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# Evaluation of medical equipment management in educational hospitals in Isfahan

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## Abstract:

**BACKGROUND:** Medical equipment plays an important role in the diagnosis, treatment, and medical education, and each year the major share of hospital costs (about 5%–15% annually) is allocated to the purchase of medical equipment. The 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 safety. The purpose of this study was to study and evaluate current systems of medical equipment management and identify their strengths and weaknesses in Isfahan educational hospitals in 2018.

**MATERIALS AND METHODS:** This is a descriptive-applied research that was done in a cross-sectional way in 2018. The statistical population of the research is the authorities of medical equipment and other persons related to the management of medical equipment of selected educational hospitals in Isfahan. The data collection tool is a questionnaire.

**RESULTS:** The result of this study was gathered in four areas: medical equipment management, safety, preventive maintenance, and training.

**CONCLUSION:** According to this study, there is no comprehensive program in hospitals for how to manage medical equipment, which itself causes the loss of material and equipment capital of the organization. In most cases, the lack of a system for planning and controlling the amount of inventory and purchasing and maintaining medical equipment creates many problems, such as the accumulation and depreciation of equipment or the lack of these facilities in critical situations. In this study, it is suggested initially a scientific control system. Medical equipment is designed so that the hospital's need for equipment at any time of year and the amount of its equipment are clear so that it can be easily decided in this field.

## Keywords:

Equipment, hospitals, Iran, management, supplies

## Introduction

The importance of medical equipment and the development of related technologies and a major influence in the health-care system are clearly evident today as the result of medical professionals due to the use of this technology in the prevention, diagnosis, alleviation, and treatment of cardiovascular diseases.<sup>[1]</sup> Furthermore, from the point of view of health economics, medical equipment has a special place

and most of the capital of medical centers and medical institutions is spent on equipping, maintaining, and modernizing medical equipment.<sup>[2,3]</sup> In fact, every year, a large share of the cost of hospitals (about 5%–15% per year) is allocated to the purchase of medical equipment from inside and outside the country.<sup>[4]</sup> In general, the available information indicates that in developing countries, including Iran, more than 40% of medical equipment is rarely used properly, and due to mismanagement and lack of infrastructure, it is necessary to provide, maintain, and benefit.<sup>[5]</sup> The

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withdrawal of imported medical technology from the waste of national health resources continues, with some experts pointing out that Third World hospitals have become new cemeteries. Meanwhile, inactive equipment is a major factor in wasting costs and wasting resources.<sup>[6]</sup> Rapid and correct diagnostic services in the hospital are necessary, which will reduce the cost of repairing medical equipment by 30%–40%.<sup>[3]</sup> and now, the medical engineering unit is located in most educational hospitals in Isfahan province. The selection and allocation of medical equipment should be commensurate with the actual needs of the medical centers, the clinical goals, the necessary workforce, and the conditions required to ensure safety.<sup>[7]</sup> This will be achieved if a codified plan for the management of medical equipment is designed at the level of medical centers in the country and is considered as the main rule and policy of the programs of the relevant authorities.<sup>[8]</sup>

The medical equipment management process ensures that the risks associated with the use of medical equipment are minimized. Therefore, responsible organizations should set up a medical equipment management process and review it to ensure that the medical equipment used is appropriate, used in accordance with the factory's operating instructions, and is kept in a safe and reliable condition.<sup>[9-10]</sup> The purpose of this study is to evaluate the current systems of medical equipment management and identify their weaknesses and strengths in Isfahan educational hospitals in 2018. It is hoped that this research will be able to provide a useful research resource for the improvement of current medical equipment management systems and the establishment of efficient and effective management systems in hospitals.

## Materials and Methods

### Study design and setting

This research is a practical descriptive cross-sectional study conducted in 2018. The environment of this research includes selected educational hospitals, including Ayatollah Kashani, Amin, Al-Zahra, Noor, and Hazrat Ali Asghar.

### Study participant and sampling

Population of the research is the officials of medical equipment and other people related to the management of medical equipment of selected educational hospitals in Isfahan. The whole statistical population is the sample size of the research.

### Data collection tool and technique

The data collection tool is a questionnaire. The questionnaire was adapted from a reputable accreditation organization based in Abu Dhabi called HAAD.

In this study, the questions in the questionnaire were categorized into four separate areas, which include: management area with 14 questions, safety area with 7 questions, preventive maintenance area with 10 questions, and education area with 7 questions. The questions in the questionnaire were asked by the project manager from the respondents, and during the answer to each question, the respondents were asked to provide the relevant documents and documents as evidence to the interviewer. In addition, the answers related to each of the questions were graded based on three criteria, which include in general, to some extent, and completely, and the criteria related to the selection of each of these degrees are mentioned next to each of the questionnaire questions. Furthermore, for each of these grades, scores were considered, and finally, the scores obtained in the hospitals in each field were calculated. Descriptive statistics (frequency, percentage, and mean) and inferential statistics (including *t*-test, ANOVA, and factor analysis) were used to analyze the research data.

