Features of Computerized Systems for the Management of Medical-Hospital Equipment in Clinical Engineering Departments in Brazil

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Abstract. The rapid evolution and complexity of medical-hospital equipment (EMH), as well as the appearance of adverse events that had not occurred until then, resulted, in the United States, in the emergence of the area of activity called Clinical Engineering (CE). In Brazil, although the profession does not have its proper recognition and regulation, the need for a qualified and designated professional to manage health technologies, within a Health Care Facility (EAS), has been increasingly evident. To manage these technologies, in addition to being mandatory, is the responsibility of each Hospital, requiring dedication and control. The use of computerized systems (SI), aiming at successful management of health technologies, including the preparation of inventories and control of technical intervention events (e.g., maintenance), has been consolidated. Despite having available in the market diversified software intended for the realization of maintenance management, notoriously, the foundation, structuring and functionality of these, are convergent. The present work aimed to list, through bibliographic references, parameters and essential functions, which should make up an SI for the management of EMH, applied in the Departments of CE in Hospital Units. Thus, through the study carried out, it was observed that a software for this purpose can be divided into four main modules: Module of registrations, EMH inventory, service orders (maintenance) and, reports/indicators. Finally, given the functionalities identified in the analyzed SI, it is suggested to conduct new studies related to the incorporation of specific tools and functionalities, aimed at CE in Brazil.

Keywords: Clinical engineering · Maintenance software · Medical-hospital equipment · Hospital maintenance · Health maintenance

1 Introduction

With the significant advance of technologies applied in health care establishments (EAS), in addition to the constant demand, by society, for excellence, quality and safety in the services provided by these establishments, to carry out the management of health technologies, specifically under the medical-hospital equipment (EMH), has become a major challenge for clinical engineering (CE) and hospital managers.

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The quality of service provision in a hospital is directly related to the efficient management of the respective medical and hospital equipment [1].

The term clinical engineer, created in the 1970s by Thomas Hargest and César Caceres, according to Gordon [2], in order to identify the professional responsible for managing technologies in healthcare environments, despite not being a modality recognized by the Federal Council of Engineering and Agronomy (CONFEA) in Brazil, according to Souza and More [3], has undeniable importance in the face of activities developed in the hospital environment.

Although there is no recognition by the competent class body (CONFEA), as presented by the National Health Surveillance Agency (ANVISA), through the Technovigilance Manual, health services in Brazil have had these professionals for at least 30 years, however in a reduced way and concentrated only in reference services or linked to universities [4].

Furthermore, as recommended by the health authority (ANVISA), through Resolution of the Collegiate Board (RDC) No. 509, of May 27, 2021 [5], which repeals RDC No. 02 of 2010, it is the responsibility of the health establishments manage health technologies used in the provision of health services, in order to guarantee their traceability, effectiveness, quality and safety, as well as carry out the elaboration and implementation of a Management Plan for the respective technologies, including medical-hospital equipment.

For the World Health Organization [18], there is a need to establish priorities in the selection and management of health technologies, resulting from the implementation and inappropriate use of these technologies.

According to Brito [6], in specialized literature, different methods of planning and management of technologies can be found, and the use of computerized systems is the most applied resource.

Thus, aiming for success in the management of health technologies, contemplating the control of preventive, corrective and calibration maintenance events, carried out in medical-hospital equipment [7], the use of specific applications and programs, generically called software, become essential for the organization and administration of a hospital, according to Malagón-Londoño [8].

Simply called CMMS, a computerized maintenance management system is a technological tool to support the maintenance strategy, which through a set of functions promotes data processing to produce indicators to be used in support of maintenance management activities [16].

In view of the above, through articles and studies already carried out, the present work aims to list the parameters and essential functions that must compose a computerized system (SI) for the management of medical and hospital equipment, applied in the departments of Clinical Engineering in Hospital Units.

2 Methodology

The present work was elaborated through research carried out on articles and literary works related to hospital management, specifically to the clinical engineering and hospital maintenance sector.

To delimit the bibliographic references to be consulted, the following keywords were defined to be used as search filters along with renowned websites of scientific articles: clinical engineering, maintenance management, medical equipment, maintenance software, cmms and management hospital.

Through the filters, fourteen (14) scientific/academic/technical works were initially selected, among them twelve (12) articles, one (01) dissertation and one (01) technical publication of the WHO, obtained from the websites Scientific Electronic Library (SciELO), CAPES Journal Portal, UNIFACEF Journal Portal, UFRN Journal Portal, Health and Technology Journal (joint publications by Springer and IUPESM—International Union for Physical and Engineering Sciences in Medicine, in cooperation with WHO—World Health Organization), PubMed, Institute of Electrical and Electronics Engineers—IEEE, ScienceDirect, World Health Organization—WHO, Google Scholar and institutional repository of UTFPR.

