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Barriers to Medical Equipment Utilization in Public Hospitals of Bahir Dar City: A Qualitative Study

Habitamu, Ayehualem

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BAHIR DAR UNIVERSITY

COLLEGE OF MEDICINE AND HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

**DEPARTMENT OF HEALTH SYSTEMS MANAGEMENT AND
HEALTH ECONOMICS**

**BARRIERS TO MEDICAL EQUIPMENT UTILIZATION IN
PUBLIC HOSPITALS OF BAHIR DAR CITY: A QUALITATIVE
STUDY**

BY: HABITAMU AYEHUALEM BAYU (BSc)

**A THESIS RESEARCH SUBMITTED TO THE DEPARTMENT OF
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<p>RESEARCH TITLE</p>	<p>BARRIERS TO MEDICAL EQUIPMENT UTILIZATION IN PUBLIC HOSPITALS OF BAHIR DAR CITY: A QUALITATIVE STUDY</p>
<p>NAME OF INVESTIGATOR</p>	<p>HABITAMU AYEHUALEM BAYU (BSc IN PH)</p>
<p>PHONE NUMBER</p>	<p>0918- 224687/ 09- 30316768</p>
<p>EMAIL ADDRESS</p>	<p>habteayehualem@gmail.com</p>
<p>ADVISERS</p>	<p>DESTA DEBALKIE (BSc, MPH) TSION ADEBABAY (BSc, MPH)</p>

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Acronyms and abbreviations

ATLAS ti - ArchivfürTechnik, Lebenswelt und Alltagssprache (qualitative data analyzing software)

BME – Bio medical engineer

BMET - Biomedical Engineering Technicians

BSc- Bachelor in Science

CSA – Central Statistical Agency

ECG- Electrocardiography

EPSA- Ethiopian pharmaceuticals supply agency

FMOH- Federal Ministry of Health

GC- Gregorian Calendar

HSTP – Health Sector Transformation Plan

ICU –Intensive Care Unit

MCH – Maternal and Child Health

ME- Medical equipment

MPH – Masters in Public Health

OR- Operation room

PFSA – Pharmaceuticals fund and supply agency

WHO- World Health Organization

Abstract

Background

Nowadays continuous developments in science and technology are increasing the availability of thousands of medical devices, all of which should be of good quality and used appropriately to address global health challenges. Many appropriate technologies are inaccessible to the majority of people who need them, particularly in low and middle-income countries. To the best of our knowledge, we can't find evidence about barriers in medical equipment utilization in the study area.

Objective

The objective of this study is to explore the barriers in the utilization of medical equipment among public hospitals of Bahir Dar city, Ethiopia, 2022

Method

A phenomenological study design was used. Store managers, matron, Operation room heads, intensive care unit coordinator were included purposively for the key informant interview. Ten interviews were performed from February 11 2021 to March 19 2021 GC. The principal investigator conducted all the interviews, transcribed them, and then translated into English. The qualitative data coding and categorizing were done using ATLAS.ti version 7.0. A thematic analysis approach was used for analysis. Caution during coding and colleague debriefing were used to maintain the quality of the study. Ethical approval was secured from the institutional review board of Bahir Dar University and verbal informed consent was applied.

Results

Non-functionality, procurement-related, maintenance-related barriers, acquisition issues, and training were identified as barriers in medical equipment utilization. A majority of the participants reported that there was problem from donated medical equipment and repeatedly became un-functional. As reported by respondents they had disposed of non-usable equipment by donating to other institutions and using it as an accessory for other equipment.

Conclusion and recommendation

Major barriers in the medical equipment utilization were; non-functionality of equipment, procurement-related, maintenance-related barriers, acquisition issues, training and donation. Disposing of medical equipment was done haphazardly. The public hospitals in the study are better to have attentions towards wise utilization and handling of medical equipment.

1. INTRODUCTION

1.1. BACKGROUND

A health system consists of all the organizations, institutions, resources, and people. It delivers preventive, promotive, curative, and rehabilitative interventions through a combination of public health actions and the pyramid of health care facilities that deliver personal health care(1).

Even though cross-cutting components there are six building blocks that contribute to the strengthening of health systems. They include leadership/governance and health information systems, financing and the health workforce, medical products and technologies, and service delivery. These building blocks reflect the immediate output of the system and reveal the availability and distribution of care(1). One of the building blocks, medical equipment, is rapidly showing advancements. This is due to improved diagnostic and therapeutic facilities, wide growth in medical innovations, the occurrence of new disease scenarios, and spectacular progress in development in surgical procedures and other health care services(2).

Medical equipment is devices used for the specific purposes of diagnosis, treatment, or rehabilitation following disease or injury. It can be used either alone or in combination with any accessory, consumable, or other medical equipment. But, it excludes implantable, disposable, or single-use medical commodities explained by the World health organization (WHO) medical device technical series. It usually requires professional installation, calibration, maintenance, user training, and decommissioning(3).

Globally, there are numerous medical devices estimated at around 5 million different kinds categorized into more than 22,000 generic devices groups. Continuous developments in science and technology are increasing the availability therefore the utilization of thousands of medical devices. They should be of good quality and used appropriately to address global health challenges. Engineering and information technology advancement, particularly during the last few decades, have increased and revolutionized medical care. As a result, medical equipment plays a very significant role in the health care delivery system(4).

The human right to medical products, vaccines, and medical technologies, is a derivative right from the right to health. It also includes the right to benefit from scientific progress as an inclusive right for all. This is understood here as including access to medicines, vaccines,

and devices, and procedures. This has also been emphasized in Alma-Ata Declaration as the availability and utilization of various health care equipment, at all levels, in the health system for effective and efficient service delivery(5, 6).

The health policy of Ethiopia in 1993 mentions the provision of essential medicines, medical supplies, and equipment as one of the priorities in the policy. Preparing lists of essential and standard drugs and equipment for all levels of the health service system with updating, encouraging national production capabilities, developing a standardized and efficient system for procurement, distribution, storage, and utilization, developing quality control capabilities, and developing maintenance and repair facilities were general policies in this health policy(7).

The Federal Ministry of Health(FMOH) announced the Ethiopian health sector transformation plan (HSTP) which has strategic initiatives concerning medical devices. Some of the initiatives included developing an essential medical equipment list, strengthening regulations to encourage technology transfer, strengthening and scale-up the training of biomedical engineers and technicians, establishing a medical equipment refurbishment center, and supporting transparent and accountable decision-making, prioritizing and implementing strategies to promote biotechnology in health including traditional medicine and establish a mechanism to promote innovation and transfer of knowledge and technology from the global innovation market place. There is also a strategic objective in HSTP, efficiency, and effectiveness which describes proper allocation, efficient utilization, tracking, and controlling of resources. It also entails harmonization and alignment among stakeholders to strengthen the financial and procurement management system of the government. This in turn minimizes wastage of resources and duplication of efforts. Due emphasis will be given to equity in resource allocation(8).

