REVIEW OF JULY 2006 HEAT WAVE RELATED FATALITIES IN CALIFORNIA

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Acknowledgements

This following report prepared by Roger B. Trent, Ph.D., Epidemiology and Prevention for Injury Control Branch, California Department of Health Services. The report is based on work of several members of the Climate Change Public Health Impacts Assessment Group. They include: Paul English, Ph.D., M.P.H., Chair; Thomas J. Kim, M.D., M.P.H.; Helene Margolis, Ph.D.; Kathleen Fitzsimmons, M.P.H; Environmental Health Investigations Branch.

Introduction

This review is based on two sources. The first source is a case-series study of 140 deaths* identified by California county coroners and medical examiners as "heat related" (HR) from July 15 to August 1, 2006. Coroners and medical examiners provided copies of death certificates, investigation narratives, and autopsy reports with toxicology findings. The investigators (Thomas Kim, M.D. and Roger Trent, Ph.D.) consider the findings reliable but not final. This document summarizes the preliminary findings, and is not a detailed discussion of all aspects of the investigation or a detailed chronicle of all known aspects of the deaths. Analysis of this California case series continues.

The second source is a literature review of 26 studies of HR morbidity and mortality from the United States, Europe, and Australia. The review is the work of Thomas Kim, M.D. and Kathleen Fitzsimmons, M.P.H. Any findings of the California study that appear to be new or different from findings in the literature are emphasized. A working hypothesis was that heat related deaths in California might differ from those in other places, especially parts of the United States and Europe with generally higher humidity and differences in demographics, activity patterns, the number of microclimates, and other factors. By looking at both past research and the California case series findings, we aimed to ground the assessment of the Draft Plan in data that are comprehensive as well as germane to California's experience in last summer's heat wave.

This document describes the main factors in HR illness and deaths, and opportunities for prevention. All the data graphs and tables come from the California case series. At the end, we provide conclusions based on our findings about these main factors.

HR illness is described according to three stages of increasing severity:

1. Heat cramps. Mild and easy to treat, this level involves fevers generally under 102 degrees Fahrenheit.
2. Heat exhaustion: Involves fevers over 102 degrees Fahrenheit, often with vomiting, diarrhea, and fatigue.
3. Heat stroke: A severe and life-threatening failure of body's ability to cool (e.g., sweating ceases), with fevers over 104 degrees Fahrenheit. Heat stroke can result in organ and neurologic damage and lead quickly to death. All cases in the California heat death series are assumed to have died of heat stroke.

* This number may increase as some late determinations are made by coroners and medical examiners.

Place

1. Most deaths occurred in counties with strong and persistent high and low temperatures and high Heat Index levels.
2. People in these high-death counties are assumed to be better acclimatized to high heat than are people in counties with generally cooler summer temperatures, such as those nearer the coast or at higher elevations.
3. In the two weeks of the 2006 heat wave, seven counties accounted for 80 percent of the deaths. They are inland, low-lying counties in a swath from Imperial County, through the Inland Empire county of San Bernardino, up through the San Joaquin Valley. Counties along the coasts, in the Sierra, and north of Sacramento had fewer deaths. In the months of June through August for the years 1999 through 2004, California averaged a HR death rate of 0.12 per 100,000 population annually. Rates for the two weeks of the heat wave in the seven counties are:

