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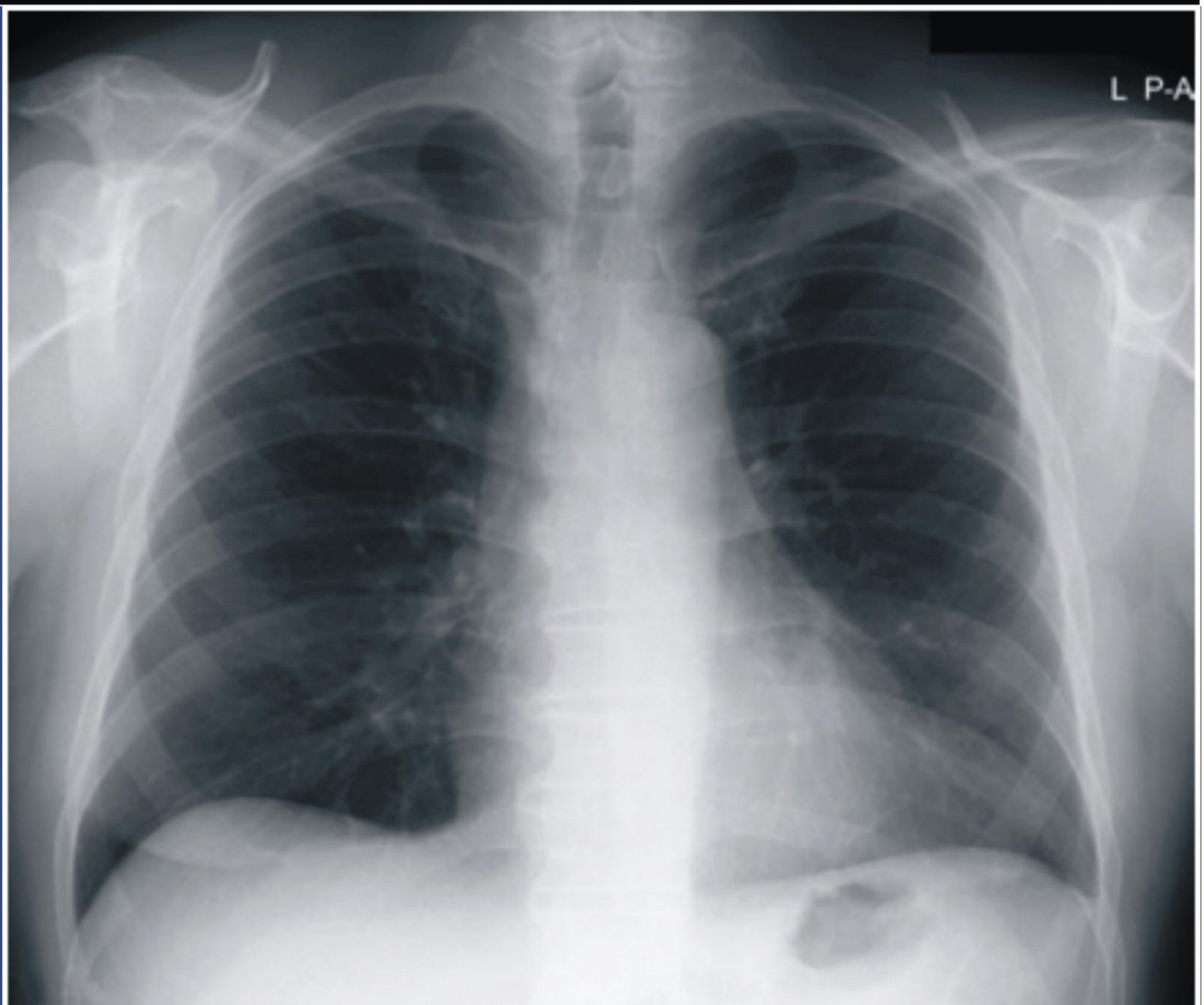

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Computed Tomography Scanner Distribution and Downtimes in Southeast Nigeria

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ABSTRACT

Background: It is clearly known and documented that the first computed tomography (CT) scanner was installed in 1987 at the University College Hospital (UCH) Ibadan, Southwest-Nigeria. Ironically, it is neither clearly documented how many more scanners have been installed after then, nor about their functionality.

