Usability Problems in Patient- and Clinician-Oriented Health Information Systems: What Are They and How Do They Differ?

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Abstract. This study aimed to identify the usability problems in the eVisits based on the interaction experience of the three target user groups and compare their preferences for usability features. We used think aloud usability sessions with 5 patients, 5 nurses and 5 physicians in a laboratory setting to examine users' interaction with the eVisits. Nielsen's usability heuristic principles were applied to analyze the recorded usability sessions in Morae. Usability feature preferences among three groups were overlapped in the four heuristics. However, each user group had their own perceptions of these criteria specific to their unique needs. Clinicians tended to emphasize the importance of features relevant to their professional activity. Error prevention and aesthetic/minimalist design heuristics were brought up in the comments of physicians while two other groups did not mention anything related to these criteria. Only patients expected the features related to help and documentation heuristic.

Keywords: usability, e-visit, electronic visit system, health information system.

1 Introduction

Health information systems (HIS), which are computer based information systems used in healthcare settings, are represented by patient centered information systems, administrative information systems, clinical and laboratory information systems, and other types (see overview of HIS in [1]). HIS are designed for storing and processing health information, which later can be communicated by and presented to either health care professionals or patients in the context of inpatient or outpatient care [2].

Electronic visit systems (also known as eVisits) have been a recent innovation developed in an effort to provide health care available in many forms and whenever

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needed [3]. According to the American Academy of Family Physicians (AAFP) definition, e-visit is an evaluation and management service provided by a physician or other qualified health professional to an established patient using a web-based or similar electronic-based communication network for a single patient encounter. eVisits are typically offered to treat routine illnesses (nasal allergies, urinary tract infections, sinus infections, stomach flu, sore throat, pink eye, high blood pressure) and other health conditions (weight management, contraception, insomnia, back pain, and gastroesophageal reflux disease). Several parties can benefit from eVisits. Hospitals benefit from reducing bed occupancy in favor of those patients with greater need for them. Physicians benefit by saving in-office time spent with a patient [4] and allowing asynchronous care. Patients benefit from eVisits because they get faster, convenient (e.g., even when travelling and 24/7), and affordable access to healthcare. Additionally, parents of young children and adult children of aging parents can request health care on behalf of their dependents. Success of an eVisit greatly depends on the effectiveness/efficiency of the individuals involved and the cooperative efforts of the main actors involved in the process.

With the increasing demand for HIS utilization in healthcare, usability of such systems, as eVisits, is crucial to improve their usefulness, ease of use, and user satisfaction [5]. A substantial body of research has been reported on the usability problems of HIS [6–8] and the most suitable methodologies for revealing them [9, 10]. However, there is a lack of research that addresses the differences in the preferences for system usability features by the various user groups who are involved in interaction through the system. Learning about the differences in usability expectations from the main user groups of e-Visits system would help the system designers and developers improve these health care systems.

2 Purpose of Study

For this study we selected an eVisits that was under development by an international health care information technology corporation that specializes in providing/supplying complete systems for hospitals and other medical organizations. Prior to its launch, eVisits went through rigorous evaluations with three different user groups: patients, nurses, and physicians.

The main goal of this study was to identify the potential usability problems in eVisits based on the interaction experience of the main target user groups of the system.

Specifically, we pursued the following research questions:

1. What types of usability problems did patients and clinicians experience when completing an eVisits and interacting with the system?
2. What were the differences, if any, in feature preferences reported by patients and clinicians when interacting with an eVisits?

Methodology

2.1 Participants

Participants of the study represented three user groups: patients (n=5), nurses (n=5), and physicians (n=5). We recruited local community people in the roles of patients and the practicing clinicians at a large Midwestern university in the roles of nurses and physicians on the voluntary basis. Participants represented the convenient sample of users and received the monetary compensation, in the form of gift cards, for their participation.

2.2 Procedures

Data was collected through usability testing, which allowed for examination of how each user group performed on a list of specifically developed tasks, for which the system was designed in a controlled lab setting [11]. These tasks were representative of the naturalistic scenarios that each user group would be performing in a fully functional eVisits (Table 1).

