Summary Report

Monitoring Health Impacts from Extreme Heat Events in North America Workshop Summary Report

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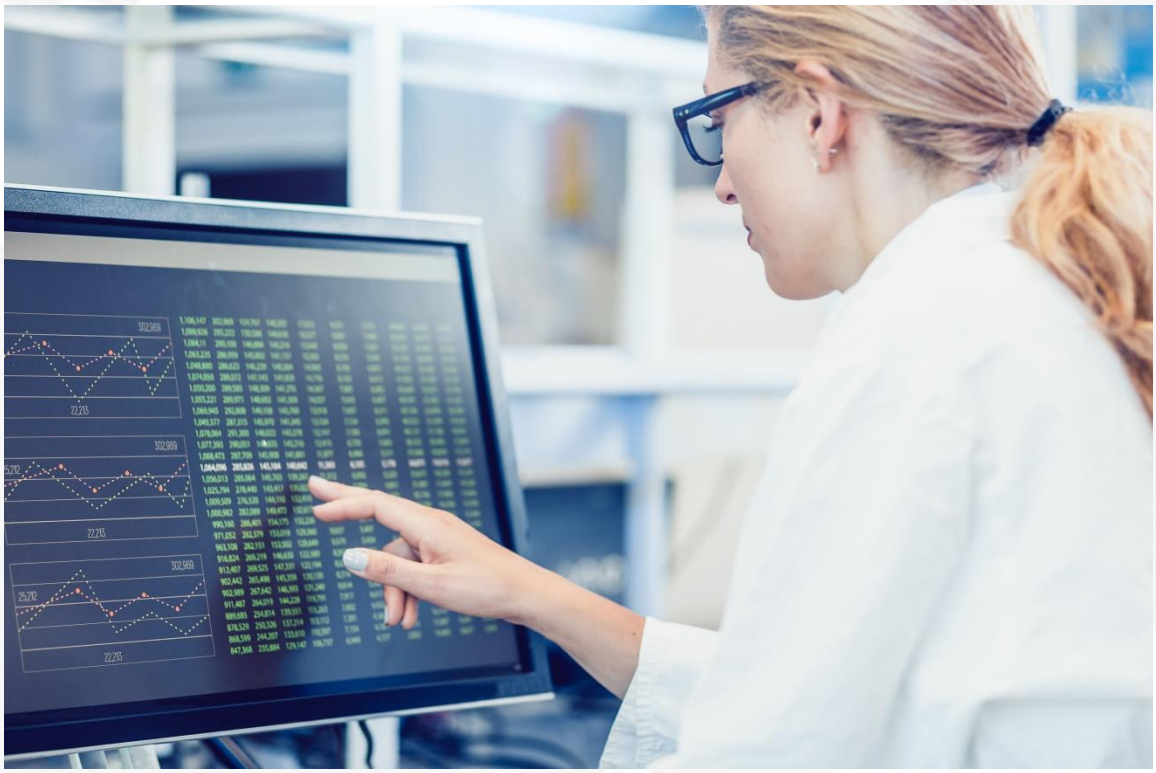

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List of Abbreviations and Acronyms

ACES	Acute Care Enhanced Surveillance
BioSense	SyS application available through the NSSP to US health departments
BCCDC	British Columbia Centre for Disease Control
BCHIPS	British Columbia Heat Impacts Prediction System
CDC	Center for Disease Control and Prevention (United States)
Coespris	*Comisión Estatal Para la Protección Contra Riesgos Sanitarios* (Chihuahua)
Coesprisson	*Comisión Estatal de Protección contra Riesgos Sanitarios del Estado de Sonora*
Cofepris	*Comisión Federal Para La Protección Contra Riesgos Sanitarios*
CEC	Commission for Environmental Cooperation
CoP	Community of Practice
CSTE	Council of State and Territorial Epidemiologists
ECI	*Expediente Clínico Integral*
ESSENCE	Data analysis platform associated with BioSense
GEHOS	*Sistema de Gerencia Hospitalaria*
GIS	geographical information system
HC	Health Canada
HRI	heat-related illness
IMSS	*Instituto Mexicano del Seguro Social* (Mexican Institute of Social Security)
MSSS	Michigan Syndromic Surveillance System
NACRS	National Ambulatory Care Reporting System
NSSP	National Syndromic Surveillance Program
OPH	Ottawa Public Health
OSSEH	Ottawa Syndromic Surveillance for Extreme Heat
PHIMS	Public Health Information Management System
SyS	syndromic surveillance

Executive Summary

As part of its 2017-18 Operational Plan, the Commission for Environmental Cooperation (CEC) established a project titled, *Monitoring Health Impacts from Extreme Heat Events,* with the goal to expand the capacity of North American communities to anticipate and prevent negative health outcomes from extreme heat events. This project is considered to be Phase 2 of related work conducted under the CEC's 2015-2016 project, *Helping North American Communities Adapt to Climate Change: A Pilot Syndromic Surveillance System for Extreme Heat.*

A key component of the current phase was a close-out workshop with the objectives of sharing knowledge, best practices and lessons learned from Phase 1 and 2 project partners, to discuss evaluation frameworks to assess syndromic surveillance (SyS) systems, and to identify avenues and opportunities for future work.

The workshop, held on December 11th, brought together the CEC project's steering committee and organizers, pilot communities, and climate and health experts to share lessons learned and best practices relative to SyS for monitoring extreme heat events, as well as other potential climate scenarios that may impact health. Presenters at the workshop included representatives from all project pilot communities and invited speakers with expertise in SyS in North America.

