KNOWLEDGE AND PRACTICE OF QUALITY ASSURANCE TESTING OF ULTRASOUND EQUIPMENT AMONG PRACTITIONERS IN NIGERIAN HEALTH FACILITIES

Mohammed Sidi, Rufa'I Gambo Isah, *Anas Ya'u

Department of Medical Radiography, Faculty of Allied Health Sciences, Bayero University, Kano Nigeria.

***Corresponding author:** ayau.radg@buk.edu.ng +2348066338046

ARTICLE INFO	ABSTRACT

Background: To provide optimal images for the diagnosis of various pathological conditions, ultrasound practitioners require good knowledge and practice of quality assurance of the ultrasound equipment.

Methods: This study was a cross-sectional conducted among ultrasound practitioners in West African population from March, 2020 to August, 2020. An informed consent was obtained from each respondent. A structured questionnaire was used as an instrument for data collection. The questionnaire was validated by experienced colleagues using content validity. The reliability of the measuring tool was tested using test-retest method and Cronbach's alpha reliability coefficient was found to be 0.86. All ultrasound practitioners outside the study area were excluded. Eighty questionnaires were administered to the respondents. Descriptive statistics was employed to determine the frequency distribution of all the responses using SPSS version 21.0.

Results: Out of the 80 (100%) administered questionnaires 79 (98.75%) were returned and 73 (91.25%) were properly filled.42 (57.5%) did not know what quality assurance is and 55 (75.3%) didn't know the components of ultrasound quality assurance. However, 53(72.6%) of the participants do carry out quality control test on their ultrasound equipment and 64(87.7%) perform checks brightness and contrast controls on the monitor.

Conclusion: This study found poor knowledge of ultrasound quality assurance among ultrasound practitioners. It however reported good practice of quality assurance among the study population.

Introduction

Ultrasound is an imaging modality that uses higher frequency sound waves (2-20 megahertz) to produce images of internal structures of the human body for the diagnosis and monitoring of disease conditions[1].It visualizes the organs by recording pulses (echoes) of the ultrasonic waves using high frequency ranges[2]. It could also be used as a guide for some interventional procedures and treatment follow up[1,3]. Some of the advantages of ultrasound imaging modality includes; not been associated with ionizing radiation, readily available, non-invasive, portability, relatively low cost and can be operated using the domestic power supply[1]. It is however, highly operator dependent and in most cases the findings are usually more suggestive rather than tentative diagnosis therefore; the usefulness of an ultrasound examination depends on the experience and the capability of the ultrasound examiner[4,5].

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities

Ultrasound is among the most rapidly advancing imaging techniques; advancesin equipment technology allow users to discover wide range of pathologic conditions with minimal image noise and improve resolution[6].It has various clinical applications which include obstetrics and gynecology, cardiovascular imaging, diagnosis of solid and cystic abdominal masses, small parts imaging, sonoelastography and musculoskeletal scan[1,7]. Increase uses of this modality are accompanied by an increase in need of knowledge and practice of quality assurance for the equipment to ensure accuracy and repeatability of the result[8].

Quality assurance (AQ) is defined as an effort being made by staffs operating a facility to ensure that the equipment persistently provides higher quality diagnostic images at relatively minimal cost and with the lowest dose of ionizing radiation, however, ultrasound does not use ionizing radiation, therefore quality assurance on ultrasound equipment mainly emphasize on higher-quality diagnostic images at lowest possible cost[7]. QA consists of quality control techniques and quality administrative procedures. The main objectives of QA are to ensure that the equipment functions as expected; safe for clinical use and performs consistently over time[9].Equipment quality assurance is essentially performed every day during routine scanning by the ultrasound practitioners, who should and can recognize major problems with the images and the equipment[10]. Equipment performance testing has been seen as the domain of the Medical Physics Department, involving extensive use of tissue mimicking phantoms (TMPs) and other test devices. Over time it has been recognized that sonographers have an essential role in the QA of ultrasound scanners[11]. Sonographers should note that in signing off a report, they are certifying that their equipment is fit for purpose[11].Therefore practitioners are supposed to take a leading role in demonstrating the consistency of performance of their equipment for the benefit of their patients[11].