Objective: To establish the actual number and functionality of CT scanners in the Southeast geopolitical zone of Nigeria.

Methodology: The survey was undertaken from March – June, 2016. Radiographers across different tertiary hospitals in southeast (SE) Nigeria, were requested through phone calls to ascertain the number of CT scanners in their respective states of residence. Their feedback was crosschecked using entirely different Radiographers. Internet searches were conducted to authenticate some information obtained. For Anambra State where all but one of the authors worked or schooled, physical visits were made to all centres. Data elicited covered scanner specifications, installation details, ownership, and functionality, amongst others. These were recorded in a *pro forma* sheet and later collated and presented in tables.

Result: A total of 23 CT centres with 28 CT scanners were confirmed. These were distributed across the zone as follows: Anambra; 10 (35.8 %), Imo; 6 (21.4 %), Enugu; 6 (21.4 %), Abia; 4 (14.3 %) and Ebonyi; 2 (7.1 %). Private ownership accounted for 19 (68.0 %) of the scanners while the remaining 9 (32.0 %) were distributed between the Federal Government (n = 5; 18.0 %), public-private partnership (n = 2; 7.0 %), and state governments (n = 2; 7.0 %), respectively. Appropriate personnel were engaged in the facilities. Majority of the scanners were installed in the current decade (2006 – 2016). At least 12 (43.0 %) of the scanners experienced downtime within the period of the survey with 7 scanners having downtime ≥ 1 year.

Conclusion: There are 23 radiodiagnostic facilities with 28 CT scanners in the Southeast zone of Nigeria. Five facilities each own two scanners. There appears to be a good distribution of CT scanners with appropriate personnel. A high downtime rate was observed, suggesting the need for the employment of centre-based CT engineers, to ensure that CT patients have as prompt an access as can be achieved.

Keywords: Computed tomography, radiographer, downtime, functional, Southeast Nigeria

Introduction

The advent of computed tomography (CT) has revolutionized diagnostic radiology. Since its inception in the 1970s, CT has been used extensively and the demand for this imaging modality has increased rapidly [1]. Data from various national surveys have confirmed, the growing impact of CT as a major source of patient and population exposure [2].

Advancement in CT technology has evolved rapidly with single slice spiral CT (SSCT) being introduced into clinical practice in 1989 [3],

while multi-slice spiral CT (MSCT) systems followed closely in 1992 [4]. Several manufacturers in 1998 launched CT systems capable of scanning four slices simultaneously within a reduced scan time. These opportunities definitely increase the clinical efficacy of CT procedures and offer promising new applications in diagnostic imaging [5, 6].

The first CT scanner in Nigeria was installed on November 19, 1987 at the University College Hospital (UCH) Ibadan, in Southwest Nigeria. A decade later, the Southeast geopolitical zone got its first CT scanner installed at the University of Nigeria Teaching Hospital (UNTH), Enugu around 1996-1998 [7]. Since then, there have been a multiplication of CT scanners and examinations in Nigeria, and, globally, this trend would obviously increase [8, 9].

The increase in CT investigations may eventually result in an increased incidence of cancer [9], hereditary diseases in descendants of the exposed persons and the possibility of induced deterministic effects [10]. Concomitantly, both international [2,11,12] and local [8,13,14], surveys have been, and are being undertaken, to establish the actual number of CT scanners available, and the associated potential dose impact.

Downtime complicates effective utilization of imaging resources as it has been noted that low levels of machine availability are unacceptable both clinically and financially [15]. Although equipment breakdown is inevitable in clinical practice, tremendous effort is required to ensure that equipment used in patient care are available, accurate, affordable and longlasting [16].

This survey was undertaken in the Southeast geopolitical zone of Nigeria, to establish the actual number of functional CT scanners in the zone as at June, 2017.

Material and methods

The survey to ascertain the number of scanners was undertaken from March – June, 2016 while statistics on downtime continued up to June 2017. Radiographers across different tertiary hospitals in southeast (SE) Nigeria, were requested through phone calls to ascertain the number of CT scanners in their respective states of residence. Their feedback was crosschecked using entirely different Radiographers. Internet searches were conducted to authenticate some information obtained. For Anambra State where all but one of the authors worked or schooled, physical visits were made to all centres. Data elicited covered scanner specifications, installation details, ownership, and functionality, amongst others. These were recorded in data *pro forma* and later collated and presented in tables.

