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TOPIC:

THE DETECTIVE IN A RADIOLOGIST

By
PROFESSOR RASHEED AJANI AROGUNDADE

THE DETECTIVE IN A RADIOLOGIST

An Inaugural Lecture Delivered at the University of Lagos Main Auditorium on Wednesday, 22nd July, 2015

By

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Wilhelm Conrad Roentgen (1845-1923)

1901 Nobel Prize Ceremonial Address

"The Academy has awarded Professor W.C. Roentgen from Munich the Nobel Prize for Physics on the grounds of discovery; the name of which will always remain linked with him as, 'roentgen rays,' or as he calls them himself, 'X-rays.' From the properties associated with roentgen rays, only those are considered that contribute to the far-reaching application these rays have found in medical practice."

PROTOCOL

The Vice Chancellor, sir, Deputy Vice Chancellor (Research and Academic), Deputy Vice Chancellor (Management Services), the Provost of the College of Medicine, the Registrar and Secretary to Senate and Governing Council, the University Librarian, Bursar, Members of the Council, the Dean; Faculty of Clinical Sciences and Deans of other Faculties, Members of the Senate, My Lords Spiritual and Temporal, Colleagues, Students of the University of First Choice, Gentlemen of the Press, all invited Guests, Lovely Members of my Family, Distinguished Ladies and Gentlemen.

May Allah be praised for this special day of my life and profession. Every genuine practitioner of the Islamic faith is familiar with the 99 Beautiful Names of Allah. With HIS first two beautiful attributes – **The Beneficent** and **The Merciful**.

Allah endowed me with the gift of sound physical and mental health and HIS continual renewed kindness, which enabled me to run this academic race with great vigour. Divine guidance and inexhaustible patience derived from the last two of the 99 Beautiful Attributes of Allah – **The Guide to the Right Path** and **The Patient** saw me through the thorn-filled wilderness of academia. It is by His Grace, that, I did not PERISH in the academic wilderness on two different occasions in 1994 and 2001 when I decided to, 'check out,' like the proverbial Andrew because my spirit was at the lowest ebb. HE alone deserves to be worshipped.

Vice Chancellor, sir, I want to thank you most sincerely for this unique opportunity which you have given me to dance well-robed in public space today to show cause why I should be counted among the outstanding teacherscholars of this great academic community: the University of Lagos and University of First Choice.

At the end of this public recognition of the notable achievements of my academic carrier in this great Institution, I hope you will pronounce the traditional needful so that I can continue to play a distinctive role in leading the scholarly pursuits of this prestigious University; a responsibility which the attainment of my full professorial rank carries.

My department is no longer a stranger to you as the conglomerate department borne out of forced merger of the first three strange bed fellows in December 1997; further compounded by the incorporation of a new BSc program which had the first set of students admitted in 2005/2006 academic session. I am referring to the Department of *Radiation Biology*, *Radiotherapy*, *Radiodiagnosis* and *Radiography*, alias, "Department of RBRRR."

In November 2014, a very distinguished colleague delivered the first inaugural lecture ever of our department -the first by a Professor of Radiation Biology. Also in January 2015, the second inaugural lecture from our department and the first by a Professor of Radiotherapy and Oncology was delivered. Mr. Vice Chancellor, sir, I submit with humility that the lecture of today is the first to be delivered by a *Diagnostic Radiologist* in the history of the University of Lagos, although it is the third inaugural lecture of the Department of *Radiation Biology*, *Radiotherapy*, *Radiodiagnosis* and *Radiography*.

MY JOURNEY INTO RADIOLOGY

It was never my dream to be a Doctor, talk less of being a *Radiologist*, but destiny made it so. My aim was to study *Petroleum* or *Chemical Engineering* because of my deep interest in *organic chemistry*, and for which I had been admitted into Higher School Certificate (HSC) science class with *Mathematics*, *Physics* and *Chemistry* subject combination. In a dramatic twist of event; nature's kindness beckoned on me.

A friend of my uncle; Alhaji Haroun Kolawole Bidmus of blessed memory, then, a Federal civil servant with the Ministry of External Affairs came knocking with a scholarship gift from the slot of the Bureau for External Aids for that year, it took over an hour before my uncle, Alhaji Assan Olasupo Arogundade, my invaluable benefactor and the Late Alhaji Bidmus, finally convinced me to exchange my Engineering ambition for a degree in Medicine. This was the beginning of my journey to the Institute of Medicine and Pharmacy in Cluj, Romania. This singular privilege gave me the opportunity of both spoken and written fluency in another foreign language other than English.

Vice Chancellor, sir, if for any reason, therefore, you need my service in any bilateral relationship with any institution in Romania; I will be more than ready to offer it free of charge to the University.

The second turning point in the course of my carrier and professional life occurred after completion of my Housemanship and National Youth Service (NYSC), when I chose to pursue General Medical Practice (now Family Medicine) as my specialty of choice, in preparation for setting up a private medical practice. This time, after setting out on my dream, which took me to

Baptist Hospital, Shaki, a remote part of Oyo North, nature again brought me in close contact with Dr. G.O.G. Awosanya; a good friend and brother, now Professor of *Radiology* at the Lagos State University Teaching Hospital (LASUTH).

He was the sole resident doctor in *Radiology* at the time in the Department of *Radiodiagnosis* of the Lagos University Teaching Hospital. He was able to convince me that *Radiology* was the General practice I was looking for as it provides services across all clinical disciplines.

Today, Mr. Vice Chancellor, sir, the *Engineering* profession I was unable to acquire I now have in two of my children; my first and last child respectively graduated with degrees in *Mechanical* and *Electronic/Electrical Engineering* in Second Class Upper division. Therefore I never regretted these two significant turning points signposting my *Medical career* and *Radiology* profession.

INSPIRATION FOR THE INAUGURAL LECTURE

Mr. Vice Chancellor, sir, please permit me to flash a cutout from the Punch newspaper of Monday September 15, 2014 (Figure 1) which was made available to me by a very senior colleague and *Professor of Radiology* who was concerned about the adverse effect of such widely circulated publication on our profession.

How do we improve radiology reports?

Dr. Biodun Ogungbo

Figure 1: The Punch Newspaper News Flash

The main grouse of the writer of the article in this circumstance is the questionable *radiological detective instinct* of the *radiologist* in dispute. Unfortunately there are many of them out there whose *sense of imaging judgment* may misguide the direction of patient management by the attending physicians. I have adopted the import of this, "flashed news," in formulating the title of this Inaugural Lecture – **"The Detective in a Radiologist."**

In this academic exercise, I shall take us on a journey through:

- What is Radiology?
- Who is a Detective and who is a Radiologist?
- Foundation of the Specialty of Radiology
- X-rays as Member of Electromagnetic Radiation Family
- Medical Imaging…The New Order
- The Thought Process and Imagination in Medical Imaging
- Education and Training in Radiology

- My Modest Contribution to Knowledge
- Recommendations
- Acknowledgements

WHAT IS RADIOLOGY?

Radiology is a branch of *medical science of imaging which enabled us to peer inside the body of a living, breathing patient without the use of scalpel.*

The technologies that produce **alternative to scalpel** include *X-radiation* in *Conventional Radiography* and *Computerized Tomography (CT), sound waves* in *Ultrasound (US), Magnetic fields* in *Magnetic Resonance Imaging (MRI*) and *Nuclear Medicine* (Figure 2).

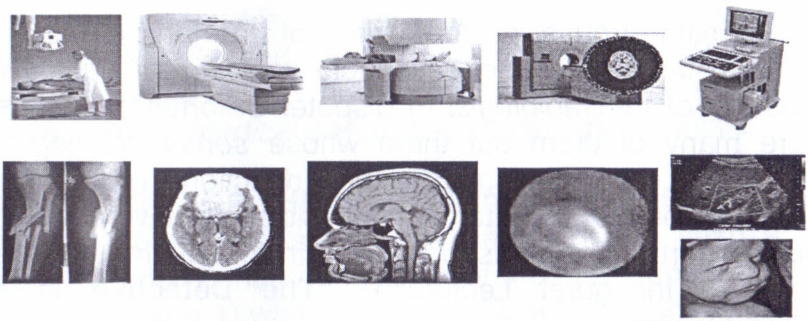

Figure 2: Technologies that Pierce beyond Human Skin

Today, development of *digital computer* represents the pivot of all *modern imaging methods* (Figure 3), providing opportunity for *image data measurement*, *analysis*, *display*, *archiving* and *distant communication.*

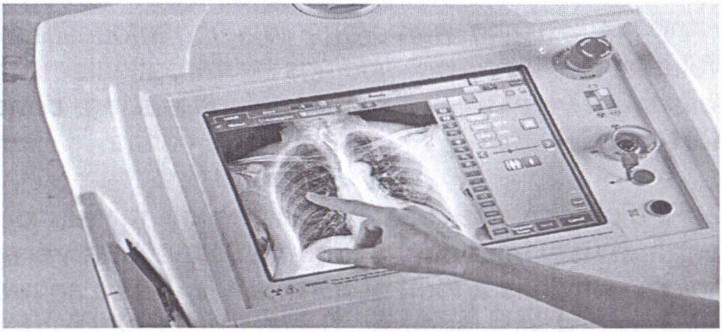

Figure 3: Digital Computer as Pivot of all Modern Imaging Methods

Radiology also involves a subspecialty called *Interventional radiology*, which embraces *minimally invasive image-guided procedures to diagnose (e.g., angiogram)*, or *treat diseases (e.g., angioplasty)* in nearly every *organ system* in order to minimize risk to the patient and improve health outcomes. *Radiology* is richly satisfying only for people who love to solve mysteries and puzzles.

