IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 10 Ser.4 (October. 2022), PP 32-40
www.iosrjournals.org

Assessment of Utilization of Digital Imaging and Teleradiology in Nigeria: A Case Study of Kaduna Metropolis Hospitals

Rad. Ahmed Adamu[1*,] Dr. Neeraj Malviya [2*]
[1,] *Research Scholar*
[2,] *Professor*
[1] *Department of Radiology and Imaging Technology- Singhania University, Raj. India*
[2] *Faculty of Medical and Paramedical Sciences- Singhania University, Raj. India*

Abstract
Background*: Teleradiology and digital imaging forms an integral part of the telemedicine concept. Teleradiology is becoming a mature technology because of advances in imaging technology, database design and communications infrastructure and capabilities. Increasing use of Digital imaging reflects the changing world of clinical practice, service delivery and technology.*
Objective*: The aim of this study was to assess the utilization of Digital imaging and teleradiology among Radiographers and Radiologist and to also assess the available infrastructure in place at hospitals within Kaduna metropolis. Also to bring the attention of medical bioengineers to collaborate with the information technologist engineers within Kaduna metropolis to encourage ministry of health on rapid speedup utilization of teleradiology in their hospitals both public, private and teaching hospitals.*
Method*: The study was a cross-sectional prospective survey that targeted Radiographers and Radiologist. Data was collected using a 24 item self-completion questionnaire designed in line with the objectives of the study. Data were categorized into groups and analyzed using statistical package for social sciences version 20.0, where descriptive statistics such as the percentages and frequencies were generated and tabulated*
Results*: The study was carried out in six hospitals, four public and two private and others optional institutions analysis, the total number of questionnaires distributed in the hospitals were (n= 120) 100.0% and only (n=104) 86.70% were successfully collected. (n=68) 54.9% had formal training on digital imaging, (n=93) 78% are not aware of any policy regarding implementation. (n=115) 96.1% practiced digital imaging, (n=94) 78.4% don't practiced tele-radiology. While study involved 368 survey respondents in advance countries and showed that 64.8% use teleradiology and 36.1% plan to do so soon. Although most teleradiology involves distribution of images in the same institution (70.9%) (Although it is debatable whether distribution within an institution is true teleradiology), 44.4% involves reading images from home overnight and on weekends. Image outsourcing is done by 35.5% to obtain expert opinions (20.2%) or deal with capacity problems (19.7%). Services are provided by 31.6% on a noncommercial basis and by 26% commercially.*
Conclusion *From this study, it's apparent that knowledge of digital imaging and teleradiology is encouraging among radiographers and radiologist even though there are no adequate available equipment e.g. PACS, RIS to harnessed the full potentials of digital imaging practice in the hospitals. Also, majority are ignorant of any established policy either by the government or by the hospitals where they work to implement such innovation. The study discovered that there is absence of teleradiology practiced within the metropolis.*
Keywords: *Digital imaging, Teleradiology, e-Health, Knowledge,Hospital, Nigeria*

Date of Submission: 02-10-2022 Date of Acceptance: 14-10-2022

I. Introduction

Advances in digital imaging technologies, digital storage, telecommunication and viewing technologies have made teleradiology readily available and reasonably affordable with high diagnostic quality images at high transmission rates with customized software maximizing accuracy and convenience. Digital imaging came into vague by utilizing advances in electronic and computer technologies to realize a better diagnostic efficacy and to evolve new diagnostic modalities. These are generally known as digital radiography where the x-ray sensor is mainly either the conventional image intensifier, tele-camera combination or the linear array sensor as used in the computed tomography. Conversion from analog to digital methods in the medical imaging and the emergence of widely available mechanisms to quickly and affordably transmit digital data over large distances have fueled the rapid growth of teleradiology. In modern radiology departments in both the academic and

private sectors it has become commonplace to select the location of a fully functioning picture and archiving communications system (PACS) workstation based on manpower and workflow considerations rather than proximity to the site of image acquisition. Teleradiology services have long been performed with special solutions (Gitlin 1986, Batnitzky et al. 1990, Dwyer et al. 1991, Goldberg et al. 1993), but gradually connections came to be established with far less effort and cost than before (Dohrmann 1991, Yamamoto et al. 1996, Berry & Barry 1998, Engelmannet al. 2002). The advances in telecommunication and computer technology have given us widely standardized tools, which can be applied into clinical practice (Henri et al. 1997, Hussein et al. 2004). The combination of radiology with the application of information technology has led to the digitization of radiology. The images are created digitally, stored and communicated over long distances quickly and consulted on by medical specialists. The images can be saved in structured archives and opened quickly when needed. The digitization of radiology is associated with information technology developments in medical applications. The focus is on the use of information systems in teleradiology networks.