1.2. STATEMENT OF THE PROBLEM

Health systems throughout the world, whether in developed or developing countries, are struggling with the challenge of how to manage healthcare delivery in conditions of resource constraint. Even the concept of health system management emerges here, increasing demand with a shortage of resources especially in third world countries(9).

Even though medical devices are crucial for all aspects of healthcare, many appropriate technologies are inaccessible to the majority of people who need them, particularly in low and middle-income countries. About 70% of complex medical devices sat inoperable at their

destinations in developing countries, while on the other hand, most basic devices did not reach adequate numbers(10).

World Health Organization (WHO) estimates between 50% to 80 % of the laboratory and medical equipment from 60 resource-poor hospitals located in 11 nations in Africa, Europe, Asia, and Central America are nonfunctional(11). This underutilization of medical equipment has a devastating effect on healthcare quality and patient outcomes in resource-poor settings. Certainly one of the most common causes for a piece of medical equipment being out-of-service is the lack of consumables, including reagent packs, electrodes, and other single-use devices. However, a large quantity of out-of-service equipment does not require consumables. Another reason for medical equipment being out-of-service is the lack of trained professionals able to execute the needed repairs or maintenance, usually considered a lack of biomedical engineering technicians (BMET) or biomedical engineers(BME)(12).

Medical equipment has a lifecycle requiring calibration, user training, maintenance, repair, and finally retirement. Increasing operational efficiency and reducing costs, while improving service provided to the patient, are a constant challenge. Shortage of medical equipment, either due to unavailability or non-functioning, is a barrier to the ability of the health system to deliver quality health services (13).

Weak after-sales support from manufacturers and distributors and limited maintenance budgets, clinicians not trained on the operation or clinical application, facility issues, and disrepair due to no parts, documentation, or trained service staff are also common problems in the medical device arena(14).

Although the new technologies are often advantageous for the patient, health professionals often encounter difficulties in using devices associated with these technologies, which can increase the risk of accidents and complications during surgery. For example, hand-eye coordination problems can occur when using long instruments inserted via small incisions or natural openings(14).

Many low-resource countries rely heavily on donations of medical devices to equip their healthcare facilities. In fact, some acquire nearly 80% of their healthcare equipment in the form of donations from international bodies. Only 10–30% of donated equipment, however, actually become operational. Donations of medical devices, particularly complex equipment, often do not match the recipient's needs. Seldom does the recipient of a donated medical

device participate in the selection of the device. Especially developing countries lack technology assessment systems and regulatory controls to prevent importation of inferior medical equipment by the name donation (13,15)

In a report by International Federation for Medical and Biological Engineering in 2011, Ethiopia was one of the countries included in the study of quantifying the medical devices out of service after a donation from the developed world. As a report stated from a total of 65,668 medical equipment, 25,610(39 %) were nonfunctional. From factors listed in the report, some of them include resource deficiencies, lack of spare parts, disposables and accessories, failed to report equipment problems by the users, no maintenance schedule, lack of trained technicians, and donors' procurement without technical advice(16).

There is limited data on the utilization of medical equipment in our country; a study in Jimma zone shows the problem was significant and about 35.2 % of available equipment in Jimma University generalized hospital was found to be nonfunctional. And 32.1 % of available equipment in Limmu Genet Hospital is also nonfunctional(9).

To the best of our knowledge, the causes for this low utilization rate are not yet explored, and there is no studies as per our search about barriers in medical equipment utilization by health care professionals in the study area.

1.3. SIGNIFICANCE OF THE STUDY

In hospitals, it is very crucial to explore the utilization of medical equipment to increase the quality of health care delivery and improve patient outcomes. However, there is limited evidence in exploring the utilization of medical devices and technologies in Ethiopian hospitals in general and in public hospitals of Bahir Dar city in particular. This study will evaluate the barriers in utilization of medical equipment, which brings significant improvement in the health care service delivered by the hospitals.

In addition, the result from the research will benefit hospital administrators of the city administration and the administrators of public hospitals in the city for informed decision making about medical equipment management. And the result from this research will help policymakers for a better understanding of the issue for the formulation of new policy and/or updating the existing policies/procedures. On the other hand, finding from this will provide updated information and be used as a baseline for further studies.

2. LITERATURE REVIEW

2.1. Medical equipment utilization

Effective utilization is very essential for any organization to achieve its goal and also quicken the equalization of the cost and income from equipment. However just obtaining the best equipment available in the market alone will not guarantee the achievement of the target, proper training and allocation of staff is required to utilize the equipment to its full potential(17).

A study conducted in the diagnostic laboratory (histopathology) of tertiary health care set up at Chandigarh of India shows of 30 types of medical diagnostic equipment under study 23(77%) of them showed adequate utilization of medical equipment. As it was a tertiary health care setup and diagnostic laboratory in which most works rely on the medical device it may not be a surprise that more than half(60.2%) of the equipment were functional and utilized(2).

From studies in Africa, research done at Benin in the year 2017 stated that health technology management issues were most evident at the intermediate and peripheral health facility levels, particularly in departmental and zone hospitals where maintenance structures and practices were lacking compared to the central level hospital. In all visited health facilities, the proportion of medical devices out of operation was estimated to be 48%, 65% in the central hospital, 40% in the departmental hospitals, 30% in the zone hospitals, and 26% in health centers. This study gives us a clue that as we go from central hospitals to health centers proportion of medical devices out of operation decreased(10).

Other studies from Nigeriastated that it was the unanimous conclusion of a participant that the perceived poor quality of service delivered by target primary health care centers was because appropriate equipment was either lacking or inadequate(18).

According to a study conducted by Lora Perry and Robert Malkin, a total of 112,040 pieces of medical equipment were inventoried from 16 developing countries around the world. In developing world countries, 38.3% (42,925 pieces) of the equipment were out of service. Some equipment was more likely to be out of service (X-ray and sterilizers) while some were less likely to be found out of service (anesthesia machines and operating room tables). Individual types of equipment were out of service at a rate of 32% (anesthesia machines) to

47% (X-ray machines). About 40% of donated medical equipment is out of service. Generally, Data from 16 countries showing numbers of medical equipment pieces out of service is about 38.31 % (42,925 out of 112,040) from which Ethiopia was one of them(19).