WHO IS A DETECTIVE AND WHO IS A RADIOLOGIST?

A *detective* is a person employed to *discover*, *determine*, and *assess situations* and *clues*. He is an *investigator* who is usually *trained* or has *developed skills* that allows him to *connect pieces of information* to form a *clearer picture of something unknown*. He conducts *interviews* and *surveillance*, *locates missing persons* and *criminal suspects*, *examines records*, *makes arrests* and *writes detailed reports*. The detective may provide service in public institution or opt for private, independent investigative outfit.

A *radiologist* on the other hand is a *physician who has had specialized training in interpreting medical images of* *specific parts of the human body obtained through the use of the existing numerous imaging modalities.* He correlates the *imaging findings* with patients' *clinical details* to arrive at a final *imaging diagnosis* in a **concise report form**.

The *Radiologist* also *treats diseases* by means of the newer and very important emerging field of *interventional radiology*, which is a form of *minimally invasive corrective surgical procedure*, such as *dilation of blocked arteries*, *drainage of fluid collections*, and *biopsy of tumors with needles*.

The *radiologist* may find employment and carry out *clinical services* on patients in public and private hospitals. However, individuals who enjoy teaching and conducting research may work in medical schools to pursue a career as *academic radiologists*.

The detective and *the radiologist* are, therefore, two of a kind. They are both *professional experts who perform problem-solving activities at a high level by using an organized, complex knowledge base*.

A good detective or *well qualified radiologist* will require an *inquisitive mind*, *keen observational* and *analytical skills*, *extreme attention to details*; *thirst for solving mysteries*, *ability to think logically and out of the box whenever the situation demands*. Both must have a remarkably keen memory in other to piece and make sense of all identified clues or leads. Excellent oral and written communication skill is especially very important for both because, they must prepare detailed written reports.

Just as the *field of detective* has been revolutionized by advances in the *technology of identification* and *detection of criminals through finger-printing, human tissue analysis and matching, voice-printing* and *DNA-typing genetic technique*, the pace of *technological advancement in Radiology* is so frightening that *CT, MRI, ultrasound* and *nuclear medicine scanners* of a decade ago would seem outdated in today's practice.

FOUNDATION OF THE SPECIALTY OF RADIOLOGY

Mr. Vice Chancellor, sir, science and technology have improved the quality of human life throughout the world and only few of us here today can be in any doubt about the enormous impact that radiology has made on the practice of medicine. In fact, in the history of *medicine*, only the discovery of the *microscope* could boast of a *comparable technological* contribution to *medical vision.* Perhaps, a brief historical perspective of radiology is pertinent at this point for appreciation of how much energy, dedication and ingenuity were needed to achieve what the entire world now take for granted.

On a cold night of November 8, 1895, Professor Wilhelm Conrad Roentgen of the University of Würzburg observed certain physical phenomena he could not explain. Roentgen had been experimenting with an apparatus that, unknown to him, caused the *emission of x-rays* as a by-product. Accustomed to the darkened laboratory, he observed that whenever the apparatus was working, a chemical-coated piece of cardboard lying on the table glowed with a pale green light. This observation is now realized to be the *phenomenon of fluorescence*, or the *emission of visible light*, which can be produced in a variety of ways by complex *nuclear energy exchanges.*

Figure 4: The Night of Revelation

In 1895 Roentgen recognized at first only the fact that he had unintentionally produced a hitherto unknown form of *radiant energy* that was invisible; could cause *fluorescence*, and is able to pass through objects *opaque* to light. When he placed his hand between the source of the beam and the glowing cardboard, he could see the bones inside his fingers within the shadow of his hand. He found that the *new rays*, which he named, *"x-rays,"* penetrated wood.

Using *Photographic paper* instead of a *fluorescing material*, he made an *"x-ray picture"* of the hand of his wife through the door of his laboratory.

Figure 5: X-ray Roentgen Wife's Hand

X-rays were also discovered to travel in all directions from their source unless stopped by an absorber, with very small part absorbed by air, whereas the entire beam is absorbed by a sheet of thick metal.

Six years later, in 1901, the first Nobel Prize in physics was awarded to Roentgen for his discovery, by then this remarkably *systematic investigator* has explored most of the basic *physical* and *medical applications* of the *new ray*. There are powerful *x-ray machines* capable of *producing hard, penetrating beam* of very *short wavelength* to *detect flaws, cracks*, and *fissures* in heavy steel of big industrial equipment or building materials.

X-rays of *long wavelength*, or *soft x-rays*, are used to study *thin* or *delicate objects*. Very *soft x-rays* are used to study *tissue sections* of bone one or two *microns* in thickness *(microradiography)*, while very *hard x-rays* are used to penetrate deep into the body and destroy *malignant tumor cells (radiation therapy)*. Between these two extremes fall the *wavelengths* that are used in *medical x-ray diagnosis*.

Mr. Vice Chancellor, sir, I believe today's researchers and those yet to come have two distinct lessons to learn from this remarkable man called Wilhelm Conrad Roentgen.

The first is that of absolute dedication and absorption in his experiments to the extent that he allowed his *scientific imagination* to take over by retreating into strict seclusion before his great discovery.

Roentgen, "switched his working hours to night time; took his meals to his study and even had his bed installed there for a longer period of time to be left undisturbed by any trivialities of life or such like interferences, so that during waking moments he could put his thought immediately to test." Even his wife confirmed she hardly saw her husband at all in those days preceding the exciting news of the discovery.

The second and more important lesson from this great man is his scientific integrity. Although, he knew how important his discovery was, he refrained from benefiting financially from his investigations and discoveries, and renounced all patent applications, insisting that his discovery was intended to be for the good of mankind. Not only that, Roentgen donated the entire sum of his Nobel Prize money of 50,000 Swedish kroner, which he won 6 years after his discovery, to his University, to be used for scientific research.

Vice Chancellor, sir, without mincing words, many of us here today will argue that Roentgen was a product of the times in which he was born; most especially, with the multifarious challenges of dysfunctional PHCN, lack of research equipment to actualize dream and unpaid salaries of the modern times in Nigeria.

X-RAYS AS MEMBER OF ELECTROMAGNETIC RADIATION FAMILY

X-rays are members of the *electromagnetic radiation (EMR)* spectrum family. The *EMR spectrum* is a scaled arrangement of all types of *radiant energy* according to their *wavelengths* (Figure 6). The *visible light*, which all of us enjoy daily, is also a member.

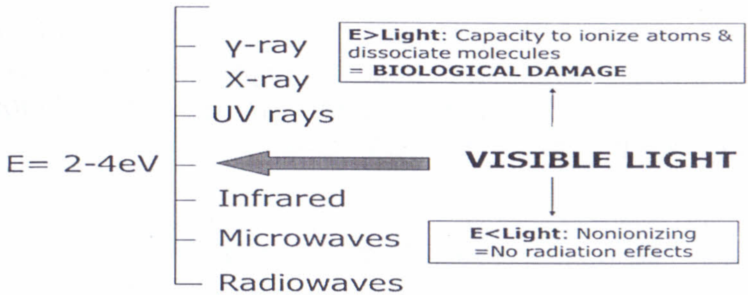

Figure 6: Electromagnetic Radiation Spectrum (EMR)

In fact, *visible light*, with its *energy* of about *2-4eV* represents the boundary of the good and bad members of this *electromagnetic family*. The *infrared* is useful in the hands of our colleagues in *Physiotherapy* to manage their patients; the microwaves come handy in the kitchen for the women folk, the *radio frequency waves – SW, LW, FM*, etc. – allow us to enjoy our favorite stations like, "Faaji FM." All of these represent the good members of the family with energies lower than *4eV*.

On the upper end of the *electromagnetic spectrum* are the *ultraviolet*, *x-rays* and *gamma radiations* with energies high enough to cause IONIZATION with biological damage under injudicious use.

All of these members of the EMR are made of some elementary particles called *photons*. The *radiation energies* of these *photons* are responsible for all their *electromagnetic interactions*, including the effects upon *biological systems*. In the case of EMR of *visible frequencies or lower* (i.e., *radio*, *microwave*, *infrared*), the damage done to *cells* and other materials is mainly caused primarily by *heating effects* from the combined *energy transfer* of many *photons*. By contrast, for *ultraviolet* and *higher frequencies* (i.e., *X-rays* and *gamma rays*), *chemical materials* and *living cells* can be further damaged beyond that done by *simple heating*, since *individual photons* of such *high frequency* have enough energy to cause *direct molecular damage* through the process of IONIZATION.

Mr. Vice Chancellor, sir, every good thing has its bad aspect. The use of *x-rays* to produce *diagnostic images* for patient management is no exception. The human nose is a cruel organ so says the wise ones. It can warn us of burning fire in our apartments so we don't get consumed by it, but it lacks capacity to smell mischievous individuals who lurk around to harm us.

