Hospital Equipment Maintenance Management for Reliable and Effective Health Care Services in Nepal

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Abstract

The management of biomedical engineering instruments accuracy in Nepali hospitals has been a pressing issue, largely attributed to the lack of qualified biomedical engineering operations management teams. This challenge becomes even more complex due to the vast array of biomedical equipment imported from abroad, many of which are not only diverse but also relatively expensive. The primary concern in Nepal is to establish an efficient and competent biomedical equipment accuracy management system that can optimize the precision, longevity, and reliability of these crucial medical devices. The absence of well-organized biomedical engineering operations management teams has far-reaching consequences, as it hinders the healthcare sector's ability to deliver superior and consistent services to patients, ultimately affecting diagnostic accuracy.

To overcome this challenge, it is imperative to develop a well-managed and qualified biomedical engineering operations management workforce in hospitals and healthcare centers. This entails the acquisition of modern skills to effectively oversee, test, calibrate, and validate medical devices, thereby extending the lifespan of these instruments and ensuring consistent and accurate diagnostics for reliable healthcare services. The integration of such skills is essential for elevating the standards of healthcare in Nepal and enhancing the well-being of its population.

Keywords: *biomedical engineering, accuracy management, healthcare services, medical devices, operations management, diagnostic accuracy, healthcare improvement*

Introduction

Biomedical engineering operations management have a significant role in facilitating and promoting better healthcare services in Nepal. It helps to ensure that medical equipment is properly calibrated, maintained, and repaired. It supports to improve the accuracy and reliability of diagnostic and therapeutic procedures, leading to better patient outcomes. By extending the lifespan of medical equipment and reducing the need for costly repairs, biomedical engineering operations management can help to reduce healthcare costs. This make healthcare more accessible and affordable for Nepali patients (Thapa et al., 2022). It helps to improve the efficiency and productivity of healthcare providers by streamlining the process of procuring, installing, maintaining, and repairing medical equipment. It improves the safety of patients and healthcare providers by ensuring that medical equipment is properly operated and maintained. This reduce the risk of accidents and injuries (Aruna et al., 2018).

In the context of Nepal, the management of hospital equipment and biomedical devices takes on a crucial role in enhancing and advancing healthcare services within the country (Thapa et al., 2022). This holds for Nepalese hospitals, nursing homes, pathological laboratories, polyclinics, healthcare centers, diagnostic facilities, as well as in the conduct of research studies across different health sectors. Effective management of biomedical equipment assumes significant importance in this context.

The field of biomedical engineering operations management is instrumental in ensuring the accuracy and reliability of these medical devices. This, in turn, empowers healthcare professionals to operate more efficiently and resourcefully in various healthcare settings. The management of hospital equipment and biomedical devices provides consistent and dependable information, allowing users to deliver better healthcare services, optimize resource utilization (David & Jahnke, 2004) and contribute to advancements in healthcare delivery in Nepal.

Biomedical engineering accuracy management system is developing in Nepal due to rapid increase in number of big hospitals, health care research centers, health diagnostic centers, medical colleges, health research labs and research institutes. Biomedical equipments are on the other hand, imported from abroad (World Health Organization, 2011). In Nepal superior biomedical equipment accuracy management systems are required to deliver reliable and improved health care services, i.e., patient report should be reliable and accurate because doctor is technology dependent and medicine prescribe by doctor is depend upon test report of biomedical equipment so healthcare services are directly related with biomedical equipment accuracy and its proper management (Blair & David, 2002).

There are a number of hospitals, health care centers, health research Institutes, Health polyclinics in Nepal. Biomedical engineering operations management assumes significant role for equipment accuracy management /spare parts management, Biomedical equipment proper testing calibration and validation management as per manufacturer guidelines USFDA guidelines ,WHO guidelines, ISO 17025 testing and calibration/validation of biomedical equipment international guidelines) must be play vital role in preserving and promoting the operational efficiency and useful lifecycle of devices of such biomedical equipment. It helps to reduce operational costs too.