Results

There were 28 CT scanners in the Southeast with Anambra State accounting for the highest (n = 10; 35.8%) while Ebonyi State had the least (n = 2; 7.1%). Private ownership accounted for 19 (68.0 %) of the scanners while the remaining 9 (32.0 %) are distributed between the Federal Government (n = 5; 18.0%), public-private partnership (n = 2; 7.0%), and state governments (n = 2; 7.0%), respectively (Tables 1 & 2).

The Federal and state governments' facilities employed fulltime radiologists and radiographers but the private centres had more of part time radiologists and a significant number of full time radiographers. No single centre had a medical physicist in their employment (Table 3). As shown in Table 4, head CT examination was more expensive in private centres (₦ 35,000 – 50,000) than in government hospitals (~ ₦ 35,000). Table 5 shows that a total of 12 scanners (43 %) experienced downtime with 7 (25 %) of the scanners having downtime ≥ 1 year.

This survey was undertaken in the Southeast geopolitical zone to establish the actual number of functional CT scanners in the zone. The findings from this work show that a total of 27 scanners (96.4 %) were installed within the last ten years, bringing the total number in the zone to 28.

Table 1: Distribution of CT facilities and scanners with prolonged downtime prior to July 2017

S/ No	Name of Diagnostic centre	Ownership	Model	Slice	Manufactured	Installed	Functional
			Anambra State				
1.	Crescent Diagnostic centre, GRA Onitsha	Private	GE	32	?	2016	Yes
2.	Eldorado Diagnostic centre, Awka	Private	GE	16	?	2016	Yes
3.	Onitsha Med. Diagn. Centre	Private	Siemens	16	2015	2015	Yes
4.	General Hospital, Onitsha	PPP	GE	4	2007	2015	Yes
5.	Iyi Enu Missions Hosp, Ogidi	Anglican	Toshiba	16	2013	2014	Yes
6.	Conquest Imaging, Nnewi	Private	GE	1	1998	2011	Yes
7.	NAUTH, Nnewi	FG	GE	4	2007	2011	Yes
8.	Borromeo Hospital, Onitsha	Catholic	Toshiba	16	2013	2014	**No**
9.	Onitsha Med. Diagn. Centre	Private	Philips	2	?	2008	**No**
10.	Chukwuemeka OOTH, Awka	State	?	?	?	**Incomplete installation**	
			Imo State				
11.	Digital Imaging, Owerri	Private	?	?	?	2016	Yes
12.	Human Race, Owerri	Private	Philips	4	?	2015	Yes
13.	FMC, Owerri	FG	GE	16	?	2015	**No**
14	Ochiedike Diagnostic C, Owerri	Private	GE	16	?	2014	**No**
15.	St John's Cath Hosp, Owerri	Catholic	?	?	?	2014	**No**
16.	IMSUTH, Orlu	State	?	?	?	**Incomplete installation**	
			Enugu State				
17.	Hansa Clinics, Independence L/Out	Private	GE	8	?	2014	Yes
18.	Memphys Neuro Hosp, Trans-Ekulu	Private	Philips	64	?	2014	Yes
19.	Memphys Neuro Hosp, Trans-Ekulu	Private	CereTom	8	2007	2009	Yes
20.	Conquest, Trans-Ekulu	Private	GE	16	2009	2009	Yes
21.	Hansa Clinics, Independence L/Out	Private	GE	4	?	2016	**No**
22.	UNTH, Ituku-Ozalla	FG	GE	2	2003	2006	**No**
			Abia State				
23.	Livingworld Hospital, Aba	Private	?	?	?	2016	Yes
24.	Mecure, Umuahia	PPP	Yes	1	< 1999	2014	Yes
25.	Mecure, Aba	Private	Yes	1	< 1999	2014	Yes
26.	FMC, Umuahia	FG	GE	4	2007	2014	Yes
			Ebonyi State				
27.	Diagnostic centre, Abakaliki	Private	?	?	?	2016	**No**
28.	FETHA, Abakaliki	FG	GE	1	1998	2012	**No**

