



The Role of Medical Equipment in Emergency Departments and Hospitals

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Abstract

1. Introduction

Medical equipment, as defined in the medical equipment and supplies specification guide document, is any machine or instrument that is used for diagnostic or therapeutic purposes and is generally not intended to be disposable. The procurement of medical equipment in hospitals should be in accordance with the overall company's procurement policies and procedures. Each department in the hospitals should assess their equipment procurement needs and fill out a medical equipment and supplies requisition form. The department would then submit this form, along with comparative and competitive quotations, to the procurement department.

Countries like the Saudi Arabia and United States of America and Canada have implemented a Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) and when hospitals reach a certain size, they require the hospitals to accumulate an individual database for all equipment. Generally, medical equipment plays a vital role in the diagnosis, treatment, and medical education of every healthcare institution. Purchasing medical equipment necessarily requires guidelines, standards, and plans. Nevertheless, a study showed that many medical equipment management systems were not adequate to maintain the current efficiency of medical equipment. These shortcomings were determined to be more considerable in educational hospitals than other types of hospitals. A proper management system should be designed immediately and the contribution of medical staff and personnel in trying to make the system and training are vital.



methods

A questionnaire, consisting of open and closed questions based on the objectives and the domains of safety, effectiveness, serviceability, reparability and manageability, as well as a checklist for evaluating management practices, were prepared and distributed among hospital experts. A checklist to evaluate the current systems of medical equipment management was also prepared for filling by the heads of the relevant units. These questionnaires and checklists were finalized through a preliminary study and interviewing a dozen experts in the fields of medical equipment management and hospital management. The reliability of the questionnaire through the intra-class correlation coefficient was confirmed by expert judgment.

conclusion

In general, due to the lack of a precise and consistent plan regarding the management of medical equipment in hospitals, there will be waste of material and capital equipment, thus causing failure in some cases. In this regard, the lack of a planning and control system for inventory, purchasing and maintenance of medical equipment leads to problems such as unplanned accumulation and depreciation of equipment or shortcomings of various equipment and facilities in critical situations, for example, in the recent outbreak of some diseases or pandemics (Ghasemi et al., 2022). Therefore, it is recommended that a comprehensive condition to replace the equipment of hospitals and emergency departments in critical situations (natural disasters, wars, earthquakes, pandemics, etc.) according to the type of equipment and its cost and its vital condition be developed. Moreover, the existence of programs to regularly check the safety of equipment in various aspects including design, fabrication, installation, operation and maintenance of medical equipment in hospitals and emergency departments helps hospitals in planning and maintaining proper and standard medical equipment in a way that hospitals have more resilient organizations with a higher tolerance against sudden or adverse events. Regarding the patterns of utilization of medical equipment, on average, the utilization coefficient of medical equipment in the study hospitals was low as compared to other study findings. Specifically, 2 out of the 5 pieces of medical equipment were under-utilized. Doctors' and nurses' shortages in the hospital, regular unavailability and frequent breakdown of equipment, equipment receiving form, absence of trained staff to operate the medical equipment, performing preventive maintenance, availability of adequate spare parts and accessories, and absence of support from upper hospital managers were found to hinder the proper utilization of medical equipment (Tesfaye Geta et al., 2023). Hence, every hospital should develop an appropriate strategic



framework along with a management plan to manage and utilize the available medical diagnostic equipment based on its level and demand.

2. Overview of Medical Equipment

In today's advanced medical society, medical equipment plays an important and instrumental role in the health of the community. Medical equipment is the main structure in the correct diagnosis, effective treatment, and appropriate medical education. As a rule, the activity of health care providers in these centers is based on the equipment, and for this reason, the equipment makes sense and a major share of annual hospital costs is allocated to its purchase. The cost of medical equipment is one of the most important and unavoidable costs for the effective delivery of health care services. Proper selection and allocation of medical equipment should be appropriate and in line with the actual needs of the medical centers, clinical goals, human resources, and the conditions required to ensure the safety and effectiveness of medical procedures. On the other hand, improper procurement of this equipment causes dangerous events, injuries, and harm to patients (Ghasemi et al., 2022).

Medical equipment is defined as all the devices, apparatus, instruments, and other types of rescuer supplies used in hospitals to display some functions, the performance of which requires complete knowledge and its use involves art and skill. Efforts in this regard improve the diagnosis process and begin the treatment process, or create the conditions for the treatment process in the relevant wards. Medical facilities and equipment consist of devices, tools, machines, and other devices that generally increase based on the need and care issues. Therefore, in most cases, patient planning is performed or limited service is provided based on the availability of and applying medical equipment to provide medical services. When absent, obtaining service may not be possible.

3. Types of Medical Equipment

Most hospitals deal with several types of medical equipment covering various therapeutic and diagnostic categories throughout their departments. The running of patient care departments occurs through examination, diagnosis, monitoring, therapy, and daily care of patients through the equipment and tools that have been purchased to evaluate physical health and obtain biological information of the patients, control (reduce) illness and modify patient's environmental conditions. All these tools and equipment are often referred to as medical equipment. Medical equipment plays an important role in hospitals addressing patient's ailments. Patients are made up of various physiological systems. By



using medical equipment, the physiological signs of these systems are obtained directly or indirectly, and based on that, the condition and ailment of the patient are diagnosed. The majority of these medical equipment are expensive, and acquisition, usage, storage and maintenance are costly and require expertise (Ghasemi et al., 2022).

