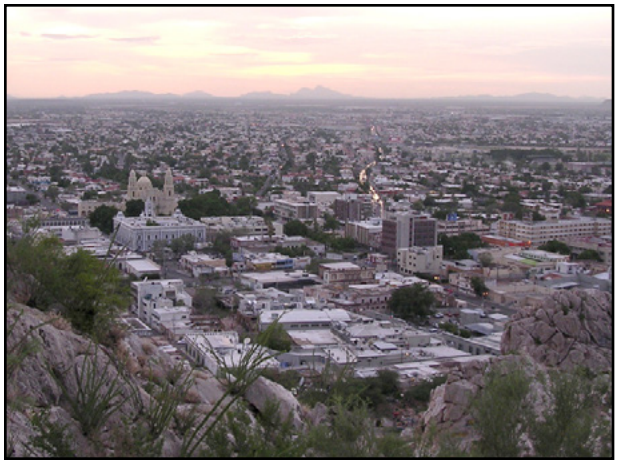


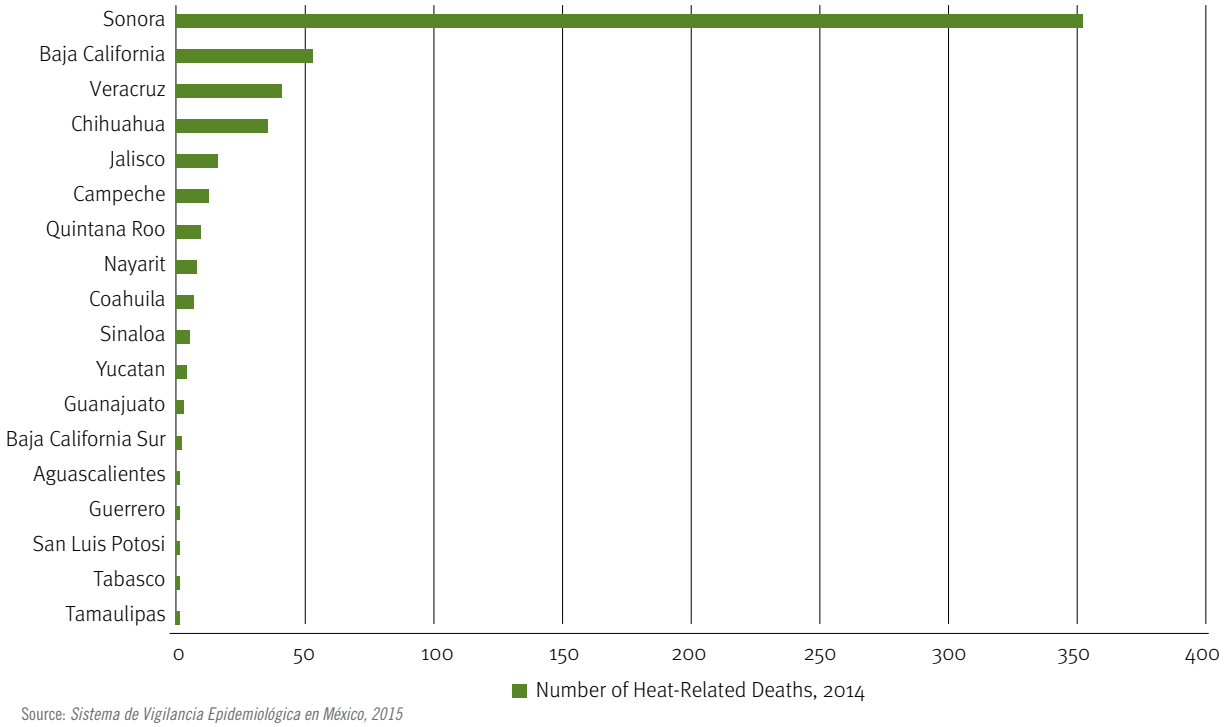
CASE STUDY: Hermosillo, Mexico, Captures Heat-Related Illnesses at Medical Facilities Using New Database

The Problem:

The threat of climate change in the state of Sonora raises serious concerns regarding the protection of human health, as daily maximum temperatures over 44°C are often recorded and conditions are expected to worsen. Sonora State has a desert climate, characterized by low precipitation, high sun exposure, and extreme heat. Approximately 60 percent of all heat mortality observed in Mexico for 2015 occurred in that state (Figure 10).

The high rates of mortality prompted all levels of government and health authorities to support measures to protect and prevent heat exposure in the region. Although reportable diseases are included in routine epidemiological surveillance in the region, information on HRI is not collated nor reported to central health authorities. Furthermore, electronic medical records are collected in hospitals or other medical facilities in Hermosillo, the capital city of Sonora, but for epidemiological analyses, paper records prevail.

