ''determinants'' based on dispatcher-entered answers to MPDS's scripted question, and then automatically assigns a dispatch priority. Each call has its own individual record and all of this information is stored in a secure database at TEMS.

A memorandum of understanding was created between the researcher team and TEMS. The study also received ethics approval from the University of Toronto, and Toronto Public Health (TPH). All individual identifiable information was removed to ensure confidentiality prior to transfer from EMS to TPH. The dataset included only 911 medical dispatch calls to which an ambulance actually responded. Calls cancelled before dispatch (such as when a 911 caller person calls back indicating an ambulance is no longer required), and scheduled inter-facility transfers were removed from the dataset.

Daily call information for all heat-related calls and aggregate counts of emergency calls transferred electronically in a secure, password-protected system to the study researchers. This transfer happened daily, and included the calls for the previous 24 hours. The call data was collected daily from May 1 – Sept 30, 2007. In earlier research, we identified a group of MPDS codes that represent heat-related illness (Table 1). The daily total number of calls in these code categories was determined and defined as HRI calls. In addition, the percentage of heat-related calls was calculated for each day.

Table 1:  911 determinant codes used in the construction of the case definition of heat-related illness

| MPDS determinants meeting the case definition for heat-related illness |
| --- |
| 20A01 (heat/cold exposure—alert) |
| 20B01 (heat/cold exposure—change in skin colour) |
| 20C01 (heat/cold exposure—cardiac history) |
| 20D01 (heat/cold exposure—not alert) |
| 20B02 (heat/cold exposure—unknown status) |

For the descriptive analysis, the proportion of HRI calls were graphed across time with values for mean and maximum temperature (°C) obtained from Environment Canada.

Each day, the number of HRI calls were analyzed using an aberration detection software program, the Early Aberration Reporting System (EARS), to detect anomalies in the number of calls from expected based on a historical baseline. This free software is available from the USA Centers for Disease Control and is most commonly used for the surveillance of syndromes. EARS uses three baseline aberration detection methods, C1-MILD (C1), C2-MEDIUM (C2), and C3-ULTRA (C3) using simulated data. The terms mild, medium, and ultra refer to the level of sensitivity of these methods where C1-MILD is considered to have the lowest sensitivity and C3 the most sensitive. The thresholds for these statistical methods are based on a cumulative sum (CUSUM) calculation, designed to detect sudden changes in the mean value of a quantity of interest. EARS maintains a running total of the deviations between the observed and expected values; if the total exceeds a predetermined threshold then an alarm is generated. For C1 and C2, the CUSUM thresholds are the mean plus 3 standard deviations. A moving window of the past 7 days is used for the former, and the past 3 to 10 days for the latter. For C3, the CUSUM flag is based on two standard deviations with a moving window width of the previous two days and the current day. All three baseline aberration detection methods were used in this pilot study.

On days when the EARS system reported an aberration, the Hot Weather Response Team was notified. Otherwise, descriptive charts of the calls were circulated to the Hot Weather Response Team on a weekly basis.

Days of Toronto heat alerts were also added to these graphs to get a sense of the timing of morbidity increases in relation to the current mortality-based heat health warning system.

The location of HRI calls for each of Toronto's 140 neighbourhoods was mapped using the assigned latitude and longitude to illustrate areas of the city with a higher burden of calls. These calls were mapped using the software, MapInfo (MapInfo Professional v8) to create a dot-density map, with each dot representing a call for HRI. Total number of HRI calls, rather than the proportion of calls to all emergency calls per neighbourhood was used, given we were only provided with an aggregate total for all emergency calls (without individual latitude and longitude values).