The morning session presentations consisted of updates from Phase 1 partners, which were all positive. For example, the pilot project in Hermosillo, in the State of Sonora, Mexico, has expanded to include data collection for the whole state, with a 51-percent reduction in morbidity and mortality observed since the initiation of the custom SyS system. This success is attributed to the ability to implement targeted messaging and preventive measures for vulnerable populations. Similarly, both the US State of Michigan and the City of Ottawa, in the Canadian Province of Ontario, reported ongoing improvements in the surveillance of the health impacts of extreme heat as a result of enhancements to their systems that were developed in Phase 1.

During the first afternoon session, Phase 2 project partners from the three countries shared their results, as follows:

1) The British Columbia (Canada) Centre for Disease Control (BCCDC) presented a project using historic data on temperature and health outcomes to predict extreme heat events that are specific to either—rural or urban—settings and populations. The objective of this project is to provide an open, web-based dashboard for citizens to access information on heat-health risks relating to local conditions.
2) In the State of Chihuahua, Mexico, a comprehensive, electronic medical record database that alerts local and regional epidemiologists and public health officials to incidences of health impacts from extreme heat was implemented in hospitals, pharmacies and private healthcare institutions. The program is just being implemented, but early indications of healthcare workers' adherence to the protocol are encouraging.
3) The project in Pinal County, Arizona, US, included interviews with patients following hospital emergency room visits for heat-related illnesses (HRIs). These interviews allowed for a better understanding of the health impacts of extreme heat exposure. The information collected also enabled a better allocation of resources to centers closer to vulnerable populations.

During the second afternoon session, presenters discussed evaluation frameworks, the application of SyS to other health impacts from climate-change related hazards, and next steps for the development of these programs. Common themes emerged from the presentations and discussions, including:

1) the need for ongoing education programs relating to both the health impacts of climatic changes and the application of SyS for public health surveillance;
2) the need for standardization of SyS methods and practices through ongoing communications and professional development, such as a Community of Practice (CoP); and
3) the need to support the ongoing development of SyS applications for the health impacts of climate hazards beyond extreme heat, such as extreme cold, extreme weather (e.g., hurricanes, tornados), and expansion of vector-borne disease exposure (e.g., Lyme disease). The axiom, "*expect the unexpected,"* must be considered in relation to climate change.

The following sections of this report provide a detailed summary of the workshop presentations and discussions.

Acknowledgments

The CEC wishes to thank the following individuals and organizations who, in addition to their other project contributions, took on the responsibility of facilitating this workshop and helped to make it a success:

- José Jesús Heraclio Herrera-Bazán (*Comisión Federal para la Protección contra Riesgos Sanitarios*),
- Victor Gallant (Health Canada), and
- Paul Belanger (KFL&A Public Health).

For their presentations and/or contributions to the meeting discussions:

- Dametreea Carr, Infectious Diseases and Epidemiology Section, Pinal County Public Health Services District, Arizona
- Gilberto García, *Secretaría de Salud, Comisión Estatal para la Protección contra Riesgos Sanitarios— Coespris*, Chihuahua
- Sarah Henderson, British Columbia Centre for Disease Control
- Rasneet Kumar, Maricopa County Department of Public Health, Arizona
- Fatema Mamou, Michigan Department of Health and Human Services
- Laura Lorena Robles Ruiz, *Comisionada Estatal, Comisión Estatal de Protección contra Riesgos Sanitarios del Estado de Sonora*
- Francisco Rogelio Rivera Ledezma, *Servicios de Salud, Gobierno del Estado de Chihuahua*
- Matthew Roach, Arizona Department of Health Services
- Vjollca Berisha, Maricopa County Department of Public Health, Arizona
- Manuela Bowler, United Way of Pinal County, Arizona
- Sara Chronister, Arizona Department of Health Services, Phoenix
- Krystal Collier, Arizona Department of Health Services
- Aaron Gettel, Maricopa County Department of Public Health, Arizona
- Clancey Hill, Pinal County Public Health Services District, Arizona
- Sara Johnston, Arizona Department of Health Services
- Melissa Kretschmer, Arizona Department of Health Services
- Maria Piña, Maricopa Association of Governments, Arizona
- Martha Robinson, Ottawa Public Health, Ottawa, Ontario
- Nancy VanStone, KFL&A Public Health, Kingston, Ontario

The CEC gratefully acknowledges the particular contributions of Paul Belanger and Nancy VanStone, of KFL&A Public Health, who were instrumental in developing this workshop and preparing the present report.

The CEC also wishes to thank the following Secretariat staff for their support throughout this project: Orlando Cabrera, Gabriela Sánchez, Danielle Vallée and Erika Hercules.

Workshop Themes and Objectives

Orlando Cabrera—CEC Secretariat; Victor Gallant—Health Canada; and José Jesús Heraclio Herrera Bazán—*Cofepris*, Mexico

This workshop represented the final activity of the CEC project *Monitoring Health Impacts from Extreme Heat Events.* In addition to the partner communities from this project, the workshop brought together representatives of the pilot communities from Phase 1 entitled *Helping North American Communities Adapt to Climate Change: A Pilot Syndromic Surveillance System for Extreme Heat*, as well as Canadian, US, and Mexican syndromic surveillance (SyS) experts and climate and health scientists. The objectives of the workshop were to:

- discuss ongoing results from Phase 1 projects;
- share results of the Phase 2 projects;
- share knowledge, best practices, and lessons learned from all Phase 1 and Phase 2 project partners; and
- network with fellow participants representing all stakeholders (e.g., community groups, national organizations) with the goal of: sharing information; identifying gaps and needs in research and implementation; discussing approaches to evaluating SyS systems; and identifying avenues and opportunities for future work anticipated from this project and the partnerships that have been created.

