



Electronic Whiteboard in Hospitals: a systematic review

Lousa Eletrônica nos Hospitais: uma revisão sistemática

Pizarra electrónica en los hospitales: una revisión sistemática

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ABSTRACT

Keywords: Systematic review; Medical informatics applications; Information technology

Objective: The present study aimed to review the literature on electronic whiteboards and identify the processes, techniques, methods, practices, tools and difficulties for the implementation of this new technology in hospitals. **Methods:** Systematic searches of relevant bibliographic databases identified studies about electronic whiteboards adoption by healthcare professionals. Two hundred forty nine (249) papers were collected, twenty seven (27) were selected for full reading. **Results:** Positive and negative effects on the use of the electronic whiteboard were diagnosed. This review allowed to highlight issues regarding design, technical concerns and how whiteboard system works. **Conclusion:** The knowledge obtained by the study of previous work allowed the identification of practices that could effectively promote the successful adoption of electronic whiteboards. Perception of the benefits was the most common facilitating factor, followed by the changes in the work performed in hospitals. Issues regarding familiarity with information e communication technologies were limiting factors identified.

RESUMO

Descritores: Revisão sistemática; Aplicação de informática médica; Tecnologia da informação

Objetivo: Este estudo tem como objetivo revisar a literatura sobre lousas eletrônicas e identificar os processos, técnicas, métodos, práticas, ferramentas e dificuldades na implantação dessa tecnologia em hospitais. **Métodos:** Buscas sistemáticas em repositórios de bibliografia relevante de estudos sobre a adoção de lousas eletrônicas por profissionais da saúde. Duzentos quarenta nove textos (249) foram recolhidos, vinte sete (27) foram selecionados para leitura completa. **Resultados:** Efeitos positivos e negativos da lousa eletrônica foram diagnosticados. Esta revisão permitiu destacar alguns fatores relacionados ao design, problemas técnicos e como o sistema da lousa funciona. **Conclusão:** O conhecimento obtido com o estudo de trabalhos anteriores permitiu a identificação de práticas que podem efetivamente promover o sucesso na adoção de lousas eletrônicas. A percepção de benefícios foi o fator mais comum, seguido pelas mudanças nas práticas de trabalho em hospitais. Problemas relacionados à familiaridade com as informações e as ferramentas de comunicação foram os fatores limitadores identificados.

RESUMEN

Descriptores: Revisión sistemática; Aplicaciones de informática médica; Tecnología de la información

Objetivo: El presente estudio tuvo como objetivo revisar la literatura sobre las pizarras electrónicas e identificar los procesos, técnicas, métodos, prácticas, herramientas y dificultades para la implementación de esta nueva tecnología en los hospitales. **Métodos:** Búsquedas sistemáticas de las bases de datos bibliográficas pertinentes identificaron estudios sobre pizarras electrónicas adopción por los profesionales de la salud. Doscientos cuarenta y nueve (249) artículos han sido recogidos, veintisiete (27) fueron seleccionados para la plena lectura. **Resultados:** Los efectos positivos y negativos sobre el uso de la pizarra electrónica se diagnosticaron. Esta revisión ha permitido poner de relieve los problemas relativos al diseño, las preocupaciones técnicas y la forma en la pizarra las obras del sistema. **Conclusión:** El conocimiento obtenido por el estudio de la obra anterior permitió la identificación de prácticas que pueden promover eficazmente la adopción exitosa de las pizarras electrónicas. La percepción de los beneficios fue el factor facilitador más común, seguido por los cambios en el trabajo realizado en los hospitales. Las cuestiones relativas a la familiaridad con las tecnologías de comunicación e información han sido los factores limitantes identificados.

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INTRODUCTION

We live in a historical moment where the technology advances are conducted in an extremely fast way. Every single area in the market can take advantage of the technological novelties. Smartphones, tablets, laptops and others devices can be bought by people of any financial class, due to the great variety of products available.

This paper addresses a relatively new technology. The electronic whiteboard is a presentation tool, a “virtual” version of the dry-erase board. It is commonly used in classrooms or auditoriums and allows the user a greater interaction with the content to be presented⁽¹⁾.

The shortcomings of dry-erase whiteboards include that information can only be found on multiple dry-erase whiteboards (allocated in different places) through a repeated and manual data entry. Therefore, the information in different sites is rarely updated in real time, which incurs risk of incompleteness and inconsistency. Furthermore, the information is lost when erased and there is no possibility of automatic integration with other information systems⁽²⁻³⁾.

To address these shortcomings, electronic whiteboards are replacing the old dry-erase to provide distributed information access to clinicians from any computer⁽³⁻⁵⁾. With the increase of the process of transitioning from dry-erase to electronic whiteboards in hospitals, the publications in the literature that describe the results of these experiences arise.

