Terminology, Modeling, and Measurement

Terminology

The term medical physics refers to: the application of physics principles to medicine, by using our physics knowledge to develop tools and treatments that helps humans to be healthy.

There are many branches of medical physics the main ones are:-

. Diagnostic radiology: which includes X-ray, computed tomography

(CT scan), ultrasound US and magnetic resonance image (MRI).

. Nuclear medicine: which deals with the use of radioactive substances in diagnosis, treatment and research.

. Radiation oncology (radiation therapy) : its medical specialty that involve treating cancer by radiation .

.Health physics (Radiation protection) : is the application of scientific principles to the protection of worker and public from the hazards of radiation.

Physics can be found in various area of medicine too,

Examples :

- In Physiology : where law of physics can be applied to the function of the human body in health and disease .
- In Practice of medicine : the application of the physics of stethoscope, percussion and the application of sphygmomanometer, pacemaker, defibrillators and so forth .
- Biophysics : is the study of biological process using the theories and tools of physics .

- Biomedical engineering : they develop mechanical and electrical solutions to medical problems ,such as develop diagnostic and imaging equipment and designing artificial organs .
- Health physics (Radiation protection) : is the application of scientific principles to the protection of worker and public from the hazards of radiation .

Modeling

In general it's the process of representing phenomenon as set of mathematical equation, to study the effect of changes on it.

Modeling often resort to different ways to understand the phenomena, for example:

- To understand physical phenomena use ;
  - Simplification by selection of main features
  - Analysis
  - Qualitative or quantitative expression and verification

Analogies is used to understand the physical aspects of the body. (Not perfect), such as the eye analogous to camera.

To describe and explain phenomena that can't experience directly physicists employ models, using different types for different aims.

Example:

- Mechanical model common in scientific activities, such as Quantum mechanical model, Bohr's atomic model.
- Electrical circuit model, which analogous the blood flow by the flow of electricity in wire.
- Mathematical model : consist of Equation and Function

  Equation such as Newton second law { F = ma }

  Where : F : is the force

  M : is the mass

a : is acceleration

- Function model such as { R =f (p) } to indicate the heart rate R is the function of the power produce by the body .
- Feedback control (homeostasis): it is acontrol mechanism that uses information from measurement to manipulate a variable to achive the desired result.

  There are two type of feedback control

  - Negative feedback - Positive feedback
- Negative feedback helps the system toward equilibrium state.

Example:

- Home thermostat that maintain specified temperature, by increase or decrease the temperature to reach the setting temperature.
- Regulation of blood sugar level, by insulin secretion into the blood, when blood sugar levels reach homeostasis the pancreas stops releasing insulin.

- Positive feedback is mechanisms enhance the original stimulus ,

Example:

Blood clotting, once the vessel is damage the platelets start cling to the injured site and release chemicals that attract more platelets, the platelets continue to pile up until the clot is formed.

Measurement

Are values which made meaningful into specific units ,its act as labels which make those value more useful in term of details, for example instead of saying that someone tall , we can say that the individual length is (6 feet) .

Practice medical measurements can be divided into: quantitative and qualitative measurements.

Quantitative measurement includes:

1. Thermometer: which measure the temperature.
2. A weighing machine to measure the weight.
3. Sphygmomanometer to measure blood pressure.
4. Syringes of different sizes for injection and aspiration of blood and fluid from the body.

Qualitative measurement gives information about the inside of the body ,such as x-ray image , computed tomography (CT scan) , ultrasound (US) image , magnetic resonance image (MRI) …

Units

There are several system of units

- International system SI unit: it measures quantity such as length (meter)

Mass (kilogram), time (second), current (ampere).

- Nonstandard unit: which is used in medicine such as blood pressure which is measured in millimeter of mercury (mmHg).
- Static characteristics that include accuracy and precision it is used in science and has different meanings.
- Accuracy: refers to the degree of correctness of measurement when compared to true or absolute value.
- Precision: refers to the degree of refinement of measurement.

After taking a lot of measurements , you notice that they are all close to each other this is precision , if they are degree with the true value this is accuracy .

Sources of error in medical measurements

1. Psychological effects
2. Human factors such as environmental, individual characteristic which influence behavior.
3. Laboratory misleading test values, this errors can be reduced by

   Development of new clinical tests and better instrumentation.

Errors or uncertainties from measurements can be reduced by: -

1. Being Careful in taking the measurement.
2. Repeating measurements.
3. Using reliable instruments.
4. Properly calibrating the instruments.

The physician can decide if the patient is ill or not

After he or she has reviewed the patient's following information: -

1. Medical history.
2. The findings of the physical examination.
3. The results of clinical laboratory measurements

In summary

1. All measurements are uncertain and inaccurate.
2. With special effort we can reduce the error and the uncertainty.
3. In many cases there is no need to improve the measurement because the quantity being measured is variable.