The importance of evaluating the knowledge and practice of ultrasound quality assurance which is aimed at improving the quality of services cannot be over imprecise. However, empirical study shows that an evaluation of knowledge and practice of quality assurance on ultrasound equipment has not been performed in some centers in Kano metropolis, and a comprehensive literature searched showed no documented published work on knowledge and practice of ultrasound quality assurance in the study area. The absence of QA practice could undermine the diagnostic quality of ultrasound examination and exposed the operator to innumerable risks, including for the health of the patient. Findings of this study will serve as a reference baseline for making recommendations to the management or relevant authorities on how to improve the standard of QA practice among ultrasound practitioners so as to ensure adequate diagnosis and improve patient care delivery services. It will also serve as a guide for practitioners to know where they need to improve as regard to QA practice.The study aimed at evaluating knowledge and practice of ultrasound quality assurance among practitioners in West African population.

Materials and Methods

This study was a cross-sectional conducted among ultrasound practitioners in Kano metropolis, Nigeria from March, 2020 to August, 2020. An ethical approval to conduct the study was obtained from Human Research and Ethics Committee of Ministry of Health, Kano State (MOH/Off/797/T.I/1990). An informed consent was obtained from all the participants (Appendix I). A structured questionnaire was used as an instrument for data collection (Appendix II). The questionnaire was validated by experienced colleagues using content validity. The reliability of the measuring tool was tested using test-retest method; the questionnaire was administered to a single group of people on two separate occasions at two weeks interval. The relationship between the respondent scores from the two different administrations was estimated through statistical correlation and the Cronbach's alpha reliability coefficient was found to be 0.86. All ultrasound practitioners within Kano metropolis were included and those practicing not within the study area were all excluded from the study. Eighty questionnaires were distributed to the respondents. Knowledge score of 50% and above was considered to be good and less than 50% as poor in this study. Descriptive statistics was employed to determine the distribution of all the responses using SPSS version 21.0.

Results

Out of the 80 (100%) administered questionnaires 79 (98.75%) were returned and 73 (91.25%) of the questionnaires were properly filled.

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities
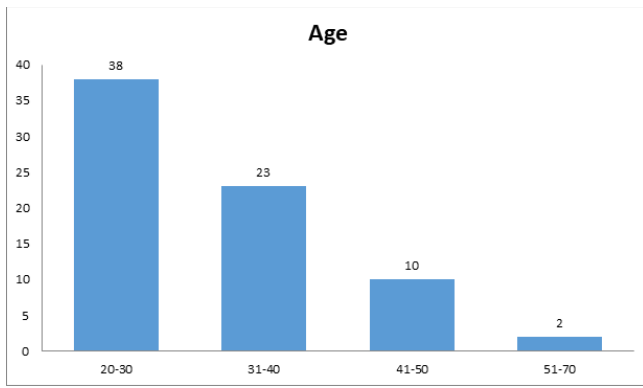
Figure 1: Age of the participants.

Figure 1 Shows that 38 (52%) of the participants were within the age range of 20-30 years, 23 (31.5%) were within the range of 31-40 years, 10 (13.7%) were within the range of 41-50 years while 2 (2.7%) were within the range of 51-60 years.
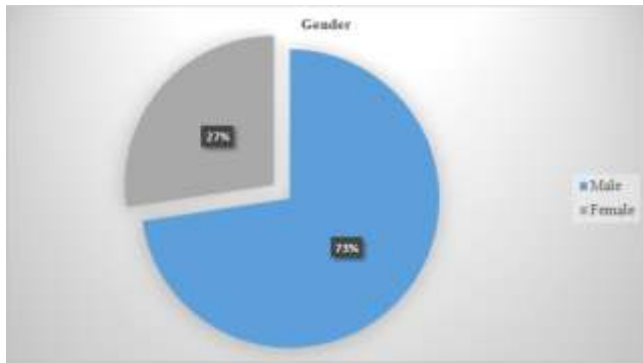

