Original Article

Health Impact of the Proliferation of Ultrasound Machines in a Community

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ABSTRACT

The application of ultrasound technology in medicine without doubt was a great medical innovation. This technology has provided an efficient use of sound waves for investigative purposes in medicine and has produced accurate reports when used and reported thereafter by trained specialists. In the hands of trained health care providers, ultrasound technology is an awesome instrument helping in the proper diagnosis of disease of internal organs without any major side-effects, complications or overdose as may occur in x-ray modulated investigations. The technology uses the generation of high frequency sound waves to function, no radiation involved, hence it is very safe and investigations can be repeated frequently with no side effects. However, because of the availability of the machines and its safety profile, just about anybody that can afford one can purchased it and release reports with no regard to accuracy, and subsequent impact on the trusting populace. This study aims to show the cadre of professionals that has these machines in their facility and who interprets their findings.

Keywords: Health professional, Medical reports, Side-effect, Ultrasound machines

INTRODUCTION

It is reported that across the world, millions of ultrasound investigations are done yearly. In the UK alone, in the year 2018, the NHS claimed that well over 43 million people had such imaging investigations done. [1]. Without doubt, the reports and results emanating from these millions of investigations have helped health care providers worldwide. But, these tests must be done and interpreted by experts trained in the use of ultrasonography. The year 1794 marked possibly the first time that the term and usage of ultrasound technology came into being. Here, researcher Lazaro Spallanzani reasoned that flying night bats utilized sound for direction rather than vision.By 1880, works by researchers; Brothers; Jacques and Pierre Curie laid the path ways to the development of the first machine that actually generated ultrasound wave.Further down the decade, by 1928, a Russian researcher S.Y. Sokolov invented an ultrasound producing machine for use in industrial metallic works, but not for human use.

It was the American, George Ludwig, in 1949 who first reported that used ultrasound technology in diagnosing hepatic gall stones in humans; a great milestone. Then by 1956, the Scottish obstetrician and gynaecologist Ian Donald finally used this new emerging technology in modern obstetrics and gynaecology (OBGYN) specialty in determining the bi-parietal skull diameter of a foetus in-utero.[1-6] In

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1963, Ian Donald in collaboration with John MacVicar; an obstetrician and gynaecologist and Tom Brown; an industrial engineer, built the first commercial ultrasound machine called the Diasonograph.[7] Ultrasounds are sound waves that are greater than 20KHz in frequency and this marks the upper audible frequency in human beings.[4] This innovative technology has found immense use in medical practices where it can be used to assess muscles, tendons, and a host of internal organs to assess their well-being.

The resultant machines are inexpensive and may even be portable for easy movements, making it possible to be used in rural and sub-urban areas where most of the populace actually live. With advancement in technology, there has been development of several types of ultrasound machine systems with different functions. These include Veterinary machines for use in the veterinary industry, Vascular and Echocardiography machines for examining the heart, blood vessels, cardiac valves and arteries, Console which is a machine, on movable wheels and Portable machines that may even fit in a computer bag.[8] These different machines come in four categories; So, we have 2D ultrasound machines which are the most common and gives real-time imaging; 3D ultrasound machines that gives better quality images; 4D ultrasound machines that ensures the highest quality colour images; and finally, the Doppler ultrasound machines that are used to check the flow of blood inside the vascular tree.[9]

The average cost of a functional machine ranges from N250,000 for a 6 in 1 Hydra facial machine to as much as N5million for a 4D colour Doppler machine with varying prices in between. Some portable machines may be as low as N170,000. [10,11] The costs mentioned above are possibly affordable by most health care providers who need to acquire these machines. This probably has led to high proliferation of these machines in many medical facilities. Also, the availability of loan facilities has also been of great help to the practitioners that desire to purchase these machines, but the wide distribution of these machines comes with its own serious impact on the unsuspecting population who will need these services.