The workshop was divided into three general sessions, as follows:

(1) updates from pilot communities that participated in Phase 1: City of Hermosillo, State of Sonora, Mexico; the US State of Michigan; and the City of Ottawa, Canada;

(2) presentations of the findings and research results of Phase 2 pilot communities: the Province of British Columbia, Canada; the State of Chihuahua, Mexico; and Pinal County, United States; and

(3) presentations and discussion of next steps for the project participants, including draft evaluation frameworks and future directions.

Orlando Cabrera (CEC), Victor Gallant (Health Canada) and José Jesús Heraclio Herrera Bazán (Cofepris), workshop facilitators, welcomed the participants and provided the following opening comments:

Orlando Cabrera:

Participants were welcomed to the workshop on behalf of the CEC.

The project started in 2015 with the aim to strengthen the capacity of communities in North America to monitor health outcomes related to extreme heat events. The participants for Phase 1 of the project were from health agencies in Hermosillo, Mexico; the state of Michigan, United States; and Ottawa, Canada. A guide was developed for SyS in North American communities to monitor the health outcomes of extreme heat that includes case studies from the Phase 1 communities. In 2017, the project continued with Phase 2, including the state of Chihuahua, Mexico; the British Columbia Centre for Disease Control (BCCDC), Canada; and the Pinal County Public Health Services District, United States.

The goal of the workshop is to bring together partners from Phase 1 and Phase 2 to share knowledge (i.e., results, experiences, and lessons learned), SyS evaluation frameworks, and avenues and opportunities for future work.

Victor Gallant:

The role of Health Canada in this project has been comprehensive regarding planning and learning. While Health Canada does not have an administrative role in providing oversight of regional or provincial SyS systems (defined as systems using acute care data, such as those described in Phase 1 of the project), it does provide support to existing systems to develop, enhance, and improve implementation of specific functions or research programs. Health Canada is primarily interested in providing ongoing support to SyS activities generally, and specifically for supporting the implementation of such systems to provide surveillance of health impacts related to climate change. Health Canada's role in this workshop is to listen, learn, and participate in developing opportunities for future work.

José Jesús Heraclio Herrera Bazán:

Cofepris is very pleased with the results of the pilot projects in the States of Sonora and Chihuahua. The surveillance system implemented in Sonora has improved prevention of heat-related illnesses (HRIs) in that area. *Cofepris* is committed to supporting the development of heat surveillance and response (systems) and is pleased to participate with the CEC in this project.

Updates from Phase 1 Partners

Pilot Community: City of Hermosillo, State of Sonora, Mexico

Laura Lorena Robles Ruiz – *Comisión Estatal de Protección contra Riesgos Sanitarios del Estado de Sonora*

Objective of the Presentation

To provide an overview of the ongoing implementation of the heat surveillance system developed in Phase 1 for the City of Hermosillo.

Summary

The SyS system for extreme heat health impacts was developed during the Phase 1 CEC project in 2016, and is used by all units of the health authority in six health jurisdictions in the State of Sonora. The collection of data allows the information to flow through the jurisdictions up to the state level; data are analyzed at different geographic levels.

Operational definitions for the syndromes surveilled are as follows:

1. Heat Stroke: inability to dissipate heat and regulate body temperature, with symptoms such as increased temperature, dry and congested skin, headache, fatigue, thirst, vomiting, drowsiness, muscle spasms, seizures and loss of consciousness.
2. Heat Exhaustion (Dehydration): inability to eliminate excess heat causing body temperature increase, failure of multiple organs; and presenting with one or more of asthenia, edema, headache, nausea, tachycardia, or body temperature from 40-41°C.
3. Sunburn: burns to varying degrees and extent with edema of the skin, erythema, local pain, increased body temperature, vesicles, or blisters.

In addition to health data, information collected about individuals included age, sex, location of HRI occurrence (e.g., workplace, home, etc.), and date of occurrence. These data help in identifying vulnerable populations.

Coespris analyzed the heat season health data for the period 2013- 2018. In the year 2000, Sonora started collecting health data during the heat season. This effort was incremented in 2013, and in 2016, it started having better data as a result of implementing the SyS. The incidence of HRI decreased 51 percent between 2017 and 2018. *Coespris* highlighted the fact that having data on HRIs in real time allowed the implementation of timely preventive actions and treatment.

Between 2016 and 2018 there were 968 non-fatal cases of HRI. Of these, dehydration and heat stroke accounted for 19 percent. Sixty-nine percent of the 58 deaths during that period resulted from heat stroke. The majority of the cases were male migrant and/or rural workers between 24 and 44 years of age. In 2018, most of the heat-related cases were registered in the municipalities of Hermosillo, Guaymas and Caborca. The number of heat-health impact cases per year decreased significantly between 2017 and 2018.

The capture of data allowed for state-wide allocation of resources for preventive actions, including capacity-building to improve the surveillance system and improved health promotion communication strategies. Specifically, these efforts include: (1) prevention activities, (2) coordination with health units to promote the distribution of information about injuries and diseases caused by exposure to extreme heat, (3) implementation of shelter modules in rural areas, and (4) continuous training for medical personnel.