Figure 2: Gender of the participants

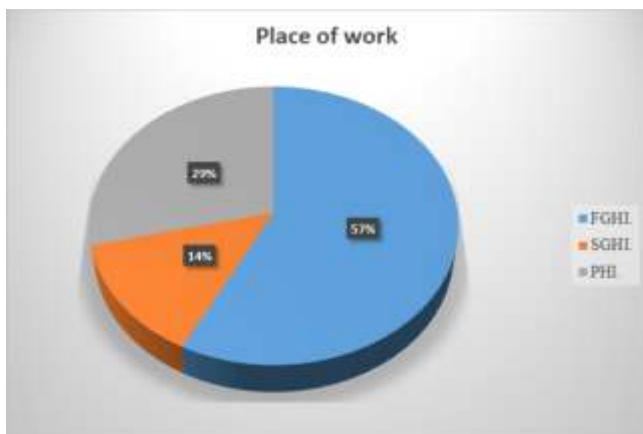Figure 2 Shows that 53 (73%) of the participants were male while 20(27%) were female.

Figure 3 Participants place of work

Figure 3 Shows that 42(57.5%) of the participants were working in Federal Government own Hospital 10(13.7%) were working with State Government Hospital while 21(28.8%) were working in Private Hospitals/Diagnostic centers.
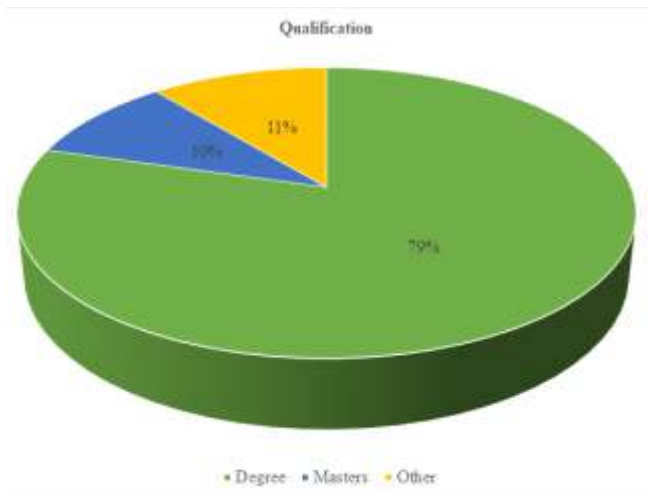

Figure 4: Qualification of the participants

Figure 4 Shows that 58(79.5%) of the participants have Bachelor's degree as their highest qualification 7(9.6%) have Masters while 8(10.9%) have other qualifications.
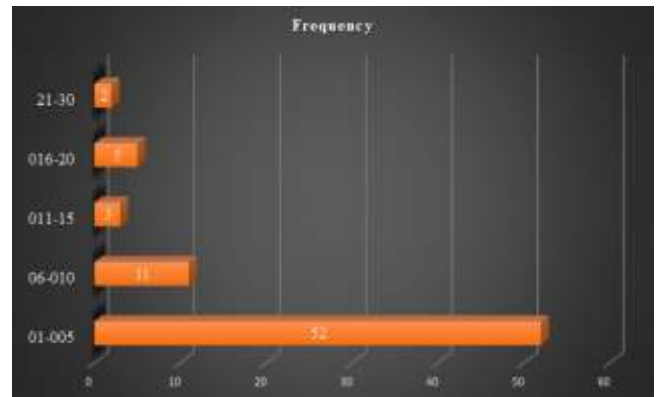

Figure 5: Work experience of the participants

Figure 5 Shows that 71.2% of the participants were within the range of 1-5years working experience,11(15.1%) were within range of working experience of 6-10, 3(4.1%) were within the range of working experience 0f 11-15, 5(6.8%) were within the range of working experience of 16-20 while 2(2.7%) were within the range of working experience of 21-30