The challenge of who actually performs the ultrasound examination on a patient comes to the table. Is this "sonographer" really trained, or is he/she a self-trained "specialist"? Can anyone truly trust the results that are turned out by these numerous sonographers that are found everywhere doing ultrasound investigations? It has been a recognized fact that a good and probably a correct report of an ultrasound examination depends greatly on the skills of the operator as well as his experiences in performing such imaging investigations.[12-14] The expected high technical skills and vast experiences should be linked with the knowledge of the physiological and pathological alterations that can take place in the examined organ. [12,15]

The health implication of having an ultrasound report of a patient that has been given a wrong impression can be devastating if it is acted upon by the attending physician. And this is one major reason why examinations should be done by trained personnel who would give out detailed results that can be acted upon by the attending physicians. A study by Shwayder reported the legal endpoints of some reported ultrasonographic investigations and found out that most physicians simply accept the results dished by sonographers without taking a look at the usually attached films of the images. He suggested that at all times, a referring physician should examine the images, or repeat the scan by himself, if he knows what to do or how to do it, or better still refer to specialist radiologist for second opinion.[16] Therefore, a good report must be seen to have made adequate efforts to answer the medical questions that originated the investigation. It is expected to be focused, concise, clearly written out, and preferably may suggests possible differentials and further investigations if need be.[17]

It is because of our concerns premised on the chilling knowledge and facts that ultrasound machines can be found, in fact are located in many hospitals, clinics, nursing homes and maternity homes that are owned by private individuals that this research has emanated. Our interest is singularly to identify the cadre of the sonographers in these numerous places and may then extrapolate on the kinds of expertise,

skills and knowledge available to these personnel. A visit on named health facilities in Warri metropolis, in Niger-Delta Region of Nigeria that offers ultrasound services and the personnel performing their scanning was documented. Also, their level of education and possible expertise in their radiological findings was also documented.

MATERIALS AND METHODS

This study aims to determine the cadre of personnels involved in carrying out ultrasound examinations in different health facilities and then extrapolate on the kinds of expertise, skills and knowledge available to these personnel. This was a cross-sectional study where data was collected from one hundred and three (103) health facilities using a mixed questionnaire with both open and closed ended questions. The study was carried out in Warri and its environs. Warri is a major crude oil rich city located in Delta state, Southern Nigeria. It is regarded as the commercial hub of the state and is home to several companies and also houses a sea port and a petroleum refinery. Due to the commercial nature of the city, many surrounding towns like Effurun, Osubi, Agbarho, Okuokoko have also grown to merge with it. These surrounding towns were also included in the study.

RESULTS

One hundred and twenty (120) questionnaires were distributed, out of which one hundred and three (103) were retrieved with a return rate of 85.8%.Majority of respondents 90 (87%) were in private facilities, while 10 (10%) were in government hospitals. This is depicted in Figure 1, which shows the distribution of facility type.

Figure 2; shows the sex distribution of the respondents. A vast majority of the respondents were males numbering 72 (70.0%) as compared to females 31(30.0%).

The age distribution of respondents is shown in Figure 3. The age range of the respondents was between 18-60years, with the 31-40yrears age bracket constituting the largest group 43(41.7%), followed by the 41-50years 33(32.0%), 18-30years 19(18.4%). The smallest group 8(7.8%) was in the 51-60years age bracket.

The educational qualification of respondents is depicted in Figure 4. Majority 63 (61.2%) were medical school graduates, 14(13.6%) were doctors who had done specialized training in radiology, while 8(7.8%) were radiographers with no additional training in sonography. 6(5.8%) were radiographers with additional training in sonography. While 12(11.7%) had non-specific qualifications.

Table 1 displays the years of experience of respondents in ultrasound scanning. A large proportion 71(68.9%) of the respondents had less than five years ultrasound scanning experience. 21(20.4%) had 6-10yrs experience in ultrasound scanning while only 8(7.8%) and 3(2.9%) respondents had 11-20yrs and >20yrs experience in ultrasound scanning respectively.

Figure 5 shows that among the non-radiologists (n=89), those that claim to verify their results from a radiologist before the results are sent out are 66 (74%), while 23 (26%) do not get their results verified.

The categories of persons who refer patient to these health facilities are illustrated in Figure 6. Doctors and nurses constituted the largest sources of referral; 71 (68.9%) and 68(66%) respectively. Self-referred patient 57(55.3%) was also relatively high compared to those from traditional birth attendants 40(38.8%).

