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Original Research Article

Pattern of Head Computed Tomography Requests, Common Indications and Findings at a Tertiary Health Center in North-Central Nigeria

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Abstract: ***Background*****:** Since its introduction in the early 1970s**,** Computed tomography (CT) has evolved over time into a useful diagnostic imaging tool with expanding applications, especially in the evaluation of head pathologies ***Aim*****:** This study aimed at assessing the pattern of head-CT requests, common indications, and findings at a tertiary health center in north-central Nigeria. ***Methods*****:** We retrospectively reviewed 350 case-files, retrieved from the radiology department's head-CT archives at Benue State University Teaching Hospital (BSUTH) between January and December 2022. Using SPSS version 23 and Microsoft Excel 2007, data was entered into a spreadsheet and analysed. The statistical significance level was set at $P< 0.05$. Tables, figures, and percentages were used to display the data distribution. ***Results*****:** Men outnumbered women 2:1 in the 350 head-CT requests that were evaluated. 150 (42.9%) of those scanned were in their second to fourth decade of life, when people are more active and energetic, thus more prone to accidents. Traumatic brain injury (TBI), 77(22.0%) was the commonest clinical indication. The findings were entirely normal in 119(34.0%) head-CTs. The abnormalities that physicians suspected before requesting a head-CT were positive in 231 (66.0%) of the patients. The level of confirmation of abnormality was statistically significant (P=0.001). ***Conclusion*****:** Men had more head-CTs than women. Most of the patients had the abnormalities that the physicians suspected before requesting a head-CT. TBI was the commonest clinical indication**,** while **m**ajority of head-CTs revealed normal findings. This establishes the pattern of head-CT requests, common indications, and findings for future planning and research.

Key words: Common indications, findings, head CT requests, north-central Nigeria, pattern, tertiary health centre.

INTRODUCTION

Diagnostic medical imaging, particularly the radiological subspecialties, were significantly revolutionized with the introduction of computed tomography (CT) in the early 1970s. Prior to this development, conventional radiography combined overlapping elements into a single two-dimensional image, making it impossible to distinguish internal anatomic structures. However, CT demonstrated the capability to recognize previously superimposed structures by producing a series of two-dimensional cross-sectional images. The first clinical application was head imaging, which revealed brain tumours and bleeding inside the skull. CT was extended to the chest and abdomen after faster scanning protocols were introduced, which eliminated problems with peristalsis and respiratory motion, allowing specific organs to be viewed in fine details. The fact that CT was given the Nobel Prize in 1979 is proof that it was a game changer [1, 2].

Computed Tomography is now widely accepted as a major imaging technology in its own right. A few of its more recent clinical applications include the diagnosis of appendicitis, the investigation of renal colic, the detection of pulmonary embolism and the diagnosis of abdominal discomfort. The introduction of multidetector techniques and enhanced multiple reconstructive algorithms have opened up new possibilities for the identification of vascular, orbital, spine, brain, and traumatic bone disorders using CT. Without CT and a thorough understanding of its

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capabilities, practicing radiology in any of its subspecialties will become nearly impossible [2].

However, the advantages of CT must be evaluated against its infrastructural cost, availability and the hazards it poses to patients and the health-care system, due to the potentially carcinogenic ionizing radiation it emits. The Food and Drug Administration (FDA), however, asserts that the doses used in head CT have a very low cancer risk, particularly in children. Nevertheless, no amount of radiation can be completely considered safe. Furthermore, CT requires the time-consuming contribution of both the radiographer and the radiologist and may involve the use of contrast media. Besides, younger children may require sedation to achieve excellent imaging results, necessitating inputs from the department of anaesthesia [3, 4].

The lack of constant electricity, as well as issues with equipment availability and maintenance, are the key obstacles to the use of CT in radiological practice in Nigeria [5], as such CT is not too economical to operate in several Nigerian cities and villages, forcing doctors to make tough patients` beneficial clinical choices [6]. Even though things are changing for the better, Nigeria, with a population estimate of about 215 million in 2022, according to United Nations (UN) estimates [7], had her first installed CT scanner in 1987. The number rose to about 183 in 2018, suggesting an annual average of six installations [8]. As at the time of this research, Benue state, with 23 local governments areas (LGAs), had only one such CT Machine in active use, domiciled at BSUTH, Makurdi.