This study presents a systematic review of the published literature to verify which are the trends, the consequences of the implementation, positive and negative effects and the feedback received from the users of the electronic whiteboard in hospitals.

Previous works showed reviews about whiteboard implementation in a specific hospital department or country. In a related work, Rasmussen and Kushniruk⁽⁶⁾ presents a systematical review of the published literature of implementing electronic whiteboards in emergency medicine. Otherwise, this work presents a literature review considering publications in any hospital department.

This paper is organized as follows. Section 2 presents the methodology to search and select papers for this study. Section 3 discusses the results, including positive and negative aspects, design, methods and practices to promote the use of the electronic whiteboard in hospitals. Finally, in section 4 the conclusions and directions for future work are presented.

MATERIALS AND METHODOLOGY

In this study a systematic review was conducted, based mainly on the steps proposed by Kitchenham⁽⁷⁾. This review aims to search and gather knowledge regarding multiple elements of implementing an electronic whiteboard in a hospital.

The materials used were papers and texts, selected based on inclusion and exclusion criteria elaborated by the authors of this article.

Research Question

Five questions are addressed in this study:

Q1 – Has the electronic whiteboard implementation in

hospitals been beneficial to the same?

Q2 – Which are the processes, techniques, practices and tools that promote the use of the electronic whiteboard in the medical field?

Q3 – Which are the benefits of the electronic whiteboard implementation in a hospital environment?

Q4 – What are the limitations, difficulties and barriers found in the implementation of this technology?

Q5 – What do the results obtained with the implementation of the electronic whiteboard suggests?

Keywords

Each research question points out that the definition of keywords to search for texts and papers are essential to elaborate a systematic review. The definition of these keywords depends on the experience of the researchers involved. The keywords used in the search process were: “Electronic Whiteboard in Medicine”, “Whiteboard in Medicine”, “Electronic Whiteboard in an emergency department”, “Medical Whiteboard”, “Electronic Whiteboard”, “Electronic Emergency Department Whiteboard”, “Mobile Whiteboard System”, “Whiteboard System”, “Electronic Whiteboard System”, “Interactive Whiteboard” and “Computerized Whiteboard System”.

Inclusion and exclusion criteria

During the search process, inclusion and exclusion criteria were applied. Reading the abstracts and titles, those papers or texts that met the criteria was selected for full reading. The inclusion criteria are:

- Processes, techniques, methods, practices or tools adopted to promote the use of the electronic whiteboard in hospitals.

- Difficulties, problems or barriers found in the implementation of this technology.

- Benefits of using the electronic whiteboard in hospitals.

- Design description of the electronic whiteboard, and the integration with other systems.

The exclusion criteria are:

- Processes, techniques, methods, practices or tools adopted to promote the use of the electronic whiteboard in other areas not related to hospitals.

- Papers or texts written in languages other than English or Portuguese.

- Papers and texts not available for full reading.

- Papers and texts published before the year 2003.

Search strategy

The texts and papers searched for this review were, initially, automatic, utilizing the keywords to search in three different electronic indexed databases: ScienceDirect, Pubmed and GoogleScholar. The author searched throughout the results to find related titles and separated them for full reading.

The references of the already selected articles were covered, in order to locate other texts that were not found in the automated searches. This whole process lead to a selection of twenty seven (27) papers for full reading.

RESULTS

A total of two hundred forty nine (249) papers were

assessed for eligibility. Of these, two hundred twenty two (222) were excluded from the review because they did not meet inclusion criteria. Twenty seven (27) papers that fulfilled the inclusion criteria were selected for detailed evaluation.

Of the twenty seven (27) papers and texts, twenty five (25) are about a case study in a single or multiple sites. This seems to be a dominant type of study in the area, possibly because it's hard to conduct controlled experiments in a

scenario so volatile as a hospital. There are five (5) studies about comparisons between the dry-erase and the electronic whiteboard. The papers and texts that treat this subject present benefits and difficulties found in the implementation of the new technology, that is replacing the old one. Table 1 summarizes the characteristics of the selected papers and texts. Most of them refer to studies about the implementation of the electronic whiteboard.