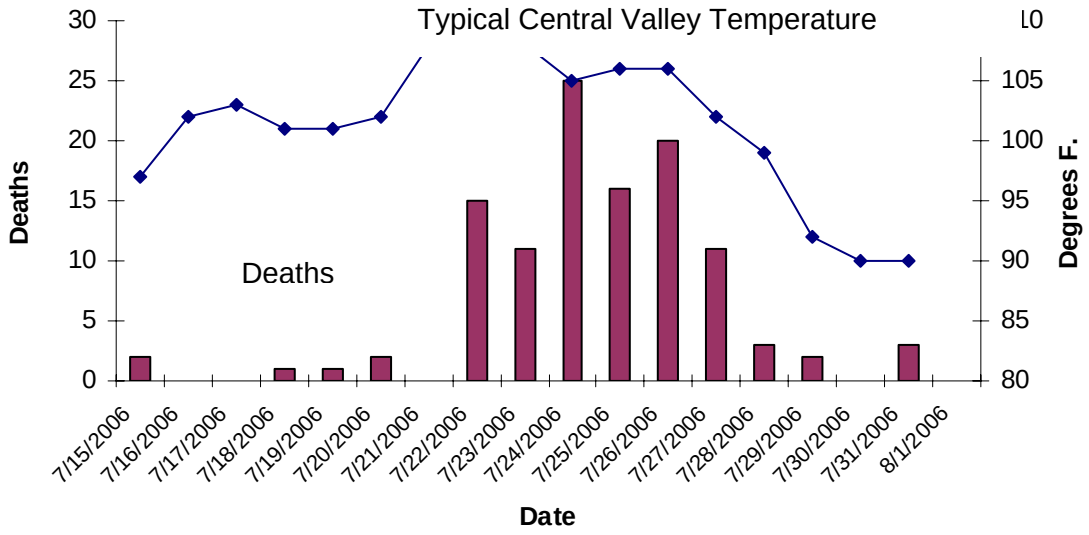
County	Rate
Imperial	6.4
Stanislaus	4.6
San Joaquin	3.2
Fresno	2.3
Kern	2.0
Sacramento	0.9
San Bernardino	0.6

4. Ninety percent of the HR victims lived in socioeconomically depressed areas (that is, in zip codes where more than 50 percent of the residents live under the Federal Poverty threshold).

Time

1. Most deaths occurred between July 22 and July 28, after the heat wave had been underway for several days, depending on location. A lag from onset of heat to increase in deaths is consistent with all studies of European heat waves.
2. The number of deaths dropped rapidly as temperatures cooled, but some deaths appear to have been delayed.
3. Uncounted delayed deaths could have been hard to attribute to HR illness and may not have been examined by coroners or medical examiners. Therefore, the death toll documented in the California case series may underestimate the true toll. Studies have found general death rate increases during heat waves, apart from deaths specifically attributed to heat.

Heat Stroke Deaths and Typical Temperature, by Date, California July 15—August 1, 2006



Source: California Department of Health Services

Classification of Heat Stroke

Researchers often classify heat stroke exposure into two types. The distinction is based on several factors and cannot be applied precisely.

- *Exertional heat stroke* tends to occur among younger (under 50 years old), healthier persons who develop heat stroke after strenuous activity and inadequate hydration. The result is dehydration and electrolyte imbalance. Exposures may involve work or recreational activities outdoors.

- *Classic heat stroke* tends to occur among persons who are older (over 50 years old), frail, and with chronic diseases. They may take medications, have psychological or cognitive problems, and live alone. They are assumed to have a compromised thermoregulatory response due to their age, illnesses, and medications. They generally are not in an air conditioned space when discovered with heat stroke symptoms or deceased.

Source: California Department of Health Services

Key heat stroke related findings related to fatalities in California include:

- Only about ten percent of the deaths (14 persons) appeared to be exertional heat stroke, rather than classic heat stroke.
- Only one death occurred to someone under 20 years old (a child with cerebral palsy).
- Exertional heat stroke deaths were more likely to occur among Hispanic persons.
- Most exertional heat stroke deaths involved outdoor work or recreational activities.
- Only one person was known to have died after having illegally crossed the border from Mexico.

