

**Addis Ababa University College of Health Sciences**  
**School of Public Health**

**IMPROVING MEDICAL EQUIPMENT MANAGEMENT IN ALERT  
CENTER A PRE AND POST INTERVENTIONAL STUDY, ADDIS  
ABABA,ETHIOPIA**

**A capstone project is submitted to College of Health Sciences, School of public health in  
partial fulfillments of the requirements of Degree of Masters in Hospital and Health Care  
Administration**

**By**  
**Senait Asfaw**

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**Addis Ababa**

**Student**

I acknowledge that this capstone project is submitted for the partial fulfillment of the requirements for the Degree of Masters in Hospital and Health Care Administration at the Addis Ababa University School of Public Health.

Senait Asfaw

Signature \_\_\_\_\_

Date \_\_\_\_\_

**Advisor**

We acknowledge that this project has been done under our supervision and submitted with our approval

Dr. Mesfin Addissie

Signature \_\_\_\_\_

Date \_\_\_\_\_

This project has been evaluated under my approval as a university examiner

Signature \_\_\_\_\_

Date \_\_\_\_\_

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## **Acronyms**

ART	Anti Retro Viral Therapy
ALERT	All African Leprosy and Tuberculosis Rehabilitation and Training Center
BME	Biomedical Engineers
EHSTG	Ethiopian Hospital Service Transformation Guidelines
MDR	Multi Drug Resistance
MEMC	Medical Equipment Management Committee
MEMU	Medical Equipment Management Unit
PMTCT	Prevention of Mother to Child Transmission
SMT	Senior Management Team
TB	Tuberculosis
TOR	Terms of Reference
VCT	Voluntary and Counseling and Testing

## **Abstract**

**Introduction:** Medical equipment management play a great role to function a hospital in a maximum capacity. In hospital medical equipment management has several domains such as, planning and assessment of needs, procurement, training, operation, maintenance, decommissioning and disposal and ensure performance within the accepted standards, safe and effective use. In Alert center there is a gap on Ethiopian Hospital Transformation Guideline standard on medical equipment management from baseline assessment 40% of standard are met 60% of standards are not met.

**Objectives:** To improve the management of medical equipment standard from 40% to 80% by implementing an intervention at ALERT center, Addis Ababa, Ethiopia.

**Methods:** Apre post hospital interventional study will be conducted. All health care providers working in the selected units and directly involved in medical equipment management were included in the study.

**Result:** Compliance with Ethiopian Hospitals Service Transformation Guideline (EHSTG) standards for medical equipment management show improvement from 40% to 80%.The result showed that one month implementation of the selected strategies have significant improvement on medical equipment management in ALERT center.

**Conclusion:** The findings of this capstone project shows that the strategies were effective and showed an improvement on medical equipment management in the center. However, the hospital management needs to develop long term strategies to strengthening the medical equipment management and staff capability building.

## **1. Introduction**

### **1.1 Organizational Description**

Alert hospital is located in Addis Ababa and it was established in 1932, specializing in leprosy. It was originally the All Africa Leprosy Rehabilitation and Training Center, but the official name is now All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre. Under administration of the Ethiopian Ministry of Health's. Also in ALERT the Armauer Hansen Research Institute, founded in 1970, specializing in leprosy research. The Hospital has a capacity of 364 beds, Services delivered by the hospital include Out-patient, Emergency, Pediatric, Surgical, Gynecology and Obstetrics, Dermatology, Dental, Neurology, Leprosy, Ophthalmology, treatment for MDR and TB patients, Psychiatry, Rehabilitative services, Orthopedic workshop, Physiotherapy, Occupational therapy, VCT, ART, PMTCT and recently opened bio-medical department with four biomedical engineers and twotechnicians. With regard to the outpatient service, the average monthly outpatient flow is 29,476 and annual average outpatient flow at the hospital is 353,712[Source, ALERT center].

The Hospital serves for 5million an estimated population with five catchment areas for referral system, and staffed by 558 health workers and 695 supportive staff from the health professional 15 specialists, 77 General Medical Practitioner, 279 Nursing Professionals, and the rest 187 other health professionals. The total human resource in the hospital is 1,253 [Source, ALERT center].

The mission of ALERT is making ALERT CENTER a hospital, research and training service deliverer focusing on Leprosy, dermatology, other communicable and non-communicable diseases, and its vision is by 2020 being leading, quality having, qualified and accepted hospital, research and training center across the continent [Source, ALERT center].

## **2. Background**

In hospitals it is very crucial to implement Medical Equipment Management to manage and coordinate the medical equipment management cycle that ensure the successful management of medical equipment's [1].

Quality hospital equipment management is also important to reduce accidents caused by improper handling of unsafe equipment to the patients and staff [1]. To ensure proper hospital equipment management basic, accurate and update records are needed such as, nomenclature, manufacturer, nameplate model, serial number, cost maintenance assessment other useful data includes, warranty, location, other contractor agencies, scheduled maintenance due dates and intervals and service agreement [1]. These fields are vital to ensure appropriate maintenance is performed, to ensure device is safe to use in patient care [1].

In the hospital the management of medical equipment is a series of activities from planning to equipment disposing and important component of a health system which can be interpreted as including a wide range of instruments, equipment, machinery or apparatus used for medical and para-medical purposes [2].

The contributions of medical equipment to health care include prevention, screening, diagnosis, treatment, rehabilitation, improvement of quality of life by enabling patients to lead a full and more comfortable life and outside the hospital environment by means of ambulatory infusion pumps and monitoring equipment and reducing the cost of healthcare by reducing the length of hospital stay, shortening surgical and diagnostic procedures, and improving the outcome of treatment [3].

Medical equipment management has several domains such as, planning and assessment of needs, procurement, training, operation, maintenance, decommissioning and disposal [4].

## **2.1 Statement of the problem**

Biomedical equipment is used for preventive, diagnostic therapeutic, supportive and control procedures for daily activity in patient care functioning of biomedical equipment is vital for producing accurate and reliable test results and effective treatment. It helps health care facilities to provide quality health services and meet health service standards [1].