Table 1 shows only 31(42.5%) of the participants knew the definition of quality assurance. Also 55(75.5%) of the participants didn't know what quality assurance consist of. However, 51(69.9%) of the participants considered infections control as part of quality assurance programme.38(52.1%) of the participants did not know any method of quality control (QC) tests. Only 15(20.5%) knew the common faults of ultrasound transducers. 43(58.9%) knew that maximum depth of penetration and contrast resolution are not the only test for accreditation.40(54.8%) of the participants

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities

are aware that phantoms are used for ultrasound equipment QC test.39(53.4%) did not know that quality control performance parameters for B-mode and Doppler mode ultrasound are different.

Likewise 41(56.2%) didn't know how often to check for transducers, transducer cable housing and transmitting surface for cracks, separations, and discolorations.

Table 1: Knowledge of ultrasound quality assurance among practitioners

Questions	Response	
	Positive N(%)	Negative N(%)
Q6. What is Quality assurance programme	31(42.5)	42(57.5)
Q7. Quality assurance programme consist of;	18(24.7)	55(75.3)
Q8. Do you consider infections control as one of the aims of quality assurance programme?	51(69.9)	22(30.1)
Q9. What method of quality control test do you know?	35(47.9)	38(52.1)
Q10.What is the common faults of ultrasound transducer?	15(20.5)	58(79.5)
Q11. Maximum depth of penetration and contrast resolution are only tests for accreditation	43(58.9)	30(41.1)
Q12.Are phantoms used in ultrasound equipment quality control test?	40(54.8)	33(45.2)
Q13.Are quality control performance parameters of B -mode and Doppler the same?	34(46.6)	39(53.4)
Q14.How often transducers, cable housing and transmitting surfaces should be checked for cracks, separations, and discolorations?	32(43.8)	41(56.2)

Table 2 shows that 53(72.6%) of the participants do performed QC test on their ultrasound equipment. Likewise 63(86.3%) of the participants do cleaned transducer from gel after each patient. However, 40(54.8%) of the participants does not performed streak line or cracks checks on ultrasound monitor.

64(87.8%) do checked for brightness and contrast controls on the monitor.58(79.5%) of the participants performs checks for transducer uniformity, while only 32(45.2%) performs distance measurement accuracy test.

Table 2: Level of quality assurance practice on ultrasound equipment by practitioners

Questions	Response	
	Positive N(%)	Negative N(%)
Q15. Do you carry out quality control test on yourultrasound equipment?	53(72.6)	20(27.4)
Q16. How often do you clean transducer from gel?	63(86.3)	10(13.7)
Q17. Do you check monitor for streak or inspected crack?	33(45.2)	40(54.8)
Q18. Do you Check brigh tness and contrast controls on the machine monitor?	64(87.7)	9(12.3)
Q19. Do you check for transducer uniformity?	58(79.5)	15(20.5)
Q20. Do you perform distance measurement accuracy?	33(45.2)	40(54.8)

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities

Discussion

As indicated in Figure 1, the findings of this study shows that majority of the participants 52% were within the age range of 20-30 years. This finding might serve as an indicator that ultrasonography profession is very young in the study area since must of those practicing in the field are at their mid-years of age. The findings of this study as shown in Figure 2, also shows vast majority 73% of the participants to be male. The possible explanation to this disparity may be as a result of sociocultural factors of the study population, were male to female ratio in both schools and places of work are very high, hence, the gender disparity. As indicated in Figure 3 higher proportion of the participants 57% were working in tertiary hospitals. This is probably because tertiary hospitals are used for training Radiology residence and intern Radiographers. Figure 4 shows most of the participants 79.5% has bachelor's degree as their highest qualification. On the same vein Figure 5 Shows that 71.2% of the participants were within the range of 1-5years working experience. The implication of these findings is that our participants are probably less might be less experience considering their years of working experience, therefore may lack technical knowhow to be able to carry out some basic QA procedures without the guidance of more experience personnel.

