Heat Stress in the Workplace

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www.ohnans.com

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Learning Objectives

- Why worry about Heat Stress?
- Discuss some external heat source controls.
- Health Effects of Heat Stress
- Discuss Pre-disposing factors to heat stress
- Who is typically vulnerable to heat stress illnesses.
- Heat exhaustion, heat stress, heat syncopy, prickly heat, heat stroke.
- Monitoring the workplace
Why Worry about Heat Stress?

- Heat can kill!
- Work-related heat stroke fatalities:
  - 1990: student, second day collecting garbage
  - 2001: bakery worker in Barrie
- If global warming is happening, heat stress will become more important
Desertification in Hebei Province, China 2000

Health Effects of Climate Change, Environmental Health Effects Perspectives, April 2007
External Heat Source Controls

► At the source
  ▲ Replace/isolate heat producing processes
  ▲ Block radiant heat with barriers (shade)

► Along the path
  ▲ Isolate worker from heat
  ▲ Air condition workplace (booth)
  ▲ Capture hot air with exhaust ventilation

External Heat sources
hot weather
radiant heat sources - Ovens
## Internal source controls:

### At the source
- Reduce workload
  - improve ergonomics,
  - provide assistance,
  - increase relief time
  - slow down
- **Provide adequate** water
- Actively cool body
- Gradually acclimatize
- Ensure good nutrition and rest

- **Internal**
- Heat sources
- muscle activity
Promote Cooling

- Wear loose clothes that allow sweat to evaporate easily (cotton)
- Take internal heat sources into account when using any personal protective clothing that prevents sweat from evaporating
- Wash clothes regularly and maintain good personal hygiene
Heat Balance

External Heat sources
- radiation
- convection
- conduction

Internal Heat sources
- basal metabolism
- activity
  muscle activity

Cooling
- evaporation
- radiation
- convection
- conduction
Transient Heat Fatigue:

Symptoms: General feeling of tiredness or fatigue.

First Aid: Fluid replacement and rest.
Symptoms: Skin becomes reddened and may itch, feel prickly or hurt.

First Aid: Practice good personal hygiene; keep the skin clean and the pores unclogged, allow skin to dry, wear loose clothing, see doctor if rash persists.
Heat Syncope (fainting)

Symptoms: Syncope means “fainting.” First signs are dizziness, feeling light-headed and perhaps nauseous, then the person may faint. Usually occurs in the beginning of heat stress season before the circulation system is adapted.

First Aid: Lay victim in a cool location horizontally with feet elevated. If conscious, give fluids. Treatment the same as shock.
Heat Cramps:

Symptoms: Cramping of either active muscles (arms, legs) or involuntary (usually abdominal) muscles (or both).

First Aid: Replenish electrolytes through drinking of fluids such as Gator-Ade, Squincher, PowerAde, etc-Ade. Rest in a cool environment.
Heat Exhaustion:

Symptoms: Nausea, dizziness, weakness headache, blurred vision, profuse sweating, cold/wet (clammy) grayish skin, unconsciousness, coma and death.

First Aid: Place victim in a face down position in a cool location, administer fluids if the victim is conscious. If unconscious, seek medical care or transport to a medical emergency room.
Heat Stroke

Life threatening medical emergency resulting from failure of the body’s normal thermoregulatory mechanisms resulting in elevation of body temperature to extreme levels usually greater the (41C) producing multisystem tissue damage and organ dysfunction.
Heat Stroke:

Symptoms: Chills, restlessness, irritability, euphoria, red face and skin, disorientation, hot/dry skin (not always), collapse, unconsciousness, convulsions and death.

First Aid: Immediate, aggressive cooling of the victim’s body using wet cloths, immersion into cold water or alcohol wipes. Transport to emergency medical facility ASAP!
Heat Stroke Treatment

- Secure the airway
- Remove patient’s clothing
- Monitor temp with rectal probe and Urinary Output with Foley
- Immediate cooling with evaporative methods or immersion (stop when body temp reaches <102.2 F)
- Administer oxygen
- Administer IVF with D5 1/2 NS or D5NS, or LR
- Check glucose
- CBC, Lytes BUN Creatine, lactate, coags, DIC, urinalysis
Heat Stroke – Lab Findings

- Decreased Na, K, Ca, and PO4
- Increased BUN
- Hyperuricemia
- Lactic acidosis
- Leukocytosis
- Hemoconcentration
- Thrombocytopenia
- Fibrinolysis

- Consumption coagulopathy
- Concentrated urine
- Dehydration
- Proteinuria
- Tubular casts
- Myoglobinuria
- Elevated AMIP
- EKG changes
- ***Elevated AST/ALT***
Development of Heat Stroke

Strenuous Exercise
Hot, Humid Environment

Inadequate Temperature Regulation

Severe Elevation of Core Temperature
Impaired CNS Function

Organ and Tissue Damage

Death
Specific cellular mechanism underlying the failure of thermoregulatory homeostasis is not completely understood.