The conversion from analog to digital methods in the medical imaging world and the emergence of widely avail rapid growth of tele-imaging/radiology. In modern radio diagnostic departments in both the academic and private sectors it has become commonplace to select the location of a fully functioning lable mechanisms to quickly and affordably transmit digital data over large distances has fueled the picture and archiving communications system (PACS) workstation based on manpower and workflow considerations rather than proximity to the site of image acquisition (Boland, Schlakman, & Thrall, 1998)

Teleradiology is newer Radiology systems that provide for direct digital capture of radiographic images which eliminates having to print plain films and secondarily scan them into a digital format. The images are typically captured in Digital Imaging and Communication in Medicine format (DICOM). A typical DICOM image of 14 by 17 inches is approximately 10 MB but can be compressed down 1 MB (ratio of 10:1, lossy comprssion) and remain of diagnostic quality. Digital imaging is a term used to describe general radiography when the radiographic images are in digital form and are capable of being displayed on a computer monitor(Nyathi, Chirwa, & Van Der Merwe, 2010). Teleradiology is the electronic transmission of radiologic image data from one location to another for the purpose of interpretation or consultation. This means combining both engineering and medical knowledge in an effective way. The application systems such as HIS, RIS and PACS is the central task that can only be achieved by using internationally consistent communication standards. In radiology DICOM is established as the image communication standard. This makes it possible to make statements about the compatibility of devices and programs and to connect them in a heterogeneous network. DICOM supports many radiological modalities such as X-ray, CT, MRI, ultrasound, and computed radiography. The exchange of storage media is made possible in the DICOM standard by defining the application profile for each DICOM media (Kimura et al. 1995). It describes which modalities‘ pictures may be stored on the disk, what number formats and compression may be used and which disk is to be used. Besides the actual DICOM images, every DICOM disk contains a file containing the key information of all images such as patient name, modality, unique identification number, in order to quickly and efficiently search for images without having to read all the information to disk. The purpose of this study is to evaluate the utility and application of teleradiology, more precisely the following: whether low-end technology could combine acceptable image quality and reasonable costs for primary care centers and local hospitals, whether there will be noticeable changes in the work processes when two different institutions start to work together, whether international teleconsultations using data networks could link together differentinstitutions in a feasible manner, whether new ubiquitous communication tools, such as mobile data communication, are suitable for radiological purposes, whether smartphones could be used for image interpretations, and finally, to chartthe usage status of teleradiology and digital radiology in the electronic health care (E-health) domain in Finland in general. This study will discuss important research steps and achievements from traditional point-to-point teleradiology to mobile and internationally networked services over a time span of more than ten years. As some of the sub-topics in this study were among the earliest published work in this field, the results will draw a natural development path and summarize the newest trends in the rapidly developing field of teleradiology as part of the present electronic health care environment. The contribution of the government is particularly important in developing countries, where the public health system is usually the major provider of services. Government policies often have a significant impact on governing, financing and regulating the health sector in developing countries. Most developing countries in recent years have recognized the importance of ICT in their economic development and social progress. A number of countries in the developing world have initiated national policies towards integrating ICT into their economic plans.

However, it is surprising that, in most cases, these national ICT initiatives have not considered the health sector as an important sector.(Sisira, Marasinghe, Dissanayake, Abeykoon, & Wootton Richard, 2009). In Nigeria there is an existing draft of national health information and communication technology framework (2016-2021) with the vision of achieving universal health care coverage UHC by the year 2021. And the future of teleradiology has the potential of developing a large scale memory on optical discs to facilitate the exchange of medical images and information between health care facilities or hospital for effective service delivery.

Digital imaging has the potential to improve the security and quality of patient care, but its impact has varied between developed and developing countries(Brieux et al., 2015). Nigeria being one of the developing country and the largest in Africa is facing so many challenges in the implementation of good health care delivery. It is found that employing information and communication technology (ICT) to deliver health care at distance (i.e. tele health or e-health) would be useful to address at least some of the problems in developing countries(Sisira et al., 2009).

The world in which we live in today has been changed by ICT. ICT has the potential to transform radically the delivery of health care and to assist in defining strategies to address future health problems. ICT has assisted in driving down healthcare costs (Remlex, 2007); and improved the delivery and effectiveness of healthcare services through help in disease management, improved patient safety and decision support for practitioners (O'Carroll, et al,

Over the last few years, public hospitals in Nigeria have been purchasing digital units for their Radio diagnostic departments. This is in line with worldwide trends of migration from screen-film radiography to digital Imaging. Upon adoption of new technology, it is advisable that the technology undergoes evaluation and critique so that strategies are devised to optimize its use.(Nyathi et al., 2010). Hence, provision of digital imaging facilities will enhance the practice and can bridged the existing gap between the specialist and the patient who currently deprived access to good health care.