Literary works, totaling three (03), related to hospital management and maintenance management, were also preliminarily selected due to their respective titles: "Hospital Management—For an Effective Administration", "Maintenance Management in Health Services" and "Management information systems in healthcare organizations".

After the initial selection of works and books, in order to limit the bibliographic bases to be used, the introduction of these documents was read, aimed at identifying contents associated with the use of information systems for maintenance management by the sectors of clinical engineering in health care establishments.

That said, it was defined for the development of this study to use the articles written by Barbosa [9], Oliveira [10], Silva [11], Fernandes [12] Chein [15], Medenou [17], Patrícia's dissertation [13], the technical document prepared by the WHO [18] and the literary work of Malagón-Londoño [8].

In addition to the selection of one (01) literary work and the eight (08) works obtained via websites, the use of Collegiate Board Resolution nº 509, of May 27, 2021 [5], issued by the National Health Surveillance (ANVISA), which discusses the management of health technologies in health establishments, and the Brazilian Standard NBR 15943 [14], issued by the Brazilian Association of Technical Standards (ABNT), addressing the guidelines for a management program for infrastructure equipment for health services and equipment for health, in order to complement this study.

Therefore, the purpose of this work is to list, through the bibliographic references, the functions and the main parameters recommended to compose an information system (software) destined to the effective management of medical and hospital equipment by a clinical engineering sector, having as based on their incidence, their respective foundations and compliance with specific norms and resolutions available in Brazil.

Next, Fig. 1 illustrates the methodology applied to carry out this work.

3 Results

Through the bibliographic references used for this study, a standardized structuring of the main functions and parameters necessary in the information systems used for the management of medical and hospital equipment by the clinical engineering sector in Hospitals was obtained.

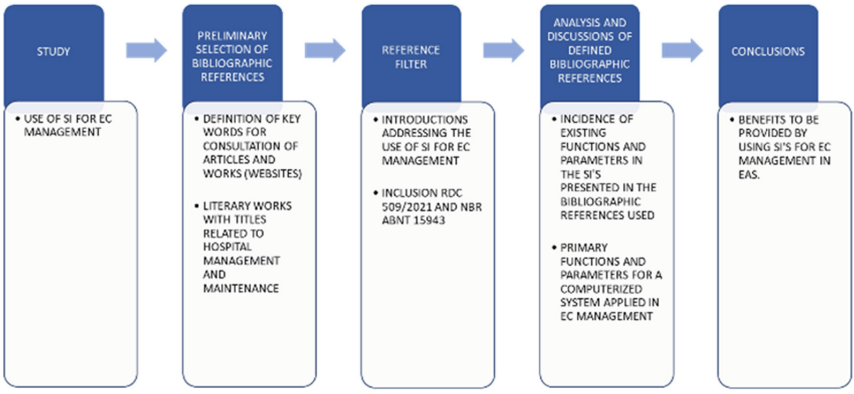

Fig. 1. Flowchart illustrating the methodology of this work. (The Author 2022).

Silva [11] presents that, in order to perform a better management control of medical-hospital equipment, an information system should basically enable the insertion of: registration/code generation/research for each medical-hospital equipment; registration and research of customers/companies/suppliers; issuance/evaluation/closure and research of service orders; registration of users/sectors with definition of usage profiles, to restrict the access of each user.

In the same way, Barbosa [9] shows that the Hospital Maintenance System 4.0, used by the clinical engineering sector in a large hospital located in Rio Grande do Sul, makes it possible to carry out an effective administrative control through the following applicability: registration of products, cost centers, employees, equipment, suppliers, payment methods, users and permissions, dollar exchange rates; issuance of maintenance service orders with priority level definitions; issuance of various reports for management controls.

Therefore, as mentioned by Malagón-Londoño [8], Oliveira [10] and Fernandes [12], the Computerized Maintenance Management System (CMMS) applied in clinical engineering provides benefits to the respective sector. The CMMS software must present as functionalities: fields and tables for entering data in general, related to the types of medical and hospital equipment, equipment models, manufacturers/sellers, warehouses/spare parts, personnel/users, maintenance (contemplating service orders) and the health establishment; equipment inventory module defined as the CMMS core, referring to the registration of information related to each medical-hospital equipment; spare parts management module; modules for preventive, predictive and corrective maintenance, with the possibility of defining calendars and schedules for efficient inspections; contract management module and diversified reporting.

