NUR/P 4.4: Pediatric Heat-Related Illness

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Nursing Planetary Health Report Card (N-PHRC) and Global Consortium on Climate and Health Education (GCCHE) Core Competency

- 2023 PHRC Metrics_Resource Map Curriculum 2.0

Global Consortium on Climate and Health Education (GCCHE) Core Competency

- 2023 GCCHE Core competency - 1.1.2, 1.2.1 & 1.6.1

Goal:

Understand the danger of an extreme heat wave to pediatric patients, risk factors for health impacts and apply knowledge to provide anticipatory guidance to patients and families.

Climate related learning objectives

1. Define heat-related illness and recognize pediatric populations are more vulnerable to the effects of heat-related illness.
2. Describe the relationship between extreme heat events and pediatric health and well-being.
3. Incorporate the prevention of heat-related illness in age appropriate anticipatory guidance/patient education in the outpatient setting.

Clinical Vignette

- GF is a 17 year old female who presents to the community-based Urgent Care at 1600 with her mother and complains of dizziness, nausea, mild headache, muscle cramps, and some shortness of breath. She reports feeling weak after playing in her soccer tournament and that she normally keeps right up with her high school teammates. She said she stopped playing because she needed to sit down due to dizziness, headache, nausea and mild shortness of breath. Pt. reports slightly decreased solid intake for breakfast and lunch and reports she "just doesn't have much of an appetite". She drank approximately 1 liter of water since breakfast. She last voided after breakfast. Her last bowel movement was also after breakfast and it was runny (but denies bloody). .

Review of Systems

- **Denies recent hospitalizations/Emergency Room visits/surgeries/Illnesses**

Past Medical History/Chronic Conditions

- Mild, Intermittent Asthma

Setting (General)

- Outside temperature is 92 degrees F (33 degrees Celsius) at sea-level with 90% humidity at 1630 in the afternoon.. It is sunny and calm with a light breeze and intermittent shade from scattered clouds. Typically, average temperatures during this time of year range from 67-82 degrees F (19-28 degrees Celsius) with 70% humidity. Local temperatures this week have spiked higher than this area has seen in years (95-100 degrees F (35-37 degrees Celsius).
- The soccer tournament was held on an artificial turf surface.

Social History/Pets

- Lives with mother, father, younger sister and pet dog, Bubbles

Family History

- Maternal - Hyperthyroidism. Taking Synthroid po QD.
-

Cultural Considerations

- Parents are spanish-speaking only

Allergies (Environmental/Medication)

- Pollen, Cats
- No Known Drug Allergies (NKDA)

Current Medications

- Albuterol Inhaler with spacer PRN. Last dose at 1500 today.
- Multivitamin po QD
- Ibuprofen 200 mg po at 1200 for headache with no relief
-

Nutritional Considerations

- Food Insecurity - Hunger Vital Signs Screening - Negative

Risk Factors/Health Equity

- Family recently moved to a rural area from a nearby inner city. The air conditioning unit in the family home recently broke. The family is waiting for the unit to be fixed. Heat Index report indicates high risk for sensitive groups, 90% humidity 92 degrees F (33 degrees Celsius).

Differential Diagnosis

- Heat exhaustion or stroke, dehydration, hypoglycemia, GI infection, Hyperthyroidism, Asthma Exacerbation, electrolyte abnormality, pregnancy

Physical Exam

Temp: 99.3F/37.3C BP: 132/83 RR: 24 O2 sat: 90% HR: 100 BMI: 79%ile
Weight: 143 pounds (65 kg) Height: 66.75 inches (169.54 cm)

General Appearance: In no acute distress, Periodically unable to speak in complete sentences and mildly diaphoretic.