Principally, in hospitals, two expert and major groups are involved in issuance of medical equipment procurement requests throughout all departments: End-user groups and suppliers. End-User groups include Clinical Engineering, Laboratories, Departments of Nursing, Determining Hospitals' Equipment Needs, Radiology or Radiotherapy, Pathology, Anesthesia, Conference Hall, Health and Safety and Upkeep, Library and Information Basis, Improvement of In-patient and Non-Patient Wards, Medical Importation, Electronics, Wake or Recovery Rooms (ICU), renal diseases, STM and Sterilization, CCS, and CCH. Two major groups are primarily involved throughout hospitals. The first major group is the Procurement Unit in the Department of Health Economy. It deals with procurement matters for the whole hospitals. The other group is the central accounts unit in the Drug, Supplies, and Food Directorate with responsibilities as regarding suppliers' tactics of firms offering medical equipment. There is an utter division of labor between the two groups.

3.1. Diagnostic Equipment

Over the last few decades there has been a huge use of medical equipment in hospitals around the world. Any medical equipment that produces a signal or image that may help a doctor to make a diagnosis is considered diagnostic equipment. Radiological equipment: X-rays, CT-scanners, MRIs, Nuclear medicine scanners, Ultrasonic diagnostics (echocardiographic and other) such other specific diagnostic equipment, general pathological diagnostic equipment, and radiation dose meters are included under this category.

Actually it is difficult to imagine modern medicine without the use of medical equipment. The accurate and timely diagnosis of a disease of a patient is the most important component in the therapeutic scheme. Death dilemma of a patient's life mostly lies on the dedicative and expert opinion of a physician. Although important notes and symptoms observed by a physician hold quantifiable weight of a diagnosis, but this type of diagnosis is only tentative. Conclusive or valid diagnosis needs quantitative data assessing various aspects of patient's physiology and bio-chemistry. The various medical equipment available at hospitals are used to carry out various diagnostic tests on patients



to take a holistic assessment of the diseased condition. The successful therapeutics of a disease depend on diagnosis and thus testing is the important first step in a care plan. The tests thus carried out are not only important for diagnosis of the diseases but also are vital for monitoring disease progress, to choose and determine the efficacy of a therapeutic measure, to provide information about safety limits of further treatment, and for preventive care as well. Thus the rail-roofing and continued use of medical equipment is absolutely required for a well-functioning health instantiation. The starting phase of the equipment allocation program in a new hospital is more difficult. Existing hospitals wishing to extend their activities and hence want to increase the comfort. Hospitals, where the equipment is defective or the utilization time is up and the equipment is to refit, need equipment management.

3.2. Therapeutic Equipment

Therapeutic equipment is employed to treat patients suffering from traumatic injuries or illnesses. Medical staff include respiratory therapists, physical therapists, speech therapists, and pharmacists. Therapeutic life-support equipment includes ventilators, knitted mesh pressure bandages, oxygen delivery devices, crutches, and assistive wheelchairs. Examples of other therapeutic equipment include drain systems, infusion pumps, feeding tubes, and syringe pumps.

Therapeutic equipment may also be used to improve general health and well-being. In this context, medical equipment refers to any piece of apparatus that is used for the purpose of guaranteeing patient health and safety, apart from disposable products that are meant for single use only. The non-disposable medical equipment is tested and validated by the manufacturer and must be effectively maintained and periodically serviced by qualified personnel, such as bioengineers, in compliance with current laws and regulations.

The malfunctioning of the medical equipment is, therefore, a great social threat because many people depend on this equipment for their safety and comfort, namely in a hospital environment. Assuring the proper function of the therapeutic equipment is an important goal to pursue in medical institutions. In hospitals, medical equipment operates in a dynamic and complex environment. Devices of many different kinds, from a multitude of manufacturers, may interact and be supervised through decentralized networks. The use of medical equipment monitoring systems may help in the intelligent automation of these complex and safety-critical operations.



3.3. Monitoring Equipment

In emergency medicine, many patients visiting an emergency department (ED) are in reduced general condition of health. However, they are waiting for treatment in large areas where no monitoring equipment is present. With the aim of detecting clinical deteriorations of the patients, an experimental setup with monitoring devices providing vital signs via short-range radio (SRR) that can be used in a waiting area was tested. Twelve patients were monitored at the waiting area of an ED. Monitoring devices were attached to the patients. The monitoring devices transmitted a real-time time-stamped packet each time one of the vital signs was sampled and transmitted to the display unit (Hubner et al., 2015). Increases in mean arterial pressure of greater than 15 mmHg were defined as alarming changes that must be reported to the nurse. Sensitivity, specificity, and clinical feasibility of the system was evaluated. After a median monitoring period of 178 min per patient, 684 h of vital sign data were collected. When comparing vital sign data with the nurse's admission assessment, significant differences in the respiratory rate and noninvasive blood pressure courses were shown. All patients had to fill out a questionnaire about their acceptance of the monitoring system. Overall, the acceptance by the patients was rated very good. A new monitoring system that transmits vital signs via short-range radio to a phone-size display unit was tested at the waiting area of an ED. It proved to be feasible and safe. It could detect clinically relevant changes in vital signs and was well accepted by the patients.

