ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF PUBLIC HEALTH

A PRE AND POST INTERVANTIONAL STUDY ON MEDICAL EQUIPMENT MAINTENANCE SYSTEM IN ALL AFRICA LEPROSY, TUBERCULOSIS AND REHABILITATION TRAINING CENTRE (ALERT), ADDIS ABABA, ETHIOPIA, JUNE 2018

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Approval by the Board of Examiners

This capstone project by **Yemiserach Tamirat** is accepted in its present form by the board of examiners as satisfying thesis requirement for the degree of Master of Public Health in Hospital and Health Care Administration.

Research Advisor

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Examiner

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Full Name:	Sig.	Date

Acknowledgment

I would like to acknowledge ALERT hospital for giving me this chance to attend my second degree public health, hospital and health care administration specialty truck.

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Acronym/Abbreviations

ALERT - All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre

ART – Anti-Retroviral Therapy

CM – Corrective Maintenance

CR – Completion Rate

ETB – Ethiopian Birr

EFY – Ethiopian Fiscal Year

FMOH – Federal Ministry of Health

IPM – Inspection and Preventive Maintenance

JCAHO - Joint Commission on Accreditation of Healthcare Organizations

LR – Location Rate

MDR-TB - Multi Drug Resistance Tuberculosis

ND – Not Done

PM – Preventive Maintenance

PZWMH – Prince Zenebework Memorial Hospital

TJC - The Joint Commission

WHO – World Health Organization

Abstract

Introduction- Medical equipment is defined as any devise that is used in the rendering of patient care [1]. According to the world health organization, Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury.

Problem Statement – The medical equipment maintenance system as a whole (both the IPM and corrective maintenance) in All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre (ALERT) is not functioning well, the management and the maintenance system is not well organized and is not done in a regular interval, in addition the department of biomedical engineering is newly opened.

Objective - The general objective of the study is to improve the preventive maintenance system in ALERT hospital. The specific objectives for the study were to increase the CR from 79% to 90%,LR from 25% to 60%and IPM from 40% to 60%by May 2018.

Project Design/Methods: Pre-post interventional study was conducted at ALERT hospital located in the capital city of Addis Ababa with a catchment area of approximately five million populations with the total budget of the project 16000 at ALERT hospital from February to June 2018.

Data Collection Procedure and Analysis - A pretested questioner which was developed by reviewing different literatures, which also includes international standards in equipment maintenance was used. SPSS version 20.0 was used for data entry, coding, cleaning and analysis. Chi square test of association was used to detect the association between pre and post intervention studies. The finding was presented using tables, graphs and texts.

Result– The result of one month implementation of selected strategies showed that a significant improvement of preventive maintenance in the hospital.This was objectively measured by an increment in the completion rate from 79% to 90.5%, location rate from 25% to 61% and inspection and preventive maintenance yield from 40% to 72%.

Conclusion and Recommendation - The result of this capstone project showed that, those selected strategies were effective on improving preventive maintenance system. Although the finding proves the effectiveness of selected strategies, user training is still a gap for the hospital. So, it will be better if these selected strategies will be implemented in a larger scale by including all clinical service providing departments.

Organizational Description

In the nineteen thirties leprosy was widespread in Ethiopia, especially in northern Ethiopia, Gojjam, Wollo and Tigray and in some parts of Addis Ababa & Gurage zone. Following the stigma and discrimination, people having this disease come to settle in the outskirt of Addis Ababa city called 'Zenebe work', Then by the year 1934 Princes Zenebe work Memorial hospital (PZWMH) was established with the aim of providing health services to this segment of population. The meeting of African Hades of state in AddisAbababas influenced the opening of leprosy management. Thishad ensured the opening of the training division of ALERT by the year 1965.When the hospital service endorsed the training, the name Zeneb work Hospital was changed in to All Africa Leprosy and TB rehabilitation training center (ALERT). Until 2000 the center was technically and financially supported by non-governmental organizations, currently it is under the FMOH.

By now ALERT is providing integrated health services by opening several departments including 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.

Currently ALERT is providing health service for an estimated Five million population with the total human resource in the hospital 1253 from those 558 health workers and 695 supportive staff the health professionals, 15 specialist doctors, 77 general practitioners, 279 nurses and 187 from different professional categories which give a total of 558 professional workers in the hospital.
Specifically focusing on the maintenance system, ALERT has a recently opened bio-medical department with four bio-medicalengineers and twotechnicians. Equipment inventory is being conducted in a yearly base. But the medical equipment maintenance system in ALERT is in its infancy stage.

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.

1. Background

1.1 Introduction

Medical equipment is defined as any devise that is used in the rendering of patient care [1]. According to the world health organization, Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury; it can be used either alone or in combination with any accessory, consumable, or other piece of medical equipment. Medical equipment excludes implantable, disposable or single-use medical devices [2].

Poor health outcomes in low income countries result from health care systems that lack infrastructure. Some health care facilities in resource limited countries have trained personnel but lack appropriate equipment and supplies, thereby limiting their ability to provide medical care [3, 4]. In addition to this health facilities should properly handle medical equipment available in their health facilities. The term 'medical equipment' management is generally focused on how engineers and technicians deal with repair work and its development [5]. But, in practical terms, especially in developing countries, health technology management, including medical equipment maintenance, is among the areas that need to be built [6].

Medical equipment maintenance can be divided into two major categories: inspection and preventive maintenance (IPM), and corrective maintenance (CM). IPM includes all scheduled activities that ensure equipment functionality and prevent breakdowns or failures. Preventive maintenance (PM) refers to scheduled activities performed to extend the life of a device and prevent failure (i.e. by calibration, part replacement, lubrication, cleaning, etc.). Inspection can be conducted as a stand-alone activity and in conjunction with PM to ensure functionality; this is important as PM can be fairly invasive in that components are removed, cleaned or replaced [2].

Unlike the developed world, in developing countries, including Ethiopia, healthcare delivery continues to expand and improve and an increasing number of sophisticated medical equipment is being introduced. In parallel to this, a system capable of supporting and managing these medical technologies must be in place. However in developing countries like Ethiopia this system is not developed as expected [6].

1.2 Problem Statement

Medical technology includes all medical equipment used by health organizations for diagnosis, therapy, monitoring, rehabilitation and care. Therefore, medical technology management plays a key role in the process of health care. To ensure high quality patient care, effective medical equipment management is required. These activities must be performed within the scope of the program 'maintenance program' [7, 8].

The rising number of these 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 are factors that contribute to equipment breakdowns [9].

Medical equipment management including maintenance should be a field of concern, if health care organizations need to provide health services in a smooth manner. But this is shown to have a practical gap, especially in developing nations, including Ethiopia.

ALERT as a public clinical service providing hospital has its own medical equipment management system. But while undergoing a need assessment, it's found that the system is not functioning well. Even though the hospital has a recently opened bio-medical department, the equipment maintenance system is going in an interrupted way. There was no regular inspection and preventive maintenance system going on by bio-medical professionals. Even though they are doing medical equipment maintenances, it isn't done in a regular fashion and most importantly there was no regular schedule/plan for that.

Similarly, some health workers are doing preventive maintenance by themselves, but they are not well trained to do that, and also they have no schedule/plan to conduct it.

Hence, this study will try to focus specifically on the factors contributing for low implantation of preventive maintenance (which is going to be done by health workers) and design a specific intervention which will try to address the cause of low implementation that contributes a lot for the identified gap.

1.3 Anticipated Outcome

The anticipated outcome for this study was 'improving the medical equipment maintenance system in ALERT hospital', which was planned to be objectively measured by indicators (a standard measurement for inspection and preventive maintenance (IPM) from WHO), and the following table was used to compare the percentage difference in the pre and post intervention of the study.

Anticipated outcome after the intervention, of each of the indicators, ALERT, May 2018

S.no	Indicator	Baseline/Pre-intervention	Expected outcome - after Intervention
1	Completion Rate (CR)	**79%**	**90%**
2	Location Rate (LR)	**25%**	**60%**
3	IPM Yield	**40%**	**60%**

1.4 Public Health Relevance

The results of this study will provide a system to improve the medical equipment maintenance, especially the inspection and preventive maintenance system in ALERT hospital. This will in turn contribute for the smooth health service provision in the hospital, as the failure of medical equipment will interrupt the smooth health service provision.

In addition to this, the study will assess the root causes of this low implementation of medical equipment maintenance in ALERT hospital and intervene for the priority problem identified during the root cause analysis. The produced intervention package will be shared with the health facilities of the same setting.

