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Assessment of Availability and Utilization of Medical Equipment's in Nekemte Specialized Hospital, August, 2021

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Abstract: Objectives: The aim of this study was to assess the availability and utilization of medical equipment in Nekemte Specialized Hospital (NSH). Methods and Materials: A retrospective cross-sectional study design was employed. Adapted and pre-tested structured English version checklist for availability and utilization of medical equipment, document review and an in-depth interview were used for data collection. Data were collected by observation of availability of the medical equipment and interviewing selected professionals for utilization of capital item medical equipment. Microsoft excel 2013 was used for data analysis. Descriptive analysis was made to determine the availability and functional status of medical devices and qualitative part were thematically analysed. Results: This finding showed that about 60.4% (209) of medical equipment are available from the total required quantity of 348 which account only 45 (37.2%) of them were items. Among the available 209 medical equipment's about 84.67% of them are functional and 15.33% of them were non-functional during the assessment. Besides, the Donated equipment accounts 45%. From eight-capital item three of them were properly utilized with utilization coefficient of 81.4%, 100% and 100.0% while the rest five were underutilized with utilization coefficient of 2.5%, 5.77%, 9.2% and 0%. Conclusion and Recommendation: The hospital lacks valuable, advanced and specialized medical equipment that are needed for diagnosis and treatment. Medical equipment fails due to lack of training for user, infrastructure problem like power surge and hard water, and misuse. Training that improves skill of the user and technicians should be given.

Keywords: Availability, Medical Equipment, Nekemte, Utilization

1. Introduction

Medical equipment can be defined as including a wide range of instrument, equipment, machinery or apparatus used for medical and para-medical purposes. Their contribution in health care service is protecting against disease by preventing or reducing the risk of its occurrence by serving as vaccine delivery devices. They have great role in detecting a disease or abnormality, or risk factor associated with these in asymptomatic populations by screening disease like breast cancer and diagnosis to identify the cause and nature or extent of the disease. Medical equipment management defines organization and coordination of activities that ensure the successful management of equipment related to patient care in a health facility. [1] Medical equipment requirement may range from sophisticated life-support equipment like MRI (magnetic resonance imaging) in a tertiary hospital setting to simple equipment thermometer needed for effective diagnosis and safe treatment of patients in a primary health care setting. For this important component of health service developing country invests about $5billion (or 7.0%) of the $ 71billion spent each year on medical equipment worldwide. [2] For health institution to deliver equitable and reachable service to the community at appropriate level, quality and quantity of medical equipment must be available. Health service improvement of the population is based on improved ability to predict, prevent, diagnose and cure many illnesses, and to alleviate functioning problems using treatments and technologies. They have to equip with essential, efficient, cost effective, quality technology and functional medical equipment. [3] Utilization of medical equipment essentially

means the use of the equipment to its full potential. Clear vision and thought regarding the use of the equipment are necessary so that realistic performance may be set. It should be the endeavour of the management to optimize the equipment utilization to obtain maximum return for the capital invested. Proper utilization of the hospital equipment will lead to optimal patient handling and rapid turnover, minimum possible cost, quality patient care and satisfaction. [4] Availability and functionality of medical equipment plays a vital role in producing accurate and reliable test results that increase effectiveness of treatment. It also accelerates health care facilities to provide quality health services and meet the demand of health service standards. [5] There is limited evidence in availability and utilization of medical equipment and technologies in our country in general, and in Nekemte specialized hospital in particular. Therefore, this study designed to assess the availability of all medical equipment as per standard of ESA as well as utilization of capital item.

2. Methods and Materials

2.1. Study Area and Period

This study was conducted in Nekemte specialized Hospital, Nekemte, Ethiopia and located 325Km from Addis Ababa (the nation capital). Nekemte specialized hospital serves five zones, and one neighbour region: - East Wollega, West Wollega, Kellem Wollega, Horro Guduru Wollega, Bunno Bedelle, and Benishangul Gumuz region. It serves around ten million peoples. The hospital has 17 departments with around three hundred beds.