The findings of this study as indicated in Table 1 shows only 42.5% of the participants knew the exact meaning of quality assurance. Also 75.5% of the respondents didn't know what quality assurance actually consist of. These findings imply ultrasound equipment in the study area were most likely been operated without a proper quality assurance plan in place which may probably undermine the quality of images produced by the equipment and the subsequent inference derived from such images thereby increasing the risk of incorrect diagnosis. Promoting and facilitating QA assurance program is essential in producing images with optimal diagnostic quality[12]. Itis often suggested that the greatest risk to the patient is that of misdiagnosis: this emphasizes the need for standardized assessment of imaging ability and the use of QA procedures[13]. However, 69.9% of the participants considered infections control as part of quality assurance programme as shown in Table 1. This is probably because proper infection control is a known practice that curt across every unit in the field of medicine and the consequences of not observing it is almost known to all personnel. As indicated in Table 1, 52.1% of the participants did not know the methods of quality control (QC) test. The implication of this finding is that optimal operational condition of the ultrasound equipment in the study area was not guaranteed. For an effective quality control test, practitioners most know the methods involve in QC test. QC ensures that the equipment is operating at optimal operational condition by providing the required diagnostic information[14]. Also, Table 1 show only 20.5% knew the common faults of ultrasound transducers. This is alarming as each practitioner is expected to demonstrate good knowledge of common ultrasound transducer faults been it one of the most essential and expensive part ultrasound. It is evidenced that transducers in clinical practice are subject to degradation in performance with annual failure rates of 10 – 13 % or unacceptably high incidence defective transducers of 40 % of detected defective transducers[15,16]. However, as demonstrated in Table 1 the results of this study shows 58.9% of the respondents knew that maximum depth of penetration and contrast resolution test are not the only test to be carried out during accreditation. This might not be unconnected with the interest of both the management and practitioners in ensuring that their facility scale through the accreditation process by the regulatory body. More than fifty four percent (54.8%) of the participants are aware that phantoms are used for ultrasound equipment QC test as shown in Table 1. Meanwhile as shown in Table 1, 53.4% of the participants did not know that quality control performance parameters for B-mode and Doppler mode ultrasound were different. This is probably because most of the ultrasound equipment maned by the respondents does not have Doppler software facility. Likewise, 56.2% of the participants were not aware of how often to check for transducers, transducer cable housing and transmitting surface for cracks, separations, and discolorations. The implication is that transducers that become defective might not be detected on time which may lead to several patient misdiagnosis or under-diagnosis.

The results of the study as shown in Table 2, shows that 72.6% of the participants do performed QC test on their ultrasound equipment. This is surprising because of the display of poor knowledge of QC test by the participants as shown table one above. On the same vein 86.3% of the participants do cleaned transducer from acoustic gel after each patient as indicated in Table 2. It is not surprising

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound
Equipment among Practitioners in Nigerian Health Facilities

because good number of the participants consider cleaning the transducer from coupling gel after each patient as part of infections control. However, it is also noted as shown in Table 2 that 54.8% of the participants doesn't checked monitor for streak line or cracks. This is not surprising considering the poor knowledge of quality assurance programme recorded by the respondents. The implications of this finding is that; subtle changes or malfunction of ultrasound equipment may not be picked up at its initial stage for appropriate action to be taken until it becomes apparent and devastated in which case little or nothing can be done to reverse the effects and damages recorded do to misdiagnosis that might have occurred unnoticed. This study found as indicated in Table 2, that 87.8% of the participants do checked for brightness and contrast controls on the monitor and also 79.5% of the participants performs checks for transducer uniformity. It is however revealed only 45.2% of the participants that performs distance measurement accuracy test. This is probably because it involves the use of phantom, which might not be available and it's perceived to be time consuming. The absence of quality assurance could undermine the diagnostic quality of ultrasound examination and expose the operator to innumerable risks, including for the health of the patient[13].

