

ALAYEN IRAQI UNIVERSITY
Health and Medical Technologies
Anaesthesia Department



Medical physics

Heat and Cold in medicine

Lec 4

Dr. Fouad Abbas

Heat and **cold** have been used for medical purpose for several thousand years.

Heat: It is the energy transferred from the hot object to the cold object causing to raise the temp of cold object.

If we want to describe temperature as a physical phenomenon, we should try to understand it on a molecular scale.

- Matter is composed of molecules that are in continuous motion.
- Molecules motion means that they have kinetic energy
- Kinetic energy is related to the temperature.
- K.E increase when temperature increase

If enough heat added to a solid, it melts, forming a liquid. The liquid may be changed to a gas by adding more heat.

the reverse is also true, heat can be removed from a substance المادة to lower the temp, Low temp. referred to as the **cryogenic region**

Temperature scales:

Reference points on the three common scales:

- 1- **Fahrenheit ($^{\circ}\text{F}$)** scale: water freezes at 32°F and boils at 212°F . the normal bodytemperature = 98.6°F .
- 2- **Celsius ($^{\circ}\text{C}$)** scale: water freezes at 0°C and boils at 100°C . the normal bodytemperature = 37°C .
- 3- **Kelvin ($^{\circ}\text{K}$)** scale (Absolut scale): water freezes at 273.15°K and boils at 373.15°K . The normal body temperature = 310°K . This scale

is not use in medicine.

The relationship between different temperatures scales are:

To change °C to °F

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9 \quad \text{or}$$

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

Also °C = °K - 273 or °K = °C + 273

H.W: what is the normal body temperature on kelvin and Fahrenheit scale?

Temperature measurement

A number of temperature sensitive devices used in medicine to measure T:

1-Glass fever thermometer

It used to know the temp of the body

* The most common way to measure a temperature is with in the glass fever thermometer containing mercury or alcohol.

* Input fever thermometer ,a temperature increase causes the alcohol or mercury to expand more than the glass and thus produces an increase in the level of the liquid.

To increase the visibility of the thermometer

A- The glass acts as a magnifying glass.

B- Use an white backing. In most Fever thermometer .

they use mercury because

A- The volume expansion ΔV with temperature ΔT is very small.

B- It's clear color

C- It has a small adhesion **التصاق** force with the wall of the glass

2- Thermistor

It's a special resistor that changes its resistance rapidly with temp (0 - 5% $^{\circ}C$)

* The principle behind this thermistor is that a temperature change causes the thermistor resistance to change

The thermistor advantage:

- a- Very sensitive, it's easy to measure temperature change of (0.01 $^{\circ}C$).
- b- Small mass
- c- Breathing rate temp. Measurement (**pneumography**).

Pneumography: it's a Thermistors are occasionally placed in nose to monitor the breathing rate of patients by showing the temperature change between inspired cool air شهيق and expired warm air زفير

3- Thermocouple → measuring the temp from “-190 to 300 $^{\circ}C$ “.

* A thermocouple consists of two junctions of two different metals . If the two junctions are at different temperature, a voltage is produce that depend on the temperature difference.

Because it has a sharp end then it can measure the temp of “individual cell

4- Thermograph:

It is a simple method for obtaining a surface temp (mapping).

Thermography is the process in which the infrared radiation emitted by the body is used to produce a **thermal image** or **temperature** map of the surface of the body. The images are called **Thermograms** and are normally displayed on a **TV** screen.

Different temperatures are represented by different colors or, in a black and white display, by different shades of gray.

It is used to

- 1- It has been used to detect other type of cancer not only breast cancer سرطان الثدي
- 2- It used to study the circulation of the blood in the head.
- 3- It used to study the blood in the diabetics leg قدم لسكري

One method to obtaining a thermogram is to measure the *radiation emitted* from the body. In the infrared (IR) region.

The basic equation describing the radiation emitted by a body was given by Max Plank

for our purposes the **Stefan-Boltzmann law** for total radiative power per surface area W is more useful, it is

$$W = e \sigma T^4$$

W ; is total radiative power per surface area
 T ; is absolute temperature

E ; is the emissivity =1 for radiation from the body

σ ; is the Stefan Boltzmann constant = $5.7 \times 10^{-12} \text{ W/cm}^2 \cdot \text{K}^4$

therapy Heat مع لجمبال حراره

Heat has two primary therapeutic effects الأثار العالجية :

1- Increase in metabolism resulting in relaxation of the blood capillaries (vasodilation) توسع الأوعية .

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

Methods of producing heat in the body:

1-Conductive method

Heat will transfer by conduction from the warmer object to the cooler one.

The *total heat transferred will depend on*

A- The area of contact.

B- The temperature difference.

C- The time of contact.

D- The thermal conductivity of the material.

Conductive heating used in treating conditions such as

- ArthritisContusions التهاب المفاصل Neuritis التهاب العصب
- Sprains pain. Back Strain لتواء ال فطلى Back التهاب
- Sinusitis الجيوب الكدمات

2-Radiation IR. Heating

The heat can be transferred to the body by radiation. It is used for surface heating of the body .This is the same heat. We feel from the sun and flame.

* The IR wave length used is between (800- 4000nm).

*These waves penetrate the skin about (3mm) & increase the surface temp.

* This type of heating is used to treat the same conditions of conductive heating.

* Excessive exposure causes reddening and sometimes swelling. This method is more effective because the heat penetrates deeper.