The proposed study therefore, is believed to be very significant for the hospitals, health care centers, health care research institutes, polyclinics, biomedical equipment suppliers, to develop better appreciation and understanding of biomedical equipment accuracy management for unfailing and maximizing work efficiency of biomedical equipment.

Objectives of the Study

The essential objective of this study is the advance assessment of biomedical equipment accuracy management system of hospitals and health care research centers of Nepal. Conversely, the specific objectives of the proposed study are as follows:

- To generate reliable and accurate information about biomedical equipment accuracy management in the contest of Nepal.
- To understand overall biomedical engineering operations management regulations systems of big hospitals (end users) of bio- medical and scientific Instrumentation market of Nepal.
- To analysis the overall effectiveness of biomedical equipment accuracy (Testing, Calibration and Validation of Biomedical Equipment) management system of hospitals and health care systems of Nepal.
- To examine the biomedical equipment accuracy for operations risk management system of users' organizations like hospitals, policlinics research labs, etc.
- To find out the major problems of biomedical equipment Testing, Calibration and Validation for accuracy management and also provide suggestion for effective operations management system of biomedical engineering sector of Nepal.

Methods

The proposed study has followed a basic research design with a descriptive and analytical approach,

primarily based on existing literature reviews. In order to fulfill the objectives of study, both primary and secondary data sources are applied. Primary data is collected directly from healthcare facilities and research centers within Nepal. Information and data related to biomedical equipment are gathered from officially certified distributors operating in Nepal. This included data on equipment specifications, availability, and usage. Valuable information is extracted from publications and reports generated by hospital and research laboratory facilities. These documents provide insights into the performance and management of biomedical equipment. The records and documents maintained by the Biomedical Engineering Operations Management Department. These records may contain valuable historical data, maintenance schedules, and equipment inventories.

Information is gathered from the official websites and publication of relevant organizations, including WHO Nepal, UNDP Nepal, Save The Children Nepal, and JICA Nepal. These sources may provide data, reports, and publications related to healthcare and biomedical equipment management. The combination of primary and secondary data sources ensures a comprehensive and well-rounded approach to gathering information for the proposed study. This approach allows for a thorough analysis of the management of biomedical equipment in the context of Nepal, contributing to a more informed and insightful research study.

Status of Hospital Equipment in Healthcare

The importance of hospital equipment in healthcare cannot be overstated. Hospitals and other healthcare facilities rely on a wide range of equipment and technology to provide high-quality care to patients (Thapa et al., 2022). These tools are essential for diagnosis, treatment, monitoring, and overall patient well-being.

Hospital equipment such as X-ray machines, MRI scanners, ultrasound devices, and laboratory instruments play a vital role in diagnosing various medical conditions. Without these tools, healthcare professionals would have limited abilities to understand the underlying causes of illnesses and injuries. This equipment is essential for delivering treatments, surgeries, and interventions. Surgical tools, anesthesia machines, ventilators, and infusion pumps are just a few examples of equipment that directly impact a patient's well-being during medical procedures (Nepal et al., 2011).

Hospitals use a range of monitoring equipment, such as EKG machines, blood pressure monitors, pulse oximeters, and telemetry units, to continuously assess and track patient vital signs. This helps healthcare providers identify changes in a patient's condition and respond promptly. Sterilization and disinfection equipment are critical for maintaining a safe and hygienic healthcare environment (Topham et al., 2008). Autoclaves, UV sterilizers, and cleaning devices are essential to prevent the spread of infections within healthcare facilities. Equipment like ventilators and extracorporeal membrane oxygenation (ECMO) machines are crucial for patients with severe respiratory or cardiac issues. These devices provide life support and can make the difference between life and death in critical situations.

Hospital beds, wheelchairs, and mobility aids help ensure patients are comfortable and can move safely within the facility (Nepal et al., 2011). This equipment is particularly important for patients with limited mobility. Infusion pumps, syringe drivers, and medication dispensing systems are used to administer precise doses of medications and fluids to patients. Accurate drug delivery is essential for effective treatment and patient safety (Gurung & Gauld, 2016).

