Title

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Journal

Family Practice, 35(5)

ISSN

0263-2136

Authors

Vashishtha, Devesh
Sieber, William
Hailey, Brittany
et al.

Publication Date

2018-09-18

DOI

10.1093/fampra/cmy013

Peer reviewed

Family Practice, 2018, Vol. 35, No. 5, 567–570
doi:10.1093/fampra/cmy013
Advance Access publication 10 March 2018

OXFORD

Epidemiology

Outpatient clinic visits during heat waves: findings from a large family medicine clinical database

Devesh Vashishtha[a], William Sieber[a], Brittany Hailey[b], Kristen Guirguis[b], Alexander Gershunov[b] and Wael K Al-Delaimy[a,*]

[a]Department of Family Medicine and Public Health, University of California San Diego, 9500 Gilman Drive, La Jolla CA 92093-0507, USA and [b]Department of Climate, Atmospheric Sciences, and Physical Oceanography, Scripps Institution of Oceanography, 8622 Kennel Way, La Jolla CA 92037, USA.

*Correspondence to Wael K. Al-Delaimy, Professor and Chief, Division of Global Health, Department of Family Medicine and Public Health, UC San Diego; E-mail: waldelaimy@ucsd.edu

Abstract

Introduction. The purpose of this study was to determine whether heat waves are associated with increased frequency of clinic visits for ICD-9 codes of illnesses traditionally associated with heat waves.

Methods. During 4 years of family medicine clinic data between 2012 and 2016, we identified six heat wave events in San Diego County. For each heat wave event, we selected a control period in the same season that was twice as long. Scheduling a visit on a heat wave day (versus a non-heat wave day) was the primary predictor, and receiving a primary ICD-9 disease code related to heat waves was the outcome. Analyses were adjusted for age, gender, race/ethnicity and marital status.

Results. Of the 5448 visits across the heat wave and control periods, 6.4% of visits (***n*** = 346) were for heat wave-related diagnoses. Scheduling a visit on heat wave day was not associated with receiving a heat wave-related ICD code as compared with the control period (adjusted odds ratio: 1.35; 95% confidence interval: 0.86–1.36; ***P*** = 0.51).

Discussion. We show that in a relatively large and demographically diverse population, patients who schedule appointments during heat waves are not being more frequently seen for diagnoses typically associated with heat waves in the acute setting. Given that heat waves are increasing in frequency due to climate change, there is an opportunity to increase utilization of primary care clinics during heat waves.

Key words: Cardiovascular disorders/hypertension/DVT/atherosclerosis, patient education, prevention, primary care, public health, respiratory diseases.

Background

It is projected that climate change will increase the frequency and intensity of extreme heat events worldwide (1). This is an important public health concern because heat waves are the leading cause of weather-related deaths in the USA (2). In addition to increased mortality, heat waves have been associated with increased emergency room (ER) and hospital visits for a number of cardiac, renal, respiratory and mental health disorders (3–6). The 2006 California heat wave, for example, was associated with significant statewide increases in hospitalization for a number of diseases, including acute renal failure, cardiovascular disease, diabetes and electrolyte imbalances (7). This same heat wave was responsible for over 600 excess deaths (8).

Although it is known that heat waves have acute impacts on health, there have been few studies examining the effect of heat waves in the less acute, outpatient setting. One study in England found that

during the summer months, there was an increased number of primary care consultations for heat illness but did not look specifically at heat wave periods or at any other diagnoses (9). Accordingly, we proposed to assess the association between heat waves and outpatient clinic visits in a demographically diverse outpatient population. We hypothesized that heat wave periods would be associated with increased odds of outpatient visits for International Classification of Diseases (ICD-9) disease codes that have traditionally been assessed in the emergency room or hospital setting.

Methods

Study design and setting

This was a retrospective analysis of cases according to target exposure (heat wave) and control exposure (non-heat wave) that resembles the case-crossover design. We analysed data from the University of California, San Diego family medicine clinic system, which consists of three major clinic sites located throughout San Diego County. The combination of these three clinics represents an ethnically and geographically diverse study population of 35 000 men and women aged 18 years and older, and all patients with electronic medical records were deemed eligible for the study. The study was approved by the Institutional Review Board at the University of California, San Diego.

