UC San Diego Health

Clinician Information Sheet:

Health Impacts of Extreme Heat

RESOURCES FOR PATIENTS	
Americares Climate Resilience Toolkit	• General Extreme Heat Tip Sheet • Heat Action Plan
Cal Department of Public Health	• California Department of Public Health Extreme Heat Resources
CDC	• Climate and Health Guidance • Heat Advisory Page
Heat Ready Cal	• Heat Ready California Heat Plan • Cooling Center Locater
Ready.gov	• Extreme Heat Preparedness
Red Cross	• Extreme Heat Safety Tips • Red Cross Heat Preparedness Checklist
UCSD/Scripps SoCal Heat Hub	• Southern California Extreme Heat Research Hub

I. BRIEF BACKGROUND

The frequency, duration, and intensity of heatwaves have increased across North America[1,2] driven by climate change[3]. These climate extremes are projected to persist in the second half of the 21st century[4]. Heatwaves contribute to a decline in air quality, heightened electricity demand, increased water usage, and an augmented risk of human morbidity and mortality[5,6,7]. Extreme heat in the United States has caused more annual deaths than all other severe weather conditions combined in recent decades,[8] impacting non-white populations disproportionately. Clinicians should be familiar with the dangers of extreme heat, heat illnesses, and what additional risk factors and medications can exacerbate health during episodes of extreme heat. **Patient education materials on how to stay well during heat waves can be found here.**

Heat Related Syndromes: Symptoms and Management

	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	• Muscle cramps, especially in the legs • Flushed, moist skin	• Muscle cramps • Often fever > 100.4° F • Nausea, vomiting, diarrhea • Fatigue • Headaches	• Elevated fever, over 104° F (or 40° C) • Tachycardia • Nausea, vomiting • Altered mental state, headache, lethargy • Fatigue • Seizures, coma, and death are possible
Management	• Move to a cool place and rest • Cease strenuous activity • Remove excess clothing and place cool cloths on skin; fan skin • **Oral hydration is advised.** Oral rehydration is equally effective as IV rehydration	• Perform similar interventions as for heat cramps. • **If no improvement, treat in an emergency department** • **Replenish fluids orally if able with cold water or a sports drink** • IV fluids may be needed	• Heat stroke is life-threatening • Requires prompt intervention in emergency department • **Rapid cooling is essential to reduce morbidity and mortality and should be initiated within 30 minutes of presentation**

II. RISK FACTORS ASSOCIATED WITH INCREASED MORBIDITY AND MORTALITY DURING EXTREME HEAT[9]

Factors such as age, pre-existing medical conditions, medications, and fitness levels influence an individual's susceptibility to heat-related illnesses.

Conditions Predisposing to Heat Related Illness	Heat-related outcomes
Cardiovascular disease	• Primary cause of death during heatwaves[10]
COPD	• Secondary cause of death during heatwaves[11]
Acute respiratory distress syndrome	• ARDS brought on by immune response to heat-related cell death[12], and by increased air pollution with heatwaves[13]
Cerebrovascular disease	• Tertiary cause of death during heatwaves[11] • Heat-related reductions in cerebral blood flow and damage to blood–brain barrier can lead to increased intracranial pressure, cerebral ischemia, and possibly intracranial hemorrhage[14]
Chronic Kidney Disease	• Related to dehydration and increased stress on kidney due to heat response[15,16]
Hypertension	• Cardiovascular strain due to physiological heat response[17]
Lack of air conditioning[18]	
Living alone, confined to bed, and/or unable to access aid[19]	

Extreme heat affects the rate of metabolism of various drugs and alters their side effect profiles.[20] Consider providing individualized guidance to patients taking the following medications during a heat wave. (**Examples of patient guidance materials here.**)

Medications that may need adjustment during Extreme Heat

Medications	Potential Drug Effects During Extreme Heat
NSAIDs (ie Ibuprofen, naproxen)	• Acute kidney injury in context of dehydration
Anticholinergics (Atropine, Scopolomine)	• Impaired sweating • Centrally impaired thermoregulation • Hypotension, decreased cardiac output
Antiparkinson (Benztropine, Trihexyphenidyl, Procyclidine)	• Impaired sweating • Cognitive impairment
Antiseizure (Carbamazepine, Oxcarbazepine, Topiramate)	• Sedative effect • Impaired sweating • Cognitive impairment
Diuretics	• Diuresis, hypovolemia, dehydration • Syncope • Electrolyte abnormalities • Acute kidney injury
Psychotropics (Antipsychotics, SSRIs/SNRIs, CNS Stimulants, TCAs, MAOIs)	• Impaired sweating and thermoregulation • Hypotension • Vasoconstriction • Increased metabolism
Muscle Relaxants	• Impaired sweating • Sedative effect

Tailored Education:

- High-risk individuals can benefit from targeted education addressing signs of heat-related illnesses, first aid measures, the importance of cooling strategies and hydration, and personalized strategies for their specific risk factors such as medication guidance as above.