Likewise, hospital information systems and electronic health records rely on advanced software and hardware for storing and managing patient data. These systems enable healthcare providers to access patient information quickly, enhancing the quality

and efficiency of care. Hospitals often serve as hubs for medical research and education. Advanced equipment is vital for conducting experiments, clinical trials, and training the next generation of healthcare professionals. In the modern healthcare landscape, technology plays a significant role in enabling telemedicine and remote patient monitoring (Topham et al., 2008). This requires the use of equipment such as telehealth platforms, wearable devices, and remote diagnostic tools to extend healthcare services beyond traditional hospital settings.

The availability and quality of hospital equipment have a direct impact on patient outcomes, safety, and the overall effectiveness of healthcare delivery. Investing in the latest technology and maintaining existing equipment is essential to meet the demands of an evolving healthcare landscape and provide the best possible care to patients. Without proper equipment, healthcare providers would struggle to diagnose, treat, and care for patients effectively, which underscores the vital importance of hospital equipment in healthcare.

Hospital Equipment in Nepal

Nepal is facing numerous challenges in providing quality healthcare to its citizens. Hospital equipment are important in addressing the challenges and improving healthcare services across the country. The paper has explored the equipment availability and accessibility, and the challenges associated with equipment management.

In Nepal, healthcare infrastructure is a complex web of hospitals, clinics, and health posts that serve a diverse population spread across challenging geographical territory. The healthcare system is primarily administered by the government, with a network of public hospitals and health centers (Thapa et al., 2022). Additionally, there are numerous private healthcare providers and non-governmental organizations (NGOs) that contribute to healthcare services (Shah et al., 2015).

The government of Nepal has been making efforts to improve healthcare infrastructure, but significant challenges persist (Topham et al., 2008). Many healthcare facilities, especially those in rural and remote areas, face shortages of trained healthcare personnel and essential medical supplies, including hospital equipment. The distribution of healthcare resources is uneven, with urban centers having more advanced equipment and medical facilities compared to rural regions (Shah et al., 2015).

Equipment Availability and Accessibility in Nepal

Hospital equipment availability and accessibility vary greatly across Nepal. In urban areas and larger city area, well-equipped hospitals with modern diagnostic and treatment tools can be found (Shah et al., 2015). These hospitals are equipped with X-ray machines, ultrasound devices, surgical equipment, and advanced laboratory instruments, enabling them to provide a higher standard of care.

However, in rural and remote areas, the situation is obviously different. Many health centers and smaller hospitals lack access to even basic diagnostic equipment. The scarcity of equipment such as X-ray machines, EKG monitors, and laboratory devices in these areas makes timely and accurate diagnosis challenging. Consequently, patients often have to travel long distances to urban centers for specialized care, causing delays in treatment and increased healthcare costs (Thapa et al., 2022).

In Nepal, the insistent issue of dysfunctional equipment in public hospitals stands as a significant obstacle to accessing healthcare services, resulting in a diminished perception of the health system among the population. A prevailing sense of dissatisfaction has driven an increased reliance on private healthcare facilities, even among those with limited financial means (Gurung & Gauld, 2016). When new equipment is initially provided, suppliers typically offer a one-year warranty for repair services. However, once this warranty period

expires, a combination of factors, including a dearth of reliable data on hospital equipment, financial constraints, and a lack of robust technical expertise in biomedical engineering within the Ministry of Health and Population, leads to infrequent servicing and repair of hospital equipment.

Between 2011 and 2014, Nepal, with support from KfW as part of the Nepal Sector Programme for Health and Family Planning, the Ministry of Health and Population undertook an innovative approach to address the corrective and preventive maintenance of medical equipment. This initiative was initially implemented in the Mid-West and Far-West regions, encompassing 24 out 77 districts of Nepal. Notably, this effort covered all district-level facilities, as well as zonal, sub-regional, and regional hospitals (Gurung & Gauld, 2016).

The pilot program introduced a novel public-private partnership model for the preventive maintenance and repair of a specific range of complex medical equipment. This involved contracting private engineering teams established within each region. Additionally, a software solution known as PLAMAHS (Planning and Management Assets in Health Services) was introduced and customized to meet Nepal's unique requirements. PLAMAHS enabled the Ministry to effectively manage equipment inventories, maintain an up-to-date centralized record of all serviced and repaired equipment, and automatically generate invoices for the ministry to remunerate contractors for their maintenance services.

