



Maintenance and Repair of Biomedical Equipment at NHSL

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ABSTRACT

Medical equipment usually comprises of huge number of components and many interacting devices with each other making complex repairable systems. Proper maintenance management of medical equipment is of foremost importance to the health sector during the economic crisis. Sustainable maintenance system of medical equipment in government hospitals of developing countries is vital to efficiently delivering effective healthcare.

The objective of this case study is to identify the obstacles in Maintenance and Repair process of Bio Medical Equipment and to recommend solutions to rectify the identified problem.

Key informants were MO Planning, Accountant Supply, Surgical Pharmacist, Superintendent Radiographer, Superintendent MLT, Nursing Officers and Management Assistants. Identified problems were prioritized based on the in-depth interview with the Registrars attached to the unit. The problems identified were "There are barriers to do proper preventive and corrective maintenance at NHSL and no internal audit system to monitor and evaluating the maintenance and repair process".

The root causes for this situation were identified using problem tree. The main root causes identified were no updated equipment survey, bureaucratic delay as two administrative hierarchy (NHSL and Bio Medical Engineering Services (BMES)/Ministry of Health), no liaison unit available at NHSL for Bio medical equipment maintenance and repair and no mechanism to do internal audit to evaluate the Bio medical equipment maintenance and repair.

It is therefore recommended to maintain an updated equipment survey, establish a liaison unit at NHSL for Bio Medical Equipment maintenance and repair and do an internal audit to evaluate will improve overall the maintenance and repair process of bio medical equipment at NHSL.

1. Introduction

Health technologies are essential for a functioning health system. Medical devices in particular are crucial in the prevention, diagnosis, and treatment of illness and disease, as well as patient rehabilitation. They are considerable investments and, in many cases, have high maintenance costs.

Effective maintenance management of medical equipment is indispensable to maintain the quality of care, to provide the cost-effective health care services, with minimum resources (Zozani et al., 2021). World Health Organization estimated that over 50 to 80 percent of medical equipment in developing countries are mal functional or non-functional (Moyimane & , Sogo France Matlala, 2017). This figure enlightens that the equipment is not used to optimum level and not get return of investment perpetually and effectively. Majority of medical equipment are technically complex and require specific expertise to use, maintain, and repair (Koggalage & Alwis, 2019). There are several implications of malfunctioning medical devices identified due to improper maintenance in major hospitals. The major implications detected are wasted healthcare funds, delayed times for patient treatment, and substandard healthcare outcomes for patients.

The National Hospital of Sri Lanka (NHSL) has a bed capacity of 3404 and over 7000 dedicated health staff in providing uninterrupted service to the whole nation. NHSL comprises with many Medical sub specialities in Health care and most of these specialities are only available at NHSL.

The National Hospital has 18 well equipped Intensive Care Units and 17 High Dependency Units located at each major care providing sectors such as Surgical Department and Medical Department. There are 19 surgical theatres under operation. While some Operation theatres are dedicated for certain surgical specialities, some are in operation 24 hours per day. For a single given month more than 5000 Major and Minor surgeries done. This reflect the extent of need of bio medical equipment need in NHSL. The unavailability or failure of medical equipment can lead to significant risks to patients and the staff as well. Therefore, it is the responsibility of any healthcare provider to manage their own medical equipment which includes planning, acquisition, maintenance, repair, and disposal (Koggalage & Alwis, 2019).

2. Objectives

To identify the obstacles in Maintenance and Repair process of Bio Medical Equipment and to recommend solutions to rectify the identified problem.

3. Methodology

The existing maintenance system and repair studied and analysed by performing detailed situation analysis. Direct observation, key informant interviews were used to assess the existing situation.

Key informants were MO Planning, Accountant Supply, Surgical Pharmacist, Superintendent Radiographer, Superintendent MLT, Nursing Officers and Management Assistants.

Identified problems were prioritized based on the in-depth interview with the Registrars attached to the unit.

4. Situation analysis

4.1 Definition of biomedical equipment

Medical equipment is used for the specific purposes of diagnosis and treatment of disease or rehabilitation following disease or injury (WHO, 2022). In some instances, they can be used alone or in combination with any additional, consumable or other piece of medical equipment. Medical equipment excludes implantable, disposable or single-use medical devices. Medical devices requiring, maintenance, periodic calibration, repair and user training activities usually managed by bio medical engineers.

