Descriptive Analysis of User-centered Usability Techniques to Health Technology Management

M.R. Brandão[1], R. Garcia[1*]
[1] Biomedical Engineering Institute, Federal University of Santa Catarina, Florianópolis, Brazil
[*] renato.garcia.ojeda@ufsc.br

Abstract

The use of usability techniques to understand the user's perception is essential in the evaluation and development of technological solutions in healthcare environments centered on the end user. In the incorporation of technologies in healthcare establishments, the management has become essential in terms of safety, reliability and efficiency for the patient. This article addresses the techniques of interviews, focus groups, surveys and the delphi method, bringing a general descriptive conceptual analysis of Human Factors Engineering techniques aiming to assist in the management of health technologies more efficiently and with quality for the patient. The techniques of data collection can be applied both in the pre commercialization stages of the technology, in the data collection of the user's technological need and validation of prototypes of new solutions, and in the post-commercialization stages, analyzing the main usability problems, involving devices already commercially available. Each usability technique for data collection has its advantages and disadvantages, and it is necessary to analyze the objective of the research to determine the choice of the most appropriate method. This article addresses conceptually the possibilities of practices including all actors in the technological health process creates a collaborative, interdisciplinary and innovative ecosystem, with interaction of the technical area with the clinical, essential to develop better technological solutions in health, focusing on the end user's needs. The application of these tools can assist the Clinical Engineering area in the discussion of strategies that may better use of technologies in patient care.

Keywords: Clinical Engineering, Human Factors Engineering, Health Technology Management, Medical Equipment, Usability.

1. Introduction

The use of technologies in the health area is increasingly frequent in healthcare establishments, including home care. The technological diffusion to different environments highlights the importance of carrying out an efficient and quality management of health technologies in order to guarantee their adequate and safe use for end users. The Health Technologies Management (HTM) process consists of an extremely effective approach to clinical engineering aimed at patient safety. HTM operates throughout the technological life cycle, from the period of innovation, development, incorporation and use, until its obsolescence, going through the pre marketing and post-marketing phases [1], [2]. The Biomedical Engineering Institute (IEB-UFSC) bases the Management of technologies through three main pillars: infrastructure, human resources and the technology itself. The interaction between them is extremely relevant to analyze the entire context in which it is being used. The search for quality in the technological process is achieved by balancing the three pillars, contributing to an improvement in safety, reliability and efficiency in the use of these technologies [3], [4], [5]. One of

dx.doi.org/10.24254/CNIB.20.43

the requirements to be considered in the process of evaluating and developing new technological solutions in health is usability, which establishes a relationship between the characteristics of human factors with ease of use, efficiency and user satisfaction when using the technology [2], [6]. The area of study of human interaction with other elements of a system to achieve adequate usability is Human Factors Engineering, being fundamental to analyze human behavior in face of new technologies and to establish improvements in usability protocols [6], [7].

Usability assessments can be performed both in the pre marketing stages, when the technologies are still in the process of innovation, exploration, experimentation and evaluation of prototypes [8], and in the post-marketing, when the technologies are already inserted in your user environment. To assist in tests and evaluation with users, the construction of a collaborative and interdisciplinary ecosystem in which all the actors involved with technological resources in health interact with each other, has great potential in helping to execute solutions and user-centered technological incorporation [9]. The insertion of suppliers, developers, researchers, engineers, designers, patients and health professionals in the usability evaluation processes before, during and after the implementation of technological solutions in health, helps to improve safety, efficiency and satisfaction of the end user [9]. Understanding the needs of users helps in building a better interaction of technologies and systems, and consequently makes products with more usability (more usable and efficient) and safer [10].

The usability problems that can arise when using technologies, have the potential to cause harm to the patient [11], an incident characterized as an adverse event [1]. Approximately 70% of adverse events related to medical devices are due to some failure on the part of the operator, usually due to limited human skills but often due to inadequate design projects in technological products [12]. To improve solutions focused on better usability for the end user of the technology and to avoid the occurrence of injuries to the patient, there are several techniques that can be applied. Each method has specific principles and characteristics that need to be known to ensure that the analysis of medical technologies is objective and with valid results [11]. Usability techniques can be classified into three stages: data collection, to understand users and the environment of use; human factor assessment methods and risk analysis [11]. The focus of the article will be on descriptive analysis data collection techniques, which are used to collect information from users to be used for the management of health technologies [13], [14], [15], [16], being used as the first approach for applying other human factors techniques [11].