Also to balance the existing crisis of a significant shortage of Radiographers and Radiologist as compared to the population. In Zambia for instance (Gregory & Tembo, 2017) says despite the application efforts on e-Health in Zambia the adoption and usage rates remain relatively low.

There is no doubt about the advantages of information technology applied to health, but in most developing countries there are serious barriers to its effective application. Information technology may allow significant improvements across various aspects and has the potential to benefit both developed and developing countries. The World Health Organization (WHO) identified the use of eHealth as a priority skill in the development of human resources in health (human resources in eHealth require people with knowledge in medical informatics and standard terminology. Furthermore, it is increasingly recognized as a crucial piece to improve health systems to achieve the WHO Millennium Development Goals(Brieux et al., 2015).

It is imperative to say that the study will go a long way in finding out the level of awareness, application and utilization of Digital imaging/Teleradiology for an improved and modernize health care services in radio diagnostic department. Also in identifying areas of concerns and challenges that needs to be addressed by the appropriate authorities responsible for infrastructure provision, governing, financing, regulating, monitoring and evaluation in achieving seamless operation of the system as obtained in other developed countries. Moreover, it will also provide awareness on the importance of adopting Digital imaging/Teleradiology which can lead to improved access to health care, enhance the quality of service delivery and timely result outcome.

The study was carried out in teaching hospital, some state owned Hospitals and private diagnostic centers within Kaduna metropolis

Teleradiology is a means of electronically transmitting radiographic and patients images from one location to another and it is also known as one of the most established and most widely used forms of a larger entity called telemedicine (Wootton 1996, Roine et al. 2001, Ruotsalainen2010). One of the early comprehensive definitions of telemedicine is that of Dripps et al. (1992), stating that telemedicine is the investigation, monitoring and management of patients and staff using systems which allow ready access to expert advice no matter where the patient is located.

Telemedicine is actually an umbrella term that encompasses any medical activity involving an element of distance (Wootton 2001). A few years ago the term telemedicine began to be supplemented by the term telehealth (Watanabe etal. 1999, Krupinski et al. 2002), which was thought to be more "politically correct", but since the year 2000 or thereabouts this too has been overtaken by even more fashionable terms, such as online health and e-health (or eHealth) (Wootton 2001).

Telemedicine is the exchange of medical information between two parties located at different geographical sites via a telecommunication link (WHO, 2012).

e-health: This has been defined by the World Health Organization (WHO, 2013) as the cost-effective and secure use of ICT in support of health and health-related fields, including health care services, health surveillance, health literature, and health education, knowledge and research.

ICT: information and communication technology. Information and communication technology is increasingly penetrating outpatient, inpatient and administrative health care areas. The vendor-independent integration of information and application systems such as HIS, RIS and PACS is the central task that can only be achieved by using internationally consistent communication standards. In addition, the function processes of these systems must be harmonized to ensure temporal and logical dependencies are included. In radiology DICOM is established as the image communication standard and HL7 is leading and generally established for the

transmission of management data. This shows the merging of internationally operating procedures and IT businesses in the IHE (Integrating the Healthcare Enterprise), in order to model patient-and process-oriented scenarios, based on industry standards such as DICOM and HL7 (IHE, 2006).

Digitization: The process by which analogue (continuous wave) information is converted into digital (discrete value) information. This process is a necessary function for computer imaging applications because visual information is inherently in analog format and most computers use only digital information. The digitization of radiology is based on the developments and findings of the medical specialist area of radio diagnostics and therapeutics in connection with the progress of information technology. Radiology as a science and the tenet of medical utilization of certain types of radiation in diagnosis and therapy (Pschyrembel 2004) is itself a fusion of electronics and medical knowledge.

PACS: Picture archiving and communication systems are management information systems used for distributing, viewing and archiving digital images by integrating different types of modalities through communication networks.(IAEA, 2015). PACS is a medical technology that provides economical storage, presentation, retrieval, distribution, and management of medical images. Transmission of electronic images and reports takes place digitally via PACS. The imaging modalities, Transmission of patient information through a secured network, Interpreting and retrieving of images through a workstation, and storage archives for retrieval of images and patient reports are the four major components of PACS that improves efficacy in electronic data handling workflow. An effective viewing and analysis is possible as PACS' digital images enables you to zoom in and operate the images for a more elaborate analysis. PACS enables simultaneous multi location viewing of images. It enables collaboration among radiologist as they can seek for each other's opinion by viewing the cases simultaneously and discussing them under peer review module.

