Epidemiology of Heat

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Outline

- Historical View
- Heat Illness
- Measuring Heat Deaths and Extreme Heat
- Lessons Learned from 2006 CA Heat Wave
- Other Heat Research
- Other Issues
Heat Waves

- Kill more than all other extreme events combined: “Silent and invisible killers of silenced and invisible people” (Klinenberg, 2002)

- Expected to increase in severity and frequency, last longer and occur earlier:
  - Nights warming faster than days

Effects on/of Air pollution and Wildfires
July-Aug Temp Anomalies (summertime hot outliers)

Extremely hot areas now cover 10% of earth’s surface (Hansen, et al 2011)

% area

hot ($\sigma > 0.43$ from average), very hot ($\sigma > 2$), and extremely hot ($\sigma > 3$)

July-Aug Temp Anomalies (summertime hot outliers)

Extremely hot areas now cover 10% of earth’s surface (Hansen, et al 2011)
Great Recent Heat Waves

- **Chicago Heat Wave of 1995**
  - 700 deaths in 5 days; humid; most deaths elderly men (poor black community hit)

- **European Heat Wave 2003**
  - 40 to 60K deaths

- **Europe/North America Heat Wave 2006**

- **Moscow Heat Wave 2010 (killed 55,000)**
Some Lessons Learned

• Chicago: Poor Preparedness: City response system that calls on vulnerable and elderly; fear of crime and closed windows

• France: Vast majority elderly; during summer vacation; not enough staff to cool residents; poor living conditions; isolated populations; poor public communication

• Russia: Lack of Preparedness, lack of cooling centers, firefighters
Sweating is primary means of thermoregulation. Evaporation has cooling effect, decreases core temp. Heat exposure exceeds physiological capacity to cool; core body temperature increases.
Heat cramps. Mild and easy to treat, this level involves fevers generally under 102 degrees Fahrenheit.

Heat exhaustion: Involves fevers over 102 degrees Fahrenheit, often with vomiting, diarrhea, and fatigue.

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.
Classic and Exertional Heat Stroke

Maria Isabel Jimenez
May 14, 2008
17 y.o. picking grapes

Jose Hernandez
June 20, 2008
64 y.o. picking squash

Abdon Garcia
July 9, 2008
46 y.o. loading grapes

Ramiro Rodriguez
July 9, 2008
48 y.o. picking nectarines

Jorge Herrera
July 31, 2008
37 y.o. loading grapes

Maria Alvarez
August 2, 2008
63 y.o. picking grapes
Measuring heat deaths

- Coroners’ reports
- Death Certificates
- Excess mortality
- Case definition:
  - Primary and underlying cause of death
Measuring “Extreme Heat”

- No universal definition of extreme heat or heat waves
- Consensus revolving around using a percentile cutpoint (say 95%) of max temp or heat index compared to historic (30 yr) baseline record for that day
- Heat waves: 2 or more days of extreme heat?
NWS Heat Alerts

- Not pegged to health outcomes; use meteorological definitions

Number of heat-related emergency room visits during heat products, SF Bay Area, Sep 2009
2006 CA heat wave

- 655 excess deaths, 16,166 excess ED visits and 1,182 excess hospitalizations
- Children, the elderly, and the poor were at greatest risk.
- Cost CA $133 million in health-related costs
- Agricultural losses exceed $1 billion
Notes on 140 coroner cases
California 2006

- Inside temperatures (noted in 36 of 140 cases) averaged 103.5 degrees Fahrenheit with a range of 85 to 140 degrees Fahrenheit

- 46% of decedents lived alone, 55% of these had a social contact who routinely checked on them, and 19% seen by social contacts within 24 hours prior to death.

- 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. Only one child death.

- Only one decedent had AC on.

- Some classic heat stroke victims were reported to have had a fan trained on them.
Morbidity from CA heat wave

- 16,166 excess ED visits and 1,182 excess hospitalizations

- Children and the elderly were at greatest risk.

- ED visits showed significant increases for HRI, acute renal failure, cardiovascular diseases, diabetes, electrolyte imbalance and nephritis.

- Significantly elevated RRs for hospitalizations for HRI (RR 10.15; 95% CL 7.79, 13.43), acute renal failure, electrolyte imbalance and nephritis.
Rate Ratios for ER visits for heat related illness; California July 15-August 1, 2006 (Knowlton, et al EHP, 2008)
Green et al. 2010 found that a 10 degrees F increase in mean apparent temperature was associated with a 3.5% increase in ischemic stroke and increases in several other outcomes including all respiratory diseases, pneumonia, dehydration, diabetes and acute renal failure.

Basu, et al. 2008: Each 10 degrees F increase in same-day mean apparent temperature corresponded to a 2.3% increase in mortality (95% confidence interval = 1.0%-3.6%)

No confounding by air pollution.
OTHER ISSUES

Loss of worker productivity.

• 10% productivity loss over a working year since 1980 Delhi (Kjellstrom and Lemke, 2009)

Harvesting Effect.

• decrease in overall mortality during the subsequent weeks after a heat wave

Threshold Effect.

• Mortality from heart disease and stroke increase from heart disease and stroke increase at temps > 60-70 F (32 Cities). Many more time periods of exposure than rarer heat waves; overall greater morbidity. (Rogot and Padgett 1976)

Urban Heat Island Effect
Policy Responses: Community

- **Urban Heat Island Mitigation**
  - Cool roofs
  - Urban forestry
  - Urban design elements and land use

- **Energy Conservation**

- **Reduction of cumulative stressors** (crime, env. degradation, food insecurity)
Policy Responses: Gov’t

- Improve Capacity of Public Health (response capacity/surveillance/public messaging/cooling centers)
- Develop Heat-Health Alert Warning Systems
- Utility shut off protection for low-income groups
- Improved OSHA regulations for outdoor workers