Developing a Modeling Approach for Real-time Tracking of Heat-related Morbidity Counts in Maricopa County

Vjollca Berisha and Ahmed Mohamed
vjollcaberisha@mail.maricopa.gov ; ahmedmohamed@mail.maricopa.gov

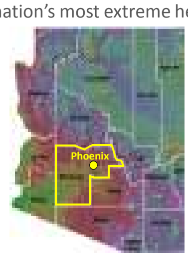
WeArePublicHealth.org twitter.com/Maricopahealth facebook.com/MCDPH

Presenter Disclosure

- No relationships to disclose

Maricopa County, Arizona

One of the largest urban centers to experience the nation's most extreme heat



Typical year:	
Environmental temperatures ≥ 100°F	Start: mid-May End: 1st week October
Days where max. temp ≥ 110°F (119°F)	26 days (average)
Days where min. temp ≥ 90°F (95°F)	13 days (average)

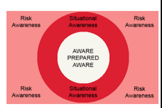
Surveillance for Heat-Related Morbidity and Mortality (HRM/M)

- MCDPH has been tracking HRM/M since 2006
  - Death certificates
  - Medical examiner data
  - Hospital discharge data (HDD)
  - Syndromic Surveillance (under development)
    - Biosense 2.0
    - AZ-PIERS (prehospital data)

Heat-related	Total	Average per year
Deaths	694 (2006 – 2014)	77
Injuries	9,419 (2008 – 2013)	1,569

Heat Surveillance Goals

- To obtain real-time data and timely detection of any aberrations
  - Situational awareness
  - Disseminate more timely information to stakeholders (heat relief network)
  - Activate more timely responses
  - Decrease the burden of heat-related morbidity / mortality
  - Examine long term trends, risk factors



Study objective

To identify the baseline levels & epidemic thresholds for heat-related morbidity (HRM) in Maricopa County using Hospital Discharge Data (HDD)

Methods: Data source

- Hospital Discharge Data (HDD)
  - Date range: January 2006 – December 2012
  - Emergency department & inpatient visits in Maricopa County, Arizona
  - Extracted ICD-9 codes associated with HRM from:
    - Primary diagnosis
    - Secondary diagnosis

Methods: Statistical Analysis

- The total number of hospital visits (regardless of reason for visit) from January 2006 to December 2012 was used as the denominator to calculate proportion of heat morbidity
- Heat morbidity rate (per 100,000 visits) along a 95% binomial confidence interval were calculated for year and month in the study period
- Extracted data were organized in a time-series format for the analysis

Methods: R package

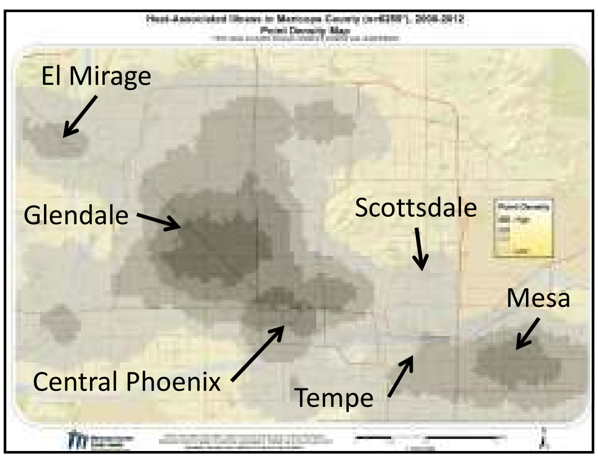
- In R, the *surveillance package* was used to build and run the model for aberration detection [1, 2]
- The model:
  - Based on a statistical process control methods known as "prospective cumulative sum" (CUSUM)
  - Makes use of the generalized additive models for location, scale, and shape (GAMLSS); a flexible method for various model distributions [3]

(1) Michael Höhle, Sebastian Meyer and Michaela Paul (2015). Surveillance: Temporal and Spatio-Temporal Modeling and Monitoring of Epidemic Phenomena
(2) R: A Language and Environment for Statistical Computing (2015). R Core Team, Vienna, Austria.
(3) Rigby RA, Stasinopoulos DM. Generalized additive models for location, scale and shape. Journal of the Royal Statistical Society: Series C (Applied Statistics). 2005;54(3):507-54.