Even though there is limited data about medical equipment utilization in Ethiopia, there was a study done in the year 2016 in hospitals of Jimma zone of Oromia region. According to the study, 299 medical devices were available in the three hospitals among which, 196 (65.6 %) of them were available in Jimma University Specialized Hospital whereas 57 (18.1 %) and 46 (15.4 %) were available in Limmu genet hospital and Shenen Gibe Hospital respectively. Among 196 available medical devices, 127 (64.8 %) were functional and the rest; 63(32.1 %) and 6 (3.1 %) were not functional and not in use respectively. Twenty-eight (60.9 %) and 30 (52.6 %) of the devices in Shenen Gibe hospital and LGH respectively were functional. The study shows us the huge amount of equipment were non-functional.(9).

In Ethiopia, lack of proper management of medical equipment has limited the capacity of health institutions to deliver adequate health care. It is estimated that only 72% of medical equipment found in Addis Ababa public hospitals are functional and in some hospitals, in the regions, functional equipment is near to 50%. The rising number of this non-functional equipment are due to Poor equipment handling and utilization, frequent power surges, the age of the equipment, lack of operator training, lack of preventive maintenance, lack of spare parts, lack of maintenance capacity, and minimal knowledge regarding sophisticated equipment(20). As a result FMOH introduced a hospital service transformation guideline that elaborates the source, donation, commissioning, maintenance, training, and disposal of medical equipment.

2.2. Barriers to medical equipment utilization

As WHO report in title of medical device: managing mismatch barriers to using medical devices are largely interrelated and stem from a mix of factors. The relative importance of each factor will vary with the context—geographical, social, cultural, economic, demographic, medical, reimbursement—in which a medical device will be used(14).

Studies show that a large quantity of medical equipment is not in an operable state, due to different reasons, such as a lack of staff, lack of technical services, and lack of finances to

provide the maintenance. In addition, the purchased medical equipment remains without proper control by the authorities. The Supreme Audit Office of the Czech Republic has pointed out that public procurement of medical equipment for university hospitals was carried out without previous allocations of state analyses of already used devices, which increases the risk of inefficient spending of financial resources(21).

The following factors were identified as the most crucial factors affecting the utilization of medical diagnostic equipment as per the perceptions of the respondents of research conducted in India. Some were: restricted availability, obsolete machinery, non-availability of consumables and accessories, break down, maintenance delays, and low accessibility of the procedures in the hospital(2).

By the assessment done by TadesseWaktola et. al, 2021 GC to assess and identify the gaps and challenges of Ethiopian public hospitals in the planning and procurement of medical devices was found to be below 50%. This assessment also shows that there is no proper medical devices procurement plan, and technical specification preparations. This contributed to the barrier in medical equipment utilization in most public hospitals in the country (23).

Donations of medical devices are another barrier for the utilization of medical devices; often do not match the recipient's needs. In this sense, donations constitute an insidious barrier to choosing appropriate medical devices. Many low-resource countries rely heavily on donations of medical devices to equip what healthcare facilities they have. In fact, some acquire nearly 80% of their healthcare equipment in the form of donations from international bodies or foreign governments. From them, only a little is functional and on use(14).

There is also an argument that says while donations can cause problems and there are undoubtedly some hospitals where the situation is much worse, the analysis does suggest that donating equipment can improve the available healthcare options(17). It is true that if the receiving institutions were participated in requesting and selecting the equipment, the criteria for receiving donating equipment the donation would have a great role in delivering quality health care.

Much of the laboratory and medical equipment in resource-poor settings is out-of-service. The most commonly cited reasons are a lack of spare parts and a lack of highly trained

technicians. From equipment- repairing requests almost 72 % of medical equipment were back into service without requiring the use of imported spareparts (11).

The three main causes for medical equipment underutilization as studied by Lora Perry and Robert Malkin to discover the utilization of donated medical equipment were lack of training, health technology management, and infrastructure. Infrastructure problems include lack of spare parts, lack of disposables, and lack of required accessories, While health technology management problems also include failure to report equipment problems to technicians or administrators, regular preventive maintenance schedules were rarely followed leading to early breakdown and escalation of problems and in most systems, administrators or donors were left making procurement decisions without technical advice(19).

From a study conducted in the Jimma zone, some of the factors affecting availability include lack of finance, problems in the procurement system (“proforma”), lack of post-sale support, low staff attitude towards equipment handling, lack of monitoring, and unavailability in the market. The staff overload, dissatisfaction of staff, negligence, less sense of accountability, and being teaching hospital were identified as some reasons for low utilization of medical equipment(9).

Generally nowadays because of improved diagnostic facilities, sophisticated equipment, better progress in surgical and other health care services, complicated sampling techniques, and advancement in information and technology obligates every health caregiving facility to use medical equipment for quality health service and excellent patient outcomes. However, there is an availability problem in third world countries including Ethiopia, as numerous equipment are donated but not functioning as there is no best setup. Even the country’s data are not fully known, so do the region and the city administration.

3. RESEARCH OBJECTIVE

- To explore the barriers in medical equipment utilization among public hospitals of Bahir Dar city, Ethiopia, 2021

4. METHODS

4.1. Study setting and period

This study was conducted in Bahir Dar city which is the current capital of the Amhara Regional State. The city is structured with 6 sub cities, 41 kebeles, (4 satellite towns, 27 city kebeles, and 10 rural kebeles) and has 11 health posts, 10 health centers, and three hospitals (one referral, one teaching, and one primary) and four private hospitals. The study was conducted in three public hospitals namely Tibebe Ghion Specialized Hospital, Felege Hiwot Comprehensive Specialized Hospital, and Addisalem Primary Hospital.

Concerning medical equipment public hospitals in the city receive equipment from direct procurement, from Pharmaceuticals Supply Agency; EPSA (former Pharmaceuticals Fund and Supply Agency; PFSA), and donation. And they have medical equipment purchasing committee, drug therapeutic committee, and de-junking committee for medical equipment and supply management.

4.2. Study Design

A Phenomenological study was conducted in three public Hospitals in Bahir Dar city from February 11 2021 to March 19 2021 GC. Government hospitals were purposively selected for this study because of their large patient flow and the high utilization of medical equipment.

4.3. Sample size and sampling techniques

Ten service providers and Coordinators with experience of the medical equipment utilization, or the coordination of a system that utilizes the medical equipment, were included purposively as they have first-hand knowledge about the utilization of the medical equipment and from departments mostly rely on medical equipment at their work place.

Key informant interview- Matrons, Medical Directors, Operation room heads, ICU coordinators, Pharmacy heads, and Store managers were included in the purposive selection. We preferred this sampling technique to access information-rich individuals, and the numbers of interviews were determined based on saturation by the principal investigator.

