Heat Illness: Hospitalizations for Heat Illness

Type of EPHT Indicator	Health outcome
Measures	1. Age-adjusted rate of hospitalization for heat stress per 100,000 population 2. Crude rate of hospitalization for heat stress per 100,000 population 3. Number of hospitalizations for heat stress
Derivation of Measure(s)	*Numerator*: Hospital admissions having any ICD-9 code in the range of 992.0-992.9, or cause of injury code E900.0 or E900.9, EXCLUDING cases with a code of E900.1 (man-made source of heat) anywhere in the record. *Denominator*: Midyear resident population, by gender, for state and by county *Adjustment*: Age-adjustment by the direct method to the Year 2000 US Standard population
Unit	1. Age-adjusted rate per 100,000 population 2. Rate per 100,000 population 3. Number
Geographic Scope	EPHT grantee states with hospitalization data
Geographic Scale	State
Time Period	Hospital admissions between May 1 to September 30, inclusive, for each year, 2000 to most recent year available
Time Scale	May–September of each data year
Rationale	The Intergovernmental Panel on Climate Change (IPCC) projects with "virtual certainty" suggest that climate change will cause more frequent, more intense, and longer heat waves (1). Any individual, regardless of age, sex or health status can develop heat stress if engaged in intense physical activity and/or exposed to environmental heat (and humidity). Physiologic mechanisms maintain the core body temperature (i.e., the operating temperature of vital organs in the head or trunk) in a narrow optimum range around 37 °C (98.6 °F). When core body temperature rises, the physiologic response is to sweat and circulate blood closer to the skin's surface to increase cooling. If heat exposure exceeds the physiologic capacity to cool, and core body temperature rises, then a range of heat-related symptoms and conditions can develop. Heat stress or Heat-related illness ranges from mild heat edema and rash, heat syncope, heat cramps, to the most common type, heat exhaustion (2). Heat-related cramps, rash, and edema are relatively minor readily treatable conditions; however, they should be used as important warning signs to immediately remove the affected individual from the exposure situation. *Heat cramps* are brief, intermittent, and often severe muscular cramps occurring typically in muscles that are fatigued by heavy work (2). Individuals with heat cramp can also exhibit hyponatremia and

	hypochloremia (which are low serum sodium and chloride levels). *Heat syncope* is a temporary loss of consciousness as a result of prolonged heat exposure (2). Individuals adapt to hot, humid environment by dilation of cutaneous vessels in the skin to radiate heat. Peripheral vasodilation along with blood volume loss, results in lowering the blood pressure which can result in inadequate central venous return and cerebral perfusion, causing light-headedness and fainting. *Heat exhaustion* is a consequence of extreme depletion of blood plasma volume, which may be coincident with hyponatremia and/or peripheral blood pooling (2). Heat exhaustion often does not present with definitive symptoms and may be misdiagnosed, often as an acute viral illness. Symptoms include mild disorientation, generalized malaise, weakness, nausea, vomiting, headache, tachycardia (rapid beating of the heart), and hypotension. Because untreated heat exhaustion can progress to heat stroke, the most serious form of heat-related illness, treatment should begin at the first signs of heat exhaustion (3). *Heat stroke* is an extreme medical emergency that if untreated can result in death or permanent neurological impairment (2). Heat stroke occurs when a person's core body temperature rises above 40 °C (104 °F) as a result of impaired thermoregulation. High core body temperature and disseminated intravascular coagulation results in cell damage in vital organs, such as the brain, liver, and kidneys, which can lead to serious illness and death (3). Death may occur rapidly due to cardiac failure or hypoxia, or it can occur days later as a result of renal failure due to dehydration and/or rhabdomyolysis (i.e., the breakdown of muscle fibers with release into the circulation of muscle fiber contents, some of which are toxic to the kidney and can cause kidney damage) (4). Heat stroke is typically divided into two types. The two types are in general clinically the same, except that the individuals/population groups affected require medical interventions specific to their unique physiology and medical status (3). "Exertional Heat Stroke," as the name implies, involves strenuous physical activity under high temperature conditions to which the heat stroke victim was not acclimatized, and usually affects healthy young adults, such as athletes, outdoor laborers and soldiers. "Classic" heat stroke, by definition does not involve exertion, and usually affects susceptible individuals, such as infants and young children, the elderly, or people with chronic illness. Because heat stroke, even if treated, can have a death rate as high as 33%, and up to 17% of heat stroke survivors suffer permanent damage, measures should be taken to prevent heat-related illness, especially among vulnerable populations. The relationship between extreme heat and increased daily morbidity and mortality is well established. This indicator captures hospital admissions directly attributed to heat stress (e.g., heat illness, heat stroke, and hyperthermia). It is a measure that can be tracked easily and consistently across geography and time, and acts as a sentinel for the broader range of heat-related illness that is not recognized and/or coded as such.
Use of the Measure	Heat stress can manifest in a number of clinical outcomes, and people with chronic health problems (e.g., cardiovascular disease, diabetes,