Methods: Baseline & Threshold

- The model used known reference values to make predictions
  - A baseline representing the overall expected mean number of heat related visits (years 2006 – 2007)
  - An epidemic threshold representing the expected mean number of visits corresponding to two-fold increase in the odds of heat morbidity
- The model can accommodate seasonal variations

Study Results



Heat Morbidity Rates by Year

Year	Total hospital visits	Rates (95% CI) *
2006	1,490,708	83.65 (79.01-88.29)
2007	1,574,666	84.02 (79.49-88.54)
2008	1,630,952	73.82 (69.65-77.99)
2009	1,692,626	72.90 (68.84-76.97)
2010	1,696,305	82.12 (77.81-86.43)
2011	1,790,260	95.96 (91.43-100.50)
2012	1,822,682	94.53 (90.07-98.99)

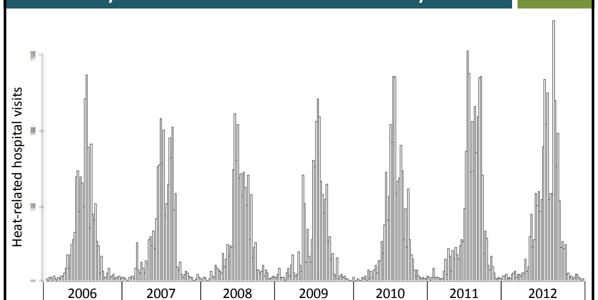
*per 100,000 hospital visits

Heat Morbidity Rates by Month

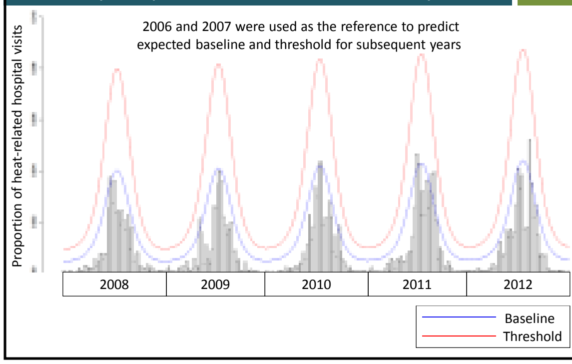
Month	Total Visits	Rates (95% CI) *
January	1,021,104	5.68 (4.22-7.14)
February	979,397	5.82 (4.31-7.33)
March	1,036,538	19.39 (16.71-22.07)
April	980,012	34.59 (30.91-38.27)
May	985,802	81.66 (76.02-87.3)
June	912,737	205.1 (195.82-214.38)
July	931,847	300.4 (289.26-311.48)
August	971,069	249.5 (239.6-259.44)
September	965,131	96.98 (90.77-103.19)
October	983,024	21.67 (18.76-24.58)
November	958,665	9.7 (7.73-11.67)
December	972,873	4.73 (3.36-6.09)

*per 100,000 hospital visits

Weekly Counts of Heat Morbidity Visits



Weekly Proportions of Heat Morbidity Visits



Conclusions

- We used surveillance tools designed in R to predict the expected proportions and thresholds for heat-related morbidity among hospital visits
- The prediction model requires:
  - Reference data for estimating expected values
  - A threshold for determining the accepted deviation from the expected values

Many Applications

- The advantage of this model is flexibility
  - Can fit a wide range of distributions
  - Allows inclusion of covariates
  - Can accommodate seasonality
- This methodology can be applied to <u>other data sources</u> that are more real-time
  - Would need to consider which aberrations warrant further investigation or taking action
- This model can be modified for <u>other morbidities</u> or health-related issues to aid in trend evaluation and decision making

Next Steps

- Validate model against real-time data
  - Improve model sensitivity
- Make the necessary adjustments to improve the model's predictions

Acknowledgments

- MCDPH Office of Epidemiology Staff
- Maricopa County Office of the Medical Examiner
- Maricopa County Office of Vital Registration (OVR)
- Arizona Department Of Health Services (ADHS)
- Arizona State University (ASU)
- National Weather Service (NWS)
- Local hospitals (infection preventionists, emergency departments, social worker staff)

Questions?

Vjollca Berisha MD, MPH
Senior Epidemiologist, Office of Epidemiology
Maricopa County Department of Public Health
4041 N. Central Ave. Phoenix, AZ 85012
(602) 372-2611 |
vjollcaberisha@mail.maricopa.gov

Ahmed Mohamed, BVSc, MSc, PhD.
Public Health Scientist, Office of Epidemiology
Maricopa County Department of Public Health
4041 N. Central Ave. Phoenix, AZ 85012
(602) 372-8417 |
AhmedMohamed@mail.maricopa.gov