



EVALUATION OF PROCESSES, PRACTICES AND MAINTENANCE OF BIOMEDICAL EQUIPMENTS IN OPERATION THEATRES

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Abstract : The study has been undertaken to discuss biomedical services and inventory management in healthcare, emphasizing the importance of maintaining medical equipment for effective patient care. It highlights aspects of biomedical inventory management, such as equipment tracking, vendor relationships, regulatory compliance, and budget allocation. The relevance of real-time equipment management is emphasized. The objective was to evaluate biomedical equipment maintenance in operation theatres, examining existing documentation and conducting an audit. The study finds that 97.58% of equipment is present, with reasons for utilization beyond preventive maintenance. The utilization reasons include equipment availability, low risk of failure, in-house expertise, service engineer availability, and planned phased replacement.

Index Terms – Biomedical equipment, Equipment management, Inventory management

I. INTRODUCTION

Biomedical services refer to a specialized branch of healthcare services focused on the maintenance, repair, calibration, and management of medical equipment and devices used in clinical settings. These services are essential for ensuring that healthcare facilities can operate effectively and provide high-quality patient care.

Biomedical service professionals, often known as biomedical equipment technicians (BMETs) or clinical engineers, play a critical role in this field.

Biomedical inventory refers to the stock of medical equipment, devices, and supplies that healthcare facilities maintain to support their operations. This inventory plays a vital role in ensuring that healthcare providers have access to the necessary tools and resources to deliver high-quality patient care. Biomedical inventory management is essential for maintaining accurate records, optimizing costs, and ensuring the availability of critical items when needed.

Biomedical inventory management is critical for the efficient operation of healthcare facilities.

A computerized medical equipment management system is a useful tool in tracking device inventory and maintenance history, and it takes into consideration the advances in device reliability, reduced preventive maintenance requirements, and internal device surveillance along with changes in standards.¹

Inventory based medical equipment management improves the transparency and accountability regarding the maintenance jobs and the cost of expenditure and estimation.²

Aspects of biomedical inventory management include:

- **Equipment Inventory:** This includes medical devices, diagnostic equipment, and therapeutic instruments used in clinical settings. Each item is typically tracked with details such as make, model, serial number, location, and maintenance history.
- **Maintenance and Calibration Parts:** Biomedical departments also stock spare parts and calibration tools required for the maintenance and repair of medical equipment.
- **Vendor Relationships:** Maintaining relationships with reliable vendors is critical for timely and cost-effective procurement. These relationships may include service agreements, warranties, and bulk purchasing options.

- Regulatory Compliance: Biomedical inventory management must adhere to regulatory standards and documentation requirements to ensure patient safety and meet compliance standards.
- Asset Tracking Systems: Implementing asset tracking systems, such as barcoding or RFID technology, aids in accurate inventory management, reducing manual errors and streamlining the tracking process.
- Budget Allocation: Determining budget allocations for the procurement, maintenance, and replacement of biomedical inventory is crucial for effective resource management.
- Emergency Preparedness: Maintaining emergency supplies and equipment, such as defibrillators or trauma kits, is essential for responding to critical situations.
- Inventory Audits: Regular audits of biomedical inventory are conducted to verify the accuracy of records and identify any discrepancies or missing items.³

Relevance to clinical practice a real-time biomedical equipment management system is helpful to effectively manage all the equipment in the hospital.⁴ Currently the hospital was using a state of art inventory management system with over 3000 Biomedical equipments listed in the inventory.

II. OBJECTIVE AND NEED FOR THE STUDY

1. To evaluate the current processes, practices and maintenance of Biomedical equipments in Operation theatres.

The need for this study arises from the critical role that biomedical services and inventory management play in ensuring the effective operation of healthcare facilities, particularly in operation theatres. The study proposes to address the challenges in maintaining accurate records, optimizing costs, and ensuring the availability of critical medical tools. By evaluating the current state of biomedical equipment management within operation theatres, the study aims to identify gaps, propose improvements, and contribute to the overall efficiency of healthcare services.

III. METHODOLOGY

Existing documentation related to the maintenance of biomedical equipment was reviewed.

This included equipment maintenance logs, service reports and policies and procedures. A comprehensive inventory of all biomedical equipment already existed. Checklist was prepared for this existing inventory of Operation theatre Equipments. A total of 330 equipments in the operation theatre were audited for the purpose.

Various parameters pertaining to maintenance records for each piece of equipment was analysed. Maintenance logs for scheduled maintenance performed, preventive maintenance, calibration, and any issues or repairs were checked for completeness.