	obesity) are more susceptible to the effects of heat than healthy individuals. For these reasons, heat stress may not be listed as the primary diagnosis. This indicator therefore includes all cases where heat stress is explicitly listed as the primary diagnosis or any other diagnosis. Increases in the rates of hospital admission for heat stress are one potential impact of rising global temperatures. Tracking these data can help document changes over place and time, monitor vulnerable areas, and evaluate the results of local climate-adaptation strategies.
Limitations of the Measure	Periods of extreme heat are frequently associated with increases in hospital visits and admissions for many causes. This measure does not capture the full spectrum of heat stress, where exposure to excess heat is not explicitly documented.
Data Sources	*Numerator*: State inpatient hospital discharge data (using admission date) *Denominator*: US Census Bureau population data
Limitations of Data Sources	*State hospital discharge data* • Using a measure of all heat stress hospitalizations will include some transfers between hospitals for the same individual for the same heat stress event. Variations in the percentage of transfers or readmissions for the same heat stress event may vary by geographic area and impact rates. • Without reciprocal reporting agreements with abutting states, statewide measures and measures for geographic areas (e.g., counties) bordering other states may be underestimated because of health care utilization patterns. • Each state must individually obtain permission to access and, in some states, provide payment to obtain the data. • Veterans Affairs, Indian Health Services and institutionalized (e.g. Prison) populations are excluded. • Practice patterns and payment mechanisms may affect diagnostic coding and decisions by health care providers to hospitalize patients. • Street address is currently not available in many states. • Sometimes mailing address of patient is listed as the residence address of the patient. • Patients may be exposed to environmental triggers in multiple locations, but hospital discharge geographic information is limited to residence. • Since the data captures hospital discharges (rather than admissions), patients admitted toward the end of the year and discharged the following year will be omitted from the current year dataset. • Data will need to be de-duplicated (i.e. remove duplicate records for the same event). • There is usually a two year lag period before data are available from the data owner. *Census data:* • Only available every 10 years, thus postcensal estimates are needed when calculating rates for years following the census year.

	• Postcensal estimates at the ZIP code level are not available from the Census.
Related Indicators	• Heat vulnerability • Heat-related mortality • Temperature distribution • Emergency department visits for heat stress
References	1. Confalonieri U, Menne B, Akhtar R, Ebi KL, Hauengue M, Kovats RS, et al. 2007. Human health In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE. , editors. Climate Change 2007: Impacts, Adaptation and Vulnerability Contribution of Working Group II to: Fourth Assessment Report of the Intergovernmental Panel on Climate Change. New York: Cambridge University Press. pp. 391–431. 2. Rosen's Emergency Medicine: Concepts and Clinical Practice. 2010. Chapter 139: Heat illness. In JA Marx Editor-in-Chief; RS Hockberger & RM Walls Senior Editors; JG Adams … [et al] Editors (7th ed). Philadelphia: Mosby Elsevier. 3. American Medical Association. Heat-related Illness During Extreme Weather Emergencies (Report 10 of the Council on Scientific Affairs (A97), 1997; www.ama-assn.org/ama/pub/category/13637.html). 4. Centers for Disease Control and Prevention. Heat-related deaths--Los Angeles County, California, 1999-2000, and United States, 1979-1998. MMWR 2001; 50(29):623-6.