Head: Normocephalic, atraumatic

Eyes: Both Eyes - extraocular movement intact (EOMI), pupils equal, round, reactive to light and accommodation (PERRLA)

Ears: Both Ears - auditory canal clear, tympanic membrane intact, clear, light reflex present

Nose: Nares patent, no lesions, no discharge

Oral Cavity: Mucosa slightly dry, no lesions, palate normal

Throat: Normal, uvula midline

Neck/Thyroid: Neck supple, full range of motion

Lungs: Clear to auscultation bilaterally with intermittent scattered wheezing, good air movement, no flaring, grunting or retractions, tachypneic

Heart: S1,S2 normal, no murmurs; tachycardic

Chest: Normal shape and expansion

Breasts: Tanner 4

Abdomen: Soft, non-tender to palpation throughout, nondistended, bowel sounds present and active x 4, no hepatosplenomegaly

Female Genitourinary: Normal external genitalia, Tanner 4

Extremities: Extremities warm and moist to touch

Skin: Intact, flushed, diaphoretic, no suspicious lesions

Neurologic: Normal strength, tone and reflexes, Alert, oriented X4

Back: Normal exam of the spine, no scoliosis

Peripheral Pulses: Normal

Psych: Alert, oriented, cooperative with exam

Pain: Headache 4/10

Pertinent Labs

- Complete Blood Count (CBC)
- Complete Metabolic Panel (CMP)
- Total Thyroxine (T4) and Thyroid Stimulating Hormone (TSH)
- Urinalysis (UA)
- Urine Pregnancy Test (HCG)

Mini Case

- GF is a 17 year old female who presents to the community-based Urgent Care with her mother and complains of being hot, and having an upset stomach, mild headache, muscle cramps, and some shortness of breath. She reports feeling weak after playing in her soccer tournament and that she normally keeps right up with her high school teammates. She said she stopped playing because she needed to sit down. Temperature is 92 degrees F (33 degrees Celsius) with 90 % humidity at 1630 in the afternoon in late August. It is sunny and calm with a light breeze and intermittent shade from scattered clouds. Typically, average temperatures during this time of year range from 67-82 degrees F (19-28 degrees Celsius) with 70% humidity. Local temperatures this week have spiked higher than this area has seen in years (95-100 degrees F (35-37 degrees Celsius). The soccer tournament was held on an artificial turf surface.

Answers to Learning Objectives

Define heat-related illness and recognize pediatric populations are more vulnerable to the effects of heat-related illness.

- Heat related illness is a spectrum of illness. It occurs when there is an increase in body temperature due to exposure to ambient heat +/- metabolic heat production with the inability to compensate (Harding et al., 2020; Norris, 2019).
- Heat cramps-a loss of salt and fluid causes muscle spasm and thirst
- Heat exhaustion-a loss of salt and fluid after prolonged exertion in the heat
    - Clinical features: fatigue, extreme weakness, nausea, headache, faintness, tachycardia, oliguria, and cool, pale, clammy skin. (Table 1) (Sorenson et al., 2022)
- Heatstroke-core temperature is greater than 40C, there is a direct effect on cells releasing cytokines and causing a local and systemic inflammatory effect
    - Clinical features: altered mental status, hot dry skin, hypotension, tachycardia, tachypnea, weak. (Table 1) (Sorenson et al., 2022)

What is the pathophysiology related to heat-related illness?

- Thermoregulatory mechanisms overwhelmed by environmental heat, increased production of heat or impaired dissipation. Sweating, vasodilation, and increased respirations can not compensate for increased temperature (Norris, 2019).
- Heat index is a more physiologically relevant measure of ambient heat (temperature and humidity) and is important to consider because humidity impairs the ability to sweat and evaporate to cool the body (Abbinett et al., (n.d.).
    - Evaporation of sweat is a mechanism of heat dissipation in humans. This method becomes less effective when humidity levels are above 75% (Greenfield & Cligenpeel, 2016)
    - When the atmospheric moisture content (i.e. relative humidity) is high, the rate of evaporation from the body decreases. The human body feels warmer in humid conditions. The opposite is true when the relative humidity decreases because the rate of perspiration increases. (National Weather Service. (n.d.).

What would management look like if the signs and symptoms of this patient progressed to Heat Stroke?

