The role of kiosks on health services: a systematic review

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Abstract

Introduction: Difficulties in accessing to healthcare services have been described, being a motor to new solutions to improve clinical care. The number of patients in hospital emergency departments has been increasing, and a significant part of this affluence are patients of low clinical severity. Kiosks are a new solution in healthcare facilities, allowing to reduce the waiting times and to increase efficacy and users satisfaction.

Purpose of the Study: The objective of this systematic review was to analyze the efficacy of the use of self-service kiosks by patients compared to the standard procedures associated with each domain.

Methods: An systematic review of studies on diagnosis and triage kiosks, published from january 2009 to october 2019 was performed in the databases PubMed, IEEE Xplore, Web of Science, Cochrane Library, ScienceDirect and Scopus. PRISMA guidelines were followed.

Results: Eight studies included 2298 participants in total with the mean age of these ranged from 16 to 94 years. The domains presented vary from triage to face-to-face consultation replacement. The kiosks of the various studies have as their main objective to measure vital signs through biosensors and extract health information from patients according to the domain applied. The most significant outcomes in studies was systematized and clarify, offering a more concrete interpretation of the effectiveness of kiosks in health services.

Conclusion: The results suggest that self-service kiosks are an effective medium to apply in the healthcare services in different environments. Good results were obtained in kiosks usability. Thus, kioks could be an alternative to standard procedures.

Keywords

Health Kiosk; Self-Service Kiosk; Feasibility; Emergency Departments: Primary Care; Systematic Review

Abstract (251/250 words)

Introduction

Healthcare is delivered in a variety of settings, including small or medium-size practices, hospital outpatient departments, community health centers, and integrated care systems. Four-fifths of adults surveyed in 2006 have a usual doctor or source of care. However, only 27% of them could easily contact their physician using the telephone, obtain care or medical in small number of hours, or experience timely office visits [1].

The relative shortage of physicians in rural areas of the United States of America (USA) is one of the few constants in any description of the US medical care system. The lack of access to primary care affects not only rural areas but also emergency departments. Forty-six per cent of respondent patients to USA, two-thirds would have consulted a primary care physician instead of visiting the emergency department if they had got a consultation [1].

Emergency departments (ED) crowding remains an important topic that has received special attention from health professionals and decision makers [3]. Delays in treatment interventions due to crowding increases mortality and increased medical errors ED crowding provokes increased waiting time for patients before physician visit decreasing patient satisfaction and also hard outcomes [5].

For instance, in US hospitals the probability of being examined by a physician, within the time recommended at triage, declined by 30% from 1997 to 2006; waiting time increased from 46.5 minutes to 58.1 minutes from period between 2003-2009 and the length of stay in ED increased from 132 minutes in 2001 to 154 minutes in 2005 [5]. In a study realized outside the USA in fifteen countries, showed that one of the major factors for ED crowding is ‘‘inappropriate use’’ and the rise in ED visits is often attributed to use of the ED for problems that could potentially be cared for in a physicians’ office [6]. It is believed that these patients of low clinical severity, represent internationally 24% - 40 % [7].

Technology improvements allowed new alternatives to provide health information and advise patients over the Internet, television, and telephone. Moreover, it gave to the population the possibility of obtaining health data parameters and make use of this information, without having to go to a hospital or other type of medical facilities [8].

Studies on telemedicine have shown success in reducing the geographical and time obstacles incurred in the receipt of care in traditional modalities with the same or greater effectiveness [22].

However, others medical devices that are emerging permit to create a system that can help in the collection of vital signs from patients. These devices, together with an interface, usually a computer or tablet, allow the conception of a system that can collect and evaluate these parameters and provide useful feedback to users according to collected data. [8]. Self-service kiosks are independent units that contain computer programs that provide the user with information services. They are widely portable, so they can be moved and adapted for newest service's needs. Kiosks-based programs are primarily interactive and generally have a simplified user interface, such as a touch screen or keyboard [9].