For those with acute head injuries, CT is the gold standard and an imaging modality of choice for their evaluation. It's rapid and non-invasive, with few side effects. The sensitivity of CT for demonstrating acute extra- and intra-axial bleeding, ventricular size, bony fractures, and mass effect makes it a good choice for the assessment of traumatic brain injury (TBI). However, low sensitivity in the early detection of hypoxic–ischaemic encephalopathy as well as, detecting of small non-haemorrhagic lesions such as diffuse axonal injuries (DAIs) and cortical contusions, are some of its limitations [9].

The most common clinical indications and findings during CT examinations have been shown to vary in different locations over time, most likely due to regional disparities in direct-access CT diagnostics for practitioners, the versatility of CT scanners, patient knowledge, and an aging population [10, 11]. The common head CT findings may also differ based on the study's indications, often leading to the discovery of findings unrelated to the patient's complaints, known as incidentalomas. Head CT scans may show no abnormal findings despite the patients' complaints [12, 13].

There is therefore, a need to find out what is obtainable in our environment. To the best of our knowledge, there is paucity of research on this topic in our locality. Thus, prompting this study, which is aimed at assessing the pattern of head computed tomography (CT) requests, **common** indications, and findings as obtainable **at** BSUTH, Makurdi.

MATERIALS AND METHODS

This is a retrospective study aimed at assessing the pattern of head CT requests, common indications, and findings in patients who underwent the study at the CT suite of BSUTH, Makurdi, between January and December 2022. Benue State's capital, Makurdi, is located between latitudes 7.3 and 8.32 degrees on the south bank of the Benue River. In 2016, the city and its environs had an estimated population of 365,000 people [14]. Over four million people in Nigeria's north-central region and beyond are served by this hospital.

Inclusion criteria were patients who had complete records of head CT examination, retrieved from the radiology department's head-CT archives at BSUTH, and who were well provided with all but mostly the following desired information: age of the patient, indication for the scan and/or provisional diagnosis, CT requesting department, and the investigation findings.

Exclusion criteria were scanty records without the desired information, use of non-standardized abbreviations and requests from outside our healthcare institution. All radiological records that were not for head CT were also excluded.

All head CT examination were done using Brilliance CT (BR16 System), Philips medical systems (Cleveland) Cleveland, Ohio 44143 USA, Model:453567023331, SN:1642, June,2010

D**ata Analysis:** All request forms for this study period were collected, and data entry and analysis were carried out using SPSS statistical software version 23 and Microsoft Excel 2007. $P<0.05$ was chosen as the statistical significance level. Tables, figures, and percentages were used to display the data distribution.

Ethical consideration: The health research ethical committee (HREC) at BSUTH reviewed and approved the protocols, reference, BSUTH/MKD/HREC/2023/002, including a waiver for informed consent since the study involved the use of pre-existing head CT records.

RESULTS

Three hundred and fifty (350) Head CT requests were evaluated, out of which 232(66.3%) were males and 118 (33.9%) were females. Majority 252(72.0%) were married, 215(61.4%) resided in

Makurdi, while more than half 208(59.4%) were of the Tiv ethnic nationality. Their age ranged from 0.2 to 92 years, with a mean, median and modal age of 45.5±1.2, 48.5, and 63.0 years, in that order. Majority of the respondents 114(32.6%) were between the ages of 41-60 years. This was followed by 77 (22.0%) patients, in the age brackets of 21-40 and 61-80 years old respectively. The least number of respondents, 4 (1.1%), were those below 1year old as displayed in Table 1.

Table 1: Distribution of baseline demographic characteristics of respondent (n=350)

Variable	Frequency	Percentage (%)
Age Group (years)		
<1	4	1.1
1-20	70	20.0
21-40	77	22.0
41-60	114	32.6
61-80	77	22.0
81-100	8	2.3
Total	350	100.0
Marital status		
Married	252	72.0
Single	37	10.6
Divorced	3	0.9
child	58	16.6
Total	350	100.0
Sex		
Male	232	66.3
Female	118	33.7
Total	350	100.0
Residence		
Makurdi	215	61.4
Gboko	82	23.4
Oturkpo	34	9.7
Others	19	5.5
Total	350	100.0
Ethnicity		
Tiv	208	59.4
Idoma	53	15.1
Igbo	37	10.6
Hausa	23	6.6
Others	29	8.3
Total	350	100.0

The main source of patients who underwent head CT were distributed from amongst the eight clinical departments at BSUTH, namely accident and emergency (A&E), medical outpatient department (MOPD), surgical outpatient department (SOPD), emergency pediatric unit (EPU), in-patient medical ward (IPMW), pediatric outpatient department (POPD), in-patient surgical ward (IPSW) and general outpatient department (GOPD) as shown in Figure 1, below. Majority 146(41.7%) of the patients came from A&E, while the least number 4(1.1%) were from GOPD.