*Findings*

Of the 88,321 emergency calls that were made during the study period, 79 met the criteria for HRI. The proportion of HRI calls to all emergency calls were graphed for the study period, with values for mean and maximum temperature (Figure 1).
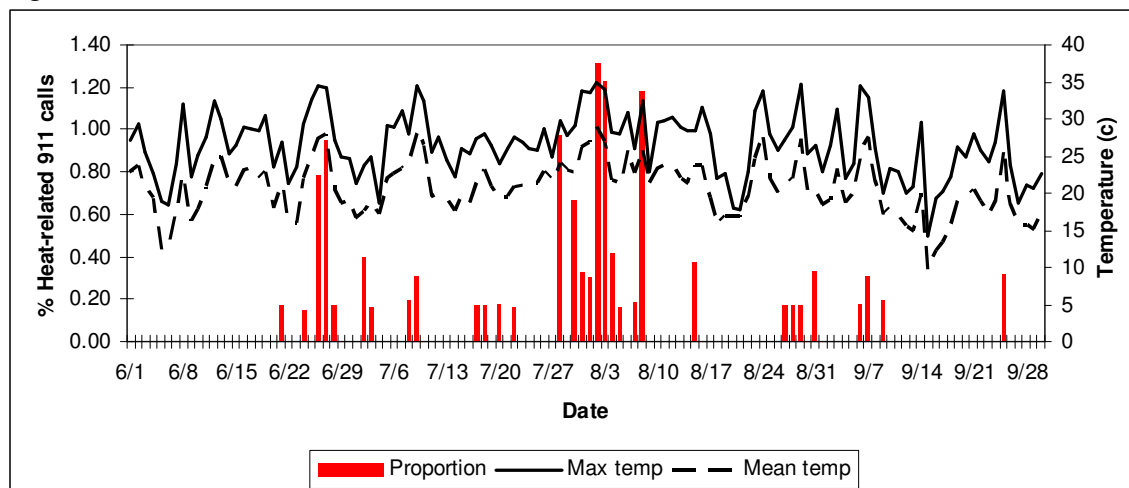
Figure 1



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Table 2 illustrates the breakdown of the total calls for the study period by a threshold of 24°C mean temperature and 28°C maximum temperature, selected as they represent the averages of recent summer temperatures.

Table 2a: Number of total calls for HRI occurring on days with a mean temperature above or below 24°C

| Maximum temperature | Call for HRI | | |
|---|---|---|---|
| | Yes | No | Total |
| Above 24ºC | 46 | 11,477 | 11,523 |
| Below 24ºC | 33 | 76,765 | 76,798 |
| Total | 79 | 88,242 | 88,321 |

Table 2b:  Number of total calls for HRI occurring on days with a maximum temperature above or below 28°C

| Maximum temperature | Call for HRI | | |
|---|---|---|---|
| | Yes | No | Total |
| Above 28ºC | 64 | 30,069 | 30,133 |
| Below 28ºC | 15 | 58,173 | 58,188 |
| Total | 79 | 88,242 | 88,321 |

Figure 2 provides the output from the EARS reports for the entire study summer. Days where an aberration occurred are marked in red shapes, depending on the aberration detection method CUSUM used. Figure 3 compares the HRI calls with days the City of Toronto declared a heat alert. Figure 4 illustrates the geospatial distribution of HRI calls across Toronto neighbourhoods.

Figure 2: Early Aberration Reporting System Results, Summer 2007



Heat-Related Illness Calls to 911 (Counts)

| Heat Alert | Extreme Heat Alert |
|---|---|
| May 24 | June 26 |
| May 31 | June 27 |
| June 1 | August 1 |
| June 12 | August 2 |
| June 13 | August 3 |
| June 25 | |
| July 8 | |
| July 9 | |
| July 31 | |
| August 6 | |