The three-year pilot program, conducted with the support of KfW, achieved a remarkable enhancement in equipment functionality, increasing it from an initial 64% to an impressive 99%. In July 2015, recognizing the success of this initiative, the Ministry of Health and Population made the decision to expand and implement this approach nationwide, with technical cooperation provided by KfW. A similar outsourcing model was adopted for the national-scale program, and the selected maintenance contractors began their fieldwork in 2017, deploying a total of 60 qualified engineers and technicians stationed across eight strategically located workshops (Topham et al., 2008). This digital tool empowers engineers to access essential data and input information regarding equipment status and any repairs conducted while in the field. This web-based version is open-source and follows a standard data structure, enabling the exchange and sharing of information with other digital applications. This contributes significantly to the interoperability of Nepal's digital health system. Remarkably, after the first six months of implementation, the results are promising, showcasing an improvement in equipment functionality to over 90%. It's worth noting that although the four-year nationwide program is still in its early stages, the outcomes thus far are highly encouraging.

Challenges in Equipment Management in Nepal

The management of hospital equipment has limited healthcare budget in Nepal raise a significant barrier to acquiring and maintaining modern medical equipment. Public healthcare facilities often struggle to secure the funds required for purchasing, maintaining, and upgrading equipment (Lenel et al., 2005). The diverse topography presents a logistical difficult for equipment distribution. Transportation of medical equipment to remote areas is expensive and challenging, resulting in uneven distribution and accessibility issues.

Many healthcare facilities in Nepal face difficulties in maintaining and servicing their equipment due to a lack of skilled technicians (Topham et al., 2008). Additionally, training healthcare personnel in the proper use of equipment is essential to ensure its effectiveness. Ensuring the quality and safety of medical equipment is crucial, but Nepal faces challenges in implementing stringent regulatory standards. This has led to issues related to the authenticity and effectiveness of equipment.

Nepal receives donations and aid from international organizations and governments, contributing to the availability of equipment in some healthcare facilities. However, the coordination and distribution of donated equipment can sometimes be inefficient, leading to mismatches between what is needed and what is provided (Thapa et al., 2022).

While there have been improvements in recent years, ensuring equitable access to modern and well-maintained equipment across the country remains a significant challenge. Addressing these challenges in equipment management is essential to improving healthcare services, reducing healthcare disparities, and enhancing the overall health and well-being of Nepali diverse population (Topham et al., 2008). The government, in collaboration with international partners and NGOs, must work towards sustainable solutions to bridge the equipment gap in healthcare and ensure better health outcomes for all Nepali citizens.

Summary and Conclusions

This paper has raised awareness regarding the biomedical engineering operations equipment accuracy management system in Nepal. The multifaceted nature of the biomedical engineering operations management system, spanning various levels including hospital biomedical engineering departments, hospital laboratories, equipment suppliers, authorized distributors of biomedical equipment for Nepal, hospital biomedical engineers, and end-users, has been comprehensively examined.

By the conclusion of this paper, a clearer and more insightful understanding of what can and should be done to enhance the current situation has emerged. The study has detailed and constructive roadmap for improvements can be envisioned. This paper has illuminated the strengths of the biomedical equipment operational efficiency, especially concerning the equipment accuracy management system. The findings underscore the areas where the system performs well, providing valuable insights into best practices and areas of excellence. This paper has also exposed the problems and shortcomings that currently exist within the biomedical engineering operations management system. In doing so, it paves the way for recommended corrective measures that can address these challenges effectively. This paper provides a foundation upon which healthcare authorities, biomedical engineers, and stakeholders can build, working collaboratively to fortify the strengths and overcome the weaknesses in Nepali biomedical equipment accuracy management system.

ket dynamics for investment decisions. Therefore, the relationship between returns and trade volume has been studied over the past few years. An efficient stock market must provide up-to-date and accurate data on past transactions, liquidity, minimal transaction costs, and stock prices that promptly respond to all available information.

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