In the same vein, every of our sense organ is insensitive to *x-rays* – **WE CAN'T SEE X-RAYS, WE CAN'T SMELL X-RAYS, WE CAN'T HEAR X-RAYS, WE CAN'T FEEL X-RAYS AND WE CAN'T TOUCH X-RAYS EITHER.**

At the time Roentgen made his discovery, he was unaware of the tremendous side effects of x-rays. He was not alone in this naivety as shown by the spectacular gathering of numerous members of *Society of Physicists* during the open room demonstration of his, *"new ray"* discovery (Figure 7).

One needs no soothsayer to conclude that all the spectators would have had a reasonable dose of *radiation exposure*.

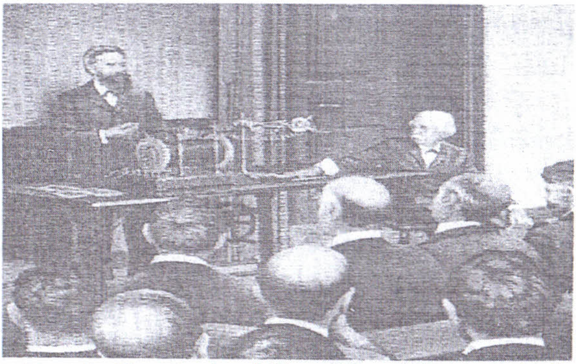

Figure 7: Deadly Spectacle of Open Room Demonstration of newly Discovered *X-rays* by Roentgen to Members of Society of Physicists

When *x-rays* pass through the *human tiss*ue on their way to the *image receptor*, they encounter three interactive fates of reaction – *Scatter*, *Absorption*, *Penetration (SAP)*. Any of the *SAP processes* of *x-ray interactions* with our body structures has potential to collide with *body atoms* to cause *electron removal* (IONIZATION) leaving in its trail a *positively charged* and *highly reactive at*om. Because most of the human body is water, it is a high target for IONIZATION, resulting in the formation of *highly reactive free radical molecules*, which in turn may react *chemically* with such *molecules* as DNA and *proteins*, thereby, damaging them.

In the early years, *x-ray* of a body part could require up to 11 minutes of *exposure time* due to lack of knowledge of *radiation risks* by the earliest practitioners of the trade with subsequent *severe body damages*; including *loss of hair*, *skin redness*, *swelling* and *blisters*. Even as late as 1948, a study showed that 48% of *radiologists* had *radiation-induced skin lesions* on the hands, and it was not uncommon for such *skin lesions* to lead to *amputation* of the hand. Occurrence of lack of *living spermatozoa* in the *semen* of men who had worked with *x-rays* over an extended period of time had also been documented.

MEDICAL IMAGING – THE NEW ORDER

Immediately after discovery of *x-rays*, *radiology* became a branch of *medical science of radiation* which enabled us to peer inside the body of a living, breathing patient without the use of *scalpel*. The publication of a *radiograph* of his wife's hand (Figure 5) which, by current standard, is a *crude radiograph*; marks the dawn of a new era of fascinating and influential modern techniques for the examination of the human body.

In honour of the discoverer of the *new rays* that made this specialty possible, it was first called *Roentgenology* but, today, it is generally referred to as *Radiology*, which literarily translates to, *"Science of Radiation."*

Although, our Colleagues in the disciplines of *Radiotherapy*, *Radiation Biology* and *Radiography* also occupy themselves with the, *"Science of Radiation,"* the term *"Radiology"* has continued to remain synonymous with practitioners of *clinical or diagnostic imaging* because that was the first practical application of *radiation*.

a. The First 50 Years...*Conventional Radiography*

For the first fifty years of *radiology*, the primary examination involved creating an image by focusing *x-rays* through the body part of interest and directly onto a single piece of film inside a *special cassette*. In fact, publication of the *radiograph* of the hand of Roentgen's wife, as credible evidence of his newly discovered rays, naturally gave significance to the pioneering use of *x-rays* in the *skeletal system*.

Later in 1953, it was possible to see *x-ray images* in real time during *fluoroscopy* because of development of *fluorescent screens* and *special glasses*.

The field of *forensic radiology* gained prominence soon after *x-ray discovery*. It is remarkable that as early as November 1896 in USA, just after a year of discovery of *x-rays*, *radiographs* of a boy who had been injured falling from a ladder were used in a case of malpractice.

As knowledge increased, *x-rays* were also used in the *assessment of gunshot wounds*, to define the passage or the type of bullet. This is still practiced by modern *criminologists*. *Abdominal radiography* has been used in law enforcement to search suspected drug smugglers for illegal drugs that have been sealed in condoms and swallowed or inserted into *orifices*. Thus, apart from the possibility of *image documentation* for patient management, it became evident that *radiology* would play an important role in judging medical activities.

Radiographs were taken in the fifties and sixties to study *ossification centers* in the *prenatal* period to assess *foetal maturation*. They were also used to *diagnose* suspected *atypical positioning* of the *fetus*, *multiple pregnancies* and *anencephaly*. Even foetal death could be confirmed *radiographically*. *Obstetrical radiography* has now become superfluous.

It can also be said that the foundation of *interventional radiology* had been laid soon after *x-ray* discovery because as early as the 1920s, attempts had been made to reduce *invagination* of one segment of the intestine within another; called *intussusception*, in children with *barium enema* and to drain the *gallbladder suppuration* by means of a *fluoroscopic guided puncture*.

Although the application of *x-ray technology* is now over 100 years, it is still the frontline study in evaluation of many diseases in most developing countries because of its wide availability, speed and relative low cost. However, times have moved on since *plain films* and *fluoroscopic contrast studies* made the majority of the workload with the addition of *computer-based diagnostic armamentarium* to obtain images of patients.

b. The Nuclear Medicine Era

Nuclear Medicine studies, (also called *radionuclide scanning*) gained clinical use as a full-fledged *medical imaging specialty* in the early 1950s, as knowledge expanded about *radionuclides*, *detection of radioactivity*, and using certain *radionuclides* to trace *biochemical processes*. Its small beginning cannot be precisely dated because of contributions from the different disciplines of *physics*, *chemistry*, *engineering*, and *medicine*. It may be probably best placed between the discovery of *artificial radioactivity* in 1934 and the production of *radionuclides* in 1946.

Nuclear medicine imaging involves the administration of substances with affinity for certain *body tissues*, labeled with *radioactive tracer*, into the patient. The most commonly used tracers are *Technetium-99m*, *Iodine-123*, *Iodine-131*, *Gallium-67* and *Thallium-201*. The *heart*, *lungs*, *thyroid*, *liver*, *gallbladder*, and bones are commonly evaluated for particular conditions using these techniques. While *anatomical detail* is limited in these studies, *nuclear medicine* is useful in displaying *physiological functions* of these organs.

The principal imaging device is the *gamma camera* which detects the *radiation* emitted by the tracer in the body and displays it as an image. With computer processing, the information can be displayed as *axial*, *coronal* and *sagittal images*.

In most modern devices, *Nuclear Medicine* images can be fused with a *CT scan* taken simultaneously – *PET/CT* or *SPECT* – so that the *physiological information* can be overlaid with the *anatomical structures* to improve *diagnostic accuracy*. *PET/CT imaging* is now an integral part of *oncology for diagnosis*, *staging* and *treatment monitoring*.

c. *Sonography...* The Pearl of Imaging

After nearly 50 years of dominance of *conventional radiography*, *ultrasonography* evolved as an *imaging modality* in the late 1940s in Maryland, USA. *Ultrasound waves* were considered for *diagnostic applications* in humans following the use of *sonar equipment*, about two decades earlier, to locate submarines.

The real advances in *ultrasound diagnostics* was established in 1949 by John Wild. He was considered to be the father of *medical sonography*, through the use of *ultrasound* to study *bowel tissue thickness*.

The first *heart ultrasound examination* in Sweden was in 1953, which was followed up by the publication of the first *echo-encephalogramin* in 1954. By 1962, the first *compound contact B-mode scanner* was developed, while the first commercial hand-held *articulated arm compound contact B-mode scanner* was, launched in 1963. The *first ultrasound images* were *static* and *two dimensional (2D)*, but with modern-day *ultrasonography 3D reconstructions* can be observed in real-time; effectively becoming *4D*.

Sonography today remains the frontline imaging modality of choice despite countless other *diagnostic tools* and *techniques* readily available. It is generally performed first before other *imaging studies* because of its ability to look inside a patient without the need for *surgery* or use of *radiation* to obtain the image. It is also *radiation-free*; cheap, simple to perform and requires minimal space.

In *cardiology*, ultrasound has become indispensable to assess the *heart valves* and *pericardium*. *Color-Flow Doppler ultrasound* is now available for dynamic evaluation of the *cardiovascular system*, including *echography*. *Ultrasound* completely changed the *diagnostic approach* to pregnancy and the evaluation of newborns and infants. It has also become important as a modality that *complements mammography*. *Ultrasound* is useful for *image-guided interventions* like *biopsies* and *drainages*.

The *signal processing* required for *real-time sonography* would not have been possible without today's computer technology as well as improved design in *transducers*. *Transducer* represents the microphone and amplifier of the ultrasound system, a technical masterpiece of the highest precision with penetration and resolution determined by the desired application. It can be customized for specific application, even for *intraoperative* and *intracavitory examinations*.

d. CT Technology...Marriage of Conventional X-ray and Computer

CT imaging technology was invented in 1972 by Godfrey Hounsfield in England using *x-rays* and a *detector* mounted on a special rotating frame together with a digital computer to create detailed cross sectional images of objects.