Figure 10. Mortality due to extreme heat in Mexican states for 2015



Source: *Sistema de Vigilancia Epidemiológica en México, 2015*

The Solution

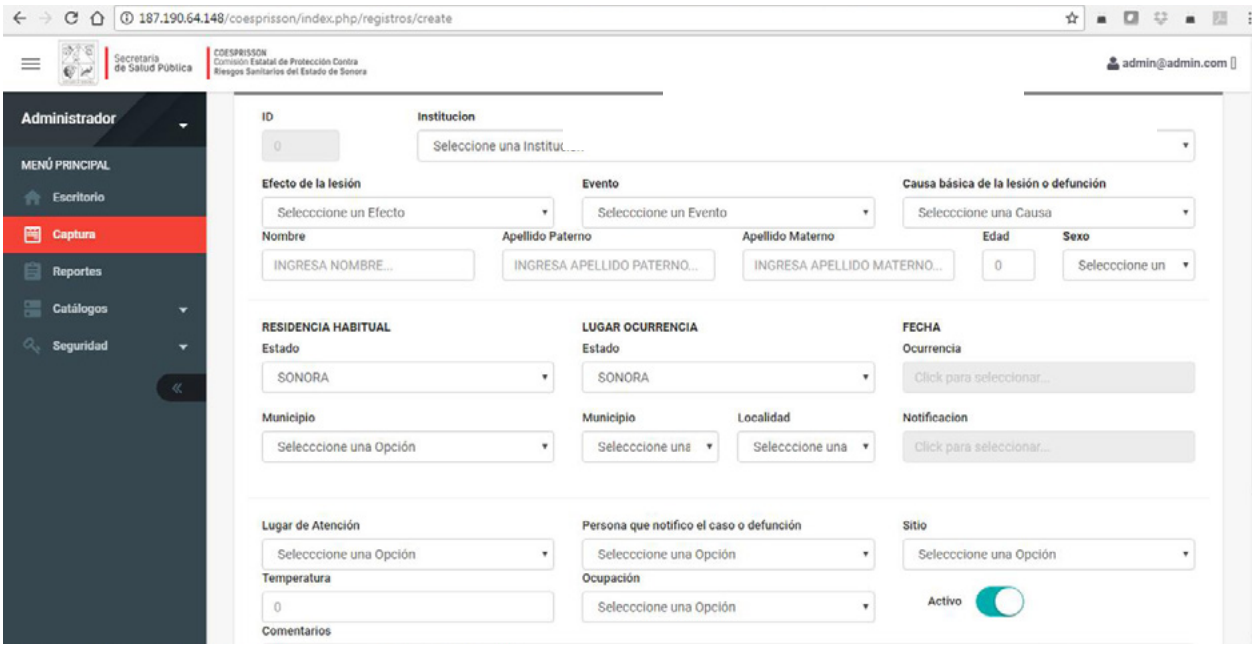
Working with Cofepris, the Ministry of Health, and the CEC, Sonora's regional health authority (*Comisión Estatal de Protección contra Riesgos Sanitarios del Estado de Sonora*—Coesprisson) established several objectives with the goal of creating a real-time SyS system for the city of Hermosillo in a 2016 pilot SyS project that would enable timely identification of health impacts due to extreme temperature and evidence-based policy development to reduce mortality and morbidity rates. These objectives included the following:

- conducting an analysis of HRI rates in the region,
- designing and implementing a computerized platform to receive and store real-time data related to the health effects and correlating these data with climate and demographic information,
- promoting coordinated work by data owners (i.e., meteorology and health), and
- implementing coordinated measures for health protection and prevention strategy during extreme heat events.

The common occurrence of extreme heat in this region makes it difficult to generate adherence to protective measures for extreme heat; messaging needs to be targeted to the most vulnerable populations to reduce "alert fatigue."

Four main presenting HRI were identified by the medical facilities in Hermosillo: (1) dehydration, (2) heat exhaustion, (3) sunstroke and (4) sunburn. The causes of the heat exposure in most of the cases identified were attributed to occupational exposures (e.g., farm and mine workers). The existing epidemiological surveillance consisted of weekly bulletins provided by local medical facilities of reportable diseases, but Coesprisson wanted to design a real-time system that included SyS of HRI. The team approached the problem by hiring six staff (two medical students, three nurses, and one paramedic) to be employed within two Hermosillo hospitals to actively seek out HRI cases and record their details into a newly constructed database (Figure 11). Using appropriate security and privacy features, the team established the basis of a heat-specific SyS system that was implemented in the two hospitals, and can be expanded to more hospitals and/or health outcomes as resources permit. For

Figure 11. The dashboard for Hermosillo's syndromic surveillance for heat-related illnesses



Source: Hugo Medina 2016

example, one measure to protect data security and patient privacy allows only system administrators access to all medical records; staff that input data have access to records only as they are entered into the database.