4.4. Study participants and data collection

Tenkey informant interviews were performed from February 11 2021 to March 19 2021 GC using a semi-structured interview guide. The interview guide was translated to the local language (Amharic) by the principal investigator and re-translated to English. Audiotape records were used to collect the data. There was a note taker, health Officer. The principal investigator conducted all the interviews. Strong attention was given to initial contact with participants, sequencing of questions, probing of information, control of conversations, and creating an atmosphere in which participants can willingly explain their views and opinions.

The interviews continued until saturation of information was obtained. Saturation maintained when repetitive same answers got from different respondents and when our question answered. Probing was used to explore adequate data on the field. A unique code was given to each participant. Each individual was interviewed in their facilities.

The principal investigator conducted the interviews using the local language to explore health workers' experiences and views about medical equipment utilization in the study area. To grant informative data: age, sex, profession, and responsibility of the participants were taken into consideration in the sampling process.

4.5. Data analysis, quality control and trustworthiness

Data analyses of the interviews were started during data collection by transcribing daily and by performing a preliminary analysis. The principal investigator has transcribed all the audio-taped interviews and was reviewed the transcript by listening to the recordings. Descriptive notes were made during the review of the transcripts, which also included the inclusion of new probing questions and a merging of some of the other questions in the interview guide.

The qualitative data coding and categorizing were done using ATLAS.ti7 version 7.0. We reviewed a list of verbatim codes with associated quotations and categories. A thematic analysis approach was used for identifying, analyzing, and describing patterns and deviant cases within the data.

The analysis was carried out in three phases. At the beginning, the transcriptions were read and re-read to generate key categories and were then reviewed several times to ensure that concepts pertaining to the same phenomena were placed in the same category. Steps were

taken to ensure consistent analysis of the data. These included the use of a comprehensive topic list and a code-recode procedure. After coding (verbatim), the same data were recoded 2 weeks later and the results compared. In addition, two colleagues (one Medical director and one obstetrician and gynecologist in private hospital) independently coded and categorized portions of the transcripts, and compared and discussed discrepancies in the categorization process. Finally, the coding was aimed at identifying more general and abstract categories and creating connections between identified themes and different levels. So the data were coded into exhaustive, mutually exclusive, and specified categories to identify the emerging themes by using ATLAS.ti7 software.

Data interpretation was done by searching core meanings of the participants' thoughts, feelings and behaviors described but with wider social and logical relevance. To avoid investigator's bias the interpretations were discussed with the colleagues listed above. The overall interpretation was made by identifying how themes related to each other, explaining how the research question was answered, and what the findings mean beyond the context of the study. In addition, the most important quotations were presented to illustrate the main ideas.

4.6. Ethical considerations

Ethical approval was secured from the institutional review board of Bahir Dar University. Additionally, Oral informed consent was obtained from each participant. Furthermore, privacy and confidentiality were ensured by the anonymity of the study participants in the interview. Moreover, data was stored on a computer with a password (Soft Copy) and a locked cabinet (hard copy).

5. RESULTS

5.1. Characteristics of the study participants

The total numbers of participants were ten. Their age ranges from 22 to 48 years. All are male and from the three public hospitals of the study area.

Table 1: Basic characteristics of the participants, Bahir Dar City, 2021 (n=10)

Code	Age(years)	Sex	Qualification	Profession	Responsibility
H	23	M	Diploma (level IV)	Pharmacy Technician	Store Manager
I	30	M	BSc	Nursing	Matron
J	48	M	BSc	Nursing	OR coordinator
K	32	M	BSc, MPH candidate	Nursing	OR coordinator
L	22	M	Diploma	Pharmacy technician	Store manager
M	35	M	MD+	General Surgeon	OR case manager
N	29	M	BSc	Critical care nurse	ICU coordinator
O	31	M	BSc	Pharmacist	Store manager
P	34	M	MD+	Anesthesiologist	ICU case manager
Q	32	M	BSc	Nursing	Matron

Table 2: Summary of themes of the study

SN	Themes	Remark
1.	Source of medical equipment	
2.	Non functionality of medical equipment	
3.	Purchasing related barriers	
4.	Maintenance of medical equipment	
5.	Acquisition related	
6.	Training about medical equipment	
7.	Duration and frequency of utilization	

8.	Donated medical equipment	
9.	Disposal of medical equipment	

5.2. Sources of medical equipment

A majority of study participants among service providers and coordinators at public hospitals reported that the sources of medical equipment were from the break down as per their catchment population and as per their standard from regional health bureau and federal ministry of health with other hospitals and health institutions in the region and the country, from purchasing from Ethiopian pharmaceuticals supply agency, EPSA, Bahir Dar hub (the former Ethiopian pharmaceuticals fund and supply agency, PFSA). They also reported that the source was from donations from international and local donors.

"The one we got the medical equipment is from the so-called "break down" [a way of distributing materials at the federal, regional, zonal and Woreda level as per the facilities' catchment population]." H, a 23-year-old male store manager

"[...] we got through donation, from regional health bureau, and EPSA [the former PFSA] ... we get from them." Q, a 32-year-old male Matron

Other sources reported by the study participant were from direct purchase of that equipment which was not available at the EPSA and is necessary to the hospital by private vendors after tender and/or direct communication of a single vendor. As one of the public hospitals in the study was newly established in recent years the medical equipment was obtained from borrowing from other public health institutions, direct purchase from financial sources from people around the hospital, donations from regional health bureau after confiscated closed private hospital as a start-up of the new hospital was one a report from study participant. One participant explained:

"[...] Thirdly we collect the medical equipment from other public institutions as the Hospital start working. Especially, there was one private hospital that was confiscated by the local government so we got many types of equipment from that. We got many materials including hospital beds by this way." J, a 48-year-old male OR coordinator

5.3. Non-functionality of medical equipment

A majority of the study participants among the study participants reported that the main reason for the non-utilization or underutilization of medical equipment was the non-functionality of equipment.