During a usability testing session, each participant worked on task completion individually and was asked to verbalize his/her thoughts and actions. The sessions took place in a laboratory setting, lasting approximately 45-60 minutes, and were recorded with the Morae 3.2.1 software. Upon completion of each task, participants were asked to rate their perceived level of satisfaction with the ease of completing each task and the amount of time it took them to complete each task on a 7-point Likert scale. At the end of the session, participants were invited to participate in a semi-structured interview to share their overall thoughts of their interactions with the system and its usability. For the purpose of data triangulation, participants' self-reported feedback was coupled with facilitator observations. This procedure allowed us to capture the characteristics of user interactions with the system not reported by participants per se.

Table 1. Examples of tasks

	Patients	Physicians	Nurses
Task 1	Start a sore throat eVisit with the Northline Clinic	Locate eVisit in provider's queue	Locate a new sore throat eVisit in triage queue
Task 2	Start a pink eye eVisit with the Northline Clinic	Locate newly assigned eVisit in provider's queue	Locate an eVisit that needs to be reassigned in the triage queue
Task 3	Start a stomach flu eVisit with the Northline Clinic	Review summary	Locate a new pink eye eVisit in triage queue
Task 4	Start a nasal allergy eVisit with the Northline Clinic.	n/a	Locate a specific patient case

2.3 Data Analysis Approach

Data analysis included reviewing the recorded sessions and coding their content for occurring themes of usability problems, based on ten usability heuristics proposed by Jacob Nielsen [12]. We chose this approach for data analysis because all ten heuristics relate to criteria that affect product/system/website usability,[1] especially since usability heuristics has been previously applied to evaluation of health systems in several studies [12, 13]. To draw a bigger picture of users' preferences for usability criteria among different user groups, we also employed an inductive approach by being open to new occurring themes.

3 Results

3.1 Participants

Patients. The patients user group was represented by females (n=5) between 30 – 69 years old. The developers of eVisits requested the selection of this specific age group and gender for patients' group. In terms of education level, all but one user had graduate degrees. All five representatives of the patient user group reported that they use computer on a daily basis and considered themselves as proficient computer users. Only one person reported having used an eVisits previously.

Nurses. The nurses user group was represented by females (n=5) between 20 – 49 years old. Three participants were registered nurses, one was an education nurse, and one was a nurse practitioner. Their years of experience varied between 3 and 26 years. Three nurses had bachelor's degree, and two nurses master's degrees. All nurses reported that they use computer on a daily basis and considered themselves as proficient computer users. Four nurses had five or fewer years of using EMR, and none of them had used an eVisits before.

Physicians. The physicians user group was represented by males (n=3) and females (n=2) between ages 30 – 69 years old. The sample included four practicing family physicians and one dermatologist. Two physicians had less than 15 years of experience, while the other three had been practicing for over 30 years. The highest level of education among physicians was a doctorate in medicine. All physicians reported using a computer on a daily basis and considered themselves proficient in computer use. Two physicians reported using an EMR system for less than 10 years, while the other three said between 11 and 15 years. One physician had used an eVisits in the past.

[1] The ten usability heuristics include (1) Visibility of system status, (2) Match between system and the real world, (3) User control and freedom, (4) Consistency and standards, (5) Error prevention, (6) Recognition rather than recall, (7) Flexibility and efficiency of use, (8)Aesthetic and minimalistic design, (9) Help users recognize, diagnose, and recover from errors, (10) Help and documentation [12].

3.2 Research Question 1

What types of usability problems did patients and clinicians experience when completing an eVisit and interacting with the system?

Patients. Analysis indicates that patients expected to have six out of ten heuristics to be applied to the eVisits. They preferred more user control and freedom. For example, when initiating an eVisit and completing the form, they wanted to be able to provide more comments to further describe the symptom for their visit, to move freely between the questions, to change their answers, and to choose from readily available information instead of trying to come up with information on their own, such as the name of the pharmacy. They also wanted to be guided and provided with examples of how to fill out the form correctly. This part could serve as an indication of preference for better help and documentation about the system. In terms of system flexibility and efficiency of use, patients expected the system to change the requirements automatically for completing an eVisit based on the patient's physical condition. For example, if patients reported high fever or severe vomiting, they expected the system to reduce the number of questions they needed to answer due to the inability to spend a significant amount of time in front of the computer. Alternatively, if patients were not eligible for an eVisit, they expected to see such a message early on in the process of completing the form. Upon completing an eVisit, patients also wanted to have clear indication about the next step from the system, such as when and how they would be contacted regarding their visit. In terms of matches between system and the real world, patients thought that some symptoms overlapped, e.g., watery eyes and discharge from the eye, and some terms that described pain could be confusing for ordinary users. The average perceived satisfaction score (1=strongly disagree; 7=strongly agree) with the ease of completing tasks and the amount of time spent on task completion are reported in Table 2.