2. Root Cause Analysis

By using the fishbone tool, many causes were identified as determinant factors for the existence of low preventive maintenance;

3.1Methods were used to identify the root causes:

Discussion with the bio-medical engineers and technicians, with health care workers (end users) Review national and international guidelines.

3.2Possible root cause

- Lack of awareness and training.
- Shortage of logbooks, operation manuals, documentation sheets
- Shortage of tools/chemicals
- Shortage of personal protective material
- Lack of Responsibility
- Un availability of maintenance policy
- Inadequate budget for medical equipment maintenance
- Interrupted power supply

3.3 **Verification**

1. Lack of awareness and training about medical equipment maintenance –there is no user training given for health care provider to create awareness on preventive maintenance how to handling and preventequipment's before damage.No documents found about training for usersfrom human resource office and biomedical department. Approved
2. Shortage of logbook (operational manual, documentation sheet) - by observing the selected departments there is only one unit use log book for recording preventive maintenance procedure. Approved
3. Unavailability of maintenance policy –there is no maintenance policy for medical equipment maintenance especially the preventive maintenance .Approved
4. Shortage of tools: -by observation there is enough tools/chemical and test analyzer for preventive maintenance procedure. Disprove
5. Lack of service and operational manual-most of the equipment does not have manual because of old and donated. Approved
6. Shortage of personal protective materials:-there is shortage of personal protective materials specially working operation room but not much influence in preventive maintenance. Disprove
7. Lack of Responsibility: - most health care provider they don't take training for preventive maintenance because of that responsibility gap. Disprove
8. Shortage of budget:-budget allocated for purchased equipment no enough budgets for medical equipment maintenance. Approved
9. Interrupted power supply:-that much influence for preventive maintenance most of the equipment don't use power for pm. Disprove

3.4 **Identified real root causes**

- Lack of awareness and training and
- Shortage of logbook, operational manual and documentation sheet.

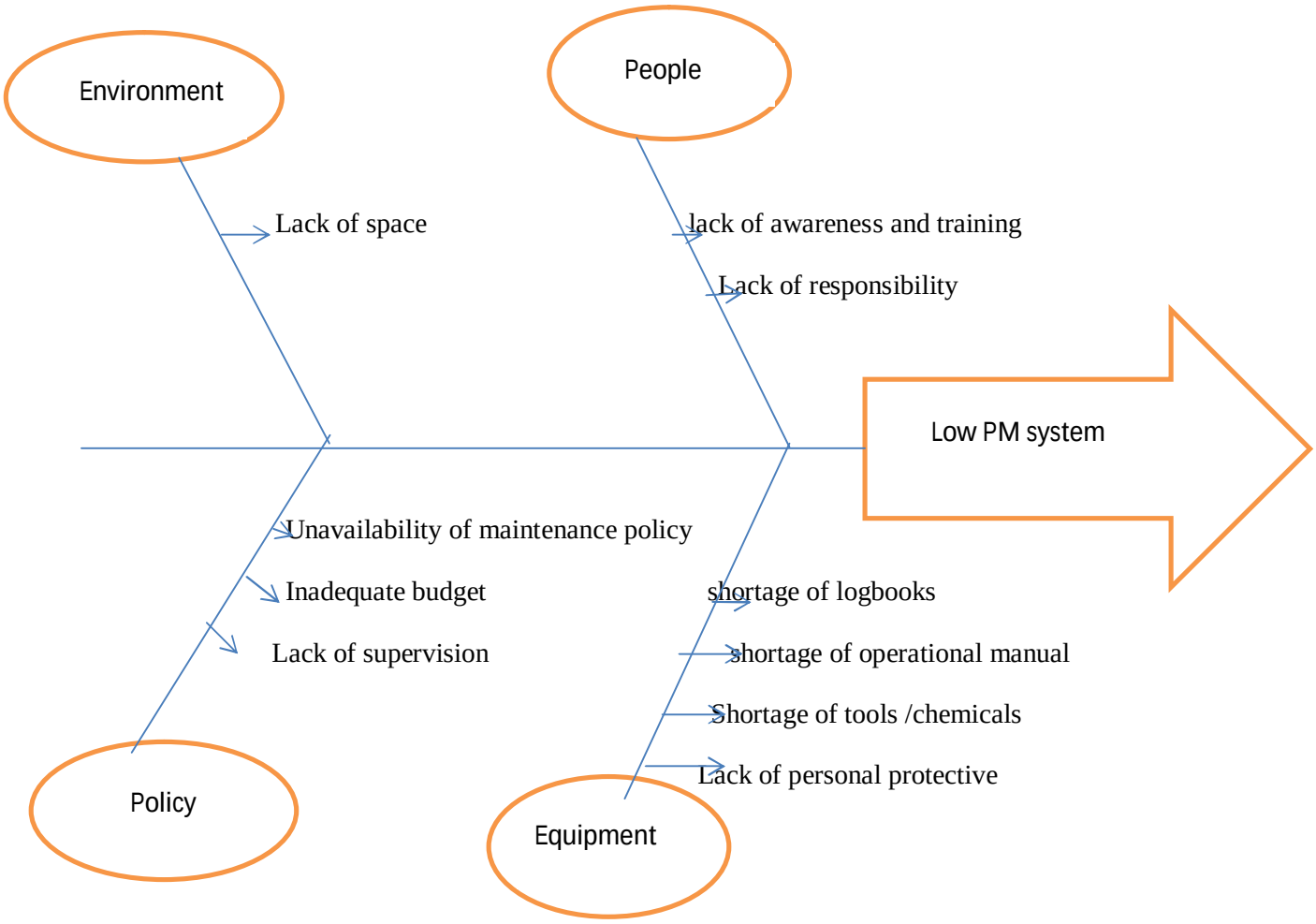

Fig. 1 - Fish bone diagram (Low PM system) in ALERT hospital, Addis Ababa, May 2018

4 Literature Review

In Canada most of the healthcare organizations include all their medical equipment in their maintenance program and just follow manufacturers' recommendations for preventative maintenance [10].

A study conducted in one of a big medical center in Iran showed the effects of using preventive maintenance (PM) system for medical equipment on reducing costs for the center, while installing for 21.7% of medical equipment after maintaining a proper PM system they could reduce 36% of their costs [11].

Previous studies in different countries indicated that the annual medical equipment maintenance and management cost is approximately 1% of the total hospital budget. In addition to its high maintenance costs, medical equipment is often involved in patient incidents that resulted in serious injuries or deaths [12].

Analysis done in African countries showed that, approximately 60% of the medical equipment were not maintained properly and evaluated by medical equipment inspectors [13].

The buyer should implement an effective periodic maintenance program in addition to an efficient repair program. Periodic maintenance provides scheduled time to inspect equipment and eliminate problems prior to their negative impact on patient care. Repair parts can be ordered and installed at scheduled times [14, 16].

Initial and continuing education of all operators of the equipment and associated staff present in the procedure room during examinations is required to ensure high quality imaging at reduced radiation doses to both patients and operators. All staff, physicians, technologists, nurses, anesthesiologists, etc., must receive appropriate generic instruction on basic imaging principles, quality control, radiation protection, and required equipment care before receiving specific instructions for a new unit [17].

After installation and acceptance-testing of the equipment is complete, a comprehensive, ongoing quality improvement program is required to maintain equipment performance at optimum levels throughout its lifetime [17].

Regular maintenance is indispensable to optimize the performance of the device. The Medical Service Law defines the maintenance requirements for medical devices including ultrasonography and the Japanese Circulation Society issues legal guidelines, but these guidelines are not specific to each equipment [18].

Statistics accumulated by The Joint Commission (TJC) show medical equipment-related "sentinel events" is typically among the top ten types every year. Therefore, Hospitals and healthcare organizations must ensure that their critical medical devices are safe, accurate, reliable and operating at the required level of performance [19].

Joint Commission on Accreditation of Healthcare Organizations (JCAHO) introduced standard, a standard and this standard allows hospitals to not have schedule inspection or maintenance tasks for certain pieces or types of medical equipment, if these tasks are not needed for safe and reliable operation [20].

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 in resource-poor settings are not in service [21].

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 found in Ethiopian public hospitals and other health facilities are functional at any one time. Medical equipment management defines organization and coordination of activities that ensure the successful management of equipment related to patient care in a health facility [22, 23].

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 hospital in the regions functional equipment reaches near to 50% [24].

A study conducted in Jemma zone public hospitals should that Of all available devices in specialized hospitals, only 1.01 of devices were monitored either once or twice per year in the three hospitals, also the factors associated with medical equipment utilization were, Purchasing

devices with bids and preference for cheap price, lack of training on how to operate devices, less sense of accountability, power interruption, staff work overload and lack of maintenance experts, and inappropriate referral system were among the reported reasons for influencing availability and utilization of medical devices [25].