The *X-ray generating tube* is located directly opposite an array of *x-ray detectors* in a *ring-shaped apparatus*, which rotates around a patient. *CT device* relied on data acquisition from *multiple X-ray transmissions* through the object under investigation, followed by image data reconstruction by the computer.

Hounsfield's original *CT scan on EMI Scanner*, dedicated to *head imaging* only, took hours to acquire a single slice of *image data* and more than 24 hours to reconstruct this data into a *single image*.

"Whole body" CT systems with larger patient openings became available in 1976. Continuing improvements in CT technology has led to development of more sophisticated *CT scanners* with *spiral multi-detector facility utilizing 8, 16, 64 or more detectors* during continuous motion around the patient. Thus, today's state-of-the-art *CT systems* can acquire a single *computer-generated cross-sectional image* in less than a second and reconstruct the image instantly with improved *image resolution*, much *finer image details* and *increased diagnostic accuracy*. In recognition of his outstanding work, Hounsfield received the Nobel Prize for Medicine in 1979 and in 1981 was granted Knighthood by the Royal Family of England.

CT images are acquired in the *axial plane*, while *coronal* and *sagittal images* can be rendered by computer reconstruction. CT examination can detect more subtle variations in *attenuation of X-rays* and may require the use of *contrast agents* for enhanced delineation of *anatomy*. *CT scanning* has become the test of choice in diagnosing emergency conditions such as *cerebral hemorrhage*, *pulmonary embolism* and *aortic dissection*.

e. MAGNETIC Resonance Imaging...Sensor of Body Hydrogen Distribution

Countless scientists have been involved in the innovation of *Magnetic Resonance Technology*, which was initially used for chemical analysis. However, through the earlier discoveries of Nikola Tesla; a brilliant inventor, the use of *magnetics* in medicine was able to achieve new heights. Thus, in *radiology terms* it was his invention of Tesla units, or how we measure *magnetic images*, that laid the foundation for an important step in *medical imaging*. Harnessing *magnetic resonance phenomenon* for *medical imaging* can be considered a major contribution to mankind, comparable to the discovery of *x-rays*.

Basic principles of Magnetic Resonance (MR) of materials were initially investigated in the 1950s, which established that different materials resonated at different *magnetic field strengths*. Initially researched in the early 1970s, it was the American chemist Paul C. Lauterbur who caused excitement and publication over a new type of imaging in 1977, while the first *MR imaging prototypes* were tested on clinical patients in 1980. *MR imaging* creates an image of the human body using *nuclear technology* from any angle and direction.

Atomic nuclei in the human body have an inherent spin and their own *magnetic field*, with *compass-needle behavior* which align in *strong magnetic field*. *MR Imaging* uses *strong external magnetic fields to align these atomic nuclei, usually hydrogen protons, within body tissues.*

The *radio signal* generated as the *nuclei* return to baseline state following application of *radiofrequency waves* to disturb the *axis of rotation* of these *nuclei*, are then observed. The *radio signals* are collected by small *antennae*, called *coils*, placed near the area of interest.

An advantage of *MRI* is its ability to produce images in *axial*, *coronal*, *sagittal* and *multiple oblique planes* with equal ease. *MRI scans* give the best *soft tissue contrast* of all the imaging modalities with particular usefulness in *musculoskeletal radiology* and *neuroradiology*. *Magnetic Resonance Imaging* method does not use *x-rays* or other *ionizing radiation*.

Technical advances have remarkably improved the quality of *MR images*. These images are not based on density differences as in *CT*, but on the distribution of *hydrogen atoms* in the tissues, which is relevant for the interpretation of the images.

New pulse sequences and new acquisitions were introduced to reduce the examination times. *MRI* is a highly sensitive method of differentiating *soft tissue structures*. Entirely new diagnostic possibilities have opened up, particularly in the field of *neuroradiology* and *degenerative joint diseases*. Progress is so rapid that new indications for *MRI* are constantly added. These advantages have to be balanced against the facts that *MRI* is a very complex and one of the most expensive techniques.

Previous versions of *MRI machine* have confined space for the patient during examination, but recent improvements in magnet design including stronger magnetic fields; shortening examination times, wider, shorter magnet bores and more open magnet designs have brought some relief for patients.

MRI equipment is susceptible to *external magnetic influences* but also exposes its environment to a strong *magnetic field*, potentially disturbing nearby installations. Shielding is therefore of great importance.

MRI is currently contraindicated for patients with *pacemakers*, *cochlear implants*, some indwelling *medication pumps*, certain types of *cerebral aneurysm clips*, *metal fragments* in the eyes and some *metallic hardware* due to the *powerful magnetic fields* and strong fluctuating *radio signals* to which the body is exposed.

f. Interventional Radiology as Alternatives to Surgery

Interventional radiology also known as *Surgical Radiology* or *Image-Guided Surgery* is a subspecialty of *radiology* that uses minimally invasive image-guided procedures to diagnose(e.g., *angiogram*), or treat diseases(e.g., *angioplasty*) in nearly every organ system. The concept behind *interventional radiology* is to diagnose and treat patients using the least invasive techniques currently available in order to minimize risk to the patient and improve health outcomes.

Interventional radiology connects *conventional radiology* with *clinical specialties*. In fact, the foundation of *interventional radiology* had been laid soon after x-ray discovery as early as the 1920s, when *intestinal invagination (intussusception)* began to be reduced with *barium enema* in children. It, however, took 4-5 decades to develop into a method accepted in its own right.

Modern minimally invasive medicine has been pioneered by practitioners of *angioplastic* procedures who have overseen significant advancements in the design and manufacturing of catheters and accessories.

In order to direct the *interventional needles* and *catheters* throughout the body and subsequently obtain images to provide road maps; *X-rays*, *CT*, *ultrasound*, *MRI*, and other imaging modalities are commonly used. Many conditions that once required surgery can now be treated non-surgically by interventional procedures, which minimize physical trauma to the patient, while reducing infection rates, recovery time and hospital stays.

Developments in *interventional radiology* are numerous. *Stenotic vessels* can now be widened by means of a *balloon catheter*. *Percutaneous transluminal angioplasty* has also replaced many *vascular surgeries*. In addition to *recanalization*, methods of obstruction are used to embolize *hypervascular tumours*, to close *AV fistulae* and to obliterate *cysts* or *veins* (e.g. *varicocele*). Dilatation of the *biliary* or *renal collecting system* can be relieved by drainage through a percutaneously inserted *catheter*, frequently used as a palliative measure. *Renal* and *ureteral stones* can also be removed by *lithotripsy*.

Intravascular and *intracardiac objects* that have been left behind following *pacemaker implantation* or *angiography* and even *emboli* can now be retrieved percutaneously under *fluoroscopy* with grasping devices attached. *Mechanical recanalization devices: Intraluminal prostheses – stents* – have been designed for percutaneous insertion via a *catheter* to treat *stenosis* recalcitrant to dilatation; catheters with rotational cam or torque-controlled cutter at their tip for *thromboembolism*; filters with umbrella-like or net-like wire mesh to trap emboli while preserving blood flow.

Percutaneous biopsies have gained significance. Under guidance by *sonography* or *CT*, *lesions* in the *abdominal* or *thoracic cavity*, as well as *lymph nodes* of the extremities or neck can be punctured and tissue obtained for *cytologic* or *histologic* examination. Previously, this often could only be accomplished with major operations. Establishing the diagnosis of an unclear finding has become faster and less distressing for the patient and, less costly too.

g. Digital Imaging Techniques...The Future is Here!
Advances in computer technology have made it possible for the *radiologist* to utilize an array of *imaging modalities*, including facilities using sound waves in *Ultrasound (US)*, the body's natural magnetism in *Magnetic Resonance Imaging (MRI)*, marriage of *conventional X-rays* and computer in *Computerized Tomography (CT)* and *radioisotopes* in *Nuclear Medicine scans* of *Positron Emission Tomography (PET)* and *Single Photon Emission Tomography (SPECT)*.

Digital imaging techniques were implemented in the 1970's with the first clinical use and acceptance of the *Computed Tomography or CT scanner*. Analog-to-digital converters and computers were also adapted to conventional *fluoroscopic image intensifier/TV systems* in the 70's as well. *Angiographic procedures* for looking at the *blood vessels* in the *brain*, *kidneys*, *arms* and *legs*, and the blood vessels of the heart all have benefited tremendously from the adaptation of *digital technology*.

A large majority of conventional *x-ray systems (analogue process)* have now been upgraded to all *digital technology*. All of the *film cassette/film screen systems* have been replaced by *digital x-ray detectors*. Full digital imaging technology is available in most sites in the developed world, while the intermediate step called *phosphor plate technology* is currently available in some of the centers in the developing world. These plates trap the *x-ray energy* and require an intermediate processing step to release the stored information so it can be converted into a *digital picture*.

Teleradiology is the transmission of *radiographic images from one location to another for interpretation by a radiologist*. It is most often used to obtain consultation with an expert or sub-specialist about a complicated or puzzling case, including rapid interpretation of *emergency room*, and *ICU examinations*. *Teleradiology* requires digitized image to be transmitted from a sending station through high speed Internet connection to a high quality receiving station. The *interpreting radiologist* then faxes or e-mails the *radiology report* to the requesting physician. Laws and regulations concerning the use of *teleradiology* vary among countries, with some requiring a license to practice medicine in the country sending the *radiologic examination*.

