University OF ALQadisiya

collage of dentistry

first stage

medical physics : 

Lecture:  ***luma hafedhe abed***

*Heat and Cold in Medicine*

**Heat and Cold in Medicine**

Matter is a composed of molecules that are in motion. This means that the molecules have kinetic energy and this kinetic energy is related to the temperature .the average kinetic energy of molecules (gas, liquids, solids) is directly proportional to the temperature.

**Heat**: is the energy transferred to the molecules causing the temperature

rise.

**Solid → liquid → gas → ions**

* Heat can removed from substance to low temperature .low temperature are reefed to cryogenic region.
* The ultimate in cold is "absolute zero" (−273.5°𝐶) a temperature that experimentally unattainable.

**Temperature scales**

**1- Fahrenheit scale (°F):** in this scale the freezing temp. is 32°F and boiling point is 212°F, and normal body temp. is about 98.6°F.

**2- The Celsius (°C):** the freezing point is 0°C and the boiling point is 100°C, in between is divided into 100 division.

**3- The Kalvin scale (°K):** or the absolute scale this scale has the same divisions as the Celsius but takes the 0° K at the absolute zero which is −273.15°𝐶.

**To change** °C to °F

[°𝐶 = (°𝐹 − 32) 5/9] 𝑜𝑟 [°𝐹 = °𝐶 (9/5) + 32]

Also °𝐶 = °𝐾 − 273 𝑜𝑟 °𝐾 = °𝐶 + 273

**Example**

Convert 20 degrees Celsius to Kelvin:

*T*(K) = 20°C + 273.15 = 293.15 K

**Thermometry**

Temperature is difficult to measure directly, so we usually measure it indirectly by measuring one of many physical properties that change with temperature. We then relate the physical property to temperature by a suitable calibration.

There are three main types of temperature measurement devices:

**1. Glass fever thermometer**

Containing mercury or alcohol. The principle behind this thermometer is that an increase in temperature of different materials usually causes them to expand different amount. i.e. when the temperature increase, alcohol or mercury expands more than the glass thus the level of liquid increase in the glass.

* The expansion of liquid in thermometer is not large. It's about 1.8% of

its volume in going from 0 to 100 °𝐶. Thus the mercury is forced to rise from the bulb in the capillary tube. The smaller the diameter of the capillary the greater sensitivity of the thermometer .fever thermometer has a diameter less than 0.1mm.

**Two things increase the visibility of the capillary:**

1. The glass case acts as a magnifying glass.

2. An opaque white backing is used.

The capillary of fever thermometer has a restriction just above the bulb so after the liquid is forced in to the stem by expansion it does not return when the temperature falls.

**2. Thermistor**

It is a special resistor that changes its resistance rapidly with temperature

(about 5% ⁄ °𝐶). Thermistors are used in medicine because of their sensitivity. It can measure temperature changes of 0.01°𝐶. Because of its small mass, a thermistor has a little effect on the temperature of the surrounding tissues and responds rapidly to temperature change. Thermistor are placed in the nose to monitor the breathing rate of patient by showing the temperature change between inspired cool air and expired warm air .an instrument of this type called ***pneumograph.***

**3. Thermocouple**

It is consist of two junctions of two different metals. If the two junctions are at different temperature, a voltage is produced that’s depends on the temperature difference. One of the junctions is kept at reference temperature such as in an ice-water bath and the other for temperature measurement. It measure temperature from -190 to 300 °𝐶. It can be made small enough to measure the temperature of individual cells.

Voltage

Copper

Copper

Constantan

Measuring junction

Ice

Fig. (1) Shows thermocouple

**Thermography – Mapping the bod's temperature**

* Measurement of body surface temperature indicate that the surface temperature varies from point to point depending upon external physical factors and internal metabolic and circulatory processes near the skin.
* One very appealing method of obtaining a thermogram is to measure the radiation from the body. All objects regardless of their temperature emit radiation. If the temperature is sufficiently high (red hot), the radiation is visible. At body temperature the emitted radiation is in the far infrared (IR) region at wavelength much longer than those observable by the human eye.