Table 2: Location and Ownership Structure of Scanners in Southeast Nigeria

Parameters					Frequency	Ownership			
State	Location/frequency				Total (%)	FG	State	Private	PPP
Anambra	Onitsha:5	Nnewi:2	Awka:2	Ogidi:1	10 (35.8)	1	1	7	1
Imo	Owerri:4	Orlu:1	Nekede:1		6 (21.4)	1	1	4	0
Enugu	Metropolis:5	Ituku-Ozalla:1			6 (21.4)	1	0	5	0
Abia	Umuahia:2	Aba:2			4 (14.3)	1	0	2	1
Ebonyi	Abakaliki:2				2 (7.1)	1	0	1	0
			Total		28 (100)	5 (18.0 %)	2 (7.1 %)	19 (67.8 %)	2 (7.1 %)

Table 3: Distribution of Skilled Personnel at CT Centres

Name of Diagnostic centre	Ownership	Personnel		
		Radiologists	Radiographers	Physicists
Crescent Diagnostic centre, Onitsha	Private	Part time	Part time	NA
Eldorado Diagnostic centre, Awka	Private	Part time	Fulltime	NA
Onitsha Med. Diagn. Centre	Private	Part time	Fulltime	NA
General Hospital, Onitsha	PPP	Part time	Fulltime	NA
Borromeo Hospital, Onitsha	Catholic	Part time	Fulltime	NA
Iyi-Enu Missions Hosp, Ogidi	Anglican	Part time	Fulltime	NA
Conquest Imaging, Nnewi	Private	Part time	NA	NA
NAUTH, Nnewi	FG	Full time	Fulltime	NA
Chukwuemeka OOTH, Awka	State	Full time	Fulltime	NA
Digital Imaging, Owerri	Private	Part time	Fulltime	NA
FMC, Owerri	FG	Full time	Fulltime	NA
Human Race, Owerri	Private	Part time	Fulltime	NA
Ochiedike Diagnostic C, Owerri	Private	Part time	NA	NA
St John's Cath Hosp, Owerri	Catholic	Part time	NA	NA
IMSUTH, Orlu	State	Full time	Fulltime	NA
Hansa Clinics, Independence L/Out	Private	Full time	Fulltime	NA
Memphys Neuro Hosp, Trans-Ekulu	Private	Full time	Fulltime	NA
Conquest, Trans-Ekulu	Private	Part time	Fulltime	NA
UNTH, Ituku-Ozalla	FG	Full time	Fulltime	NA
Livingworld Hospital, Aba	Private	Part time	Fulltime	NA
Mecure, Umuahia	PPP	Part time	Part time	NA
Mecure, Aba	PPP	Part time	NA	NA
FMC, Umuahia	FG	Full time	Fulltime	NA
Diagnostic centre, Abakaliki	Private	Full time	Fulltime	NA
FETHA, Abakaliki	FG	Full time	Fulltime	NA

Table 4: Cost of Non-Constrast Head CT Examination

Locality	Fed Government (₦)	State government (₦)	PPP (₦)	Private (₦)
Anambra	≤ 30,000	No price yet	< 40,000	≤ 40,000
Imo	No price yet	-	-	≤ 40,000
Enugu	≤ 30,000	-	-	≤ 50,000
Abia	≤ 30,000	-	< 50,000	< 40,000
Ebonyi	≤ 30,000	-	-	No price yet

Table 5: Prolonged Downtime of CT Scanners in Southeast Nigeria

State	Total number of scanners	Number down	Ownership	Duration of downtime as at July 2017	Nature of downtime
Imo	6	4	**State**	> 6 years	Not yet commissioned
			Federal	> 1 year	Not yet commissioned
			Private (a)	> I year	Malfunction
			Private (b)	< I year	Malfunction
Anambra	10	3	**Private**	> 7 years	Malfunction
			State	> 4 years	Not yet installed
			Private	< I year	Not yet commissioned
Enugu	6	2	**Federal**	> 3 years	Malfunction
			Private	< I year	Not yet installed
Ebonyi	2	2	**Federal**	> 3 years	Malfunction
			Private	< I year	Not yet commissioned
Abia	4	1	Private	< I year	Not yet commissioned
Total	28	12 (43%)	FG:3;SG:2;P:7	1 – 7 years	

Anambra State accounted for 10 CT scanners (35.8 %) while Ebonyi State had the least number of scanners (n = 2; 7.1 %). Out of the 28 scanners, 12 (43 %) experienced downtime with seven of those scanners being down for over a year.