Estimates suggest that between 40 and 70% of Purpose medical devices and equipment in low- and middle-income countries are broken, unused or unfit for purpose; this impairs service delivery to patients and results in lost resources [26].

Suboptimal device use is directly linked to incomplete costing and inadequate consideration of maintenance services and user training during procurement planning. Accurate estimation of life-cycle costing and careful consideration of device servicing is of crucial importance [27].

5 Objectives

General objective

- To improve preventive medical equipment maintenance system in ALERT Hospital, ALERT, May 2018

Specific Objective

- To increase the completion rate from 79% to 90% in ALERT Hospital, ALERT, May 2018
- To increase the location rate from 25% to 60% in ALERT Hospital, ALERT, May 2018
- To increase the IPM yield rate from 40% to 60% in ALERT Hospital, ALERT, May 2018

6 Project Design/Methods

Study area and Period

The study was conducted in All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre (ALERT), the former Princes Zenebework Memorial Hospital (PZWMH). Under administration of the Ethiopian Federal Ministry of Health, the center is serving 5 million populations as a teaching hospital with approximately 364 beds. 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 February – June 2018.

Study Design

Facility based Pre-Post interventional study was employed.

Source Population

The source population for the study was all health professionals' working in departments/case teams which are currently providing health service in ALERT hospital.

Study Population

The study population for the study was, all health professionals' working in purposefully selected departments/case teams such as Delivery room, ICU, operation theater and laboratorystaff which are currently providing health service in ALERT hospital.

Study Sample

Data was collected from all selected departments with sample size of 63.

Sampling Procedures

Purposive sampling technique was used to select four departments/case teams (Trauma ICU, Delivery, Laboratory and Operation room) that were included in the study. All health care professionals who are directly involved in preventive maintenance were included.

Inclusion and exclusion criteria

Inclusion Criteria

- All health care providers working in purposefully selected department/case team were included in the study.

Exclusion Criteria

- Specialist Doctors, health care providers on sick leave, annual leave, on study leave and out of the hospital for different purposes at the time of data collection were excluded from the study.

Data Collection Procedure

Data wascollected using a semi-structured questionnairedeveloped by reviewing different literatures and international medical equipment maintenance standards and face to face interview techniquewas used to collect required data.

Indicators

WHO standard indicators which are specifically used to monitor the effectiveness of IPM were used:

- Completion rate - % of procedures completed from the scheduled or plan*(Performance/plan)*
- Equipment location rate – % of Equipment planned to be inspected but not located*(plan/Inventory)*
- IPM yield - % of scheduled IPM performed with a real problem (which affect the equipment operation and safety) - *Real Problem (operation and safety)/PM performed*

Data Entry, Coding and Analysis procedures

Data entry, coding and analysis was done using SPSS version 20.0. Descriptive analysis was done to compare the results from the Pre-intervention and post-intervention studies. Chi square test of association was used to detect the association between the intervention and PM.

Data quality management

A pretest was done on 5 %the total sample size (8) thepretest was done two weeks before the actual data collection in General OR study tool. Data was collected by two BSC nurses and close follow up by the principal investigator was done.

Operational Definition

Health technology: The application of organized knowledge and skills in the form of devices, medicines, vaccines, procedures and systems developed to solve a health problem and improve quality of life. It is used interchangeably with health-care technology.

Medical equipment: Medical devices requiring calibration, maintenance, repair, user training, and decommissioning − activities usually managed by clinical engineers. Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury; it can be used either alone or in combination with any accessory, consumable, or other piece of medical equipment. Medical equipment excludes implantable, disposable or single-use medical devices.

Preventive maintenance: involves maintenance performed to extend the life of the device and prevent failure. PM is usually scheduled at specific intervals and includes specific maintenance activities such as lubrication, cleaning replacing parts that are expected to wear (e.g. bearings) or which have a finite life.

Corrective maintenance: A process used to restore the physical integrity, safety and/or performance of a device after a failure. Corrective maintenance and unscheduled maintenance are regarded as equivalent to the term repair.

Ethical Consideration

Ethical clearance letter was obtained from the institutional review board of Addis Ababa University and this was submitted to ALERT and then a permission to conduct the study was obtained from ALERT center. Oral informed consent was obtained from the participants' before each interview, and the data collector explained the aim of the study to each of the study participants. The response from each of the participantsremained anonymous and confidential.

Dissemination Plan

The findings of this study will be submitted to School of public health, Addis Ababa University as a partial fulfillment for the degree of Master of Science in Hospital and Health Care administration. The result will also be submitted to All Africa Leprosy, Tuberculosis and Rehabilitation Training Centre (ALERT) and capstone project.

7 Intervention

As it was identified by the root cause analysis and displayed in the fish bone diagram, there were many factors that were directly or indirectly affecting the equipment maintenance system in general and preventive type of equipment maintenance in particular. This study was prioritized factors that affect the preventive maintenance system and then as explained below four of them were entered in to the decision matrix to be evaluated using the available criteria's, i.e.impact, expense, feasibility and time. Considering the scope of this study, the first two alternatives which are contributing for low implementation of preventive maintenance were selected. The explanation about the verification was mentioned below:

- Create awareness and provide basic training for health care providers – **Selected**
  - This study considers providing basic training for health care providers is an entry point for other activities related to PM. It will have a long lasting impact with low expense and manageable time.
- Provision of log book, documentation sheet, request form, post schedules and Procedure lists - **Selected**
  - Simultaneous provision of log book, documentation sheet, request form, post schedules and Procedure lists will have a doubling effect on PM together with training. Similarly we can get a long lasting result with manageable time and moderate feasibility.
- Ratify policies with implementation guides, – **Not Selected**
  - Even though this can be considered an umbrella for the others and have a greater impact, it will go above the scope of this study, in relation to time and feasibility as well as its expense.
- Allocate adequate Budget for medical equipment maintenance-**Not selected**
  - This is also high impact but is also above the scope of the study.

Comparative analysis Decision Matrix

The following decision matrix was extracted from the root cause analysis of low preventive maintenance.

S.no	Strategic Alternatives: *Low implementation of Preventive maintenance*	Impact	Expense	Feasibility	Time	Total
1	Create awareness and provide basic training for health care providers	5	4	5	5	**19**
2	Provision of log book, documentation sheet, request form, post schedules and Procedure lists	5	5	4	4	**18**
3	Ratify policies with implementation guides	5	3	1	1	10
4	Allocate adequate budget for medical equipment maintenance	4	2	1	2	9

- **Key** - Evaluation criteria (5=very high; 4=high; 3=moderately high; 2=low; 1=very low) sum =20

Selected strategies

- **Awareness Creation and Provision of Basic Training**

Awareness creation and training provision can be considered as an entry point for other steps in preventive maintenance. This includes clearing misconceptions linked to equipment maintenance, and making this procedure routine activity in clinical service providing units of the hospital. As it is well known, to attain the optimal performance of medical equipment, proper use of the equipment is essential. Health care providers will be trained on effective components of preventive maintenance performance or safety inspection are done, the contribution of preventive maintenance for the proper functioning of the equipment, how to make routine preventive maintenances, how to prepare decontamination solutions, how to document the overall process and so on. The overall result will be the user how fell ownership for the equipment ,take good care of the equipment ,operate (maintains) it will leading to reduce work load for biomedical engineer department & improved life span for the equipment. Then, on how to make further communications when equipment maintenance needs further knowledge and skill

- **Provision of log book, documentation sheet, request form, post schedules and Procedure lists**

While providing training for health care providers, simultaneously, necessary steps on how to go with the activities should be considered. So, health care providers will be given planning sheet, to exercise planning for inspection and preventive maintenance and to post, which aims to compare their performance with that specific period. This will be done once for one department, for a specific period of time (for one month in this case). To strengthen what they have on the training, selected list of procedure used for specific type of medical equipment will be posted on the selected departments.

Then log sheet will be printed and distributed for selected departments which contain the name of equipment, date of maintenance, maintenance type and the name of health care providers maintaining it. Then this intervention will introduce documentation sheet which allow the health care provider to document all the necessary steps is gone including special observations that will be considered while maintaining that specific equipment in the future.

8. Implementation accomplishments

This project has accomplished the following activities:

1. **Provision of training:** One day training was organized to train health care workers who are working in the selected departments of the hospital. 20 participants from departments were trained on the basics of preventive maintenance: the importance and tasks of preventive maintenance, things to be considered while doing preventive maintenance and A practical demonstration on how to decontaminate the equipment undergoing preventive maintenance together with maintaining the safety of the equipment.
2. **Printing and Distribution of necessary materials –** Log book, planning sheet, and documentation sheet and inventory checklist to gather with the implementation package was distributed for the trainee and the departments. Procedure list for selected medical equipment was posted to each of the selected departments on a visible side. The implementation was closely followed.