2.2. Study Design

A retrospective cross-sectional study design was employed.

2.3. Study Population

The data were collected from all eleven department heads by using interview administered questionnaires. From the hospital management team members:-matron, executive manager and medical director are the decision maker. NSH has different basic and special units like medical unit, surgical unit, operation room, laboratory department, radiology department, gynaecology department and medical equipment management units which have attachment with the equipment.

2.4. Sample Size and Sampling Methods

NSH has 17 major departments in which medical equipment's are available and utilized. Among those major departments; 9 departments and 2 management team members were sampled purposively by including three departments in which capital medical equipment's were available.

A purposive sampling technique was used for assessment of capital items medical equipment utilization and census for medical equipment availability was conducted. This sampling technique is selected because members of the sampled respondents possess appropriate knowledge and understanding of management and status of medical equipment.

2.5. Data Sources and Collection Techniques

Observation checklist, interview guide and document review were used. In-depth key informant interview was conducted. The key informants were sampled based on their position and responsibility in the department like matrons, hospital Chief Executive Officers, department heads and biomedical engineers.

The data were collected by observation of all departments, interview of department heads and reviewing of the documents to assess the availability and utilization of medical equipment in each unit. The content of the checklists includes: - medical equipment lists which should be present in typical specialized hospital and number of available devices with level of functionality, source of the equipment and the availability of the medical devices. From available and functional equipment, capital items were selected and then using pre-developed checklist the data on medical equipment performance capacity and daily performance collection space were collected.

2.6. Data Analysis Technique

Microsoft Excel 2013 was used for quantitative data analysis and descriptive analysis was done to utilization coefficient and percentage of the available medical equipment and their functional status.

The qualitative data was analysed after the responses from each respondent and presented together with the quantitative data.

To assess utilization of medical equipment utilization coefficient was applied (that is whether the equipment is optimally utilized or underutilized). Utilization coefficient of medical equipment was measured by the following formula: -

$$\text{Utilization coefficient (UC)} = N/M \times 100$$

where N=actual performance, M=design potential (performance).

To assess utilization coefficient of capital medical equipment, the recorded number of tests, or examined number of patient or number of cycles per day or working hour of the equipment was used and empirical computation with manufacturer design performance was performed. To decide equipment is underutilized, if UC <50.0% and is bad investment. [6]

2.7. Validity and Reliability Analysis

2.7.1. Reliability

This study used split-half's reliability tests method. In this method, the instrument was administered once to the respondents. However, the responses are tested for consistency by splitting the instrument (questionnaire) into two halves. Each half consists of questions, which are similar to the other half. Then, the correlation between the two halves is calculated.

2.7.2. Validity

Validity of the findings, data collected, the instrument used in data collection and the research design is of important concern in social research. This study used content validity test type, which is preference of many researchers. The items are in this validity test, the items are subjected to review by those who are formally trained and have expertise in the subject under study. Usually, individuals with considerable domain knowledge are asked to review whether the items used, measure the intended property or not. Consensus opinion was considered in finalizing the instrument.

2.8. Operational Definitions

Medical equipment: -Are equipment requisites calibration, maintenance, repair, training and downgrading accomplishments, typically administered by clinical engineers (biomedical engineers). [7]

Utilization: - Essentially means the use of the equipment to its full potential. [4]

Capital items: -In this study capital items like X-ray, Ultrasound, Chemistry machine, haematology machine, sterilizer, panoramic x-ray, Ct scan, mobile x-ray, lithotripsy and Anaesthesia machine; with their cost are greater than one millio. [8]

2.9. Ethical Consideration

The Ethical review board of the Great land college were approved this study. Besides, Nekemte specialized hospital was communicated formally with official letter prior to starting the actual study. The study participants were informed about the study purpose and they were informed free to skip any item they did not wish to answer or withdraw from the interview any time.

3. Results

3.1. Availability of Medical Equipment

This study used a medical equipment inventory conducted by 2021 (Tables 1 to 4) and then confirmed with observation in all wards and department for their availability, functionality status and source.

