Managing Heat stress
(The Basics)
OBJECTIVES

Demonstrate an understanding of

• Mechanisms of heat exposure
• The signs & symptoms of heat illness.
• How to manage heat illness
• How to prevent heat illness from occurring.
• The potential health effects of heat illness.
Heat Stress

Environmental heat and humidity, metabolic work load and clothing, individually or combined create heat stress for the worker.

Heat Strain

The body’s response to that stress, for example:

– sweating, increased heart rate, elevated core temperature
Progression of Effects

Increased Risk of Heat Disorder
Increased rate of Mistakes/Accidents
Decreased Performance: Lower Productivity
Initial Symptoms: Fatigue, Lethargy
The Bodies Cooling System

The body has an efficient method of maintaining the normal body core temp. at 37 °C

First symptoms occur at 37-39 °C
Heat stroke at 40 °C
Death at 42 °C

A 2-3 °C increase in core body temperature can be potentially life threatening.
Metabolism Creates Heat

Core Temperature Increase

Generate Heat

Metabolism (Do Work)
Dissipating Heat

• The human body is like a car engine
• When it does work it generates heat
• The cooling systems are very similar;
  – circulating coolant (blood)
  – radiator (skin)
Heat Transfer Paths

- Core Temperature
- Environment
- Skin Temperature
- Metabolism (Do Work)
- Sweat Evaporation
Environmental Contributions to Heat Illness

- Temperature
- Humidity
- Air Movement
- Radiant temperature of surroundings
- Clothing
- Physical activity
Personal Factors Which Influence Heat Illness

- Age
- General Health
- Weight & Physical fitness
- Hydration State
- Acclimatisation
- Drugs
Clothing Factors for Heat Stress:

- **Ventilation:**
  - Affects the amount of cooling by sweat evaporation as air moves around and the skin.

- **Insulation:**
  - Affects heat transfer

- **Permeability:**
  - Affects sweat evaporation.

- **UV Protection:**
  - Long sleeves and trousers to protect from UV radiation and skin cancer.
Clothing

- Shirts should be designed to extend down outside the lower garment where possible. (Does this create safety issues?)
- The neck should be capable of being opened for convection.
- Sleeves should be long with buttons.
- One piece unrestricted (where practical)
- If sufficient free air flow is provided by openings for use in the humid tropics, the material could still be relatively dense.
- Colour; where solar radiation is an issue, should be a light dye type
### Reflection of total sunlight by various fabrics

<table>
<thead>
<tr>
<th>Item</th>
<th>Fabric</th>
<th>Contributing to the heat load</th>
<th>Reflected per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shirt, Mock Leno, slightly permeable</td>
<td>55.9</td>
<td>44.1</td>
</tr>
<tr>
<td>2</td>
<td>Cotton, khaki—8.2 oz.</td>
<td>43.7</td>
<td>56.3</td>
</tr>
<tr>
<td>3</td>
<td>Cotton, percale, white</td>
<td>33.2</td>
<td>66.8</td>
</tr>
<tr>
<td>4</td>
<td>Cotton, percale, O.D.</td>
<td>51.5</td>
<td>48.5</td>
</tr>
<tr>
<td>5</td>
<td>Cotton, tubular balbriggan</td>
<td>37.6</td>
<td>62.4</td>
</tr>
<tr>
<td>6</td>
<td>Cotton, twill, khaki</td>
<td>48.3</td>
<td>51.7</td>
</tr>
<tr>
<td>7</td>
<td>Cotton, shirting worsted, O.D.</td>
<td>61.1</td>
<td>38.9</td>
</tr>
<tr>
<td>8</td>
<td>Cotton denim, blue</td>
<td>67.4</td>
<td>32.6</td>
</tr>
<tr>
<td>9</td>
<td>Cotton, herringbone twill</td>
<td>73.7</td>
<td>26.3</td>
</tr>
<tr>
<td>10</td>
<td>Cotton, duck No. 746</td>
<td>92.8</td>
<td>7.2</td>
</tr>
<tr>
<td>11</td>
<td>Cotton shirt, white unstarched, 2 thicknesses</td>
<td>29.0</td>
<td>71.0</td>
</tr>
<tr>
<td>12</td>
<td>Cotton shirt, khaki</td>
<td>57.0</td>
<td>43.0</td>
</tr>
<tr>
<td>13</td>
<td>Flannel suiting, dark gray</td>
<td>88.0</td>
<td>12.0</td>
</tr>
<tr>
<td>14</td>
<td>Dress suit</td>
<td>95.0</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Data of Aldrich