Assistance in the administrative processes, screening, health diagnoses and replacement of face-to-face consultations are examples of domains where kiosks are applied [9]. The kiosks in the triage domain work as a tool as a pre-consultation tool with the objective of giving healthcare professionals more time to assess a larger number of patients [8]. One study demonstrated that placing kiosks in waiting rooms, users were able to use the time between patient registration and meeting with the physician, allowing patients to use their waiting time more productively [10]. Concerning diagnostic systems, they were designed to facilitate the diagnoses of common diseases by performing a set of pre-established physiologic tests. Data obtained are then compared with the information available in the kiosk workstation [11, 12].

Other alternatives to the location of this application would be in public places, for population screening or control, as a form of health surveillance of elderly communities [8]. Particularly in these places with difficulties in electricity, transportation, communication and shortage of doctors, medicines and other resources, this technology has been increasingly sought after, replacing the face-to-face consultation. A study in India indicates that the doctor-patient ratio for primary care in rural areas is only 39.8 doctors per 100,000 people, compared to 53.3 doctors per 100,000 in urban areas [13].

Self-service kiosks continue to emerge as one of the new technologies to offer a solution in the area of health, filling the gap between people who have access to health information technologies and those who do not have access, in addition to reducing waiting times in ED and the burden imposed on health professionals [9].

The objective of this systematic review is to analyse the efficacy of the use of self-service kiosks by patients compared to the standard procedures associated with each domain.

Methods

Search strategy

This systematic review was conducted in PubMed, IEEE Xplore, Web of Science, Cochrane Library, ScienceDirect and Scopus, considering only the articles published since January 2009 to October 2019. Search terms included ‘hospital kiosks’, ‘public health kiosk’, ‘health kiosk’, ‘healthcare kiosk’, ‘systematic review kiosk’, ‘hospital kiosk and medication’ and ‘urgency kiosk’. The use of Boolean operators among the terms, in addition to the keywords, was a strategy used to obtain more restricted searches (queries are exposed in electronic supplementary materials). Regarding the choice of the mentioned terms, the keywords were considered, related to kiosks in health area. Publications in newspapers and books were also considered for analysis.

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were followed [14].

Inclusion and exclusion criteria

The research question was defined through PICO (Population, Intervention, Comparison, and Outcomes) method. Studies of self-service kiosks were included that stand out mainly in the fields of clinical diagnosis, triage, replacement of face-to-face consultation. Only studies in English were considered. Review articles and studies without abstracts were not included. Studies related to the domains of management, information, prevention, telemedicine, paediatric care, and specific pathologies were excluded during the selection process, as well as articles that did not present full text or with irrelevant results for the study.

Study selection

Data collection and their analysis were carried out independently by 2 reviewers (JS and PP), and articles that met criteria were reviewed by the other two reviewers. Each reviewer classified the articles based on the main aspects of this research, in order to obtain the relevant articles for the final review. Any difference of opinion was resolved through discussion and consensus meetings.

Data extraction

Two reviewers (JS and PP) independently extracted a set of information from the studies, using the CASP (Critical Appraisal Skills Programme) [15] checklist to support extraction. Throughout this process, both reviewers verified the methodological quality of the studies through the limitations referenced by them to identify possible bias risks.

Data items

The extraction variables taken from each study were as follows: (1) Domain (process that the kiosk will perform), (2) Area (location of the kiosk), (3) Country (country where the kiosk was tested), (4) Study period (length of the kiosk test period), (5) System Objective (purpose of the kiosk), (6) Architecture (characteristics of the system architecture), (7) Population (characteristics of the population that intervened in the use of the kiosk), (8) Study parameters (metrics used to evaluate the kiosk) and (9) Results (effects of the application of the kiosk).

Regarding the system architecture, which refers to the type of system implemented, description of the biosensors and their connectivity, in case of use and presence of touchscreen. The population variable contains the number of participants who used the kiosk and their average age or range of ages. It also includes the presence of support in the use of the kiosk or patient referral.