Among the reasons of non-functionality of medical equipment claimed one was while installed and acquisition of new equipment they were told to start working without proper installation information and there were no startup training given. One of the study participants clarified it as:

"[...] it is so difficult because there is no training conducted. For instance, when one chemistry machine or other machines arrived, he (the professional) doesn't know about what about of the machine. Even he doesn't read the manual [user manual of the machine]. This is because of the absence of hints, information about the machine, and training." H, a 23-year-old male store manager

Some of the study participants also claimed that the unavailability of reagent and supplies were the reason for the non-functionality of medical equipment especially in Laboratories as sometimes there were single reagent vendors and when they stop supplying they become in trouble of functioning by that machine. One of the participants described like this:

"[...] in the laboratory because of the unavailability of consumables and reagents, there are machines stop working ...we search up to Addis Ababa, but we can't get it. Sometimes as some reagents are closed reagents and the reagent from a single vendor when the vendor stops accessing the reagents we can't find an alternative from other sources. So many machines stop working for this reason." I, a 30-year-old male Matron

The medical equipment has become non-functional as a result of a power surge as described among many service providers and coordinator in public hospitals. They claim as there was also a power requirement difference among machines and our electrical output. It shortens the service year as described by the participants. And also equipment became dysfunctional by the error committed by professionals who run them. A participant elaborates on this issue:

"There are occasions to become partially dysfunctional by errors committed by professionals even totally stop working. Some MEs also become under-utilized by the problem faced as a result of a power surge. For example, if the equipment intended

*to work for 4 years, it may stop working within a year."*K, a 32-year-old male OR coordinator

The participant continued telling the reason as some equipment were scarce and they intended to be used by moving place to place which was claimed as a reason for non-functionality as well as short service year of that specific medical equipment. He stated as:

"Even the places of equipment have an effect. When transporting scarce equipment from one room to the other, the wheels have broken so that it becomes un-functional although intended to work for extended times." K, a 32-year-old male OR coordinator

Another reason of non-functionality was reported as the mishandling of the equipment and then after the equipment became inoperable even by the biomedical engineers as stated as:

*"[...] there are other many ways that the equipment became un-functional. First, the full specifications of the equipment may be unknown by the BMEs so they (the equipment) became difficult for them to manage. So the BME become naïve for equipment; it become difficult to manipulate, even when trying to adjust the equipment become vulnerable for dysfunctional. I.e. handling problem"*P, 32 years old Anesthesiologist and ICU case manager

5.4. Purchasing related barriers

We probed the professionals in the study area about the direct purchase processes, the involvement of the service provider, and how it affected the medical equipment utilization. A majority of participants reported that they had little involvement in the procurement process. A participant expressed:

"[...] after specification, the request arrives at our desk. Then after checking the minute [of purchasing committee] and price of equipment, we simply received the equipment. So we have little involvement." L, 22 years old store manager

And some had no involvement other than requesting the equipment to be purchased by name and in the process, the professionals had no chance of checking the sample. As a result, they reported as they faced a requested-purchased mismatch. A store manager spoke about the situation:

*“The professional himself doesn't see before purchasing and he [professional] doesn't see the sample or anything. In the process, the professional request by name and then purchased as requested. There are times the professional disagree with the equipment purchased, as unwanted equipment is purchased. ... Here in our institution, there is equipment returned to the store because the professionals got the equipment was not of request. For example, there is a steam sterilizer at the store.”*H, a 23-year-old male store manager

Another respondent responds as it was a preventable error that was committed:

*“So it shows that the professionals are not involved in the procurement process. They will pick up the problem if they were involved there.”*O, a 31-year-old male store manager

5.5. Maintenance of medical equipment

The absence of preventive maintenance was the major challenge in medical equipment utilization, which was reported by many service providers and coordinators of public hospitals in the study area. Medical equipment faces maintenance only when stops working as they reported during the interview. OR case manager explained about this:

“One, preventive maintenance for purchased equipment is not done. This is one of the problems. We always have a problem with preventive maintenance.” M, a 35-year-old OR case manager and specialist in general surgery

Among service providers and coordinators in a public hospital in the study area most of them reported that even though there were bio-medical engineers (BMEs) starting from first degree to Master's Holders, they have limited skills along with most machines. The professionals claimed they were not fully practiced a wide range of equipment in their school studies. Because of this sometimes service engineers from Addis Ababa were recruited but they were delayed as they have other duties. Here are some expressions from participants:

“[...]. Even the BME are not fully practiced the maintenance at their academic training. So the BME become naïve for equipment; it becomes difficult to manipulate, even when trying to adjust the equipment become vulnerable for further dysfunctional.” I, 30 years old Matron

“[...] they may not be exposed to all machines. What we identified as a problem is we have a variety of medical equipment and they don't have plenty of skill to manipulate

them. So there is a skill gap."M, a 35-year-old OR case manager, and Specialist in general surgery

"[...] it is not easy to find them. Some easy maintenances are not undergone because of unavailability of these experienced BMEs; most are from Addis Ababa." H, a 23 years old store manager

The spare part problem was the repetitive report spoken by study participants. Some equipment, as reported, was become un-functional because of the unavailability of spare parts. And some of the equipment in the study area were of old fashion and it was difficult to get spare parts. Participants explained:

*"[...]. Now at the time of the interview, there is one mechanical ventilator stopped working and we are thinking to give rest for some weeks."*N, a 29-year-old ICU coordinator

*"[...]. Others ultrasound, ECG, and mobile x-ray are stopped working because of each one spare part. These all will be functional if we change the spare part for them. ..."*N, a 29-year-old ICU coordinator

The other element that emerged as a factor that influenced medical equipment utilization was corrective maintenance given by the bio-medical engineers, voluntary service engineers, and experienced professionals. Among service providers, the majority of participants reported that they had BME and when medical equipment was stopped, they filled a form called work order. Then the BMEs tried their best to maintain the equipment. One participant told us that in his room there are experienced professionals who were capable of fixing some problems even they were called up to the regional health bureau for inspecting equipment. Some clarification reported as:

"[...]. We will report to the BME, if there is dysfunctional material. The BME will evaluate them if there is damage or dysfunction unto them. He [BME] will report for another service engineer if he can't fix them so that he finds the way returned to the functional status." J, a 48-year-old OR coordinator

5.6. Acquisition-related Barriers

When medical equipment was acquired from many sources sometimes low-standard equipment was acquired from governmental sources and donations, this was reported by service providers in the study area.

"[...] But there are also materials with a low standard that we can't compare with the Hospital [set up] . . . even the health centers' [standard] were given by the name of Break down." H, a 23-year-old store manager

5.7. Training

Based on the interview with service providers and coordinators, the absence of training towards the utilization of medical equipment was one of the reasons for the non-functionality of medical equipment. They reported that when a new machine is acquired there is no induction given for end-users and because of this reason the professionals became naïve for machines and afterward a reason for poor handling so that non-functionality of equipment. A respondent expresses his feeling as:

"As our room, no one is trained. There is like on job/ onsite training. Like press this one ... this is power on button, this is power off button ... press this one when it reaches here This type of peer education is present. No professional get calibration and manipulation training from trainer or BME or donors." J, a 48-year-old OR coordinator

Because of the absence of information and technical knowledge even sometimes it was difficult to understand the user manual of the machine and equipment became non-functional which was reported by the responders of the interview. They also claimed because of the absence of knowledge about the equipment, so the absence of preventive and corrective maintenance of that equipment, the service year became short. The store manager also explained there must be minimal training on how to store and handle equipment which was absent in the study area. They spoke like:

"[...] There is no training given for the storeman. Now I am working with experience, without any knowledge and skill from training. It is better doing little troubleshoots." L, 22 years old store manager

Some voices were also heard; because of training given about oxygen administration, they easily manipulate all types of oxygen sources from concentrators up to oxygen implants. The

same reports were also found about endoscopy surgery training given for OR nurses the training made preventive and corrective maintenance easy and the working environment smooth.

