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Challenges of radiological equipment management policies in some northern Nigerian hospitals

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Abstract

Background: The availability and use of medical imaging equipment is undoubtedly on the increase which means wear and tear is expected by the users.

Objective: To outline the challenges of medical imaging equipment operational policies for efficient radiodiagnosis in nine northern Nigeria hospitals.

Materials and methods: Sixty five (65) questionnaires were administered to radiographers and equipment engineers; interviews were conducted; and data obtained from log books.

Results: Result showed that only two out of the nine hospitals had a full typical radiology department. The chief executive officers/hospital administrators carry out all radiological equipment procurement and are oblivious to the need of professional input. Out of the 61 imaging equipment installed in the area 51 (84%) were functional at the time of survey while 10 (16%) had broken down. In terms of downtime 81% of minor faults lasted for between 48 to 72 hours; 9% lasted for 24 hours. Major faults lasted for up to two months. Only one of the nine hospitals (11%) implements planned patterns of inventory documentation, including clinical risk assessment.

Conclusion: Reduction in the downtime of imaging equipment; utilization of a medical equipment maintenance plan; use of high caliber professionals for quality assurance in establishing prompt service delivery as well as enhanced efficiency and effectiveness in all radiological processes should significantly improve equipment lifespan.

Keywords

Planned preventive maintenance, quality control, planned procurement pattern, total preventive maintenance.

Introduction

The medical equipment management plan (MEMP) defines the mechanism for interaction and oversight of the medical equipment used in the diagnosis, treatment and monitoring of patients and the overall responsibility falls under facilities management[1-3]. Related policies and procedures govern activities ranging from selection and acquisition to inspection and maintenance. The mission is to ensure that all equipment used in patient care should be available, accurate, affordable and long lasting[4]. Equipment breakdown and non-functionality are inevitable. The real challenge is how to minimize the frequency of breakdown and reduce equipment downtime[5]. Possible reasons for breakdown include faulty materials for design, defective lubrication, loosening of parts, failure of insulation of short circuits and abnormal stress. Others are lack of skill and carelessness of the operator, obstruction by foreign bodies and overloading of such equipment[5]. Faults may be catastrophe and cannot be predicted or maintainable and may require immediate rather than routine maintenance. There are more than 4000 x-ray machines in Nigeria but less than 5% are under regulatory control[6]. This situation of the majority not been under such control poses hazards to patients, personnel and the public and challenges to the regulatory bodies due to increased radiological examinations being undertaken[7]. Increasing cost and complexities of state of the art radiographic equipment and the need for more comprehensive safety performance assurance have increased maintenance expenditure of radiology department[8]. In the absence of the above some equipment is unserviceable and inappropriate for service delivery. This causes an increased financial burden on service providers which means that a comprehensive in-house maintenance programme is often put in place. These programmes include planned procurement pattern (PPP), planned preventive maintenance (PPM), total productive maintenance (TPM), and quality control (Q.C) measures[5, 9, 10].

This study assessed diagnostic radiological equipment used in nine northern Nigerian hospitals. Also included in the assessment were policies to enhance the effectiveness/efficacy of such equipment, and related policies and procedures that govern activities like selection, acquisition, monitoring, inspection and maintenance of the equipment.

Materials and methods

A survey of equipment installation and maintenance policy was conducted in radiology departments of nine northern Nigerian hospitals. Each surveyed hospital was coded. The surveyed equipment included conventional diagnostic x-ray units, mammography units, fluoroscopy units, ultrasound units, computed tomography (CT) scanners, magnetic resonance imaging (MRI) machine and radiotherapy equipment. Data were drawn from log books, administered questionnaires and interviews. The authors sought to determine the following:

- the surveyed hospitals' procurement patterns,

- implementation of post installation tests,
- practice of quality control tests and planned preventive maintenance measures.

In addition the following were ascertained

- duration of equipment downtimes
- availability of current equipment breakdown inventories
- adequacy of measures adopted to fix such equipment
- clinical events involved during and after equipment breakdown.

Data were analyzed with simple frequency and percentage distribution.