Radio Diagnostics was founded on a technological discovery by Wilhelm Roentgen in 1895.(Bashshur et. al, 2016). Teleradiology also had its roots in technology dating back to 1947 with the successful transmission of radiographic images through telephone lines. Diagnostic radiology has become the eye of medicine in terms of diagnosing and treating injury and disease (Bashshur et. al, 2016). The increasing use of Digital imaging reflects the changing world of clinical practice, service delivery and technology (Binkhuysen & Ranschaert, 2011) . Today digital imaging has many purposes worldwide ranging from services for expert or second opinions to international commercial diagnostic reading services (Binkhuysen & Ranschaert, 2011). In the last 20 years, technological developments have revolutionized numerous sectors of society and Healthcare in particular has employed the improvement in telecommunication to facilitate the exploitation of technology by medical practice, and has created the e- Health principle (Mohannad Alajlani, 2010). Also, Digital imaging provides rapid and improved flow of diagnostic information where Electronic images can potentially be viewed on a screen immediately after acquisition, rather than waiting for a film to be processed. In practice, images are available for viewing less than a minute after they have been taken.(Goethe-, 2007).

These changes are particularly relevant to radiology, where our day-to-day workflow is intimately intertwined with the technological tools at our disposal and more so Radiology makes significant use of the latest computers for each step in the pathway from image acquisition to reporting. Within radiology, not only has the technology changed, but the expectations of the public in response to those changes have changed as well, in part, leading to the increased sub-specialization of radiologists along systems- and disease-related specialties.

One consequence of this sub-specialization has been increased expansion and utilization of teleradiology, as clinicians and patients not only expect but often demand expert interpretation of images, not only in major urban, but in rural and medically underserved areas as well.(Elizabeth A Krupinski 2014)

Consequently, Radiographers and Radiologists often unexpectedly find themselves leaders in the application of computers in medicine (Auffermann et al., 2013). Teleradiology is also a segment of telemedicine ,therefore according to world health organization definition of telemedicine states that "is the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities (WHO 1998) cited in (Ferdous, 2017). With regard to WHO's health-for-all strategy, it recommends that the World Health Organization (WHO) and its member states:"integrate the appropriate use of health telematics in the overall policy and strategy for the attainment of health for all in the 21st century, thus fulfilling the vision of a world in which the benefits of science, technology and public health development are made equitably available to all people everywhere." (WHO 1998) cited in (J. A. Dawson, 2011)

New imaging modalities, like tomographic nuclear medicine (NM) imaging with computerized image display and storage in the 1960s and CT in 1971, were digital from the beginning and paved way to a digital medical image, which consisted of computer-made measurement results and had only a representation as a physical image (Langan & Wagner 1969, Thrall 2005, Beckmann 2006). Magnetic resonance imaging (MRI or MR), digital subtraction angiography (DSA), digital fluoroscopy (DF), ultrasound (US) with digital image capture followed soon after, and finally computed radiography (CR), digital radiography (DR) and digital

mammography (DM) signalled the start of the digital age, making the computerized image commonplace (Kiuru et al. 1991b, Thrall 2005). First, these digital modalities revolutionalized image acquisition, resulting gradually in digital storage and transmission of images in everyday practice. PACS took care of the images (Huang et al. 1988, Taira et al. 1988, Kiuru et al. 1991a, Viitanen et al. 1991), while radiology information systems (RIS) managed the radiological workflow and information exchange with the other components in the HIS (Kotter & Langer 1998, Kinsey et al. 2000)

The study evaluated Digital imaging infrastructure in Kaduna metropolis northwestern region of Nigeria and compares the level of application and utilization among various hospitals in the state. The study was a cross sectional prospective survey design. It was conducted in four public hospitals and two private centers. Data was collected through a structured questionnaire from radio diagnostic departments of Barau Dikko Teaching Hospital, National Ear Care Center Kaduna, National Eye Center Kaduna, Nigeria Army 44 Reference Hospital, First care Medical Diagnostic Medical Diagnostic Department Giwa Hospital all located within Kaduna metropolis. A total of 70 questionnaire was issued to Radiographers and Radiologist and collected and analysed base on their responses.

Purposive sampling technique was employed to extract the sample from the population.

Purposive sampling results in a varied set of participants. Theoretically, this sampling technique achieves fruitfulness in understanding the issues identified in the early analysis of the data, or who could address aspects of the inquiry that remained underdeveloped or thin. The data captured was analyzed using SPSS version 20. Results were presented in Frequencies and percentages. Descriptive statistics include summary measures and frequency tables

The tables and figures below are the results obtained from the questionnaires distributed and collected from the study respondents which helped in accomplishing the objectives of the research. The data are presented in line with the sequence of the objectives.