3.4. Surgical Instruments

Surgical instruments are fundamental equipment in surgical departments. They aid in diagnosis and physical examination, surgery, and recovery. Surgical instruments should be made of stainless steel with specific alloys such as chromium, nickel, and molybdenum. Appropriate alloys are essential for obtaining desirable properties. The crucible powder method is the most commonly used. Ferro alloys and stainless steel composition and fabrication largely determine the properties of instruments. Surgical instruments are used in operating theatres, intensive care units, endoscopic examination rooms, and outpatient departments. Biomedical waste management should be designed and operated to minimize risks to personnel, patients, the public, and the environment (E. George et al., 2024).

Surgical instruments are used in many hospitals and healthcare centers. Health workers face potential exposure to harmful agents that can cause diseases. Problems at any point in the cycle may lead to the spread of infections among health workers and patients.



Improper handling or malfunction of surgical instruments can also harm health workers and patients. Because of the health risk associated with surgical instruments, this study is intended to explain the challenges and solutions in the cleaning, disinfection, and sterilization of surgical instruments.

Access to surgical instruments is one of the key challenges in developing countries. Poor investment, lack of sterilization facilities, and shortages of trained staff in the sterilization chamber often lead to improper disinfection or a total lack of disinfection. Surgical instruments undergo various stages before and after a surgical procedure. Failure in any step may lead to potential risks, injury, or the spread of communicable diseases. Continuous exposure of surgical instruments to different corrosive agents also leads to potential impacts on composition.

3.5. Support Equipment

Non-essential devices that aid in the overall processes of medical care are classified as support equipment. These devices are responsible for assisting in everyday medical procedures, which, while not directly offering treatment or diagnosis, are essential components of patient care. Different types of procedures require specific support equipment. An example of ancillary equipment used in minor procedures is the medical cart. Medical carts are mobile carts that are utilized in various medical settings, including hospitals, nursing homes, and private practices. At a minimum, they contain drawers or shelves and a work space, but many are customized with features to accommodate specific uses or medical specialties. These carts are sometimes called clinical desks, treatment carts, medication carts, nurses' carts, medical supply carts, exam carts, or other terms depending on their use. The most common type of medical cart is the emergency crash cart, which is typically used in hospital settings and frequently kept on hand in emergency departments, intensive care units, and operating rooms. In surgery, there are two types of anesthesia carts: general anesthesia carts and IV sedation carts. General anesthesia carts are specialized medical carts used for administering anesthesia in operating rooms. IV sedation carts are used for administering intravenous sedation in emergency rooms, imaging centers, and surgeries that are not necessarily performed in operating rooms. Both types of anesthesia carts are stocked with lifesaving supplies and medications that are necessary to safely perform anesthesia on a patient. Anesthesia machines are also often attached to or included with these carts. Another commonly required support equipment in an emergency department is an instrument sterilizer. An instrument sterilizer is a machine designed to sterilize surgical instruments. After an



instrument is used and before another patient is treated with the same instrument, it has to be sterilized. The sterilizer uses high-pressure steam to destroy pathogens; the temperature and pressure must be sufficient to reach the cores of all items placed in it. It is normally used for cleaning surgical instruments and supplies and for preparing the instruments, materials, and equipment for surgeries.

4. Importance of Medical Equipment in Emergency Departments

Medical equipment is a centerpiece of healthcare service delivery systems in hospitals and health centres. It is an essential input in the provision of medical diagnosis, prevention, and treatment of disease or health problems. Availability, effectiveness, and proper use of medical equipment has a significant impact on the provision of high-quality diagnostic services and quality management of patients in a clinical setting. Adequate provision and optimal utilization of medical equipment in health institutions leads to improved hospital performance in terms of efficiency of patient handling, quality of care given, and patient satisfaction. In health service delivery systems medical equipment is any device used in the prevention, diagnosis, and treatment of disease or any health problem (Tsfaye Geta et al., 2023). It can range from simple, single-purpose, and cost-effective equipment to highly complex, advanced, and costly equipment. Nearly all hospitals, health centres, and other health facilities require some range of medical equipment for basic health care services. In many developing countries, despite the increasing pressure for improvement in the quantity and quality of health services, health professionals are poorly aware and unequipped with necessary medical devices and equipment to work. Without advanced medical medicals, it becomes impossible to prevent disease, make accurate diagnosis, and provide proper treatment (Ghasemi et al., 2022). Medical equipment provides healthcare providers with tools to accomplish the aims and objectives of a health delivery system. However, without properly structured management medical equipment increases the costs of health care delivery. World health resource inventories indicate that most medical establishments use widely diversified types of devices with a notable number of simple equipment. In least developed countries, however, more than 50% of medical equipment are inoperable or not maintained. Consideration of efficiency of medical equipment utilization is oftentimes ignored and overlooked in pursuit of greater levels of return towards output and diagnostic standards. Particularly, inadequate operating medical equipment has a heavy toll on the delivery of health care services ideally intended in their establishment within resource scarce and less developed settings. A third of medical devices in low resource hospitals remain not in use due to variability of broken down condition. In Ethiopia, more