Table 1 – Papers/Texts revised

Reference/Year	Scenario	Type	Topics	Publication type
Abujudeh et al. (2010) ⁽³⁾	Emergency Radiology Department, aprox. 101.000 exams per year	Single site, case study	Electronic whiteboard vs dry-erase, system description, effects on work practices.	Journal Article
Aronsky et al. (2008) ⁽⁸⁾	Adult and pediatric emergency department	Multiple sites, case study	Electronic whiteboard vs dry-erase, system description, effects on work practices.	Journal Article
Belser et al. (2005) ⁽⁹⁾	Emergency department	Single site, case study	Implementation and design considerations	Book chapter
Bisantz et al. (2010) ⁽²⁾	Emergency department, aprox. 95.000 visits per year	Single site, case study	Electronic whiteboard vs dry-erase, information display changes	Journal Article
Boger (2003) ⁽¹⁰⁾	Emergency department	Single site, case study	Implementation, considerations, effects on patient length of stay	Professional report
Brewster Mallalieu et al. (2011) ⁽¹¹⁾	Radiology department	Multiple sites, case study	Implementation of a electronic whiteboard for process management	Journal Article
France et al. (2005) ⁽¹²⁾	Emergency Department	Single site, case study	Effects of the electronic whiteboard in work practices	Journal Article
Fromme and Pralle (2003) ⁽¹³⁾	Multimedia conferences for teleconsultations	Case study	System description	Journal Article
Hertzum (2011) ⁽⁴⁾	Two emergency departments and one pediatric department	Multiple sites, case study	Staff expectations towards the electronic whiteboard	Journal article
Hertzum (2012) ⁽⁵⁾	Emergency department	Single site, case study	Distribute use of the electronic whiteboard	Journal article
Hertzum and Simonsen (2010) ⁽¹⁴⁾	Two emergency departments and one pediatric department	Multiple sites, case study	Staff expectations towards the electronic whiteboard	Conference article
Hertzum and Simonsen (2013) ⁽¹⁵⁾	Emergency department	Single site, case study	Design descriptions, benefits and limitations of the electronic whiteboard	Journal article
Jensen (2004) ⁽¹⁶⁾	Operational center	Single site, case study	Benefits of the implementation of a electronic patient tracking system	Professional report
Lu and Lajoie (2008) ⁽¹⁷⁾	Comparative study of collaborative tools for decision making	Case study	Dry-erase board vs electronic board	Journal article
Mainthia et al. (2012) ⁽¹⁸⁾	Otorhinolaryngology department	Single site, case study	New functionality for surgical procedures	Periodical journal
Mendonça et al. (2004) ⁽¹⁹⁾	Biomedicine department	Case study	Use of the electronic whiteboard as an extension of the hospital inner system	Journal article
Patterson et al. (2010) ⁽²⁰⁾	Two emergency departments, aprox. 22.500 visits per year	Multiple sites, case study	Study of the electronic whiteboard functions and data precision	Journal article
Pennathur et al. (2007) ⁽²¹⁾	Two emergency departments	Multiple sites, case study	Effects on work practices	Conference article
Pennathur et al. (2008) ⁽²²⁾	Emergency department, aprox. 95.00 visits per year	Single site, case study	Dry-erase board vs electronic board, changes in information content	Conference article
Rasmussen and Kushniruk (2013) ⁽⁶⁾	Emergency department	Single site, survey	Positive and negative effects on implementing an electronic whiteboard	Journal article

Rasmussen et al. (2010) ⁽²³⁾	Two emergency departments	Multiple sites, case study	System description and considerations on work practices	Conference article
Tiwari et al. (2013) ⁽²⁴⁾	Pre surgical practices	Single site, case study	Use of the electronic whiteboard	Journal article
Unluturk (2013) ⁽²⁵⁾	Operational center	Single site, case study	Use of the electronic whiteboard by the nurses	Journal article
Vest et al. (2006) ⁽²⁶⁾	Emergency department	Single site, case study	Development and implementation	Journal article
Wears et al. (2003) ⁽²⁷⁾	Four emergency departments	Multiple sites, case study	Changes in work practices	Conference article
Wong et al. (2009) ⁽²⁸⁾	Department overview	Single site, case study	Development, changes in work practices, implementation	Journal article
Xiao et al. (2007) ⁽²⁹⁾	Emergency department	Single site, survey	Importance of the electronic whiteboard in communications	Journal article

Positive Effects

Abujudeh et al.⁽³⁾, Aronsky et al.⁽⁸⁾ and Wong et al.⁽²⁸⁾ describe cases where there was an improvement in communications between the staff and a quicker way to access information through the electronic whiteboard; the data is updated in real time and is also traceable. Wong et al.⁽²⁸⁾ complements that idea, saying that the new whiteboard provides a better overview of the hospital actual status, an positive effect also seen in Brewster Mallalieu et al.⁽¹¹⁾, Hertzum⁽⁴⁾, Jensen⁽¹⁶⁾ and in Belser et al.⁽⁹⁾.

Mainthia et al.⁽¹⁸⁾ show in their study, that with the addition of a preventive checklist for operations, the electronic whiteboard allowed greater acceptance of pre-operative practices by clinicians. As seen in Tiwari et al.⁽²⁴⁾, the information presented on the electronic board helps coordinate surgery practices. At Boger⁽¹⁰⁾ and Jensen⁽¹⁶⁾, it's noticeable that the new board allowed a better control of the patient flow by the staff of the emergency department.