Results

Study selection

According defined search strategy, we identified a total of 1438 studies from the database search and 11 studies from the other sources. After the removal of duplicates (n = 820) and rejection after abstract reviewing (n = 499), 130 studies in healthcare kiosks were obtained. Applying exclusion criteria (n = 97) 33 studies were obtained. After full article reviewed, more studies were rejected because they did not present relevant results to the study (n = 25). In the final analysis, 8 studies were considered for the systematic review. A summary of this selection is shown in figure 1.

Study characteristics

In all 8 studies, 4 were considered from the triage domain and 4 from the face-to-face consultation replacement domain. Of all the associated countries, 4 belong to America, 2 to Asia, 2 to Europe and 1 to Oceania. Regarding the area, 5 studies were conducted in health areas (Hospital, Polyclinic, Clinic), and the remaining outside this context (Community room, Rest Homes, Private Apartments, University, Villages). The study period varies between 8 weeks and 12 months. The total number of participants was 2298 and the mean age of these ranged from 12 to 94 years. Most kiosks provided assistance. The main objective of the system in the various studies is to measure vital signs and extract health information from patients according to the domain applied. The type of architecture of the system varies between Web App and Software. Most studies mentioned the biosensors (height, weight, blood pressure, pulse oximeter, pulse rate, glucometer and heart rate) present and their type of connectivity at kiosks. The use of touchscreen was predominant in most studies. The study parameters identified in the studies meet the evaluation of the effective of the kiosks. The characteristics of the studies are summarised in table 1 and 2.

Authors of the studies were contacted to obtain missing information or confirmation of data extracted for the systematic review. In the study [16], the age range was confirmed by the author, since this parameter was not present in the article.

Risk of bias within studies

To analyse the risk of bias, the limitations of each study were extracted. The use of assistance proved to be a common limitation in most studies, except for the studies [8, 17]. Regarding the study [18], the kiosk was tested only at peak hours, meant that ED stressors would be felt most during these times, and the kiosk's success or failure would be highlighted. The single centre design and modest sample size were the factors that contributed to the increase in the risk of bias in study [10]. In the study [8], the usability tests were made at a Sciences Faculty a lot of participants had some technical background, and it was not the first time they interacted with medical de- vices or a touchscreen interface, increasing usability. The use of the kiosk because it is not accessible throughout the day and only at certain times became a limitation for the study, as well as the modest sample size it presents [17].

Study results

This review systematizes and clarifies the results of the various studies related to healthcare kiosks. Thus, the various outcomes will enable the creation of relationships between studies, offering a more concrete interpretation of the effectiveness of kiosks in health services. There are 4 randomized studies and 4 observational studies, with study periods ranging from 21 days to 12 months. Regarding the population that used the kiosk, it was mostly senior. The biometric sensors used in the various kiosks were BP (blood pressure), scale, pulse oximeter, glucometer, heart rate, and height, with BP being the sensor common to all kiosks. The BP sensor showed a low accuracy in the results obtained from the measurements [17,19]. All studies showed high results in relation to usability. In addition to patients, health professionals also showed satisfaction and acceptance by the system [10, 19]. However, some patients felt that the kiosks were impersonal [19].

Discussion

Most studies report that kiosks have been implemented in healthcare units, except for the following studies [8, 16, 21] that implemented in Universities, villages (a small community or group of houses in a rural area) and community rooms. Despite this, some studies [8, 16] present kiosks for screening or continued monitoring, prior to consultation, which may change future of healthcare, due to the location of their implementation in different healthcare unit environments.

Some studies tested the [10, 17, 16] implementation of kiosks in developing countries. However, only two studies aim at the need to implement kiosks, due to the growth of the aging population and frequent shortage of doctors in these countries. Thus, the use of kiosks in developing countries allows to overcome the scarcity of health care services [10, 17]. The study period is considerable in most studies, except in [16], in which only 21 days of testing was explicitly mentioned, which may cause unfeasible results due to the short test period.

The type of architecture of the systems varies between Web App and Software, however none of these provide evidence of your choice.