A medical equipment management assists with the management of medical equipment, from initial purchase through to decommissioning and replacement [1]. Some study shows Health Capital Investment Support Project finds that 30% of the medical equipment needs repair, are out of order, or uncommissioned, which need immediate attention [2]. It has been widely reported that a significant proportion of healthcare equipment in developing countries is not used. The World Health Organization (WHO) estimates that up to 60 % of medical equipment in developing countries may not be in service at any given time [4]. Although many explanations have been offered, it was commonly expressed that better equipment management would improve usage in developing countries [4].

The availability and utilization of various health care equipment's at all levels of the health care system has been emphasized for effective and efficient service delivery. In hospitals lack of proper management of medical equipment limited the capacity of health institutions to deliver adequate health care [5]. As healthcare delivery continues to expand and improve in Ethiopia, and an increasing number of sophisticated medical equipment is introduced, a system capable of supporting and managing these medical technology must be in place. In ALERT center there is a gap on Ethiopian Hospital Service Transformation Guideline from the baseline assessment 40 % of standards are met and 60% of standards are not met.

This project will address the gaps of medical equipment management in ALERT center by using an interventional study and consider various important aspects, concerned with medical equipment management which brings significant improvement in the health care service delivered by the hospital.

## **2.2 Significance of the study**

In hospitals, it is very crucial to implement medical equipment management to manage and coordinate the medical equipment management cycle.

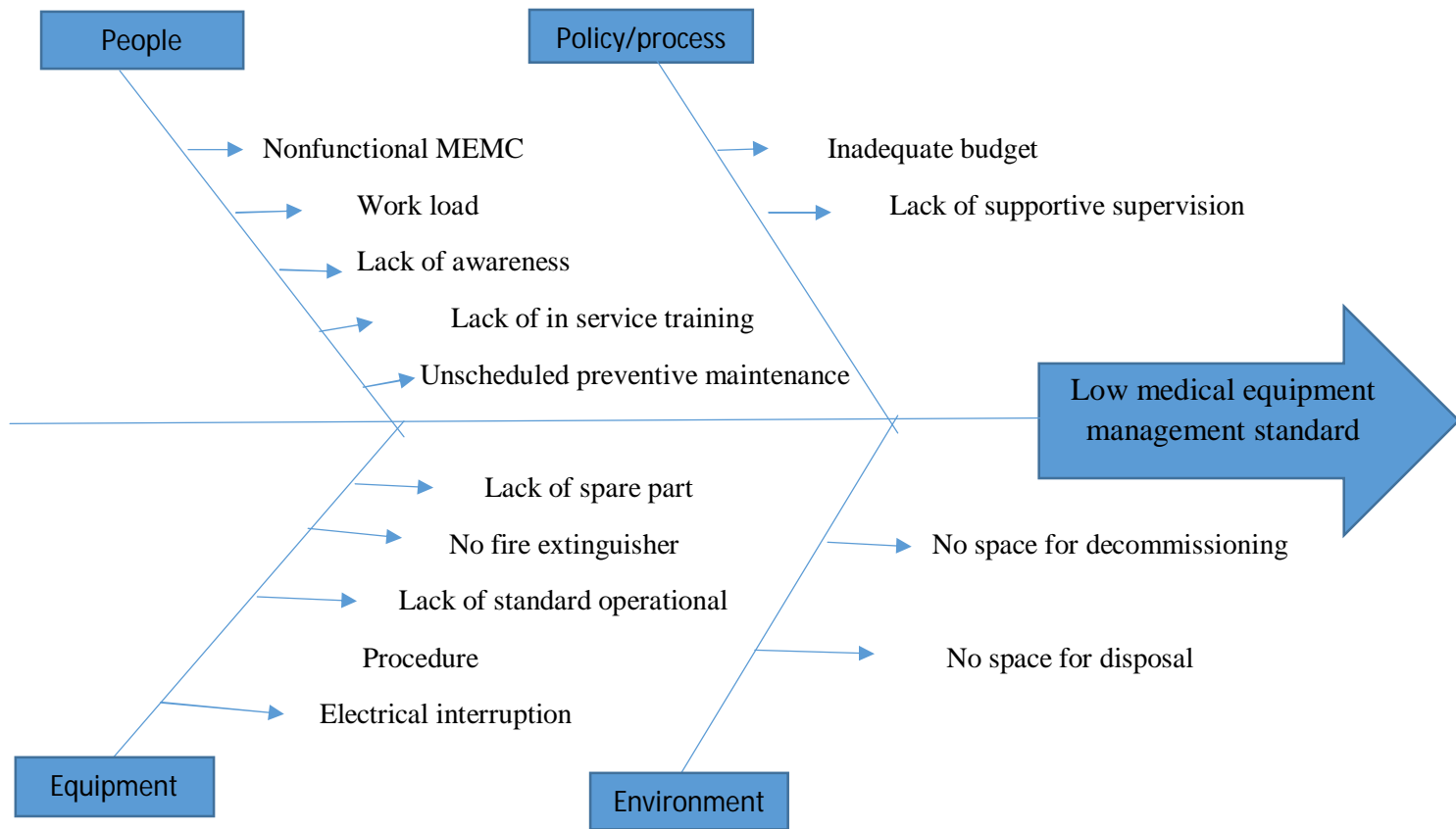
This project will address the gaps of medical equipment management by using an interventional study & consider various important aspects, which brings significant improvement in the health care service delivered by the center.

In addition, the result of this finding will alleviate the problem related to medical equipment management in the center and also the staffs acquired knowledge of overcoming medical equipment management related problem through conducting continuous training on awareness creation on medical equipment management. On the other hand, this study has enhanced the improvement of quality of care by suggesting focus areas for supportive supervisions and monitoring and evaluation of medical equipment management. Finding from this, the study will provide updated information and used as baseline for further studies.

### 3. Root cause analysis

Using the fishbone tool, many causes were identified as contributors to the existence of low medical equipment management standard.