than 40% of medical equipment is malfunctioning all the time, greatly obstructing competent provision of quality health care. It demands an urgent approach to evaluate the effective use of medical equipment in public hospitals.

4.1. Triage and Assessment

When a patient presents to an emergency department (ED), a triage nurse must efficiently assess the patient to determine urgency and priority for assessment and treatment. This incorporates consideration of the acuity of the presenting condition as well as assessment of the medical, ethical, and legal appropriateness of the patient's care needs in the ED setting. Triage nurses must often synthesise an assessment of the patient across many elements from a broad range of potential medical and behavioural complaints and conditions and assign an urgency rating that categorises patients into one of several groups and communicates these results to multiple other ED staff members (Pusic et al., 2007).

The ability of clinical staff to adequately assess new patients and provide them treatment early in their ED visit is essential for the triage process. Patients who have a lower acuity presenting complaint are less likely to require further medical intervention and treatment by the ED staff and are therefore assigned a lower urgency category and a longer wait time to treatment. Conversely, patients who are assessed as needing treatment urgently or immediately receive priority access to assessment and treatment by ED clinical staff. Initial assessment of a patient across many different medical conditions using minimal time and contact with the patient is a difficult process. A rapid assessment of these elements must be broad in scope to facilitate the adequate triaging of patients into the full range of possible triage outcomes.

Conventional triage assessment in South Australian EDs is a manual process requiring an assessment scale with a minimum of five observation components. This scale is complex due to presentation and patient-complemented variables, requiring a cohort of trained staff to conduct assessments. Many assessment variables introduce subjectivity into the triage process (Polley et al., 2022). The current triage solutions are unable to cope with the increasing number of patients presenting to EDs throughout Australia.

4.2. Life-Saving Interventions

Acute medical emergencies are characterized by acuteness, seriousness, and affected patients. In an emergency situation, a doctor must evaluate the physiological condition of the patient quickly and then conduct appropriate procedures. Intervention procedures



should be performed more rapidly than conventional ones. So, dedicated new medical equipment must be developed for emergency treatment. These include simple, easy-to-use devices for which devices must be made to comply with the criteria for use. The monitoring and intervention systems can be modified and downsized to be mounted on an ambulance. (H. Mayo et al., 2022) Life-saving medical equipment is one of the most crucial elements in hospital emergency departments and is prone to faulty use, incorrect use, and improper maintenance. Furthermore, in most cases, the devices are not accessible when needed. To focus attention on these concerns and raise awareness so that measures can be taken, a list of essential life-saving medical equipment is proposed. After 12 years of clinical experience in a hospital emergency department, the life-saving medical equipment is divided into five categories based on the level of application. The main devices for hospitals and health centers to prioritize in acquiring and maintaining are presented. (Carpenter & Glenn, 2013) If medical equipment is to be extensively used in hospitals, it must be permanently located and made accessible in the emergency room. Furthermore, the equipment must not be only life-saving but must also be usable. That is, the design must comply with the criteria for good use, including innovative operation, simplicity, timing of execution, limited power, feel, knowledge, friendliness, and unexpected evaluations.

4.3. Patient Stabilization

For effective diagnosis and treatment of illnesses, patients must be physically stabilized before operations. In the emergency unit of a hospital, the physician must determine and activate the patient's condition for the purpose of stabilization including obtaining a brief history of events, use of rapid assessment tools to classify the severity of illness, and useful use of prompt interventions as dictated by the assessment for effective stabilization (Michael et al., 2021). Operationally available medical equipment is vital in emergency departments and hospitals for smooth handling and use in stabilization of patients. National standards have been set for effective management controls of medical equipment devices in Critical Care and Transfer teams. These standards are vital, attainable and sustainable for the handling and use of the equipment available in the emergency departments and hospitals. There has been a lack of proper management of this medical equipment especially in emergency departments leading to chaos at the time of managing patients' health. This has not only led to duplicated efforts of staff and loss of valuable time but adverse outcomes for the patient's health as well (Mark Hunter et al., 2022). Provision of medical equipment is a very key independent variable that involves putting together provisions made for medical equipment. This provides a consistent



means of initial resource availability. Current solutions include checking equipment and requesting emergency supplies of equipment. Use of digital solutions with a standardised framework improves provision of emergency equipment. Use of standard documentation and reporting processes improves standardisation & accountability of team roles and specialisation of roles leads to efficiency improvements in the provision of emergency equipment in emergency departments. It is worth noting that provision of medical equipment is an interdependent variable and should be handled regularly to ensure smooth management of medical or equipment safety in hospitals. Proper management of equipment provision will ensure effectiveness of medical care laws especially in emergency departments of hospitals where time is of great essence.