Cusum Flags: C1=Mild Sensitivity  C2=Moderate Sensitivity  C3=Ultra Sensitivity
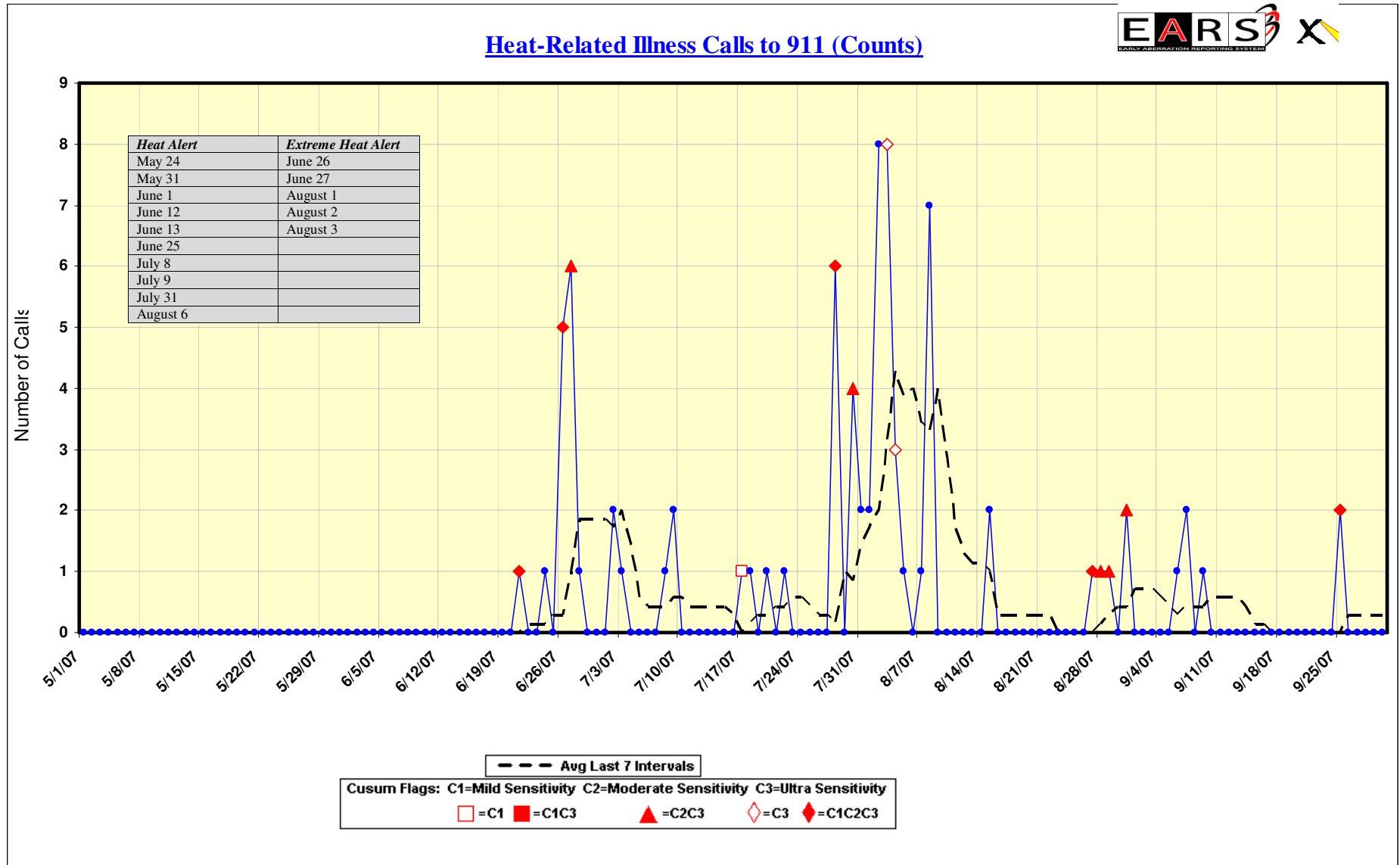
□ =C1   ■ =C1C3   ▲ =C2C3   ◇ =C3   ◆ =C1C2C3