Data of Martin (3)

From: Blum, H.F., "The solar heat load: its relationship to total heat load and its relative importance in the design of clothing".
Vented Clothing
Who gets the hottest?

Where might you see Heat Stress?

- Places readily recognised as being hot
- Physically demanding work
- Jobs requiring protective clothing
Factors Which Influence Heat Illness

- Dehydration
- Salt Balance
- Acclimatisation
- Alcohol
Fluid Replacement

- Thirst is generally an inadequate indicator
- Rule of Thumb: Drink until thirst is satisfied then have one more drink.
- Frequent Drinking, small quantities
- Water is the essential component but must be an acceptable drink.
- Pre and post-hydration is important when there are restrictions on drinking.
Caffeine

• Can increase non-sweat body fluid losses (increased urine production) in some individuals.

• This effect is more common in less active individuals.

• Moderate caffeine intake does not alter fluid-electrolyte parameters during exercise or always have a bad impact on the ability to perform exercise in the heat.

• It does add to the overall fluid uptake of the individual.

• Excessive caffeine intake can result in nervousness, insomnia, gastrointestinal upset, tremors and tachycardia in some individuals.
# Caffeine Content of Selected Beverages

<table>
<thead>
<tr>
<th>Beverage</th>
<th>mg caffeine per 100mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coca Cola</td>
<td>9.6</td>
</tr>
<tr>
<td>Diet Coke</td>
<td>9.5</td>
</tr>
<tr>
<td>Diet Pepsi</td>
<td>10.1</td>
</tr>
<tr>
<td>Pepsi Max</td>
<td>19.4</td>
</tr>
<tr>
<td>Pepsi</td>
<td>10.7</td>
</tr>
<tr>
<td>Mountain Dew</td>
<td>15.2</td>
</tr>
<tr>
<td>Black Tea</td>
<td>17.8</td>
</tr>
<tr>
<td>Green Tea</td>
<td>10.6</td>
</tr>
<tr>
<td>Instant Coffee</td>
<td>24.1</td>
</tr>
<tr>
<td>Percolated Coffee</td>
<td>45.4</td>
</tr>
<tr>
<td>Drip Coffee</td>
<td>61.3</td>
</tr>
<tr>
<td>Decaffinated</td>
<td>2.4</td>
</tr>
<tr>
<td>Expresso</td>
<td>173</td>
</tr>
<tr>
<td>Chocolate Drink</td>
<td>2.1</td>
</tr>
<tr>
<td>Milk Chocolate (50g bar)</td>
<td>10.7</td>
</tr>
</tbody>
</table>

Source: Energyfiend.com
How Much Salt?

- Salt tablets are not recommended.
- Average Western diet is high in salt.
- As part of acclimatisation a hormone is produced within the body that improves the ability to conserve salt.
- Regulated quantities of electrolyte supplements may sometimes be used in situations of high sweat loss.
Acclimatisation

A complex physiological response that results in increased tolerance. i.e. more efficient means of sweating with more dilute sweat.

May take a week or longer to obtain.

Is rapidly lost in part or whole.

As a general practice, reduce expectations during periods of acclimatisation.
ALCOHOL

• Alcohol acts as a diuretic (ie. it makes you pee more) hence increasing the risk of dehydration

• A 200 ml glass of beer may make you pass approx 300 ml of fluid.

• Electrolytes such as sodium & potassium are also lost.
Heat Cramps

Symptoms: Painful muscle cramps, especially in abdominal or fatigued muscles.