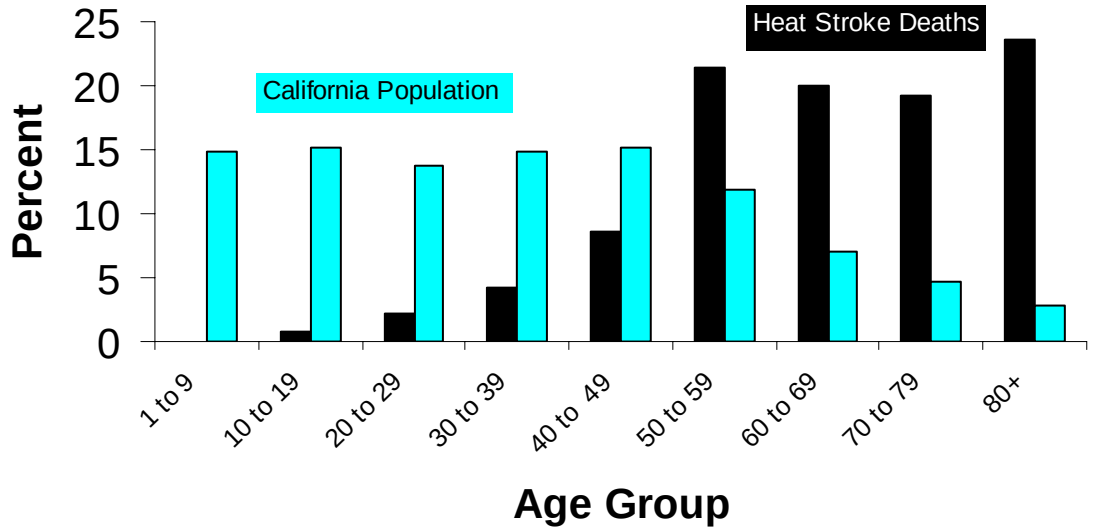
Demographic Risk Factors

1. Risk in the California case series appears to be higher for males and for Hispanics and Black, non-Hispanics.

Risk Factors	Heat Deaths 2006	All Deaths CA 2004
Male	66%	50%
White, Non-Hispanic	64%	71%
Hispanic	24%	14%
Black, Non-Hispanic	12%	6%
Asian/Pac. Islander	.08%	11%

2. Age is a major risk for HR death.
3. The number of deaths rises rapidly after age 50.

Percentage Age Distribution of Estimated 2005 California Population (U.S. Census) Versus Heat Stroke Deaths, July 15—August 1, 2006.



Environmental Risk Factors

1. No classic heat stroke death in California was known to have involved strenuous activity.
2. Most classic heat stroke deaths appear to have had greater exposure to heat indoors than outdoors.
3. Forty-six percent of all deaths occurred among persons who were known to have lived alone.

Comorbid Factors

Comorbid risks identified in past research were common in persons in the California death series. The following percentages are based on all deaths. Some persons had more than one of these risk factors.

Risk Factors	Percent
Cardiovascular disease	47%
Psychiatric	23%
Alcohol/drug use	19%
Pulmonary	7%
Confined to bed	2%

Air Conditioning Availability and Use

1. Only one person was reported to be using air conditioning prior to death.

Air Conditioning	Percent*
AC not present	45%
AC unknown	20%
AC present	35%
Not functional	46%
Functional	54%
Used	5%
Not used	95%

* Based on 96 indoor deaths only

2. Inside temperatures (noted in 36 of 140 cases) averaged 103.5 degrees Fahrenheit with a range of 85 to 140 degrees Fahrenheit.
3. High-death counties have a high proportion of dwellings with air conditioning (about 90 percent, according to the California Energy Commission).

Social Contacts

1. Of all 140 cases, 65, or 46 percent, were known to have lived alone (compared to 19 percent in California in the year 2000 census).
2. Of those who were known to have lived alone, 55 percent had a specific social contact (such as relative, neighbor, or friend who routinely checked on the person).
3. Of those who were known to have lived alone, 19 percent were contacted or seen by social contacts within 24 hours prior to death.

Summary

1. Classic heat stroke cases predominate, with a few exertional heat stroke cases.
2. Despite research literature identifying children as a high risk population, only one child death occurred in the California heat wave. We have no information on HR morbidity in this or other age groups.
3. Isolation, residence in a poor area, age, and chronic disease are common risk factors. Risk rises rapidly with age, after about age 50 years old.
4. Information on housing type, transportation options, and other ecologic factors was generally not available in death records.
5. Most classic heat stroke victims either lived in quarters that lacked usable air conditioning, or they had not used available air conditioning.
6. Many older persons died even though a social contact had contacted or seen them with 24 hours. There is virtually no information on the presenting symptoms of victims.
7. The spike in deaths occurred after several days of high temperatures.
8. HR deaths among persons crossing illegally into California from Mexico are endemic (about 30 percent of all California HR deaths in 1999 through 2004,

data not shown). For reasons unknown, only one person who died in the July heat wave appeared to be in this category.