*“: [...] in laparoscopy around 5 nurses took training in Israel and also in Addis Ababa, then we are working now smoothly.”*K, a 32-year-old OR coordinator spoke

“We took training about how to administer oxygen, how to manipulate every oxygen cylinder, and the like. For example, some professionals took training how to use and how to clean each type of oxygen [sources] like concentrator, cylinder and oxygen implant.” I, a 30-year-old matron elaborate

5.8. Duration and frequency of utilization

An ICU coordinator described how the duration of utilization affects the functionality of medical equipment by exemplifying mechanical ventilators had stopped working one by one and there were only 2 functional ventilators out of 8 ventilators in one of the public hospitals in Bahir Dar city.

*“[...] Because of their age, they stop working one by one and now they become only 2 mechanical ventilators [out 8].”*N, a 29-year-old ICU coordinator

Some machines were used frequently because they were limited in number and necessary and they were prone to frequent non-functionality. While others were used intermittently or not used anywhere because of their level of usefulness, as described by the OR case manager among one of the public hospitals in Bahir Dar city administration. He clarified:

“Some machines come in limited number so that we are using them more frequently. From this perspective, they are very necessary. And we may not use some machines after purchasing or we may intermittently in use.” M, a 35-year-old OR case manager

5.9. Donated medical equipment

A majority of service providers in the study area spoke about donation in their interviews concerning medical equipment utilization. The donation was one of the common sources of medical equipment in all public hospitals in the study area. (As mentioned in section 5.2)

A majority of the participants reported that there was donated medical equipment which was become un-functional on day one. For example, there was a mechanical ventilator with

no oxygen sensor, autoclave, and ceiling operation light in two public hospitals in the study area. They explained it as:

I: *“Have you experienced the machine [donated] stop working on the first day?,*
Principal investigator

R: *“Yes we have. For example, there is one mechanical ventilator donated but has no oxygen sensor.”*N, a 29-year-old ICU coordinator

“Yes, there is for example, OR ceiling light which doesn't give service after Donation. Autoclaves also installed by themselves [donors] but stop working after a while.” K, 32 years old

Respondents reacted vigorously about donated equipment as they became non-functional because of differences in the standards of the donors and the setup in public hospitals of the study area which was exemplified by power requirement difference and human power requirement difference. They also described that the donated equipment was old-fashioned and second hand as a result it was difficult to know why they were stopped working and to do maintenance. They explained as:

*“First, our standard and their standard of MEs are different. Second, their power requirement and the human power that manipulates them ... But the main reason is they are second hand (**usednache**w). After they used them, they used us as garbage (**ende maswegeja**).”*L, a 22-year-old store manager

*“Especially those we receive from the donation are problematic. They are old-fashioned or there are not latest equipment. There are many types of equipment which we don't know how to operate or which we don't know their status when arrived. We tried to make functional but we get some of them nonfunctional at the beginning.”*M, a 35-year-old OR case manager

One participant pointed out the solution for problems rose about donated medical equipment that they have already criteria for accepting any donation. He clarified like:

*“For those from donation, firstly we were accepting all. But after we realized unfunctional machines, those we don't know how to operate we decided to have a minimum standard to accept the donation. This system is currently installed; the last 6 months.”*M, a 35-year-old OR case manager

5.10. Disposal of medical equipment

The last theme is about the disposal of medical equipment. Almost all participants gave their opinion and shared experience about disposing of un-functional and non-usable medical equipment. As reported by some of the service providers in the public hospitals of the study area they had disposing non-usable equipment by distributing to other governmental institutions which potentially used them. A participant said:

"[...] We only give for other institution by lending... about the disposal ... One is; it may be given as a gift [for other institution]." L, a 22-year-old store manager

As reported thoroughly, some medical equipment was also used as spare parts for other equipment. The metallic part was used for other purposes or two non-functional equipment became one functional by sharing functional parts of the equipment from both sides. They talked;

"If they failed to work the parts may be used for maintenance of other MEs. For example, if the IV stand wheel is functional and another part of the IV stand is dysfunctional, the functional part is used to another IV stand to be it functional." I, 30 years old Matron

"For example, if the bed become dysfunctional or become old, the metal part is given to the volunteers so they use as a raw material for another service." L, a 22-year-old store manager

We were probed the participants about the dejunking committee and a majority of study participants responded as there is no and un-functional committee. Even if they had visited other parts of the hospital the study participants were claimed they didn't visit them. And they also added they must have a strong commitment for the future. As one of the participants expressed his feeling as:

"We believe that the dejunking committee must identify the nonfunctional equipment. In our setup even though there is the dejunking committee, they don't visit OR yet. I recommend committed committee members to decide and dispose of nonfunctional equipment." M, a 35-year-old OR case manager

6. DISCUSSION

The present study explores the barriers to the medical equipment utilization in public hospitals of Bahir Dar city administration. Our findings were grouped into themes named; Source of medical equipment, non-functionality of medical equipment, purchasing related barriers, maintenance of medical equipment, acquisition related, training about medical equipment, duration and frequency of utilization, donated medical equipment, disposal of medical equipment.

Our finding suggests that the common *sources of medical equipment* were from governmental institutions, from the federal ministry of health and regional health bureau, through breakdown, from Ethiopian pharmaceuticals supply agency (EPSA); the former PFSA, from donation, from direct purchase. And one of the participants reported the source of the medical equipment was from the regional health bureau after one private hospital was confiscated by the local government. This finding was in line with the Ethiopian hospital service transformation guideline released by FMOH in August 2017 because the sources of medical equipment was almost uniform across the country(20).

We also found that many types of equipment among different service delivery units were un-functional. This finding is supported by other studies which signify the majority of medical equipments in Ethiopia, sub-Saharan Africa and globally at general were non-functional due to different reasons (2,10, 18-20).

According to our findings, there are different and interrelated *barriers to utilization of medical equipment*. Major barriers to the utilization of medical equipment include; non-functionality of the equipment, sources of the medical equipment which doesn't match recipients' need, requested-purchased mismatch and no or little involvement of technical staffs during direct procurement, no training during commissioning and maintenances, difficulty in maintenance, obsolete equipment, and absence of planned preventive maintenance(2, 9, 14, 17, 20).