Cause: Electrolyte imbalance due to prolonged sweating without adequate fluid and salt intake. Unacclimatised

First Aid: Rest in cool environment. Replace electrolytes. Massage muscles.
Heat Rash  
(Prickly Heat)

**Symptoms:**  Itching skin, reduced sweating, Skin rashes

**Cause:**  Prolonged uninterrupted sweating, inadequate hygiene practices.

**First Aid:**  Keep skin clean and dry, reduce heat exposure
Dehydration

**Symptoms:** Fatigue/weakness, Dry mouth. Increased response time.

**Cause:** Excessive fluid loss due to sweating, illness (ie. Vomiting or diarrhoea) or alcohol consumption

**First Aid:** Fluid replacement.
Heat Syncope
(Fainting)

Symptoms: Blurred vision (grey out), Normal Temperature, Fainting (brief)

Cause: Drop of blood pressure from prolonged static posture and heat exposure

First Aid: Lay on back in cool environment. Drink water.
Heat Exhaustion

Symptoms: Fatigue, Blurred vision, Weakness, Dizzy, Headache

Signs: High pulse rate, profuse sweating, Low blood pressure, Insecure gait, Pale face, Collapse,

Cause: Dehydration, Low level of acclimatization, Low level of fitness.

First Aid: Rest in cool environment, Drink water, Loosen clothing.
Heat Stroke

Symptoms: Chills, Irritable, Restlessness

Signs: Euphoria, Red face, Disorientation, Hot dry skin (usually), Erratic behaviour, Collapse, Shivering, Unconsciousness, Convulsions, Body temp > 40°C (104°F)

Cause: Excessive exposure, Drug/alcohol abuse, Subnormal tolerance (genetic or acquired)

First Aid: Immediate cooling (ie spray with cool water and fan to evaporate) Get immediate medical attention.
Two approaches to control

1. Modifying the work or environment to suit the work

2. Limiting work to suit the environment

The approach taken will determine the assessment method. Approach 1. should be the first avenue of attack.

Control slides adapted from AIOH; A guide to managing heat stress (2013)
Controls (Elimination/engineering)

- Hot tasks should be scheduled to avoid the hottest part of the day or where practical undertaken during night shifts.
- Walls and roof structures should utilize light coloured or reflective materials.
- Structures should be designed to incorporate good air flow. This will help remove the heat from the structure.
- Walls and roofs should be insulated.
- For field teams with high mobility, a simple portable shade structure or large umbrellas can provide relief from solar radiation.
Controls (Cont)

• Hot pipework and vessels should be insulated and clad.
• In high humidity areas more air needs to be moved, hence fans to increase air flow or in extreme cases, cooled air from ‘chiller’ units can also be utilised.
• Insulating barriers or reflective barriers can be used to absorb or re-direct radiant heat. These may be permanent structures or movable screens.
• Relocating hot processes away from high access areas.
Controls (Admin)

- Ready access to cool palatable drinking water is a basic necessity.
- Where applicable, suitable electrolyte replacements should also be available.
- A clean cool area for employees to rest and recuperate can add significant improvement to the cooling process.
- Training workers to identify symptoms and the potential onset of heat-related illness as part of the ‘buddy system’.
• Consider pre-placement medical screening for work in hot areas (ISO 12894).
• Use work/rest cycles where higher level controls are not practical
• Encouraging “self-determination” or self pacing of the work to meet the conditions and reporting of heat related symptoms.
Controls (PPE)

- PPE such as cooling vests with either ‘phase change’ cooling inserts (not ice).
- Vortex tube air cooling may be used in some situations, particularly when a cooling source is required when supplied air respirators are used.
- Choose light coloured materials for clothing and ensure they allow good air flow across the skin to promote evaporative cooling.
Some Keys to the Prevention of Heat Stress

- Drink appropriate fluids to maintain hydration
- Education
- Cool the environment
- Cool the person
- Acclimatisation
- Reduce the exposure time
- Where practical, reschedule hot jobs to cooler times.