- See heat related illness treatment table and algorithm (Sorenson & Hess, 2022).
- Heat Stroke is an emergency and the child should be transported to the hospital immediately (American Academy of Pediatrics Council on Environmental Health, 2019). Ensure ABCs stable provide O2, reduce core temperature-Gold standard cold water immersion (if immersion not available: cool room-fan, cooling blankets, wet cloth/sheet, cooled fluids, ice packs to groin axillae), IV placement for fluid and

electrolyte replacement, EKG, CBC, BMP (electrolytes, renal function), ongoing monitoring Vital Signs (Harding et al., 2020; Sorenson & Hess, 2022).

- Cold Water immersion or other cooling should begin while awaiting hospital transport (American Academy of Pediatrics Council on Environmental Health, 2019).
- When indoor air temperatures are hotter than about 95 °F, fan use may cause a body to gain heat instead of lose it. Sweat evaporates off the skin slower than normal on hot, humid days and fans make it more difficult for the body to lose heat through sweating. (New York State Department of Health (August, 2017)
- Ideally, an air conditioned space is recommended to cool the patient. (New York State Department of Health (August, 2017)

Given this scenario, what pertinent labs might you consider?

- Complete Blood Count (CBC), Complete Metabolic Panel (CMP), Total Thyroxine (T4) and Thyroid Stimulating Hormone (TSH), Urinalysis (UA), Urine Pregnancy test (HCG)

Describe the relationship between extreme heat events and pediatric health and well-being.

- When compared to adults, children are more sensitive due to various physiological factors including having a higher surface area to mass ratio, lower sweating capacity, higher temperature at which sweating begins, lower cardiac output, and lower blood volume (Health Canada, 2011). The combined effect of these physiological factors increases strain on circulatory systems and decreases ability to thermoregulate, increasing risk of heat-related illness (Dover, G. et al., 2020).
- Children's activity patterns and dependence on caregivers may heighten susceptibility as they are unable to respond to heat exposure themselves. Children's susceptibility is likely additionally heightened in lower socio-economic communities with reduced access to cool spaces, water, air conditions, and social services (Kassem, H., 2023)
- Older children, often depend on the direction of coaches and camp counselors to take breaks from exercise or hydrate
- Athletes are often required to wear protective athletic gear when participating in practices or games in the heat. Heat dissipation is often further impeded by the insulative effects of the athletic gear required for certain group sports. (Abbinett et al., (n.d.).
- Commonly prescribed stimulant medications for Attention Deficit Hyperactivity Disorder (ADHD) (ie. Methylphenidate/Ritalin/Concerta/Quillichew), have anticholinergic properties which can decrease sweating and predispose children to heat intolerance. (Greenfield & Clingenpeel, 2016)
- Medications and Drugs with Potential to Increase Risk of Heat-Related Illness (Sorensen & Hess, 2022). https://www.nejm.org/doi/full/10.1056/NEJMcp2210623
- Alcohol may reduce alertness and affect judgment and perception of heat; exacerbates dehydration and affects vasodilation and cardiac contractility

(Sorensen & Hess, 2022)

- Antihistamines (ie. Diphenhydramine/Benadryl) may cause peripheral vasoconstriction, limiting radiative cooling. (Sorensen & Hess, 2022)
- Serotonin-reuptake inhibitors (ie. Sertraline (Zoloft)/Fluoxetine (Prozac)) may interfere with hypothalamic thermoregulation. (Sorensen & Hess, 2022).
- Thyroid agonists (ie. Levothyroxine (Synthroid) may increase metabolic heat production. (Sorensen & Hess, 2022).
- Extreme heat can lead to asthma exacerbation; general heat-related illness, heatstroke, dehydration/electrolyte imbalance; diarrhea and infectious diseases (Uibel. et al, 2022).
- Every year children and pets left unattended in motor vehicles during conditions of extreme heat die due to heat-related effects. In addition to these deaths, it is estimated that hundreds of children experience heat-related illness annually from being left inside motor vehicles.

What is your assessment, anticipated problems, and plan? (Management/treatment)

- Heat exhaustion. Consider possible progression to heat stroke.
- See heat related illness treatment table and algorithm (Sorenson & Hess, 2022).

What are some nursing Implications and interventions?