Prolonged heat stress produces significant increases in peripheral vasodilation as skin blood vessels dilate in an attempt to dissipate heat eventually producing a reduction of the thermal gradient between the core and the skin.

As severe heat stress continues, the cutaneous blood flow decreases and failure to perfuse the skin with heated blood from the core results in dramatically increased rate of heat storage.
Victims are usually aged, often bedridden, persons confined to poorly ventilated homes without air conditioning during summer heat waves

▲ 465 deaths in Chicago 1995 certified as heat related

Victims of Classic Heat Stroke commonly suffer from chronic diseases, alcoholism, or mental illness that predispose to heat illness.

Patients are often taking anticholinergics, antiparkinsonian drugs, or diuretics that impair the ability to tolerate heat stress and therefore increase risk.
Watch out for each other!

- A worker heading into a heat stroke will no longer realize what’s happening to him/her.

- It is vital that co-workers be able to recognize what’s happening and intervene.

- Without quick attention, the co-worker may die!
Indirect Health Effects:

**Reduced Work Performance:** tired, fatigued workers perform with reduced accuracy, efficiency

**Increased Accidents:** tired, fatigued workers are more susceptible to accident and injury

**Reproductive Problems:** heat has been shown to reduce both male and female fertility and can be a problem for the fetus

**Heart/Lung Strain:** if you already have heart, lung, kidney or circulatory problems; heat stress is an added strain on your body which in severe situation may precipitate serious episodes of acute problems
Predisposing Factors:

- very small body size
- overweight
- over 40 years old (the older the more sensitive)
- previous heat illness
- heart disease
- high blood pressure
- diabetes
- inactivity
- physical activity

...sooner or later we’re all vulnerable ...
... with all these vulnerabilities who typically gets heat stroke?

young physically fit males and sick older people
General Duty Clause:

25(2)(h) “… an employer shall, … take every precaution reasonable in the circumstances for the protection of a worker;” taken from: OH&S Act
Screening WBGT (in °C):

<table>
<thead>
<tr>
<th>work demands:</th>
<th>light</th>
<th>moderate</th>
<th>heavy</th>
<th>very heavy</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% work; (breaks incl.)</td>
<td>29.5</td>
<td>27.5</td>
<td>26.0</td>
<td>not allowed</td>
</tr>
<tr>
<td></td>
<td>27.5</td>
<td>25.0</td>
<td>22.5</td>
<td></td>
</tr>
<tr>
<td>75% work; 25% rest</td>
<td>30.5</td>
<td>28.5</td>
<td>27.5</td>
<td>not allowed</td>
</tr>
<tr>
<td></td>
<td>29.0</td>
<td>26.5</td>
<td>24.5</td>
<td></td>
</tr>
<tr>
<td>50% work; 50% rest</td>
<td>31.5</td>
<td>29.5</td>
<td>28.5</td>
<td>27.5</td>
</tr>
<tr>
<td></td>
<td>30.0</td>
<td>28.0</td>
<td>26.5</td>
<td>25.0</td>
</tr>
<tr>
<td>25% work; 75% rest</td>
<td>32.5</td>
<td>31.0</td>
<td>30.0</td>
<td>29.5</td>
</tr>
<tr>
<td></td>
<td>31.0</td>
<td>29.0</td>
<td>28.0</td>
<td>26.5</td>
</tr>
</tbody>
</table>

Acclimatized
Unacclimatized
TLV® Clothing Criteria:

- Requires a penalty be added to the WBGT measurement (do not add to the standard!) for certain types of clothing which hinder the evaporation of sweat:

<table>
<thead>
<tr>
<th>clothing type:</th>
<th>add to measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>summer work clothes</td>
<td>0°C</td>
</tr>
<tr>
<td>cloth (woven material) overalls</td>
<td>+3.5°C WBGT (~ +5° to +7°C Humidex)</td>
</tr>
<tr>
<td>double-cloth overalls</td>
<td>+5°C WBGT (~ +7° to +10°C Humidex)</td>
</tr>
</tbody>
</table>
Clothing Issues:

► Thomas Bernhard, has done research on specific types of clothing and calculated exact clothing factors

► He appears to use the 50\textsuperscript{th} percentile for his correction factors whereas the TLV appears to use the 95\textsuperscript{th} percentile

► thus, for cotton overalls, his recommendations is around 2°C WBGT correction factor instead of the 3.5°C WBGT correction factor cited in the TLV
When are you acclimatized?