Equipments were categorised based on their maintenance contracts. For the ease of conducting the audit, only the equipments under annual maintenance contract were included under the purview of the study.

IV. RESULTS AND DISCUSSION

The evaluation was carried out to identify any gaps in Biomedical equipment inventory management.

All the equipment at the time of installation are provided with a unique identifier, and the inventory includes details like make, model, serial number, location, purchase date, and warranty status and asset was tagged with the inventory management software. The equipment can then be tracked using the software.

The software also provides for tracking assets, Annual Maintenance Contract due dates, Preventive Maintenance & Calibration schedules, and department allocation. Service requests are assigned to team members for preventive maintenance, calibration checks, and daily round logs.

Of the 330 equipments listed in the inventory management software, 322 (97.58%) were physically present at the time of audit. The remainder 8 (2.42%) equipment were sent to the Biomedical department for breakdown maintenance. The same could be tracked on the inventory management software.

Table 1 presents equipment distribution in various operation theatres based on maintenance contracts. The Main OT has 144 equipments, with 31 (21.52%) under AMC. In Oncology OT, out of 65 equipments, 17 (26.15%) are under AMC. Cardiac OT has 18 equipments, with 3 (16.66%) under AMC. Labour OT has 57 equipments, and only 3 (5.26%) are under AMC. Ophthalmology OT has 21 equipments, with 3 (14.28%) under AMC. Emergency OT has 25 equipments, and 5 (20%) are under AMC.

Table 2 shows 13 (3.94%) equipments were due for their preventive maintenance and were functioning beyond their schedule. Table 2.

Utilization of equipment beyond preventive maintenance, while sometimes necessary, can result from a variety of reasons, which may not always be ideal but are often practical and resource-driven. Here are some common reasons for equipment utilization beyond preventive maintenance:

- Equipment Availability: Operation theatre being a high tension atmosphere requires certain critical equipment in high demand, and not feasible to take it out of service for preventive maintenance without causing significant disruption in patient care. The immediate care of a patient takes precedence over planned maintenance.

- **Low Risk of Failure:** Some equipment have a history of reliability, making it less likely to fail unexpectedly. Periodic calibration by the in-house engineers and daily maintenance provides to extend the utilization of such equipment beyond the recommended preventive maintenance schedule.
- **In-house Expertise:** In-house biomedical engineering expertise opt to extend equipment use if they believe they can maintain and repair the equipment effectively, reducing the need for expensive manufacturer servicing.
- **Service engineer availability:** At times, service engineers optimize their appointment schedules to consolidate the preventive maintenance of multiple equipment units within a single day, thereby minimizing the need for multiple visits to the facility.
- **Planned Phased Replacement:** Few equipment are long due for phased replacement. In such cases, equipment is being used beyond its original lifespan until the planned replacement phase begins.

Table 3 provides an overview of inventory data and existing inventory in the equipment management system. It indicates full compliance (100%) in recording the physical location within the healthcare facility. However, the installation date is only recorded in the Biomedical department's log book (36.17%) and is not consistently entered in the long-term inventory management. The warranty end date is documented for 31.30% of the equipment, revealing a lack of establishment in inventory management following the Central Store's equipment acquisition. Preventive maintenance due dates are captured at 71.12%, reflecting challenges in adhering to maintenance schedules outlined in vendor contracts. Calibration due dates, at 80.54%, show inconsistency in maintaining non-critical equipment by in-house Biomedical staff.

As health technology rapidly evolves, an array of biomedical equipment is becoming increasingly prevalent in healthcare settings, serving diverse roles in disease prevention, diagnosis, treatment, and patient recovery. The demand for medical equipment is on the rise, accompanied by escalating costs.⁵

Inventory management and documentation represent crucial initial phases in the equipment life cycle. These stages can be viewed as the foundational steps when crafting an efficient equipment management program within any organization. Consequently, it is imperative for every healthcare institution to uphold a medical equipment inventory⁶

A study conducted by Dicky et. al introduced a Biomedical inventory management system at Lehigh Valley Hospital, which identified a 35.1% decrease in the annual scheduling of preventive maintenance, leading to a 29.3% reduction in necessary labor hours. This newfound time enabled the staff to achieve set preventive maintenance completion rate objectives, implement cross-training initiatives to enhance departmental coverage during staff shortages.⁷