9. Results

Pre-Intervention Study

Socio-Demographic Characteristics

This study has a response rate of 96.9% in the pre-intervention study. The mean age of participants is 29 years old (SD ± 5.5 years). Of all participants female participants constitute 39 (61.9%) were female and male participants constitute 24(38.1%). Regarding the profession of the study participants, 7(11.1%) were laboratory technicians, 37(58.7%) were nurses, 17(27.0%) were midwives and 2(3.2%) were anesthetists. Most of the participants were on BSc degree level, which constitutes 47(74.6%) of all participants. Of the participants 59(93.7%) of them have a service year of less than & equal to 10 years. Seven (11.1%) of the participants were from laboratory department, 17(27.0%) were from operation room, 24(38.1%) were from delivery case team, 15(23.8%) were from trauma ICU.

Characteristics	variable	pre-intervention	
		N	%
Age	18-25	12	19%
	26-32	33	52%
	33-40	18	28.5%
Gender	Male	24	38.1%
	Female	39	61.9%
Professions	Laboratory technicians	7	11.1%
	Nurses	37	58.7%
	Mid-wives	17	27%
	Anesthetists	2	3.2%
Educational status	BSc degree	47	74.6%
	Diploma	16	25.4%
Service year	<10 Yrs.	59	93.7%
	>10 yrs.	4	6.3%
Departments	Major OR	17	27%

Table9.1 Socio-demographic characteristics of study participants at pre intervention period

Medical Equipment Maintenance System

the available maintenance methods most of the participants 22(34.9%) respond as they are usually using corrective maintenance method while there is equipment failure, 7(11.1%) respond as they are usually using preventive maintenance and 17(27%) of them respond as they use the combination of the two and equal proportion of the participants don't know what type of maintenance option is usually being used in the hospital. Most of the participants, around 47.6%, mention preventive maintenance as one of the successful element of maintenance management system.

Majority of the participants 46(73.1%) didn't do inspection and preventive maintenance by themselves. As it is shown in figure 2, majority of the participants didn't do inspection and preventive maintenance by themselves.

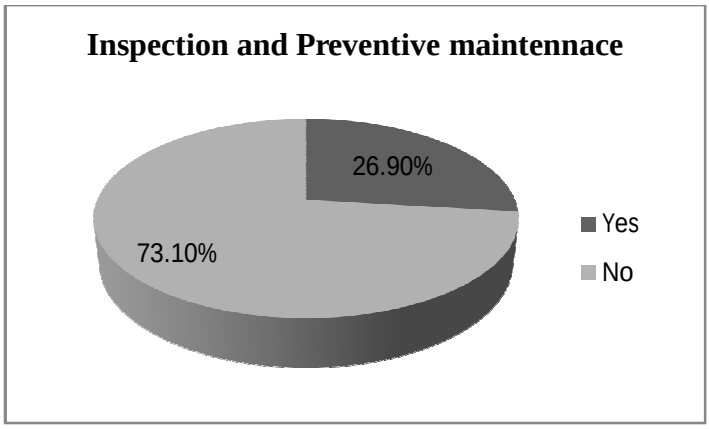

Fig 2, Conducting IPM – Pre intervention, ALERT, Addis Ababa, Ethiopia May 2018

Similarly majority of the participants didn't plan for inspection and preventive maintenance.

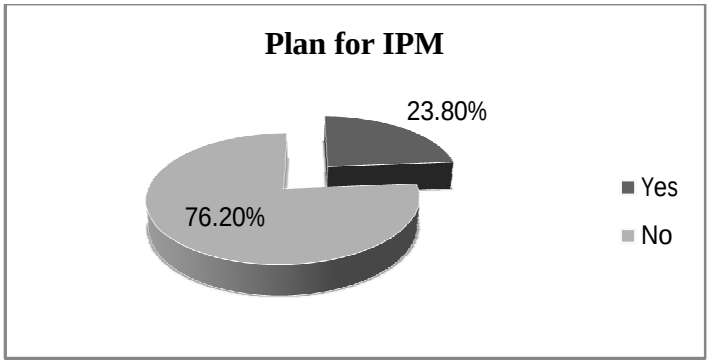

Fig 3, Plan for IPM – Pre Intervention, ALERT, Addis Ababa, Ethiopia May2018

Of those who plan for IPM majority of them 7(11.1%) plan for IPM in a frequency of less than a month, and in contrary 1(6.7%) of the participants didn.t know the frequency of planning.

The following figure (fig 4) showed that more than 90% of the participants didn't have basic medical equipment maintenance training.

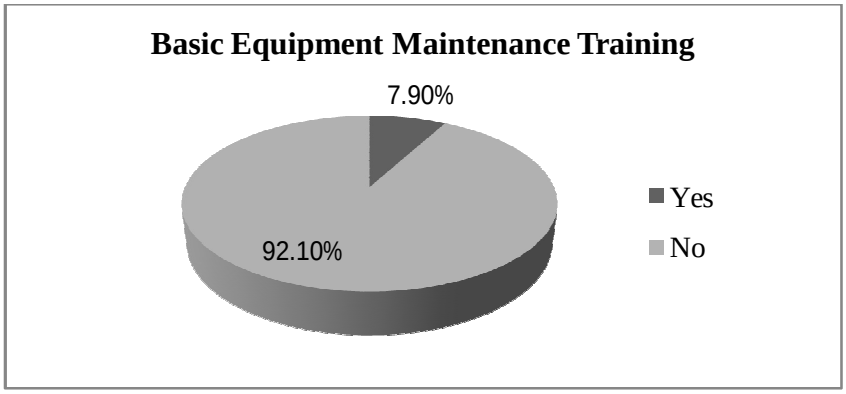

Fig 4, Basic MEM Training – Pre-intervention, ALERT, Addis Ababa, EthiopiaMay 2018

Majority of the participants 53(84.1%) think as they don't have adequate understanding of maintenance requirement. Most of the participants 35 (55.6%) didn't know the contents of preventive maintenance program. Majority 22 (34.9%) of the participants use facility experience while performing preventive maintenance. 77.8% of the participants didn't put tag for equipment undergoing preventive maintenance. More than half the participants 36 (57.1%) didn't know which of the tools for preventive maintenance are available in their unit.

Regarding the supply for preventive maintenance procedures, most of the participants 28 (44.4%) respond as the supply for preventive maintenance is not available in their unit.

As shown in figure 5, less than a quarter (22.2%) has log book for preventive maintenance.

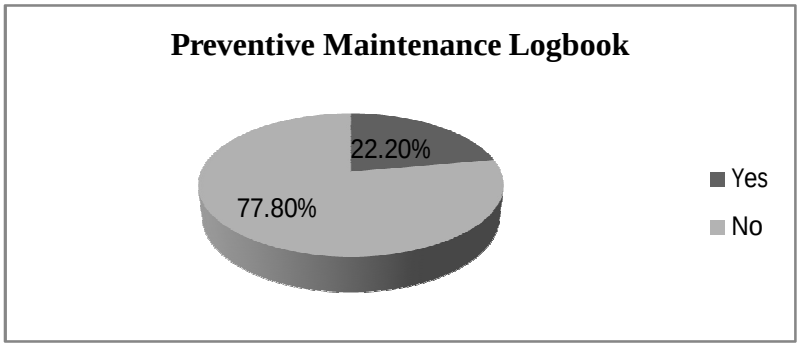

Fig 5, Availability of PM Logbook – Pre-Intervention, ALERT, Addis Ababa, EthiopiaMay 2018

Majority of the participants 50 (79.4%) didn't know the availability of written procedure or guideline for preventive maintenance of medical equipment. Forty three (68.3%) of the participants respond as there is decontamination before the repaired equipment is started to be used. Of those who respond as decontamination has been done after PM, 25(39.6%) were by cleaning, 12(19.0%) were by disinfection and 6 (9.5%) were by sterilization. Thirty two (50.7%) of the participants respond as cleaning and disinfection were the most commonly used types of decontamination methods, similarly 28(44.4%) of them respond as cleaning, disinfection and sterilization were the commonly used types of decontamination methods. .