- Major implication would be: Monitoring mental status and obtaining a core temperature if any perceived decline in mental status to ensure no progression to heat stroke
- Providing a cool environment/ice packs/fans
- When indoor air temperatures are hotter than about 95 °F, fan use may cause a body to gain heat instead of lose it. Sweat evaporates off the skin slower than normal on hot, humid days and fans make it more difficult for the body to lose heat through sweating. (New York State Department of Health (August, 2017)
- Ideally, an air conditioned space is recommended to cool the patient. (New York State Department of Health (August, 2017).
- Encouraging PO intake (if able) or establishing an IV.
- Education for this patient and family since prevention is priority-hydration, checking heat index and adjusting activity related to heat index, recognizing early signs of heat related illness, screening for home environment (i.e. access to air conditioning, top floor apartment, etc).

- Heat cramps/exhaustion-replace fluids and salt/electrolytes, cool wet cloth/sheet

Incorporate the prevention of heat-related illness in age appropriate anticipatory guidance/patient education in the outpatient setting. The patient/parent would like to talk with you about how to prevent heat related illness. How do you talk with them?

Primary Prevention (Individual/Family)/Patient Education

- Maintain adequate hydration - Drink water and/or electrolyte-containing fluids before exercise, during exercise, after exercise.
    - Void every hour
    - Urine should look like water/lemonade)
- Encourage the consumption of water before the sensation of thirst, since once thirst is perceived a person is already suffering from mild dehydration.
- Wear loose-fitting, light-colored clothing.
- Provide a shaded area for breaks.
- Apply and reapply reef-safe waterproof sunscreen especially with sweating and swimming.
- Educate coaches and employers (many youth who are employed work outdoors) of adolescents regarding the need for acclimation to heat, water breaks, periods of rest and recovery, and opportunity for cooling (American Academy of Pediatrics Council on Environmental Health, 2019)
- Pay attention to local heat index air quality indicators (National Weather Service. (n.d.).
    - Heat Index > 126 degrees F (52 C) - Cancel activities
    - Heat Index 104-125 degrees F (40-51 C) - Dangerous
    - Heat Index 91-104 degrees F (32-40 C) - Warrant Extreme Caution
- During the heatwave, the patient should make every effort to stay out of the sun.
    - Recommend refraining from normal outside exercise until the heat wave passes (Gosling, et al., 2009)
    - Avoiding the hottest parts of the day for activity
    - Encourage outdoor activity before 11 AM and after 6 PM (National Weather Service, n.d.).
- Identify cooling centers that may be accessible by the patient and explore community public health resources on early heat warnings and surveillance (Gosling, et al., 2009)
- Do NOT leave children and pets unattended in motor vehicles

- Consider heat-related illness guidance for infants and small children. (United Nations Children's Fund Health Programme, 2023)

- Monitor for heat cramps which may result from dehydration and fatigue (most improve with rest, oral hydration, stretching, and removal from hot environment (Greenfield & Clingenpeel, 2016)
- Americares

- Natural turf vs artificial turf (Synthetic Turf Research at Penn State (n.d.).
    - Synthetic Turf Research @ Penn State
    - Generally, synthetic turf 35˚ to 55˚ F (20˚ to 30˚ C) hotter than natural grass
    - Fibers are a major contributor to high surface temperatures
    - Grass Leaves Transpire/Release water vapor/Evaporation causes cooling

- **Secondary Prevention**
    - Review and/or ensure patient has an updated Asthma Action Plan

What are some mitigation and adaptation efforts that have the potential to decrease the impacts of heat on health?
(Individual/Family/Community/Region/Nation/International/Planetary)