9. There was some scant evidence (not shown) that victims may have failed to hydrate themselves adequately. Older persons are prone to dehydration, particularly if they are taking certain medications (such as some common anti-hypertensives).
10. Some classic heat stroke victims were reported to have had a fan trained on them. Fans were not found to be effective in the Chicago heat wave of 1995.
11. Patterns are consistent with those found in other studies of heat waves in the United States and Europe. California conditions and death patterns thus do not appear to be exceptional.

Conclusions

1. **Cooling**. Consistent with the Interim Plan, people with risk factors for classic heat stroke should be moved to air conditioned places, including public "cooling centers." Transportation must be available. Cooling strategies for persons exposed to risk of exertional heat illness (people engaged in outdoor work, recreation, or other strenuous activities) should also be implemented. Cal OSHA has already implemented new regulations for protecting workers against HR effects.
2. **Monitoring by social contacts.** There is no evidence to support the belief that social contacts of people at risk of classic heat stroke are able to identify symptoms or respond appropriately. Social contacts should ensure an air conditioned environment for any such persons, *whether or not they show any symptoms of HR illness.*
3. **Timing**. Nothing in the California case series indicated that criteria for declaring a heat emergency in California should be different from other places. As soon as a heat wave is predicted or a heat emergency is declared, social contacts and others involved in the response should mobilize to move vulnerable persons to cooling centers. Social contacts need guidance on
    a. How to identify persons and housing situations that constitute high risk, and
    b. How much time needs to be spent in an air conditioned environment? For example, how many hours each day should a person at risk remain in a cooling center before returning to a place without air conditioning? This could become very important if a heat wave continues for a long period. Staying at a cooling center for long periods could be complicated by power outages, transportation problems, personal mobility limitations, and other medical issues. Experience last summer at Pacific Gas and Electric Company's cooling centers was that people came to the centers to spend the day and returned home by five in the evening. Because deaths lag the onset of high temperatures by a few days, social contacts need guidance on strategies for preventing cumulative exposure that can lead to HR stroke.
4. **Location**. Risk appears to be much greater in poor neighborhoods (particularly in inland counties in the Inland Empire and the San Joaquin and Imperial Valleys). Vigilance should be especially careful in such places. However, if historically atypical climate patterns cause future heat waves to strike coastal or mountain counties, residents there could be in great danger. Residents of the ordinarily cooler counties could be more vulnerable because of lack of both acclimatization and home air conditioning.
5. **Personal cooling strategies**. There was some scant evidence that people who died were not using effective personal cooling strategies. For example, there was almost no evidence that people cooled themselves with cool baths, appropriate cold beverages (like ice water rather than alcoholic or caffeinated drinks), or used cold packs or ice to promote body cooling. Inappropriate use of

fans was mentioned. Specific “tips for staying cool” should be widely disseminated.

6. **Sentinel monitoring.** To acquire immediate information on heat emergencies as they begin, systems could be developed to report sentinel cases of HR illness presenting at selected emergency departments or heat stroke deaths encountered by coroners and medical examiners.
7. **Border crossing**. It would be worthwhile to know more about the pattern of HR deaths associated with border crossing, particularly since there appeared to be only one. More might have been expected. We do not know if the period of the heat wave was atypical in some way that averted HR deaths or whether patterns of crossing changed in some important way. The Office of Border Health has much experience in the border crossing issue.
8. **Expert panel**. To develop recommendations for personal cooing strategies and to provide advice to social contacts of persons at risk, the help of a panel physicians experienced in HR illness should be enlisted.
9. **HR morbidity.** Non-fatal HR morbidity, especially heat stroke that does not cause death, is a public health concern. HR illness in general may strain emergency care. Heat stroke can cause serious permanent injury to organs. The same strategies that prevent fatal heat stroke may also help control HR morbidity. It would be useful to develop ways to monitor the range of HR effects in order to refine policies and practices in future heat waves.