Almost all studies use biosensors, but only in some of these the data have transmitted the data via Bluetooth [8, 16, 21]. This communication brings benefits in terms of interoperability and accessibility, however, they can cause some errors impossible to correct and the only option is to skip the exam and move forward [16]. The studies [8, 16, 20] present biosensors that use batteries as an energy source, creating the need for their replacement, which may indirectly interfere with the usability of the system [8, 16].

Half of the studies explicitly indicate the use of touchscreen [10, 8, 16, 20], that allows to offer direct and easy to use interfaces. The authors of the studies [8, 16] affirm that this feature of the kiosk allows us to understand the unintentional parts that the user interacts, promoting subsequent changes to correct this problem and improve the flow of the application. Touch screen also helped the older people who have hearing or speaking difficulties by showing messages or pictures [20].

The number of participants in the studies was higher when applied to emergency departments [18], and villages [16], where the kiosk is directed for all kinds of patients. In contrast, the studies that presented a lower number of patients are due to kiosks being associated with patients with chronic diseases [17] or elderly [20, 21]. Still in the study [8] the number of patients was possibly limited due to the place where the kiosk was implemented in a university, offering a smaller number of participants.

The studies [20, 21] are applied to participants with a more advanced age group proving that elderly patients demonstrate capacity and are willing to participate in

technological interventions.

Only four randomized studies [18, 10, 17, 19] allowed a controlled comparison of the use of the kiosk and the standard procedures normally realized. Most of these randomized trials reported the effective use of care, both for referral of patients to the kiosk [18] and to assist in the use of the kiosk [10, 19]. This parameter is considered a limitation and may generate results at the level of usability unreliable, because, as the patient presents help in the use of the kiosk, it will be influenced for the ease of use of it.

Regarding the availability of the use of the kiosk, some studies [18, 17] were conditioned only to a certain period of use. In the first [18], because the kiosk is only tested during peak hours, the authors believe that the success or failure of the kiosk will be highlighted. Regarding the second [17], as the kiosk is only accessible in a certain period of the day, clinic hours, this does not allow patients to use it when intended, conditioning them.

The time of use of the kiosk in relation to the time of the standard procedure performed by health professionals was shorter, providing a strong proof of concept for the use of kiosks in ED [18]. The use of kiosks allowed more time for physicians to be allocated to the treatment of other patients, since the system allowed performing the procedures, which would normally be performed by health professionals [10, 17, 19]. By utilizing a kiosk for taking blood pressure and performing other activities means the physician can spend more time talking with the patient [23].

The quality of the measurements performed by the sensors compared to those performed by health professionals was another evaluation performed in [10, 17, 19]. The accuracy of the measurements performed in the kiosk was evaluated, in [19], by patients, who stated that the measurements of the BP were accurate, however some of these reported higher values of BP. The physicians explained that this happened because patients did not have the chance to sit and wait in the reception area before measuring their BP. These instructions regarding the BP sensor should be considered at any kiosk to reduce unrealistic measurements. In [17], a discrepancy be- tween the values of measurements made by the kiosk and by clinical professionals was described, affecting the confidence in the system.

The implementation of the kiosk translated into significant savings in relation to face-to-face consultations and flexibility of alternative health

service options, offering a better cost-benefit option to patients [17].

The kiosk may be a feasible care option; however, it presents a low sample size, which contributes to limit the generalization of the results, as it happens in the study [10,17].

The remaining four studies [8, 16, 20, 21], non-randomized, had a minimum study period of 21 days, with no effective use of the kiosk only in [8]. In the study [16], only users in Brazil did not need help with the use of the kiosk. The fact that patients do not need assistance makes the results of the usability of the kiosk more reliable.

As in the randomized studies, these also present high results in terms of usability, however, some problems were found, such as the BP sensor taking a long time to collect data, calibration of the scale and amount of clothing that the patient carries [8]. Incorrect placement or difficulty in placing the BP cuff and the size of the kiosk, were also problems identified [16, 20]. Most participants in the study [8], had technological knowledge, constituting a limitation, which may contribute to an incorrect increase in usability. In opposition the study [16] provides evidence that even poor and less educated patients were able to use the kiosk, not offering a limitation to the study.