**Figure 1: fish bone diagram (problem: low medical equipment management standard in Alert hospital)**



#### Methods used to identify the root causes include:

- Assessment of compliance with Ethiopian Hospitals Service Transformation Guideline (EHSTG operational standards were used).
- Focus group discussion with senior management team, biomedical engineers, technicians and case team leaders about medical equipment management activities.
- Assessment of the notification and maintenance work order system.
- Document review on equipment history file

**Possible root causes were selected for closer inspection based on the above methods:**

- Nonfunctional medical equipment management
- Unscheduled preventive maintenance
- Lack of awareness and in service training
- No standard operational procedure for equipment history file
- No space for decommissioning and disposal
- Lack of spare parts
- Lack of supportive supervision

**Verification**

**Nonfunctional medical equipment management**

- There is medical equipment management committee but not functional and never had a meeting before evidenced by interviewing the committees and also the assistance medical director describes that the medical director is the chairperson not only for MEMU and he is also chairperson for other departments so he was busy to handle these all things.

**Unscheduled preventive maintenance**

- There is a schedule on preventive maintenance but not done timely and also done only by biomedical engineers, the problem is the BME post schedule to do preventive maintenance and tell the scheduled unit to ready for that day but when they go to the unit they are not ready due to that the scheduled will be cancelled and post pond to some other day the other thing is the BME also called to fix lifesaving equipment's on the scheduled.

**Lack of awareness and in service training**

- The staffs are not trained on proper operation, safety, and maintenance of medical equipment and are not aware of MEMU, evidenced by self-administered questionnaire the result showed that the selected department staffs are not trained also not aware of medical equipment management.

### **No standard operational procedure for equipment history file**

- There is an equipment history file but not for each equipment and also has no standard operational procedure evidenced by reviewing randomly ten equipment history file and it's found that there is no standard operational procedure (a standard operational procedure is a simple 'how – to' guide that describes how to use the equipment, instructions for care of equipment and basic safety and troubleshooting procedures)

### **No space for decommissioning and disposal**

- The medical equipment management unit has no space for decommissioning and disposal for the equipment's, evidenced by observing while they are cleaning and use the normal sink which is used for hand washing purpose not for decontamination of medical equipment.

### **Lack of spare parts**

- There is lack of spare parts evidenced by seeing the non-functional medical equipment's kept in the unit which needs a spare part.

### **Based on verification the identified real root cause is:**

- Nonfunctional medical equipment management committee.
- Lack of awareness and in service training

## **4. Literature review**

**A Medical Equipment** is any instrument, apparatus, implement, machine, appliance, implant, *in vitro* reagent or calibrator, software, material or other similar or related article that is used for: Diagnosis, prevention, monitoring, treatment or alleviation of disease or injury [3].

### **4.1 Medical equipment management**

Medical devices have a crucial role in saving lives and improving health through prevention, diagnosis, treatment and management of all medical conditions, diseases, illnesses and disabilities. Assistive devices, in particular, are indispensable for rehabilitation and to enhance the functionality of people with disabilities [4].

World Health Organization (WHO) estimates that less than half of all medical equipment in developing countries is usable. WHO (2010) also accounted the loss due to inability to correctly specify and foresee total needs when tendering and procuring equipment for 10-30%, for extra cost purchase of sophisticated equipment which remains unused due to lack of skilled technical staff for 20-40%, and for equipment extra modifications or additions to equipment initially unchecked due to lack of staff expertise 10-30%. Maltreatment by operating and maintenance staff accounted for 30-80%, lack of standardization 30-50%, for extra spare parts cost down-time due to inability to repair, or no spare parts or accessories.

The other major scenario was 25-35% of equipment's fail prematurely in part because maintenance budgets are inadequate. In many cases, improving maintenance to increase operating life and reduce equipment downtime would be more efficient than buying new equipment.

Due to the absence of data on equipment in the public health system, procurements are often made in unscientific and ad-hoc manner resulting in the import of wide variety of equipment's. For developing countries WHO (2010) showed glaring example of equipment diversity for instance, different models of the same machines are found in use in hospitals. Reports also revealed that

most of the machines were not installed and commissioned even after their receipt at the facilities [5].

A study (Perry and Malkin, 2011) shows that around 37% of scientific equipment, excluding equipment used for medical diagnostics and therapy, is dysfunctional around 50% of medical equipment including clinical laboratory equipment are non-functional in developing countries, thereby affecting performance of research activities or provision of scientific services [6].

The management of medical-care equipment requires an organizational structure that ensures the effective acquisition, maintenance and use. The handling and operation of equipment in hospitals require detailed standards, from the acquisition to the qualification and skill assessment of the involved professionals, whether in transportation, cleaning, sterilization, handling, operation and during procedures performance [7].

When deploying a medical equipment management system, it is relevant to consider the importance of the service to be executed and its specific characteristics required for the handling and operation. Professionals need to know the importance of equipment in medical procedures or in support activities and especially be trained periodically for proper use and maintenance [7].

It is essential to maintain a clear and objective description, following the rules and techniques, of the duties of health professionals. Professional working on medical equipment's management need to be qualified and possess skills required for its operation, application and minor maintenance lack of professional qualification and periodic training is deemed to be one of the factors contributing to frequent and immense equipment damage [7].

It is considered that the frequency of a medical equipment is damaged, interferes directly in care results, administrative and financial. Hospitals. Through medical care equipment management, it is possible to maintain forms of traceability to provide processes that ensure quality, safety and reliability in the use of equipment in patient care [8].

According to McKie, 1990, 80% of all medical equipment failures caused by preventable factors (McKie, 1990), among those, about 60% of all the failures happened because of inadequate

maintenance which mostly arises from deterioration of accessories and consumable components. And 20% due to inappropriate handling, environmental stress and wear. The deterioration time of the accessories and consumable components can be predicted by carrying out maintenance and inspection [9].

A large proportion of the existing stock of equipment in health facilities is not operational. The health care literature provides numerous examples of the poor performance of medical equipment in developing countries McKie estimates 60 percent of the equipment in medical units in a typical third World country is not usable (McKie, 1990). McKie the problem of poor operational performance of equipment is more evident in public sector health facilities and less severe in privately owned medical institutions [10].

In Brazil 20 to 40 percent of the \$2 billion to \$3 billion worth of public sector medical equipment is not functioning (World Bank, 1993:138). And in Cameroon, 20 to 40 percent of their medical equipment stock is not operational.

A study of 17, out of a total of 76, Public and NGO hospitals in Uganda revealed that only around 20 percent of the inventory was in good working order, while it was estimated that perhaps another 30 percent of the faulty stock would be worth repairing. Extrapolated over all the hospitals in Uganda, this would mean that about half of the US\$ 15 million investment in such assets had been wasted and most a third of the total inventory was providing no benefit [11].