Usability techniques can be widely used in the evaluation and development of new technological solutions focused on user experience, assisting in the management process of health technologies throughout their life cycle, from the pre marketing stages to the post-marketing. The perspective of health professionals can be analyzed during the development of technological solutions, in the incorporation of technologies and in the continuous analysis of products, systems and / or processes involved in health environments. The application of usability techniques reinforces the importance of the interaction of health professionals with Clinical Engineering in the management of technologies, contributing to the democratization of management and assisting in the decision-making processes in the management stages of health technologies. The objective of the article is to provide rapid general descriptive analysis of Human Factors Engineering techniques to know the perspective of the end user of the health technologies in relation to the its usability, and to present the conceptual analysis the importance of application of the techniques during the life cycle of the technologies,, aiming to assist in the management of health technologies more efficient and with quality for the patient.

2. Methodology

This study consists of a descriptive and qualitative research, presenting the possibilities and importance of applying usability techniques throughout the technology's life cycle and to providing a description of the methods for data collection involving medical equipment centered on the end user. In this article, the focus is on usability techniques of data collection, which is a fundamental step to start the processes of research and technological assessments, helping to understand the user's needs and difficulties.

Some tools can be used in data collection: observational analysis, task analysis, interviews, focus groups and surveys (questionnaires) [11]. Observational analysis and task analysis are techniques where the technology operator is observed, and the data is generated from the perspective of the observer, not the technology user. Understanding from the perspective of the individual helps to prevent the observer from introducing the bias of their own assumptions to something that has been observed [11]. In order to extract as much information as possible from the end user, this comparative study focuses on the following techniques: interviews, which are individual meetings where a person responsible for data collection obtains information from one or more participants [17]; focus groups, which consists of a technique in which an interview is conducted with a small group of participants by a trained moderator [11], [17], [20], and survey, which is a method used to collect data from participants through a tool (form/questionnaire) that contains open or structured questions [17], [19]. An additional technique called the Delphi method will also be presented, being a branch of the survey, however it seeks to obtain a satisfactory convergence of opinions from a group of participants through the interactive and sequential application of questionnaires, where in each interaction the feedback is given to each one of the participants related to the questionnaires answered with a summary presentation of the results of the previous round [18].

This research was conducted in two stages: a rapid descriptive analysis of the interview techniques, focus groups, research and Delphi method, and the theoretical approach to the application of data collection in the management of health technologies. Initially, to differentiate each data collection technique for technological development and / or evaluation, a rapid analysis was developed between the techniques of interviews, focus groups, surveys and the Delphi method, containing a description of the advantages and disadvantages of each one, to assist in choosing the technique that best corresponds to the research expectation.

Then, a theoretical study was carried out on the possibilities of using usability techniques throughout the life cycle of health technologies, involving the end user in each of the phases. Data collections can occur in the technological pre-commercialization processes, in the stages of creation, research, development and testing of prototypes. As well as in post-marketing, in the stages of planning and technological selection in healthcare environments and when the product is already inserted in healthcare facilities or in home environments, in the case of technologies that are present in home care.

3. Results and Discussion

Empirical approaches using human factor engineering techniques to identify potential hazards involved in the interaction of users interacting with health technologies or their prototype, provide additional information in the technological development process. For the data to be reliable and valid, it is important that the studies include the intended users, making the information as impartial as possible in order to capture the responses of the participants regarding their needs in the use of health technologies [21]. The processes of application of human factors engineering through usability techniques are recommended in the development of new products for health, in the pre-marketing

stages, being also important in the post-marketing stages so that the technological design improvements are updated constantly, iterating whenever possible with technology users. The following is a brief descriptive analysis of usability techniques and an analysis of the possibilities of applying methods in the management of health technologies throughout the life cycle of medical equipment.

3.1. Rapid descriptive analysis

There is not only a single ideal technique that can meet all needs, therefore, it is suggested a combination and choice of methods that consider the resource limitations for conducting the research [2]. Each technique has its advantages and disadvantages depending on the objective of the study. A more detailed specification of the differences between the techniques of interviews, focus groups, surveys and the delphi method is shown in table 1.

Interviews and focus groups are flexible methods, as the interviewer can conduct in real time, making the most of the interviewee's responses [11]. These methods generate qualitative information about the perceptions, opinions, beliefs and attitudes of individuals or groups of device users and patients. Users may be asked to describe their experiences with existing devices, specific problems they had while using them and provide their perspectives on how a new device should be designed [21].

The surveys are preferably chosen when it is desirable to obtain a greater number of participation, or when there is a difficulty in the availability of an interview and or focus group. This technique may involve a contextual consultation of the user's interaction with health technologies, in order to understand the users' perspectives on the difficulties of interaction with medical equipment.