Table 2 shows the various types of ultrasound machine used by the respondents. The types of ultrasound machine used is quite varied however Mindray product 17(16.5%) seemed to be the commonest in the study area.

With regards to preferred type of ultrasound machine (Table 3), a vast number 59 (54.37%) had no preference while 27 (26.21%) preferred machines with Doppler/duplex capabilities. Similarly, a huge number of the respondents 60(58.25%) did not state any particular reason for their preference, while 16(15.53%) also stated Doppler/duplex capabilities as their reason for preference.

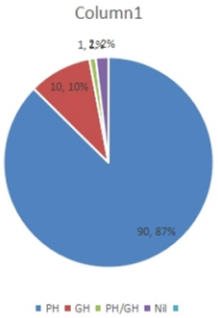

Figure 1: Distribution of facility types studied

PH – Private hospital

GH – General Hospital

PH/GH – one of the respondents wrote PH/GH

Nil – Two of the respondents didn't indicate

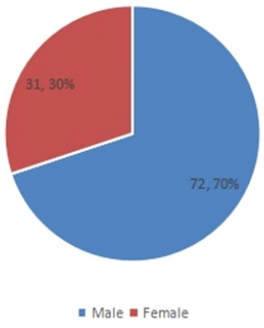

Figure 2: Sex distribution of respondents

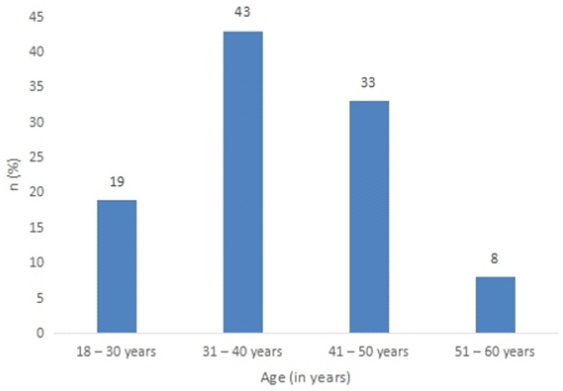

Figure 3: Age distribution of respondents

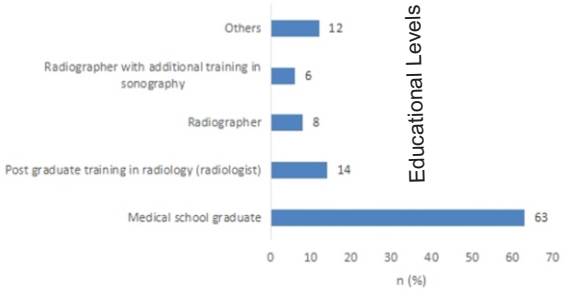

Figure 4: Educational qualification of respondents

Table 1: Years of experience in ultrasound scanning among respondents

Years of practice		
< 5 years	71	68.9
6 –10 years	21	20.4
11 – 20 years	8	7.8
> 20 years	3	2.9

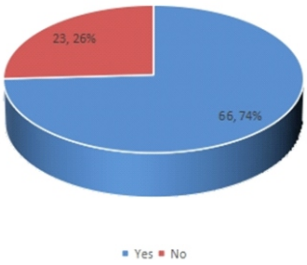

Figure 5: Radiologist verification of ultrasound report findings done by non-radiologists (n = 89)

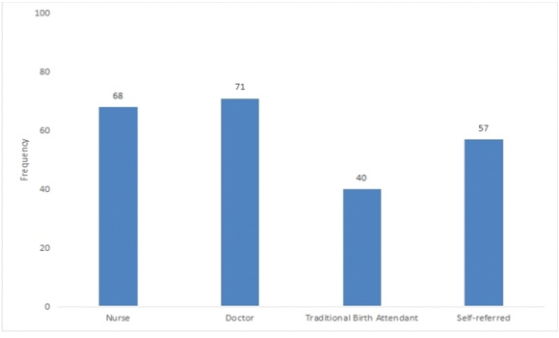

Figure 6: Sources of referrals among respondents

* multiple response

Table 2: Type of US machine in use (n = 103)