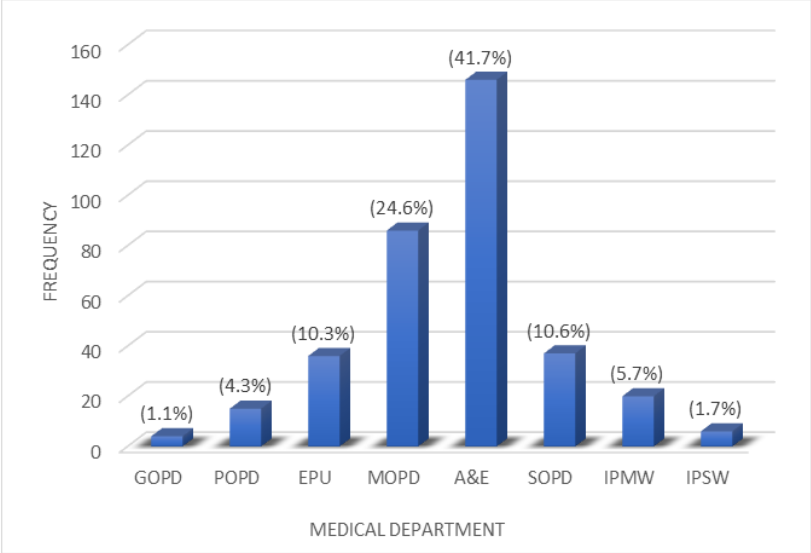

Figure 1: Distribution of patients referred for Head CT according to the medical departments at BSUTH

The three most prevailing clinical indications for Head CT were 77 (22.0%) traumatic brain injury (TBI) from road traffic accidents (RTAs), 75(21.4%) cardiovascular accident (CVA) and 45(12.9%) headaches whereas the least clinical indication were cerebral palsy, malaria, hydrocephalus, brain metastasis (Brain Mets) and human-immunodeficiency virus (HIV) infection each with a frequency of 2(0.6%) as depicted in Figure 2.

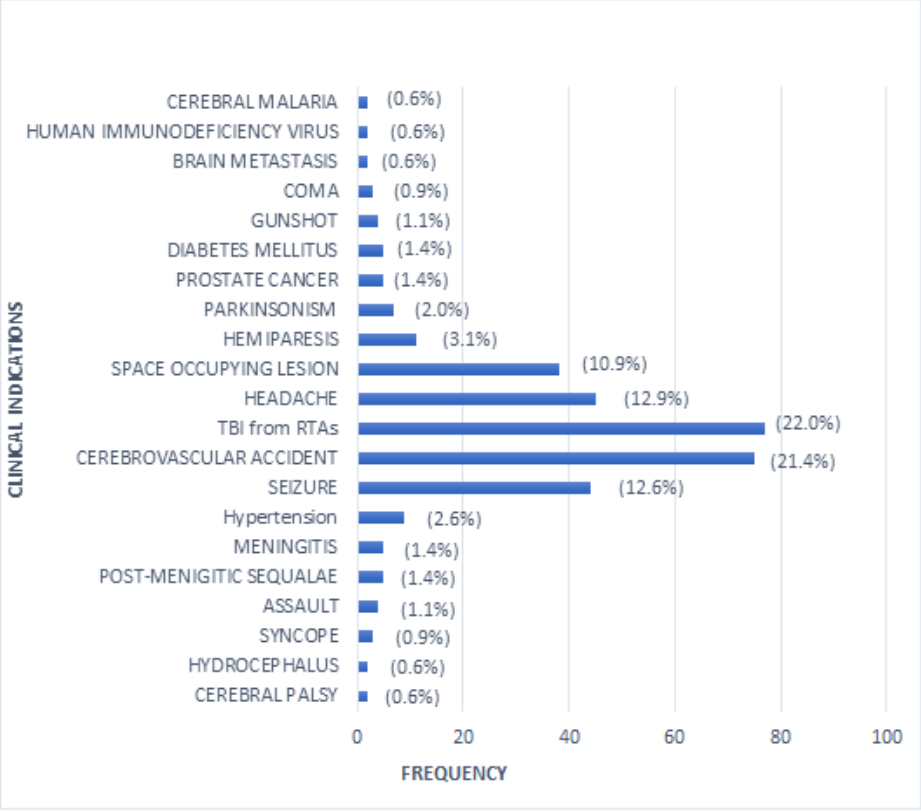

Figure 2: Distribution of clinical indications for Head CT at BSUTH

The commonest head-CT findings by radiologists were normal 119(34.0%), followed by cerebral atrophy 46(13.1%) and cerebrovascular accident 27(7.7%) in that order, as demonstrated in Figure 3.