Communication strategies and materials were developed to target rural workers. These include: (1) identifying industries and workplaces with vulnerable populations (e.g., workers), (2) identifying specific agricultural sectors or employers with workers who spend the day outdoors, (3) providing training on the effects of heat illnesses and the ways to avoid them, (4) encouraging healthy strategies such as frequent breaks from sun exposure during the hot season, (5) implementing oral hydration modules in strategic locations, and (6) providing instruction to medical care personnel, including use of 911 emergency protocols. Some of the same communication strategies and materials mentioned (specifically, #3 to 6) were developed to target minors and seniors.

As part of these preventive actions, more than 27,000 informational items, consisting of written materials and presentations on preventing health risks associated with the heat season (March-October), were distributed to the general public and target populations. Approximately 40,380 oral serum doses were distributed to prevent dehydration, including 2,046 oral hydration modules and 3,880 oral sera distributed at centers installed throughout the state. In total, 169,330 preventive actions were performed in 2018.

The health department was very encouraged to see a reduced incidence of HRIs in the first year of implementation. The success was due to an increased understanding of the epidemiology of HRI, which allowed targeted communication with vulnerable populations. Health departments were able to implement public health messaging throughout the state, as well as put hydration modules in place for vulnerable populations and monitor health impacts in agricultural workers.

Pilot Community: State of Michigan, United States

Fatema Mamou – Michigan Department of Health and Human Services

Objective of the Presentation

To provide an update on the deployment of the HEAT syndrome with the Michigan Syndromic Surveillance System (MSSS) that was enhanced during Phase 1.

Summary

Almost 90 percent of emergency departments in Michigan share data with the system, and this represents 94 percent of all emergency department visits in the state. The MSSS has recently introduced enhanced feeds that include more demographic data, disposition, and discharge diagnoses; aberration detection occurs every hour and triggers alerts that a regional epidemiologist investigates. There are 7 built-in syndromes, excluding heat. The system uses an algorithm, Complaint Coder, designed to work with Michigan data and to classify visits into a syndrome category. Before Phase 1, passive *ad hoc* searches of key words in chief complaints were necessary for surveillance of HRIs, which included weekly reviews and reports sent out to partners during summer months. The Phase 1 project allowed the MSSS to create a HEAT syndrome through the development of inclusion terms, 1- and 2-word phrases, and weighting of terms. Furthermore, a custom baseline based on previous summers was developed for the state and for each county.

The results of deploying the new HEAT syndrome allowed improvements in heat surveillance in Michigan: heat alerts are included in the weekly reports, reporting is started earlier in the season, and local health departments and state partners are able to track morbidity with early heat events. The system also supports statewide press releases to educate the public, and jurisdictional data have been made easier to access.

Pilot Community: City of Ottawa, Ontario, Canada

Martha Robinson – Ottawa Public Health, Ontario, Canada

Objective of the Presentation

To provide an overview of the Phase 1 project objectives, results, and ongoing activities.

Summary

The experience of Ottawa Public Health (OPH) indicates that although there may not be many extreme heat events in the city, the first two or three events of the season have the greatest health impacts. Working with the Acute Care Enhanced Surveillance (ACES), the Ontario, Canada-based SyS using acute care visit data, allows for access to data for real-time visits to five local hospitals. The ENVIRO syndrome collects triage data for visits, which indicate exposure to extreme heat (or extreme cold), or direct effects of extreme temperature. For Phase 1, OPH sought to improve its surveillance of extreme heat events using ACES data. The tasks completed for Phase 1 for the City of Ottawa were as follows:

1. identify new data sources and prepare data sharing agreements;
2. collect historical health, climate, geospatial and census data to build the database;
3. conduct statistical analysis of historic data and mapping vulnerabilities;
4. deliver training sessions for health care providers;

5. develop a protocol to collect and communicate real-time health and climate data;
6. implement and test the pilot SyS;
7. evaluate and validate the pilot SyS; and
8. analyze the data collected.

As a result of the project, an agreement with Telehealth Ontario (province-wide telephone nursing advice system) enabled sharing of their SyS data for HRI. SyS data for both ACES and Telehealth are displayed using a custom GIS dashboard called the Public Health Information Management System (PHIMS), in concert with various meteorological, geographic, demographic, and administrative data.

One focus of the project was to develop and provide education sessions for healthcare workers, such as triage nurses, to increase risk awareness and improve reporting of HRI. Educational materials were created for distribution using platforms such as Youtube.com, and the links were shared with telehealth nurses and paramedics. In 2017-18, PHIMS developed a module that enables mapping of urban heat islands. This module has proven helpful for estimating the effects of city development, which is of interest to municipal planning professionals studying the effects of various building materials and practices on heat dynamics.

Phase 1 Projects – General Discussion

Best Practices for Training Healthcare Professionals:

Sharing educational materials via Youtube represents a low-cost, easy method of distributing information. The experience of OPH was that the uptake of educational materials is improved by sharing materials that can be accessed when needed.

Success Criteria for SyS:

The decrease in case counts in the State of Sonora is attributed to the implementation of the SyS system, in concert with efforts to communicate heat-health risks and healthy practices to vulnerable communities, as well as the state-wide implementation of a program to distribute oral serums to treat dehydration. Discussions regarding these successes centered on the fact that the implementation of the SyS system enables interagency cooperation in public health messaging and resource allocation, all of which contributed to the reduction in health impacts from extreme heat in 2017 and 2018. The project thus enabled cooperative participation in preventive activities for different stakeholder agencies in the region.

