

- (3) Radiosensitivity of tissue affected or structure to be dealt with.

All these combined, determine the Radiobiological effect R.B.E. of a given quantum on a given living structure.

To treat and control diseases, radioactive elements are used in various forms in accordance with mainly site of infection. These are:

- (1) As pills for swallowing - in the case of gastrointestinal infections.
- (2) For superficial infections of Tumour growth on the skin; in form of needle which is implanted on the affected spot.

- (3) Injections - for other spots not superficial or accessible via the alimentary tract.

- (4) Gaseous form - for inhalation.

#### Care of Radioactive Drugs:

Radioactive drugs need great care in handling to ensure no accidental entry into the body of either staff or patient.

This can be through:-

- (1) the mouth - injection;
- (2) the nose - inhalation;
- (3) the skin - percolation.

On each occasion causing hazards due to unbalanced and wrong application.

end

---

### IONIZING RADIATION IN MEDICINE

by

Dr. A.C. Ude, MB, BS, D.M.R.D.  
Senior Consultant Radiologist

Dept. of Radiation Medicine, U.N.T.H., Enugu.

Excerpts from a paper read at the 10th Conference  
of the Association of Radiographers of Nigeria,  
in Enugu in August 1977.

**IONISING RADIATION IN MEDICINE.** This is clearly a big topic which I can hardly do justice to in such a short time. Nevertheless I think we could start by trying to define or explain what one means by ionizing radiation.

RADIATION is a term used in physics to denote any form of energy that can be propagated through space - sometimes a material medium is required for the propagation as, for example, in case of sound. However most forms of radiation are capable of travelling through free space.

All "free-space" radiations (except "neutrino") are classifiable as "ELECTROMAGNETIC" OR "CORPUSCULAR" - the latter is associated with atomic particles.

One of the most important and certainly the most familiar forms of radiation is electro-magnetic. This is radiated by matter whenever electric charges (usually electrons) are accelerated. The accelerations of the charges may result purely from the motions associated

with the temperature of the material in which case the radiation is said to be thermal or they may be due to specific processes, such as electrical discharge, high frequency alternating currents, etc.

Electromagnetic radiation occurs over a wide range of wavelengths.

RADIO WAVES account for the longest wavelengths from the order of kilometres down to the order of millimetres.

Below the radio waves (but overlapping them to some extent) come the RADIATIONS associated with various molecular and atomic processes. These range from OMS down to less than  $10^{-12}$  metres.

X-rays come next and extend from some  $10^{-10}$  metres downwards and are associated with nuclear processes.

THE VISIBLE RADIATION occurs at rather under  $10^{-6}$  metres. Between this and the RADIO WAVES we have the INFRA RED RADIATION.

U-V RADIATION of course comes on the other side of the visible radiation. It merges into the short wave X-ray region.

X-RAYS start at about  $10^{-8}$  metres, and in principle extends downwards indefinitely - just as radiowaves extend upwards indefinitely.

CORPUSCULAR RADIATION - This takes a wide variety of forms and these include:-

- (a) Beams of electrons (cathode rays)
- (b) Beams of Protons
- (c) Beams of neutrons
- (d) Naturally occurring corpuscular radiation such as products of radioactivity (a & B rays), cosmic radiation (which consists of protons).

It is interesting at this stage to remind ourselves that the SUN forms the main source of ELECTROMAGNETIC RADIATION that falls upon

the Earth. Solar radiation, as you are probably aware occurs over most of the range of wavelength mentioned previously, though only a small part of this radiation reaches the Earth's surface, owing to the strong absorption by the atmosphere. As a matter of fact there are only two quite narrow "windows" or, if you like, "gaps" in the atmosphere namely:

- one for visible light, together with the nearby infra-red and ultra-violet zones.
- the other for a range from about 1 centimetre to 30 metres - the range used in radio and radio astronomy.

Corpuscular Radiations and Electro-magnetic radiation in the U-V and X-ray regions are noted for their ionizing effect and therefore are often called ionizing radiations. This is a process whereby part or all the energy of an incident particle or quantum is used to bring about the ionization of the material through which the radiation is passing.