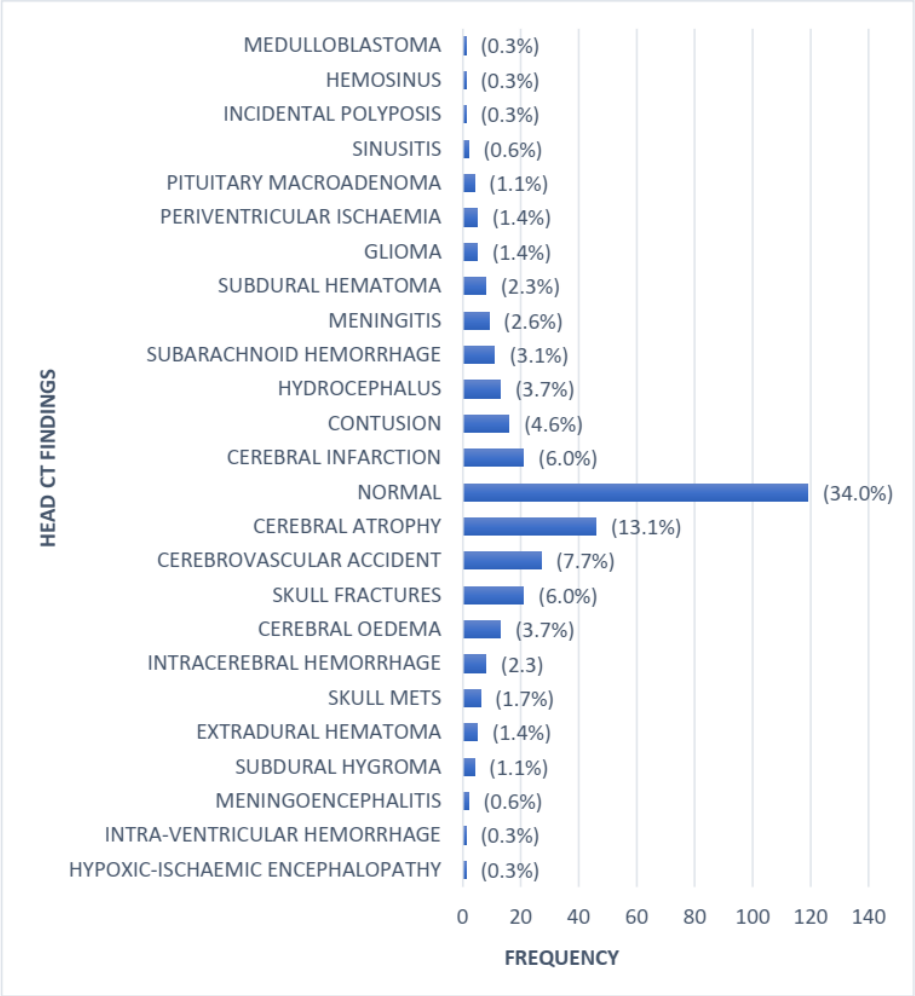

Figure 3: Distribution of Head CT findings at BSUTH

Table 2 shows that 231(66.0%) patients were positive for the abnormalities suspected by physicians prior to requesting for Head CT scan whereas, 119(34.0%) were negative. A total of 9 (3.9%) positive cases (incidentalomas) were found as a result of Head CT scan for seizures. Regression analysis showed that the level of confirmation of abnormalities suspected during Head CT scan was statistically significant and correlated with findings (rho=0.167, *P*=0.001). Confirmation of CVA recorded the highest positive rate 66(28.6%).