Project Highlights and Lessons Learned from Phase 2 Partners

Pilot Community: Province of British Columbia, Canada

Sarah Henderson – British Columbia Centre for Disease Control

Objective of the Presentation

To provide an overview of the British Columbia Heat Impacts Prediction System (BCHIPS)

Summary

British Columbia has a generally temperate climate, but experiences extreme heat events periodically. In 2018, a heat-health warning system was created for the province (although the City of Vancouver has used an extreme heat warning system previously). Extreme heat events have been attributed to

several deaths in the province, and the alerting thresholds have been determined using morbidity and mortality rates. However, the geography of British Columbia is vast and diverse, leading to difficulties in determining heat thresholds that are relevant to the variety of populations and areas, including dense urban areas, sparsely-populated regions, and rural areas. Participation in Phase 2 of the CEC project has given the research team an opportunity to develop a tool for analyzing the heat risk throughout the province, allowing for targeted heat-risk information in both rural and urban areas.

The British Columbia Centre for Disease Control (BCCDC) communicates heat-health risks to health professionals, but is interested in developing communication strategies that can be directly targeted to the public. The project objectives are to:

1. identify regions of British Columbia with different heat-risk profiles,
2. compile historic data on temperature and health outcomes in each region,
3. use historic data to define low, moderate, and high heat-health risk,
4. develop models to predict health risk in each region using temperature forecasts, and
5. visualize all information on an accessible and searchable online platform.

Thirty-two regions are identified in British Columbia, but the vast majority of the population lives in just a few regions; therefore, mortality data are difficult to obtain or interpret as there are many regions with no deaths recorded. The use of telehealth data was explored, but the data seemed too "noisy"; ambulance dispatch data provided clearer signals of heat-health impacts. To evaluate the utility of dispatch data to predict daily temperature, z-scores for each variable for temperature were plotted (2010 to 2018), and the best fit for cold and heat exposures was explored; a strong relationship is observed between temperature and "man down" (generally, this indicates a non-responsive patient). The data were modeled using a random forest model to predict times of high risk/temperature from the dispatch data.

The resulting model is able to predict potential heat-health risk according to ambient temperature. A web-based application showing historical and predicted risk has been created that will be modified for mobile viewing. The website will be launched in the summer of 2019, and risk maps will be downloadable for both health professionals and public consumption.

Public Health Messaging:

Materials communicating heat-health risks are in development for the heat-risk dashboard, and specific and targeted messaging may be available on the risk-map or data graphics, providing risk mitigation strategies. The system is being designed to reach and educate the public, in order to enable informed decision-making.

Pilot Community: State of Chihuahua, Mexico

Gilberto García – *Comisión Estatal para la Protección contra Riesgos Sanitarios*, Chihuahua;

Francisco Rogelio Rivera Ledezma – *Servicios de Salud, Gobierno del Estado de Chihuahua*

Objective of the Presentation

To provide an overview of the Syndromic Surveillance project implemented in the Municipality of Juárez, Chihuahua, in 2018.

Summary

The Municipality of Juárez, in the State of Chihuahua, covers a geographical territory of 3,560 km^2, with a population of 1.4 million, or 39 percent of the total for the state. The goal of the project was to design and develop a web-based interface allowing private medical units (those that are not part of the state's Hospital Management System, or *Sistema de Gerencia Hospitalaria*, GEHOS) to report cases of interest to the State's health authority. The project team developed the Comprehensive Clinical File (*Expediente Clínico Integral*, or ECI), a web-based system to create a unique and accessible clinical record for each patient.

Despite the difficult terrain and limited access to some areas, the health department strives to provide health care for most people in the state that is timely and of good quality. This project started in Ciudad Juárez. This municipality is considered high risk because of high outdoor temperatures, as well as the additional problem of a vulnerable migrant population at the border. The goal was to integrate healthcare information from private institutions, pharmacies, and hospitals into an automated platform that would simplify the process of filling in information, in order to improve the identification and notification of illness. Many of these private institutions are oftentimes the first points of contact for a large part of the state's population; therefore, it is important to integrate them into our reporting system, which is envisaged as a single, multi-institutional data management system. The basis of the platform is the system developed for use in the State of Sonora, with modifications for use in the State of Chihuahua.

At present, 126 healthcare units use the Comprehensive Clinical File (ECI); by the 2019 heat season, 189 additional units will be using it, with reach into isolated regions. Of these units, 95 are private institutions. The system functions as follows: (1) the physician records patient visit information in the system, (2) if the physician makes prescriptions and diagnoses within a heat alert, an email is automatically forwarded to the system, and (3) the data are added to the ECI system and are demarcated as a heat or cold event. This information in turn is integrated into GEHOS. There are levels of administrative access incorporated into the system, including one level of access for the physician, another for administrators, and so on. The role of the manager is to have access to all alerts, and to be able to inform the health authority of potential problems. Furthermore, information identifying the patient is included to allow for the correlation of health impacts and demographics. Both patient temperature and ambient environmental temperature are recorded with each case, as well. When an alert of health impact is triggered, local and regional epidemiologists are notified automatically and immediately. The system has the potential to improve communication and to impact real-time decisions (e.g., resource allocation) during extreme heat events.

Discussion

Participants asked about the system's acceptability by local private physicians and healthcare providers, and access to the system by individuals (e.g., general public). The system was presented for the first time in November 2018, and the interest and positive response have been overwhelming. The clinics from the Mexican Institute of Social Security (IMSS) are interested in sharing their information with our system through the implementation of standardized healthcare digital messaging security (e.g., HL7 ADT messages). In terms of access by the public, the system currently is for the exclusive use of health care agencies and professionals. The plan is to broadcast the health alerts generated by the system through social media as a means to create public awareness about the relationship between heat and health. The hope is that this information can be used to provide better understanding of heat-health risks and improve public health messaging throughout Mexico, including messaging about other important health risks, such as poor air quality.