This ionizing property has a variety of effects - thermal effects, physical effects, photographic effects, fluorescent and phosphorescent effects and of course biological effects.

These effects in fact form the basis for the wide-range uses - and perhaps misuses of ionizing radiations in Medicine - which brings us to the main TOPIC of this exercise - IONIZING RADIATION IN MEDICINE.

Now that we know a little bit about what IONIZING RADIATIONS are, I think we can safely go ahead and examine certain areas in Medicine where ionizing radiations have made most impact.

The Specialties that immediately come to mind are obviously Radiology, Radiography, and Radiotherapy.

RADIOLOGY is the branch of Medicine in which x-rays, Radioactive substances and other sources of radiation are used to diagnose and treat diseases (Radiotherapy).

RADIOGRAPHY X-rays pass through body tissues and after passing through the body, the x-rays register on a photographic plate or film which, when developed, shows a pattern of the body tissues.

In diagnosis x-ray photography shows up abnormalities in bones, and internal organs. Soft organs, such as digestive tract and urinary tracts are less readily seen in an x-ray photograph unless they contain introduced substances which are opaque to X-rays. This immediately brings to mind the familiar contrast examinations - Barium Studies, Cholecystographic examinations, Excretion Urography, Vascular works, and all that.

FLUORESCENT effect of ionizing radiation has been mentioned. By using a FLUOROSCOPE (a standard equipment in most Radiology department) - which projects a continuous picture on to a screen, it is possible to study and examine internal organs in motion.

And yet more recent advances have been made in the use of ionizing radiations in diagnostic medicine. EMI Scanner or C.A.T. is a good example. This is an exciting and revolutionary new technique with great possibilities. It differs from the conventional X-ray systems in that X-ray film is replaced by a system of CRYSTAL DETECTORS and a COMPUTER. This new technique offers a further non-invasive method of diagnosing CEREBRAL TUMOURS and other lesions.

The price at the moment is prohibitive.

## RADIO ISOTAPE IMAGING

In recent years the use of radio-isotopes (radioactive forms of certain elements) has added a new diagnostic method to the investigation of several lessons. As, for example, since IODINE SALTS introduced into the body concentrate in the thyroid gland, radioactive iodine is used to diagnose disorders of that gland. The amount of radioactive iodine taken up by the gland can be measured by a suitable sensor device. Thus it is possible to assess whether the gland is overactive (thyrotoxicosis) or underactive (myxedema). IRON is a very important constituent of Hb. Radioactive IRON compounds are used in diagnosing various blood disorders including anaemias.

Many other abnormalities such as those of the C.N.S., Liver, Bones and lungs can be diagnosed by using radioactive materials.

RADIO THERAPY - This is a Specialty which deals with treatment using X-rays, Radium and other Radioactive substances (e.g. caesium).

Radiation damages any living tissues but it is especially destructive to cells that are multiplying rapidly.

- An overactive thyroid may be treated with radioactive iodine.
- Radioactive phosphorus is useful in destroying RBCs in a condition called Polycythemia Rubra Vera - too many RBCs are being manufactured by the bone marrows and other blood making organs.

Radioactive phosphorus is also used in the treatment of chronic leukaemia.

X-rays may be used to clear up certain stubborn cases of ACNE and CERTAIN SKIN DISORDERS.

In cancer therapy RADIUM and RADON and RADIOACTIVE COBALT (COBALT 60) are of considerable value. Co<sup>60</sup> is used in treating deep-seated cancers and the rays can be focussed on the affected part of the body by a suitable device.

RADIUM AND RADON are usually embedded directly into the diseased tissue.

Since the discovery of X-ray in 1895 by the German physicist Conrad, Wilhelm Rontgen, the technique of using X-ray for therapy has been greatly improved. A narrow beam of x-ray can now be aimed accurately at the tumour with little or no damage to nearby healthy tissues.

You will notice that so far I have restricted myself to IONIZING RADIATIONS i.e. the Electromagnetic Radiations in the U-V and X-ray regions. This is not to say that other forms of RADIATION have not been employed in Medicine.