Some of the main operational differences of the techniques are: surveys and interviews take place individually, as a focus group collectively; the instrument used to collect data from the interview is a script of questions as well as in the focus group, used to guide the moderator and / or the interviewer, in the surveys a questionnaire or form containing fixed and static questions is used for answered by the participants.

The implementation of practices that involve all stakeholders in health technologies is essential in the processes of technological development and assessment, aiming at the discussion, construction and validation of strategies that will help to improve patient care. Courses in the health field, such as nursing, medicine and physiotherapy, have great importance for the sectors of technology, innovation and clinical engineering, as they can contribute to the development of technological solutions for health, bringing the final product or process of the clinical reality of the services. There is often no communication between sectors, and analyzes are carried out without a complete evaluation of information that has the potential to be collected. The absence of the clinical staff in all health technology processes, both in development, incorporation and use, results in projects, products and processes without testing with users, without validating the usability of professionals who use technology on a daily basis as well as in lack of training on best practices in the use of technologies.

Table 1: ADVANTAGES AND DISADVANTAGES OF USABILITY TECHNIQUES [11], [17], [18], [19], [20], [22], [23].

Technique	Description	Benefits	Disadvantages
Individual Interview	Meeting in which the researcher asks questions and the participants individually provide the answers.	- Obtaining information about the user's individual perspectives and experiences and without interference from other people; - Interviewers can delve into issues in real time, to delve into a particular subject of interest. - Interaction in real time between the interviewer and the participant.	- Interviewer can induce bias when asking questions; - The order of the questions can influence the answers; - Does not address how the team does the work in reality; - There is no interaction with others to share ideas.
Focus groups	Meeting with a small group of participants to answer and discuss questions on a specific topic.	- Possibility of greater insight, group stimuli (exchange of experience and opinions among participants); - Group synergism, making participants reflect on factors that might not reflect on their own; - One-time interaction with all participants. - Possibility of the moderator to deepen and instigate certain topics and explore subjects.	- Group tendencies, which can generate confirmation, polarization or oppressed opinions by the participants; - Does not guarantee anonymity (embarrassing or controversial topics may not offer real answers); - Difficulty in selecting and participating in the session (difficulty in uniting all participants) - Session can be dominated by a single participant, distorting the objective of group interaction. - Incorrect judgment of the data and biased moderation.
Survey	Application of a questionnaire to be answered individually by the participant, with structured, semi-structured or unstructured questions.	- Performed anonymously, without having to worry about being exposed to other people; - The participants choose the time and place for the research; - Participant can reflect before taking a survey; - Obtaining standardized data set to conduct statistical analysis.	- Risk of obtaining incomplete information from users' perspectives since it is not possible to formulate questions or delve into a particular subject in real time; - Static tools, it is not possible to have real-time interaction with the participant. - Issues can be misinterpreted, generating inaccurate or incomplete data; - It can be difficult to capture detailed information from past incidents, understand the real causes.
Delphi	Application of a series of questionnaires to a certain number of participants, interspersed with feedback.	- Allows anonymity (equality in the expression of ideas); - Controlled feedback; - Possibility to obtain statistical response from the group, - Minimizing the omission of participants and political manipulation; - Production of a large amount of ideas and the possibility of individual and collective reflection on a subject; - Sharing ideas between experts.	- Difficulty in creating an unambiguous questionnaire, - Difficulty in the selection and quality of the sample; - Participants can give up the research during the occurrence of interactions; - Time to carry out analyzes and feedbacks between interactions; - In order to reach a consensus, some relevant ideas for research can be left out.

3.2. Application in Health Technology Management

Usability techniques for data collection must be applied throughout the management of health technologies. A diagram containing the interaction of the main actors in the health network (health professionals, suppliers, clinical engineers, technicians, patients, among others) with the technologies is shown in fig. 1.