Half 32(50.8%) of the medical equipment maintenance procedures were not documented properly. When the participants were asked about the challenges of preventive maintenance lack of training was the major challenge which accounts 44(69.8%), lack of spare parts, lack of interest and lack of human power account 8(12.7%), 6(9.8%) and 3(4.7%) respectively, similarly 12(19%) of the participants respond as lack of training, spare part and interest were the challenges for PM and 7(11.1%) of them respond for all of the motioned challenges for PM. Fifty four (85.7%) of the time the departments/case teams were not receiving supervisions concerning medical equipment maintenance. In times when the department/case team is receiving supervision concerning medical equipment maintenance, annual supervision accounts around 3(4.7%) of the cases. When supervisions were undertaken concerning equipment maintenance, around 5(7.9%) of the feedbacks from supervisors were given orally. More than half of the participants 37(58.7%) don't know whether there is functioning system in the hospital that links the unit in need of maintenance and biomedical department. Similarly 40(63.5%) of the times the communication between the maintenance department and the unit in need of maintenance is not effective.

Major proportion 25(39.7%) of the participants communicated the maintenance department more than a month ago. When asked about the appropriateness of current PM system, 52(82.5%) of the participants agree that the current PM system is not appropriate. Most of the participants 54 (85.7%) didn't believe that the organization medical equipment maintenance to ensure an acceptable level of safety & quality. Majority 40(63.5%) of the participants believe as there is no enough biomedical engineer and technician available in the hospital. Three out of four 47 (74.6%) participants didn't believe as the biomedical engineers/technician have sufficient competence. Of the participants 51(81%) of them didn't know by what frequency the

organization did full equipment inventory, but 7(11.1%) of them respond as the full equipment inventory was done annually. Fifty three (84.1%) of the participants respond, as there is no quality control mechanism for equipment maintenance in the hospital.

Performance Monitoring

Indicators to follow IPM, which were approved by WHO were below, and the result of pre-intervention study is presented in the following table.

Table 2– Pre- Intervention Results (indicators for IPM), ALERT, and Addis Ababa, Ethiopia May 2018

S.no	Indicator	Pre-Intervention
1	Completion Rate	79%
2	Location Rate	25%
3	IPM Yield	40%

Post-Intervention Study

Socio-Demographic Characteristics

This study has a response rate of 96.9% in the post -intervention study. The mean age of participants is 29 years old (SD ± 5.5 years). Of all participants female participants constitute 38 (60.3%) were female and male participants constitute 25(39.7%). Regarding the profession of the study participants, 8(12.7%) were laboratory technicians, 37(58.7%) were nurses, 16 (25.4%) was a midwife and 2(3.2%) were anesthetists. Most of the participants were on BSc degree level, which constitutes 46(73.0%) of all participants. Of the participants 58(92.1%) of them have a service year of less than & equal to 10 years. Seven (11.1%) of the participants were from laboratory department, 17(27.0%) were from operation room, 24(38.1%) were from delivery case team, 15(23.8%) were from trauma ICU.

Table 3 Socio-demographic characteristics of study participants at post intervention period

Characteristics	variable	Post-intervention N	percentage %
Age	18-25	14	22.2%
	26-32	30	47.6%
	33-40	19	30.1%
Gender	Male	25	39.7%
	Female	38	60.3%
Professions	Laboratory technicians	8	12.7%
	Nurses	37	58.7%
	Mid-wives	16	25.4%
	Anesthetists	2	3.2%
Educational status	BSc degree	46	73%
	Diploma	17	27%
Service year	<10 Yrs.	58	92.1%
	>10 yrs.	5	7.9%
Departments	Major OR	17	27%

Medical Equipment Maintenance System

Of the available maintenance methods most of the participants 1(1.6%) respond as they are usually using corrective maintenance method while there is equipment failure, 7(11.1%) respond as they are usually using preventive maintenance and 47(74.6%) of them respond as they use the combination of the two and 8(12.7%) of the participants don't know what type of maintenance option is usually being used in the hospital. More than 60% of the respondents mention at least two programs which are parts of the successful element of maintenance program.

Majority of the participants 43(68.3%) did inspection and preventive maintenance by themselves. As shown in figure 6, majority of the participants did do inspection and preventive maintenance by themselves.

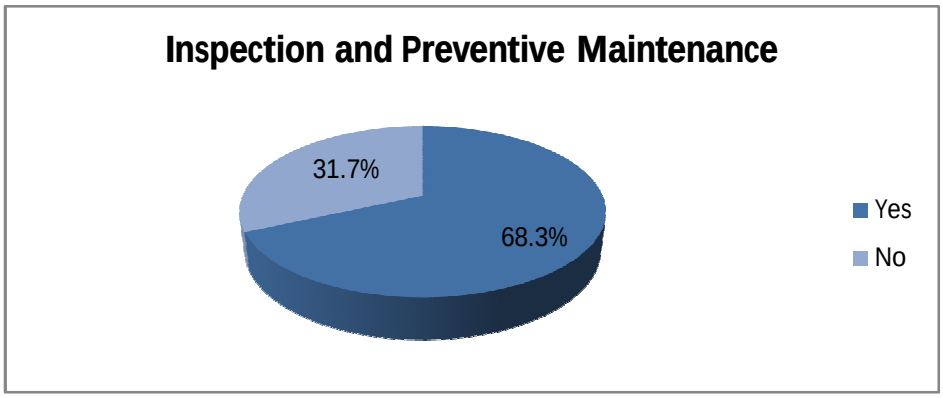

Fig 6, Conducting IPM- Post -Intervention, ALERT, and Addis Ababa, Ethiopia May 2018

As shown in figure 7 below, in the post intervention assessment majority of the participants 46(73.0%) have planned to conduct inspection and preventive maintenance.

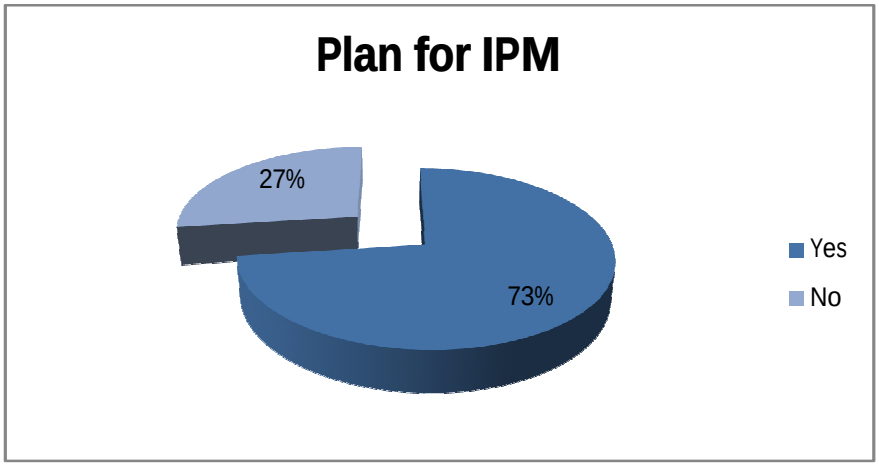

Fig 7, Plan for IPM Post-intervention, ALERT, Addis Ababa, EthiopiaMay 2018

Of those who plan for IPM majority of them 26(41.2%) plan for IPM in a frequency of less than a month, and in contrary 1(1.5%) of the participants didn.t know the frequency of planning.

The following figure (fig 8) 52.4% of the participants have took basic medical equipment maintenance training.

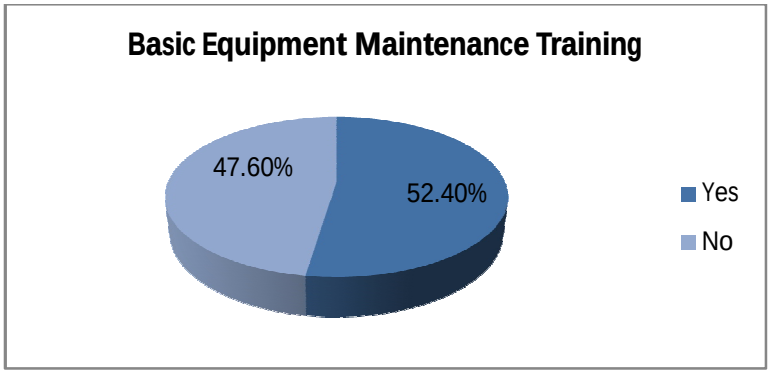

Fig 8, Basic MEM Training, Post-intervention, ALERT, Addis Ababa, EthiopiaMay 2018

In the post-intervention study, more than half of the participants 35(55.6%) think as they have adequate understanding of maintenance requirement. More than 60% of the participants can list at least two components of preventive maintenance program. In the post intervention assessment 42(66.7%) of the participants put tag for equipment undergoing preventive maintenance. More than 42% of the participants can list at least 2 of the tools for preventive maintenance.