## Results

### Part one: Medical equipment management

According to Table 1, the findings show that in 100% of hospitals, policies and procedures are relatively available for all stages of the equipment life cycle, meaning that the policies are scattered. In 80% of hospitals, there are no policies and procedures for purchasing medical equipment, which means that there are no formal and internal policies and procedures in the ward, and in 20% of hospitals, there is a relative meaning that policies and the procedures are scattered. In 60% of hospitals, there are relatively few policies and procedures for the proper use of medical equipment, which means that there are scattered policies and procedures. And in 60% of the hospitals, there are no official policies and procedures in the ward. In 80% of hospitals, there are

**Table 1: Percentage and rank of medical equipment management components**

Area	Percent	Rank
Existence of policy and procedure	100	5
Codified policies and procedures for purchasing medical equipment	80	4
Codified policies and procedures for the proper use of medical equipment	60	3
Existence of policies and procedures for using the call system or removing medical equipment under the call system from the service	80	4
Existence of policies and procedures for decommissioning medical equipment	100	5
Availability of compiled medical equipment available	100	5
Medical equipment update	100	5
Existence of a program to monitor vendors/contractors for equipment under warranty or contract	100	5
Schedule and decommissioning equipment on site	80	4

no policies and procedures for using the call system or the elimination of medical equipment under the call system from service delivery at all, which means that policies and procedures are not officially and in place in the department and in 100% of hospitals, call system policies are not implemented. In 100% of hospitals, policies and procedures for decommissioning medical equipment have not been developed at all. In 100% of the hospitals, the inventory of medical equipment is available in written form, and the inventory is complete and has the desired features.

In 100% of hospitals, the inventory of medical equipment is updated, which means that the inventory system can be updated. In 80% of the hospitals, the number of medical equipment is not enough for the scope of services and their performance, and in 20% of the hospitals, where the number of medical equipment is sufficient for the scope of services and their performance, there is no specific calculation method to determine the needs.

### Part two: Safety

According to Table 2, 80% of the equipment purchased according to the technical characteristics, regulatory rules, and compliance with the standards of the supervisory organizations in the hospital have not been estimated at all.

In 80% of the hospitals, the option is somewhat selected, which means that there is storage equipment in the hospital, but there is no contract with the equipment agencies to replace the equipment if a defect occurs. And in 20% of hospitals, in the event of a crisis, no defects for medical equipment are anticipated. In 60% of the hospitals, there is no written list of the hospital's vital equipment, and in 60% of the hospitals, there is a list of the hospital's vital equipment in the ward, but it is not complete. In 80% of the hospitals, the list of vital equipment of the hospital is not updated at all and cannot be updated.

In 100% of hospitals, there is a plan to monitor vendors/contractors for equipment under warranty or

**Table 2: Percentage and rank of safety components**

Safety	Percent	Score
Existence of purchased equipment based on having technical characteristics	80	4
Existence of purchased equipment based on technical characteristics, regulatory rules, and compliance with the standards of supervising organizations	80	4
Anticipated alternative in case of crisis	80	4
Existence of necessary installation resources for vital equipment	60	3
Safety and performance guarantee for new equipment	60	3
Use of all test equipment for maintenance and safety of medical equipment	60	3

contract to some extent, which means that the program is available in writing and written, but the principles in question are not followed. In 80% of the hospitals, there is no program or process of decommissioning the equipment at all, and in 20% of the hospitals, there is a certain amount, which means that the program is written and written, but it is incomplete.

In 60% of hospitals, before receiving the use of new medical equipment, safety and proper performance of the relevant department are not received at all, and in 30% of hospitals, before the use of new medical equipment, safety and proper performance of the relevant department are received to some extent. This means that there is a plan to check safety and the documentation is recorded, but it is not complete, and 20% of hospitals receive complete safety before using new medical equipment and ensuring the proper functioning of the relevant department. This means that there is a program to check the safety of equipment before use and also there is documentary evidence to ensure the safety of equipment before use.

In 100% of hospitals, all services, including test results (safety performance), calibration, settings, and reports (QA and QC) are archived and fully maintained for each piece of equipment.

In 60% of the hospitals, not all the testing tools used to maintain the safety of medical equipment are calibrated, and in 60% of the hospitals, all the testing tools used to maintain the safety of the medical equipment are somewhat calibrated, which means that tools are calibrated but not recorded.