Table 2: The distribution of clinical Indications with Head CT findings

Clinical Indications	**Head CT Findings**		
	NEGATIVE	**POSTIVE**	**Total**
SEIZURES	35(29.4%)	9(3.9%)	44(12.6%)
HEADACHE	31(26.1%)	14(6.1%)	45(12.9%)
TBI from RTAs	16(13.5%)	61(26.4%)	77(22.0%)
SPACE OCCUPYING LESION	14(11.8%)	24(10.4%)	38(10.9%)
CEREBROVASCULAR ACCIDENT	9(7.6%)	66(28.6%)	75(21.4%)
PROSTATE CANCER	2(1.7%)	3(1.3%)	5(1.4%)
COMA	2(1.7%)	1(0.4%)	3(0.9%)
HEMIPARESIS	2(1.7%)	9(3.9%)	11(3.1%)
POST-MENIGITIC SEQUALAE	2(1.7%)	3(1.3%)	5(1.4%)
ASSAULT	1(0.8%)	3(1.3%)	4(1.1%)
DIABETES MELLITUS	1(0.8%)	4(1.7%)	5(1.4%)
HYPERTENSION	1(0.8%)	8(3.5%)	9(2.6%)
MENINGITIS	1(0.8%)	4(1.7%)	5(1.4%)
PARKINSONISM	1(0.8%)	6(2.6%)	7(2.0%)
SYNCOPE	1(0.8%)	2(0.9%)	3(0.9%)

BRAIN METS	0(0.0%)	2(0.9%)	2(0.6%)
CEREBRAL MALARIA	0(0.0%)	2(0.9%)	2(0.6%)
CEREBRAL PALSY	0(0.0%)	2(0.9%)	2(0.6%)
GUNSHOT INJURY	0(0.0%)	4(1.7%)	4(1.1%)
HUMMAN IMMUNODEFICENCY VIRUS	0(0.0%)	2(0.9%)	2(0.6%)
HYDROCEPHALUS	0(0.0%)	2(0.9%)	2(0.6%)
TOTAL	119(34.0%)	231(66.0%)	350(100.0%)

Table 3 depicts a statistically significant (*P*=0.000) correlation between patient`s clinical indications and radiologist`s findings at head CT.

Table 3: The distribution of Spearman's correlation (rho) with selected variables (n=350)

Variable	Spearman's corelation (rho)	*P*-value
Findings vs Departmental source of referral	-0.296	0.000
Clinical indications vs Findings	0.291	0.000

DISCUSSION

Our study found that males outnumbered females in terms of the total population, with a male-to-female (M: F) ratio of 2:1, which is generally consistent with previous reports [12, 13, 15]. Majority 251(71.7%) of the patients were in their second to eighth decades of life, with the peak value in the second to fourth decade, which accounted for about 150 (42.9%) of the total study population. These groups of people, who are in their second to fourth decades of life, are the most active and energetic in the society and appear to be more susceptible to both occupational and social hazards [13, 16]. They are also the ones, especially the males amongst them, who commonly engage in strenuous physical activities, militancy, cultism, disobedience of traffic laws, heavy use of alcohol or hard drugs and are therefore more prone to trauma and RTAs than females, necessitating head CT scans [10, 15, 17].

The departmental description of cases that underwent head CT at BSUTH during our review showed that majority 146(41.7%) of patients were from A&E, followed by 86(24.6%) from MOPD and 37(10.6%) from SOPD. The least number, 4(1.1%) came from GOPD. The differences in how patients were distributed among the departments could simply be coincidental, but it's also possible that they were brough on by institutional record-keeping practices, incorrect filing of case notes, loss, misplacement or the hospital's variation of patient types among the eight distinct departmental units under study [18]. The high number of patients referred from A&E for head CT is not surprising, given that the department is charged with saving the lives of patients who develop sudden illnesses or traumatic injuries that cannot wait for routine care. Because of this, the A&E department is considered a crucial component of the hospital, and how well it performs directly affects how the general public perceives the facility [19].

In our study, the commonest clinical indication for head CT was TBI, 77(22.0%) due to road traffic accident (RTA). This is consistent with previous studies that identified TBI as a major indication for head CT [10, 15, 20]. The high occurrence of head injuries caused by RTA is due to drivers' carelessness and disregard for the law, poor vehicular maintenance, bad roads, and the heavy use of alcohol and hard drugs [15]. This contradicted the findings of an Israeli study [21], which found headache to be the most common clinical indication for 470 (38.0%) patients who underwent head CT. This disparity may be due to the fact that Israel and Nigeria are at different stages of their respective national development, with the former performing significantly better in terms of infrastructure, economy and quality of life [22]. Nigeria is comparatively more vulnerable to RTA due to infrastructural neglect, increase in bad roads and a high level of indiscipline by drivers and other road users [22, 23].