Regarding the supply for preventive maintenance procedures, majority of the participants 26(41.3%) respond as the supply for preventive maintenance is sometimes available in their unit.

As shown in fig 9, 81% of the cases log sheet for preventive maintenance was available.

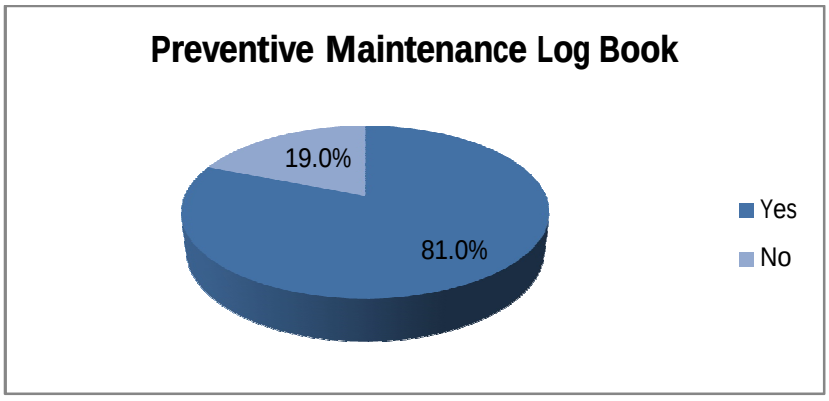

Fig 9, Availability of PM Logbook, Post-intervention ALERT, and Addis Ababa, EthiopiaMay 2018

Majority of the participants 53(84.1%) were aware of the availability of written procedure or guideline for preventive maintenance of medical equipment. Fifty four 85.7% of the participants respond as there is decontamination before the repaired equipment is started to be used. More than 50% of the participants list at least two methods of decontamination. Twenty eight (44.4%) of the participants respond as documentation were the usual procedure after preventive maintenance. When the participants were asked about the challenges of preventive maintenance lack of training was the major challenge which listed by almost all of the participants 62(98.4%). Thirty two (50.8%) of the time the departments/case teams were not receiving supervisions concerning medical equipment maintenance. In times when the department/case team is receiving supervision concerning medical equipment maintenance, monthly supervision accounts around 13(20.6%) of the cases. When supervisions were undertaken concerning equipment maintenance, most of the feedbacks 18(28.5%) from supervisors were given orally. Twenty eight (44.4%) of the participants respond, as there is no functioning linkage between the unit in need of maintenance and biomedical department.

Nineteen (30.2%) of the participants communicated the maintenance department before two weeks of data collection. When asked about the appropriateness of current PM system, 34(54.0%) of the participants agree that the current PM system is appropriate. Most of the participants 31 (49.2%) believe that the organization medical equipment maintenance to ensure an acceptable level of safety & quality. Majority 41(65.1%) of the participants believe as there is enough biomedical engineer and technician available in the hospital. Three out of four 44(69.8%) participants didn't believe as the biomedical engineers/technician have sufficient competence. Twenty two (34.9%) of the respondents mention as the full equipment inventory in the hospital was done annually. Thirty two (50.8%) of the participants respond, as there is no quality control mechanism for equipment maintenance in the hospital.

Performance Monitoring

Similarly, the result of indicators to follow IPM in the post-intervention study is presented in the following table.

Table 4 –Post Intervention Results (indicators for IPM), ALERT, Addis Ababa, Ethiopia May 2018

S.no	Indicator	Post-Intervention
1	Completion Rate	90.5%
2	Location Rate	61%
3	IPM Yield	72%

Comparison of Findings from the Pre and Post Intervention Study

Overall while comparing the results of the pre-intervention and Post intervention study the equipment maintenance system, especially the preventive maintenance is improved. These were shown in some of the selected results.

Knowledge wise, when we see the participant's response, before the intervention, Most of the participants, around 47.6%, mention only preventive maintenance as one of the successful element of maintenance management system. But after the intervention More than 60% of the respondents mention at least two programs which are parts of the successful element of maintenance program.

The following figure (fig 10) shows the status of inspection and preventive maintenance before and after the intervention.

Inspection and Preventive maintenance

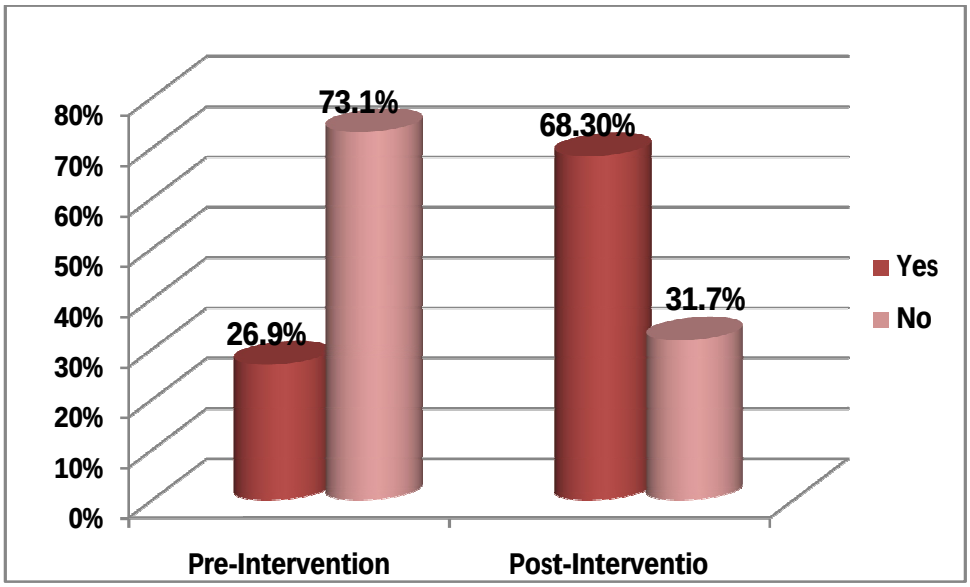

Fig 10, IPM, Pre and Post Intervention Comparison, ALERT, Addis Ababa, Ethiopia May 2018

One of the improvements is also explained, using the figure 11, by the difference in planning for inspection and preventive maintenance results before and after the intervention.

Plan for Inspection and Preventive Maintenance

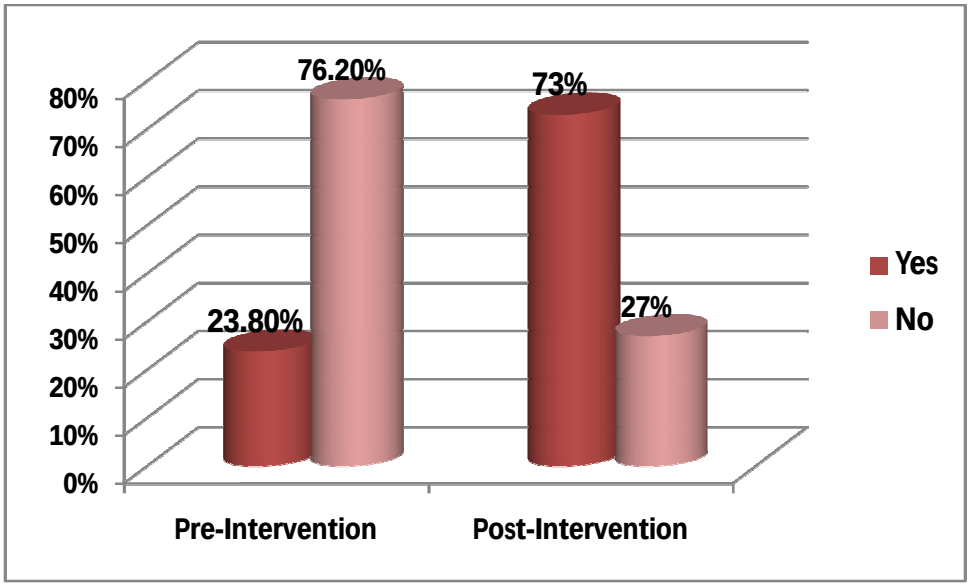

Fig 11, Plan for IPM, Pre and Post Intervention Comparison, ALERT, Addis Ababa, Ethiopia May 2018

Concerning the provision of basic training on preventive maintenance for health care providers, even though the training need is still not satisfied, improvement has been observed after the intervention.