Although estimates, as to what proportion of equipment in developing countries is not functioning, vary considerably, all sources agree that poor performance of the existing equipment is an important contributor to the health crisis in developing countries. Poor performance of installed equipment clearly exacerbates the already serious constraints on providing effective health care, caused by the low total volume of medical equipment available in these countries and the highly unequal distribution of that equipment [12].

There are many references in the literature which suggest reasons for poor performance of medical equipment in developing countries. The reasons given are multiple and often complex. McKie, for example, attributes the medical equipment problem in developing countries due to poor management of health care technology McKie, 1990.

Health systems throughout the world whether in developed or developing countries, are struggling with the challenge of how to manage health-care delivery in conditions of resource constraint [13]. Lack of working equipment has a devastating effect on healthcare in resource-poor settings. It is often said that most of the medical equipment in the developing world is broken with estimates ranging up to 96 % out of service. More than 50 % of the laboratory and medical equipment's in resource-poor settings are not in service [14].

The management of medical equipment yields a better productivity which means a state of efficiency or the rate and quality of output based on the rate and quality of input (Kirkland, 1985). As it relates to hospital facilities management, higher productivity can mean safer and more reliable equipment, less service cost, less equipment downtime, more revenue and more effective use of man power [16].

The medical equipment management professionals ensure that equipment used in the patients care are operational, safe, properly configured to meet the mission of the medical treatment facility and continue to function effectively in a good working condition. Human factors engineering is frequently being cited as an important method to reduce medical error and adverse events and to increase patient safety, when it is applied to the design and evaluation of medical equipment [17].

Periodic training on medical equipment maintenance will normally involve the manufacturer or supplier initially and the in-house technical service thereafter (McKie, 1987:50). Previous studies in developing countries show that a high percentage of equipment malfunctions is caused by operator mishandling. As equipment maintenance includes much more than just repairs activities it will be useful to give an outline of what an effective maintenance system should look like. Equipment maintenance has been described as any action or combination of actions carried out to retain an item, or restore it to, an acceptable condition [18].

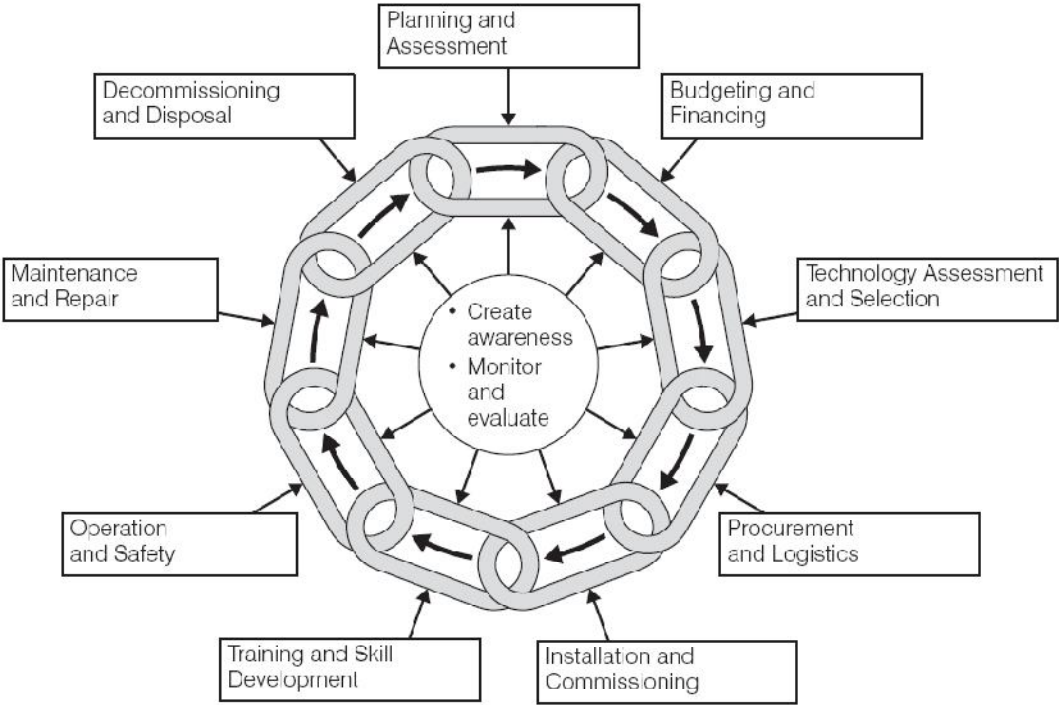
In Ethiopia, lack of proper management of medical equipment has limited the capacity of health institutions to deliver adequate health care. It is estimated that only about 61 % of medical equipment's found in Ethiopian public hospitals and other health facilities are functional at any one time [19].

## **4.2 Conceptual frame work**

Medical equipment management is a process and used in the diagnosis, treatment and monitoring of patients. Accurate and comprehensive data are needed in order to have a good medical equipment management [19].

Health care delivery continues to expand and improve in Ethiopia and also in developing country, sophisticated medical equipment's are introduced therefore a system which has supporting and managing these medical equipment's must be in place to handle [19]. It is very important to implement Medical Equipment Management in the hospitals to manage and coordinate the medical equipment management cycle which includes planning and assessment of needs, procurement, training, operation, maintenance, installation and commissioning, decommissioning and disposal [19].

**Figure 2: Medical equipment management life cycle**



## **5. Objectives**

### **5.1 General objective of the project**

- The main objective of the study is to improve the management of medical equipment management by suggesting and implementing an intervention

### **5.2 Specific objective of the project**

- To assess the medical equipment management system of ALERT center Addis Ababa through base line survey March 2018.
- To improve medical equipment management at ALERT center from 40% to 80% by the end of June 2018.
- To create awareness on medical equipment management.