4.2 Acquisition of biomedical equipment

Supply of biomedical equipment for NHSL is managed by the Bio medical engineering (BME) unit of Ministry of Health. Bio medical engineering unit request annually the equipment availability, working condition, items to replace existing defective equipment and newly required items usually in June each year. Surgical stores/ chief pharmacist is involved in preparing the estimate which needed for the hospital. She will collect the requests from various units of the hospital. In-charge nursing sister prepare their unit requirements of needed equipment and send through their respective consultant to chief pharmacist/ Surgical stores. Finally, the surgical stores pharmacist makes the summary, the master estimate for NHSL. As funds are limited, equipment summary prioritized by planning team with the DDG/NHSL input, before sending to BME unit. This estimate is finalised and forwarded to biomedical engineering unit of Ministry of Health.

4.3. Receiving and allocation of new equipment to units

The equipment which are done through procurement are delivered to the surgical stores from the BME unit, Ministry of Health. Transfer of equipment is done through an issue order (Common 141). Particulars related to the receipt of equipment are entered in general inventory book of surgical stores.

Surgical pharmacist distributes the respective equipment according to the requests made to the relevant units. Surgical pharmacist enters all the items/equipment in the inventory register at the surgical stores. This includes important details about the equipment. Wards/ Units inventories are updated accordingly.

4.4. Maintenance and repair of biomedical equipment

It is mandatory and good practice to maintain a personal file for each equipment by the respective inventory holder. It should include all the documents relevant to the equipment such as user manuals, service agreements, and service records.

The ward in-charge sister needs to inform the director in complaint book when there is a fault in an equipment found. The request for repair has to send to the director bio medical engineering unit in a manifold book after obtaining the DDG's approval. This manifold book is sent through the DDG/NHSL to the surgical stores. Surgical stores pharmacist has mentioned the details in the job reporting card register with a registration number and the relevant job card forwarded to the biomedical engineering unit with the manifold book.

Equipment can be transferred to the biomedical engineering unit of Ministry of Health by the unit minor staff only after necessary documentation are completed especially noted in a job card register in surgical stores. It should consist of the details of the item, date and time of transfer, job card number etc. Bio Medical Technicians after analyzing the broken status of and then attempt to repair the damaged equipment with the consultation with BMEs.

Repaired items are directly received by the respective unit. There is a service agreement for some equipment with the private company/Sole agent, who provided the equipment. Repairs of such items are directly informed to the relevant company. The repairs will be done by them inside the institution or few instances have to be moved out of hospital premises by obtaining permission from the DDG/NHSL.

5. Identified Problems and underlying causes.

Three major problems are identified in evaluating the Maintenance and Repair of Biomedical Equipment at NHSL and identify the factors influence the functionality, and utilization of equipment.

1. There is a lack of technical experts (BME/BMT) with in the NHSL.
2. There are barriers to do proper preventive and corrective maintenance at NHSL.
3. There is no internal audit system to monitor and evaluating the maintenance and repair process.
4. There is a deficiency in training on safety and quality assurance program of medical equipment.

5.1 Increased down time of equipment due to lack of technical experts (BME/BMT) with in the NHSL.

Some units do not have adequate number of equipment as most of the time equipment are undergo minor repair and take more time for repair and ended up in increased down time and the unit cannot be function into its full potential. Some of the new equipment are delayed or not in use due to lack of knowledge about the installation until a BME comes from Ministry of Health to complete the installation process. For example, there is an analyzer (AT 700) in biochemistry department is not installed for one and a half years. This will increase other analyzer workload and prevent the scheduled preventive maintenance as due to service exigencies. Nursing officer's at NHSL perceived that the repairs can be expedited when they have BME or BMT appointed for NHSL. Most of the staff working in NHSL believe, having a BMET will create the ability to have prompt repair by the BMT. They also felt, that they can learn or upgrade their knowledge about equipment management.

BME or BMET with in the hospital will improve the confidence level of health workers of the hospital and it will reduce lot of document process as at present excessive documentation to send a repair to BMES in MOH. In addition, BMETs can help in reducing the economic burden, especially during the economic crisis as if a BMET available at NHSL, he would have been involved in the continuous maintenance of the machines. There is a trend observed of buying new equipment when something is damaged and most occasion not pursue the repair of that equipment.

The lead time also prolonged due to excessive documentation as two institutions involved in the procurement process to place a new purchase order. It will affect the continuous service of the particular unit.

5.2 There are barriers to do proper preventive and corrective maintenance at NHSL

Periodic maintenance and the intervals should be in agreement with equipment manufacturer's recommendations and it is an essential criterion need to be satisfied to obtain the accreditation for a hospital. It includes predictive maintenance, preventive maintenance, corrective maintenance and scheduled maintenance.

Some Consultants are less cooperative to do preventive maintenance at scheduled date. In cardiology section consultant cardiologist not willing to close one day session in Cath-lab to do preventive maintenance as they having a large waiting list.