The quantitative result showed that about 60.0% (209) number of medical equipment are available from the required quantity of 348, which account only 45 (37.2%) of the items. Among the available 209 medical equipment's about 85.0% of them are currently functional, and about 45.0% of them were donated equipment. The qualitative result from in-depth key informant interview indicated that medical equipment's that were purchased or acquired through donation fails at maturity level or they are incomplete when arrive. Besides, it depicted that the hospital acquired these equipment in different ways like direct purchase, support from different government organization and donation.

The inventory indicated that about 43.0% (90) of medical equipment were acquired through donation whereas 57.0% (119) of them were purchased by hospital and given from different government organization like Oromia regional health bureau and Federal Ministry of Health by support.

From the content analysis of the in-depth interview, it was indicated that the causes for mal-functionality of the equipment was long period stay of medical equipment without returning to their normal operating status, the presence of acceptance or rejection policy, before deployment training, and preventive maintenance training arrangement for user.

All key informants reflect that absence of adequate essential medical equipment in the hospital and all equipment threated equally whether they are expensive or not which mean there is not special attention for management and utilization of capital item medical equipment's. The user does not get adequate training on how to perform simple maintenance like preventive maintenance but orientation how to operate the machine was give during installation by some company where done. Even some technicians perform their maintenance or installation by closing room not to share their skill to hospital biomedical engineers.

Respondents agreed that breakdown of medical equipment's are mainly due to power surge, misuse, hard water for those use water to generate steam, the hospital have no rejection and acceptance regulation for any source of medical equipment except for visible breakdown or total non-functionality. Even though the hospital biomedical engineer's response for maintenance is quick because of spare part, cost of spare part, absence of spare at nearby, skill gap on sophisticated equipment's and absence of some accessories like software the medical equipment decommissioned or stay for long time before returning to normal working condition. Additionally, lack of skilled person to operate equipment and shortage of room, there were equipment that is not giving service. While reviewing the document many medical equipment breaks while unloading, beaten by rat and absence of preventive maintenance.

3.2. Utilization of Capital Item Medical Equipment

To assess the utilization of functional capital item; official 8 (eight) working hour have been used and their performance was measured. Using their designed capacity utilization coefficient has been calculated. If equipment's are more than one, the summation of their designed capacity and actual performance were used (Table 5).

The first three-capital item medical equipment's digital x-ray, ultrasound machine and steam sterilizer have utilization coefficient of 81.4%, 100.0% and 100.0% respectively which represents good utilization and can be regarded as good investment. On the other hand, panoramic dental x-ray, clinical chemistry, haematology analyser and lithotripsy possess 2.5%, 5.77%, 9.2% and 0.0% utilization coefficient respectively, and this means these four equipment's investments were bad as they are underutilized. This showed that only 42.0% of equipment under study was properly utilized whereas 58% of the medical equipment was underutilized (Table 5).

Table 1. *Laboratory department Equipment and their status, Nekemte Specialized Hospital (NSH), Ethiopia, 2021.*

Equipment Name	Standard	Available	Source		Status	
			Donated	Purchased/Support	Functional	Non-functional
Chemistry machine	2	2	1	1	1	1
Refrigerator, Vaccine	2	8	6	2	8	
Refrigerated centrifuge, Blood bank	1	1	1		1	
Haematocrit	1	1	1		1	
Centrifuge	2	4	1	3	4	
Shaker	2	2	1	1	2	
Analyser, Electrolyte	1	1	1			1
Analyser, Hematology, 5 Differential	2	5		5	3	2
Hormonal Analyser	1	1		1	1	
Gene expert Machine	1	2	2		1	1
Microscope, fluorescence	6	5	5		5	
Distiller	1	3	1	2	3	
Bio-safety cabinet	1	2	2			2
Haemocytometer	1	1	1			1
Analyser, CD4	1	1	1		1	
Boiler	1	1	1		1	
Glucometer	1	2	2		2	
Acid Base analyser	1					
PD meter	1					
blood mixer	1					
Vortex	1					
Blood Gas Analysers	1					
Spectrophotometer	1					
Haemoglobin meter	1					
Viral load	1					
Amalgam mixing machine	1					
Multiple headed (>6) Microscope	1					
PH meter	3					