Just before the new era of sophistication in imaging commenced in 1970, a future was foreseen of *conventional radiographs* declining in importance over the next few years since image interpretation will increasingly take place at the monitor. The image can be manipulated at the monitor for better evaluation of details, for quantitative measurements, or for three-dimensional reconstructions that are valuable for surgical planning. Through networking with *PACS system*, examinations can be transmitted and reviewed in various locations at any time, completely eliminating *radiographic films*.

In difficult *diagnostic cases*, the images can be rapidly and easily transmitted by telephone to a specialist for consultation. That future is now here of modern imaging modalities with storage of *radiographic information* largely carried out digitally and all these foreseeable developments have come to take place.

BENEFITS OF DIGITAL TECHNOLOGY TO ALL X-RAY SYSTEMS

a) Less *x-ray dose* can often be used to achieve the same high quality picture as with film.

b) *Digital x-ray images* can be enhanced and manipulated with computers.

c) *Digital images* can be sent via network to other workstations and computer monitors for many people to share the information and assist in the diagnosis.

d) *Digital images* can be archived onto *compact optical disk* or *digital tape drives* to save storage space and manpower needed for a traditional *x-ray film library*.

e) *Digital images* can be retrieved from an archive at any point in the future for reference.

f) *Digital images* give extremely high *resolution film* to show *small lesions*.

MECHANISMS OF RADIOLOGIC DETECTION TOOLS

Each of the imaging modalities used in the field of *diagnostic radiology* to peer into the patient's body to solve mysteries, from the *radiology* era to modern computer-based facilities, function to produce images through the flow of different forms of ENERGY in the portion of the human body part under examination. There are three distinct modes of these imaging modalities as shown in Table 1.

Table 1: Three Modes of Image Production

TRANSMISSION IMAGING **Plain radiography** = "snapshot" **Fluoroscopy** = "movie" **Computerized Tomography** transmission of data from multiple perspective	**RADIATION ENERGY**

REFLECTION IMAGING	
Ultrasound	**SOUND ENERGY**
EMISSION IMAGING	
Magnetic Resonance Imaging	**MAGNETIC ENERGY**
Nuclear medicine	**RADIATION ENERGY**

THE THOUGHT PROCESS AND IMAGINATION IN MEDICAL IMAGING

Thinking exists as the top mental activity demonstrated by man. Thinking combines both stored information and new information from the outside world bringing them together into something comprehensible through the process of reasoning.

Reasoning implies taking facts and evidence perceived by our five extremely vital senses of sight, smell, hearing, taste and feeling, which we share with other animals for well-being and survival; combining it with thinking to draw conclusions. In radiology, thought and activity are inseparable in the course of detective work on diagnostic images.

The radiologic thought process represents the step-by-step activities of reviewing medical diagnostic images with the aim of making diagnosis on them for patient management. The activities can be divided into three components of *Detection*, *Description* and *Differential Diagnosis* – the so-called *3-D concept*. Alternative components of *See*, *Abstract* and *Deduce* – the *SAD* concept are often used. Both concepts can be superimposed where DETECTION results from SEEING, DESCRIPTION results from ABSTRACTING and DIFFERENTIAL DIAGNOSIS is the result of DEDUCTION.

In *radiology*, the thought process alone is not adequate for excellent performance without nature's special, *'seventh sense'* which he has bestowed on human beings in addition to the animal senses. It is an immensely powerful IMAGINATION which no other animal has. It is commonly called, "*Inner Eyes*," or "*Oju Inu*," in Yoruba. It has increased our cognitive powers enormously and allowed us to perceive the beauty of God's creativity. Its sensors are the billions of pathways located in the matter of the cortex of our enlarged brain. It is nature's special gift that allows us to think abstract thoughts and associate profound ideas of other human beings. However, not all men are gifted or endowed with it.

Imagination is the ability of humans to visualize in their mind; a creative ability of forming mental images. The creative power of imagination has an important role in the learning process and achievement of success in any field. It is the faculty through which we encounter everything. The things that we touch, see and hear coalesce into a *"picture"* through our imagination. It helps provide meaning to experience and understanding to knowledge. Lack of understanding of the power of the imagination is responsible for the incompetence and difficulties people experience. This is more than true in the visual expertise field of *radiology*.

Imagination and vision are inseparable. *Visual stimuli* are the strongest of the sensory perceptions of humans, at least 80% of incoming stimuli being visually based. However, ability of an individual to see does not confer imagination capacity as depicted in Figure 8.

Figure 8: A novice will see a black Championship cup. Imaginative visual expert will identify two white facial silhouettes forming the cup.

In the figure, a novice will see a black championship cup but an *imaginative visual expert in radiology* domain must be able to identify the two white facial silhouettes behind the formation of the cup. Therefore, in *radiology*, imagined images are seen with the, *"mind's eye"* as a process of reviving objects in the mind; relying on observations made following perceptions and analysis of events to solve problems.

Since perception represents the unified awareness of the content of a displayed image and analyses the determinant of the meaning of the perceived image, a typical would-be master or visual expert in the domain of radiology must acquire complete imagination ability to optimally unravel or decipher entire content of the image in space to avoid diagnostic errors. The consequences of such errors to the patient; attending physician and the *family of radiology* can only be imagined.

It must be understood that when faced with the task of analysing imaging studies, the three components of the thought process and imaginative ability often take place simultaneously. The first component of the *radiologic thought* process is the DETECTION OF LESIONS.

Deep knowledge and understanding of normal anatomy; how it can be altered by various *pathologic processes* and the imaging characteristics of these *pathologic lesions* are critical in order to detect *lesions*. It is, therefore, necessary to know what you are looking for to be able to recognize it, according to the axiom – **YOU SEE ONLY WHAT YOU LOOK FOR AND RECOGNIZE ONLY WHAT YOU KNOW**. *Clinical information* often plays a crucial role in the *detection of lesions*. It is, therefore, vital that the referring physician provides relevant information to the *radiologist* regarding the patient's clinical presentation.

The second component of the *radiologic thought process* is the DESCRIPTION OF THE FINDING. Accuracy of description is a vital step that provides the strongest consideration for the listed *differential diagnostic possibilities*. That is, it provides a benchmark against which to weigh each diagnostic hypothesis, to determine which provides the best fit. Ability to accurately describe a patient's image is a cardinal sign of a *first-rate radiologist*.

The third and final component of the *radiologic thought process* is that of DEDUCTIVE REASONING, which represents the stage when all the identified imaging features are analyzed to generate an ordered list of likely explanations for the radiologic finding leading to generation of *differential diagnoses*. Importance of adequate *clinical history* at this stage of the thought process also cannot be underplayed. It is the failure of a radiologist to examine images systematically in the manner described and his failure to behave as if he were used to doing this everyday of his *clinical life* that leads to adverse comments.

EDUCATION AND TRAINING IN RADIOLOGY

The need for regulation of radiologic practice became of paramount importance soon after *x-ray* discovery because of identified risks to patients and practitioners of the trade. Of particular importance is the appropriate training of the personnel, from the radiologist who interprets patients' images, to the technologist who is empowered to dispense radiation judiciously from diagnostic equipment.

Education and training in *radiology* occurs at three principal levels – in the *medical schools*, during *residency* and in the form of *Continuing Medical Education (CME)* for the *practicing radiologist*.

a) Radiology Education in the Medical School

All *clinical practices* rely on *diagnostic imaging procedures* for the management of almost every patient. This is perhaps the most urgent and compelling reason why medical and dental students must have a grasp of *radiology techniques*, including understanding of their clinical usefulness and limitations.

Radiology's potential to enrich students' understanding of such *Basic Medical Sciences* as *Anatomy*, *Physiology* and *Pathology* has long been realised through the use of *diagnostic images* as powerful teaching tools to enhance learning across the whole of the medical curriculum.

In fact, the *General Medical Council* of UK defined the learning objectives of medical student teaching in terms of competencies which are specifically relevant to clinical imaging. This approach has greatly reduced overreliance on *cadaver dissection*, *dog labs*, and *autopsies*. Thus, the same very new *radiologic techniques* that the students will soon rely on to care for their own patients, can now illustrate the structure and function of the living human patient in the *radiology teaching environment*. Sufficient familiarity and knowledge in *Radiology* by medical students is very essential, so that as physicians, they can use this technology appropriately and optimally to care for their patients in an interdisciplinary manner during the post-graduation practice.

More importantly in order for the future of the discipline of *Radiology* to be assured, the young medical students trained in this manner will constitute the potential pool of bright recruits and raw materials for the *residency training programs*.

The Radiology Medical Educator in the medical school is the *academic radiologist who combines a blend of professional radiology and graduate education ideologies in the discharge of duties.* His central and enduring mission is to use *radiology* as a *lens* through which medical students can study medicine, highlighting with images the essential principles to grasp in order to excel as physicians. He must be able to develop a larger role for *radiology* within the medical school curriculum as dictated by his tripartite duties as teacher, scholar and collaborator.

In playing the teacher role; *the radiology educator* must assume leadership in curriculum development, clinical teaching and supervision, classroom teaching, seminar and "virtual teaching," application of knowledge of the learning process and management of the learning environment.

The true scholarship of the *radiology educator* is reflected in his breadth, depth and up-to-date knowledge in a particular area of his discipline; his mentoring skills and ability to demonstrate proficiency in the standards of scholarly writing, including clarity, relevance, accuracy, originality and intellectual diversity. Collaboration with peers, students and administrators is essential to the full expression of the radiology educator role.