- Acclimatization requires up to 3 weeks to be fully established and is noticeably decreased after 4 days:

- The TLV® documentation suggests as a criteria: exposed for 5 of last 7 days

- Reviewing the Jun-Sept/01 weather data for Toronto there were only 2 days which satisfied this criterion (Aug 8 & 9/01)

- “Hot spells in Ontario seldom last long enough to allow acclimatization.”
  (taken from Ontario Ministry of Labour Heat Stress Guideline:

- Dr. Bernard is of the opinion that all workers in Ontario are acclimatized once you’re into the summer
**Humidex 1** | **Response** | **Humidex 2**
---|---|---
25-29°C | supply water to workers on an “as needed” basis | 30-33°C
30-33°C | post Heat Stress Alert notice; encourage workers to drink extra water; start recording hourly temperature and relative humidity | 34-37°C
34-37°C | post Heat Stress Warning notice; notify workers that they need to drink extra water; ensure workers are trained to recognize symptoms | 38-41°C
38-39°C | provide 15 minutes relief per hour; provide adequate cool (10-15°C) water; at least 1 cup (240 mL) of water every 20 minutes worker with symptoms should seek medical attention | 42-43°C
40-42°C | provide 30 minutes relief per hour in addition to the provisions listed previously; | 44-45°C
43-44°C | if feasible provide 45 minutes relief per hour in addition to the provisions listed above. | 46-48°C
45°C or over | only medically supervised work can continue | 49°C or over
Workload Categories:

At the detailed analysis stage the TLV® requires detailed time-weighted average calculations of the workload:

<table>
<thead>
<tr>
<th>activity level category</th>
<th>workload (kcal/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>light</td>
<td>up to 249</td>
</tr>
<tr>
<td>moderate</td>
<td>249-343</td>
</tr>
<tr>
<td>heavy</td>
<td>343-447</td>
</tr>
<tr>
<td>very heavy</td>
<td>447+</td>
</tr>
</tbody>
</table>

It is important to note that the heat stress TLV® is based on data collected from army recruits (average weight 154 lbs., 20 yrs old)
Dr. Bernard is convinced there is enough of a safety factor in the TLV to handle differences in age & weight.

NIOSH Heat Stress Documentation actually gives an example of weight correction.

Ergonomists tell us you need to take age, fitness and sex into account when evaluating metabolic demands.

Issues such as dehydration, medications, medical conditions and pregnancy are also of concern to the workforce.
Problems with using the TLV:

1. Most workplaces don’t have WBGT meters (expensive) and even those that do can’t be at all places at once

2. Reading the tables is confusing; calculating the metabolic rates and time-weighted averages gets quite complicated

3. Adjusting metabolic rates for weight and age puts attention on the individual instead of the work environment and makes it an individual evaluation

4. The WBGT appears to downplay heat stress (e.g. @ 38.7°C and 25% RH the WBGT is 28.0°C (75% rest starting point))

5. It is much easier to manage heat stress on a group basis as opposed to dealing with individuals in the same group differently. Talk to your workers.
August 9, 2001: Kim Douglas Warner Died of Heat Stroke

► according to Environment Canada on August 9, 2001 outdoor temperature in Barrie is 33.4°C, and humidity was 30%; so the outdoor humidex was 36°C and the outdoor WBGT was 24.8°C. Passed away Monday Night. Age 44.

► if temperature in the bakery was estimated to be 52°C and if the humidity inside was 10%, then Humidex would have been 54°C for the workplace (33°C WBGT)

► [http://www.labournet.net/world/0108/bakery1.html](http://www.labournet.net/world/0108/bakery1.html)
Kim Warner Douglas was a CAW member

soon after the incident, the CAW approached OHLOW to find a simpler way of evaluating heat stress than the WBGT (Humidex?)

the Oshawa GM assembly plant was used as the “guinea pig”

GM management had input into the development

Humidex plan promoted among unions and implemented in numerous workplaces
How do we convert WBGT to Humidex?