Non- functionality of medical equipment and maintenance-related factors were barriers to the utilization of medical equipment which in turn were interrelated with other factors. This finding was supported by a study conducted by Poonam Chaudhary and Pankaj Kaul about factors in the utilization of medical diagnostic equipment in India reported that restricted availability, non-functioning of machinery, non-availability of consumables and accessories,

breakdown, and delayed maintenance were crucial barriers as per the perception of respondents(2).

Requested-purchased mismatch and no or little involvement of technical staff were other barriers to medical equipment utilization as perceived by study participants. This finding was consistent with the report published about the medical device at free encyclopedia in 2020 which reported that the Supreme Audit Office of the Czech Republic has pointed out that the purchased medical equipment remains without proper control by the authorities(21).

Obsolete medical equipment and no planned preventive maintenance for medical equipment were other barriers to the utilization of medical equipment in public hospitals in the study area. This study is similar to previous studies conducted reported that the age of the medical equipment and absence of planned preventive maintenance and delayed maintenance were among the repetitively cited reason for the non-functionality of medical equipment(2, 19). But it went against the study conducted by Robert Malkin and Allison Keane reported that from equipment- repairing requests almost 72 % of medical equipment were back into service without requiring the use of imported spare parts(11). This report went also with the Ethiopian hospitals' service transformation guideline developed by the federal ministry of health(20). The reason for the above discrepancies might be because of difference in maintenance set up and professional mix ups. And the earlier went with our finding as Ethiopia was one of the countries included in the study.

The absence of training towards the utilization of medical equipment and no induction given for end-users during commissioning were among other barriers to the utilization of medical equipment that we found during our study. This, in turn, made service providers naïve for machines and afterward a reason for poor handling so that non-functionality of equipment. This finding was consistent with the study conducted by Lora Perry and Robert Malkin, among 16 countries within which Ethiopia was one of them, reported that the three main causes were lack of training, health technology management, and infrastructure(19).

In the present study, we recognized that the service providers in the study area had difficulty using, manipulating, and maintaining medical equipment acquired from *donations*. They claimed that they did not know how to operate and even why they were stopped working of the donated medical equipment and they usually became un-functional on the first day. Because they are old-fashioned, second hand and difficulty in maintenance as a result of un-availability of accessories and disposables and no information about the machine for

maintenance majority of donated medical equipment were non-functional. They also don't match with recipients' needs. This finding of donated equipment was supported by a study conducted the Genale Wabe et.al at Jimma university specialized hospital(22).

The last theme was *decommissioning and disposing* of medical equipment. According to the guideline published by the federal ministry of health, the hospitals should establish medical equipment disposal committee to oversee the disposal of all medical equipment that is no longer required by the hospital. As per the guideline items may be disposed of when they are no longer required by the hospital, cannot be repaired, or have reached the end of their useful lifespan(22). This statement went against what was practiced in the study area where the majority of the study participants reported that they had no committee named for disposing of medical equipment. A majority of participants reported that they dispose of medical equipment as; donations to other facilities and used as an accessory for another machine. This finding is similar to the Ethiopian hospital service transformation guideline published by FMOH in August 2017(22).

7. STRENGTH AND LIMITATION

As a limitation, the present study reflects the view and experience of a limited number of service providers and service coordinators. Moreover, the responses from the study participants might tend to be positive, and may not address their concern fully (social desirability bias) since all of the interviews were conducted at health facilities. We attempted to reduce this bias by informing them about the objective of the study and assuring their confidentiality and anonymity. As strength of the study, we purposively selected participants in areas that have greater exposure to medical equipment.

8. CONCLUSION

The sources of medical equipment were from governmental sources; the regional health bureau, federal ministry of health and Ethiopian pharmaceuticals supply agency, direct purchase, donation from local and international donors, and other sources for new hospital startup.

According to our findings barriers in the utilization of medical equipment were non-functionality of the equipment, purchasing-related factors, maintenance of medical equipment, acquisition-related factors, training about the machine and their maintenance. Inadequate information on how to run the machine, unavailability of disposables and accessories, power surge, transportation of machines from one room to the other because of scarcity, manipulation error by professionals were reported reasons for non-functionality of medical equipment.

Being donated was found to be one of the causes of medical equipment's non-functionality. Mismatched donor-recipient need, lack of spare parts and consumables, difficulty to have preventive and corrective maintenance, and no in-depth information and induction about how to run and troubleshoot the machine was reported discomforts about donated medical equipment.

Decommissioning and disposal of medical equipment are the crucial stages in medical equipment lifespan. Medical equipment was disposed of through; donations to other facilities used as accessories. There were also difficulties to dispose of some medical equipment because there was no direction on how to dispose of them. Moreover, there is no committee named for disposing of medical equipment, and even where it was presented they were not in action.

9. RECOMMENDATIONS

According to our findings, we would like to recommend:

To Tibebe Ghion Specialized Hospital, Felege Hiwot referral hospital and Addisalem Primary hospital, it is better to:

- ☞ To have attentions towards preventive maintenance
- ☞ To engage the professionals in purchasing of medical equipments
- ☞ To conduct continues training about medical equipment and handling
- ☞ To give a due attention while receiving donations of medical equipment
- ☞ Form medical equipment disposal committee or to strengthen if already formed

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11. Annex



1.

Bahir Dar University

College of medicine and health science

School of Public health

Department of Health systems management and health economics

Questionnaire to assess the barriers in utilization of medical equipments in public hospitals of Bahir Dar city administration , North west Ethiopia

Verbal Consent form

To be read by the interviewer

Dear respondent, this questionnaire is prepared to assess the barriers in utilization of medical equipments in the public hospitals. So you are kindly requested to respond to the questionnaire honestly so that you are doing great contribution for the better health care in Bahir Dar and the region and country at large.

Your cooperation and willingness for the interview is helpful in identifying barriers in the utilization of medical devices and related to the subject matter. You have been chosen to participate in the study. Your name and other personal identifications will not be written on the sheet. All information that you gave will be kept strictly confidential.

Are you willing to participate?