5. Role of Technology in Medical Equipment

As a quality guarantee for hospital diagnosis and treatment, medical equipment is also a basic condition for teaching, medical treatment, prevention, and scientific research. Medical equipment, as a guarantee of economic and social benefits, can be realized by medical institutions. With the rapid development of the medical industry, the current medical equipment is more advanced and diversified, and the types and quantities of medical equipment in major hospitals are also increasing. However, the lack of scientificity in the purchase of equipment, the inability to effectively monitor the use of equipment, and the lack of equipment safety management in the management have a great impact on the improvement of the medical level of the hospital. In order to improve the management level of medical equipment, hospitals need to make full use of modern Internet of Things technology, give play to the value of the Internet of Things technology, and achieve the effect of intelligent equipment management (Ren & Wu, 2022). The medical center focuses on keeping equipment current. The ER receives significant attention in strategic management meetings due to the majority of patient arrivals. Covenant places an emphasis on strategic management and should ensure it has an information systems strategic plan to define the direction of information technology in the ETTC. Processing of anatomical images such as x-rays is being performed in emergency rooms to aide patient diagnosis and treatment. The medical center should consider acquiring a pan digital imaging machine to equip ER physician offices to review x-rays in the physician offices instead of making patient wait longer in ER. This would improve patient treatment quality and increase satisfaction level (Seavey, 1998). Point-of-care technology (POC) allows the medical staff to bring the technology to the patient instead of bringing the patient to the laboratory; thus enhancing documentation and access to electronic medical records. POC device will protect patient privacy and



confidentiality. With a hand-held lap-top with bar code technology, POC devices save time by being able to scan a medications bar code before administration instead of manually entering the medication into an order. POC technology also helps to ensure that the right medications are being given to the right patients at the right dosage. The literature indicates that many hospitals are looking to implement POC device technology. Covenant realizes how important IT is. Each year Covenant spends \$3.7 million on IT. With the move to digitalized systems, this amount is expected to grow tremendously as expenses for additional IT staff, software and hardware increases. This burden is expected to be eventually compensated by reduced costs as productivity from adequate technology increases.

5.1. Advancements in Imaging Technology

Advancements in imaging technology have contributed significantly to medical equipment. The aim of this research is to highlight the advancements in medical imaging in recent days. The diagnosis and treatment of various diseases related to various organs of the human body have been performed faster and easier with the help of medical imaging. The time-consuming and risky open surgeries have been reduced due to the newly invented medical imaging modalities. The medical imaging modalities being used today in health care are X-ray, CT, MRI, Nuclear Imaging, Ultrasound, EIT, etc. There are also many other imaging modalities that have not yet been routinely used in health care (K. M Shadekul Islam et al., 2023). Over time, extensive research has been conducted on medical imaging, as a result of which the medical imaging modalities have undergone tremendous advancement. These technological developments helped to view the anatomy of the human body even more accurately. Not only the anatomical images, but also the quantitative analysis of various physiological parameters has been developed to help diagnose various diseases. This chapter highlights the expansion and importance of the most commonly used clinical medical imaging modalities in the present context. Some of the imaging modalities that are device or technology based have been excluded since those are not imaging modalities. The limitations, suggestions for improvement, and concluding implications have also been described. The continuous pursuit of new medical imaging techniques helps the doctors view and study the anatomy and physiology of patients. Newer machines and add-on hardware are being introduced day by day to upgrade the existing modalities to improve quality. Such technique and device increase and enhance the quality of medical imaging. New techniques in existing imaging modalities help to treat patients rightly. The cost of the high-end examination and treatment is one of the ultimate barriers to patients desiring to relieve from pain and risk.



In this study, some commonly used medical imaging equipment and the techniques are reviewed according to the innovative and upgraded outcome. Advances in imaging technology have revolutionized the field of medical imaging. This paper presents the recent advancements in optical imaging and associated technologies for biomedical applications. Following the discussion of the cornerstone of medical imaging, a comprehensive overview of recent advancements in optical imaging is presented. Also presented is the advance technology associated with optical imaging. Furthermore, various future recommendations are discussed to advance optical medical imaging technology.

5.2. Telemedicine and Remote Monitoring

Telemedicine facilitates remote management of logistic, monitoring, and treatment tasks. It is potentially a valuable development, which would be welcome especially in mass gatherings and disasters. Systems are being developed that would enable emergency medical services to tag and physiologically monitor large numbers of patients at a remote site, providing first responders and disaster command centres with medical data to track and monitor condition. Telemedicine is the use of telecommunication technologies, which allow distant healthcare providers to receive, transmit, and analyze video, audio, and diagnostic data relevant to medical care. The use of telemedicine in ambulances has principally focused on patients suspected of suffering a myocardial infarction, where real-time transfer of electrocardiogram (ECG) data from the ambulance crew to a designated hospital is used for decision-making on whether to initiate pre-hospital thrombolysis or to redirect the patient to a center for primary angioplasty. (Nangalia et al., 2010) This reduces by 20-30 minutes the time to drug administration or balloon inflation – time which would otherwise be taken if the hospital were unaware of the patient's arrival. Using portable equipment, a range of other parameters have also been transmitted, including non-invasive blood pressure, arterial oxygen saturation, blood glucose concentration, and body temperature.