1. use moderate unacclimatized WBGT category as the basis for the warning and activity restrictions

2. use heavy unacclimatized category as the basis for the alert and program initiation

3. correlated Humidex with WBGT using calculator based on a formula correlating WBGT with dry bulb & wet bulb measurements (i.e. humidity)

4. looked for workplaces to collect data in for the summer of 2002 to check WBGT to Humidex translation
### Humidex Response Plan:

<table>
<thead>
<tr>
<th>Humidex</th>
<th>action</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-33</td>
<td>alert &amp; information &amp; water</td>
</tr>
<tr>
<td>34-37</td>
<td>warning, education &amp; double water</td>
</tr>
<tr>
<td>38-39</td>
<td>restrict activity 25% &amp; actively monitor for signs of heat strain</td>
</tr>
<tr>
<td>40-42</td>
<td>restrict activity 50% &amp; actively monitor for signs of heat strain</td>
</tr>
<tr>
<td>43-44</td>
<td>restrict activity 75% &amp; actively monitor for signs of heat strain</td>
</tr>
<tr>
<td>45+</td>
<td>stop work</td>
</tr>
</tbody>
</table>
Humidex Days
(Apr 15-Oct 5/02):

<table>
<thead>
<tr>
<th>Humidex (% work)</th>
<th>Toronto Island</th>
<th>Buttonville</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-33 (100%)</td>
<td>32</td>
<td>28</td>
</tr>
<tr>
<td>34-37 (100%)</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>38-39 (75%)</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>40-42 (50%)</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>43-44 (25%)</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>45+ (0%)</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Brian Freeman, arts student, on the second day on a summer job as a garbage collector experienced a heat stroke; died 17 days later.

- No training to recognize symptoms
- WBGT too difficult to apply and doesn’t take into account vulnerabilities
- Rather than relying on the TLV, train workers to enable them to self-regulate (recognize symptoms and know how to reduce heat stress with breaks and fluid intake)
- Have medical history done by your OHN annually and identify workers at risk. Some may not know they are at risk.
- Issues around malignant hyperthermia, a genetic condition (1 in 200) which makes people more susceptible to heat strain.
“Managing” the Problem?

- varied approach even within the same union and same employer
- some collective agreements have temperature or Humidex criteria spelled out (e.g. an auto parts manufacturing plant in Kitchener had 34°C Humidex shutdown - but not anymore … )
- others use the ACGIH TLV® and take WBGT measurements (spot measurements, fixed location - area, personal - very few as per TLV® documentation)
- others simply “manage” their way through the situation

IF IT WORKS … GREAT!

A Few Practical Issues ……..
Medical Activities

- Appropriate Medical Activities
- Educate Heat exposed workers in collaboration with Safety and IH (?union)
- Pre-assignment and Periodic Screening
- Return to Works
- Emergencies with First Aiders (Training and Intervention)
- On site Medical Screening (RN with protocol + MD follow up)
Why Medical Controls

For Heat Stress specifically:

- Early detection “safety net” example: ALCAN (350 middle aged+ workers, 45% personal risk factors, 8-12 near misses per summer, no acute cases)

- ACGIH applies to 95% of health young acclimatized reasonably dressed, well hydrated males. KINDA HARD TO FIND…Olympic Track Team!
Awareness/Vigilance is an important Safety Tool especially for an acute aggressor. Important activity of Safety Program.

“What (IH), So What (MD), Now What (Manager/Safety Rep)”

Yearly sessions of 1-2 hours given to small “natural” work groups. Based on info in their own work environment. Repeated as needed to update IH/surveillance info, if increased risk found, or cases detected (near miss)

Impact is hard to measure. Well accepted. Increased short term knowledge (awareness?vigilance?)
Drink Water

Acclimatization does not decrease your body’s need for water.

Drink plenty of water!
What to drink?

- Electrolyte drinks (e.g. Gatorade) are usually not needed for typical North American diet (can be used for first aid for cramps).

- Stay away from caffeinated carbonated, diet drinks and alcohol as they take water out of your body.