## **6. Methods**

### **6.1 Study area and period**

The Study was conducted in ALERT hospital and it was established in 1934 for memorandum of Princess Zenebework. From 1965 the official name is changed to ALERT. ALERT is a medical facility on the edge of Addis Ababa, specializing in leprosy established in 1934GC. Under administration of the Ethiopian Federal Ministry of Health, the center is serving 5 million populations as a teaching hospital with approximately 364 bed. Currently the center is providing health service with the following specialty areas Trauma and Emergency, TB and MDR-TB, Ophthalmology, Dermatology, ART (antiretroviral therapy), Plastic and Reconstructive Surgery, General surgery Delivery, antenatal and neonatal care, Dental, Orthopedic, Pediatric treatment on top of the expanded leprosy management.

The study was conducted from March – June 2018

### **6.2 Study design**

A pre and post hospital based interventional study was conducted.

### **6.3 Source population**

ALERT center staff members were the source population of this study.

### **6.4 Study population**

Management staffs, biomedical engineers and health care unit and department staffs of ALERT center were participate in this study.

### **6.5 Sampling procedure**

The respondents were selected by stratified random sampling method, where each department was considered as strata. The sample was drawn from eight departments, Biomedical, Management, Radiology, OR, Delivery, Trauma ICU, Laboratory and Ophthalmology of Alert hospital where the proportion of each department was based on probability proportion to size method.

### **6.6 Data collection procedure**

The data was collected by using semi structure questionnaire adopted from Ethiopian hospital services transformation guidelines (EHSTG) to collect information and checklist also used to assess the current status of Medical equipment management of ALERT center.

## **6.7 Indicators**

**6.7.1 Process indicator:** awareness creation and basic training on medical equipment management.

**6.7.2 Outcome indicator:** improving medical equipment management.

## **6.8 Data analysis procedure**

Both the pre and post intervention collected semi-structured questioners will be analyzed by SPSS version 21 the two data (pre assessment and Post assessment) were analyzed using paired t-test method of analysis.

The survey result of this study show the immediate, intermediate and may be the root cause of the Hospital medical equipment management of the hospital. Accordingly there is an intervention to address the identified gaps.

The post intervention data explained by comparing the survey results and the post intervention findings the hospital medical equipment management (data were analyzed by using paired t-test method of analysis).

## **6.9 Data quality management**

Different mechanism were used to implement to keep the quality of the study (Pre-testing =to assure the quality of data & for improvement of data collection tool,Supervision =to understand how the data collectors handle the questionnaire, Corrective measures was taken accordingly for any gap)

The data will be controlled through the provision of appropriate training for the data collectors. Appropriate data entry and quality control mechanism was used during entry and analysis.

## **6.10 Inclusion**

The selected biomedical engineers, Health care providers and management staff were included in the study, which undergo the process of Medical equipment management.

## **6.11 Exclusion**

Staffs that are not undergoing the process of medical equipment management were excluded.

## **6.12 Ethical consideration**

Approval of ethical clearance was taken from Ethical Clearance Committee of the Faculty of Public Health, Addis Ababa University and Permission also obtained from ALERT center and also informed consent was obtained from the respondents.

### **6.13 Dissemination of results**

The Results were disseminate to AAU where the study was conducted, to school of public health as partial fulfillment of master of hospital administration and also it will be disseminated to ALERT center.

### **6.14 Operational definition**

**Medical equipment** can be defined as “any instrument, apparatus, implement, machine, appliance, implant, *in vitro* reagent or calibrator, software, material or other similar or related article that is used for:

- Diagnosis, prevention, monitoring, treatment or alleviation of disease or injury,
- Investigation, replacement, modification, or support of the anatomy or of a physiological process,
- Supporting or sustaining life,
- Control of conception,
- Disinfection of medical devices,
- Providing information for medical or diagnostic purposes by means of *in vitro* examination of specimens derived from the human body, and which does not achieve its primary intended action in or on the human body by pharmacological, immunological or metabolic means.”

**Medical equipment management:** is the planning, organizing, monitoring, and evaluation of activities pertaining medical equipment.

## **7. Intervention**

### **Strategy/ intervention chosen**

After problem identification activities have been approved, root causes of the problems were identified and grouped into four different perspectives which include people, policy, environment, and supplies. All root causes were investigated in detail by collecting relevant data and focus group discussion with SMT, BME case team leaders, and concerned staff members of the hospital. To determine the true root causes, information and data have been collected. The main root cause for low medical equipment management standard is lack of awareness and basic training.

After main contributing factors for low medical equipment management standard were clearly identified, specific activities to fix these problems and, working modalities were developed.

These activities include

- Reestablishing medical equipment management committee.
- Create awareness and provide basic training on medical equipment management.
- Space arrangement for decommissioning and disposal.
- Supervision of medical equipment management

**Table1. Comparative analysis**

SN.	Alternative strategies	Major activities	Responsible person	Feasibility	Cost	Time	Impact	Total
1	Reestablishing medical equipment management committee	By discussion with BME and SMT and preparing meeting	PI and BME	3	4	2	5	15
2	Create awareness and provide basic training on medical equipment management	To increase knowledge, attitude and practice on medical equipment management	PI and BME	5	3	3	5	16
3	Space arrangement for decommissioning and disposal	By establishing new room for decommissioning and disposal	BME	2	2	2	4	10
4	Supervision of medical equipment management	To monitor the improvement on medical equipment management	BME and quality office	4	4	3	3	14

Each criteria has maximum score of =5, minimum score=1, total score is calculate out of 20 points.

### **Selecting best intervention**

Based on feasibility, cost effectiveness, time required and impact on productivity the best intervention selected is

1. Create awareness and provide basic training on medical equipment management.
2. Reestablishing medical equipment management committee.

## **8. Implementation Accomplishment**

As part of this project, the following results were accomplished.

- Basic training and awareness creation, the focus is to create awareness on medical equipment management and how to operate, how to use and safety by providing onsite training to solve lack of awareness, knowledge and skill gap and also how to make further communications with MEMU which is related to medical equipment management training was given for three consecutive days by dividing the staff into three groups the training materials are Ethiopian hospitals service transformation guideline and other prepared by BME. The medical equipment management committee was reestablished by working with medical director office and writing a letter for MEMU to have a meeting and the biomedical engineers should always take the responsibilities (oversee the establishment of medical equipment inventory, develop a medical equipment list, monitor the implementation of policies, standards and guidelines for planning and procurement of medical equipment , disposal of medical equipment and review incident reports related to medical equipment) to prepare a meeting and inform the medical director office before the meeting.