Climate data collection

Daily maximum temperature data were collected from the Global Historical Climatology Network (GHCN) and aggregated over San Diego County for the years 1950–2015 during the warm season (May–October). For the summer of 2016, we used temperature records provided by the San Diego office of the National Weather Service to identify heat waves. We defined heat waves as contiguous days (two or more) when the daily maximum temperature exceeded the historical warm-season 95th percentile threshold across San Diego County. This method of characterizing heat waves has been established in prior literature (6,10). This resulted in the identification of a total of six heat waves from May 2012 to June 2016.

We then selected a control period starting a full four weeks before each heat wave. This control period was selected to be twice the length and on the same days of the week as the heat wave period, so as to control for any variability in number of visits by day of the week, or by year. This control methodology is in line with prior studies of heat waves and health (7,11). The control period was assessed for temperature, and it was confirmed that none of the control period days included days during which the maximum temperature exceeded the 70th percentile or was below the 30th percentile for the warm season. In one case, a control period fell on a holiday, and a day from the prior week was selected instead.

Participants and clinical data collection

We conducted a structured query language (SQL) query to select a subset of visits from May 2012 to June 2016 for which the primary diagnosis was one of the ICD-9 code ranges related to heat waves. The ICD-9 codes used were based on prior literature on heat waves and health impacts in the emergency room and hospital settings (7,12) and included ICD-9 codes 250 (diabetes), 276 (fluid and electrolyte disorders), 390–398, 402, 404–429 and 440–448 (cardiovascular disease), 480–487, 490–492 and 494–496 (respiratory disease), 580–589 (renal disease), and 599.0 (urinary tract infection [UTI]). If a visit had one of these ICD-9 codes as the primary diagnosis, it was labelled as a 'heat wave-related visit'.

Many of the clinic visits at the UC San Diego family medicine sites are scheduled weeks or months in advance. Because these 'planned' visits would not represent the effect of an acute event such as a heat wave, we excluded all patients who scheduled their visit more than five days before their actual visit date. This is in accordance with at least one prior study of heat impacts on health (12). We then used the date that the appointment was made as the primary date of interest (rather than the day of the patient's actual visit), as this would have represented the moment in which the patient made the decision to come to the clinic. Among the clinic visits included in this study were some same-day appointments, which would have been of higher acuity but not severe enough to be seen in the emergency room.

Variables

Demographic information including patient age, gender (male versus female), race/ethnicity (White versus Asian versus Black versus Hispanic versus Other), marital status (married versus single versus other) and zip code were all determined by self-report, recorded by medical personnel, and confirmed at subsequent visits. The date that the visit was scheduled was automatically logged by the electronic medical record when patients' scheduled visits. Each visit was marked with a clinician-determined 'primary diagnosis' ICD-9 code, which represents the most pressing medical issue for which the patient was seen.

Analysis

We computed descriptive statistics for all variables, as mean and standard deviation for continuous variables or frequency and percent for binary and categorical variables. Bivariate comparisons used Fisher's exact test for categorical variables and two-sample *t*-tests for continuous variables. We computed multivariable logistic regression models to assess the relationship between scheduling a clinic visit on a heat wave day as compared with a control day and having a heat-related ICD-9 primary diagnosis. In the multivariable model, we adjusted for age, gender, race and marital status.

All analysis was conducted using R version 3.3.1; analyses were two-tailed at $P < 0.05$ significance.

Results

Overall, the number of visits scheduled was similar across the two periods, with 3609 total visits in the control period and 1839 total visits scheduled during the heat wave period. As shown in Table 1, there were a total of 125 visits for heat wave-related diagnoses during the heat wave period, and a total of 221 visits for heat wave-related diagnoses during the control period. Together, these 346 visits represented 6.4% of the total sample. Table 1 also shows that the highest proportion of visits came from the diabetes, cardiovascular disease, respiratory disease and UTI categories.