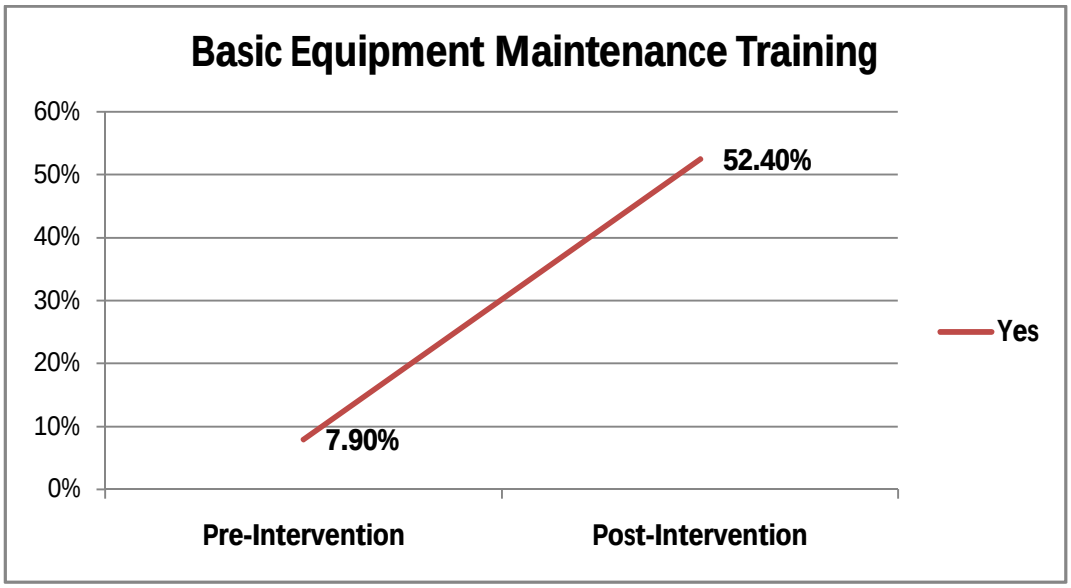

Fig 12, MEM Training, Pre and Post Intervention Comparison, ALERT, Addis Ababa, Ethiopia May 2018

As we can see from the pre-interventional study Majority of the participants 53 (84.1%) think as they don't have adequate understanding of maintenance requirement, but the findings of post intervention showed that more than half of the participants 35(55.6%) think as they have adequate understanding of maintenance requirement.

More than half the participants 36 (57.1%) didn't know which of the tools for preventive maintenance are available in their unit, but after the intervention More than 42% of the participants can list at least 2 of the tools for preventive maintenance.

Unlike the pre-intervention result (less than a quarter (22.2%) has log sheet for preventive maintenance), 81% of the cases in the post intervention assessment have log sheet for preventive was available. Majority of the participants in the pre-interventional study 50 (79.4%) didn't know the availability of written procedure or guideline for preventive maintenance of medical equipment, when the same question was asked after intervention majority of the participants 53(84.1%) were aware of the availability of written procedure or guideline for preventive maintenance of medical equipment.

Half 32(50.8%) of the medical equipment maintenance procedures were not documented properly and 28(44.4%) of the participants respond as documentation were the usual procedure after preventive maintenance in the pre and post results respectively.

Table 5 –Pre-Post Intervention Results Comparison (indicators for IPM), ALERT, Addis Ababa, Ethiopia May 2018

S.no	Indicator	Pre-Intervention	Post-Intervention
1	Completion Rate	79%	90.5%
2	Location Rate	25%	61%
3	IPM Yield	40%	72%

Test of Association

H_o = There is no association between the status of preventive maintenance and the intervention provided (training and distribution of necessary materials).

H_A = There is an association between the status of preventive maintenance and the intervention provided (training and distribution of necessary materials).

Preventive Maintenance	**Intervention Status**		**Total**
	Pre-Intervention	**Post-Intervention**	
Done	**30**	**86**	**116**
Not-Done	**125**	**69**	**194**
Total	**155**	**155**	**310**

X^2_{calc}=**<u>43.2</u>** andX^2_{tab}= **3.814** (df = 1 and 0.05 level of significance)

$X2_{calc} > \chi^2_{tab} \Rightarrow$ reject H_O

Conclusion: There is an association between preventive maintenance and interventions provided (training for health care providers and distribution of necessary supplies).

10. Discussion

In this capstone project found that, the intervened strategies have brought improvements on preventive maintenance system. Providing basic training and distribution of necessary materials like log book, procedure list, and the like were contributed for the improvement of the preventive maintenance system. This is evidenced by the internationally accepted indicators for inspection and preventive maintenance from the world health organization: (CR by 11.5%, LR by 36% and IPM yield by 32%).

This study has achieved a completion rate of 90.5% which goes in parallel with the world health organization, which states a good completion rate is 90% and above.

With the availability of planning sheet, the departments were practicing planning for IPM; this will in turn improve the inventory and plan proportion, through the process of identifying equipment for preventive maintenance. If the inventory is updated frequently, that medical equipment which remains without undergoing preventive maintenance will decrease. Making sure that each and every health care provider will have adequate understanding of preventive maintenance: will help the hospital in identifying the training need as well as refresher trainings as necessary.

Integrating equipment management and maintenance system in the supervision will help identify problems early and to respond for that, similarly those international level indicators, from WHO, will have paramount advantage on monitoring the performance of medical equipment in general and inspection and preventive maintenance in particular. This in turn will increase the documentation, reporting, accountability and responsibility of individuals and organizations in different level of the health system hierarchy.

Provision of supplies used for performing preventive maintenance will get equal priority in terms of maintaining the safety and operation of equipment undergoing any type of medical equipment maintenance. If these supplies will be provided in uninterrupted way, we can maintain the safety and operation every time. Similarly by making ‘maintenance status tag’ we can use the supplies in a more efficient and effective way. This tag also helps to identify maintenance requirement.

11. Strength and Limitation of the study

Strength

- The study is new in its type, since the already investigated topics were majorly concerned on functionality of the equipment and system level studies, and this study try to investigate one part of the equipment maintenance system, IPM, and trying to investigate its determinants and intervene on the prioritized problems.
- The study managed the intervention and the two armed evaluation (pre and post)in a limited period of time.

Limitation

- Lack of similar studies conducted on this topic, the study failed to compare the finding with other studies.
- The study comes up with the result of a single hospital
- Documentation gaps were there, and this made a limited secondary data review
- Shortage of post evaluation period.

12. Conclusion

Based on the findings of pre and post intervention study, the preventive maintenance system was improved in ALERT hospital; also selected strategies were proven to be effective on improving preventive maintenance system. Still there is a gap on basic training on equipment maintenance in the hospital; it is also mentioned in the top list, when participants were asked about the challenges related to equipment maintenance as a whole and IPM in particular. .

13. Recommendation

Federal Ministry of Health

- ® Ratify policies that guide the equipment maintenance system in general and preventive maintenance (by end users) in particular and follow the implementation
- ® Regular supervisions on MEM system and provide oral and written feedback as necessary
- ® Work to make supplies for preventive maintenance uninterrupted

ALERT

- ® Organize trainings on medical equipment maintenance
- ® Provide uninterrupted supplies for medical equipment maintenance
- ® Organize quality improvement team for medical equipment maintenance

Departments/Case Teams

- ® Update the inventory together with the concerned body in the hospital
- ® Develop and implement plan for inspection and preventive maintenance
- ® Make sure health care provider have adequate understanding of maintenance requirement and start practicing it in a routine base
- ® Timely request the supplies for medical equipment maintenance

Health Care providers

- ® Make sure they have adequate understanding of maintenance requirement
- ® Perform IPM in a routine base
- ® Document and report the procedures

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15. Annex

Annex A – Study Tool

Questioner to Improving Medical equipment maintenance system in Alert hospital Addis Ababa Ethiopia

For – Health Care Providers

Part I – Socio-Demographic Characteristics			
S.no	**Question**	**Response Category**	**Skip**
101	Age in Completed Years	_____ Years	
102	Sex	1.Male 2.Female	
103	Profession		
104	Level of Education	1.Certificate 2.Diploma 3.Degree 4. and above	
105	Service Year	_____ Years	
106	Current Working Unit	_____	
Part II – Medical Equipment Maintenance System			
201	What type of Medical Equipment maintenance do you usually use in this Hospital?	1.Preventive maintenance 2.Corrective maintenance 3.Combination of the two 4.I don't Know	
202	What do you think are the successful elements of maintenance management system? ***(Multiple answers Possible)***	1.Preventive maintenance 2.Work management system 3.PM planning and scheduling 4.I don't Know	
203	Are there occasions you did IPM by yourself?	1.Yes 2.No	
204	Do you have a plan for IPM for the equipment in your department/case team?	1.Yes 2.No	**If No skip to 206**
205	If your answer for question no. 204 is yes, How often do you plan for IPM?	1.Less than a month 2.Monthly 3.annually 4.Annually	