- **Individual** (see Primary Prevention above)
- **Family** (see Primary Prevention above)
    - Ensure verbal and written information is language and culturally sensitive
    - Educate families to check heat index prior to participation in activities, have extra water and electrolyte on hand.
    - Proper Disposal of Aerosol medications will support reduction of Greenhouse Gas emissions (Rabin et al., 2022)
- **Community**
    - Resilience hubs (Urban Sustainability Directors Network, n.d.)
    - Coach/Referee Identification and CPR Training Red Cross Training | Take a Class
    - Incorporate more greenspace and shaded areas can be a co-benefit of both mitigation and an adaptation to heat
    - School/sport team policies regarding postponing or canceling practice/games on high heat index days (Roberts et al, 2021)
    - School nurse/Physical Education (PE)/athletics curriculum incorporating signs of heat related illness and prevention education (Sorensen & Hess, 2022)
    - Policies for teams similar to OSHA having breaks/hydration scheduled based on heat index,
    - Review emergency plans in the event of a power outage. (Knowelton et al, 2014)
    - Encourage acclimatization in advance of substantial heat exposure, pre-season for sports. (Magnus & Canares, 2019)
    - Invest in preparedness: Planning and Implementing a Preparedness Campaign (schools/health care facilities). Preparedness is key to protecting vulnerable populations from heat stress. (United Nations Children's Fund Health Programme. (2023)
- **Regional**
    - University Extension Partnerships
        - Example: University of Minnesota Climate Adaptation Partnership
            - https://climate.umn.edu/
    - Health-based Advocacy and Environmental Organizations
        - Healthy Climate Wisconsin
        - Health Professionals for a Healthy Climate
- **Nation**

    - Advocacy at policy level for “green” sustainable infrastructure
- **International/Planetary**
    - Project Drawdown
    - Planetary Health Alliance
    - 350.org
- **Healthcare**
    - Americares
    - Practice Greenhealth
    - Health Care Without Harm
    - Nurses can advocate for practice, hospital and office decreases in energy usage, product waste, etc.
    - Educational simulations regarding management of heat related illness
    - Simple things can be done on an individual level such as::
        - reduce food waste
        - use public transportation
        - decrease individual vehicle-transportation usage
        - decrease use of natural gas and oil
        - walk or bike

The patient/parent would like to talk with you about PMH mild, intermittent asthma. What information do you provide?

- Pay attention air quality indicators (ie: Air Now app or website https://www.airnow.gov
- Extreme heat can exacerbate asthma symptoms. Monitor heat index and weather
- Extreme heat can lead to poor air quality, namely elevated ground level ozone and pollution from wildfires (American Academy of Pediatrics Council on Environmental Health, 2019).

How would an alternate setting (inner city/black top/natural grass/geographical location) change patient education/risk factors?

- Education of changing climate and more extreme heat days projected (assuming/dependent on region where person lives) (Center for Climate and Energy Solutions, n.d.).
- Global Impacts of Climate Change https://climate.nasa.gov/news/2878/a-degree-of-concern-why-global-temperatures-matter/
- Heat Island effects (built environment can increase ambient air temperatures on average up to 7 F, with some extremes exceeding 20 F) (Hibbard et al., 2017).
- Artificial Turf (AT) vs Natural Turf (NT) solar reflection and surface temperature (AT being hotter during midday) (Jim, 2017).

Consider/evaluate if the patient is taking the appropriate dosage of prescribed medications?

- Acetaminophen and Ibuprofen are weight based medications**.** In this case, the patient took 200 mg of Ibuprofen for a headache. The appropriate dose of Ibuprofen for pain/discomfort for a patient weighing 143 pounds (65 kg) is 400 mg Ibuprofen q 6-8 hours, as needed. (NOTE - Acetaminophen and Ibuprofen should not be given to prevent or treat heat-related illness)
- Ensure use of a spacer with Albuterol administration q 4-6 hours prn wheezing, coughing.

Medication History

- During extreme heat, there is a direct or indirect increased risk associated with the consumption of certain medications. Provide patient/caregiver education on side effects related to commonly prescribed medications and drugs to assist in managing heat-related behavior and fluid intake (Health Canada, 2011; Sorenson & Hess, 2022; Americares, n.d.).
- Medications and Drugs with Potential to Increase Risk of Heat-Related Illness (Sorensen & Hess, 2022). https://www.nejm.org/doi/full/10.1056/NEJMcp2210623

NOTE - See **N-CRHE Pediatric Heat Related Illness Slide Deck** for more information.

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Suggested Resources

- Air Now app or website https://www.airnow.gov