Results

The hospital coded AK had the highest number of installed equipment (23%). This was followed by hospitals NH (21.3%), AB (16.4%), DA (9.8%), UA (8.1%), AC and FM (6.6%) (Table 1). It was noted during the survey that 84% of equipment was functional and 16% was not functional. Equipment procurement was performed by the management and chief executive officers of the hospitals. In terms of inputs from end-users the survey revealed that 24% were asked for specifications, 54% were sometimes asked , and 22% had never been asked specification inputs. Eighteen percent (18%) of the respondents stated that procured equipment followed specifications; 52% said that specifications are sometimes followed; 28% stated that specifications are never followed (Figure 1). All nine hospitals conducted post installation tests. Only two (22%) of hospitals surveyed conducted planned preventive measures and seven (78%) did not. Six hospitals (66.6%) practiced quality control/assurance whereas three (33.4%) did not (Figure 2). There were no reported cases of injuries/adverse risks in terms of one case of misdiagnosis and two cases of disruption of patient services. Out of the nine surveyed hospitals 9% had minor equipment faults lasting for about 24 hours. In terms of minor equipment faults the survey revealed: 55% of the nine hospitals had minor equipment faults lasting for about 48 hours; 36% had minor equipment faults lasting for just about 72 hours before intervention. In terms of major faults the survey found that 91% of the nine hospitals had major faults lasting for about one month and 9% had major

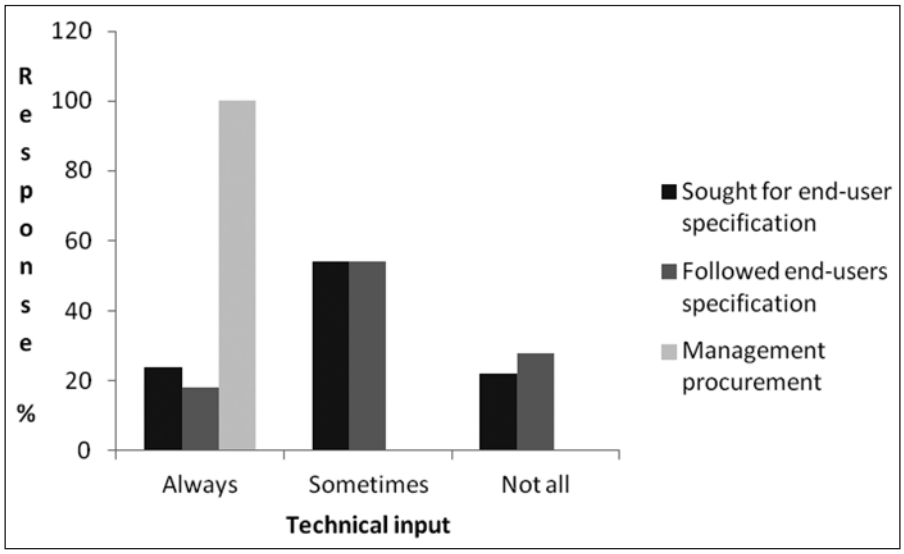

Figure 1: Distribution of equipment procurement policies.

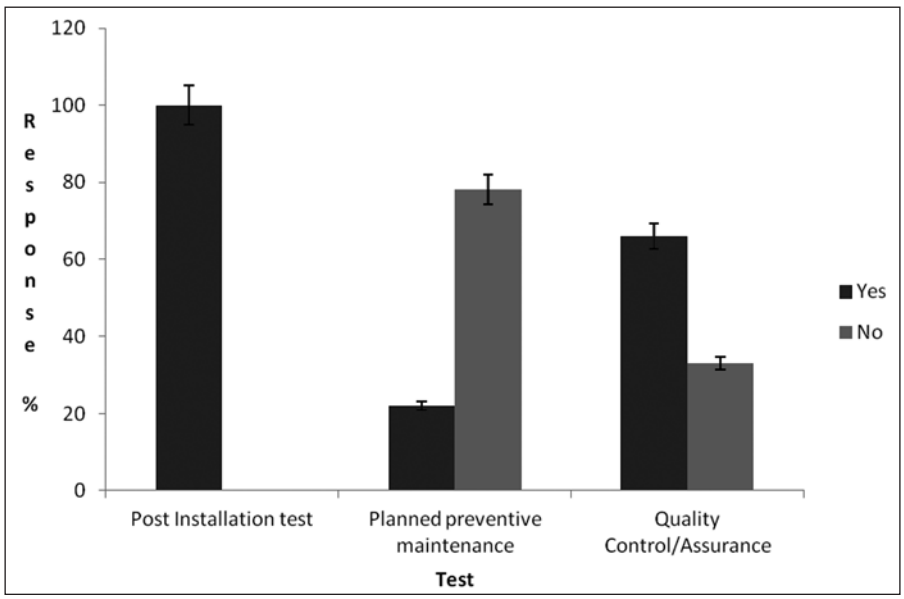

Figure 2: Distribution of equipment installation and maintenance policies.