## 9. Result

### 9.1 Socio Demographic Characteristics of Respondents

The research was composed of a total of 62 respondents who came from different disciplines, namely, Biomedical(6.5%), Management(12.9%), Radiology(12.9%), OR (14.5%), Delivery(24.2%) , Trauma ICU(11.3%), , Laboratory (9.7%) and Ophthalmology(8.1%). As it can be depicted from table 1, the composition of male and female respondents was 24 (38.7) male and 38(61.3). Majority of the respondents (72.6%) were with in age range of 25-35. The service year of respondents was assessed and it was found that 87.1 % of them had work experience of less than 10 years, where 46.8% of them had less than five years of services in the hospital (see table 2.)

**Table2. Distribution of respondents by their socioeconomic characteristics**

<b>Socio-demographic variable</b>	<b>Categories</b>	<b>Frequency</b>	<b>Percentage</b>
Sex	Male	24	38.7
	Female	38	61.3
Age	less than 25	8	12.9
	25-35	45	72.6
	36-45	7	11.3
	46-55	2	3.2
service year	<5 years	29	46.8
	6-10	25	40.3
	11-15	6	9.7
	16-20	1	1.6
	> 20	1	1.6
Department	Biomedical	4	6.5
	Management	8	12.9
	Radiology	8	12.9
	OR	9	14.5
	Delivery	15	24.2
	Trauma ICU	7	11.3
	Laboratory	6	9.7

## 9.2 Status of medical equipment management

The below mentioned question items were derived from the pre-intervention phase of this applied research. The percentage of respondents based on their agreement on the statements about different aspects of medical equipment management was assessed here under. The pre intervention percentage value indicate the assessment score of respondents on various issues of medical equipment and the post intervention result showed that the assessment of the same respondents on the previous question items. Thus, these scores were computed whether there is an existence of statistical mean difference between the two scores (pre intervention and post intervention).

**Table 3. Distribution of respondents by their responses on the below mentioned items**

Question items	Percentage of agreed people		t-value	p-value
	Pre intervention (N=62)	Post intervention (N=62)		
The MEMU use annual budget for medical equipment strategy	41.9	95.2	7.149***	0.000
The MEMU review incident reports related to medical equipment.	35.5	95.2	9.365***	0.000
The hospital have established committee on Medical equipment management system	19.4	98.4	11.603***	0.000
The hospital have maintenance workshop	75.8	100	4.365***	0.000
The hospital workshop is well equipped with the necessary tools	41.7	100	8.658***	0.000

The respondents were asked whether they were aware of “The MEMU use annual budget for medical equipment strategy”. As it can be shown in table 3, during pre- intervention phase only 41.9% of them knew about the aforementioned issue. However, after the gap was identified and intervention was conducted, the reassessment result indicated that 95.2% of them were aware of the said issue. The t-value for the paired sample t-test value (7.149) indicated that there is statistical difference between the two results (pre intervention and post intervention results) at  $p < 0.001$ .

Respondents were also assessed whether they were aware of the MEMU review incident reports related to medical equipment. The result indicates that only 35.5% of respondents were aware of such practice. However, the post intervention made them to be aware of the issues and it was found that 95.2% of them came to on board. The t-value for these paired values indicated that there is highly significant difference between the two observed values at  $p < 0.001$ .

Respondents were also assessed whether the hospital established committee on medical equipment management. The pre intervention (19.84%) and post intervention (98.4%) results and corresponding paired t-test value indicated that the percentage of responses before and after intervention was statistically significant at  $p < 0.001$ .

Existence of maintenance workshop and status of necessary equipment in the workshop were one of the central issues addressed by the respondents. Accordingly 75.8% and 41.7% of respondents revealed that they were aware of the above mentioned issues, respectively. In the same way after intervention by the researcher, the scores revealed that all of the respondents were aware of the two issues. The t-value associate with the pre and post intervention results indicated that there is statistical difference between the two assessment results at  $p < 0.001$ .

**Table 4. Distribution of respondents by the below question items**

Question items	Percentage of agreed people		t-value	p-value
	Pre intervention (N=62)	Post intervention (N=62)		
The hospital has inventory management	53.2	98.4	6.769***	0.000
The hospital inventory system is updated within past year	30.4	91.9	8.185***	0.000
All medical equipment in the equipment management program is listed in the inventory	30.6	90.3	7.35***	0.000
There is an equipment history file for Sop for equipment	35.5	85.8	2.313**	0.024
There is equipment history file for inventory data collection form	32.3	95.2	3.347**	0.001

### 9.3 Inventory Management

Existence of inventory management is crucial component in any institution, more specifically in hospitals like Alert. Sampled respondents were asked whether they were aware of existence of inventory management system and whether it was updated in a year time. The pre-intervention ( 53.2% and 30.4%) and post-intervention result(98.4% and 91.9%) for existence of inventory management system and whether it was updated every year , respectively and associated paired t-test value(6.769 and 8.185 revealed that there is statistical difference between the two results( pre intervention and post intervention) at  $p < 0.001$ . In line with this 30.6% of respondents showed that all medical equipment in the equipment management program is listed in the inventory, however, after post intervention assessment it was raised to 90.3%. The paired t-test value (7.35) showed that there exists statistical difference between the two responses at  $p < 0.001$ . Besides, the respondents were asked whether they knew existence of an equipment history file for Sop for equipment and existence of equipment history file for inventory data collection form. The

responses indicate that 35.5% and 32.3% of respondents were aware of the above two issues before intervention and 85.8% and 95.2% of the same respondents were observed after intervention. The associated t-value for the paired results of respective questions indicated that there exists statistical difference between the two observations at  $p < 0.05$  and  $0.001$ , respectively.

#### **9.4. Policies and procedures of medical equipment management**

Sampled respondents were level their responses on presence of policies and procedures for medical equipment management which address Commissioning and decommissioning. The responses indicated that before intervention the percentage of respondents who knew about the issues were 41.9%. However, the post intervention results shown that the percentage of respondents were 96.8%. The associated paired t-value and p-value for the respective question items revealed that there is statistical difference between the results of the two phases at  $p < 0.001$ .