Table 2. Participant satisfaction scores (patients)

	Task 1	Task 2	Task 3	Task 4
Ease of completing tasks	5.8	6.4	5.8	6.2
Time spent on completing tasks	6.4	6.6	5.8	6.4

Physicians. The findings of this study suggest that physicians addressed eight out of ten heuristics during their interaction with the system. Particularly, they wanted the system to suggest a narrowed down list of medications based on the entered diagnosis and to generate a list of their preferred medications. When working on an eVisit physicians expressed the preference for system-generated information feed features, such as pre-set wording for description for certain medical conditions, and automatic calculation of the quantity of pills based on the medication dosage and duration. Physicians liked a system-generated diagnosis based on the symptoms described by patient. This feature allowed them to compare their own diagnosis with those ones generated

by the system. They stated that spell checking option in the text entries would be beneficial. They appreciated the error prevention feature that stopped them from printing or sending prescription to a patient without previewing it first. As for visibility of system status, physicians wanted to be aware of the number of pending eVisits in their queue, and they expected to be able to see the latest eVisit first because such information presentation was consistent with other applications they have used before. Physicians also wanted to know patient's expectations before starting an eVisit, e.g., whether a patient initiated an eVisit because s/he simply needed an advice or a professional opinion or a prescription for medication. They also expected to have a confirmation whether patients' previous eVisits were completed. They wanted to see confirmation that they did not miss any unattended eVisits in the system. While working on an eVisit, physicians expressed their concerns about the credibility of information entered by the patient. Therefore, they wanted to know where patient history was coming from, i.e., from a patient or from EHR. Additionally, when writing a message to a patient, they did not like to be limited by the number of characters as it happened during the testing. They also expressed that they expect to see confirmation if a patient received their message. In terms of consistency and standards, physicians indicated that they were not familiar with some non-conventional abbreviations, e.g., 'pat' for 'patient', did not know the difference between 'new' and 'in triage', and preferred using medical vocabulary from the Intelligent Medication Objects (IMO). Finally, physicians did not like the fact that it was their responsibility to cancel an eVisit, especially if they had not yet started to work on it. Finally, a number of physicians were not satisfied with the look and placement of certain design elements, e.g., cancel and send buttons were hidden behind the text and were therefore effectively invisible. The average perceived satisfaction scores (1=strongly disagree; 7=strongly agree) with the ease of completing tasks and the amount of time spent on task completion are reported in Table 3.

Table 3. Participant satisfaction scores (physicians)

	Task 1	Task 2	Task 3
Ease of completing tasks	4.4	4.8	4.6
Time spent on completing tasks	4.6	5	4.8

Nurses. The findings of this study indicate that nurses addressed five out of ten usability heuristics. They emphasized the importance of visibility of system status. For example, they wanted to be informed when the system was down. Additionally, they wanted to receive confirmation of their actions, such as successful cancellation of an eVisit or re-assignment of a patient to another physician. In terms of system flexibility and efficiency of use criteria, nurses wanted to be able to locate necessary information, such as the number of patients that had been assigned to a particular physician, certain patients, and specifics about their labs in a timely manner. In doing so, nurses wanted to utilize a search function instead of browsing content. In terms of match

between system and the real world criteria, nurses wanted patients' lab results to be displayed with the latest results on top part of the list, accompanied by time stamp (time/month/date/year). Nurses also expressed their preference for conventional terminology, e.g., 'patient' vs. 'pat', or 'min' vs. 'm'. In some cases, they were confused with the meaning of 'in triage' because this expression did not indicate whether the patient returned to triage and needed to be reassigned or whether it was a new patient. When asked about the purpose and the content of a note, a few nurses were unclear about its purpose and who it should be addressed to. The average perceived satisfaction scores (1=strongly disagree; 7=strongly agree) with the ease of completing tasks and the amount of time spent on task completion are reported in Table 4.[2]

Table 4. Participant satisfaction scores (nurses)

	Task 1	Task 2	Task 3	Task 4
Ease of completing tasks	3.25	4.5	5.5	5.5
Time spent on completing tasks	4.5	4.5	5.25	5.25

3.3 Research Question 2

What were the differences, if any, in feature preferences reported by patients and clinicians when interacting with an eVisit system?