Pilot Community: Pinal County, Arizona, United States

Dametreea Carr – Pinal County Public Health Services District, Arizona

Objective of the Presentation

To provide a summary of community impacts, benefits, and lessons learned from enhanced surveillance of HRI in Pinal County, Arizona.

Summary

The climate of Pinal County, Arizona, is prone to extreme heat events and therefore, high incidence of HRIs. This project was a collaborative effort of the United Way of Pinal County, Central Arizona governments, the Heat Relief Network, and the Arizona Department of Health Services. SyS data were provided by three Pinal County emergency departments using the BioSense platform. Working with the CEC, the project team from Pinal County had three main goals for this project:

1. to improve HRI-case identification and assessment through enhanced HRI surveillance and interview processes,
2. to identify HRI risk factors and vulnerable populations in Pinal County, and
3. to recommend and implement practical interventions to prevent HRIs among Pinal County residents.

The methods included analyzing SyS data for HRIs to identify cases of extreme heat exposure, and conducting interviews with patients; chart review of heat exposure patients identified from SyS data; and finally, a detailed interview with patients to better understand the exposure route for HRI and develop targeted interventions.

In general, HRI incidence reaches a maximum in July, with the risk being highest for non-Hispanic white males aged 20-39. Exposure to extreme heat is usually in the outdoor environment (89.6%); 17 percent of patients identified as homeless at the time of exposure, 2% lived in correctional facility, and 1 percent were in temporary housing. Activities at the time of exposure were work (38%), housework or yard work (20%).[1]

The interviews were able to help the project team understand the community impacts of HRI in a number of ways, including an improved understanding of vulnerable populations so that targeted interventions could be implemented and/or improved upon. For example, the Heat Relief Network was able to identify places where relief stations would be better located to serve populations at risk. The project team was able to learn how to better serve their target population; for example, when asked if they would like more information, 49 percent of interviewees indicated they would like to receive cell phone alerts and information on resources to assist with air conditioning access.

The Heat Relief Network Map was made publicly accessible. This map includes information on station locations, including libraries and shelters, that can be downloaded, printed, shared, and searched by GPS location. This map is supported by many different local agencies.

One limitation to this project was the long delay between emergency department visits and the first call by interviewers to the patients (delay = 2 months). This delay could reduce the patients' ability to recollect the events. Furthermore, there was insufficient access to Spanish-language resources, and

[1] Interviews could not be conducted with all HRI cases and some interviews were only partially completed; therefore, the denominator for interview results is not the same for each risk factor variable.

non-Pinal County residents were excluded, but it might be important to follow these populations. The program will be continued through 2019, with the following improvements: (1) interviews will be initiated within 1-2 days of emergency department visits, (2) a questionnaire link will be developed that can be emailed or texted to the respondents, and (3) follow-up information will be sent directly after each interview.

Discussion

The project team was asked about any planned work-related intervention, considering the high rate of occupational exposure. To date, the Pinal County project team recommends that outdoor occupations be targeted with interventions including heat-safety education and awareness. The targeted outdoor occupations range from construction and roofing to landscaping and welding.

Discussions about the use of patient-level records indicate these records are useful in classifying HRI as confirmed or "not a case;" however, patient medical record reviews should be coupled with individual case interviews to gain a full picture of each case's unique situation regarding heat exposure and illness. Completing both medical record reviews and case interviews gave the project team the greatest amount of information and contributed to the team's success in meeting its project goals.

Next Steps: Evaluation Frameworks and Future Directions

ACES Evaluation Framework and Validation of the ENVIRO Syndrome

Nancy VanStone – KFL&A Public Health

Objective of the Presentation

To introduce a framework for evaluation of the Acute Care Enhanced Surveillance (ACES), and validation of its ENVIRO syndrome.

Summary

ACES provides SyS for the province of Ontario, Canada, and serves the following two primary roles:

1. public health surveillance of infectious disease (e.g., influenza) and situational awareness (e.g., mass gatherings or extreme weather events), and
2. health care administration, such as a real-time monitoring of hospital volumes (e.g., surges), hospital usage and trends, and local epidemiological trends.

Presently, ACES collects patient records (as emergency department visits) from 156 hospitals (or over 99 percent of all acute care visits, with approximately 18,000 emergency department visits per day). The visits are classified using natural language processing (maximum entropy model) into more than 80 different syndromes, according to the words and phrases found in the chief complaints. Aberration detection is automated and geographically-stratified for syndromes of public health interest (e.g., influenza, gastrointestinal illness, opioid intoxication or overdose) and alerts are sent out to regional public health agencies and hospitals for local investigation of the anomalous visit counts for a syndrome in a specific area.

ACES is a highly secure system with access limited to vetted users, following strict data-sharing agreements and adherence to privacy governance. Publicly-accessible information, however, is made

possible through the publication of a few ancillary products that allow key information regarding public health risks to be openly shared. These products include:

1. ILI Mapper (real-time influenza mapper for Ontario: mapper.kflaphi.ca/ilimapper/);
2. Opioid Monitor (tracks opioid intoxication visits to hospitals: kflaphi.ca/ontario-opioid-surveillance-monitor);
3. Ontario Acute Care Surge Monitor (displays real time hospital volumes: kflaphi.ca/ontario-acute-care-surge-monitor); and
4. Public Health Information Management System (map-based display of real-time health outcomes for syndromes of public health relevance in concert with demographics, meteorological and administrative data: phims.ca).