Conclusions
This study found poor knowledge of ultrasound quality assurance among ultrasound practitioners. It however reported good practice of quality assurance among the study population.

Recommendations
From the findings of this study, we make the following recommendations;
1. The management should encourage and support their personnel to undergo further training on ultrasound quality assurance and its practice.
2. Ultrasound practitioners should develop the habit of continues QA practice.

References
[1] Carovac A, Smajlovic F, Junuzovic D. Application of ultrasound in medicine. Acta Inform Med 2011;19(3): 168-171

[2] Udoaka AI, Enyi C, Agi CE. Sonological evaluation of the liver, spleen and the kineys in an adult southern Nigerian population. *Asian J Med Sci*2013;5(2): 33-36

[3] Khati NJ, Gorodenker J, Hill MC. Ultrasound-guided biopsies of the abdomen. UltrasoundQuarterly2011;27(4): 25 5-268

[4] Halton J, Kosack CS, Spijker S, Brant WE, Andronikou S. Ultrasound manual for trained practitioners. Amsterdam Netherland; 2018

[5] Zagzebski, JA, Ophir KJ, Garra BS, Forsberg F, BooteEJ. Routine quality assurance of clinical ultrasound equipment subcommittee.AIUM;2008

[6] Rix A, Lederle W, Theek B, Lammers T, Moonen C, Schmitz G.et al. Advanced ultrasound technologies for diagnosis and therapy. JNM2018;59(5): 740–746. doi: 10.2967/jnumed.117.200030

[7] Sipilä O, Mannila V, Vartiainen E. Quality assurance in diagnostic ultrasound. Ero J Radiol 2011;80(2): 519–525.

[8] World Health Organisation. Training in diagnostic ultrasound: essentials, principles and standards. Geneva; 1998

[9] KollmannC, deKorte C, Dudley N.J, Gritzmann N, Martin K, Evans DH. Guideline for Technical Quality Assurance (TQA) of Ultrasound devices (B-Mode). Ultraschall in Med 2012;33: 544–549

[10] BushbergJF,SeibertJA,Boone J. The essential physics of medical imaging2nd ed. New York: Lipincott William &Wilkins; 2002

[11] Dudley N. Guidelines for the regular quality assurance testing of ultrasound scanners by sonographers. J. Med. Ultasound2014; 22:8–14

[12] Sidi M. Assessment of knowledge and practice of quality assurance test for computed tomography among Radiographers in North West of Nigeria. NJMIRT 2017;6(1):6-11

[13] Shaw A, Hekkenberg R. Standards to support performance evaluation for diagnostic ultrasound imaging equipment. NPL REPORT AC 2Teddington: United Kingdom;2007

[14] Sidi M, Hussain UY, Ya'u A, Garba I. Evaluation of the computed tomography number for water, field uniformity, image noise and contrast resolutions in Kano metropolis, Nigeria. NJBCS 2020;17:21-25

[15] Hangiandreou NJ, Stekel SF, Tradup DJ, Gorny KR, King DM. Four-year experience with a clinical ultrasound quality control program. Ultrasound Med Biol 2011;37(8): 1350–1357.

[16] Martensson M,Olsson M, Brodin L. Ultrasound transducer function: annual testing is not sufficient.EUR J ECHOCARDIOGR 2010;11: 801–805

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities

APPENDIX I

Respondents consent form

My name is Rufai Gambo Isah, a 500 level student of the Department of Medical Radiography, Bayero University Kano, Nigeria. We intend to conduct a research titled "KNOWLEDGE AND PRACTICE OF QUALITY ASSURANCE PROGRAMME OF ULTRASOUND EQUIPMENT AMONG PRACTITIONERS IN WEST AFRICAN POPULATION" The study is purely for research as such all information will be treated with utmost confidentiality.

The main purpose of the study is to evaluate the knowledge and practice of quality assurance programme of ultrasound equipment among practitioners. Your consent to participate as a subject in the study is strictly voluntary and has the right to withdraw from the study at any time you wish.

