College of Science
Env. Science and Health Dept.

زانکۆی سەلاحەدین - هەولێر
Salahaddin University-Erbil

Thermal Stress

Section A

Introduction and Definitions

Fars Zedan

Definition of Thermal Stress

Thermal stress - is a significant physical agent in many working environments. Human-made environments from freezers to ovens extend the range of thermal environments in which work is expected. Because tasks must be performed under adverse thermal conditions, this lecture provides guidance for recognition, evaluation and control of work in thermal extremes.

Air Temperature

- The temperature of air varies in different parts of the day and also in the different seasons. The factors which influence the temperature are latitude of the place, altitude, direction of wind and proximity to sea. The temperature of the ground surface is always higher than that of the air. Thermometers are instruments used for measuring temperature. Mercury thermometers are widely used. Alcohol thermometers are also used.

Section B

Effects of Heat Stress

Effects of heat stress:

As many as 14 disorders resulting from exposure to heat have been recognized and documented. The important ones are:

- (1) HEAT STROKE
- (2) HEAT HYPERPYREXIA
- (3) HEAT EXHAUSTION
- (4) HEAT CRAMPS
- (5) HEAT SYNCOPE

(1) Heat Stroke

- This is attributed to failure of the heat regulating mechanism. It is characterized by very high body temperature which may rise to (43.3°C) and profound disturbances including delirium, convulsions and partial or complete loss of consciousness.
- The skin is dry and hot. Classically, sweating is absent or diminished.

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- The outcome is often fatal, even when patients are brought quickly to medical attention; death/case ratios of 40 per cent or more have been reported.
- The treatment consists of rapidly cooling the body in ice water bath. Further treatment is supportive and directed towards the many potential complications of hyperthermia.
- The patient should be kept in bed for several days until the temperature control becomes stable.

(2) HEAT HYPERPYREXIA

- This is attributed to impair functioning of the heat-regulating mechanism but without characteristic features of heat stroke.
- It is arbitrarily defined as a temperature above (41°C). It may proceed to heat stroke.

(3) HEAT EXHAUSTION

- Unlike heat stroke, heat exhaustion is not because of failure of thermo-regulation.
- It is a milder illness than heat stroke and is caused primarily by the imbalance or inadequate replacement of water and salts lost in perspiration due to thermal stress.
- Heat exhaustion typically occurs after several days of high temperature.

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- Body temperature may be normal or moderately elevated, but it is uncommon to exceed (38.9°C).
- The symptoms, primarily dizziness, weakness and fatigue, are those of circulatory distress. It may be severe enough to require hospitalization, especially in elderly patients. Treatment is directed towards normalizing fluid and electrolyte balance.

(4) HEAT CRAMPS

- **Heat cramps** occur in persons who are doing heavy muscular work in high temperature and humidity.
- There are painful and spasmodic contractions of the skeletal muscles. The cause of heat cramps is loss of sodium and chlorides in the blood.

(5) HEAT SYNCOPE

- This is a common ill-effect of heat. In its milder form, the person standing in the sun becomes pale, his blood pressure falls and he collapses suddenly.
- There is practically no rise in body temperature.

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- The condition results from pooling of blood in lower limbs due to dilatation of blood vessels, with the result that the amount of blood returning to the heart is reduced, which in turn is responsible for lowering of blood pressure and lack of blood supply to the brain.
- This condition is quite common among soldiers when they are standing for parades in the sun. Treatment is quite simple. The patient should be made to lie in the shade with the head slightly down; recovery usually comes within 5 to 10 minutes.

Section C

Preventive Measures

Preventive Measures:

The ill effects of high temperature may be prevented by observing the following precautions:

- (1) REPLACEMENT OF WATER: It has been found that a man doing hard work in the sun requires about one liter of water per hour. For a sedentary worker, the requirement is nearly half this quantity.

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- (2) REGULATION OF WORK: The duration of exposure to a hot environment should be cut down. There should be periods of rest in between intense work.
- (3) CLOTHING: The clothing worn should be light, loose and of light colors.

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- (4) PROTECTIVE DEVICES: Protective goggles, shields and helmets are helpful.
- (5) WORK ENVIRONMENT: The temperature and humidity in the work environment may be controlled by proper ventilation and air-conditioning.

Section D

Effects of Cold Stress

Effects of cold stress

- Injury due to cold may be general or local. In general cold injury (hypothermia), the individual is said to be suffering from exposure to cold.
- This is characterized by numbness, loss of sensation, muscular weakness, a desire for sleep, coma and death.
- Local cold injury may occur at temperatures above freezing (wet-cold conditions) as in immersion or trench foot.

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- At temperatures below freezing (dry-cold conditions) frostbite occurs; the tissues freeze and ice crystals form in between the cells.
- Frostbite is common at high altitudes. The affected part should be warmed using water at 44°C.
- Warming should last about 20 minutes at a time. Intake of hot fluids promotes general rewarming.