The study was carried out in six hospitals, four public and two private, the total number of questionnaires distributed were 60 (100.0%) and only 52 (86.70%) were successfully collected.

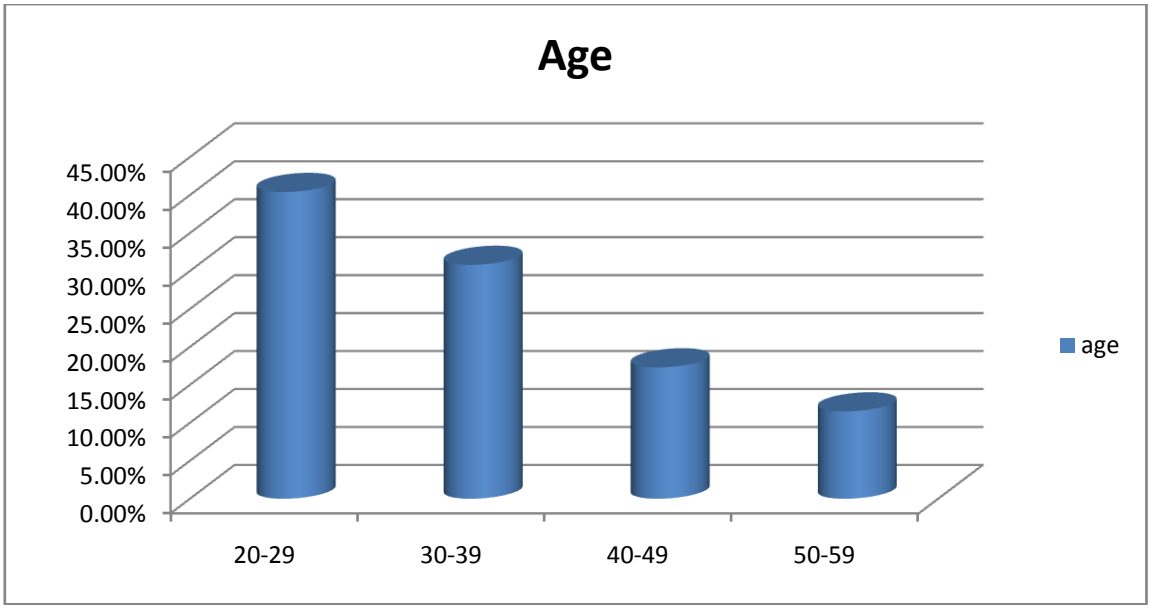

Figure 1 Distribution of respondent age

The above charts shows that respondent between the age of 20-29 have the highest frequency of 21(40.4%), followed by respondent between the age of 30-39 with frequency 16(30.8%), respondent between the age of 40-49 have frequency 9(17.3%) and the least respondent are between the age of 50-59 with frequency of 6 (11.5%).

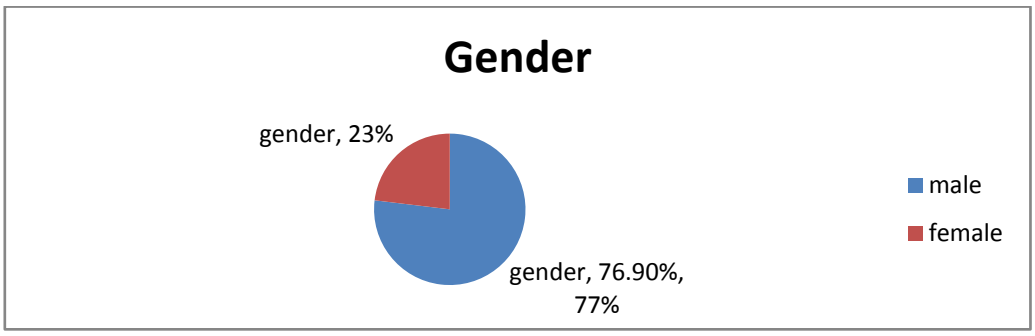

Figure 2 Distribution of respondent by Gender

The above pie chart shows that male respondent have the highest frequency of 40(76.9%) and female with frequency of 12(23.1%).