Type of US machine in use	Frequency	Percentage
2D	6	5.83
3D	2	1.94
4Da	2	1.94
Accuvix X6 (Samsung)	3	2.91
Apollo 7 table top	6	5.83
Chison ECOI	2	1.94
Contex MS US machine	3	2.91
Digital portable BW pocus	1	0.97
DW - 580 US Machine	4	3.88
GE Logiq 100 Portable US	2	1.94
German machine	1	0.97
HDII XE US (Philips)	2	1.94
Kisian digital portable US machine	2	1.94
Logic P5 (3D)	2	1.94
Mindray	17	16.50
Philips CX50	5	4.85
portable US	4	3.88
Samsung U6	3	2.91
Siemens	1	0.97
Sonoace X8 US machine	2	1.94
Sonoline S1 - 450	3	2.91
sonon scan	1	0.97
Sonoscape A6	1	0.97
Sonostar	4	3.88
Table top	15	14.56
Toshiba with doppler	1	0.97
UF - 450Ax	1	0.97
various types	2	1.94
WELD-Digital US Machine	1	0.97
No response	6	3.88

Table 3: Preferred type of ultrasound machine and Associated Factors.

Variable	Frequency	Percentage
Preferred type of ultrasound machine		
US machine with doppler/duplex capabilities	27	26.21
Siemens	9	8.74
3D	3	2.91
Mindray	2	1.94
4D	2	1.94
table top	1	0.97
Sonoline S1-450	1	0.97
logiq P5	1	0.97
German	1	0.97
No preference	59	54.37
Reasons for preferred US machine		
Doppler and duplex capabilities	16	15.53
Better/higher resolution	9	8.74
Good visualization/better image quality	6	5.83
better resolution	4	3.88
user friendly	2	1.94
Suitable for all kind of investigation	1	0.97
Better revolutions	1	0.97
Specific	1	0.97
Simplicity	1	0.97
Accuracy	1	0.97
Affordability	1	0.97
No preference	60	58.25
For Non-radiologists, does a radiologist verify findings before final result is given to patient? (n = 89)		
Yes	66	74.15
No	23	25.85
If yes, how often? (n = 66)	27	40.9
All the time	33	50.0
Sometimes	6	9.1
Only when I am not sure of the diagnosis		

DISCUSSION

Ultrasonography requires the use of intelligence, a practice of hand-eye coordination skills, medical knowledge and experience.[18] Ultrasound practitioners come from a wide range of professional backgrounds which include radiologists, radiographers, sonographers, nurses, midwives, physiotherapists, obstetricians and clinical scientists.[18-20] In this study, a total of One hundred and twenty (120) questionnaires were distributed, out of which one hundred and three (103) were retrieved with a return rate of 85.8%). Warri is a big city with widely spread diagnostic and health care facilities. It is possible that the fairly low costs of these machines had contributed immensely to its availability widely in the health practice environment.

Majority of respondents 90 (87%) were in private facilities, while 10 (10%) were in government hospitals. This is likely due to the fact that more private facilities exist as against the few government facilities. Although an individual wrote both private and government indicating that he works in both facilities. The availability of financial loan facilities with various willing financial facilities had also been of great help to the practitioners that desire to purchase these machines but the wide distribution of these machines comes with its own serious impact

on the unsuspecting population who will need these services.

The usefulness of an ultrasound examination depends on the experience and knowledge of the operator. In other words, the imaging modality is operator dependent. The challenge of who actually performs the ultrasound testing on a patient comes to the table. Is this "sonographer" really trained, or is he a self-trained "specialist"?. Of note is that majority of respondents 63 (61.2%) were medical school graduates, 14(13.6%) were doctors who had done specialised training in radiology, while 8(7.8%) were radiographers with no additional training in sonography, 6(5.8%) were radiographers with additional training in sonography, while 12(11.7%) had non-specific qualifications. This is in keeping with a study conducted in Enugu/Abuja where majority of practitioners had either a basic medical qualification (MBBS) or Bachelor of Science (BSc) in medical radiography (30% and 32.5% respectively).U4 In another study, majority of the respondents were radiographers, followed by radiology residence, while radiologist, sonographers and nurse were found to be the least among the respondents having contributed 3.12% each to the respondents respectively.[18]