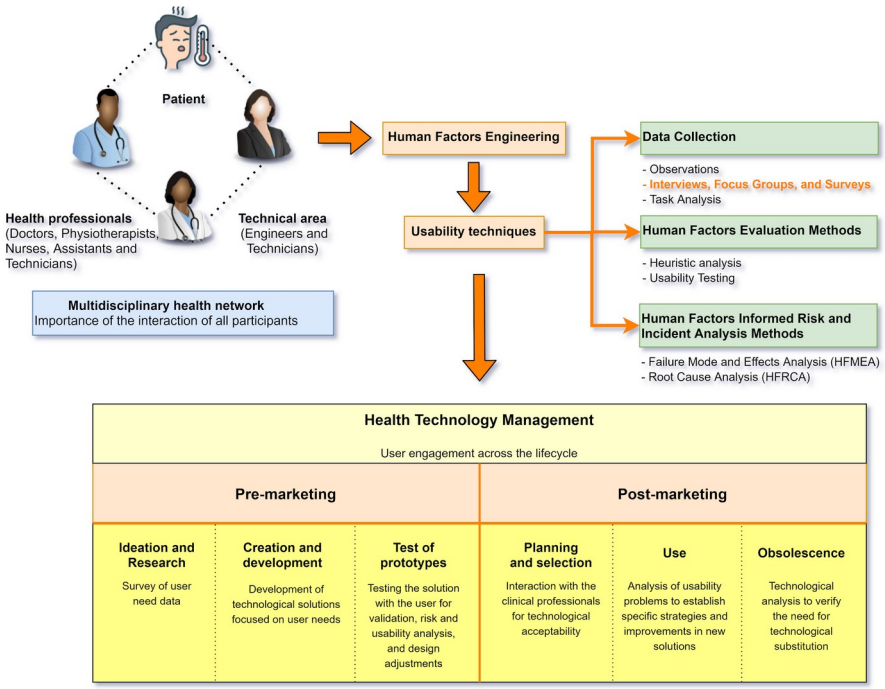

Fig. 1. Application of usability techniques in the management of health technologies.

The pre marketing can be subdivided into three main stages: ideation and research, creation and development, and prototype tests. In the pre-marketing stage, it is the moment when technology is in the development of technological solutions. The insertion of the user in the survey of data is important for knowing the need for technology and the validation of the idea or product. With this it is possible to reduce future complications, as it anticipates possible usability problems that the technology may offer. After idealizing and developing the technology, a product prototype is generated, which is essential to be tested by users to validate the product and verify aspects to make possible adjustments. Many problems with medical equipment can stem from inadequate technology design. By incorporating techniques in technological development, many problems can be anticipated and improvements can be made in advance. In addition to improving patient safety, the application of usability techniques, taking into account the user's perspective during the development of health products, reduces the need for changes in design after the introduction to the market, being a great competitive advantage in cost reduction [21].

The post marketing stages can be subdivided into the stage of planning and technological selection, use and evaluation of obsolescence or final disposal. In the post marketing stage, usability techniques should be applied: for the evaluation of commercially available technologies, interacting with the clinical staff to analyze the feasibility and technological acceptability by operators, as for example in the study applying structured interviews with health professionals to evaluate the process of incorporating infusion devices [24]; to analyze the recurring usability problems that can cause

adverse events in patients, and with this to establish specific strategies and improvements in new solutions; in addition to being able to analyze technologies to verify the need for technological substitution. Many adverse events in healthcare facilities involve technologies. When a technology does not work according to its technical specifications, due to a technical, mechanical or software failure, it can cause an adverse event. In addition, when a technology is not well inserted in its environment and with its operators it can also lead to an adverse event. Another common cause of adverse event is when the equipment is not designed, selected and implemented using the principles of human factor engineering [11]. Thus, employing usability techniques is able to identify the risks and dangers associated with the use of technologies and thus it is possible to mitigate and reduce these problems. As clinical engineering is the area responsible for managing technologies throughout the life cycle, ensuring more quality and safety in the use of technologies, the use of human factors techniques has great potential to assist the area in the most reliable use by end users.

4. Conclusion

The use of usability techniques serves to understand the perception of the end user is essential for the management of health technologies throughout their life cycle, helping to develop more reliable and safe solutions for the end user. The new technological solutions to be developed must be thought of to solve the problem that the population of interest has. The techniques for data collection can be used for market analysis, since it is essential to understand the real need of the end user of the technology to develop a product that is useful and easy to use, enabling the verification and better description of the problem to assist in decision making in the management of health technologies.

The usability tools for data collection analyzed in this study (interviews, focus groups, surveys and the delphi method) are important to start the technological evaluation research. This article has carried out a theoretical analysis of these techniques, showing possible applications and importance in the management of technologies. Each technique has its advantages and disadvantages, and the choice of its application will depend on the objective of each research. Interviews and surveys are techniques to be applied individually, guaranteeing anonymity and reducing external interference in responses. Focus groups, on the other hand, correspond to a method that encourages group interaction, which can be important for a more interdisciplinary and collective perception of problems. For a more complete analysis of the usability of the technologies, joint methods should be conducted, both for data collection discussed in this study and for observations in the usage environment, task analysis, heuristic evaluation and usability tests.