Telemonitoring is pertinent in critical care areas and general wards. In the USA, VISICU has implemented remote ICU programmes, whereby intensivists provide supplemental monitoring and management of ICU patients at off-site facilities through a centralized telemedicine control room. Vital signs, bedside monitor data, lab results, and treatment charts are available to the eICU staff, who also access physician note- and order-writing applications. Whenever thresholds are approached or exceeded, intervener log-on and nurse alerting sessions are automatically initiated. In a pilot study, the group of 31



hospitals with eICU support was compared with 212 similar hospitals that did not yet have this system, with regards to mortality, number of ventilator days, length of stay in the ICU, and other potentially relevant factors, and it was estimated that patients in the eICU group saved on average 18.2% of the outcome-adjusted number of deaths, 47.0% of the number of ventilator days, and 29.5% of the length of stay.

6. Maintenance and Management of Medical Equipment

WHO and ISO recommend organizing committees of medical equipment management in hospitals (Ghasemi et al., 2022). After the establishment of the medical equipment management committee, policies regarding the management cycle should be compiled. The policies should include all aspects of the management cycle: policies regarding selection, purchasing, acceptance, and discarding of all medical equipment in hospitals, policies regarding training of all end-users, policies regarding the establishment of a consulting group to agree on the acquisition of purchase requirements, policies regarding the training of all users on how to use equipment safely and properly, policies regarding ensuring that purchase policies include safety, quality, and performance, policies regarding clear guidelines for manufacturers of medical equipment concerning how equipment should be stored, used, maintained, and cleaned, policies regarding ensuring the availability of performance and service manuals and providing end-users with training similar to that of the manufacturer's educational program.

Drafting equipment management policy is not limited to the issues listed above. There are many other issues to consider. Considerable effort should be made to draft comprehensive guidelines and have them approved by experienced members of the medical engineering department. Good and clear guidelines are vital for the effective use of medical equipment. Organization's policies are good references for drafting equipment management policy. The manufacturer's instructions should be considered as the minimum and supplementary training on their operation should be prepared. The minimum information that should be transmitted to end-users is the storage conditions, use, maintenance, and cleaning of the equipment. Maintenance records and other information useful for technicians must also be transmitted to them. Performance and service manuals that contain information on how to maintain the equipment and troubleshoot problems must be available to engineers. The operation manual is also vital for users to avoid misoperation which leads to equipment damage or injury to patient/user. Unfortunately, performance and service manuals are not always available. The medical equipment engineering department must directly communicate



manufacturers and suppliers to receive the performance manuals and consequently receive the service manual.

7. Challenges in Medical Equipment Usage

Despite the wide variety of medical equipment utilized in Ethiopian hospitals, the volume of equipment managed was found to be inadequate in facilities other than educational facilities (Ghasemi et al., 2022). This demonstrated the urgent need for improvement in this area. Unfortunately, a large portion of the deficiencies, such as the incompleteness of the policy for decommissioning equipment, the lack of implementation of managing the use of equipment, and a lack of training for users, were not only emphasized but also acknowledged as work-undertaking areas decided to prioritize corrective actions. Moreover, instructional documentation was lacking, affecting the safety and performance of health care equipment. The weaknesses in this area, including the need for centralization of acquiring equipment, not monitoring the health of complex equipment, and redundancy in purchasing and providing, need to be addressed. Establishing such a collaborative working environment with personnel from IT, finance, and supply management departments would greatly benefit the hospitals. Furthermore, it is apparent that management of the tissue processing unit was overlooked. While this may be due to the relatively low level of maintenance difficulty compared to other systems, the eradication of maintenance issues and the subsequent return to full operational state furthers point to a historical lack of feasibility for decommissioning.

Several challenges and implementation issues can be identified. The development and implementation of performance requirements and monitoring of performance can use much of the effort, knowledge, and experience that hospitals already have. Large investments have been added to the hospitals' human resources and competence in economic methods for considering the cost of ownership of medical equipment. Thus, an economic-based approach for establishing some of the performance requirements may not only be attainable but have great potential (Tesfaye Geta et al., 2023). Perhaps a greater challenge lies in changing the culture of the central procurement process with respect to the required time and consistency in meeting criteria for a submitted offer. Approaches and knowledge originated to manage medical equipment can be beneficial in this context.