Table 2. *Radiology department equipment and their status, NSH, Ethiopia, 2021.*

Equipment Name	Standard	Available	Source		Status	
			Donated	Purchased/Support	Functional	Non-functional
Lithotripsy	1	1	1		1	
CO2 laser machine	1					
Radiation Monitor	2					
Ultrasonic cleaner machine	2					
Kerato meter	1					
Laser Machine	1					
General purpose ultrasound	1	1		1	1	
specific purpose Ultrasound	2	3	2	1	3	
Digital X-Ray,	2	2		2	2	
X-Ray, Dental	1	1		1	1	
Photo chemotherapy machine	1					
C-arm Angiography Machine	1					
Ultrasound Therapy Equipment	2					
Tele therapy machines	1					
CO-60 machine	1					
Linear Accelerator	1					
Orthovoltage X-ray 100KvP	1					
CT-Stimulator	1					
Brachy Therapy Machines	1					
Cold Light source machine	2					
Gamma Spectrometer	1					
Analytical balances and PH meters	4					
Rectilinear Scanner machine	1					
SPECT/CT	1					
PET/CT	1					
Mobile X-ray machine	1					
CT machine/ MRI	1					
Mammography machine	1					
Color Duplex Ultrasound machines	2					
Echocardiography Ultrasound machine	1					

Table 3. *Ophthalmology and operation department equipment and their status, NSH, Ethiopia, 2021.*

Equipment Name	Standard	Available	Source		Status	
			Donated	Purchased/Support	Functional	Non-functional
Anaesthesia Machine	10	6	2	4	6	
Light, OR, Ceiling	5	3		3	3	
Light, OR, Mobile	7	5	1	4	4	1
Electrosurgical unit	7	4	2	2	4	
Chemical Sterilizer	1					
OPD Microscope, Wall mounted	1					
Operating Microscope	11					
Slit Lamp	2					
Tonometer	2					
Auto refractometer	1					
Lens meter	1					
Ophthalmoscope	10					

Table 4. *Other department's equipment and their status, NSH, Ethiopia, 2021.*

Equipment Name	Standard	Available	Source		Status	
			Donated	Purchased/Support	Functional	Non-functional
Monitor, Patient	8	16	13	3	15	1
Mechanical Ventilator,	7	3	3		3	
Infusion Pump	12	2	2		2	
Defibrillator	10	4	4		4	
Suction machine, electrical	27	24	7	17	22	2
ECG Machine	11	4	4		3	1
Oxygen Concentrator	25	36	2	34	27	9
Radiant warmer, Infant	3	4	4		4	
Dry Oven	10	6	2	4	5	1
Pulse oxymeter	13	8	2	6	8	
Laparoscope	1	2	2		2	
Laryngoscope	11	1	1		1	
Phototherapy unit	2	2		2	2	
Infant Incubator	6	4		4	4	
Gastro scope	1	1	1		1	
Cryotherapy machine	1	1		1	1	
Fund scope	2	1		1	1	
Otoscope	11	3	3		3	
Monitor, Fatal	2	1	1		1	
Drying Machine	1	1	1		1	
Laundry Machine	2	5	1	4	3	2
Cardiorespiratory monitor	1					
CPAP	6	4		4		4
EKG	1					
Chemical Sterilizer	1					
Gas Sterilizer	1					
Colon scope	1					
Cystoscopy	2					
Dialysis Machine	1					
Uretero scope	1					
Perfumer	1					
Fume hood	1					
Procto scope	1					
IV fluid Warmer	1					
CGT monitor	1					
Cardiac monitors with telemetry	1					
Pace maker, External	1					
ET CO2 Monitor	1					
Telemetry Monitor with Transmitters	2					
Patient Cardio-respiratory monitor	1					
ECT machine	1					
EEG machine	2					
Tissue Processor machine	1					
Activated clotting time machine	1					
Transport Monitor	1					
Patient Warmer	1					