I hereby testify that I have been informed about the research and what it entails and I am fully convinced with all the explanation given to me by the researchers. In view of this I therefore consented to be part of this research as a subject and promise to cooperate and be committed up to the end of the research.

-----------------------   ------------------------------

   Respondent sign/date   Researcher sign/date

APPENDIX II

Questionnaires

Instruction

Please answer the following questions by choosing the correct option among the options provided, read each question or statement carefully before answering. Answer truthfully and to the best of your knowledge. All the information will be kept confidential and will only be used for the purpose of research.

Section A:

Demographic data of the respondent

1. Age (years)
   (a) 20- 30 [ ]   (b) 31-40 [ ]   (c) 41-50 [ ]   (d) 50 and above [ ]
2. Gender
   (a) Male [ ]   (b) Female [ ]
3. Work place
   (a) Federal Government Health Institute [ ]   (b) State Government Health Institute [ ]
   (c) Primary Health Care [ ]   (d) Private Health Institute [ ]
4. Qualification
   (a) Degree [ ] (b) Masters [ ] (c) PhD [ ] (d) Others, please specify …………………………...
5. Work experience
   (a) 0-5 years [ ]   (b) 6-10 years [ ]   (c) 11-15 years [ ]   (d) 16-20 years [ ]   (e) 21-25 [ ]
   (f) 26 to above

Section B:

Knowledge of quality assurance

6. What is Quality assurance programme?
   (a) Is an organized effort by the staff operating the facility to ensure that the diagnostic images produced are of sufficiently high quality [ ]
   (b) Are managements actions planned to ensure monitoring techniques are properly performed and properly evaluated [ ]
   (c) Mainly concerns with instrumentation and equipment that involves the measurement of the quality control parameters [ ]
   (d) Is the ability to evaluate images with low contrast [ ] (e) All of the above [ ]
7. Quality assurance programme consist of:
   (a) Quality evaluation [ ]   (b) Quality control technique [ ]   (c) Quality administration procedure [ ]   (d) B&C [ ]   (e) All of the above [ ] (f) none of the above [ ]

Mohammed S., Rufa'I G. I., Anas Ya'u

Knowledge and Practice of Quality Assurance Testing of Ultrasound Equipment among Practitioners in Nigerian Health Facilities

8. Do you consider infections control as one of the aims of quality assurance programme?
   (a) Yes [   ]   (b) No [   ]
9. What method of quality control test do you know?
   (a) Visual inspection [   ] (b) Test objects [   ] (c) Phantom [   ] (d) All the above [   ]
   (e) None of the above [   ]
10. What is the common fault of ultrasound transducer?
   (a) Dead or weak element (b) Delamination [   ] (C) Cable fault [   ]
11. Maximum depth of penetration and contrast resolution are the only test for accreditation.
   (a) True [   ]   (b) False [   ]
12. Is phantom used in Quality control test for ultrasound equipment?
   (a) Yes [   ]   (b) No [   ]
13. Is quality control performance parameters of B-mode and Doppler the same?
   (a) Yes [   ]   (b) No [   ]
14. How often transducers, cable housing and transmitting surfaces should checked for cracks, separations, and discolorations?
   (a) Annually [   ]   (b) After two years [   ]   (c) Not applicable [   ]

Section C:
Practice of quality assurance
14. Do you carry out quality control test on your ultrasound equipment?
   (a) Yes [   ]   (b) No [   ]
15. How frequent do you clean transducer from gel?
   (a) After each patient [   ](b)After two patient [   ] (c) After three patient and above [   ]
17. Do you check monitor for streak or inspected crack?
   (a) Yes   [   ]   (b) No [   ]
18. Do you Check brightness and contrast controls on the machine monitor?
   (a) Yes [   ]   (b) No [   ]
19- Do you check for transducer uniformity?
   (a) Yes [   ]   (b) No [   ]
20- Do you perform distance measurement accuracy?
   (a) Yes [   ]   (b) No [   ]