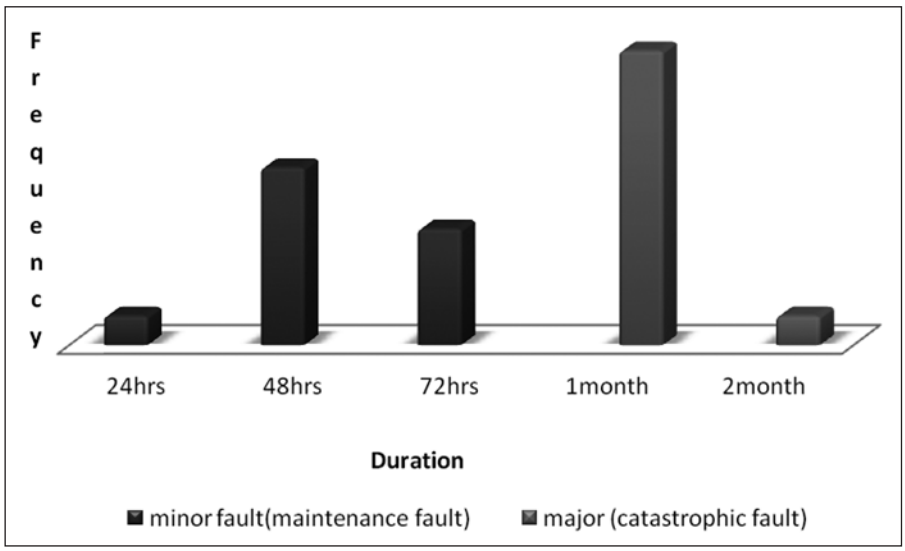

Figure 3: Distribution of duration of downtime of equipment breakdown (%).

Table 1: Number and types of installed equipment in the surveyed hospitals (fluoro = fluoroscopy; mammo = mammography; USS = ultrasound scanners; CT = computed tomography; MRI = magnetic resonance imaging).

CENTRE CODE	EQUIPMENT TYPE						
	X-RAY	FLUORO UNIT	MAMMO	USS	CT	MRI	RADIO-THERAPY
AK	5	1	1	5	2	-	-
AB	3	1	1	2	1	1	1
GH	1	-	-	1	-	-	-
AC	-	1	1	1	1	-	-
NH	3	2	1	3	1	2	1
UA	2	-	-	3	-	-	-
FM	1	-	-	2	-	-	-
DA	1	1	1	3	-	-	-
MC	1	-	-	3	-	-	-

faults lasting for about two months before intervention (Figure 3).

Discussion

The survey results suggest that equipment procurement and maintenance policy are a major problem. Figure 1 suggests that there is little or no involvement of end-users or other expert opinion in the purchasing of equipment. This has resulted in purchasing of substandard equipment or equipment with short lifespans.

The aim of this survey was to critically assess the equipment used in northern Nigerian hospitals as well as the management policies put in place to enhance the effectiveness of such equipment. Furthermore the survey also sought to asses policies governing selection, acquisition, monitoring, inspection and maintenance of radiology equipment. The survey revealed that only two (22%) of facilities had a full complement of radiology equipment for diagnosis and therapy (Table 1). In terms of type of modalities available thirty-two (52.5%) used x-radiation (conventional X-ray machines formed the bulk). There were twenty-three ultrasound units listed in the survey which constituted 37.7% of all equipment (Table 1).

In terms of the role of experts the survey revealed that in the majority of cases there was no professional input by the end-users. The results indicated that some consultation process was implemented (54%) before procurement but the level of such consultation is difficult to ascertain. Functioning equipment was found to be 84% at the time of survey. All nine hospitals conducted post installation tests but only a few, namely 22%, routinely implement planned preventive measures. Quality control/assurance tests were conducted by 66.6% of the surveyed facilities (Figure 2). Minor equipment faults lasted a minimum of 24 hours and maximum of 74 hours. Major equipment fault were corrected within 1-2 months (Figure 3).