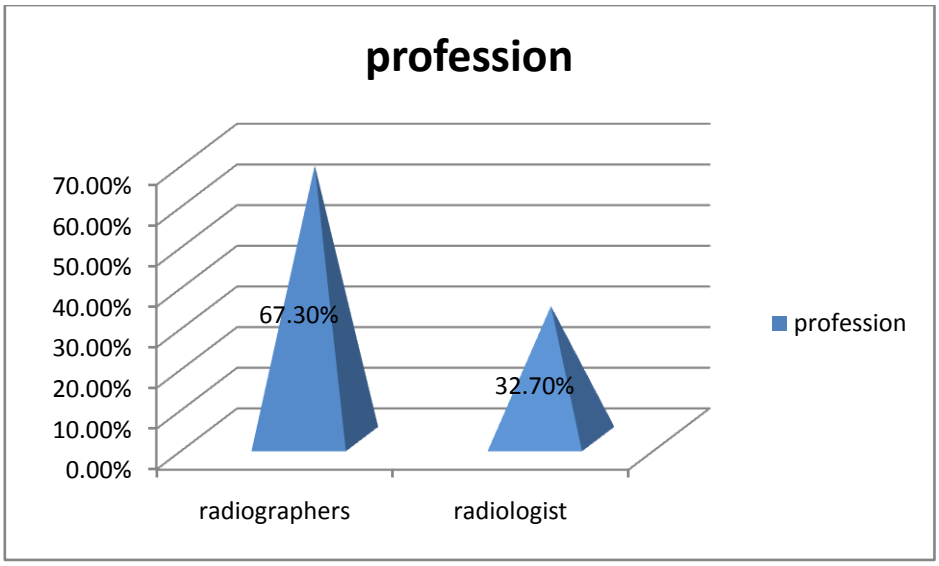

Figure 3 Distribution of respondent by their Profession

The above shows that respondents with highest frequency of 35(67.3%) are Radiographers and respondent with frequency of 17(32.7%) are Radiologist.

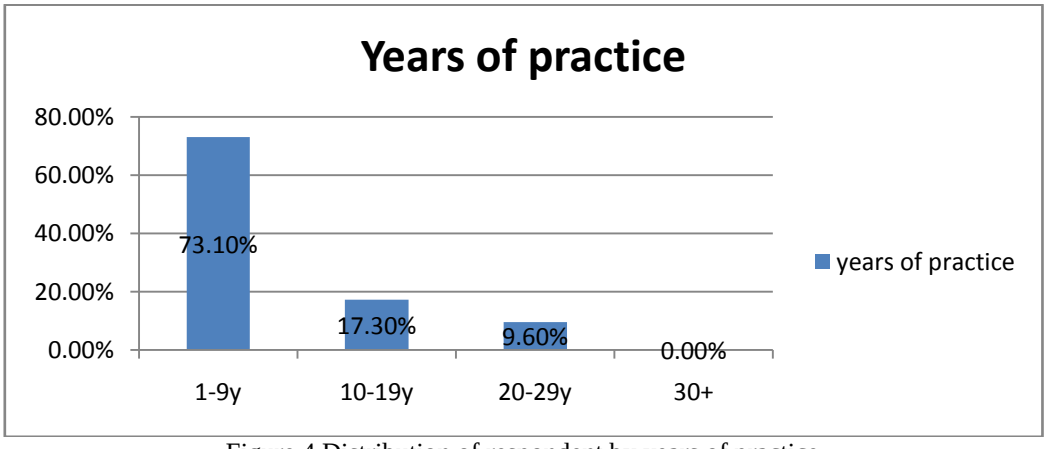

Figure 4 Distribution of respondent by years of practice

The chart above shows that majority of respondents are between 1-9 years of practice with frequency of 38(73.1%) and the least are between 20-29years with frequency of 5(9.6%).