		5. don't know	
206	Do you take basic medical equipment maintenance training before?	1.Yes 2.No	
207	Do you think you have adequate understanding of maintenance requirement?	1.Yes 2.No	
208	What does the preventive maintenance program includes? ***(Multiple answers Possible)***	1.Checklist lubrication 2.Detailed checklists for inspections 3.Employee responsible for the work 4.I don't know	
209	What procedures do you commonly use to perform PM? ***(Multiple answers Possible)***	1.Manufacturer's recommendation 2.Industrial Recommendation 3.Facility Experience 4.I don't know	
210	Do you use any identification mechanisms for the equipment undergoing PM (indicating maintenance status)?	1.Yes 2.No	
211	Do you have the tools for the following: Tools for preventive maintenance……. Tools for safety and performance inspection…….. Tools for calibration of devices…… ***(Multiple answers Possible)***	1.Tools for preventive maintenance 2.Tools for safety and performance inspection 3.Tools for calibration of devices 4.I don't know	
212	How do the supply for preventive maintenance looks like?	1.Always available 2.Usually available 3. sometimes available 4.Not available	
213	Do the department/case-team has PM log book?	1.Yes 2.No	
214	Is there any written procedure or guideline for preventive maintenance of medical equipment's?	1.Yes 2.No	
215	Does all medical equipment returned for serving & repair are properly decontaminated?	1.Yes 2.No	**If no skip to 217**
216	What method of decontamination has been used? ***(Multiple answers Possible)***	1.Cleaning 2.Disinfection 3.Sterilization 4.Other, Specify_____	

217	Does all medical equipment maintenance procedures documented properly?	1.Yes, Always 2.Yes, Usually 3.Yes, Sometimes 4.Not done	
218	What do you think are the challenges for equipment maintenance? ***(Multiple answers Possible)***	1.Lack of training 2.Lack of spare part 3.Lack of interest 4.Lack of human power 5.Others, specify_____	
219	Did your department/case team receive supervisions, concerning on medical equipment maintenance?	1.Yes 2.No	**If no skip to 222**
220	If your answer for question. 219 'yes', how frequently did you receive this supervision?	1.Weekly 2.Twice a month 3.Monthly 4.Quarterly 5.Bi-annually 6.Annually	
221	Did you receive feedback from these supervisions?	1.Yes, Oral feedback 2.,written feedback 3.Yes.both 4.Didn't receive feedback	
222	Is there a regularly functioning existing system in the hospital that links the unit in need of maintenance and biomedical department?	1.Yes, regularly functioning 2.Yes, not regularly functioning 3.No system in this regard 4.I don't know	
223	How do you rate the communication between you/your department and the maintenance team/department?	1.Very efficient 2.Efficient 3.Not efficient 4.I don't know	
224	When was the last time you request for maintenance of medical equipment (for IPM or CM)?	1.In this week 2.Before a week 3. 2 weeks 4.Before 3 weeks 5.More than a month	
225	Do you think the current PM system you have is appropriate?	1.Yes 2.No	
226	Does your organization medical equipment maintenance to ensure an acceptable level of safety & quality?	1.Yes 2.No	
227	Do you think there are enough bio-medical engineer/technicians available in this hospital for maintenance?	1.Yes 2.No	

228	Do you consider the bio-medical engineer/technicians have sufficient competence regarding maintenance?	1.Yes 2.No 3.Idont know	
229	How often does this hospital conduct full equipment inventory?	1.Quarterly 2.Bi-annually 3.Annually 4.I don't remember 5.I don't know	
230	Does hospital have quality control system for PM?	1.Yes 2.No 3.Idont know	
Part III – Performance Monitoring (Last one Month)			
301	Can you please tell me how many PM schedules were planned and how many were located (in numbers)?	**Planned Inventory ND**	
302	Can you please tell me how many PM schedules were planned and how many were completed (in numbers)?	**Planned Performance ND**	
303	Can you please tell me how many PM schedules were planned and how many had real problem (w/c affect operation and safety) (in numbers)?	**Planned Actual ND**	

Annex B – Intervention Package

Improving Preventive Medical Maintenance system

Intervention Package

Designed for Health Care Providers

By: YemisrachTamirat (BSc)

May 2018
Addis Ababa, Ethiopia

Table of Contents

Introduction

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 functional and in some hospital in the region a functional equipment near to 50%.

The rising number of these 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 are factors that contribute to equipment breakdown

Planned preventive maintenance is regular, repetitive work done at scheduled intervals to keep equipment in good working condition. The activities under preventive maintenance involve routine cleaning, calibrating and adjusting, checking for wear and tear and lubricating to optimize working efficiency and to avoid breakdown. Also consumables replacement like the fitting of new of filters etc. is done as part of this work. Effective planning for preventive maintenance involves proper selection of the equipment to be included in the plan. Decisions must be made on what to include in order reducing costs. Inexpensive units can be replaced or repaired if they break down, so need not always be included. The overriding consideration is cost effectiveness.

General Objective

- The aim is to improve the preventive type of medical equipment maintenance system in ALERT Hospital.

Specific Objective

- To provide care and servicing by health care providers (Users) for maintaining equipment in satisfactory operating condition by providing systematic inspection detection and correction of failures either before they occur or before they develop in to major defects.

What Does Preventive Maintenance Mean?

Preventive maintenance: involves maintenance performed to extend the life of the device and prevent failure. PM is usually scheduled at specific intervals and includes specific maintenance activities such as lubrication, cleaning replacing parts that are expected to wear (e.g. bearings) or which have a finite life.

Preventive maintenance is designed to preserve and restore equipment reliability by replacing worn components before they actually fail.

Importance of Preventive Maintenance

- Equipment down time is decrease and the number of major repairs is reduced
- Better conservation of medical equipment and increased life expectancy of equipment their by eliminating premature replacement of equipment.
- It assures optimal working condition and conserves the life span of the equipment
- Maximize cost effectiveness
- More economical use of maintenance workers, due to working on a scheduled base instead of crash bases to repair breakdowns.

Tasks for preventive maintenance

- Full inventory within the unit
- Planning user maintenance
- Establish a system to check all maintenance log sheet
- Prepare for each item of equipment a time table /schedule for each of the task
- Accomplish at least 90% of normal equipment and 95% of essential equipment
- Prepare a tag for maintained equipment
- Early communication for equipment that need further procedures/maintenance
- Documentation

Aim of user training on Preventive Maintenance

- Increase the habit of planning for preventive maintenance
- Increase equipment capabilities
- Knowledge of where /how to access user manual and receive equipment updates
- How to perform basic routine maintenance
- How to request equipment maintenance, for equipment that need further procedure (work order)
- Proper documentation of procedures

Major Components of Equipment Maintenance

- Cleaning checking
- General inspection
- Accessory checking
- Functional checking
- Operational checking

Note:- *Health care providers (end users of equipment), will use the checklists to monitor the proper preventive maintenance procedures.*

Annex

Inventory Checklist (Capstone Project)

Case Team/Department: _____

Date of inventory check: ____/_____/_____

No. of medical equipment in the department/Case team (in number): _____

Checked by: _____

Plan for Preventive maintenance

Case Team/Department: _____

Date of Plan: ____/_____/_____

Plan for the next three weeks (in number): _____

Planned by: _____

Log sheet: Preventive maintenance (Capstone Project)

Department/Case Team: _____

S.no	Name of Equipment	Date of maintenance	Maintenance type (Minor/Major)	Maintained by	Remark

Preventive maintenance – Documentation Sheet (Capstone Project)

Department/Case Team: _____

- Equipment name:_____
- Date of maintenance:_____/_____/_____
- Preventive maintenance done by: _____
- Preventive maintenance type: (Minor/Major):_____

  (Major: maintenance involving problems of operation and safety, Minor: Not Major)

- Preventive maintenance needs further procedure: _____ Yes _____No
- If yes, Work order filled: _____ Yes _____No

Special Observations made during preventive maintenance:

Declaration

I, the undersigned, declare that this capstone project is my original work and has not been presented for a degree in this or other University and all sources of materials have been fully acknowledged.

Name: YemiserachTamirat (BSc)

Signature: _____

Place: Addis Ababa

Date of submission: _____/_____/_____

This capstone project work has been submitted for examination with our approval as University advisors:

Advisor's name	Signature	Date
A. MesfinAddise (MD, MPH)	**_____**	**_____/_____/_____**
B. AdiamNega (BSc, MPH)	**_____**	**_____/_____/_____**