Piccinini [13], in her dissertation published in the Postgraduate Program in Biomedical Engineering at UniversidadeTecnológica Federal do Paraná, with the objective of developing, analyzing and implementing an information system for EMH maintenance management, called SIGMEH (Sistema of Medical-Hospital Equipment Management), presents as utilities of the respective SI: registration of users with definition of access

limits (profiles); registration of employees, positions, environments and suppliers; registration of medical-hospital equipment, values of technical maintenance hours, technical standards, EMH manuals, attachment of photos; management of preventive and corrective maintenance service orders; prioritization of equipment for maintenance and warehouse control.

For Chien [15], as exposed in his work on the development of a medical equipment management system structure for the clinical engineering department, applied in a University Hospital in Taiwan, the architecture of a CMMS for the management of EMH can be classified into four groups: the first intended for basic registration information, such as equipment inventory, cost center codes, staff data, etc.; the second comprising EMH acquisition, acceptance and disposal practices, involving the recording of dates and times, enabling monitoring and evaluations; the third, defined by the author as the busiest group in an CE sector, is dedicated to the maintenance of EMH, contemplating a system of service orders, with tracking of the progress and content of the repairs, allowing the future issuance of indicators of performance and failure trends; the latter includes warranty, maintenance and contract management systems, allowing the engineer to track information such as expired warranty, preventive maintenance or other contracted service.

With the objective of significantly improving the management and control of health technologies, especially in low-income countries, the work carried out by Medenou [17] demonstrates the application of CMMS in three hospitals located in Benin, West Africa. The implementation of a computerized system for the management of these technologies in low-income countries was motivated by the WHO. The CMMS developed, in its first version, had 35 database fields, with different purposes, enabling the registration and control of the inventory of the equipment park, the management and planning of preventive and corrective maintenance, the management of suppliers, the supplying spare parts, generating and controlling service orders and issuing reports.

In a technical document prepared by the World Health Organization [18], it is mentioned that computerized maintenance management systems always include medical equipment inventories and usually include information related to service history, maintenance procedures, performance indicators and information of costs. According to the WHO, the following are basic modules for composing a CMMS: equipment inventory module; spare parts management module; maintenance module, which includes several tools for the management of preventive and corrective interventions, service orders, schedules, parts, among others; and contract management module. In addition to the division into modules, a management system must also enable the issuance of various reports through the selection of fields, tables and existing modules.

Thus, it can be defined as the result obtained through the analyzed works, that the structuring of a computerized system intended for the management of medical-hospital equipment in clinical engineering, at least, must have the following functionalities and parameters, as illustrated in the Figs. 2 and 3.

STRUCTURING - INFORMATION SYSTEM FOR THE MANAGEMENT OF EMH IN CLINICAL ENGINEERING	
1 REGISTRATION MODULE	**2 EMH INVENTORY MODULE**
1.1 Cost centers; 1.2 Contracts; 1.3 EAS; 1.4 Suppliers / Companies; 1.5 Employees; 1.6 Users and permissions; 1.7 Standards and resolutions.	2.1 EMH name; 2.2 EMH manufacturer; 2.3 EMH model; 2.4 EMH serial number; 2.5 EMH Heritage; 2.6 EMH Location/ Sector; 2.7 EMH priority level; 2.8 EMH Periodicity MP; 2.9 Date of acquisition of EMH; 2.10 EMH acquisition value; 2.11 Date of installation of the EMH; 2.12 EMH Warranty; 2.13 EMH maintenance contract; 2.14 EMH accessories; 2.15 EMH ANVISA Registration.

Fig. 2. Modules 1 and 2 of structuring an SI for EMH management (The Author 2022).

STRUCTURING - INFORMATION SYSTEM FOR THE MANAGEMENT OF EMH IN CLINICAL ENGINEERING	
3 WORK ORDERS MODULE (MAINTENANCE)	**4 REPORT AND INDICATOR MODULE**
3.1 EMH data; 3.2 Applicant data; 3.3 Requested service (e.g. MP, MC); 3.4 Request date; 3.5 Defect Reported by the applicant; 3.6 Data of the person responsible for receiving the EMH; 3.7 EMH Exit Date; 3.8 Priority level; 3.9 Resp. execution of the service (e.g. internal or external); 3.10 Resp data. the execution of the service; 3.11 Failure displayed (actual defect); 3.12 Detailed description of the service performed; 3.13 EMH return date; 3.14 Status (e.g. in progress, completed); 3.15 Cost ($) of services and parts performed; 3.16 Cost center; 3.17 Additional information (e.g. warranty). *Obs.: There is information that will automatically be filled in through the previous modules already registered.*	4.1 Reporting based on the selection of information from previous modules 4.2 Issuing indicators based on the selection of information from previous modules

Fig. 3. Modules 3 and 4 of structuring an SI for EMH management (The Author, 2022).