Analysis of usability problem types by user groups revealed that representatives of three user groups emphasized the importance of different system features (Table 5).

Usability feature preferences among three groups were overlapped in the following four heuristics: match between system and the real world, consistency and standards, recognition rather than recall, and flexibility and efficiency of use. They wanted the system to support and improve their performance, to exclude the use of any unfamiliar words and terminology, to present information in the order of urgency and in the format they were accustomed to, and to include an automatic feed of already available information to avoid information re-entry, e.g., pharmacy name, a preferred medication list, patient search. Nurses and physicians brought up the features related to visibility of system status. Nurses expected to see the clear indications in the system to be informed whether the system was down, messages to the patients were sent, or an eVisit was cancelled. Physicians wanted to be able to see the most current eVisit information on top part of the screen and have visual cue for the number of pending eVisits. Both patients and physicians wanted to have more user control and freedom during completing an eVisit – patients were willing to provide more specific information than asked in the form, and physicians wanted to tailor the repetitive actions in the system. Physicians liked that the system demonstrated error prevention functionality, which made them to preview the prescribed medication to proceed further. In

[2] One of the nurses was unable to provide ratings of her satisfaction with the task performance due to a technical problem. Therefore, we reported the average score of four participants only.

addition to this function, they expected having spell checker and automatic calculation of medication quantity based on suggested dosage and duration. Physicians also noted that the icons and buttons should stand out from the background color to be easily noticeable.

Table 5. Comparison of system feature preferences among the three user groups

Heuristics/User groups	Patients	Physicians	Nurses
(1) Visibility of system status		+	+
(2) Match between system and the real world	+	+	+
(3) User control and freedom	+	+	
(4) Consistency and standards	+	+	+
(5) Error prevention		+	
(6) Recognition rather than recall	+	+	+
(7) Flexibility and efficiency of use	+	+	+
(8) Aesthetic and minimalist design		+	
(9) Help users recognize, diagnose, and recover from errors			
(10) Help and Documentation	+		
Total n of heuristics addressed:	6	8	5

Error prevention and aesthetic/minimalist design heuristics were brought up in the comments of physicians while two other groups did not mention anything related to these criteria. Only patients emphasized about the importance of features related to the help and documentation heuristic.

4 Conclusion

This paper sought to investigate the specifics of user interaction with an eVisits – an interactive web-based system capable of offering medical care to a patient by a medical institution that can replace regular face-to-face visits. We aimed to explore if there are any differences in the types of usability problems encountered by the three different user groups (physicians, nurses, patients) when they interacted with eVisits. We applied Nielsen's usability heuristic principles in our data analysis.

The findings of our study revealed that clinicians tended to emphasize the importance of features relevant to their professional activity. Physicians pointed out eVisits features that would support their performance and allow them to be efficient in their work (e.g., error prevention and minimalist design) by overcoming cognitive and information overload (e.g., recognition rather than recall, user control and freedom, flexibility and efficiency of use) and spending minimum time on learning system

features (e.g., aesthetic and minimalist design). Nurses, as an intermediary between patients and physicians, emphasized the importance of usability features that would assist them with more efficient work coordination (e.g., recognition rather than recall) and overall control of an eVisits process (e.g., visibility of system status).

All three user groups expected the system to demonstrate a match between system and the real world, consistency and standards, recognition rather than recall, and flexibility and efficiency of use heuristic criteria. However, each user group had their own perceptions of these criteria specific to their unique needs. Only patients emphasized the importance of features related to the help and documentation heuristic. They reported perceived difficulties to interact with eVisits. A well-designed and built-in help feature in the system would help patients to interact with the system more easily.

Obvious differences in feature preferences for eVisits between patients and clinicians might be related to the fact they interacted with the interfaces designed with slight differences for their specific needs. However, the findings of the present study demonstrate the general trends for user interface design features and functionalities that should be incorporated in e-Visits type of health information systems for patients and clinicians. Revealing the distinct needs for various user groups as well as the system flaws and successes through usability testing can contribute to successful system design and its further implementation, adoption, and use.

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