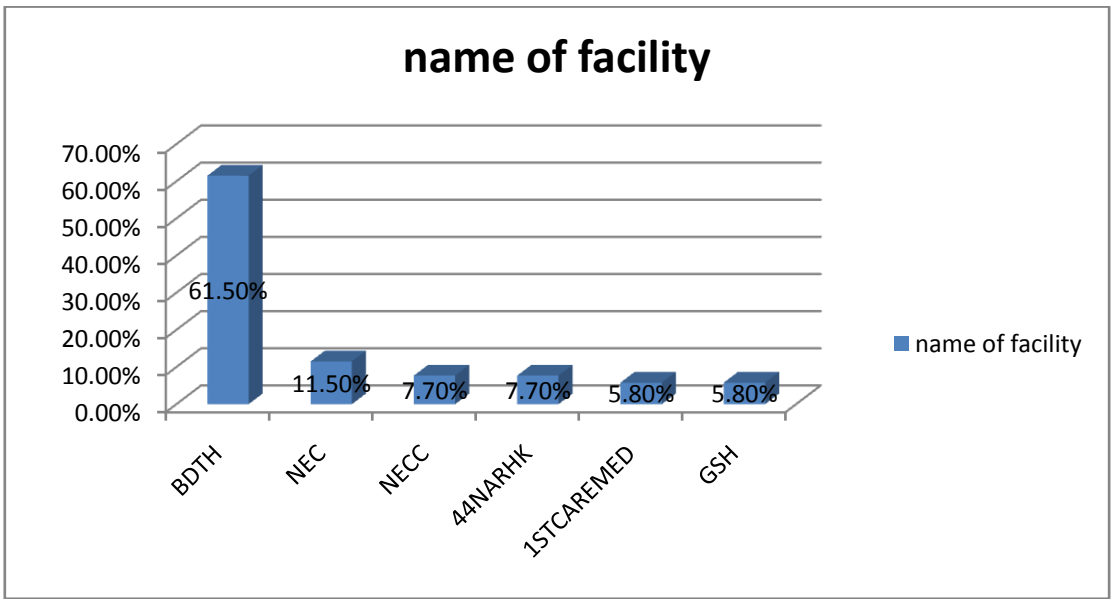

Figure 5 Distribution of respondent by Workplace

The chart above shows respondents from various hospitals or facilities, respondents in BDTH have frequency of 32(61.5%), NEC have frequency of 6(11.5%), NECC have frequency of 4(7.7%), 44NARHK have frequency of 4 (7.7%), 1ST CARE-MED have frequency of 3(5.8%) and GSH have frequency of 3(5.8%).

SECTION B:

Table 1: Awareness of Digital imaging and Teleradiology

Variables	**Response**	**N**	**%**
Have you ever had formal training on digital imaging?	Yes	28	54.9%
	No	23	45.1%
Do you feel that Information and Communication Technology ICT can transform Radiology services from Analogue to Digital?	Yes	50	96.2%
	No	02	3.8%
Teleradiology is the transfer of images from one place to another for interpretation or consultation.	True	52	100.0%
	False	0	0.0%
PACS is a system used for the storage, distribution and review of medical images.	True	52	100.0%
	False	0	0.0%

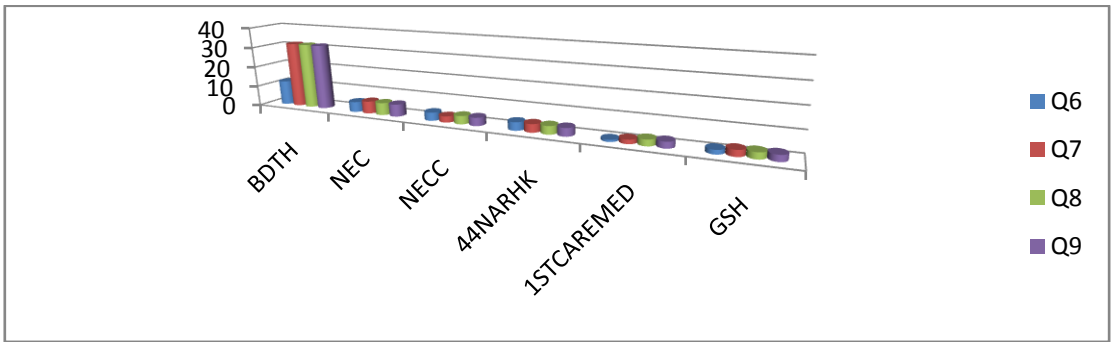

Figure 6: Application in various Hospitals

Table 2: Implementation of Digital Imaging and Teleradiology

Variables	**Response**	**N**	**%**
Do you know of any Government policy on Telemedicine services e.g Teleradiology or on ICT for health?	Yes	10	%
	No	41	
Modality present	Computed tomography	48	
	Magnatic Reasonance Imaging	10	
	Computed Radiography	51	
	Digital Radiography	40	

	Digital Mammography	17	

SECTION D: Table 3: Practice of Digital imaging and Teleradiology

Variables	Response	N	%
Do you practice Digital imaging in your facility?	Yes	49	96.1%
	No	2	3.9%
Do you provide Teleradiology services in your facility?	Yes	11	21.6%
	No	40	78.4%
The use of computed Radiography CR	Yes	49	94.2%
	No	3	5.8%
The use of digital Radiography	Yes	43	82.7%
	No	9	17.3%
The use of picture archiving and communication system (PACS)	Yes	21	40.4%
	No	31	59.6%
Use of Radiology Information System RIS	Yes	4	7.8%
	No	47	92.2%
The use of internet e.g. local area network	Yes	27	52.9%
	No	24	47.1%

Figure 8: Practice base on Hospitals

Table 4: Modalities in various hospitals

Variables	BDTH	NEC	NECC	44NARHK	1ST CARE	GSH
Computed tomography	100.0%	100.0%	0.0%	100.0%	100.0%	100.0%
Magnetic Resonance Imaging	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%
Computed Radiography	100.0%	83.3%	100.0%	100.0%	100.0%	100.0%
Digital Radiography	96.9%	16.7%	0.0%	100.0%	33.3%	100.0%
Digital Mammography	21.9%	0.0%	0.0%	100.0%	100.0%	100.0%

The table above shows that all the 6 hospitals within the study have computed Radiography, 4 have Computed Tomography and 2 have MRI, Digital Radiography and Digital Mammography.