In another research article authored by Hossain MA, the need for enhancing the inventory and documentation system for medical imaging equipment in public hospitals in Bangladesh was emphasized. Despite the extensive use of over 1200 various medical imaging devices in these hospitals, the absence of a suitable inventory and documentation system could be attributed to an inadequate management system for medical imaging equipment. To address this gap, a computerized inventory and documentation system would be established within public hospitals in Bangladesh, offering comprehensive information support for various facets of medical equipment management.⁸

V. TABLES AND FIGURES

Table 1: Operation theatre wise equipment distribution based on maintenance contract

Operation Theatre	Total number of equipments	Equipments under AMC	Percentage (%)
Main OT	144	31	21.52
Oncology OT	65	17	26.15
Cardiac OT	18	3	16.66
Labour OT	57	3	5.26
Ophthalmology OT	21	3	14.28
Emergency OT	25	5	20.00

Table 2: Operation theatre wise equipment distribution beyond PM schedule

Operation Theatre	Total number of equipments under AMC	Equipments beyond PM schedule	Percentage (%)
Main OT	31	6	19.35
Oncology OT	17	3	17.64
Cardiac OT	3	0	0
Labour OT	3	3	100.00
Ophthalmology OT	3	1	33.33
Emergency OT	5	0	0

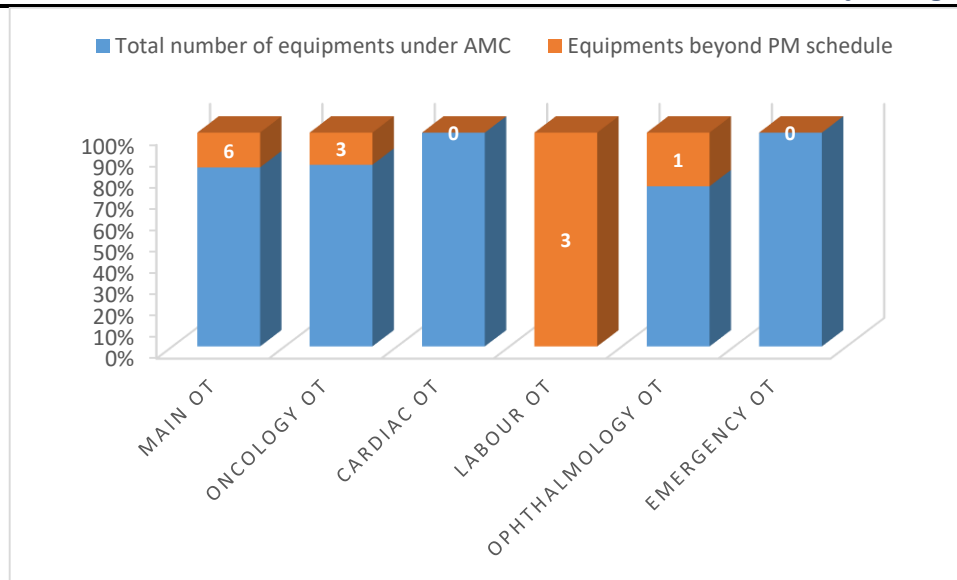


Figure 1: Equipment distribution beyond preventive maintenance schedule

Table 3: Inventory data and existing inventory in the equipment management system

Parameter	Existing percentage (%)	Findings
Physical location within the healthcare facility	100.00	Total compliance
Installation date	36.17	The Biomedical department maintains in log book, but it is not consistently entered in the inventory management for the long term.
Warranty end date	31.30	The Central Store acquired most of the equipment, and there was no establishment of inventory management.
Preventive maintenance due date	71.12	A maintenance contract was established between vendors and the central medical store, but the vendors were unable to uphold the maintenance as per schedule.
Calibration due date	80.54	Performed by in house Biomedical staff. Inconsistent maintenance of non-critical equipment.

VI. CONCLUSION

Biomedical services and inventory management in healthcare, particularly within operation theatres have a crucial role. The study evaluates current practices and maintenance processes, emphasizing the importance of a real-time biomedical equipment management system. To enhance current biomedical equipment management practices, it is recommended to improve documentation consistency, particularly in recording installation dates. Streamlining warranty tracking by integrating automated reminders and optimizing preventive maintenance schedules to align with operational priorities can address challenges in adherence.

Enhancing calibration record-keeping and leveraging in-house biomedical expertise for maintenance can contribute to cost reduction. Implementing advanced asset tracking systems, such as RFID or barcoding, can improve inventory accuracy. Integrating automated alerts for preventive maintenance due dates and regularly updating emergency supplies strengthen emergency preparedness. Continuous training and a culture of continuous improvement will further contribute to the overall efficiency and compliance of biomedical equipment management in the healthcare facility.

VII. REFERENCES

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