Al- mustaqbal University College
Anesthesia Techniques Department
First stage /medical physics
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Lecture 3:

Heat and Cold in Medicine

Matter is composed of molecules that are in motion that is means have kinetic energy (KE) it related to Temperature (Temp.):

$$KE \alpha Temp.$$

Heat: It is the energy transferred from the hot subject to the cold subject causing to rise the temp. Of cold subject.

Solid $\xrightarrow{heat}$ Liquid $\xrightarrow{heat}$ Gas $\xrightarrow{heat}$ Ions

Thermometry and temperature

Scales Temperature is difficult to measure directly, so we usually measure it indirectly by measuring one of many physical properties that change with temp.

1-Fahrenheit scale (°F): in this scale the freezing temp. Is 32°F and boiling point is 212°F.

2-The Celsius (°C): the freezing point is 0°C and the boiling point is 100°C.

3-The Kalvin scale (°K): or the absolute scale this scale which calculate from the law °C+273.

-Types of thermometers

1- Glass Fever Thermometer:

It used to know the temperature of the body, the most common way to measure a temperature is within 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.

Fig. 1 Glass Fever Thermometer.

2- The Thermistor

It is a special resistor that changes its resistance rapidly with temperature (5% C). The principle behind this thermistor is that a temperature change causes the thermistor resistance to change.

Because it is very sensitive and very fast for measuring temp change it has been used to monitor the breathing rate of the patient.

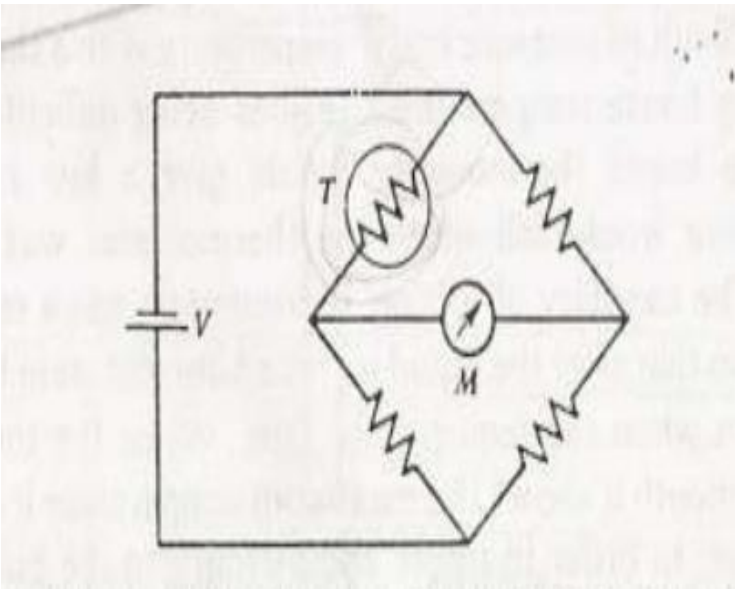

Fig.2 Thermistor circuit.

3- Thermocouple

This devices measuring the temperature from (– 190 to 300 C).

A Thermocouple Consist of two junction different metals, if the two junctions are different temperature. A voltage is produced that is depend on the temperature difference.

Thermograph:

It is a simple method for obtaining a surface temperature “mapping "

So it is used in:

1-It has been used to detect other type of cancer not only breast cancer.

2- It used to study the circulation of the blood in the head.

3-it used to study the blood in the diabetics leg.

Thermogram:

One very appealing method of obtaining a thermogram is to measure the radiation emitted from the body. At the body temp. Emitted radiation in the far infrared (IR) region at wavelength greater than (4000-7000) A.