8. Case Studies

The provision of emergency equipment relies upon processes that are often opaque and inefficient. At present, standardised government oversight and regulation of emergency equipment provision does not exist and the legality of any devices or equipment that are placed within an emergency bag is uncertain. Government regulation of emergency equipment would massively improve the effectiveness of emergency personnel within Metropolitan and Urban regions. If every building fitted with a defibrillator had to adhere to certain guidelines upon installation (i.e. equipment that conform to OEM standards should be fitted) standards would be considerably raised. With increased reporting and enforcement for equipment provision it is possible to imagine far fewer deceased prior to ambulance arrival, however improved standards would likely go hand in hand with accessibility issues and increased inequity service favours for wealthier constituents (Mark Hunter et al., 2022). All systems have frequent interoperability problems; either due to software compatibility, operators come into unfamiliar situations, inappropriate design decisions, or some combination of the above. Sadly, para-public services are often poorly funded and there exists little legislative oversight and accountability for why things fail most often. The new systems proposed—notional solutions to old problems—could render emergency equipment provision significantly improved but significant debate and discussion must first be held regarding how realistic and desirable it is to augment human abilities at the expense of their own decision making and freedom (James Hansen, 2018). The emerging determination is that with the efficacious implementation of suitable hardware/software known QR codes, 2-D barcodes, Android/iOS devices, open source systems capable of being run through low access personal computers and PHP/MySQL the reliability of emergency bags will be utterly improved and invaluable lives saved.

8.1. Successful Implementation of New Equipment

Medical equipment is a vital tool in the emergency department to deal with a wide variety of problems. The following is a list of common equipment used: airway equipment, for maintaining and clearing the airways; intravenous access equipment, for providing intravenous fluids and medications; monitoring equipment, for continuous monitoring of patients; medication; and other uncommon equipment (Mark Hunter et al., 2022).

In many hospitals, entry into the emergency department is restricted and locked. This is to ensure patient safety and maintain secure Health Information Portability and Accountability Act protection for patients. It can be stressful waiting for an emergency to



happen and dealing with equipment in an unfamiliar setting. Pre-planning, visual observation aids, and the attendance of a ward nurse can help with establishing and using an unfamiliar system. More information like ward-specific equipment location or guidelines can help. Induction checklist can be developed and be used to ensure that all the essential areas have been checked and that keys have been obtained and demonstrated. This is especially important when training staff new to the hospital or emergency department (Sewberath Misser et al., 2018).

Each month equipment checking instructions, using checklists, should be sent to ward charge nurses. A memorandum should accompany it, highlighting issues found from the previous month's checks. Feedback is important so nurses perceive the assignment positively. Results of checking should also be documented in the directory. Equipment should be checked regularly and the expected checking rate set at 100% or a risk-free basis.

8.2. Impact of Equipment on Patient Outcomes

The quality of diagnostic services in the medical field is substantially affected by the use of medical equipment (ME). Medical equipment is an important component in healthcare facilities worldwide. The effective use of ME in the health sector can affect the quality of diagnostic services. Proper utilization of ME could lead to optimum patient handling, quality of care, and patient satisfaction in the health sector. ME is defined as any instrument, apparatus, implement, machine, or device used in the diagnosis, prevention, monitoring, treatment of a disease or disability; or in the study of the anatomy or of a physiological process (Tesfaye Geta et al., 2023). Simple medical equipment includes a thermometer, scales, stethoscopes, etc. These types of equipment are required in small amounts in health institutions. Diagnostic units require ME ranging from the simple to the advanced. CT, X-ray, and MRI are examples of advanced medical equipment required in medium to large hospitals. Many healthcare professionals rely heavily on medical equipment in their day-to-day activities. It gives the healthcare professionals the ability to carry out their tasks correctly and successfully. However, healthcare facilities are unaware of the required type and amount of ME for their activities. This could lead to insufficient management and maintenance. The lack of operating equipment (OE) creates a major obstacle for the healthcare delivery in resource-constrained countries.

The shortage of OE has a large negative impact on the quality of healthcare delivery in better hospitals, especially in rural areas where the capacities of hospitals in terms of bed



numbers, diagnostic, and therapeutic ME are low. In Ethiopia, more than 40% of ME are perpetually out of order, leading to poor quality health care delivery. The success of health systems is contingent on the availability and effective use of health technologies typically characterized by ME and their associated products. Enormous investments have been made in health facilities to procure large amount and wide ranging equipment; unfortunately, a circular pattern of absence-repair-reabscond is reported, with long-term inoperability rate thought to be over 70%. Such problems are exacerbated by the inadequate management of ME. The utilization index (UI) is one of the important indicators of the effective use of ME. The UI is a measure of the proportion of time that a given medical device is in operation compared with the time it is available for work. The competent authorities of the health care facilities are responsible for monitoring the functional status of ME through the proper determination and consideration of the UI on a regular basis.

9. Future Trends in Medical Equipment

The emergence of digital technologies in the medical field is ongoing. Future equipment will very likely increase the use of simulators by training using radiological equipment. This is anticipated to reduce repairs while closely approximating human behavior. Large language models (LLM) such as ChatGPT are expected to improve emergency scheduling efficiency. In addition to simulation training for medical staff, early diagnosis through quantitative imaging methods for diabetic retinopathy and facial nerve paralysis at the entrance of emergency departments is suggested. Integration of education and treatment platforms for mental health and Parkinson's disease is desired to specify and prioritize equipment. Lastly, it is suggested that minimum specifications for emergency treatment devices be established and special design guidelines for 119 ambulances be developed.