In many circumstances of basic and *clinical education*, the *academic radiologist* who finds himself in the medical school environment would appear to lack basic teaching skills as well as rudiments of basic and *clinical research*. Therefore, every novice *radiology medical educator* must embark on appropriate training in teaching methods and principles and practice of radiology research techniques essential for taking observations from the patient's bedside into the laboratory, making basic discoveries in the *imaging sciences* and translating these discoveries into new methods for *imaging diagnosis* and patient management.

b) Radiology Residency Requirements in Training

Diagnostic Radiology has become a comprehensive and versatile field today. It is comprehensive because it includes the entire patient, involves all clinical specialties and uses a variety of methods. It is versatile because it uses not only x-rays as imaging medium but also *ultrasound* and *magnetic resonance*, which are two completely different media.

Clinical experience is required before embarking on training in *diagnostic radiology and imaging* in order to fulfill the concept of a physician who is skilled in *radiological techniques* and experienced in clinical problems. The years of service during the compulsory housemanship and National Youth Service may serve this purpose, but, it is quite often insufficient because of the spectacular breadth and depth of knowledge required.

A pass in the primary examination in the knowledge of O-level physics, basic and *clinical medical sciences*, which tests the ability and preparedness of a candidate to undertake postgraduate specialist training in *Radiology*, is also compulsory. This will guarantee not only acquisition of a large amount of factual information but also their effective use in the clinical situations.

The training of a *diagnostic radiologist* takes a minimum of at least four years and demands great efforts from both the resident in training and the teaching *radiologist*. Because of the complexity of *radiology*, adequate training is only feasible in large clinics or university hospitals that can guarantee involvement of trained personnel – specialized *radiologists*, *physicists*, *biochemists*, *engineers* – in the teaching program and a sufficient number of patients. *Radiology departments* of such institutions should be responsible for and proficient in all imaging modalities.

The resident-in-training must complete a gamut of studies in *radiological physics*, *equipment*, *medical photography* and *film faults*. *Radiological anato*my, *general radiography*, *principles of pathology* and *clinical radiology* of the various body systems are also key elements in the training. In-depth knowledge of practical *radiological procedures and techniques* including *radioisotopes*, *diagnostic ultrasound*, *computerized tomography* and *magnetic resonance imaging* is quite essential. If *radiology* is to take part in the scientific pursuit of *MR spectroscopy*; knowing *biochemistry* is a prerequisite. *Principles of therapeutic radiology*, including *interventional procedures* is also required.

The administration of contrast media, *radiopharmaceuticals* and drugs used in *radiology* requires a basic knowledge of *pharmacology*. He must also acquire core knowledge in the biological effects of *ionizing radiation* on living tissue, and be able to observe proper radiation protection principles.

In order to manage and derive maximum benefit from all of the imaging equipment in use for training, the efficient *radiologist* must keep up with cutting edge technology, developments in software, hardware and new research data. In other words, *the modern radiologist* must be a physician with knowledge in *physics*, *biochemistry* and *pharmacology*. He must become an expert in *image capture*, *processing*, *communication* and *data exchange technology*, *broad-based advances in engineering* and more recently, *applications of information technology for healthcare*.

At the end of training, the *radiologist* must pass a *licensing examination in radiology*. Through extensive clinical work and related research, he may also specialize in one or more *radiology subspecialties*. For many *trainees in Radiology* who aspire to future employment in teaching and University hospitals, a period of dedicated full time research training may be attractive and desirable.

c) Continuing Medical Education in Radiology

The practicing radiologist, irrespective of practice engagement, must maintain his skills and acquire new knowledge and expertise as the field advances. Indeed, education is a lifelong endeavor at this level of practice.

Certain characteristics and skill sets required for the *radiologist* to continue to excel in professional duties for the benefit of the patients and referring physicians include *improved visual expertise*; *dispassionate imaging conclusions with consistent, uniform and definitive information provision.* With improvements in communication skills, ensuring properly recorded, clear and accurate notes on the reported images must also be ascertained.

MY MODEST CONTRIBUTION TO KNOWLEDGE

Mr. Vice Chancellor, sir, I had the privilege of working in my department when the available imaging facilities were exclusively the *"Old School" x-ray equipment*. All of them have now given way to the *"modern imaging" equipment*. It is remarkable that these new imaging equipment began to roll into our department in LUTH, characteristically many years behind their first appearance and use in developed environment. For instance, the first *ultrasound machine* was acquired in my department in 1986, some 39 years after being available for clinical use in developed countries. *CT and MRI equipment* also became available in our department only after 24 years and 26 years respectively. I therefore want to state categorically that even if an academic decides not to perish, this country can make it to.

Mr. Vice Chancellor, sir, the experience I had with my first paper during the *"Old School" era*, with an international journal outlet supports this assertion. The article was returned unpublished for want of supporting illustrations with modern imaging modalities. There was no way I could offer what I did not have.

Distinguished audience, nonetheless, today I state with delight that I have numerous collaborative publications in reputable local and international journal outlets; some of which have been and are, continually cited. In fact, the satisfaction of being noticed internationally came with requests for reprints from different countries following publication of many of the articles.

My publications cut across *general radiology*, using all the available arsenal of imaging equipment. With the arrival of *CT scan facility* in our institution in 1996, my research area began to focus on the fascinating ability of *CT machine* in making diagnosis from head to toe. I have selected some landmark research works to showcase my contributions to knowledge in the field of Radiology.

a. Ultrasound Examination and the Detective Capacity of Sound

The most popular use of *ultrasound* is in pregnant patients, where most other techniques are not so valuable because of *harmful radiation content* to the unborn baby.

Ultrasound in pregnancy is invaluable in the assessment of *fetal structures*, *placenta*, *amniotic fluid* and the *uterus*. It is particularly useful in the evaluation of the *placenta* or "*afterbirth*," which is an organ that connects the developing *fetus* to the *uterine wall* to allow nutrient uptake, waste elimination, and gas exchange via the mother's blood supply. It also allows the *fetus* to fight against *internal infection* and *produce hormones* to support pregnancy. *Ultrasound* is the principal imaging means of evaluating the location of the *placenta* on the *maternal uterus*, which may be *normal or low-lying*.

Low-lying placenta, generally called *placenta praevia*, is a *placenta* that is implanted in the *lower segment of the uterus*, presenting ahead of the leading pole of the *fetus*. It is a major cause of *antepartum haemorrhage* and is potentially life threatening to both the mother and the fetus. In Nigeria, it occurs approximately in every 1-in-81 deliveries or an incidence of 1.24%, which is higher than 0.4-0.5% of all labours in developed environments. Individuals who had past obstetric history of *caesarean section*, *grand-multiparity*, uterine evacuation of retained products of conception, multiple pregnancy and history of *placenta praevia* have predisposition to developing *low-lying placenta*.

Accurate *antenatal diagnosis* of *placenta praevia* is of utmost importance in *obstetrics* practice because it helps to reduce maternal and *foetal mortality*, hospital stays and unnecessary interventions. Since *ultrasonography* has become the imaging gold-standard in the assessment of patients with *antepartum bleeding* and *placenta praevia which* is the most common cause of this morbid state; we set out to establish the accuracy of *ultrasound imaging identification* and *localization of placenta as a cause*.

Publication: Adeyomoye, A. A. O., **Arogundade, R. A.,** Ola, E. R., Abudu, O. O., (2003). *Ultrasonographic Diagnosis of Placenta Praevia in LUTH.* **W. Afr J Ultrasound**; Vol. 4: 2-6.

Study Method

- Prospective 2-year study of 130 *antepartum bleeding* patients
- Age range – 19-41 years
- *TAS & TPS Ultrasonography* from 20 weeks to term.
- Patients followed up until delivery
- *Sonographic Accuracy* of *PP DxVs Obstetric* outcome compared
- Statistical analysis – **accuracy**, **sensitivity** and **specificity**

Findings

- 71.5% spontaneous conversion to normal position
- 28.5% PP persisted till delivery
- 2.1% false negative cases at delivery
- Accuracy – 97.7%; Sensitivity – 94.6%; Specificity – 98.9%
- Positive predictive values – 97.2%; Negative predictive values – 97.9%

Conclusion

- *Trans-abdominal ultrasound* scan is less sensitive than *trans-vaginal scan* in the evaluation of *placenta praevia*.
- Longitudinal follow-up of patients with *low-lying placenta* may reveal normally situated *placenta at term*.
- *Os–placental edge* distance determination in late pregnancy is valuable in planning route of delivery
- Screening *ultrasonography* in pregnant women may help to reduce the maternal and *perinatal morbidity* and mortality associated with *placenta praevia*.

We also used ultrasound technique to determine its potential clinical applications in the *cardiovascular management* of patients with *Sickle Cell Disease*.

Most of us must have had direct or indirect experience with patients suffering from *Sickle-Cell Disease (SCD)*, also known as *Sickle-Cell Anaemia (SCA)*. It is an incurable hereditary blood disorder, characterized by an abnormality in the oxygen-carrying *haemoglobin molecule* in *red blood cells*. This leads to a propensity for the cells to assume an abnormal, rigid, sickle-like shape under certain circumstances. Based on World Health Organization [WHO] indices, Nigeria accounts for 75 percent of infant sickle-cell cases in Africa. *Sickle-cell* *disease* is associated with a number of acute and chronic health problems, such as severe infections, attacks of severe pain, "sickle-cell crisis," and stroke, and there is an increased risk of death. At least 100,000 infants die from the sickle-cell genetic disorder in Nigeria every year, and the country still has the highest incidence of the illness in Africa.