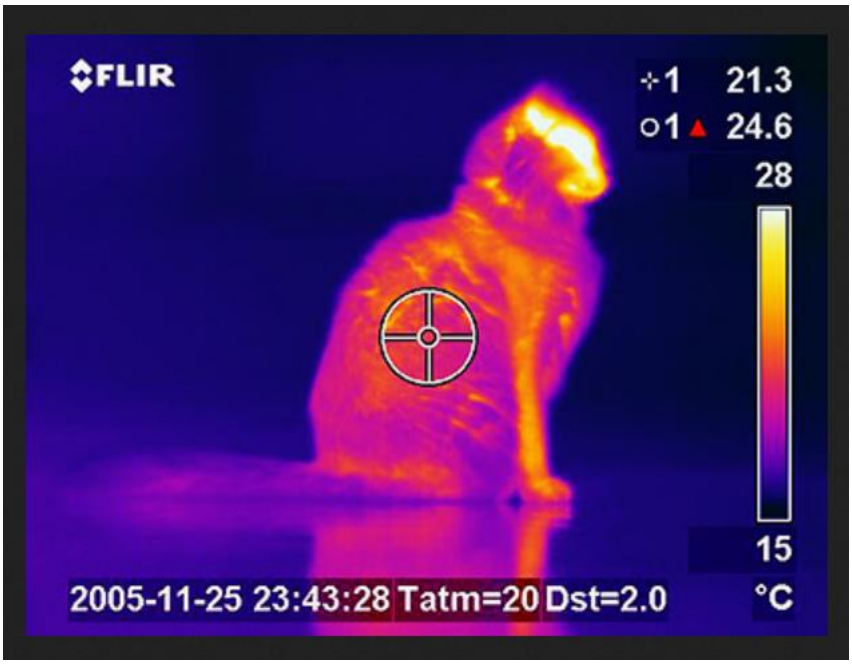

Fig.3 Thermogram of a cat.

The total radiative power per surface area (W) is given by Stefan – Boltzman law:

$$W = e\,\sigma\,T^4\ (w/cm^2)$$

Where:

e: emissivity is depending upon the emitter material and its temperature

For radiation from body **e** is almost one (e=1 for the body).

T: is the absolute temperature,

σ: the Stefan Boltzmann constant = 5.7×10^{-12} W/ $cm^2.K^4$

K: Kelvin or absolute, scale= $273k^{\circ}$

0 k°=absolute zero = $273C^{\circ}$

Normal body temperature = $(T\,C^{\circ} + 273)\ k^{\circ}$

Example:

A person of skin temp. Of $36C_o$ and body surface area $1.75m^2$ .find:

1. Net total power if he receives radioactive power from the surrounding

Walls $20C_o$ would be about 735w. ($\sigma = 5.7 * 10^{-12}$ w/cm^2)

2. The emissivity of surrounding walls.

Solution

1- $T=36C^{o}+273=309\ ^{o}K$

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

$=1*(5.7*10^{-12})*(309)^4$

$=0.052$ w / cm^2

Total power (w) = {Total radiative power per surface area}*surface area

$= 0.052\ (w/cm^2) * 1.75*10^4\ (cm^2)$

$= 910\ w$

$\therefore$ net power =910 - 735 = 175w

2- T= 20 + 273 = 293K

Heat from the wall

$735= [e* 5.7*10^{-12} *(293)^4] * (\ 1.75*10^4\ )$

$\therefore e = 735 / (735.163) = 0.998$

Physical Methods of Producing Heat in the Body

1- Conductive heating.

2- Infrared radiant heating (IR).

3- Radio wave heating (Electromagnetic Wave).

4- Micro wave diathermy.

1. Conductive Heating:

Is used in treating conditions such as:

1- Arthritis.

2- Neuritis.

3- Sprains.

4- Strains.

5- Contusions.

6- Sinusitis.

7- Back Pain.

2. IR. Heating:

The heat can be transferred to the body by radiation. It is used for surface heating of the body.

These wave penetrate the skin about (3mm) and increase the surface temp.
This type of heating is used to treat the same conditions of conductive heating.

3. Radio wave heating (diathermy).

They are very useful for internal heating because E.M.R. have energy depend on their frequency $E=h\gamma$, (γ: is the frequency).

A. Short wave diathermy (F=30 MHz)

B. Long Wave Diathermy (10 kHz)

4. Microwave Diathermy (2460 MHz)

It is penetrate deep into the tissue and causing temp. Rise and deep heating.

-Use of Cold in Medicine:

Cryogenics is the science and technology of producing and using very low temperature in medicine to preserve blood, bone marrow and soft tissue. According to the blood storage or preserve blood there are two ways to save blood:

1- Conventional method

2- Long term storage

-Cryosurgery:

It is application which has several advantages:

1- Cause a little bleeding in the destroyed area.

2-The volume of the tissues destroyed can be controlled'

3-Little pain because low temperature tend to desensitize nerves.

4-Very short recovery time.