Yes No



2. በባሕር ዳር ዩኒቨርሲቲ የሕክምና እና ጤና ሃይማኖት ኮሌጅ፣ የኅብረተሰብ ጤና ትምህርት ቤት የጥናት ተሳታፊዎች የፈቃድ ሻንት መቀበያ ሰነድ

በቅድሚያ የከበረ ሰላምታችንን እያቀረብን፤

የጤና ሥርዓት እና ፕሮጀክት አመራር ትምህርት ክፍል የሁለተኛ ደረጃ የመጨረሻ ዓመት ተማሪዎች ህብታሙ አየሁ ዓለም ጥናታቸውን በዚህ ተቋም ያደርጋሉ። ስለሆነም የሚከተሉትን ጥያቄዎችን በብቃት ለማሟላት ለደብዳቤዎቻችን እንጋብዛችኋለን።

አርእስት፡- የህክምና መሳሪያዎች አጠቃቀም አይነታቸውን በባሕር ዳር በሚገኙ የመንግሥት ስፒራሊቶች”

’/A qualitative study the barriers in medical equipment utilization among public hospitals in Bahir Dar city, Ethiopia/

ዋናው አጥኝ፡- ህብታሙ አየሁ ዓለም ባዩ

ተቋም፡- ባሕር ዳር ዩኒቨርሲቲ

የጥናቱ ዓላማ፡-

በባሕር ዳር ከተማ በሚገኙ የመንግሥት ስፒራሊቶች ስለሆኑ የህክምና መሳሪያዎች አጠቃቀም ምክንያቶቹን ማጥናት የህክምና ባለሙያዎችን የአጠቃቀም ልምድ መቃኘት ነው።

የጥናቱ ሂደት፡- የዲፓርትመንቱ ኃላፊ ስለሆኑ ወይም የመሳሪያዎቹን የሚጠቀሙ ስለሆኑ እና/

ወይም የሰው ደረጃ ላይ የሚገኙትን ምክንያቶች የተመረጡ ስለሆኑ ለጥናት ተመርጠዋል።

ጥያቄዎቹን ከልብ መመለስ ወይም ሆስፒታላቸውን በጣም ይጠቅማል።

ጥቅም፡- በዚህ ጥናት ውስጥ በመሳተፍ ዎቻችን ላይ ለሆነ ጥቅም እያገኙም።

ሆኖ ለጥናታችን የሆኑትን የህክምና መሳሪያ ተገኝነት፣ አጠቃቀም እና ምክንያቶቹን እንረዳለን።

ሥጋት፡- በጥናቱ በመሳተፍ ዎቻችን ላይ ለሆኑ ምክንያቶች ማጠቃለያ/ ማጠቃለያ ላይ ይገኛል።

ምሥጢራዊነት፡- በጥናቱ የሚሰጡት መረጃ ምሥጢራዊነቱ የተጠበቀ ነው።

ስምዎን በመጠይቁ ላይ ወይም በውይይቱ ወቅት አይጻፉም/ አይገለጹም።

በጥናቱ ያለ መሳተፍ ወይም ጥናቱን የማቋረጥ መብት፡-

በጥናቱ ያለ መሳተፍ ወይም ጥናቱን በየትኛው ሰዓት የማቋረጥ መብት ዎቻችን የተጠበቀ ነው።

ተጠሪ፡- ምንም ዓይነት ጥያቄ ወይም ጉዳይ ካለዎት ጥናታችንን /Principal

investigator በዚህ አድራሻ ማግኘት ይችላሉ።

ህብታሙ አየሁ ዓለም፡- ስልክ +251918224687

ስምዎን፡- በጥናቱ ላይ መሳተፍ ፈቃድ ሻንት?

ም

3. Key informant interview guide

Name of the hospital _____

Age of the interviewee _____

Sex _____

Educational status _____

Role in the hospital _____

1. What are the major sources of medical equipments in your hospital?
Probe – how are they obtained?
2. Are the products and technologies utilized and functioning appropriately?
Probe- per day/per patient or how
Probe- significance if equipment failure (frequency)
Probe- reason for high utilization (E.g. motivating factors, maintenance issue)
Probe – reason for less/no utilization
3. Does the hospital have sufficient human power to utilize/functionalize the existing medical devices?
Probe – to maintain and to monitor
Probe- timing for ordering equipment
Probe – any type of motivation
4. The involvements of appropriate professionals in the order, purchase, procure and utilize the products and technologies.
5. What quality assurance methods of medical device done?
Probe- frequency
Probe – by whom
Probe – how recommendations utilized.
Probe- presence of national guidelines, policies for ordering and procuring, maintaining
6. Solutions taken for non-functioning equipments ...

4. የመጠይቅመመሪያ

የሆስፒታሉስም _____

የተጠያቂው ስም _____

የታ _____

የትምህርት ደረጃ _____

በሆስፒታሉ ውስጥ የለዎት ኃላፊነት _____

1) የህክምና መሳሪያዎቹ የተገኙበት መንገድ እንዴት ነው?
ሐተታ:- በግዥ፣ በስጦታ ወይም በሌላ ሌላ መንገድ -

2) የህክምና መሳሪያዎቹ እና የቴክኖሎጂው ጤቶች ጥቅም ላይ እየዋሉ ነው?
ሐተታ- በየቀኑ ወይም በየቀኑ ካሚው እንዴት ነው አብራሩ

ሐተታ- በተደጋጋሚ ብልሽት ያጋጥማል? ድግግሞሹ ስንት?

ሐተታ- ጥቅም ላይ ለመውሰድ የሚችሉ ምክንያቶች ምንድን ናቸው?

ሐተታ- በትንሹ ሁኔታ ጥቅም ላይ መውሰድ ወይም አለመውሰድ ምክንያቶች ምንድን ናቸው?

3) ሆስፒታሉ የሰለጠነ እና መሳሪያዎቹን ሊጠቀም የሚችል የሰው ኃይል አለው?
ሐተታ - ጥገና እና ክትትል በተመለከተ

ሐተታ- አዲስ መሳሪያ ግንባታ በተመለከተ

ሐተታ - ማንኛውንም ችግር ተከላክሎ?

4) የሌሎች ባለሙያዎች በግዥ ጥያቄ፣ ግዥ እና አጠቃቀም ዘራዎች ላይ ተሳትፎ ምን ያህል መስጠት?

5) ምን ዓይነት የጥራት መቆጣጠሪያ መንገድ ተጠቅሟል?

ሐተታ- መቼ መቼ

ሐተታ - በማን

ሐተታ - ጥቅምዎች እንዲሁም የሚከሰቱት ግብራዊ ነው ታቸው እንዴት ነው?

ሐተታ- በግዥ ጥያቄ፣ ግዥ እና አጠቃቀም ዘራዎች ላይ ተሳትፎ ምን ያህል ነው?

6) አገልግሎት ለማይሰጡ መሳሪያዎች የተወሰደ እርምጃ

ASSURANCE OF PRINCIPAL INVESTIGATOR

The under sign agrees to accept responsibility for scientific, ethical and technical conduct of the research project and for provision of required progress reports as per terms and conditions

of Bahir Dar University, College Of Medicine and Health Science, in effect at the time of grant is forwarded as the result of this application.

Name of the student _____ Signature _____ Date _____

APPROVAL OF THE FIRST ADVISOR

Name of the first advisor _____ Signature _____ Date _____

APPROVAL OF THE SECOND ADVISOR

Name of the second advisor _____ Signature _____ Date _____