Normal head CT findings 119(34.0%) were the most common outcome in our study, despite the myriad of indications to perform a head CT scan. This is consistent with previous reports in which a large majority, 117 (39.0%) of 300 respondents [12] and a sizable number, 147 (88.0%) of 167 patients [24] both had normal head-CT findings. In our study, cerebral atrophy had the highest diagnosis rate 46(13.1%), followed by cerebrovascular accident 27(7.7%) and then cerebral infarction 21(6.0%). This can be attributed to a lifestyle pattern that includes smoking, high blood pressure, poor diet and lack of exercise [10]. This was, however, not the case for all researchers, for whom cerebral contusions and oedema were the most frequently identifiable diagnoses [13].

Overall, our index study revealed that 231(66.0%) patients were positive for the abnormalities suspected by the physicians prior to requesting for head CT scan, which is an attestation to the general reliability of the clinical assessments, as depicted in table 2. However, the finding of only 9 (3.9%) positive cases (incidentalomas) during a head CT scan for seizures, which was performed most likely to allay the relatives' fears of witchcraft, for example, raises doubts about the

credibility of the clinical assessments conducted prior to the head CT scan in this case. This is, however not to say that head CT scans should completely replace clinical examinations, rather they should supplement clinical examinations by validating or rebutting clinical impressions, enabling the reconciliation of complex and equivocal cases [25]. Regression analysis however, showed that the level of confirmation of abnormalities suspected during head CT scan was statistically significant and correlated with findings (rho=0.167, p=0.001). Confirmation of CVA recorded the highest positive rate 66(28.6%)

Limitation of the study

Our study was limited by its retrospective design, which resulted in the discovery of information in the patients' case-files that could not be independently verified, due either to the age of the head-CT documents or a lack of citations to back up those claims. Furthermore, the results must be interpreted with caution due to the small sample size, which did not provide enough power to assess associations in a number of comparisons. Again, since this was a single-center study, it is important to remember that the findings may not be necessarily generalizable to all regions.

CONCLUSION

This study has shown that more males than females underwent head CT at BSUTH. Whereas the majority of head scans revealed normal findings, TBI from road traffic accidents was the most common clinical indication. Even though radiation risks, accessibility, and cost considerations are important factors when considering a head-CT, particularly in a setting with limited resources like ours, the numerous CT requests, indications, and research findings justify the appropriate use of technology in the diagnosis and management of suspected head pathologies. While high radiation risks from CT can be mitigated by using lower-dose x-ray techniques or tests that use no radiation, such as magnetic resonance imaging (MRI) or ultrasound, the answer to the cost problem may ultimately be found in the universal health insurance scheme that is currently being pursued in many countries. Presently, the provision of financial assistance to those who need a head-CT scan and any subsequent treatment by governmental agencies, churches, traditional extended families, charitable organizations, and friends is greatly addressing the cost issue. To produce better therapeutic results in our locality, more research is needed to ascertain the reasons for occasional delays in the referral of patients with head-injury for CT work-up, the effects of this delay, and what can be done to shorten the delay. This study has therefore, identified the pattern of head computed tomography (CT) requests, common indications, and findings in our locality, which will not only serve as a baseline for planning and further research but also be extremely useful to healthcare professionals when the need arises.

RECOMMENDATIONS

These recommendations are directed at the public-private investors, non-governmental organizations (NGO), local regulatory authorities and international organizations; drawing inspiration in part, from the research work by Ohaegbulam *et al*., [13].

Public-private investors: Both the government and private investors in Nigeria, and particularly in Benue State, should be encouraged to venture into installation of more diagnostic CT centers in order to improve the country's very poor utilization of CT scan in the management of head pathologies. The cost of installation and running of CT service should be reduced with encouragement of public-private partnerships in the smooth maintenance of CT centres.

***Non-governmental organizations (NGOs)*:** NGOs should offer poor patients financial assistance to cover the cost of their CT scan and any subsequent medical treatment.

***Local regulatory authorities*:** To attract potential investors into this venture, the Nigerian Medical Council (NMC) should introduce continuing medical education certification programs in CT.

***International organizations*:** International organizations should assist hospitals by donating CT scanners to increase CT accessibility.

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Disclosure of conflict of interest

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