- Water is the best; juices and/or noncaffeine sport drinks are also good (juices contain energy restoring glucose).
To prevent dehydration, take advantage of scheduled water breaks!
<table>
<thead>
<tr>
<th>fluid loss</th>
<th>time*</th>
<th>effect &amp; symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75 L</td>
<td>1 hr</td>
<td>unnoticed (at 1.5% weight loss you are considered dehydrated)</td>
</tr>
<tr>
<td>1.5 L</td>
<td>2-3 hrs</td>
<td>loss of endurance, start to feel thirsty, feel hot, uncomfortable</td>
</tr>
<tr>
<td>2.25 L</td>
<td>3-4 hrs</td>
<td>loss of strength, loss of energy, moderate discomfort</td>
</tr>
<tr>
<td>3 L</td>
<td>4-5 hrs</td>
<td>cramps, headaches, extreme discomfort</td>
</tr>
<tr>
<td>3.5-4 L</td>
<td>5-6 hrs</td>
<td>heat exhaustion, nausea, faint</td>
</tr>
<tr>
<td>5+ L</td>
<td>7+ hrs</td>
<td>heat stroke, collapse, unconsciousness</td>
</tr>
</tbody>
</table>
How Much Water is Enough?

► More than you want just to satisfy your thirst

► Sources of water are:
  1. Fluids - 1 cup or 8 oz = 240 mL every 20 min
  2. Foods - fruit & veggies are 90% water

► Why 10-15°C? … to maximize the amount you drink (not too cold, not luke warm)

► Does it need to be delivered to the work station? … depends on workplace logistics …
Eat Healthy

You can and should replace essential elements lost during sweating;

Eat a balanced diet rather than taking salt tablets or drinking expensive sports drinks.
Cooler Fans

- Purpose of a cooling fan is primarily to increase the rate of sweat evaporation but it also cools by convection if the air is cooler than the skin.

- Fan coolers may interfere with local exhaust ventilation for contaminant control, therefore be careful in where they are placed and how they are pointed.
Cooler Fans (limitations)

- If the relative humidity is over 75-80% the fan will no longer increase evaporation of sweat.

- The closer the air temperature is to skin temperature (35-36°C) the less effective the cooling.
  - If the air temperature exceeds skin temperature then the fan may even heat up the body (like a convection oven)!
Wear the Gear?

Personal Protective Equipment?

Special cooling vests or ice vests have been developed to wear under chemical–resistant suits?
IH Controls

- IH controls:
- Fractionate thermal dose by rest work/cycles (see ACGIH handbook)
- Modify work (metabolic) load
- A/C rest areas to push down calculated heat load
- Ice vests, reflective insulated suits, vortex tubes (need compressed air) Hard to calculate impact unless HR/core temp monitoring.

NB: Don’t use synthetics in radiant env. They melt and stick!
Caused by hormonal changes.

Affected by lifestyle and medications.

Diminished level of estrogen

Affects the hypothalamus which controls sleep, sex, appetite, body temperature.

The drop in estrogen confuses the hypothalamus, the ‘thermostat’

And reads “TOO HOT”.

Tricks to Alleviate Hot Flashes.

First, there are practical things: wear layered clothing, no turtle necks, carry a fan, or wear less to bed if these are night sweats. Sleep and work in a cool room. Avoid hot showers, saunas, hot tubs.

Do not wear or sleep on or in wool, synthetics or silk.

Second, watch the diet. Avoid foods like spices, caffeine, chocolate, alcohol. Keep ice water on hand.

http://www.ellenedith.com/cartoons/womenswit/wowit_f.jpg
More tricks to alleviate Hot Flashes

- Third, exercise. Many women who exercise regularly appear to have less flashes or night sweats.
- Fourth, learn to say no!
- Fifth, inform your colleagues if you suffer from heat.
- Sixth, relaxation and stress reduction techniques, e.g. yoga, massage, tai-chi.
Emergencies

- Work on Emergency Response from the site to the ER (coordinate with local Health providers)
- Part of general triage system for any worksite critical event
- Train specifically for Heat Imbalance pathology (start with co-workers)
- Rehearse, Rehearse, Rehearse
Pregnancy

www.speedysigns.com

CAUTION

PREGNANT WOMEN SHOULD NOT ENTER
Essentially affects every system in the women’s body and many of those changes are a direct result of major pregnancy hormones including estrogen, progesterone, human chorionic gonadotropin, human placental lactogen and relaxin.

These hormones are responsible for respiratory, CVS, GI, GU, musculoskeletal, skin, and hair and physiological and emotional changes.

By the end of pregnancy women require 15% to 20% more Oxygen demands of maternal oxygen consumption and fetal oxygen needs.

Short of breath

Pregnant women who perform physical labor at work should be given extra time to complete their tasks.

References