In the hands of a poorly trained or an untrained operator, ultrasound may be misleading and even dangerous because of misinterpretation and may lead to an erroneous diagnosis.[18]

The health implication of having an ultrasound report of a patient that had been given a wrong impression can be devastating if it is acted upon by the attending physician. It is therefore important for non-radiologist to verify their report before it is given out. This is one major reason why the screening should be done by trained personnel who would give out detailed results that can be acted upon by the attending physicians. In this study, among the non-radiologists (n=89), those that claim to verify their results from a radiologist before the results are sent out were 66 (74%), while 23 (26%) do not get their results verified.

It had been a recognized fact that a good and probably a correct report of an ultrasound test depends greatly on the skills of the operator as well as his experiences in performing such imaging investigations.[12-14]

The expected high technical skills and vast experiences should be linked with the knowledge of the physiological and pathological alterations that can take place in the examined organ.[12,15s]

Ultrasound is neither widely available nor routinely used in the majority of low- and middle-income countries.[21] in this study ultrasound was readily available as compared to another study conducted by Eze et al. which was poor within the period studied.[22] This study was conducted more than a decade ago as compared to this study so may not be a good comparison.

Radiographers are required to undergo additional training in other to perform certain special ultrasound procedures like small parts examination; as their practice is also limited when it comes to invasive procedures such as biopsy.[18] A large proportion 71(68.9%) of the respondents had less than five years ultrasound scanning experience and this will require more supervision by more experienced persons in order to avoid misdiagnosis.

The commonest ultrasound machine was the Mindray with a total amount of 17(16.50%), followed by Table top with15(14.56%) respondents, 2D ultrasound machine and Apollo 7 table top had a total of 6(5.83) respondents respectively. A lot of variety of ultrasound machine was found in this study as opposed to a previous study where none of the respondents had either of the following advanced ultrasound modality: 3D, four dimensional (4D), echocardiography and sonoelastography in their place of work but only two-dimensional (2D) ultrasound.[18] Mindray ultrasound machine is common among the respondent probably due to the fact that it is cheap, easy to maintain and with good resolution.

CONCLUSION

The cadre of personnel that operate the ultrasound machines in Warri are both radiographers, radiologist and others. A good percentage of non-radiologist verify their results. A variety of ultrasound machine exist in this locality irrespective

of the cost.

Recommendations

Radiographers and radiologists should undergo regular training in order to update their knowledge.

Those with less than five years of experience should be mandated to work under a supervisor.