Health Canada is supporting ACES in conducting a formal evaluation, including a validation of its ENVIRO syndrome (environmental exposure to heat and cold). The evaluation follows the framework and guidelines for evaluating surveillance systems developed by the CDC. Briefly, the framework includes four main sections: (1) system description (purpose, stakeholders, simplicity, operation), (2) outbreak detection (timeliness, validity, selectivity/specificity), (3) system experience (system stability, portability, system costs, representativeness, usefulness, acceptability), and (4) conclusions/recommendations for improvement (summarize findings, validate with stakeholders, disseminate information).

The administrators of ACES are conducting the evaluation with the goal of improving communication with users and expanding the user base through knowledge translation. Specifically, knowledge translation will consist of the distribution of newsletters to users, creation of educational webinars and online videos, publication of the evaluation in a peer-reviewed journal, and access to an online data quality dashboard.

Validation of the ENVIRO syndrome is ongoing. ACES data are regularly gauged against the acute care visit records compiled by the National Ambulatory Care Reporting System (NACRS), the gold standard database for all emergency department visits at Canadian hospitals. The validated dataset has ICD-10 diagnostic data; the dataset is generally released in 3-month allotments, approximately four times per year. Regular validation of ACES data with NACRS data occurs with each data release to ensure the validity of ACES' algorithms. In general, although the total number of cases identified as ENVIRO is approximately half of the true diagnostic cases captured in NACRS, the trends are similar, as measured by a Pearson correlation coefficient (r^2). The project will use the identification of cases of exposure to extreme heat (and cold) as a case study of the validity, timelines, and selectivity/specificity criteria. Work is ongoing toward operationalizing situational awareness tools using the ENVIRO syndrome for faster and more targeted public health response and resource allocation during extreme heat events.

Creating, Validating and Utilizing the Council of State and Territorial Epidemiologists' Heat-Related Illness Syndrome Query

Rasneet Kumar – Maricopa County Department of Public Health, Arizona

Objective of the Presentation

To describe the project entitled: Creating, Evaluating, and Utilizing the Council of State and Territorial Epidemiologists' Heat-Related Illness Syndrome Query Summary.

Summary

Monitoring HRI is a public health priority in Arizona. There are on average 110 days per year with temperatures above 100°F, and there were 920 deaths attributable to extreme heat exposure between 2001 and 2014. The Maricopa County Department of Public Health explored the utility of the BioSense platform to monitor extreme heat events and concluded that it could improve situational awareness and initiate more timely responses. The Department worked with the Council of State and Territorial Epidemiologists to develop a novel query for HRI.[2] A subgroup provided evaluation of this new query by comparing it to the original query.

The Department built a dashboard in ESSENCE using the query. Minimum and maximum temperatures were plotted against the daily number of HRI. There were 791 total records identified, and 589 were classified as probable cases. The records were hand-sorted to determine positive predictive value; 74 % with higher numbers in the summer and lower in the winter. Peak volumes were observed in July 2016. Highest risk factors were associated with recreational activities, yard work, cooling system or vehicle failure, and often, homelessness or substance use. Weekly, web-based and public facing reports were created that display SyS data. The success of the heat query update has encouraged the group to consider expanding this work to other health issues not currently surveilled.

Discussion

SyS for extreme heat is limited in the context discussed at this workshop to healthcare records. It would be interesting to include alternative sources of health information in these studies to determine efficacy or improvement of timeliness. For example, one planned activity for this project had been to include a sub-project using social media posts for SyS; unfortunately, the sub-project was not included. The Canadian project teams have experience using social media applications for SyS. They experienced difficulties in managing the large datasets for meaningful trends, but these datasets have the potential to serve as secondary data sources. Absenteeism data are also useful for corroborating health records.

Application and Expansion of SyS to Other Extreme Weather Scenarios

Matt Roach – Arizona Department of Health Services

Objective of the Presentation

To describe the progress of the application and expansion of SyS to other extreme weather scenarios.

Summary

Extreme heat events are common in Arizona, as are other extreme weather hazards. High temperatures are often correlated with high pollution advisories and events. Extreme weather events, such as heavy rain, storms, extreme cold, and flooding, do occur and are devastating in terms of health impacts and infrastructure damage. The use of SyS should not be limited to extreme heat. Correlation of health impacts with weather variables is standard and common. Weather data are not

2 JR White et al. 2017. Evaluation of a novel syndromic surveillance query for heat-related illness using hospital data from Maricopa County, Arizona, 2015. Public Health Reports, 132 (S 1):31S-39S.

difficult to access, monitoring stations are available in most jurisdictions, and meteorological variables are well-defined and collected.

The results of the 2015 survey of SyS users indicated that most monitor extreme heat and cold events, as well as a variety of other hazards, such as hurricanes and carbon monoxide exposure (the latter usually due to inappropriate electrical or heat generation, such as using a gas grill indoors during electricity outage). The survey respondents indicated that they use SyS to tailor public health messaging or to direct public health actions. One respondent said that SyS data were used to reunite families separated by a tornado; another respondent described using SyS to monitor cold-related illnesses. Most SyS users use systems based on emergency department data, but about 15 percent use school absenteeism data.

The Council of State and Territorial Epidemiologists (CSTE) worked with specific jurisdictions, including Maricopa County, to develop a heat query for BioSense, as described in the previous presentation. This query has been implemented by the National Syndromic Surveillance Program (NSSP).