The time of use of the kiosks, in the process of using the system was not highly time-consuming, which is beneficial considering the possible use of cases [8]. The time of use, in [16] was slightly longer than the previous study since the study [8] presents a set of users with a technological background. In relation to the study [21], the time of use was the longest, due to the collection of cognitive evaluation data performed at the kiosk. In addition, the study required patients to be enrolled for a period of two months, which made it more conducive to withdrawals.

Sensors that present more than one pattern of use, when used by patients, caused difficulties in use [16]. This suggests that care must be taken with the choice of sensors, in order to make them as easy as possible to use.

The costs involved in all the studies were economic. A modularity which allows for the health kiosk to be easily adapted for different use cases [8] and the application of kiosks in community environments (eliminating the need for monitoring equipment to be installed in every residence) [21].

According to the data analysed, there is various evidence that demonstrates the effectiveness of self-service kiosks compared to standard procedures.

Limitations

Our study has several limitations. As we established specific inclusion and exclusion criteria meant that the number of final studies for review was reduced. Another possible limitation of the study is use of key words that might hadn't been sufficient to retrieve all the possible articles related to use of self-service kiosks in health area. The vast amount of data was difficult to present in a complete and simultaneously understandable format, such that some detail was euthanized for ease of interpretation. The quality of the studies varied, only half of them were randomized and controlled with usual care. The absence of information on illiteracy and educational level of the population in all studies would build other limitations.

Conclusions

Self-service kiosks are an effective technology to apply in the healthcare sector in different environments. Good results were obtained usability of these systems, although in most studies the presence of an assistance was necessary. Regarding the comparison with standard procedures, kiosks were an alternative, recommended by patients and health professionals. More studies are needed to investigate the long-term impact of health kiosks, especially in emergency settings and in populations that have difficulties in access to primary care.

Conflict of interest

The authors declare that they do not have any conflict of interest.

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Figure 1. Flow of studies in systematic review

Table 15 Summary of the included studies and the intervention

Authors	Domain	Area	Country	Study period	System objective	Architecture				Population			Study parameters	Results
						Type	Biosensors	Sensors Connectivity	Touchscreen	Sample size	Age (SD)	Assistant presence		
Coyle, N., et al (2019)[18]	Triage	Hospital	Canada	10 weeks	Self-identify and capture the arrival times of patients. Alert triage nurses arrival patients and primary complaint before triage	—	—	NA[6]	—	898	53 (21.0) avg.age	Yes	Prove that ED[4]patients can use a self-check-in kiosk upon arrival and to compare time-to-first-identification with current triage system	Regression analysis revealed that the adjustedtime-to-first-identification was 13.6 minutes (95% confidence interval 12.8–14.5) faster for patients who used the kiosk. Kiosk usability was found to be 97%
Ng, G., et al (2018)[10]	FCR[1]	Polyclinic	Malaysia	12 months	Measure patients physiological parameters and combines of this and their recent laboratory results to classify patients. Furthermore, also produces a result slip for the patient	Web App	BP[2], height, scale	—	Yes	120	—	Yes	Evaluate visit duration, patient satisfaction with the management process, health-related quality of life and the occurrence of any adverse	Both patients and physicians expressed high levels of acceptance and satisfaction with using the kiosk. Facilitates optimal resource allocation for patients with varying medical needs and reduce the number of physician visits by half
Silva, J., et al (2017)[8]	Triage	University	Portugal	—	Measure vital signs for screening or continued monitoring	Web App	Scale, BP[2], PO[3]	Bluetooth	Yes	74	—	No	Assess kiosk usability, the tools developed, the results of the evaluation, the identified problems, and how we are solving those problems	The measured the average time for a complete kiosk session, to be 283 seconds. Most of the participants used oximeter without any difficulty. The BP[2]monitor was the device whose result taked longer to collect. The weighing scale was the one that presented more problems of use. The kiosk saved the cost of application-specific development
Soares, E., et al (2016)[16]	Triage	University's and Villages	Portugal and Brazil	21 days	Measure vital data prior to a consultation, in the scope of a population screening, or for routinely monitoring	Web App	Scale, BP[2], PO[3]	Bluetooth	Yes	833	12-89 y	Yes	Analyse the difficulties of building a simplified Health Kiosk capable of measuring BP[2], weight and PO[3] using PHDs[5]	A full session took around 5 min. Patients the poor and less educated subjects were capable of completing the session without help from the observer. Some prob- lems were the incorrect or difficult placement of the BP[2] cuff, scale, battery replace- ment and some errors of de- vices connectivity. However, devices are affordable and easy to integrate