Atherosclerosis or *blood vessel hardening* is a common *pathology* in *sickle cell disease* that may precede the occurrence of *cerebrovascular events*. Detection of early *atherosclerosis* using imaging has the potential to predict the risk of future *cerebrovascular* events, and efficacy of administered drugs. *Carotid Intima-Media Thickness (CIMT)* measurement with *ultrasound* is one of the most widely used and best validated *atherosclerosis imaging techniques*.

Because 11% of patients with *Sickle Cell Anemia (SCA)*, on the average, will develop a clinically apparent stroke by the age of 20 and 24% by the age of 45 subclinical detection of carotid endothelial damage and plaque formation, in this morbid group, may enable early intervention so as to prevent *stenosis*, *infarction*, and *stroke*.

This is the basis of our study using ultrasound technique to investigate and compare the effects of oral Vitamin C supplementation on *intima-media thickness*, *cross-sectional diameter* and *blood velocities* of the common *carotid artery* in *sickle cell anaemia* patients and those of *Non-Sickle Cell Anemia (NSCA)* subjects.

Ascorbic acid or *Vitamin C*, in human body system, has been found to protect the *vascular endothelium* against adhesion by blood cells, thus preventing blood clotting and attendant consequences. It has also been shown to decrease *arterial blood pressure* and *vascular resistance* apart from restoring *Nitric Oxide (NO)* production and replenishing *intracellular antioxidants*, which help to enhance the tone of large artery compliance.

Publication: O. A. Olowoyeye et al. (2011). *Effects of Ascorbic Acid Intake on the Intima-media Thickness and Blood Flow Velocities of the Carotid Artery in Patients with Sickle Cell Anemia.* **J Diagnostic Med Sonography**; Vol. 27(5): 214-219.

Study Method

- Random selection of 20 *SCA* patients and 10 *NSCA* patients aged 16-25 years.
- **Baseline** Duplex *sonography* of Common, Internal and *External carotid arteries* in **study** and **control** groups.
- Average of 3 measurements of *Interadventitial Distance (IAD)*, Int*ima Media Thickness (IMT), Peak Systolic Velocity (PSV)* and *Resistive Index (RI)*.
- **Treatment** – daily oral 300mg Vitamin C supplementation x 6 weeks.
- **Repeat** *Duplex sonography* and measurements at end of treatment.

Findings

Baseline *Anthropometric* and *Haematologic measurements*

- All indices are small in *SCA* patients

Effects of Vitamin C Supplementation on *Vascular Measurements*

- Significant greater effect on reducing *CSD*, *PSV*, *EDV* and *RI*

Conclusion

- Routine consumption of Vitamin C in every individual prevents against *endothelial damage* and consequences of *cardiovascular events*.

b. CT Examination and the Detective Capacity of Digital X-ray.

The acquisition of the first *Computerized Tomography (CT) scan facility* in our teaching hospital in 1996 elicited excitement and an air of welcome development. *CT scanners* first began to be installed in 1974. Improvements have led to *higher-resolution images*, which assist in making a *diagnosis*. The first *CT scanner* in Nigeria was installed in the University College Hospital (UCH) in 1987. *CT* takes "pictures" of slices of the body to show internal area of interest and has ability to evaluate soft tissues as well as to visualize subtle abnormalities that may not be apparent on conventional X-ray imaging.
We evaluated our experience on the new imaging modality after examinations of the first consecutive 500 patients in the 1997-1999 periods.

Publication: Arogundade R. A., Nzegwu N. C., (2004). *Experience with 500 Consecutive Patients on Somatom AR.T CT Scanner*. **Nig Qt J Hosp Med. 14 (1): 35-38.**

Study Method

- Retrospective evaluation of the first 500 consecutive patients
- Examined on *Siemens Somatom AR.T scanner*
- 2-year study period
- Departmental protocol for *CT examinations*
- Statistical analysis – **accuracy**, **sensitivity** and **specificity**

Findings

- Equal Male/Female
- Age range – 1 month-old *neonate* to 86 years
- Brain scans – 52.8%, of which Head injury 11%, CVA 9.4%, *Intracranial masses* 9.8%
- 1^{st} abnormal scan – surgically and histologically confirmed *frontal meningioma*

Conclusion

- CT procedure improves clinical management decisions
- Higher cost of the examination

We also worked very closely with the National Drug Law Enforcement Agency (NDLEA), using *CT scan* and *conventional radiography*, to assist in detecting concealed illicit drugs by body packers arrested at the nation's ports of entry.

Mr. Vice Chancellor, sir, illicit drug trafficking is still on the rise in Nigeria in spite of the intensive monitoring efforts of NDLEA. Apart from drug trafficking being a criminal act, narcotic smuggling poses a serious threat to public health and safety. Only recently, four Nigerians were among eight people executed by Indonesian authorities over drug-related offences.

Over a period of 4 months, close to 106,914 kg of narcotics were impounded from 20 arrested drug smugglers in Nigerian airports. More arrests were made in males. The various ingenious methods of hiding the illicit drugs for transportation – *ingestion*, *insertion* and *concealment* – are collectively referred to as, *"body packing."* Mr. V.C, sir, the most recently identified method of concealment uses fake Silicon breasts. So when next you see a lady who appears, "blessed," it may be a blessing of concealment.

Publication: R.A Arogundade., (2006). *The Role of Imaging in the Management of Body Packing of Illicit Drugs* **J. Pharm. Sci. & Pharm. Pract. 8 (3&4): 64-67.**

Study Method

- Retrospective evaluation of two patients – one on suspicion of concealment; the other for retention of residual drug
- Plain films + oral contrast; Plain and post oral contrast abdominal *CT images* on *Siemens Somatom AR.T scanner*

Findings

- Suspects were 2 males, aged 35 and 40 years
- Total retrieved illicit drug packs = 115 wraps

Conclusion

- Imaging service will continue to be essential for evaluation of body packers from moment of arrest till complete retrieval of all concealed packs of drugs

Mr. Vice Chancellor, sir, the most enjoyable part of a doctor's job is making the *correct diagnosis* on a study that is both difficult to analyse, with positive impact on patient management. Evaluating subtle findings in such studies took some careful thought to put together and match with the clinical situation.

Case 1 – Elderly mother of a respectable female Professor of this great institution, who has had two previous examination reports of *CT abdomen* from different *Radiologists*. The third report of a *CT abdomen* done by me accompanied the patient to a United

Kingdom hospital, where she had surgery. My heart gladdened when the senior Professor phoned to encourage me to keep up the excellent job because, of all the three imaging reports, my specialist report tallied exactly with the surgical findings in the UK.

Case 2 – Female patient with *abdominal pathology* referred for *abdominal CT scan* from a private health outfit, which at that time, had a sponsored resident doctor in training in our department in LUTH. My specialist report corroborated the *intraoperative findings* as confirmed by the MD of the hospital in the course of a telephone chat.

MY MODEST CONTRIBUTION TO RADIOLOGY AND RADIOGRAPHY TRAINING

In 1987, during my residency training days, I was initiated into delivering *Neuroradiology* lectures to 400 Level MBBS, BDS and *Physiotherapy* students, which has expanded to include *genitourinary radiology, CT imaging.* I have also thought numerous 600 Level MBBS students in *Radiology of Obstetrics* and *Gynaecology.*

Mr. Vice Chancellor, sir, I must confess that the establishment of the BSc *Radiography program* in the Department of RBRRR in 2003 was a blessing in disguise. It provided the platform to learn the processes of accreditation as a Co-opted member of the Sub-Committee of Council on Accreditation under the Chairmanship of the Late Prof. Adetokunbo Sofoluwe when he was the Deputy Vice Chancellor (Research & Academics). I was, therefore, actively involved with the accreditation processes of the BSc Radiography *program* by the National University Commission and Radiographers Board of Nigeria. In the same vein, the BSc program also provided opportunity to understand the processes of presentation of examinations results at Academic Board level.

I have contributed to the training of numerous new *diagnostic Radiologists* many of who are here in this hall today. Many of them are in various public and private employments and some are in different cadres of appointments in the service of the University of Lagos.

In collaboration with some senior colleagues in *Academic Radiology*, an introductory textbook of *Ultrasonography* was published. The book, in its second edition, is the first of its kind in the practice of Imaging in Nigeria and is intended to provide beginners with simple guide to basic *ultrasound scanning*.

CONCLUSION

Mr. Vice Chancellor, sir, in the last one hour, I have attempted to present before you the account of 23 years of my stewardship as a teacher-scholar of this great academic community, the University of Lagos and University of First Choice.

In order to continue to play a distinctive role in leading the scholarly pursuits of this prestigious University; a responsibility which the attainment of my full professorial rank carries, may I plead that you pronounce the traditional needful of discharge and acquittal on me.

RECOMMENDATIONS

Vice Chancellor, sir, I wish to make some recommendations for the advancement of the Specialty of Radiology professionally and academically:

1. Acquisition of Appropriate Imaging Technologies

Mr. Vice Chancellor, sir, I remember with nostalgia the experiences of my first two weeks in *Radiology training*. There were two angiographic suites with functional equipment for diagnosis of various organ and blood vessel diseases. I acquired unquantifiable experiences on these equipment before they packed up irredeemably in 1987 without any conscious attempt to replace them. I am not aware of any *radiology trainee* after 1987, who had similar exposure.