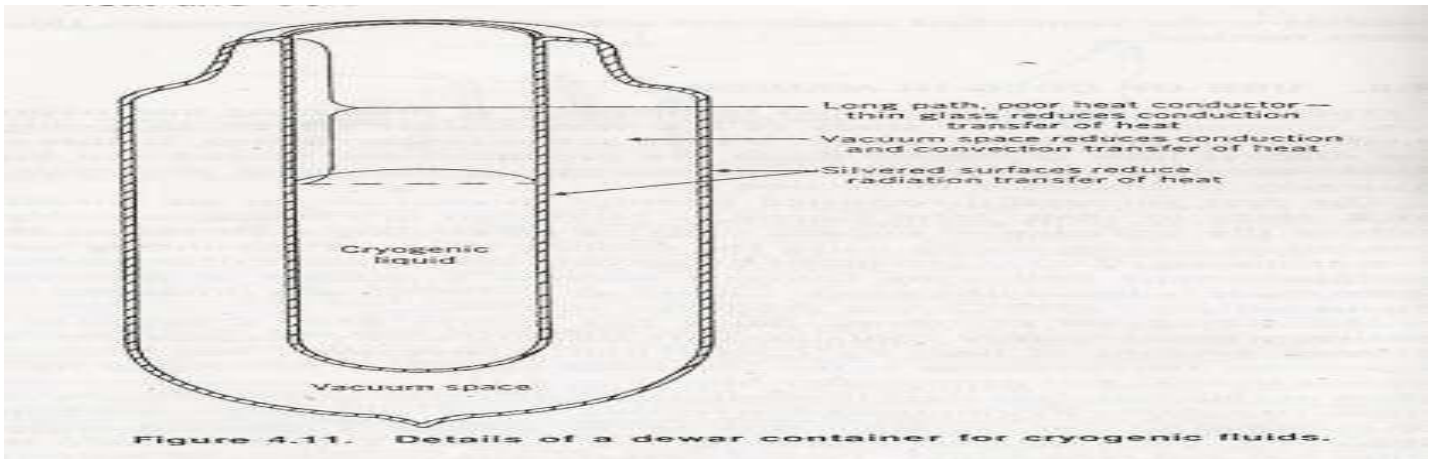
3- Radio wave heating (diathermy) Heat from diathermy penetrates deeper into the body than radiant and conductive heat, so it is useful for internal heating and has been used in the treatment of inflammation التهاب of the Skelton.

4- Ultrasonic wave heating

These waves are different from electromagnetic waves. It produces mechanical vibration inside tissue. It is the same as the sound waves but it has much higher frequencies about 1MHz with power of several watts per centimeter. It can move the tissue particles backward and forward with high frequency, in doing so it can increase the kinetic energy consequently it heats the tissue.

Cryogenics

Cryogenics is the science of very low temp, Low temperature can be produced by liquefying gases. It was succeeded to produce liquid air(-196 °C) in 1877 and liquid helium (-269°C) in 1908 and liquid nitrogen(-196°C). These cold liquids have many medical and biological advantages. The storages of liquefied gases is rather difficult because it can take heat rapidly from the environment by conduction, convection الحمل الحراري, and radiation. A special container has been designed by Dewar (1892) and its named after his death, this composed from two cylindrical bottles made of glass or stainless steel one inside the other and a vacuum in between .this can prevent heat transfer by conduction and convection the two bottles are both silvered so that radiation striking the surface is reflected rather than absorbed, they are as good reflector and poor radiation for heat, the contact between them is made only at the top to minimize heat losses .



low temp have been used for long term preservation **لخاظ** of blood, sperm, bone marrow, and tissue .

Some preservation materials added such as glycerol improve the cell survival. Sometimes and especially in blood these materials can present a problem to remove them from the blood.

For conventional blood storage it can be stored with anticoagulant **مضاد لك نختو** at 4°C , about 1% of the red blood cells hemolytic **انحلال** (break) each day so the blood will not be suitable for use after 21 day.

Blood can be preserved for very long periods of time if it frozen rapidly in liquid nitrogen (-196°C). There are two ways to freeze the blood to (-196°C):

1- The blood sand on the surface of liquid nitrogen surface and then it will be frozen in small droplets in very short time forming sand like particles, then stored at liquid nitrogen .

2- The blood is kept in a thin wall highly heat conductive with metal container The container with the blood is immersed into the liquid nitrogen bath making very rapid cooling .

Some work has been carried out to preserve cornea and skin.

Cryosurgery

The cryogenic methods are used to destroy cells called cryosurgery. It has several advantages:

1- Cause a little bleeding

2- The volume of the tissue destroyed can be controlled

3- Little pain because low temp. desensitize the nerves.

One of the first uses of cryosurgery is in the treatment of Parkinsons disease, (shaking palsy) .

This disease causes uncontrolled and tremors ارتغاش in the arms and legs. It is possible to stop it by destroying parts of the thalamus of the brain that controls nerve impulse نبض to the other part of the nerve system.

The treatment undergoes while the patient in conscious واعي, the probe at (-10°C) moved into the appropriate مالم parts of the thalamus causing temporary مؤقت freezing , while the surgeon is moving the probe and when the tremors stops he will keep the probe a few minutes at temp. near -85°C this region will be destroyed , the destroyed tissue will form a cyst كيس, which does not interferes with the normal body function .

successful results were obtained in more than 90% of cases.