Medical equipment maintenance programs do not properly plan and monitored at NHSL. Periodic maintenance plays a very important role in biomedical engineering department. They can able to identify the potential defects through planned periodic inspections. BME department can take appropriate mitigation measures to fix these catastrophes as it detected before ends in corrective maintenance. There is a gap observed for taking accountability and responsibility at NHSL to take suitable measures to ensure preventive maintenance as Bio Medical Engineering Service, Ministry of Health is not under the authority of NHSL. There are instances where there are discrepancies in opinion between the BMES and the equipment manufacturing company or agents, our staff/end users express there is no avenue to express their opinion from their side. For example, there is divided opinion on CT machine in neuro trauma unit. Engineers from BMES wants to do condemnation but the engineer of the company on service agreement wants to change the spare part cost of three million SLR.

5.3 There is a deficiency in training on safety and quality assurance program of medical equipment.

Safety and Quality assurance program of medical equipment is ensured the performance and improves the cost control, infrastructure issues, utility issues, administrative procedures and spare parts availability to prevent service interruption and productivity. This will guarantee the system safety and performance of medical devices and prevent potential failures.

There is no quality assurance program or related trainings observed at NHSL. This training program train staff in acceptance test, inspecting security of instruments, calibration standardization and technical analysis. There is no frequent training to staff on assessing risk factors, on electrical safety checks, ensuring safety practices on handling safe medical equipment. Inadequate training of staff is a limiting factor for the proper maintenance of medical equipment. There is a constraint in educating the staff to do training programs, due to Covid-19 spread for last three years though there is presence of trainers in equipment management, staff, assets and budgets were available.

5.4 There is no internal audit system to monitor and evaluating the maintenance and repair

There is a need to do internal audit comprise of the service items include the age of equipment, maintenance cost, work orders, service contract agreement, down time, repairs and replacement of spare parts, failure data and procurement and replacement decision procedures. This will help to compare the functionality of equipment between the units at NHSL by classify into the following categories such as Overall, General, Lab, Operation Theater, and Radiology and differences between the number of functional equipment can be measured and analyze the causes.

6. Prioritization of the Problem

I had discussions with registrars through in-depth interviews and eventually prioritized the problem.

6.1 Selected problem

Many emphasize the second and third problems are interrelated and can be dealt together. The selected problems are “There are barriers to do proper preventive and corrective maintenance at NHSL and no internal audit system to monitor and evaluating the maintenance and repair process”.

6.2. Root cause analysis

Problem tree is used to identify the root causes.