Although the first CT scanner in Nigeria was installed by the Federal Government in 1987, and between 1996-1998 in the Southwest and Southeast zones, respectively **[7],** the ownership structure of CT scanners within the period of this survey showed a skewness in favour of the private sector with 19 scanners (68.0 %). The Federal Government that pioneered the installation of CT was placed in a distant second with 5 scanners (18.0 %), out of which 3 were down due to malfunction.

Comparatively, reports from Kenya reveal that the first CT scanner for medical usage was installed in 1986. As at 2010, there were 21 scanners in Kenya with the last installed in 2007 [12]. The scanners in Southeast-Nigeria in the current study may appear to be more than those found in Kenya, but the time difference needs to be taken into account in comparing. However, it may be true to say that as at 2007, Southeast-Nigeria had a single scanner in the zone, effectively proving that Kenya embraced and consolidated on the CT scanner technology much earlier than Nigeria.

The extent of downtime in Kenya was, however, not ascertained.

The ownership structure of CT scanners in the Southeast zone was disproportionate amongst the constituent states. Whereas Anambra had 10 scanners with 5 located in the commercial town of Onitsha, states like Ebonyi only had 2 scanners. The Federal Government, perhaps mindful of this, ensured that a scanner was installed in each state to mitigate the imbalance. An inference from the skewed installation by the private sector may also imply that the Federal Government had no control over where scanners were installed. A proportionate distribution, rather than aggregation in certain towns, would however, bring CT services to the populace, irrespective of their locations.

Two state governments, Anambra and Abia went into a public-private partnership (PPP) agreement and the scanners did not record any downtime. Interestingly, the Anambra State government had a scanner in her teaching hospital which was not robed into the PPP arrangement. The scanner however, that was managed by its owner had reportedly, never worked in spite of the full complement of Radiographers and Radiologists. The same story was obtained in Imo State. This appears to suggest that the PPP arrangement may offer more in terms of sustaining the functionality of CT scanners [16].

Governments' responsibility to protect and advance the interests of society includes the delivery of high-quality health care. The government is expected to preserve the interests of its citizens by supplementing the market where there are gaps, and regulating where there is inefficiency or lack of fairness. The ultimate goal of achieving high quality of care will require strong partnerships between Federal, State, and Local governments and the private sector. Translating general principles regarding the appropriate role of government into specific actions within a rapidly changing, decentralized delivery system will require the combined efforts of the public and private sectors [17].

Furthermore, while government could have been motivated by service delivery as shown by its equitable spread of scanners and moderate price regime, it appears that the desire for profit was responsible for installations by other owners. This inference arose from the fact that metropolis and commercial towns hosted the scanners, rather than semi-urban or rural areas.

It was also noted that Radiographers were employed on full time basis in most CT centres. While government centres had full time Radiologists, only two private centres located in Enugu could afford to employ them on fulltime. No centre employed a medical physicist. The absence of this cadre of staff may have a direct correlation with the high downtimes observed in the zone since they are responsible for regular performance evaluation and quality control. Adequate staffing has been considered the most important of the health system inputs, as the performance and the benefits the system can deliver depend largely upon the knowledge, skills and motivation of operators responsible for delivering health services [18].

Irrespective of staffing and motivations, scanner availability is very important [15**].** Downtime is said to be inevitable yet, efforts must be made to ensure that all equipment used in patient care are available, accurate, affordable and long lasting [16]. In this study the reason for downtimes were generalized into non-commissioning, incomplete installation and malfunction. Previous researchers have however, narrowed down the possible reasons to include faulty materials for design, defective lubrication, loosening of parts, failure of insulation of short circuits and abnormal stress. Others were lack of skills, carelessness of the operator, obstruction by foreign bodies and overloading of such equipment [16, 18].

No federal agency was consulted in the course of the study. Perhaps their input would have thrown up more facts that would have enriched the work.

The authors are however, confident that inspite of that absence of corroboration, the outcome of the present study is reliable.

Conclusion: The Southeast zone has a large number of CT scanners (n = 28) with a concomitantly, high downtime (n = 12). Furthermore, no single medical physicist was employed in any CT centre to carry out regular technical quality control. The employment of this cadre of staff may mitigate the cases of downtime and guarantee improved service delivery to the populace.

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