4 Discussion

Based on the content of the nine (09) references used to carry out this work, as well as through Figs. 2 and 3, presented above, a software for the management of clinical engineering can be divided into four (04) main modules, being these: Module 01—Registration module; Module 02—EMH Inventory Module, Module 03—Service Order Module (Maintenance); Module 04—Reports and indicators module, similar to the one exposed by both Chien [15] and WHO [18].

The first module is intended for entering registration information, which are: hospital cost centers; registration of maintenance and acquisition contracts; information on the health care establishment, such as the name, the complexity of the services provided, the contacts and the respective CNES code (National Registry of Health Establishments); supplier and company information—containing fundamental data such as address, contact, company name, among others; employee data—containing name, job description

and salary, for example; data related to users of the computerized system, including creation, alteration, and definition of access permissions to be granted; the registration of current norms and resolutions, aiming at the elaboration of a technical collection of consultation to the users of the system.

Then, the second module, related to the inventory of medical-hospital equipment, has a fundamental role in the life of each EMH within the EAS, as explained by Silva [11]. In this step, data such as the name of the equipment, the manufacturer, the model, the serial number, the assets (internal information of each EAS), the location or sector in which it is located, the priority level of the equipment for the EAS, the periodicity of preventive maintenance, the purchase date and value, the installation date, the warranty provided by the supplier, the existence or not of a maintenance contract, the accessories and the registration with ANVISA, must be registered in order to obtain a "digital inventory", such as providing effective traceability of existing technologies in the establishment, as recommended by Article 15. of Resolution RDC No. 509, of May 27, 2021 [5]. At this stage, it is appropriate to use a standard nomenclature for medical equipment, such as the Universal System of Nomenclature of Medical Devices and the Global System of Nomenclature of Medical Devices, according to WHO [18].

Through the third module, it is possible to carry out the management of technical interventions that occurred in medical-hospital equipment, meeting the requirements of ABNT NBR 15943 [14], which establishes instructions for a management program for infrastructure equipment for health services and of health equipment. Fernandes [12] defines service orders, the title of this third module, as requests for maintenance services for technologies registered in inventory. The registration and issuance of maintenance service orders are registered in this location. For each service order, information related to EMH registration data, service requester data, type of service requested (e.g. preventive or corrective maintenance), request date, EMH defect reported by the requester, data of the person responsible for receiving or withdrawal from the EMH, date of departure of the EMH from the sector of origin, service status (e.g.: in progress, completed), values with the performance of services and parts (if used), cost center and additional information (e.g.: item under warranty, maintenance unfeasible), must be completed. The use and insertion of data in this module is dynamic, conditioning the quality and effectiveness of the management to be carried out by the clinical engineering team, since through the information filled in the service orders, for example, it is possible to analyze of commonly occurring failures to prioritize interventions in EMH, according to Medenou [17].

The fourth module, aiming to provide a better managerial and technical control, in addition to being used to obtain several relevant information that can be used as complements for administrative decisions, as explained by Barbosa [9], the fourth and last module is intended for the elaboration of reports and indicators. In this module, information is obtained through the random selection of data already registered in the computerized system, having its usefulness focused on managerial and administrative actions as initially mentioned. As an example, reports showing the amount of equipment with "under maintenance" status, or the total cost spent on providing corrective maintenance services in each month, can be issued. The evaluation of the general performance

of the use of a CMMS for medical-hospital equipment, according to WHO [18], is made possible using this module.

The Table 1 aims to present in an optimized way the four modules mentioned in this discussion, in comparison to the necessary functionalities that an information system (SI) must have, identified in the nine (09) analyzed works.

In addition to the exposition of the modules proposed for the composition of a CMMS—CE, the last column of the Table 1 indicates that in none of the analyzed works, the existence of a functionality destined exclusively for the issuance of an EMH management plan, in a computerized system, is mentioned, which is necessary according to ABNT NBR 15943 [14] and RDC No. 509/2021 [5].