The responses of this analysis whether all new equipment's undergo acceptance testing prior to its initial use was assessed. The pre assessment (21%) and post assessment (85.8%) and associated t and p-value (13.142 and 0.002) results of the respondents revealed that there is statistically significant difference between the pre and post intervention assessment results. Besides, to this the responses of respondents whether all equipment operators and personnel were trained or not. Before intervention, responses showed that only 25.8% of them replied that they were trained. However, after post intervention, 96.8% the respondents indicate that equipment operators and personnel were trained on the subject.

**Table 5. Distribution of respondent by their responses on policies and procedure related issues**

Question items	Percentage of agreed people		t-value	p-value
	Pre intervention (N=62)	Post intervention (N=62)		
There is an equipment history file for risk	33.9	100	10.289***	0.000

assessment form (high, medium or low risk)				
The hospital has policies and procedures for medical equipment management which address Commissioning	41.9	96.8	8.901***	0.002
The hospital has policies and procedures for medical equipment management which address Decommissioning	41.9	96.8	8.901***	0.001
All new equipment undergo acceptance testing prior to its initial use	21	85.8	13.142***	0.002
All equipment operators and personnel are trained	25.8	96.8	9.976***	0.000

### **9.5. Capacity building of medical equipment management for the operators and personnel's**

As per the EHSTG guideline, the operators and personnel's needs to be trained on proper operation, proper safety, proper maintenance of medical equipment's and proper standard operating procedures. The assessment was conducted on the above mentioned aspects. As it can be depicted from table 6, some of the training aspects were found to be significant during pre-intervention and post intervention phases. During pre-intervention test, the average score of respondents with regard to existence of training for medical equipment management on [proper operation was 45.2%, however, after post intervention assessment the result for the same category was found to be 53.2%. The paired sample t-test value and p-value indicated that the results of pre intervention and post intervention easements had significant difference at  $p < 0.05$ . Similarly the pre-post, intervention results obtained from this analysis regarding level of training concerning proper safety, Accordingly, the pre-post assessment results has shown that there is statistically significant difference between the pre assessment (45.2%) and post assessment results (90.3%) at  $p < 0.001$ .

**Table 6. Distribution of respondents by the below question items**

Question items	Percentage of agreed people		t-value	p-value
	Pre intervention (N=62)	Post intervention (N=62)		
The operators and personnel's are trained on proper Operation	45.2	53.2	2.326**	0.027
The operators and personnel's are trained on proper Safety	45.2	90.3	5.22***	0.000
The operators and personnel's are trained on proper Maintenance of medical equipment	46.9	64.5	2.03*	0.051
The existing medical equipment management prepared Standard operating procedure for each equipment	45.9	33.9	0.784	0.438
There is a schedule for Inspection	23.6	96.8	11.717***	0.000

## **9.6. Schedule for testing**

Responses were computed whether there was statistically significance difference exists between the two scores of an individual (pre and post interventions). Table 7 indicated that the percentage of respondents who knew that there was schedule for testing and preventive maintenance for each piece of equipment before intervention strategy was made were 28.8% and 32.8%, respectively. However, the intervention strategy has raised respective values to 98.4% and 88.7%, respectively. The t-value and associated p-value indicated that there is statistically significant difference between the response of pre intervention and post intervention assessments.

Existence of notification and work order, availability of notification work order for corrective maintenance and calibration were major concerns among the respondents. 32.8% of respondents replied that there is exists notification and work order system in the hospital, however, the result was turned to 100% after post intervention assessment and awareness creation done. In similar manner, other issue has also shown that there was statistically significant difference between the pre-post assessment results.

**Table 7. Distribution of respondents by their responses on schedule related issues of medical equipment management**

Question items	Percentage of agreed people		t-value	p-value
	Pre intervention (N=62)	Post intervention (N=62)		
There is a schedule for Testing	28.8	98.4	10.828***	0.000
There is a schedule for Preventive maintenance for each piece of equipment	32.8	88.7	8.386****	0.000
There is a notification and work order system	32.8	100	10.199***	0.000
There is notification work order for Corrective maintenance	41.8	98.4	8.158***	0.000
There is notification work order for Calibration	26.3	50	4.027***	0.000

## **10. Discussion**

In this capstone project found that, the intervened strategies have brought improvements on medical equipment management

Collaboration with biomedical engineers basic training and awareness creation on medical equipment management and how to operate, how to use and safety by providing onsite training to solve lack of awareness, knowledge and skill gap and also how to make further communications with medical equipment management unit which is related to medical equipment management system.

The responses of respondents in Alert center with regard to all aspects of MEMU was found to be low expected. This may be emanated from various technical and managerial issues. Lack of awareness scheme about the MEMU by concerned individuals, misunderstanding the purpose of MEMU, less attention given to MEMU by the concerned officials and lack of institutional supports might be referred as reasons for the aforesaid low responses by respondents. The post intervention result has shown that little effort can bring about significant change in terms of awareness creation and existence of the said MEMU components.

Compliance with Ethiopian Hospital Transformation Guideline the center should met 10 out of 10 standards or 100% the center fails to meet the standards .In the pre-intervention period four out of ten standards were met after strategies that are equivalent with those that are listed in Ethiopian hospital service transformation guideline were made, and found that eight out of ten operational standards were met (40% to 80%).

## **11. Conclusion and Recommendations**

### **11.1 Conclusion**

The assessment has indicated that the medical equipment management of ALERT center is not moving as per expected rate even if it is known that recently opened department in the center. Most of the issues related to medical equipment management are found in documents. However, most of the staffs have low or no awareness on medical equipment management. The Hospital management failed to discourse its responsibility to aware its staff about medical equipment management, strengthening the medical equipment management and staff capability building in the system as a whole. Though medical equipment management is crucial for the hospital, it overlooked issue in the hospital. The pre-post intervention assessment comparison of respondents showed improvement by 40% of the objectives are met and bring tremendous awareness change.

### **11.2 Recommendations**

The Hospital management committee needs to address the below mentioned issues:

1. Awareness creation workshops and periodical update about the medical equipment management need to render to the staff of the hospital.
2. The equipment management needs to be strengthened in terms of staff capacity building, equipment maintenance and related issues.
3. Full implementation of Ethiopian hospital services guideline
4. Experience sharing from other hospitals
5. Continuous monitoring and supervision
6. The Hospital management should deal with the findings of this action research.