I am sure that you are aware that SOUND ENERGY has long been employed not only in the treatment of certain Medical disorders but in fact is the basis for the development of ultrasonic equipments - equipments which are now widely used in various disciplines of diagnostic medicine. Ultrasound has made tremendous impact in obstetric works because it is virtually (in the diagnostic range) free of the radiation hazards usually associated with the conventional X-rays.

a few examples - We can now use ultrasonics to

- diagnose pregnancy
- follow the developing foetus in utero
- assess foetal maturity
- detect foetal abnormalities and foetal death
- localise the placenta in case of APH.

### LIGHT ENERGY

THERMOGRAPHY is a simple and quite harmless technique which deals with recording the RADIANT HEAT or INFRA-RED RADIATION constantly emitted by the human skin. Clinical uses of Thermography have been concerned with the detection of altered skin temperature.

Thus abnormal radiant emissions are found with superficial neoplasms with some deep tumours over the site of placental implantation. Reduced emissions, on the other hand, occur with impaired blood flow to any part of the body - e.g. internal carotid insufficiency.

We can go on and on to produce a formidable list of the uses of IONIZING RADIATION in Medicine but I would like to bring this exercise to a close by making some observations about the other side of the coin.

Biological effect of ionizing radiation is of considerable importance. Whereas light and the near ultra-violet radiations give rise to relatively "mild" changes within the molecules of living materials, the higher energies of X-rays and corpuscular rays bring about ionization and even nuclear changes.

These can disrupt life processes in a random way

A very large dose (hundreds of rem) of ionizing radiation will produce acute radiation symptoms in humans (fever & digestive disturbance). A sufficiently high dose is lethal. If recovery takes place, the patient is left with an increased chance of contracting a tumour or similar defect later on in life.

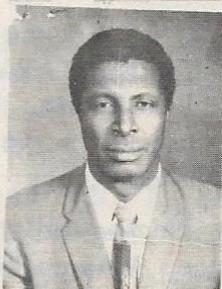
Smaller doses of radiation, so small that acute symptoms are undetectable can also lead to an increased chance of contracting a serious radiation disease at a later date. The chance appears to be proportional to the dose received. This makes it desirable to restrict the ionization to which the population at large is subjected to the lowest possible level. In practice a reasonable balance must be struck between the advantages of radiation (e.g. diagnostic and therapeutic uses of X-rays), and the chances of damage. Maximum Permissible Doses are therefore agreed upon and these are revised from time

to time. Although there is no "Safe" dose and the MPD represents only an 'acceptable risk' it is necessary to maintain a sense of proportion.

Everybody is already subjected to background radiation (e.g. from Cosmic rays) of about 0.1 rem/year, and even if this were double as a result of man-made ionization, the risks would still be small compared with many other risks that are readily accepted. The principal consideration in deciding on the Maximum Permissible Levels for the population as a whole lies in the genetic effect of the radiation, which involves possible damage to future generation rather than to the individuals receiving the radiation.

On that note I would like to end.

SAMUEL NWANKWO OTTI



(Govt. College, Umuahia was closed in 1940, as the compound was used as Prisoner of War Camp from 1941 - 1945. All class 6 students were transferred to King's College, Lagos).

BIRTH Born 19th February, 1924 at Ajalli, Awka Division, Onitsha Province, Anambra State, from the Royal Family of Mazi Oji Otti, Eze of Ajalli.

PRIMARY EDUCATION

Government School, Awka, 1930 - 1936.

SECONDARY EDUCATION

Government College, Umuahia 1936 - 1940. King's College, Lagos 1941 (Jan. to December)

PROFESSIONAL TRAINING AND HIGHER EDUCATION

1. Higher College, Yaba 1942-1944.
2. Achimota College, Accra 1943.
3. Virginia Union University, USA 1949-1950.
4. University of Cincinnati School of Radiography, USA 1950-1951.
5. University of Toronto School of Radiography, Canada 1951 - 1953.