II. Conclusson And Recommendation

utilization of digital imaging is crucial among Radiographers and Radiologist. This is paramount as the world is witnessing great transformation in the area of ICT affecting virtually all sectors including Health. According to (Rahman, 2016) he stated that, This is technology era and its use in health sector will improve general people health status and also their living standard. Findings from this study revealed that majority of the respondent have knowledge on digital imaging and Teleradiology. 54.9% (n= 28) of the respondent had formal training on digital imaging and Teleradiology this may be because majority of the hospitals have modern modalities that acquires image digitally and staff always undergo training after installation of such imaging modalities. This is in line with a study conducted by (Nyathi et al., 2010) where the results showed that the participants are familiar with digital radiography and have embraced this relatively new technology. Lack of formal training on digital imaging can easily affect the efficiency of staff , can as well lead to frequent damage of the equipment as a result of poor handling and operation and inability to harnessed all the features of the equipments for better services.

From this study, it's apparent that knowledge of digital imaging and teleradiology is encouraging among radiographers and radiologist even though there are no adequate available equipment to harnessed the full potentials of the digital imaging practice in the hospitals. Also, majority are ignorant of any established policy either by the government or in by the hospitals. There is absence of teleradiology practiced within the metropolis.

Following the outcome of the study, is apparent that there is need for awareness and investment in digital imaging and teleradiology in Nigeria. Health care institution should be encourage to adopt the innovation as that will greatly improve healthcare delivery system in the country Equipment manufacturers can encourage installation of the technology and provide education and training with respect to operation and quality as hospitals migrate from film screen to filmless imaging.

Reference

[1]. uffermann, W. F., Chetlen, A. L., Sharma, A., Colucci, A. T., Dequesada, I. M., Grajo, J. R., … Sherry, S. J. (2013). Mobile Computing for Radiology. *Academic Radiology*, *20*(12), 1495–1505. https://doi.org/10.1016/j.acra.2013.09.009

[2]. Bargale, S., Ardeshana, A., Patel, N., Karri, A., Sikligar, S., & Tailor, B. (2017). Assessment of Digital and Conventional Radiographic Practice amongst the private dental practitioner of Vadodara City. *Int. J Oral Health Med Res*, *3*(6), 27–30. Retrieved from www.ijohmr.com

[3]. Binkhuysen, F. H. B., & Ranschaert, E. R. (2011). Teleradiology : Evolution and concepts. *European Journal of Radiology Journal*, *78*, 205–209. https://doi.org/10.1016/j.ejrad.2010.08.027

[4]. Javis L, Stanberry B. Teleradiology: threat and opportunity? clin Radiol. 2005 Aug:60(8): 840-5

[5]. Blaya, J., Holt, B., & Fraser, H. S. F. (2008). *Evaluations of the Impact of eHealth Technologies in Developing Countries : A Systematic Review Methods*. usa.

[6]. Boland, G., Schlakman, J. T., & Thrall, J. H. (1998). PACS: A Guide to the Digital Revolution. *Elsevier ScienceDirect*, *28*, 523–560.

[7]. Puech PA, Boussel L. Belfkih L, Douek P, Beuscart R. DicomWorks: Software for Retrieving DICOM Studies and Promoting Teleradiology. J Dijit imaging 2007 Feb 28.

[8]. Diwakar, N. R., & Kamakshi, S. S. (2015). Recent advancements in dental digital radiography. *Journal of medicine,Radiology & Surgery*, *1*(4), 11–16. https://doi.org/10.15713/ins.jmrps.22

[9]. Dwyer SJ III, Templeton AW, Batnitzky S. teleradiology: hardware and communications. AJR 1991; 156: 1279-1282

[10]. Erik R Ranschaert. (2016). *The impact of information technology on radiology services*. University of Antwerp. https://doi.org/10.13140/RG.2.1.4799.9603

[11]. Ferdous, A. M. (2017). *Scopes and challenges of implementing Telemedicine in a developing country like Bangladesh*. The Arctic University of Norway.

Rad. Ahmed Adamu, et. al. "Assessment of Utilization of Digital Imaging and Teleradiology in Nigeria: A Case Study of Kaduna Metropolis Hospitals." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(10), 2022, pp. 32-40.