The development of the heat syndrome provides a good case study of how to successfully move from workgroup to a national syndrome. Briefly, the process to add a new syndrome includes approval from the CSTE, followed by the International Society for Disease Surveillance (ISDS), and finally, publication by the NSSP. Currently, there are two toolkits available regarding extreme cold: (1) *Kansas Cold Weather Toolkit* and (2) *Wisconsin Winter Weather Toolkit*.

Discussion

Monitoring the health impacts of extreme heat is standard practice for most public health departments and likely the most common monitoring of what is considered to be a climate-related health impact. Other health departments may include syndromes that are developed to follow the effects of poor air quality, disease vectors (e.g., Lyme disease), carbon monoxide poisoning, or any of a host of health impacts expected during wildfires. Another important potential health impact of climate change is mental health; syndromes collecting information on the impacts on mental health need to be developed to identify, in real time, the psychosocial effects of climate change.

General Discussion

Victor Gallant – Health Canada

Objective of the Presentation

To discuss the next steps for the development of SyS for monitoring the health impacts of extreme heat and other climate-related health impacts, as well as areas for further collaboration.

Summary

Over the course of the workshop, a series of questions was compiled. These questions include: (1) How do we maintain the SyS network developed by this project? (2) How do we educate the healthcare system (and others) regarding SyS? (3) How do we evaluate these systems? (4) What messaging works for extreme heat? and (5) What supports are lacking for ongoing development?

The following are some key points of the discussion:

- Participants are encouraged to move beyond just collecting data to thinking clearly about the goal of public health to prevent health hazards. Therefore, these systems need to be applied to all issues posing risks to health, such as pollution. Furthermore, making HRI a reportable

disease would give credence to the impact of extreme heat, and allow for epidemiological analyses at a greater geographical scale.

- It is important to monitor health impacts, but it is imperative to do so for the purpose of protecting health. This means that effective health protection, such as effective messaging, must be the priority for the surveillance system. There must also be consideration of those who do not use electronic devices; therefore, there must be "old-fashioned" messaging strategies in place.
- Education must also be a priority. Education must span grade school to medical school. Climate change needs to be understood in order to be addressed, and this understanding will promote resiliency. Care needs to be taken to not overcomplicate issues, but to provide simplified explanations to allow for greater understanding. It is also noted that top-down changes in policy will have great impacts at all levels, in all countries.
- Bridging climate change and health issues must be strategized by health departments. For example, the Maricopa County Department of Health has prioritized climate change health impacts in its strategic plan. Health departments need to understand local health impacts to begin to provide interventions. Data should be used to inform action.
- Leveraging artificial intelligence (AI) is a priority. The complexity of surveilling health impacts of climate change lies in knowing in advance what the effects will be. AI methods may be useful to enable populations to best prepare for situations that are hard to predict. Understanding the role of predictive modeling is important, and including many different variables and comparing expected vs observed in real time may be helpful to identify effects sooner.
- Evaluation of interventions is necessary to best serve and protect the public. When there is limited evidence of the effect of some interventions, it is difficult to justify resource allocation for programs that may or may not be supporting healthy outcomes.
- There is a need for cooperative training and data sharing amongst the three countries of North America. Extreme heat (or weather) does not respect administrative borders, and the three nations could share information and messaging for vulnerable populations.
- Communication can be maintained through a community of practice (COP). The International Society for Disease Surveillance represents an existing structure for communication. A related group to share resources is recommended.

Conclusions

Common Themes

On the topic of SyS for monitoring extreme heat, three main themes emerged from the workshop presentations and discussions, as follows:

(1) Education

Education is key to improving the practice and applicability of SyS generally, and in the context of the health impacts of climate change. Having champions of SyS in each country who can provide education and leadership on the use of SyS to address surveillance challenges will encourage the understanding and reach of SyS in public health systems throughout North America. Education of

children and healthcare professionals on the health impacts of climate change is also important. Messaging needs to take into consideration the need for a basic understanding of climate health risks, and until then must assume low climate health literacy.

(2) Standardization of Practices

The practice of SyS varies by jurisdiction, within and between the three countries. While the United States has the NSSP, no comparable organization exists in Canada or Mexico, nor is there international oversight or leadership. The ISDS provides some supports, but a concerted effort to maintain a network for sharing knowledge and surveillance practices and data is recommended. This may take the form of a CoP. Ideally, such a network would share knowledge and best practices regarding the following:

- SyS methodology (e.g., ad hoc queries, natural language processing, validation statistics, aberration detection, alerting strategies),
- communication strategies,
- public health messaging associated with SyS,
- evaluation frameworks and results, and
- professional development.

(3) Expansion of Application

The application of SyS is not limited to monitoring health impacts of extreme heat. Health impacts from other climate-related hazards include the effects from exposure to extreme cold, extreme weather (e.g., hurricanes, tornadoes, precipitation, flooding), and expansion of disease vectors such as Lyme disease (or emergence of new disease vectors). It is paramount to understand that predictions of the health impacts of climate change cannot include all possible scenarios. Flexibility and portability are needed to evolve to changing or emerging health hazards.

Next Steps

The following are recommended next steps to build on the tri-national collaboration that has developed through this CEC project:

- Support the ongoing development of educational materials, training videos, research articles, gray literature, and so on, to enhance knowledge about SyS and its applications within healthcare and for the general public;
- Support the creation of a community of practice (CoP) for SyS practitioners (health professionals) with a focus on the impacts of climate change-related health hazards.

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