6.2.1. Effect “Poor Maintenance and Repair process of Biomedical Equipment at NHSL”

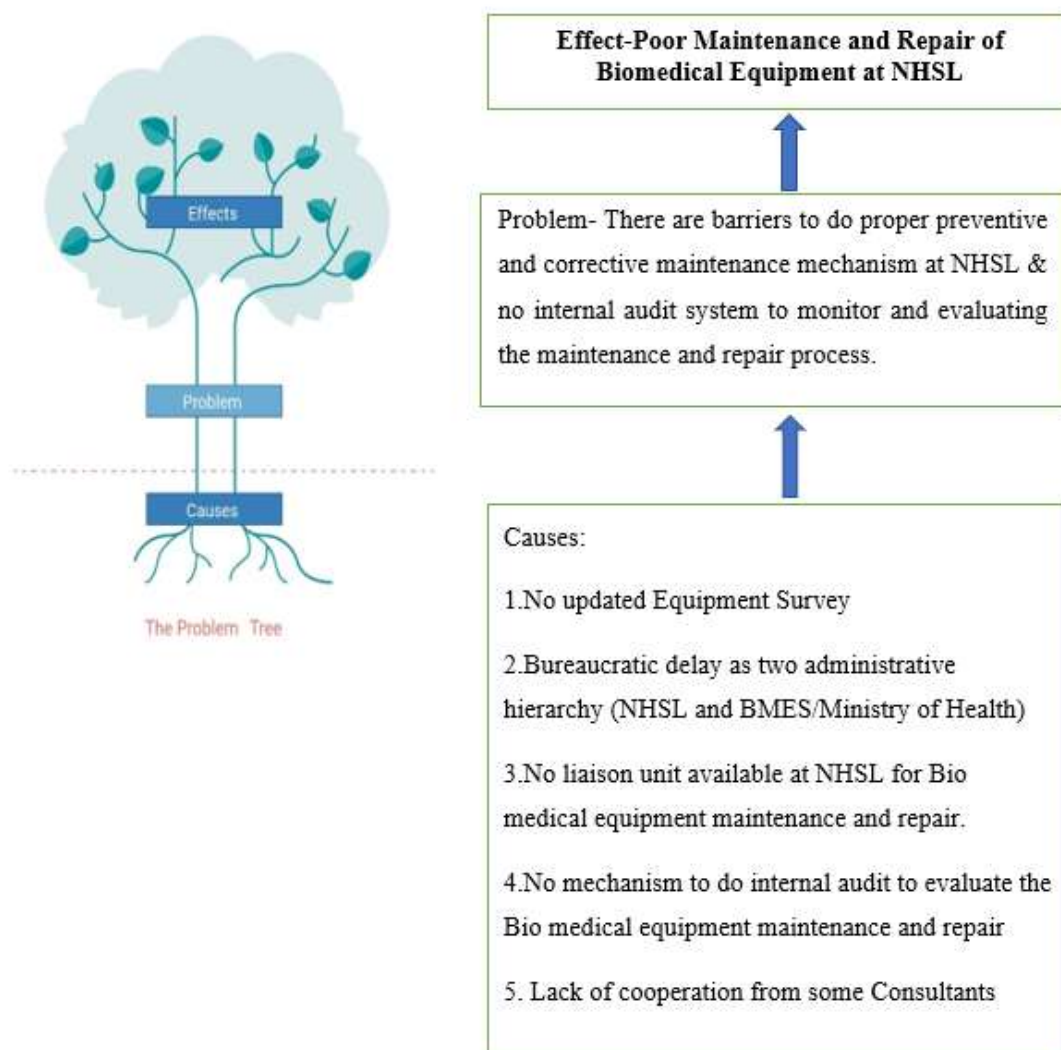


Figure 1: Poor Maintenance and Repair of Biomedical Equipment at NHSL

7. Recommendations

1.It is recommended to updated the equipment survey. It is essential to maintain an updated equipment survey each year in a hospital. This survey includes availability of equipment personal file, log book, repairs, Service records, agreements and details of equipment waiting for spare parts and waiting for

condemnation. This is not available at NHSL and leads to unnecessary purchase of new equipment by neglecting the efficient use of existing equipment and unequal distribution of equipment among wards and units.

2. There is no liaison unit available at NHSL for Bio Medical Equipment maintenance and repair. There should be a separate unit to be established and unit staff should be trained on preventive maintenance of Bio medical equipment to coordinate any preventive maintenance work. Preventive maintenance of all bio medical equipment should check the availability of equipment personal file, log book, repairs, Service records, service agreements and details of equipment waiting for spare parts and waiting for condemnation. This unit has to work with clinical staff as a team. The most important aspect is creating relationships with all hospital staff handling bio medical equipment.

3. There is no mechanism to do internal audit to evaluate the Bio medical equipment maintenance and repair process. The quality management unit has to commence the internal audit and evaluate the Bio medical equipment maintenance and repair process.

8. Implementation plan

8.1 Maintain an updated the equipment survey

- I. Get approval from the higher authorities and get allocation
- II. Appoint a responsible person to gather information
- III. Prepare data collection tool and disseminate through Matrons, Medical Superintendent Radiographer and MLT
- IV. Giving deadline for data collection
- V. Update the equipment survey

8.2 Establishing a liaison unit at NHSL for Bio Medical Equipment maintenance and repair.

- I. Get approval from the higher authorities to establish a liaison unit.
- II. Appoint a Deputy Director/MO Planning as head of liaison unit.
- III. Appointing additional staff such Accounting officer, Matron and MA/DO
- IV. Make arrangements to train the staff of this unit to check the availability of equipment personal file, log book, repairs, Service records, service agreements and details of equipment waiting for spare parts and waiting for condemnation.
- V. Staff of the liaison unit should monitor the preventive maintenance on regular basis
- VI. Adequate incentives should be provided to the staff of liaison unit who involve in the preventive maintenance since there is shortage of staff.

8.3 Adapt a mechanism to do internal audit to evaluate the Bio medical equipment maintenance and repair process.

- I. Get approval from the higher authorities to do internal audit to evaluate the Bio medical equipment maintenance and repair process.
- II. Appoint Quality Management unit as responsible team.
- III. Do the audit and submit the report to DDG/NHSL for improvements.

9. Conclusion

Equipment maintenance and repair process can be re-engineered with implementation of updated equipment survey in a health-care institution (Lanka et al., 2018). In addition, such a survey prolongs the useful life of the equipment and minimizes the cost of equipment ownership. This survey should, however, be reviewed continuously and necessary changes has to adapted in order to meet the increasing demands of healthcare organizations as well as to align with current technological advancements.

Establishing a liaison unit at NHSL for Bio Medical Equipment maintenance and repair and do an internal audit to evaluate will improve overall the maintenance and repair process of bio medical equipment at NHSL.

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