Table 5. *Capital item medical equipment utilization result, NSH, Ethiopia, 2021.*

S. no	Equipment name	Quantity	Designed capacity	Actual performance	UC
1	Digital x-ray	2	270 patient/day	220patient/day	81.4%
2	Ultrasound machine	1	8 hours/day	8hour/day	100%
3	Panoramic X ray (dental)	1	40 patient/day	1patient/day	2.5%
4	Clinical chemistry	1	520 test/day	30test/day	5.77%
5	Haematology analyser	3	1632patient/day	150patient/day	9.2%
6	Steam sterilizer	1	2 cycle/day	2cycle/day	100%
7	Lithotripsy	1	40patient/day	0	0

UC: utilization coefficient

4. Discussion

Even though the Ethiopia standard Agency for hospitals indicated equipment's to be available in specialized hospitals, valuable and specialized medical equipment's were missed. The unavailability of such valuable and specialized medical equipment comes from limitation on purchasing such medical equipment's, out of focus areas of donors to donate such expensive equipment's and even if such equipment arrive absence of operator and room operation may be the major problem. This limits the quality service that the hospital delivers especially for diagnostic centres and high-level treatment in needs.

This study finding have similarity with the previous research conducted at Jimma university specialized hospital [9] showed that about 55.0% of the equipment's acquired by donation are found out of service. Additionally, in Jimma zone hospitals the study finding revealed that 196 (65.6%) of medical equipment was available in Jimma University Specialized Hospital whereas 57 (19.0%) and 46 (15.4%) were available in Limu Genet hospital and Shenen Gibe hospital respectively. Among 196 available medical devices in Jimma university specialized hospital 127 (64.8%) were functional and the rest 63 (32.1%) and 6 (3.1%) were not functional and not in use respectively. [3] During observation, many equipment's have been seen that they were decommissioned before three months that is why functional medical equipment were score high percentage.

In-depth key informant interview result indicated that the absence of special acceptance or rejection policy in management and utilization of capital item. The user has no training for preventive maintenance that is why some time misuse or breakdown or occurs. The major reason for break down and unable to maintain were skill of operator, spare part cost and availability, infrastructure problem like power surge and hard water, absence of utilities and accessories like software, manual and consumable part. This result has similarity with the study findings conducted at different areas. [3, 10-15] From eight selected capital item only three of them were utilized properly and five of them where underutilized which were 37.5% total utilization score. This underutilization indicated that these resources are idle and the investment is bad, ineffectiveness management of this equipment which resulted in financial losses to the institution. The hospital purchase and/or accept donation without evaluating the performance of his resource. This finding has mirror image with the other study finding which showed that monitor has 79.0% of utilization, ventilator has 45.0%, infusion pump has 22.0% and the syringe pump has 27.0% which indicate only one is properly utilized from four equipment's. [7]

5. Limitation of the Study

Generalization to other hospitals is not possible due to limited sample size.

6. Conclusion

The hospital lacks specialized and valuable medical equipment's. Absence of special regulation to management, utilization, skilled operator, working room and follow up leads to underutilization of capital items which bad investment to hospital and country as general. Medical equipment breakdown occurs due to absence of user level training, power surge and mineral contained water. The main factors for equipment's being out of service were equipment condition during receiving, lack of spare parts at local market, absence of accessory along machine during receiving, lack of well-trained professionals in the organization, maintenance and operation manual not accompanying the equipment. Lack of functional medical equipment in general and capital items in particular directly related to providing quality healthcare services for the clients. Lacks of proper management and maintenance of the equipment also leads to unwanted expenses to the institutions.

Competing Interests

The authors declare that they have no competing interests.

Lists of Acronyms

ESA: Ethiopian Standard Agency; MRI: Magnetic resonance imaging; NSH: Nekemte Specialized Hospital.

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