In the Lu and Lajoie⁽¹⁷⁾ study, the group that utilized the electronic whiteboard was able to easily share information and built some understandings about the patients. At this same study, the electronic whiteboard system was portable, accessible through laptops.

Negative Effects

Bisantz et al.⁽²⁾, Wong et al.⁽²⁸⁾ and Xiao et al.⁽²⁹⁾ treat about the inflexibility of the electronic whiteboard. It didn't offer the same level of customization as the dry-erase whiteboard, and the time to input new information on the electronic whiteboard was longer than usual. The risk of exposing confidential information is discussed in

Abujudeh et al.⁽³⁾ and at Wong et al.⁽²⁸⁾. In both studies, reports had to be handmade, so that confidential information was not exposed.

Negative influence in the coordination between clinicians is seen at Pennathur et al.⁽²¹⁾ and at Wears et al.⁽²⁷⁾. Both studies quote that the clinicians used the electronic whiteboard in an isolated manner, taking the work away from a collaborative effort.

Bisantz et al.⁽²⁾, Patterson et al.⁽²⁰⁾, Pennathur et al.⁽²²⁾ and Wears et al.⁽²⁷⁾ show us in their studies that the new board was less precise than the old dry-erase whiteboard.

The electronic whiteboard in these studies was less effective in providing information related to patient care coordination.

Design Considerations

Fromme and Pralle⁽¹³⁾ show us in their studies that the electronic whiteboard is a tool commonly used in conference systems. In the reviewed literature, we can find examples of graphic interfaces utilized in electronic whiteboards, as well the description of the system integrated in it. Some of the texts and papers describe how the implementation was made, with details of the interaction between developers and users.

The electronic whiteboard is most seen in large displays, distributed throughout the hospital. The displays can be touch sensitive, as seen at Aronsky et al.⁽⁸⁾ and at Hertzum and Simonsen⁽¹⁵⁾, or regular plasma monitors, as seen at Abujudeh et al.⁽³⁾

An important aspect of the electronic whiteboard system is the possibility of accessing it in other devices, like laptops and desktop computers. At Unluturk⁽²⁵⁾, the electronic whiteboard system can be accessed by any of the computers in the emergency department, and at Rasmussen and Kushniruk⁽⁶⁾ and at Rasmussen et al.⁽²³⁾ the electronic whiteboard system is browser based, providing flexibility to the access. At Mendonça et al.⁽¹⁹⁾, the whiteboard application provides a framework to handle a variety of tasks. At Vest et al.⁽²⁶⁾ and at Boger⁽¹⁰⁾, the system was built in a collaborative manner, connecting users and developers, so that the system attends the expectations of the future users. All these researches show that the new whiteboard, to attract more users, must have a friendly user interface, otherwise, final users can reject it.

Processes and practices

Aronsky et al.⁽⁸⁾ says that the electronic whiteboard implementation had some objectives to achieve, if the purpose of the board is be more acceptable to future users. The new whiteboard should serve as an information center for the emergence department and provide a high level of resumed data to facilitate communication between co-workers, support collaborative work and serve as reference to obtain more detailed information.

At Wong et al.⁽²⁸⁾, during the period of training and

installation of the electronic whiteboard system, technicians and specialists in the hospital workflow were present full time to provide support. The feedback from the users was documented, and reviewed weekly to be a part of an improvement log, that would be used for future implementations.

Hertzum⁽⁴⁾ says that the transition between boards must be made in a non-threatening way. The design of the electronic whiteboard should be similar to the old whiteboard, and provide simple, but precise information, in order to be more user friendly.

In Bisantz et al⁽²⁾ study, pictures of the dry-erase whiteboard were taken systematically. After 18 months of implementation, screen shots of the electronic whiteboard were also taken for comparison. This type of analysis must be conducted with the purpose of identifying all functions and information that should be available in the display of the electronic whiteboard.

CONCLUSION

The work practices, including coordination and

communication, are much affected by the introduction of the electronic whiteboard. It is not surprising, because dry-erase boards have a very important role in such aspects. We can also see that the electronic board has its positive and negative effects on work practices.

The communication between developers and future users is essential to a successful implementation of the electronic whiteboard. It is also noticeable that the design of the new board tends to be very similar to the dry-erase board. The purpose is to make the new board more user friendly and accessible. The electronic whiteboard should be as intuitive to use as conventional whiteboard.

Overall, the results obtained in this systematic review are mixed and somehow inconclusive, because of the inconclusive nature of the reviewed literature. However, the results can be used as a foundation to other studies about the same subject.

A deeper study on effects of the implementation of the electronic whiteboard is needed, to indicate which factors cause these effects. The integration of the whiteboard system with mobile technologies is also a topic to be discussed in future studies.

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