REFERENCES

1. The History of UltrasoundVisla-health.co.uk/blog/history-ultrasound 11th August 2020. cited 06/05/2023
2. History of Ultrasound in Medicine(Nadr.ljanski M., Murphy A., Bell D. Et alradiopaedia.org/articles/history-of-ultrasound-in-medicine https://doi.org/10.53347/r1D-8660 accessed 06/05/2023
3. Campbell S. A Short history of sonography in obstetrics and gynaecology. Facts Views Vis obgyn.2013; 5(3):213-29. PMID: 24753947; PMCID:PMC3987368Ncbi.nlm.nih.goo/pmc/articles/pmc3987368/.
4. Ultrasound. Wikipedia.en.wikipedia.org/wiki/
5. The History and uses of Ultrasound machinesImpilomedicalsystem.co.za/the-history-and-uses-of-ultrasound-machines/
6. Who invented Ultrasound?CME Science.April 5,2018? www.cmescience.com/who-invented-ultrasound/accessed October 2022
7. Michelle Millar Fisher, Amber Winick. A brief history of the sonogram.Smithsonianmag.com/innovation/a-brief-history-of –the-sonogram-180978732/https://www.smithsonianmag.com/innovation/a-brief-history-of-the-sonogram-180978732/accessednovember 2023.
8. 4 different types of ultrasound machines. National ultrasound. National ultrasound.com/4-types-of-different-ultrasound-machines/. https://www.uscultrasound.com/blog/types-of-ultrasound-machines/ accessed August 22, 2024URL and date cited
9. What are the different types of ultrasound machines and their uses and application?USC ultrasound. uscultrasound.com/types-of-ultrasound-machines/https://www.uscultrasound.com/blog/types-of-ultrasound-machines/accessed August 22, 2024
10. Ultrasound machines in Nigeria. Jiji.ng/302-ultrasound-machines. https://jiji.ng/302-ultrasound-machine/accessed august 22 2024
11. Portable ultrasound machines in Nigeria. Jiji.ng/302-ultrasound-machines/portable. https://jiji.ng/302-ultrasound-machines/portable/cited august 22 2024
12. Pinto,A., Pinto, F., Faggaian et al. Sources in error in emergency ultrasonography.Crit ultrasound J5 (suppl. 1), S1 (2013). https://doi.org/10.1186/2036-7902-5-S1-S1 (the ultrasound journal. Springeropen.com/articles/10.1186/2036-7902-5-S1-S1) accessed 09/05/2023.
13. Robin Elise Weiss. 3 reasons why a foetal ultrasound may be wrong. Verywellfamily.com/reasons-your-ultrasound-is-not-good-enough-2760108. https://www.parents.com/signs-of-a-bad-fetal-ultrasound-8648898/cited may 2024URL and date cited
14. Wieczorek AP., Wozniak MM., Tyloch JF. Errors in the ultrasound diagnosis of the Kidneys, Ureters, and Urinary bladder. J.ultrason.2013sep; 13(54): 308-18.doi:10.15557/Jou.2013.0031.epub2013 Sep 30. PMID:26674139; PMCID:Pmc4603221. ncbi.nlm.nih.gov/pmc/articles/pmc4603221. Accessed 09/05/2023
15. Smereczynski A., Kolaczyk K., Pitfalls in ultrasound imaging of the stomach and the intestines. J ultrasound. 2018; 18(74):207-211. doi:10.15557/Joll.2018.0031.PMID:30451403; PMCID:PMC6442211.ncbi.nlm.nih.gov/pmc/articles/pmc6442211/. Accessed 09/05/2023
16. James M. Shwayder (2019). Ultrasound errors to avoid: How important is the report? Contemporary OB/GYN Journal vol 64 No 07.

Contemporary obgyn.net/view/ultrasound-errors-avoid-how-important-report. https://www.contemporaryobgyn.net/view/ultrasound-errors-avoid-how-important-report /accessed August 22, 2024URL and date accessed

17. Edwards H., Smith J., Weston M. What makes a good ultrasound report? Ultrasound 2014 Feb; 22 (1); 57-60. doi:10.1177/1742271X13515216. Epub 2013 Dec20. PMID:27433194; PMCID: Pmc4760516. ncbi.nlm.nih.gov/pmc/articles/pmc4760516/. Accessed 09/05/2023.
18. Sidi M, Sani GM,Ya'u A, Loshugno SS, Luntsi G. The current status of ultrasound practice in Kano metropolis, Nigeria. Egyptian Journal of radiology and Nuclear Medicine. 2021;52:212-220
19. The Royal College of Radiologist. The Society and College of Radiographer(2014) Standard for the provision of an ultrasound services. London. Available at:www.rcr.ac.uk. Accessed 25Nov 2020
20. Society and College of Radiographers and British Medical Ultrasound Society (2019) Guidelines for professional ultrasound practice. https://www-sor-org.webpkgcache.com/doc/-/s/www.sor.org/getmedia/00882406-9321-4b7d-b565-47262c2467de/2020.1.19_scor_bmus_guidelines_-.pdf_2 /accessed August 22, 2024URL and date accessed
21. Ginsburg AS, Liddy Z, Khazaneh PT, May S, Pervais F. A survey of barriers and Facilitators to ultrasound use in low-middle-income countries.Scientific Reports. 2023;13:3322-3333
22. Eze CU, Eze CU, Asogwa CC. A survey of quality of sonographic practice. British Journal of Healthcare Management. 2013;19(3):124-128.