## **12. Strength and limitation**

### **12.1 Strength**

- The study managed the pre and post intervention also evaluation.

### **12.2 limitation**

- Unable to find published document due to that this study failed to compare the findings with other studies.

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**Annex 1**  
**Study tool**

**Questioner to improving medical equipment management in Alert Center**

**Addis Ababa Ethiopia (pre post interventional study)**

**For biomedical, health care providers, and management staff**

**Questioner**

**Section I- Personal information**

1. Sex 1. Male  2. Female
2. Age 1. <25  2. 25-35  3. 36-45  4. 46-55  5. Above 55
3. Service year
1. <5 years  2. 5-10  3. 11-15  4. 16-20  5. >20
1. Department
- a. Biomedical
  - b. Management
  - c. Radiology
  - d. OR
  - e. Delivery
  - f. Trauma ICU
  - g. Laboratory
  - h. Ophthalmology

**Section II: Question on biomedical equipment management.**

Please marks as ✓ on the choose of your answer

SN.			
1.	Does the hospital has Medical equipment management unit?	1. Yes <input type="checkbox"/>	
		2. No <input type="checkbox"/>	
		3. I don't know <input type="checkbox"/>	
2.	If yes, does it functional?	1. Yes <input type="checkbox"/>	
		2. No <input type="checkbox"/>	
		3. I don't know <input type="checkbox"/>	
3.	If no, what do you think is the reason? _____ _____		
4.	Does the hospital have the necessary staff for bio medical equipment management?	1. Yes <input type="checkbox"/>	
		2. No <input type="checkbox"/>	
		3. I don't know <input type="checkbox"/>	
5.	Does the hospitals' Biomedical department lead by a	1. Yes <input type="checkbox"/>	

	biomedical personnel	2. No <input type="checkbox"/>	3. I don't know <input type="checkbox"/>
Does the hospital Medical Equipment Committee use a TOR to ensure the following responsibilities			
6.	Develop and monitor implementation of medical equipment strategy	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
7.	Oversee establishment of medical equipment inventory	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
8.	Develop a model for medical equipment list	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
9.	Develop and implement medical equipment policies	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
10.	Determine annual budget for medical equipment strategy	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
11.	Review incident reports related to medical equipment	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
12.	Mention if there is any other responsibility _____ _____	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
13.	Does this hospital have established committee on Medical equipment management?	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
14.	If 'Yes to question number 13' Verify that MEC membership consists of A. Nurses <input type="checkbox"/> B. Doctor <input type="checkbox"/> C. Pharmacist <input type="checkbox"/> D. Technician <input type="checkbox"/> E. Administrative personnel <input type="checkbox"/>		
15.	If the hospital has a medical equipment management committee, it is functional?	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
16.	If your answer for question number 15 is no, why do you think is the possible reason. _____ _____		
17.	Does this hospital have maintenance workshop?	1. Yes <input type="checkbox"/>	2. No <input type="checkbox"/>
		3. I don't know <input type="checkbox"/>	
18.	If yes to 'Question number 17' Is that workshop well equipped	1. Yes <input type="checkbox"/>	

	with the necessary tools?	2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
19.	Do you have inventory management system?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
20.	If yes to 'question number 19 ' is it updated within past year	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
21.	Do you know that all medical equipment in the equipment management program is listed in the inventory?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
22.	Does the inventory system used to manage the stock of spare parts?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
23.	Is there an equipment history file for Standard operational procedure for equipment	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
24.	Is there an equipment history file for inventory data collection form	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
25.	Is there an equipment history file for risk assessment form	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
26.	Does the hospital has policies and procedures for medical equipment management which address Acquisition	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
27.	Does the hospital has policies and procedures for medical equipment management which address Commissioning	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
28.	Does the hospital has policies and procedures for medical equipment management which address Decommissioning	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
29.	Does the hospital has policies and procedures for medical equipment management which address Disposal	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
30.	Does the hospital has policies and procedures for medical equipment management which address Donations	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
31.	Does the hospital has policies and procedures for medical equipment management which address Outsourcing technical services	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
32.	Does all new equipment undergoes acceptance testing prior to its initial use?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/>	

		3. I don't know <input type="checkbox"/>	
33.	Does all equipment operators and personnel are trained?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
34.	If your answer is 'Yes for question 33' are they trained on proper.....		
35.	Operation	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
36.	Safety	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
37.	Maintenance of medical equipment	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
38.	Standard operating procedure available to user	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
39.	Is there a schedule for		
	Inspection	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
	Testing	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
	Preventive maintenance for each piece of equipment	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
40.	Is there a notification and work order system?	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
41.	If your answer is 'Yes for question 40' notification work order for		
	Corrective maintenance	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	
	Calibration	1. Yes <input type="checkbox"/> 2. No <input type="checkbox"/> 3. I don't know <input type="checkbox"/>	

## Annex 2

### Medical equipment management standard

S. No	Standards	Met	Unmet
1	The hospital has in-house MEMU with operational plan, required staff and led by biomedical personnel.		
2	The hospital has a MEMU committee composed of doctors, nurses, technicians, pharmacists, and administrative personnel that oversees the medical equipment management programme.		
3	The hospital has an appropriately equipped medical equipment maintenance workshop.		
4	The hospital has a paper-based and computer based or automated inventory management system that tracks all equipment and spare parts included in the equipment management programme.		
5	An equipment history file is maintained for all medical equipment containing all key documents for the equipment.		
6	The hospital has policies and procedures in place for acquisition of new medical equipment, commissioning, decommissioning, and disposal of equipment, the receipt of donations, and outsourcing technical services for medical equipment repair and maintenance.		
7	All new equipment undergoes acceptance testing prior to its initial use to ensure the equipment is in good operating condition, and are installed and commissioned in accordance with the manufacturer's specifications.		
8	All equipment operators and personnel are trained on proper operation, safety, and maintenance of medical equipment with standard operating procedures readily available to the user.		
9	There is a schedule for inspection, testing and preventive maintenance for each piece of equipment as guided by the manufacturer's recommendations and that schedule is appropriately implemented.		
10	There is a notification and work order system for corrective maintenance and calibration of medical equipment based on their level of risk.		
	Total		