CASE STUDY:
Augmenting Syndromic Surveillance for Real-time Situational Awareness During Extreme Heat Events in Ottawa, Canada

The Problem

The city of Ottawa has a humid continental climate, characterized by four distinct seasons with large temperature variations; summers are typically warm and humid, and winters are cold with enduring snowpack. Cities in northern climates face particular threat from extreme heat events: severe health effects may occur due to limited acclimation and adaptation. Ottawa Public Health (OPH) monitors the health effects of extreme heat using the Acute Care Enhanced Surveillance (ACES) system; in addition to providing the province with SyS based on triage data from over 80 percent of Ontario's acute care hospitals, ACES displays regionally specific data for the city of Ottawa from its five participating hospitals. ACES uses NLP methods to classify free text chief complaint information in real time into approximately 80 syndromes; the *Enviro* syndrome for HRI captures keywords and phrases that are directly related to HRI, such as dehydration, sun exposure, sunburn, heat syncope, and heat stroke. The *Enviro* syndrome is retrospectively validated against heat-related diagnostic codes from the same acute care facilities.

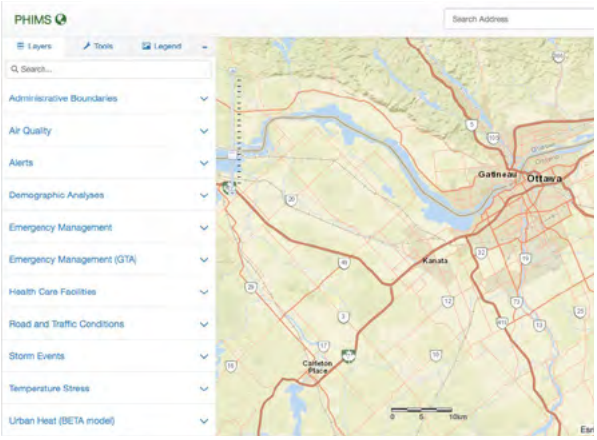
The city of Ottawa has made adaptation to climate change a public health priority. In collaboration with the CEC and HC, OPH seek to improve its understanding of the HRI and its capacity to protect the most vulnerable residents by increasing the sensitivity of the *Enviro* syndrome and enabling the integration of weather and health outcomes data sources for real-time situational awareness.

The Solution

To improve the sensitivity of ACES, new data sources were pursued that may be able to provide pre-diagnostic data earlier than the triage data currently used (e.g., see Figure 1); specifically, a data sharing agreement was negotiated with Telehealth Ontario, a nurse advice telephone service. Phone call records to Telehealth nurses may represent an earlier, and possibly larger, dataset for HRI than hospital triage data. Positive data characteristics, such as suitability, availability, timeliness, and quality, make this new data ideal to support trends observed in existing data, and possibly improve the timeliness of the system for HRI. Other data sources that were pursued (and may be included at a later date) were ambulance dispatch records, and various social media and news sources.

To integrate the health outcome data with weather data, a situational awareness tool, the Public Health Information Management System (PHIMS), has been restructured for use by OPH. The new system is called the Ottawa Syndromic Surveillance for Extreme Heat (OSSEH). PHIMS provides a web- and map-based display of both real-time and static data of relevance to emergency management and public health. Figure 14 shows the main screen of PHIMS with the right-hand menu showing the various categories of information that can presently be displayed. Data sources that are already displayed in PHIMS, and the additional data sources added for OSSEH are shown in Table 6. Data available in the system range from static information, such as the administrative boundaries of the city of Ottawa and the local public health authority, and postal codes divisions, to the display of data

Figure 14. Main Page of Public Health Information Management System



Source: www.phims.ca. Knowledge Management 2016.

that are updated in real-time (e.g., health outcomes, temperature, air quality parameters). For OSSEH, no changes were made to the acute care triage data collection protocol, nor were there changes to the NLP algorithms used to create the *Enviro* syndrome. The populations in Ontario most vulnerable to heat are older adults and children, new immigrants, outdoor workers and people who exercise outdoors, as well as the socially isolated and materially deprived (Bassil and Cole 2010; Harlan et al. 2013); vulnerability measures for them can be assessed using the demographic data available from census data collected by Statistics Canada. Deprivation indices are calculated from demographic data from the national census aggregated by postal code as a proxy for socioeconomic status (Pampalon et al. 2009).

One challenge for the OSSEH was displaying within the parameters of privacy parameters the health outcome data that were to be kept. Health outcomes from ACES are displayed as aggregated and anonymized means for specific geographic/administrative boundaries (i.e., local public health agencies and forward sortation area, or the geography defined by the first three digits of postal codes). The Telehealth data are transferred-in as anonymized data elements; the data are displayed as counts for the calls, sorted as *Heat*-related.

Several relevant parameters related to the thermal loading and transfer of heat in the built and natural environment can be derived from satellite imagery. Open source Landsat 8 satellite imagery (source: NASA) will be processed to define the local areas of possible increased heat stress. Normalized Difference Vegetation Index (NDVI) is one such source of information derived from satellite imagery, and is an estimate of the relative amount of vegetation. In combination with land surface temperature, NDVI can be used to define areas that may represent localized regional hotspots. Within cities, these areas tend to be highly built environments with minimal vegetation and impermeable surfaces. The urban "heat island effect" describes the characteristic excess heat of urban areas in comparison to rural. Understanding regional variation in temperature in relation to residential patterns is essential for determining the potential impact of heat, particularly for vulnerable population with limited access to air conditioning and substandard residential building materials.

Table 6. Data sources for the Ottawa Syndromic Surveillance for Extreme Heat system

Data Source	Source	Data Type	Details
acute care triage	ACES	health outcomes	data elements include time and date, age, sex, chief complaint free text, acuity, disposition
air quality parameters from local monitoring stations	ECCC	geophysical	data elements include AQHI ($PM_{2.5}$, O_3, NO); NO_2, PM_{10}, SO_2
demographic data	Statistics Canada	forecast	proxies for Socioeconomic status derived from census data
weather data from local meteorological stations	ECCC	geophysical	data elements include air temperature at hourly and daily intervals, humidity, humidex, precipitation volumes, wind direction and speed
weather warnings	ECCC	forecast	geospatial information and text details
Additional data sources:			
nurse advice line calls	Telehealth Ontario	health outcomes	Telehealth's Heat syndrome: data elements include time and date, age, sex
OPH heat warning	OPH	forecast	region-specific warnings
satellite imagery	NASA, KM	geophysical	static images of surface temperature, green space

Source: Knowledge Management 2016

The OSSEH provides a real-time situational awareness and decision-making tool for the City of Ottawa. The multiple data sources displayed together allow public health staff to visualize the various data during an event; at present, analytics to derive metrics, such as the relationship between temperature and health outcomes in real-time, could be made possible in this platform. In its present form, the OSSEH provides the city of Ottawa with an integrated, map-based tool that provides improved situational awareness to assist resource allocation for public health action and the capacity to conduct post event evaluation of the health impacts of extreme heat.

Lessons Learned

One of the greatest challenges for a SyS system like the OSSEH is associated with the uptake of new technologies. The OSSEH provides a wealth of information that can influence public health decision-making at all levels, from assessments of vulnerability to evaluating the actions taken to reduce heat exposure during an extreme heat event. OPH will be providing webinars and training to relevant staff to improve the adoption of the OSSEH into assessment and triage tasks by front-line staff (i.e., Telehealth call attendants, triage nurses) to improve the recognition of HRI symptomology and treatment.