### Third part: Preventive maintenance

According to Table 3, In 60% of the hospitals, the facilities are somewhat similar to the equipment and the documents are available.

In 100% of the hospitals, the accessories are according to the standard and the manufacturer's recommendation and do not damage the device, and the documents related to this match are available in the unit. In 100% of the hospitals, the consumables are to some extent and not completely according to the manufacturer's recommendation and are not in accordance with MSDS standards and its documents are available in the department. In 100% of the hospitals, the records of the PM program have been completed in full and with all the necessary features. In 60% of hospitals, there are no plans for patient safety testing before installation and use for the patient. In 20% of hospitals, there is a plan for safety testing before installation and use for the patient, but it is not complete. In 20% of hospitals, the user is provided with a program for safety testing of

equipment before use for the patient, and his records are recorded.

In 100% of hospitals, equipment safety is not tested after routine repairs and there is no documentation in this regard.

### Part four: Training

According to Table 4, in 60% of the hospitals, only a small number of employees have been trained in the use of the equipment, and the records of the training and the type of training given to the individuals in the ward are available. In 20% of the hospitals, all the employees who work with the equipment have been trained in the maintenance and use of the equipment, and there are records of the training and the type of training given to the people in the ward. In 20% of the hospitals, the staff has not been trained in the use and maintenance of the equipment and there is no documentation in this regard.

In 60% of the hospitals, there is no written training program in this regard in the ward. In 20% of the hospitals, there is a codified curriculum, but it is not complete. Twenty-five percent of hospitals have a well-written training program in the ward, and documentation of its implementation is available in the ward. In 60% of the hospitals, the personnel are not familiar with the vital equipment and do not have the list of vital equipment.

**Table 3: Percentage and rank of preventive maintenance components**

PM	Percent	Score
Alignment of hospital facilities with equipment performance	60	3
Alignment and adaptation of accessories with equipment performance	100	5
Alignment of consumables and resources with equipment performance	100	5
Existence of a PM program scheduled for clinical equipment based on the type of use	100	5
Existence of PM program implementation records	100	5
Existence of medical equipment safety during installation	60	3
Safety testing of medical equipment before and after use of the equipment	60	2

PM=Preventive maintenance

**Table 4: Percentage and rank of training components**

Training	Percent	Score
Codified policies and procedures for staff training	80	4
Codified training program for hospital-related staff for training, safe operation, and routine maintenance of medical equipment	60	3
Familiarity of staff with RFP	100	5
Familiarity of staff with vital hospital equipment	60	3
Familiarization of medical equipment users with sufficient specialized knowledge and signs indicating the emergence of defects in medical equipment	60	3

In 60% of the hospitals, a small number of users are familiar with sufficient specialized knowledge about the occurrence of defects in the equipment, and there is relevant documentation in the field of personnel training in this regard. In 60% of hospitals, users are not familiar with sufficient specialized knowledge about the occurrence of defects in equipment and there is no documentation in this regard.

### Discussion

According to the findings, several issues and problems have been identified in the hospitals under study. These issues include the first cases of incomplete compilation of policies and distribution of existing policies to manage all stages of the medical equipment management cycle. In fact, equipment management policy should include; Select, purchase, accept and discard all medical equipment. Training of all those who use the equipment should also be considered. On the other hand, sterilization, maintenance, monitoring, tracking, record keeping, and replacement of reusable equipment must have a clear policy.<sup>[3,6]</sup>

Regarding the weakness in developing policies related to the purchase of medical equipment, it can be noted that poor performance in the field of medical equipment supply leads to poor service delivery or poor performance of medical equipment.<sup>[11]</sup> The medical equipment management team must ensure that the medical equipment purchase policies include safety, quality, performance, and all aspects of the equipment purchase cycle. Policies should include, for example, the establishment of a consulting group to ensure that the acquisition of purchase requirements, interests, and preferences of all interested groups are agreed upon, and second, to ensure that the process of purchasing medical equipment with national policies is the purchase of equipment. The medicine will cover all the costs of the life cycle, the purchase methods of the medical equipment, and the purchase requirements agreed and compliant.<sup>[5]</sup>

In terms of weakness in policy development guidelines for the use of medical equipment, it can be noted that good and clear guidelines play a vital role in the effective and safe use of medical equipment. Clear responsibilities are needed to ensure that the manufacturer's instructions are passed on to all users and, if necessary, to their supervisors.<sup>[12]</sup>

The manufacturer's instructions can be supplemented with training. All information required for storage, preuse, use, maintenance, and cleaning reviews must be transmitted to end-users, including the second user or later. In the event of a defect in the transmission of the

manufacturer's instructions, the user's ability to safely use the equipment may be compromised.<sup>[2]</sup>

The operation manual is valuable not only for equipment users but also for medical equipment technicians who need to understand the details of the use of equipment used in clinical activities. The service manual is involved in inspections, preventive maintenance, repairs, and calibration.