Some studies[4, 5, 9] have reported poor planned procurement pattern (PPP), planned preventive maintenance (PPM), total preventive maintenance (TPM) and quality control (Q.C) as reasons for equipment breakdown. Elegba[6] reported that only 5% of equipment in Nigeria is under regulatory control.

None of the hospitals surveyed use job cards, and only one of the nine hospitals (11%) had an updated logbook. No patient deaths were recorded and no patient/operator injuries were reported. There was one case of misdiagnosis and two cases of disruption of patient services. Several researchers[2, 4, 7, 11] have reported clinical risks and hazards to patients, personnel and regulatory bodies due to radiological equipment in use. Poor procurement and maintenance policies in Nigeria may be fingered as a major contributor to substandard and frequent and breakdown in our hospitals.

The challenges of equipment management and adjourning policies occur as a result of non-harmonization of acquisition plans with institutional management policies. In view of this many facilities have poor planned preventive maintenance, inadequate quality control, negligence and ignorance of the end users. Since most equipment faults cannot be predicted means that planned procurement pattern, planned preventive maintenance, quality control and prompt repairs when breakdown occurs, are necessary for effective and efficient radiological practice. There is a need for continuous professional development programme and orientation of end users of equipment to provide adequate skills necessary for their operation. Job cards and inventories on equipment breakdown would provide useful data to assess the level of deterioration of installed equipment. Regular preventive maintenance completion, product hazard alert impart, current quality improvement indicators would significantly impart equipment longevity. A study[12] has recommended the adoption of quality control protocols that transcend procurement and installation of equipment.

Conclusion

The challenges of equipment management policies arise from poor procurement and maintenance policies in institutions. Ongoing reporting in terms of planned procurement pattern, planned preventive maintenance, and quality control would help prolong equipment lifespan and reduce potential risks due to equipment breakdown.

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References

1. Duke Primary Care. *Medical equipment management plan.* www.clinical engineering.duhs.duke.edu. Accessed August 2012.
2. Nolan J. *Equipment management plan.* www.aami.org/tmcconnect/exchange/department/dept.eqtplan.doc:2005:5-6. Accessed January 2012.
3. Colligan SJ , Mills JA. A philosophical approach to treatment machine maintenance and breakdown. *BJR.* 1997: 70; 1274-1279.
4. Caruso T. Benson B, Hendrix B. *Medical equipment management plan PDC 2011* www.duhsclinicalengineering.org. Last update 2011; Accessed September 2011.
5. Agarkhed D. *Mapping of medical equipment downtime.* http://cyberlectures.indmedica.com/show/126/1/Process Last updated June 2006; Accessed September 2011.
6. Elegba SB. *Radiation safety officer (RSO) in diagnostic and interventional radiology.* Keynote Address, University of Ibadan, Ibadan, Nigeria. http://archive.punchontheweb.com/articl.aspx\. Last update 2006; Accessed December 2011.

7. Mallam SP, Akpa MD. Oladipupo MD. Reappraisal of existing expressions for estimating radiation output from diagnostic X-ray machine. *Nigerian Journal of Physics*. 2004:16 (2): 30-34.
8. Oluwafisoye PA, Olowookere CJ, Oluwagbemi MA, Adeola OF. Monitoring and quality control tests of Nigerian National Petroleum Corporation (NNPC) diagnostic facilities: part of quality assurance programme of radiology in Nigeria. *Journal of Theoretical and Applied Information Technology*, 2009: 5(3): 286-294.
9. West M. The principle of quality assurance and quality control applied to both equipment and techniques. In Wooten R editor *Postgraduate Medical Science Radiation Protection of Patient*. Cambridge: Cambridge University Press, 1993:49 57.
10. Brunnett CJ, Heuscher DJ, Mattson RA, Vrettos CJ (Gould RG, ed). CT design, considerations and specification acceptance testing and quality control of diagnostic x-ray imaging equipment. *AAPM Monograph 20.* New York: American Institute of Physics, 1994;833-861.
11. Muhogora WE, Nyanda AM, Potential for reduction of radiation doses to patients Undergoing some common X-ray examinations in Tanzania. *Radiat Prot Dosim.* 2001; 94 (4): 381-384.
12. Egbe NO, Inah GB, Azogor WE, Chiaghanam NO, Ikamaise VC. Good Radiographic practice: the Nigerian experience and the CEC recommendations. *European Journal of Radiography*, 2009;1: 147-150.