As seen in Table 2, the mean age was not significantly different between individuals seen during the heat wave days versus individuals seen during the control period days (47.9 versus 47.0, $P = 0.07$). Between the two periods, there were also no significant differences in demographic characteristics by gender, race/ethnicity or marital status (see Table 2).

As shown in Table 3, in multivariable analysis adjusted for a range of covariates, being scheduled during a heat wave was not significantly associated with receiving a heat wave-related primary ICD-9 diagnosis when comparing with the control period [adjusted odds ratio (AOR): 1.35; 95% confidence interval (CI): 0.86–1.36; $P = 0.51$]. Moreover, age was a significant predictor of being seen for a heat wave-related condition (AOR: 1.03; 95% CI: 1.02–1.04; $P < 0.01$).

Table 1. Frequency of visits for each ICD code by heat waves and control periods in San Diego County, 2012–2016

ICD-9 primary code	Heat wave 1, 3 days (6 control days)	Heat wave 2, 2 days (4 control days)	Heat wave 3, 2 days (4 control days)	Heat wave 4, 7 days (14 control days)	Heat wave 5, 3 days (6 control days)	Heat wave 6, 4 days (8 control days)	Combined, 21 days (42 control days)
Diabetes							
Heat wave	0	0	3	13	7	6	29
Control period[a]	4	2	8	21	8	16	59
Fluid and electrolyte disorders							
Heat wave	0	0	0	0	0	2	2
Control period	0	0	0	1	2	1	4
Cardiovascular disease							
Heat wave	2	1	4	15	1	6	29
Control period	3	0	7	27	6	5	48
Respiratory disease							
Heat wave	1	1	4	19	4	7	36
Control period	2	1	6	16	7	14	46
Renal disease							
Heat wave	0	0	0	0	0	1	1
Control period	0	0	1	1	0	1	3
UTI							
Heat wave	1	1	5	13	5	3	28
Control period	1	1	5	38	10	6	61
Combined							
Heat wave	4	3	16	60	17	27	125
Control period	10	4	27	104	33	43	221

Values listed in this table are the frequency of visits for a specific ICD code during a heat wave and its corresponding control period.
[a]The control periods chosen were twice the length of the heat periods.

Table 2. Chi-square and two-sample *t*-test analysis of demographic characteristics in individuals seen during heat wave periods versus control periods in San Diego County, 2012–2016

Variable	Heat wave period (n = 1839)	Control period (n = 3609)	*P*-value
Age	47.9 (17.2)	47.0 (17.1)	0.07
Gender			
Female	1221 (66.7%)	2447 (66.4%)	0.30
Male	618 (32.2%)	1162 (33.6%)	
Race/ethnicity			
White	1081 (58.8%)	2104 (58.3%)	0.13
Asian	237 (12.9%)	552 (15.3%)	
Black	108 (5.9%)	200 (5.5%)	
Hispanic	225 (12.2%)	395 (10.9%)	
Other	188 (10.2%)	358 (9.9%)	
Marital status[a]			
Married	1004 (54.6%)	1971 (54.8%)	0.99
Single	830 (45.2%)	1618 (45.0%)	

All values are listed as frequency (percentage) for categorical variables and mean (SD) for continuous variables. *P*-values are from chi-square tests for categorical variables or two-sample *t*-tests for continuous variables; SD, standard deviation.
[a]Some individuals were missing information on marital status.

Discussion

In this 4-year observational study of six heat waves in a large and demographically diverse outpatient family medicine clinical setting, we report the absence of a significant association between visits scheduled during heat waves and primary encounter diagnoses related to heat waves. To our knowledge, this is the first study of the relationship between heat waves and outpatient clinic visits.

One potential explanation for our findings is that patients in our study may have used more acute-care settings during heat waves. Indeed, emergency rooms and hospitals have previously been characterized as sites of increased admission during heat waves (10,12,13). Using a linked dataset from admissions to the UC San Diego Emergency Room, we found that there was indeed a significant increase in the frequency of visits to the ER on heat wave days (data not reported).