Table 1. Minimum modules necessary for a CMMS—CE, according to this Author, compared to the minimum functionalities mentioned in the analyzed works (The Author, 2022).

	APPROACH TO SIMILAR FUNCTIONALITIES IDENTIFIED IN THE REFERENCES				
	DIVISION OF MODULES PROPOSED FOR CMMS - CE				EMH MANAGEMENT PLAN ABNT NBR 15943 [14] AND RDC Nº 509/2021 [5]
REFERENCES	01 - REGISTRATION MODULE	02 - EMH INVENTORY MODULE	03 - WORK ORDERS MODULE (MAINTENANCE)	04 - REPORT AND INDICATOR MODULE	
Barbosa [9]	✓	✓	✓	✓	✗
Oliveira [10]	✓	✓	✓	✓	✗
Silva [11]	✓	✓	✓	✗	✗
Fernandes [12]	✓	✓	✓	✓	✗
Chein [15]	✓	✓	✓	✓	✗
Medenou [17]	✓	✓	✓	✓	✗
Patricia [13]	✓	✓	✓	✓	✗
WHO [18]	✓	✓	✓	✓	✗
Malagón-Londoño [8]	✓	✓	✓	✓	✗

5 Conclusion

Including from the initial registration of data, such as the insertion of users, suppliers, contracts, in addition to the creation of a digital inventory of medical-hospital equipment existing in a health care establishment, as well as the management of maintenance services performed in EMH's through service orders, up to the issuance of management reports and indicators, are unanimous and essential functions parameterized in the computerized systems used in the clinical engineering sectors.

In addition to corroborating with the essentiality and effectiveness in the management carried out using computerized systems, by the clinical engineering sectors in Hospitals,

the present work demonstrates that despite having available in the market diversified software destined for the accomplishment of maintenance management, their foundation, structuring, and functionality are convergent.

However, in the national conjuncture (Brazil), there is a possible gap in automated tools destined exclusively for clinical engineering attributions through current health norms and resolutions. For example, through the study carried out, the existence of functions strictly intended for the issuance of a Health Equipment Management Plan, as recommended by RDC No. 509, of May 27, 2021 [5], or, for the issuance of a health equipment management program, in compliance with the Brazilian standard ABNT NBR 15943 [14].

In conclusion, despite the already consolidated use of computerized systems intended to assist sectors responsible for managing equipment and maintenance, there are specific tools and functionalities, aimed at clinical engineering, subject to further studies and incorporations.

References

1. Amorim, A. S., Pinto, V. L., Shimizu, H. E.: O desafio da gestão de equipamentos médico-hospitalares no Sistema Único de Saúde. Saúde Debate. Rio de Janeiro **39**(105), 350–362 (2015)
2. Ramírez, E.F.F., Calil, S.J.: Engenharia clínica: Parte I – Origens (1942–1996). Semina: Ciências Exatas e Tecnológicas. **21**(4), 27–33 (2000). Available at: http://www.uel.br/revistas/uel/index.php/semexatas/article/view/3009. Access 29 May 2022
3. Souza, A.F., More, R.F.: O perfil do profissional atuante em engenharia clínica no Brasil. In: XXIV CONGRESSO BRASILEIRO DE ENGENHARIA BIOMÉDICA. 13 e 17 de outubro, 2014, Uberlândia. A Engenharia Biomédica como Propulsora de Desenvolvimento e Inovação Tecnológica em Saúde. Uberlândia: CBEB (2014). Available at: http://www.canal6.com.br/cbeb/2014/index.html. Access in: 29 May 2022
4. BRASIL: Agência Nacional de Vigilância Sanitária. Manual de tecnovigilância: uma abordagem sob ótica da vigilância sanitária [recurso eletrônico] / Agência Nacional de Vigilância Sanitária, Gerência Geral de Monitoramento de Produtos Sujeitos à Vigilância Sanitária, Gerência de Tecnovigilância. – Brasília: Agência Nacional de Vigilância Sanitária (2021)
5. ANVISA: Agência Nacional de Vigilância Sanitária. Resolução de Diretoria Colegiada – RDC Nº 509, de 27 de maio de 2021. Brasília: Diário Oficial da União (2021). Availableat: https://www.in.gov.br/en/web/dou/-/resolucao-rdc-n-509-de-27-de-maio-de-2021-323002855. Access in: 29 May 2022
6. BRITO: Lúcio Flávio de Magalhães. Segurança aplicada às instalações hospitalares. 6 ed. São Paulo: EditoraSenac São Paulo (2014)
7. Dalcol, P., Gomes, L.: O papel da engenharia clínica nos programas de gerência de equipamentos médicos: estudo em duas unidades hospitalares. In: II CONGRESSO LATINOAMERICANO DE ENGENHARIA BIOMÉDICA, 23 a 25 de maio de 2001, Habana 2001. Engenharia Clínica. La Habana (2001). Available at: https://pt.scribd.com/document/423662105/00131-pdf. Access in: 29 May 2022
8. Malagón-Londoño, G.: Gestão hospitalar para uma administração eficaz/Gustavo Malagón-Londoño, Gabriel PontónLaverde, Jairo ReynalesLondoño; tradução Catia Franco de Santana, Iara Gonzales Gil. 4 ed. Rio de Janeiro: Guanabara Koogan (2019)
9. Barbosa, A.T., Spalding, L.E.S.: Análise do sistema de informação do setor de engenharia clínica de um hospital do sul do país. In: Anais do X Congresso Brasileiro de Informática em