**Heat Therapy**

Heat was recognized as therapeutic agent several thousand years ago. **It has two primary therapeutic effects**:

1- An increase in metabolism resulting in relaxation of the blood capillaries (vasodilation).

2- An increase in blood supply to cool down the heated area.

**The** **physical methods of producing heat in the body are**:

1. ***Conductive heating***

It's based on the physical fact that if two objects at different temperature are placed in contact, heat will transfer by conduction from the warmer object to the cooler one. The total heat transferred will depend upon the area of contact, the temperature difference, the time of contact, and the thermal conductivity of the materials .Its used in treating conditions such as arthritis, neuritis, sprain, strain and back pain.

2. ***Infrared (IR) radiant heating***

It is also used for surface heating of the body, the IR wave length used are between 800 and 4000 nm. The waves penetrate the skin about 3mm and increase the surface temperature .It is used for the same condition as conductive heating but it is considered to be more effective because the heat penetrates deeper.

3. ***Radio wave heating (diathermy)***

When alternating electric current passes through the body, various effect such as heating and electric shock take place. The amount of heat that can be transferred to the body by electrical diathermy increases as the frequency of the current increase. Heat from diathermy penetrates deeper in the body than radiant and conductive heat. It is thus useful for internal heating and has been used in the treatment of inflammation of the skeleton, bursitis and neuralgia. Short wave diathermy utilizes electromagnetic waves in the radio range (wave length = 10 m).

4**. Microwave diathermy**

It uses waves in the radar range (wave length = 12 cm)

***5. Ultrasonic wave heating (ultrasonic diathermy)***

Ultrasonic waves are also used for deep heating of body tissue. They produce mechanical motion like audible sound waves. In ultrasonic diathermy, power levels of several watts per square centimeter. Ultrasonic heating has been found useful in relieving the tightness and scarring that often occur in joint disease.

**Cold in medicine**

***Cryogenics***: Is the science and technology of producing and using very low temperature. The study of low temperature effects in biology and medicine is called ***cryobiology.***

Low temperature have been used for long term preservation of blood, sperm, bone marrow and tissues. Much interest has been aroused by the idea of using cryogenic methods to cool the body in to state of 'suspended animation' so that it can pass time

without aging. This science is called cryonics. One goal of cryonics is to preserve at low temperature people with fatal disease with hope in the future they could be revived and their disease cured. Since the biochemical and physical processes that sustain life are

temperature dependent lowering the temperature reduces the rates of the processes.

Preservation is much better at the temperature of liquid nitrogen (−196°𝐶) that at the temperature of solid dioxide (−79°𝐶). Survival after freezing is more dependent upon the cooling rate during the freezing cycle than on the warming rate during the thawing cycle.

The survival of some cells can be helped by adding a productive agent

before cooling.

***Blood storage***

1. Non-cryogenic method

The conventional non-cryogenic method of blood storage involves mixing

whole blood with an anticoagulant and storing at (4 °𝐶).

2. Cryogenic method

Blood can be stored for a much long time if it rapidly frozen. Two techniques are used for this method one uses thin – walled containers, the other is the ' blood – sand ' method.

***The skin, bone, muscle and organs are harder to preserve than simple***

***cells such as red blood cells for a number of reasons:***

* The large physical dimensions limit the cooling rate.
* Adding and removing protective agents is difficult.

***Cryosurgery***

Cryogenic methods are also used to destroy cells, this application is called

cryosurgery has several advantages:

* There is little bleeding in the destroyed area.
* The volume of tissue destroyed can be controlled by the temperature
* of the cryosurgical probe.
* There is little pain sensation because low temperature to desensitize
* the nerves.

One of the first uses of cryosurgery was in the treatment of Parkinson's diseases "shaking palsy" which is a disease associated with basal ganglion of the brain. Parkinson's disease causes uncontrolled tremors in the arms and legs. In the treatment of Parkinson's disease the tip of the thalamus casing temporary freezing of these regions. The patient must be conscious during the procedure so that the surgeon can observe when the shaking stops this region. The destroyed tissue forms a cyst after thawing and doesn’t interfere with normal body functions. One common use of cryosurgery is the treatment of tumors and warts.

Cryogenic methods have also been used in several types of eye surgery.