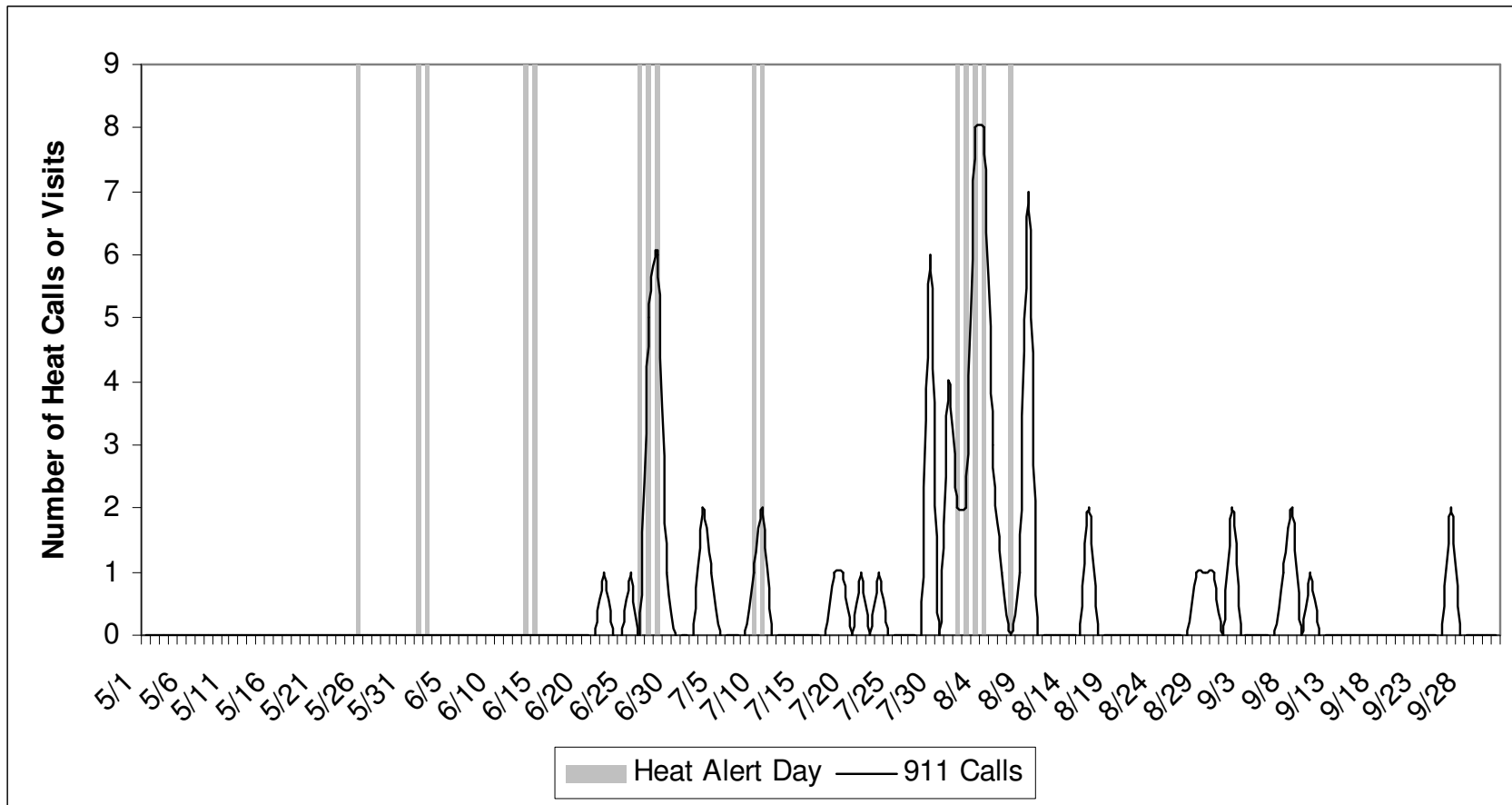Figure 3: Comparison Between Heat Alert Days and 911 Calls

Figure 4:  Dot-density map of HRI calls per neighbourhood

***Figure has been removed due to low counts.

*Utility:*

There is clear utility in monitoring 911 medical dispatch data for HRI to assist public health units in both temporal and geospatial surveillance. The 911 data provided an additional data source in making decisions about whether to call a heat alert in Toronto. These data allowed the Heat Alert and Response Team to know if the community was already experiencing burden of illness from the hot weather, information that complemented the predictions generated by the mortality-based alert system. Most promising, is the use of the geospatial data for highlighting particularly vulnerable neighbourhoods where public health interventions may be targeted to mitigate the adverse health effects. To take advantage of the unique geospatial information the 911 system provides, we learned it would be most advantageous to ask for latitude and longitude values for every emergency call from TEMS. In the pilot study we did have this for the HRI calls, but only aggregate totals for all emergency calls. In order to create shaded maps of the proportion of calls by neighbourhood, this information is needed for every call. Without this information only dot-density maps can be created (as they were in this study), making it difficult to see spatial patterns, and raising issues of small cell numbers. The use of 911 calls is currently being further explored by Toronto Public Health as part of the development of a spatial vulnerability assessment for heat-related illness.