Saúde, pp. 14–18 (2006). Available at: https://www.researchgate.net/profile/Luiz-Spal-ding/publication/237266679_Analise_do_Sistema_de_Informa-cao_do_Setor_de_Engenharia_Clinica_de_um_Hospital_do_Sul_do_pais/links/545a11a20cf2bccc49130033/Analise-do-Sistema-de-Informacao-do-Setor-de-Engenharia-Clinica-de-um-Hospital-do-Sul-do-pais.pdf. Access in: 29 May 2022

10. Oliveira, B., Borges, L.: ESTUDO DA IMPLEMENTAÇÃO DO CMMS EM UM DEPARTAMENTO DE ENGENHARIA CLÍNICA. In.: Revista Eletrônica de Sistemas de Informação e Gestão Tecnológica **9**(3) (2018). Available at: https://periodicos.unifacef.com.br/index.php/resiget/article/viewFile/1628/1146. Access in: 29 May 2022
11. Silva, L.M., Ferreira, A.C.M.: Sistema de Cadastro e Manutenção de Equipamento Médico Hospitalar: proposta para o desenvolvimento com uma ferramenta para auxiliar a gestão da manutenção da engenharia clínica nos hospitais. 2014. In: Fatec Bauru. Available at: http://fatecbauru.edu.br/mtg/source/Sistema%20de%20cadastro%20de%20equipamento%20m%C3%A9dico-hospitalar%20.pdf. Access in: 29 May 2022
12. Fernandes, A.C.S. et al.: SISTEMA DE GERENCIAMENTO WEB PARA ENGENHARIA CLÍNICA: PROPOSTA DE ARQUITETURA E IMPLEMENTAÇÃO. In.: Revista Brasileira de Inovação Tecnológica em Saúde-ISSN: 2236–1103 (2017). Available at: https://periodicos.ufrn.br/reb/article/download/11623/8975. Access in: 29 May 2022
13. Piccinini, P.S. et al.: Sistema de informação para gerenciamento de equipamentos médicos-hospitalares. Dissertação de Mestrado. Universidade Tecnológica Federal do Paraná (2016). Available at: https://repositorio.utfpr.edu.br/jspui/bitstream/1/1870/1/CT_PPGEB_M_Piccinini%2C%20Patricia%20Strapasson_2016.pdf. Access in: 29 May 2022
14. ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 15943: diretrizes para um programa de gerenciamento de equipamentos de infraestrutura de serviços de saúde e de equipamentos para a saúde. Rio de Janeiro, 21p (2011)
15. Chien, C.-H., Huang, Y.-Y., Chong, F.-C.: 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, pp. 6054–6057. IEEE (2010). Available at: https://pubmed.ncbi.nlm.nih.gov/21097122/. Access in: 26 Ago 2022
16. Lopes, I. et al.: Requirements specification of a computerized maintenance management system–a case study. Procedia Cirp **52**, 268–273 (2016). Available at: https://www.sciencedirect.com/science/article/pii/S2212827116307971. Access in: 27 Aug 2022
17. Medenou, D. et al.: Medical devices in sub-Saharan Africa: optimal assistance via a computerized maintenance management system (CMMS) in Benin. Health and Technol. **9**(3), 219–232 (2019). Available at: https://link.springer.com/journal/12553/volumes-and-issues/9-3. Access in: 24 Aug 2022
18. World Health Organization et al.: Computerized maintenance management system (2011). Available at: https://www.who.int/publications/i/item/9789241501415. Access in: 29 Aug 2022