Personalized Hydration Plans:

- Developing individualized hydration plans based on factors like age, health conditions (heart failure, renal function, etc), medications (diuretics, beta-blockers, etc) and activity levels.

Outdoor Worker Considerations:

- For outdoor workers, modify shift hours or tasks to minimize heat exposure, ensure there are planned rests in shaded or cooler areas allow the body to recover
- Recommend breathable clothing and suitable PPE based on the individual's work requirements (CDC Guidelines)

Strategies for Keeping Cool

- Developing a personalized plan for staying cool at home or at work, and knowledge of public spaces such as libraries, schools, movie theaters, and shopping malls that can serve as cooling areas will minimize risk of developing heat related illnesses.
- While electric fans may provide comfort, **fans do not prevent heat-related illness when the temperature is in the high 90s**.
- Individuals living on multistory complexes will benefit from moving to the lowest floor during an extreme heat scenario.
- **Keeping Heat Out**
  - Close any registers that may allow heat inside. Install temporary reflectors, such as aluminum foil covered cardboard, in windows and skylights to reflect heat back outside.
  - If the air temperature outside is below 95°F, open a window and place an electric fan near the open window to assist with evaporative cooling.
  - If the air temperature outside rises to 95°F or above, avoid opening the doors and windows to keep hot air outside from coming in – and seek shelter immediately – either in a public building (with air conditioning) or a public cooling-off center.

IV. FURTHER INFORMATION ON HEAT EFFECTS ON MEDICALLY VULNERABLE GROUPS

Extreme Heat and Pregnancy

- Prolonged exposure **to elevated temperatures disrupts neural tube closure leading to spina bifida**.
- Hyperthermia can affect the function of enzymes and proteins crucial for embryonic development, contributing to structural abnormalities. Notably, associations in the third trimester suggested that **late pregnancy might be a more sensitive period to environmental heat**[21].
- **Dehydration during elevated temperatures has been associated with decreased amniotic fluid levels, leading to complications such as preterm labor and low birth weight.**
- Maternal dehydration may compromise uterine blood flow thereby reducing oxygen and nutrient supply to the developing fetus.
- **High temperatures can lead to increased insulin resistance, potentially worsening existing gestational diabetes** or contributing to its development.
- Racial and ethnic disparities in maternal morbidity prevalence persist, with Hispanic mothers showing a higher magnitude of associations with heat exposure[21].

Links/Relevant Information for Pregnant Patients

» UC San Diego Press Release on Heat Effects on Pregnancy

» Pregnancy and heat — Protect yourself and your baby

Extreme Heat and COPD/Asthma

- **Elevated indoor temperatures during warmer weather were linked to heightened indicators of COPD morbidity[22].** These indicators included increased respiratory symptoms and greater use of rescue inhalers.
- **The impact of indoor heat was more pronounced in the presence of higher concentrations of indoor air pollutants[22].** A time series study covering 12 cities in the United States revealed a rise in COPD-related deaths during hot weather, with variations observed between hot and cold cities. In cold cities, **hot temperatures were associated with up to a 25% increase in the risk of death attributable to COPD, with immediate, same-day effects[23].**
- Extreme heat can result in thicker mucus production and more viscous secretions in the airways. The heightened respiratory rate and effort required contribute to fatigue and strain on respiratory muscles.
- Warmer air poses challenges for individuals with COPD and asthma, particularly during physical activities. The combination of heat and increased breathing demands can lead to shortness of breath and fatigue.

Links/Relevant Information for COPD/Asthma Patients

» American Lung Association Guidelines on Extreme Heat and Respiratory Illnesses

» Asthma Education and Toolkit

» COPD Education and Toolkit

Extreme Heat and Mental Health

- **Heat stress has the potential to heighten irritability, agitation, and anxiety, thereby exacerbating symptoms in individuals dealing with conditions such as anxiety disorders, bipolar disorder, or schizophrenia.**
- **Dehydration can disrupt the balance of neurotransmitters in the brain, potentially worsening symptoms in patients with mood disorders[24].** Moreover, heat-induced dehydration may impact the metabolism of psychiatric medications, influencing their absorption, distribution, and elimination in the body[25].
- **Medications like mood stabilizers, antipsychotics, and antidepressants can impair the body's ability to regulate temperature, elevating the risk of heat-related illnesses among patients.**
- **Medications inducing sedation or drowsiness can intensify the lethargy often experienced by individuals in hot weather.** High ambient temperatures have a diverse range of mental health effects, with the most robust evidence supporting an increased risk of suicide[26].