Health consists of an environment composed of multiple actors, which must be thought of in a systematic way, aiming to understand and encompass the maximum of involved. The interaction of the technical area with the clinical staff has great potential to develop better technological solutions in health, focusing on the needs of the end user. The importance of encouraging health professionals to act in technological development, as well as professionals in the technical area, is emphasized as the need to unite both areas. This union is essential for the further advancement of Clinical Engineering, in the discussion, construction and validation of strategies that may assist in the prevention of adverse events and other problems, aiming at a more humanized management of health technologies, focused on the best user experience and focused on quality and safety for the patient.

Conflict of interest

The authors declare that they have no conflict of interest.

References

[1] *Portaria Nº 529, DE 1º de abril de 2013,* Ministério da Saúde. Brasil, 2013.

[2] *Diretrizes metodológicas. Elaboração de Estudos para Avaliação de Equipamentos médico-assistenciais,* Ministério da Saúde. Brasil, 2014.

[3] M. Signori, et al. "Clinical Engineering Incorporating Human Factors Engineering into Risk Management"., IFMBE Proceedings, v. 25, p. 449-452, 2009.

[4] M. A. Delgado. *A engenharia de fator humano como ferramenta da gestão de tecnologia médico-hospitalar para a melhoria da segurança do processo tecnológico nos estabelecimentos assistenciais de saúde.,M.S thesis,* Univ. Federal de Santa Catarina, 2016.

[5] R. Garcia, et al. "Health care technology management applied to public hospitals in santa catarina – brazil", Proceedings of First WHO Global Forum on Medical Devices, 2010.

[6] *ABNT NBR ISO 9241-11: 2011. Requisitos ergonômicos para o trabalho com dispositivos de interação visual,* Associação Brasileira de Normas Técnicas, 2011.

[7] *ABNT NBR IEC 62366:2016. Produtos para a saúde — Aplicação da engenharia de usabilidade a produtos para a saúde,* Associação Brasileira de Normas Técnicas, 2016.

[8] R. Picard et al. "The development of the living lab approach in the health and autonomy sector", Boston, MA, 2015.

[9] B. L. Adam, et al. "Using a medical simulation center as an electronic health record usability laboratory", 2014.

[10] R. Frank & Baxter, et al. "Foundations for Designing User-Centered Systems: What System Designers Need to Know About People", 2014.

[11] *Human Factors for Health Technology Safety: Evaluating and Improving the Use of Health Technology In The Real World,* IFMBE., 2015.

[12] M. Shepherd , Clinical Engineering Handbook*",* 1 ed, *in Safety",* In: DYRO, J., 2004.

[13] CJ. Flewwelling, et al. "The use of fault reporting of medical equipment to identify latent design flaws", 2014.

[14] J. Van der peil, et al. "Design for risk control: the role of usability engineering in the management of use-related risks.", J Biomed Inform, 2012

[15] R. Schnitker, et al. "Combining situated Cognitive Engineering with a novel testing method in a case study comparing two infusion pump interfaces", 2016.

[16] S. Grebin, et al. "Estratégia de análise para avaliação da usabilidade de dispositivos médicos na percepção do usuário: um estudo com pacientes em tratamento de hemodiálise", 2018.

[17] N. K. Malhotra. "Pesquisa de Marketing: uma orientação aplicada", 3. ed, Brasil, 2001.

[18] L. Moricochi, L, et al. "Método Delphi como alternativa para previsão de safras: o exemplo do café. Informações Econômicas", São Paulo, v.25, n.12, 1995.

[19] S. Vieira., et al. "Metodologia científica para a área de saúde", Rio de Janeiro, 2001.

[20] A. K. Moser. "Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis, " *Eur J Gen Pract,* 2018.

[21] FDA. Applying Human Factors and Usability Engineering to Medical Devices. 2016.

[22] L. F. Munaretto, et al. Um estudo sobre as características do método Delphi e de grupo focal, como técnicas na obtenção de dados em pesquisas exploratórias. 2013. Brasil.

[23] S. Fazzolo, et al. "Reflexões sobre o uso da técnica Delphi em pesquisas na enfermagem", 2012.

[24] CJ. Vincent, et al. "How do health service professionals consider human factors when purchasing interactive medical devices? A qualitative interview study", 2017.

[25] R. Peter & Mertens et al. "Emergency Usability Lab - Concept to Evaluate the Usability of Healthcare Systems in Emergencies", 2017.

[26] B. Teresa & Philipsen, et al. "Watch Out! User-centered Feedback Design for a V2X-Smartphone App", 2017.