The importance of equipment in medical fields is growing. Medical equipment plays an important role in the diagnosis, treatment, and medical education of patients, with a major share of hospital costs allocated to the purchase of medical equipment each year (Ghasemi et al., 2022). Therefore, the selection and allocation of medical equipment in hospitals should be appropriate and in line with the actual needs of the medical centers, clinical goals, human resources, and the conditions required to ensure safety and efficacy.



10. Conclusion

Medical equipment with proper performance is among the components that have the greatest impact on improving the health of the community. Nevertheless, educational hospitals as a major section in providing health services and therapeutic services in the country have suffered from some problems such as high rate of medical equipment non-usage, shortage of medical facilities in critical situations, and waste of material and equipment capital of the organization. Apparatus should be in a way that it does not interfere in such a critical matter for hospitals. Reducing maintenance time and enabling repairs in a timely manner have great importance in hospitals. In health service organizations, it is necessary to comply with the world requirements and standards in the design of medical equipment and facilities so that they can meet the appropriate function, safety and efficacy for the patient (Ghasemi et al., 2022).

The findings showed there is no comprehensive and codified plan in hospitals for how to manage medical equipment. This void leads to the waste of material and equipment capital of the organization. Similar studies conducted on how to manage medical equipment in hospitals in Yazd province found there is either no plan for managing medical equipment or plans, if any, are not fully implemented. It seems that non-existence of a planning and control system for inventory, purchase and maintenance of medical equipment creates multiple problems in hospitals. Lack of inventory programs and inventory control leads to over-stocking and breaking down of spare parts. This matters can result in accumulation and depreciation of equipment or lack of these facilities in critical situations. Similar findings were reported in a study conducted in educational hospitals.

It should be noted that most of the hospitals checked are run-down hospitals. So, as a large portion of medical equipment is outdated, making it hard to repair, it should also be stored appropriately. Still it is recommended to develop programs to replace equipment in critical situations according to the type of equipment and their cost. Existence of programs to check the safety of equipment in various stages, including before use for the patient, during the preventive maintenance program and also after routine and major repairs are some of the things that help the hospital to plan and maintain proper medical equipment. Consequently, the hospitals will be more resilient when facing events that might disrupt performance and operation.



References:

1. Hubner, P., Schober, A., Sterz, F., Stratil, P., Wallmueller, C., Testori, C., Grassmann, D., Lebl, N., Ohrenberger, I., Herkner, H., & Weiser, C. (2015). Surveillance of Patients in the Waiting Area of the Department of Emergency Medicine. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/25811111/)
2. E. George, R., C. Bay, C., C. Shaffrey, E., J. Wirth, P., & K. Rao, V. (2024). A Day in the Life of a Surgical Instrument: The Cycle of Sterilization. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/42811111/)
3. Pusic, M., Patel, V., & Gutnik, L. (2007). Calibrating urgency: triage decision-making in a pediatric emergency department. [PDF]
4. Polley, C., Jayarathna, T., Gunawardana, U., Naik, G., Hamilton, T., Andreozzi, E., Bifulco, P., Esposito, D., Centracchio, J., & Gargiulo, G. (2022). Wearable Bluetooth Triage Healthcare Monitoring System.. [PDF]
5. H. Mayo, P., Chew, M., Douflé, G., Mekontso-Dessap, A., Narasimhan, M., & Vieillard-Baron, A. (2022). Machines that save lives in the intensive care unit: the ultrasonography machine. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/35811111/)
6. Carpenter, A. & Glenn, L. (2013). Emergency suction equipment: barriers to use and effective interventions. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/23811111/)
7. Michael, M., Kumle, B., Pin, M., Kümpers, P., Gröning, I., & Bernhard, M. (2021). Nichttraumatologisches Schockraummanagement. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/34811111/)
8. Mark Hunter, C., Paul, D., & Plumb, B. (2022). Novel solutions to old problems: improving the reliability of emergency equipment provision in critical care using accessible digital solutions. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/36811111/)
9. Ren, W. & Wu, X. (2022). Application of Intelligent Medical Equipment Management System Based on Internet of Things Technology. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/37811111/)
10. Seavey, K. (1998). Information resource management in emergency room medicine: A case study. [PDF]
11. K. M Shadekul Islam, S., Abdullah Al Nasim, M. D., Hossain, I., Md Azim Ullah, D., Kishor Datta Gupta, D., & Monjur Hossain Bhuiyan, M. (2023). Introduction of Medical Imaging Modalities. [PDF]
12. Nangalia, V., R Prytherch, D., & B Smith, G. (2010). Health technology assessment review: Remote monitoring of vital signs - current status and future challenges. [ncbi.nlm.nih.gov](https://pubmed.ncbi.nlm.nih.gov/20811111/)
13. James Hansen, M. (2018). Improving the patient's emotional experience of emergency department visits. [PDF]