Links/Relevant Information Mental Health Patients

» Climate Psychiatry Alliance Infographic

» Extreme heat and mental illness: toolkit for mental health care providers

Extreme Heat and Renal Disease

- The combination of pre-existing renal impairment and heat-induced dehydration can contribute to electrolyte imbalances, worsening renal function and increasing the risk of complications.
- The vasodilatory response to extreme heat will affect blood pressure negatively endangering patients with CKD who have impaired blood pressure control.
- **Antihypertensives can be affected by the heat potentially leading to decreased efficacy or increased side effects. Renal filtration and excretion of many medications are altered in extreme heat.** Includes drugs with narrow therapeutic window.
- **Heat induced inflammatory response can also accelerate kidney damage in patients with CKD.**
- Increases in risk of hospital admission and mortality associated with extreme heat were higher among non-Hispanic black and non-Hispanic white patients with end stage renal disease[27].
- **Among older adults, periods of extreme heat were associated with increased risk of hospitalization for fluid and electrolyte disorders, renal failure, urinary tract infection, septicemia, and heat stroke[28].**

Links/Relevant Information Renal Disease Patients

» Extreme Heat: Tips for Dialysis Patients

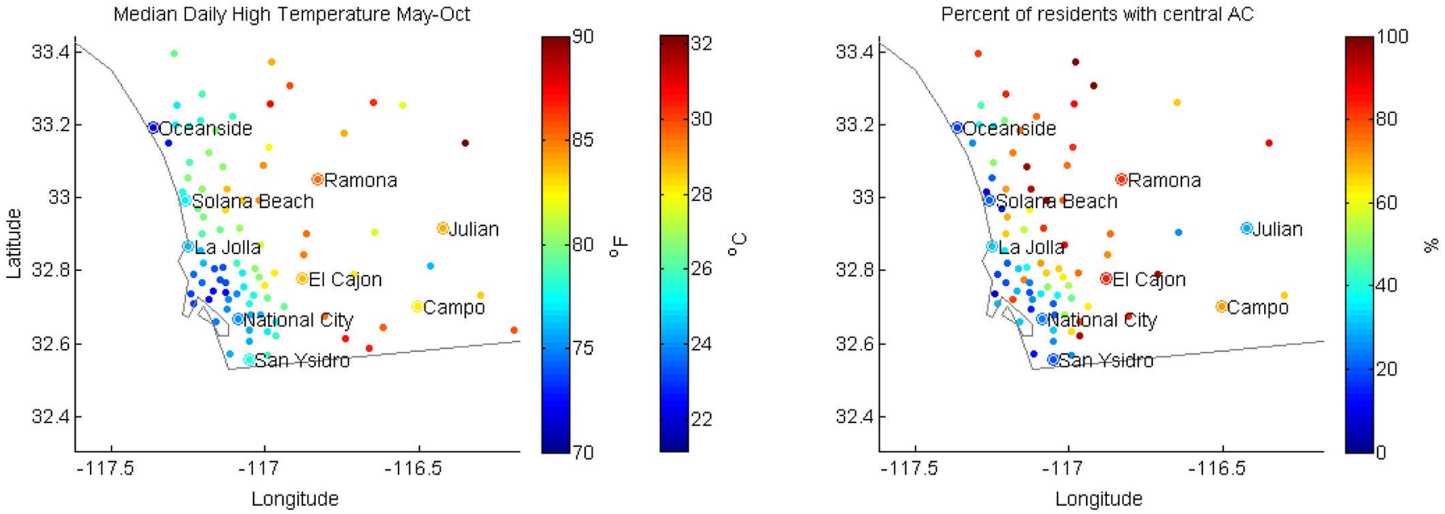
» New Study: Heat Waves from Climate Change Pushing Kidney Patients to ER

V. CASE STUDY: DIVERSE MICROCLIMATES IN SAN DIEGO COUNTY

The San Diego coastal population experiences milder temperatures compared to residents inland, thanks to the Pacific Ocean's moderating influence. Consequently, those living along the coast are less inclined to have air conditioning in their homes. The median temperatures from May to October in the Coastal, Inland, and Desert regions are 76.3°F (24.6°C), 83.0°F (28.3°C), and 86.5°F (30.3°C), respectively.

To highlight local thresholds for extremely hot conditions, the 95th percentile temperature is 87.3°F (30.7°C) for the Coastal region, 93.8°F (34.4°C) for the Inland region, and 96.3°F (35.7°C) for the Desert region. Urban heat islands, characterized by higher average temperatures, are typically lacking in trees, water sources, and natural heat barriers[32,33].

Figure 1: (*Left*) Median daily maximum temperatures during May–October. (*Right*) Air Conditioning (AC) access in San Diego County showing the percent of residents who reported having central AC[29].



Southern California exhibits diverse topography, featuring distinct ecological zones that are disproportionately affected by extreme heat[30]. Among these, the inland urban areas experience the most significant impact in terms of heatwave metrics, showing notable upward trends in frequency, duration, intensity, and season length. These metrics also correlate strongly with an increase in nighttime mean warming[31]. Notably, heatwaves commence earlier and conclude later in the year, with the current season extending from March to September, as opposed to the mid-twentieth century range of May to August.

VI. RESOURCES

Local

» 2-1-1 San Diego

» Cool Zones

State

» Transportation Resources

» Cal Adapt Temp Tools

National

» Americares Toolkit on Extreme Heat

» Ready.Gov: Extreme Heat Information

» CDC Heat and Health Tracker

» OSHA-NIOSH Heat Safety Tool

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