We live in a constantly changing technological environment and Nigeria cannot afford to persistently remain behind the rest of the world. *Radiology* is particularly *technology-driven* and *capital intensive*. Equipment investment through the Public-Private-Partnership remains the current solution and best international option.

Our teaching hospitals must acquire and maintain appropriate imaging equipment to improve radiology practice, training and research. Only acquisition of equipment with locally available engineering maintenance backup will guarantee durable functionality and uninterrupted training of medical students and resident doctors as well as good quality materials for internationally acceptable research. Availability of essential diagnostic imaging equipment will also obviate the need for unnecessary medical tourism and conservation of our national meagre resources.

2. Local and Foreign Publications Dichotomy

Mr. Vice Chancellor, efforts of the University in ensuring that research publications of members of this academic community meet high international standards, are well appreciated. However, I want to draw attention to the thorny issue of local and international publication dichotomy. Whereas a journal published in Ghana, Kenya or South African is considered international because of offshore location; the National Postgraduate Medical Journal, owned and published by the National Postgraduate Medical College of Nigeria, is not recognized as commanding international status. It took very serious effort of the former Provost of the College of Medicine, Professor Oluwole Atoyebi to get the age-long West African Journal of Medicine to be accepted as international publication outfit. Let us begin to appreciate and promote what we have.

3. Appeal for Demerging of the Department of RBRRR

Mr. Vice Chancellor, sir, I want to contribute to the previous pleas for reconsideration of the process that produced the department with the longest name in the University, the conglomerate Department of *Radiation Biology*, *Radiotherapy*, *Radiodiagnosis* and *Radiography*. This is based on the following submissions:

a) The Senate Committee on Rationalization of the Academic Programs of the University that generated the report considered and carried out the assignment as approved by the Senate in 1997 without granting fair hearing to the academic members of the merged departments. How can you shave a man's head without his knowledge?

b) The two originally merged Department of *Radiation Biology* and *Radiotherapy* and the Department of *Radiodiagnosis* employ dissimilar professional approaches to play distinct clinical roles in patient management, and are therefore physically separate departments in all medical colleges and teaching hospitals all over the world.

c) Addition of *Radiography unit* in 2003 to the merger arrangement further made the arrangement unwieldy, as it requires its own retinue of academic staff.

d) Students of the *College of Medicine* undertake separate clinical postings of distinct contents in the two departments.

e) Resident doctors in professional training in the two departments also follow distinct modules which are not interchangeable.

f) Therefore, it is obvious that the disciplines of *Clinical Radiology* and *Clinical Oncology/Radiotherapy* DO NOT REPRESENT the same sides of a coin.

g) More importantly, sir, we can say without equivocation that the ill-advised merger does not confer any form of financial benefits to the University in staff emoluments, departmental maintenance or research and teaching demands.

h) Mr. Vice Chancellor, members of the department of RBRRR are reassured that, as a listening and considerate leader that you are, you will give this matter the final burial that it deserves when it finally comes to your table for Senate approval.

ACKNOWLEDGEMENTS

Mr. Vice Chancellor, to Allah Be the Glory for this special day. I shall never cease to acknowledge and recognize the mercies of Allah in the journey of my life till this moment and beyond.

I thank Mr. Vice Chancellor, Prof. Rahamon Bello most sincerely, without whose official approval this Inaugural Lecture would not have taken place today. I appreciate other principal officers of the University.

Let me thank the first female Provost of my College of medicine, Prof. Folashade Ogunsola for her care and support. I appreciate the current Dean, Faculty of Clinical Sciences, Prof. Ebun Lesi and other past Deans of the Faculty. I cannot forget the critical role played by the immediate past Provost of the College of Medicine, Prof. Oluwole Atoyebi. I also appreciate the supportive roles of the entire staff of the Faculty of Clinical Sciences and those of the Department of RBRRR, particularly Prof. K.K. Ketiku and Prof. Tajudeen Ajekigbe. I appreciate the immense contributions towards my professional progress of all members of staff of the Department of Radiodiagnosis of LUTH, most especially the HOD, Dr. Kofoworola Soyebi and Alhaja Okubadejo, the Deputy Director of Radiography.

The choice of parental vehicle for me by Almighty Allah to this world and to Nigeria in particular was marvelous. I recognize the un-quantifiable care of my late mother-in-a-million Alhaja Safurat Ajihun Arogundade. If she was here today, she would have shed tears of joy. May Allah grant her the choicest place in Paradise. I thank my aged father Alhaji Raheem Akande Arogundade for playing his fatherly role for all his children without discrimination. I

pray fervently to Allah to make his twilight smooth in the presence of all the children.

I cannot do without paying tribute to some of those who have had profound contribution and influence on my career and what I have made of its choice. I offer special recognition to my Uncle, mentor and benefactor Alhaji Assan Olasupo Arogundade. He is the Allah-sent angel of my life who mentored me through the primary school age to the University and he has never ceased to do so till this moment. I remain ever grateful.

I acknowledge the kindness of the Late Alhaji Haroon Kolawole Bidmus who was instrumental in securing the Bureau for External Aid scholarship for my undergraduate medical education in Romania. I also remember my Late uncle; Alhaji Ahmed Adisa Arogundade, for being there to fill an apparent vacuum during my basic education period. May their gentle souls rest in absolute peace.

Through the Ambassador of Romania here present in our mist today, I express profound gratitude to the Government of Romania for the External Aid scholarship which provided the enabling environment for my strong medical foundation upon which I was able to build my postgraduate training and practice in Radiology.

Let me also recognize important individuals who guided my professional compass towards Radiology. Prof. G.O.G. Awosanya, Provost, College of Medicine, Lagos State University has been an unforgettable friend and brother who invited and paved way for my admission into residency training in LUTH. I can never forget my Late Head of Department of Radiodiagnosis and Radiology mother, Prof. Funsho Elebute-Ladapo, who recommended me to the Teaching Hospital for residency training. May her gentle soul rest in absolute peace.

I sincerely appreciate Dr. Olumide Okikiolu, who was my Head of Department while I was writing my Part II final examination in Radiology. I recognize the unique role of Mrs. Olufunmilola Ogunniya; my first teacher on my first day and first interface with radiological procedures in the department.

I want to appreciate some of my teachers and mentors who contributed in shaping my Radiology knowledge and also helped to initiate me into the art of scientific writing. The trio of Prof. D. N. Osegbe, Prof. Esho and Prof. E. O. Amaku drilled me during inter-departmental clinic-radiological urologic meetings. Prof. D. N. Osegbe co-supervised my Part II Research Dissertation project of the National Postgraduate Medical College of Nigeria. Prof. Bankole, the first Registrar of the NPMCN, impacted the rudiments of research writing during Research Methodology workshops.

Our Royal Father; the Onijanikin of Ijanikin, has always been a dependable landlord of the NPMCN. May your reign be long and fruitful, sir. I appreciate all members of the Governing Board, Senate and Past President Forum of the NPMCN here present. I thank all members of staff of the NPMCN.

My appreciation goes to all members of my Radiology Family, including my senior and junior colleagues and resident doctors who have come to honour me today. I particularly recognize my friend and brother, Prof. Victor Adetiloye, the Chief Medical Director of OAUTH, Ile-Ife. I also recognize Prof. Oluremi Ogunseyinde; my very good mentor. Members of the Professional Elites of Nigeria, members of Association of Nigerian Graduates from Romanian Universities (ANGRU), I sincerely appreciate you all.

I acknowledge my good brother and ANGRU Colleague, the former Speaker of Lagos State House of Assembly, the Right Honourable Adeyemi Ikuforiji, who made time out to be here to honor me. May God bless you.

I recognize the presence of all members of my religious family – The NASFAT Society of Nigeria from the National Headquarters and Branches, including the Council of Elders of Surulere Branch. The entire members of my family – the Arogundades, the Otun-Elewes, the Folorunshos – I thank you all for your constant support. I warmly appreciate all my In-laws here present – the Okin family, the Odutayo family, the Olanbiwonnu family.

Allah has been extremely kind to me in the way he has fashioned and blessed my nuclear family. My lovely children who used to be called "Ogo Weres," in my department during school run days are now "Ogo Nlas." Olamide, Olaseni, Olayemi and Olaniyi have grown to be adults in their own rights, and children any parent will be proud of.

By tradition, the number of my children has increased by three through extension of hands in marriage across families; Engineer Jibril Okin, Pharm. Yetunde Arogundade; a Physiotherapist-in-making and Halima Arogundade have brought additional joy into my family.
Amongst them; they have given me four beautiful grand-children – AbdulHameed, Jemil, Jafar and Azeezat. They have all remained supportive and are a source of joy to me.

Finally, I acknowledge with love Alhaja Nofisat Abiola Arogundade; my divinely chosen lover, darling, sweet heart, jewel, friend, sister, mother, my irreplaceable companion of 33 years and a totally submissive woman despite Allah's elevation at work and in the society. You have always been by my side, and so for your unalloyed loyalty, I reserve myself for you alone.

Mr. Vice Chancellor, Sir, Distinguished Ladies and Gentlemen, I thank you sincerely for your attention. I wish you all a safe trip back to your various destinations.

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