Information not provided by the study is represented by a dash;
[1] FCR = Face-to-face consultation replacement;
[2] BP = Blood Pressure;
[3] PO = Pulse Oximeter;
[4] ED = Emergency Department;
[5] PHDs = Personal Health Devices;
[6] NA = Not applicable

Table 16 Summary of the included studies and the intervention

Authors	Domain	Area	Country	Study period	System objective	Architecture				Population			Study parameters	Results
						Type	Biosensors	Sensors Connectivity	Touchscreen	Sample size	Age (SD)	Assistant presence		
Bahadin, J., et al (2016)[17]	FCR[1]	Clinic	Malaysia	2 months	Automates the management of stable patients with chronic conditions to com- plement face-to-face PCP[2] visits	—	BP	—	—	95	61.4 (6.7) avg.age	—	Show that the kiosk could be a feasible means of delivering care for stable patients with chronic conditions and could generate cost savings for the management of patients with stable chronic disease	All of the participants agreed that the kiosk was easy to use, and 96% agreed that they could use the kiosk instead of a physician. BP[3]reading was higher than that of the NC. There was a reduction of 128 physician visits, which translates to total savings of $5335. Patients need to spend only about 7 min at the kiosk
Chung, C. F., et al (2016)[19]	FCR[1]	Clinic	USA	9 months	Used to measure BP[3]	Web app	BP[3]	—	—	152	—	Yes	Evaluate BP[3] kiosk acceptability and usability, as well as its effects on the workflow of patient BP[3] self-measurement	Most patients were comfortable using the kiosk, however, they perceived the technology as inaccurate and impersonal. Patients and providers saw many benefits: increased patient engagement and saved MA[6] time. Most patients (86%) supported the clinic continuing to use the kiosks. BP values from the kiosk were higher than expected
Ahn, H. S., et al (2014)[20]	FCR[1]	Hospital Rest Homes Private Apartments	New Zealand	12 weeks	Gives helpful information to older people. Stores health information of older people for managing their health conditions	Software	BP[3]	Cable	Yes	99	—	Yes	Assess feasibility and acceptability in robot System for Older People in Private and Public Places	A kiosk type robot platform is quite good for the healthcare robot platform, but may be more acceptable in rest-home and hospital lounges than in private homes, which may be due to its size. Kiosk type robot can help older people
Demiris, G., et al (2013)[21]	Triage	Community room	USA	8 weeks	This provides users secure access to their patient profile with the ability to capture relevant vital sign data into their personal health record, and to view pertinent nutritional or educational content	Software	BP[3], HR[5], glucometer, PO[4], scale	Bluetooth	—	27	78-94 y	Yes	Demonstrate how informatics applications can support the assessment and visualization of older adult's wellness. Assess the acceptability and feasibility of the kiosk	Older adults are willing to participate in technology-enhanced interventions. Confirms the feasibility of an informatics platform to assess older adults' wellness. The duration of each session corresponds to 20 minutes (more 5 min, once a week) and is held 3 times a week. The model of a community setting has the advantages of being cost-effective

Information not provided by the study is represented by a dash;

[1] FCR = Face-to-face consultation replacement;

[2] PCP = Primary Care Physician;

[3] BP = Blood Pressure;

[4] PO = Pulse Oximeter;

[5] HR = Heart Rate;
[7] MA = Medical Assistant;