Unfortunately, performance and service manuals are not always available or in the language of equipment technicians. Therefore, it is necessary for the medical equipment engineering department to take steps to access these manuals. For new equipment, it is important that these booklets be part of the purchase agreement.<sup>[13]</sup>

The second problem is the lack of equipment to provide services and lack of a specific system to determine the deficiencies and adequacy of equipment in providing services.

Hospitals need to provide the medical equipment needed by employees to provide an acceptable level of patient care when needed.<sup>[14]</sup> This includes financial management to meet the cost of repairing and maintaining the equipment, as well as making the equipment as efficient and effective as possible. Therefore, hospitals need a mechanism to ensure that medical equipment is tailored to their needs. It has been identified and prioritized, as well as ensuring that decisions are made about the purchase, maintenance, use, and replacement of equipment based on complete and reliable information.<sup>[15]</sup>

The third problem is the lack of a specific list of critical equipment in the hospital to prioritize equipment. Accurate matching between workloads for hospital equipment and personnel who do the work is rare. Therefore, instead of planning a program to inspect and maintain all equipment, it is better to identify the equipment that is most important in health care facilities for inspection, maintenance and scheduling with priority work.<sup>[16]</sup>

The fourth problem is the lack or incompleteness of the program to decommission the equipment. Hospitals are responsible for ensuring that equipment is adequate and used effectively and safely. Deleting equipment is one of the most important parts of medical equipment management. The useful life of the equipment should be kept in the registered inventory of medical equipment and should be regularly reviewed based on the records of use, maintenance, and repair to understand whether the need for adjustment of the useful life is required. Excessive or irregular maintenance may reduce the

useful life of the equipment or increase the limited use of the equipment for the useful life.<sup>[17]</sup>

The next problem is the purchase of medical equipment and vendor monitoring systems, lack of knowledge of RFP personnel and lack of complete steps in the process, and also the lack of a comprehensive management plan in hospitals, according to the above. In fact, the responsible organizations should design a process of equipment management and review it regularly to ensure that the medical equipment used (1) it is practical and suitable, (2) it is used according to the factory's instructions, (3) it is kept in safe and reliable conditions, and (4) it is out of proportion after the end of the life cycle.<sup>[18]</sup>

The next challenge is the weakness in replacing equipment that suffers from a sudden failure, in the sense that even with a complete maintenance program, the equipment may fail. To restore performance as quickly as possible, often the easiest way is to replace similar equipment, although this requires increasing inventory levels, this is not always possible and is not possible in such large equipment as computed tomography scan. It can be incurred for possible costs such as payment for foreign-service providers or provision of services for 24-h coverage. Equipment should be decommissioned and replaced as soon as possible and repaired and maintained properly before reuse.<sup>[7]</sup>

In general, based on the results, the condition of medical equipment management is 33% lower than the average score. In a study conducted by Ahmad Amerion in two selected military hospitals, only 24% of respondents to the questionnaire considered the organization status of medical equipment management to be optimal, so in this study, the status of medical equipment management is estimated to be low.<sup>[17]</sup>

In the present study, in the field of safety management of medical equipment, hospitals are at a lower than average score with 48% of the total points. Furthermore, in the field of preventive care of hospitals, with 48% of the total points of this area, they are below the average. In a study conducted by Raeisi *et al.* With the aim of identifying the requirements for establishing a preventive maintenance program and prioritizing those requirements, the need to create capable medical engineering staff and the presence of medical engineers in all hospitals under the university and also to establish a follow-up office for preventive maintenance activities was emphasized.<sup>[19]</sup>

In the field of education, hospitals have been in a weak position with 19% of the total points in this field.

In a study conducted by Gholizadeh entitled "Determining the status of medical equipment in Tabriz medical

training centers in 2011”, the findings show that there is no proper planning system in the state of preparation, repair and training. The results of this study show that the relevant authorities have not paid enough attention to this issue and in some areas there is still a need for more attention from high-ranking officials.<sup>[20]</sup>

### Limitation and recommendation

This study was conducted only in Isfahan province. To generalize the results, it is better to do it in other cities as well.