The SyS system aims to collect information regarding both case details and the causes of the HRI. Data are collected in real time for HRI cases, including the following data elements:

- reporting medical facility,
- address of medical facility,
- effect of injury (i.e., illnesses or death),
- basic cause of injury/death (i.e., dehydration, heat exhaustion, heat stroke, sunburn),
- demographic information (patient name, age, sex, address of residence)
- address of exposure/incident,
- date of exposure/date of notification,
- name of staff member reporting case,
- SyS study site,
- environmental temperature at time of exposure, and
- date and time of information capture.

At present, temperature is entered into the database at the same time as patient information, but automatic weather information input is being pursued with the collaboration of Mexico's meteorological system.

Lessons Learned

One of the main challenges faced by Coesprisson in their pilot project was the issue of alert fatigue. The community is used to daily life in a consistently hot environment, and lives with the daily risk of exposure to extreme temperatures. Education strategies and the implementation of policies for different sectors (e.g., workplaces, schools, etc.) that are sensitive to the adaptive capacities of each specific sector need to be developed in coordination with the at-risk populations. Such collaborative policy development should ensure that messaging and adaptive strategies are appropriate to the population they target. For example, the initial data from this project indicate that most HRI are due to occupational exposures. Prevention and protective strategies need to include input from employers, workers, and occupational health authorities. Safety specialists could be put in place for specific occupational sectors to ensure that policies and education strategies are properly implemented and effective. The data collected with the SyS system in Hermosillo should be used to demonstrate the increased risk experienced by certain local occupational groups to create protective policy. Data collected during the 2016 pilot project indicate that the typical patient for HRI presenting at the participating medical facilities was a male (42 of 58 cases), exposed to extreme heat at work (35 of 58 cases) or dehydration (44 of 58 cases).

There are often circumstances where electronic data sources are unavailable and researchers need to create opportunities to collect the information. In Hermosillo, the database created by Coesprisson to collect HRI information allows researchers and public health authorities to analyze and display health outcomes in near-real time in a circumstance where electronic medical records are not readily available for this purpose. This system is an example of active surveillance, where the accuracy and effectiveness of the system are dependent upon the input practices of the staff responsible for reporting the HRI cases. Additional staff would be required to expand the pilot SyS to other medical facilities, as well as additional staff training and enhancements to the current database to support multiple simultaneous users. It is possible that further simplification of the application to run on operating systems for cell phones and tablet-based technologies could be employed to enhance the pilot SyS reporting protocols. This SyS system could easily be expanded to other reportable HRI, as well to other syndromes of medical interest (e.g., occupational injury, chemical exposures), thereby increasing the value of this database to public health surveillance strategies in Hermosillo.

3 Defining a Heat Syndrome

The pre-diagnostic data collected from the various sources must be processed and classified into medically relevant syndromes in order to derive epidemiological information. To generate syndromic groupings, the electronic record needs to be analyzed and classified using a statistical syndrome classifier; the classifier chosen depends on the data that is used. For example, if the SyS system is based on free-text chief complaints from acute care records, the classifier will be based on groupings of keywords and/or phrases. If the data consist of pre-diagnostic codes, the classifier will be based on those specific codes or groups of codes. This is relevant for SyS systems using data from hospitals that employ drop-down, pre-defined coding for recording the reason for hospital visits instead of free-text chief complaints.

Different approaches are taken by different SyS systems to define syndromes. Some are based on machine learning and natural language processing (NLP) techniques, where classification algorithms are applied to textual data to effectively teach the system to correctly classify words and phrases (or codes) into groupings of medical interest. Like a spam detector operating in an email application, a syndrome classifier can recognize text in a healthcare record that has varying probabilities of being related to specific symptoms, which can in turn indicate certain medical conditions (or syndromes). To allow the system to recognize the various syndromes of interest, the system needs to be tested with a large dataset consisting of healthcare records of known disposition. For a detailed description of these processes, various approaches are described in *Using chief complaints for syndromic surveillance: A review of chief complaint-based classifiers in North America* (Conway, Dowling, and Chapman 2013).

Applying these methods to HRI poses challenges; the etiology of HRI are generally not specific, and presenting symptoms may be misinterpreted and/or misclassified into other syndromes. Several approaches to this problem are available: for example, some systems may classify a single record into several different syndromes, and priority could be given to an HRI syndrome when temperatures are above predetermined thresholds. The approach used depends on the goals of the SyS system, as well as the quality of the data sources. The Michigan case study illustrates both the methodology and the challenges of defining a heat syndrome to capture HRI.