*Challenges:*

There were several practical challenges encountered during this pilot study that provide important lessons for moving forward in using the 911 data for ongoing surveillance. The first involved the timing of the receipt of the 911 data – each day for the previous 24 hours. Ideally, this information would be sent at regular intervals during the day, with data for that day, so decisions can be made based on current information. For HRI, although the impacts can last for a few days after the heat event, the majority of impacts are experienced the same day of exposure, thus, having this information on a near-real time basis, rather than a 1 day lag, would have improved its utility. An additional issue with the timing is in making comparisons with the Toronto Heat Health Warning System, which provides updates 4 times per day for the current day. The data from the 911 system and the Toronto system were essentially different time periods.

One issue to consider is that this system is not fully automated, as many syndromic surveillance systems aim to achieve, and requires daily person-time. In the case of days where an aberration was not detected this ranged from 20-30 minutes, however, on days when an aberration was detected more time was needed in communicating with stakeholders in the response team.

Finally, there were several technical issues in the transfer of the data. On several days data was not transferred, often due to a technical error that needed to be resolved. This occasionally resulted in a gap of a few days where no data were sent from TEMS to our research team, and then a batch of data for those days sent at once. This clearly had implications for the near-real time use of the data. However, one of the aims of this study was to develop a secure and reliable method of transferring this data, which we feel has been achieved, and the technical errors worked through, so if the data were used for surveillance in the future this method could be used.

*Discussion:*

This research demonstrates the advantages and challenges in using the 911 data source for the syndromic surveillance of an important environmental health condition, heat-related illness. While there are clear benefits in collecting these data, this is one of the first reports to explore the practical challenges and feasibility issues from a practice perspective.

One of the key lessons learned from this process is the geospatial information provided by the 911 dataset is unique, and very valuable in identifying the locations where people become ill (as compared with residential address information that many health datasets provide). This feature, coupled with the timeliness of the data make it a potentially very useful source for monitoring syndromes where place matters, like heat-related illness. This previously untapped data source should be further explored for its applications in understanding the relationship between heat and human health and more appropriately targeting public health interventions, particularly the use of geospatial information.

*Grant-related Activities:*

i)  *Training and Mentoring of Students*

| Name | Institution/Department | Degree status | Role/Responsibilities/Contributions |
|------|------------------------|---------------|-------------------------------------|
|      |                        |               |                                     |
| Kate Bassil | Dept. Public Health Sciences | PhD candidate | Lead Researcher |

ii)  *Dissemination and Knowledge Exchange Activities*

        a) Presentations/Conferences

Donald Cole included a summary of our planned work at the "Environment, Health, and Social Equity" workshop hosted by the McMaster Institute of Environment & Health on May 24, 2007.

Kate Bassil included a summary of this pilot background and goals at the annual International Society for Disease Surveillance conference in October 2007.

Kate Bassil presented the findings of this work to the International Conference on Urban Health in October 2008 in Vancouver, BC.

        b) Classroom Teaching

Kate presented a lecture on heat surveillance at the Health Trends & Surveillance MHSc course with PHS in March 2008.

Kate has presented some of this work in a Research Methods undergraduate class in Health Sciences at Simon Fraser University, Fall 2008.

      c) Invited Lectures and Other Dissemination Activities

In January 2008 we presented a summary of our findings to the Centre for Urban Health Initiatives group.

In June 2008 Kate presented the application of this work to other syndromes (e.g. influenza-like-illness) for the pandemic influenza planning group at Toronto Public Health.

      d) Collaborations with Research Users

Kate Bassil summarized our pilot project to the group of stakeholders involved in the Toronto Hot Weather Response Plan in October 2007. This included representatives from agencies involved in the Hot Weather Response including the Red Cross, Housing Shelter and Support, Toronto Public Library, and Toronto Police.

Kate Bassil and Donald Cole met with the Manager of the Hot Weather Response Program in October 2007 to discuss preliminary findings from the summer pilot study and potential utility of the system in the public health setting.

Kate Bassil presented these findings in an Epi 101 Workshop provided to a group of researchers in the Climate Change and Health Office, Health Canada, in February 2009.

Kate Bassil has shared these findings, particularly the geospatial aspects, with a group of colleagues at the University of Western Ontario and Statistics Canada, in discussions of the development and submission of a SSHRC grant to create an environmental health atlas for Canada (awarded April 2009).

Kate Bassil has informally shared these findings through ongoing conversations with colleagues at Toronto Public Health in assisting the Environmental Protection Office team develop a spatial vulnerability assessment for heat (ongoing).

*Acknowledgements:*