### Conclusion

The studies conducted in this study on how to manage medical equipment showed that there is no comprehensive and codified plan in hospitals for how to manage medical equipment, which leads to a waste of material and equipment capital of the organization. In most cases, the lack of a planning and control system for inventory, purchase and maintenance of medical equipment causes many problems such as accumulation and depreciation of equipment or lack of these facilities in critical situations. It is recommended to develop programs to replace equipment in critical situations (sudden failure) according to the type of equipment and their cost, as well as its vitality. 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. In this case, we will have more resilient organizations that have a higher tolerance for sudden events.

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### Conflicts of interest

There are no conflicts of interest.

### References

1. Ranjbar E, Sedehi RG, Rashidi M, Suratgar AA, editors. Design of an IoT-Based System for Smart Maintenance of Medical Equipment. 2019 3<sup>rd</sup> International Conference on Internet of Things and Applications (IoT). Singapore IEEE; 2019.
2. Taghipour S, Banjevic D, Jardine AK. Prioritization of medical equipment for maintenance decisions. *J Oper Res Soc* 2011;62:1666-87.
3. Ishida K, Hirose M, Fujiwara K, Tsuruta H, Ikeda N. Analysis of medical equipment management in relation to the mandatory medical equipment safety manager (MESM) in Japan. *J Healthc Eng* 2014;5:329-46.
4. Organization WH. Introduction to Medical Equipment Inventory Management. World Health Organization, Organization WH; 2011.
5. Mkalaf K, Gibson P, Flanagan J. A study of current maintenance strategies and the reliability of critical medical equipment in hospitals in relation to patient outcomes, *International Journal Of Management*; 2013. p. 15-28
6. Iadanza E, Gonnelli V, Satta F, Gherardelli M. Evidence-based medical equipment management: A convenient implementation. *Med Biol Eng Comput* 2019;57:2215-30.
7. Okorhi OJ. Assessment of Waste Electrical and Electronic Equipment Management Strategies in South Eastern Nigeria. *Health Planning, Doctoral Thesis*; 2015. p. 1-180.
8. Houria ZB, Besbes M, Elaoud B, Masmoudi M, Masmoudi F, editors. Maintenance strategy selection for medical equipments using fuzzy multiple criteria decision making approach. In: *Proceedings of the 45<sup>th</sup> International Conference on Computers and Industrial Engineering*. France: Metz; 2015.
9. Hamdi N, Oweis R, Abu Zraiq H, Abu Sammour D. An intelligent healthcare management system: A new approach in work-order prioritization for medical equipment maintenance requests. *J Med Syst* 2012;36:557-67.
10. Organization WH. Medical Equipment Maintenance Programme Overview. World Health Organization Organization WH; 2011.
11. Chien CH, Huang YY, Chong FC, editors. A framework of medical equipment management system for in-house clinical engineering department. In: *2010 Annual International Conference of the IEEE Engineering in Medicine and Biology*. International Journal Of Health Care Management IEEE; 2010.
12. Wang B, Furst E, Cohen T, Keil OR, Ridgway M, Stiefel R. Medical equipment management strategies. *Biomed Instrum Technol* 2006;40:233-7.
13. Khalaf A, Djouani K, Hamam Y, Alayli Y, editors. Evidence-based mathematical maintenance model for medical equipment. In: *2010 International Conference on Electronic Devices, Systems and Applications*. British conferences: IEEE; 2010.
14. Ivlev I, Kneppo P, Bartak M. Multicriteria decision analysis: A multifaceted approach to medical equipment management. *Technol Econ Dev of Econ* 2014;20:576-89.
15. Dalulia P, Singgih ML, Karningsih PD, Suf M. Performance model development for assessing maintenance service providers using the Kano model. *J Bus Retail Manag Res* 2018;13:225-31.
16. Cohen T, Baretich MF, Gentles WM. Computerized maintenance management systems. In: *Clinical Engineering Handbook*. International Journal Of Public Health Elsevier; 2020. p. 208-18.
17. Haji-Ali-Nili N, Khoshzaban F, Karimi M. Lifestyle determinants on prevention and improvement of dry eye disease from the perspective of Iranian traditional medicine. *Iran J Med Sci* 2016;41 Suppl 3:S39.
18. Mahfoud H, Barkany AE, Biyaali AE. Medical maintenance performance monitoring: A roadmap to efficient improvement. *Int J Prod Qual Manag* 2017;22:117-40.
19. Raeisi AR, Sattari R. Need assessment of implementing a preventive maintenance system at hospitals in Isfahan, Iran. *Health Inform Manag* 2012;9p 41-52.
20. Gholizade M, Salrhi A, Khosravi M. Investigation of the condition of medical equipment in Tabriz educational and medical centers. *Sci Inform Database* 2011;1:23-8.