Importantly, there is an emerging understanding that innovative delivery models such as clinic workup and treatment with close follow-up may provide safe, alternate management strategies to inpatient hospital admission (14,15). There is a need to examine which heat wave-related illnesses can be treated in the outpatient setting. For example, for patients with uncomplicated UTIs or mild volume depletion, the family medicine clinical setting with close follow-up would provide sufficient resources for treatment in a cost-effective manner that maximizes continuity. Indeed, for UTIs, which have been previously associated with heat waves in large, nationwide studies (12), treatment in the emergency room is $772 higher per episode as compared with the outpatient setting, resulting in excess costs of $2 billion nationwide (16). From a resource utilization perspective, there may be value in developing better access to outpatient clinics during heat wave events and shortly after.

Given that heat waves are increasing in frequency, intensity and duration due to climate change (1,13), it is essential that primary care clinics become better equipped to inform and treat patients about the health impacts of extreme heat events (17). Primary care settings and especially patient-centered medical homes (PCMHs) can serve as central locations for health care workers, social workers and patients to be informed about health practices such as adequate fluid intake and access to electric fans, which prevent the morbidity and mortality associated with heat waves (18). Our finding of no association between heat waves and clinic visits for related ICD codes suggests an opportunity to

Table 3. Multivariable logistic regression of factors associated with receiving a heat wave-related ICD-9 code in San Diego County, 2012–2016

Variable	AOR[a]	95% CI	*P*-value
Visit scheduled during heat wave	1.35	0.86–1.36	0.51
Age	1.03	1.02–1.04	<0.01
Male gender	1.12	0.89–1.41	0.33
Race/ethnicity			
White (reference)	–	–	–
Asian	1.20	0.88–1.62	0.23
Black	1.15	0.70–1.80	0.57
Hispanic	1.01	0.69–1.46	0.95
Other	1.12	0.75–1.61	0.57
Single	0.87	0.69–1.09	0.22

AOR, adjusted odds ratio; 95% CI, 95% confidence interval.
[a]The odds ratio compare heat wave days with control days.

build a stronger primary care framework for resilience to the impacts of heat waves on health so that patients are better able to access their primary care clinicians for health issues related to heat waves.

Our study has some limitations. First, because our unit of analysis was the number of visits and not the number of individuals, there is the possibility that differing patient characteristics during these periods explain our findings. We tried to control for this by choosing a control period in close proximity to and on the same days of the week as the heat waves, and we also adjusted for the key demographic factors that could explain any difference between the heat wave and control periods. A second limitation of our study is that we only considered primary ICD-9 diagnoses, and it is possible that patients could have had subacute issues exacerbated by the heat waves, such as diabetes, which were not serious enough to be considered primary diagnoses. If this was the case, we might have misclassified visits as being unrelated to heat waves when they were in fact related.

Strengths of our study include our use of a relatively large and demographically and geographically diverse population to investigate the health effects of 4 years of heat waves, which are relatively rare events. Another strength of our study is its internal validity, as our data were pulled from a robust electronic medical record in which patient demographic information was re-verified at each visit. We also carried out analytic approaches that adjusted for confounding according to age, gender, ethnicity and marital status, allowing us to isolate the independent effect of heat waves on clinic visits.

Our finding of no relationship between heat waves and heat wave-related diagnoses in the primary care setting is important because it is one of the first studies, to our knowledge, that assesses the effect of heat waves in the outpatient setting. With climate change, heat waves will continue to present a public health burden. There may be opportunities to equip primary care settings to provide care for vulnerable individuals during heat waves.

Acknowledgements

The authors thank Renu Sugathan for her assistance in data query and Florin Vaida for his assistance with statistical coding.

Declaration

Funding: Devesh Vashishtha was supported by an NIH TL-1 training grant #1TL1TR001443. This work was also supported by a UC San Diego Institute for Public Health Pilot Grant.
Ethical approval: This study was approved by the University of California San Diego Institutional Review Board.
Conflict of interest: The authors have no conflicts of interest to declare.

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