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# User Preferences for Adaptive User Interfaces in Health Information Systems

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## Abstract

**Purpose:** An adaptive user interface requires identification of user requirements. Interface designers and engineers must understand end-user interaction with the system to improve user interface design.

**Methods:** A combination of interviews and observations are applied for user requirement analysis in health information systems (HIS). Then user preferences are categorized in this paper as either data entry, language and vocabulary, information presentation, or help, warning and feedback. The user preferences in these categories were evaluated using the focus group method.

**Result:** Focus group sessions with different types of HIS users comprising medical staff (with and without computer skills) and system administrators identified each user group's preferences for initial adaptation of the HIS user interface.

**Conclusions:** User needs and requirements must be identified to adapt the interface to users during data entry into the system. System designers must understand user interactions with the system to identify their needs and preferences. Without this, interface design cannot be adapted to users and users will not be comfortable using the system and eventually abandon its use.

**Keywords:** Adaptive user interface, Focus group, Health information systems, Usability, User preferences

## 1. INTRODUCTION

Information technology (IT) facilitates the recording, maintenance, retrieval and management of information. With the development of IT and the transition from traditional information systems to electronic ones, users are directed to utilize digital user interfaces (UIs). UIs are interfaces between the end user and the system and can be either static or dynamic. Static interface does not change and has the same look and feel for all users, while a dynamic interface changes in response to user behavior during his/her interaction with the system [1]. Dynamic interfaces can be categorized as adaptable, adaptive or a combination of the two. If adaptation of the interface is managed by the user, it is called an adaptable interface. Adaptive user interfaces (AUIs) automatically adjust their displays and actions to current user goals and abilities. AUIs assist users in accomplishing tasks in an application [1, 2].

The purpose of adaptation in UI is content, navigation and presentation adaptation [3, 4]. For content adaptation, the system adapts the content of a page to user characteristics. The system provides navigation adaptation by management of hyperlinks (hiding, sorting, annotating, removing, and adding) during a user navigation session. The goal of adaptive navigation is to help users find the path to accomplish a specific goal in the application. Adaptive presentation focuses on text positioning, graphics, multimedia inclusion/exclusion, background and GUI interfaces. The combination of

1  
2 adaptable and adaptive interface can be adaptable  
3 with system support or adaptive with user control.  
4 All of these categories are different scales of  
5 personalized user interfaces [5, 2].  
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8 The accurate design of a user interface is an  
9 essential part of application design process. A  
10 software system can only deliver its full potential if  
11 it is consistent with the skills, experiences and  
12 expectations of its users [6]. Lack of good user  
13 interface has been a major barrier to the acceptance  
14 and routine use of HISs [7].  
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18 Designing user interfaces that fit user preferences  
19 and needs is a challenge of the design of HIS. The  
20 existence of a well-designed and friendly usable user  
21 interface in healthcare is so important that can have  
22 a direct impact on patient health. A poorly-designed  
23 user interface leads to incorrect usage of the system  
24 or increased user error. As a consequence, the system  
25 may be abandoned. Users with different abilities,  
26 skills and needs use the system; therefore, it is  
27 necessary to adapt the interface according to user  
28 needs. For an adaptive user interface design in HIS,  
29 the users and their needs must be known and  
30 understood and to design the interface according to  
31 user needs.  
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37 There are various principles for the design of user  
38 interfaces. Effective UIs should be easy to learn, easy  
39 to remember, easy to use, have predictable behavior  
40 and keep the user in control [8, 9]. User interface  
41 design is derived from the principles of human-  
42 computer interaction (HCI) [10-12]. Toolkits for  
43 HCI research can be used to assess user needs in user  
44 interface design. Some toolkits that can be used to  
45 identify user needs in HIS are the think-aloud method  
46 [7, 13, 14], ethnographic studies [15], cognitive task  
47 analysis [16, 17], participatory design [18], heuristic  
48 evaluation and usability testing [14, 19, 17, 20, 21].  
49 Previous studies have addressed user interfaces for  
50 healthcare environments [10, 22, 17], and evaluation  
51 of health UIs [20]. Some research has focused on the  
52 effect of user interface on doctor-patient  
53 communication [23], while others study design  
54 principles and compare alternative designs [24] and  
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develop UIs [25-28]. Researchers have proposed a  
variety of guidelines to improve UIs for HISs [29-31,  
28, 32, 17].

These studies either consider design guidelines for  
specific health applications [26-28] or design  
guidelines for one specific group of users such as  
general practitioners (GPs) [11] or nurses [25] or the  
elderly [30]. One study proposed a framework to  
redesign healthcare UIs [17], but differences  
between HIS users were not considered. Because  
users of HIS are diverse and have different needs and  
requirements, there is a need for adaptive user  
interfaces for different user groups.

An adaptive user interface improves user  
interaction with systems by facilitating user  
performance, minimizing user need to request  
assistance, helping users deal with complex systems  
and avoid cognitive overload [5]. Ramachandran [4]  
explored two major techniques to create adaptive  
interfaces: adaptive presentation and adaptive  
navigation. He provided examples of each in  
healthcare applications. Chen [33] used USHER's  
predictive ability to design intelligent user interface  
adaptations to improve data entry accuracy and  
efficiency. He then evaluated these mechanisms with  
professional data entry clerks working with real  
patient data. The USHER model gives a subset of  
answers for a form and accurately predicts values for  
unanswered questions. The results show that these  
adaptations have the potential to reduce error with  
limited effect on entry time. Findlater and Grenere  
[34] evaluated the impact of screen size on  
performance, awareness, and user satisfaction with  
adaptive graphical user interfaces. Additional  
examples exist about adaptive user interfaces and  
techniques for adaptation [2-4, 35-37]. Nguyen and  
Sobecki constructed user profiles based on  
consensus for adaptive development of user  
interfaces in multimodal web-based systems [38].

To summarize the state of the art, while some  
research projects studied user interface issues in  
health care [7, 10, 11, 17- 20, 24-28, 30] and other  
studies examined adaptive UIs [2-5, 35-37], few  
studies have examined adaptive UI design issues,  
especially for health settings [39], and none

1  
2 considered different user groups in HIS. Shakshuki,  
3 Reid and Sheltami [39] offered a multi-agent system  
4 with learning techniques to construct adaptive UIs  
5 for each patient. Other HIS users were not considered  
6 in this study.

7  
8 The contribution of the present study beyond the  
9 state of the art is that it takes the first step in the  
10 design of an adaptive user interface, which is  
11 understanding and analyzing user needs when  
12 interacting with HIS. It also presents adaptive  
13 interface design requirements with a combinational  
14 view to individual and group adaptation. To evaluate  
15 the proposed requirements, the focus group method  
16 [40] was applied as a qualitative evaluation method  
17 along with a questionnaire. The focus group is a  
18 valuable tool for understanding the needs and  
19 concerns of users in human-computer interaction  
20 studies. Meetings with different groups of HIS end  
21 users were held to discuss their requirements. The  
22 focus group discussions were then analyzed as  
23 qualitative information. Participants also filled out a  
24 questionnaire which was analyzed to gain  
25 quantitative results for this study. To the best of the  
26 authors' knowledge, the current paper is one of the  
27 very few research studies that examine user  
28 requirements to design user interfaces for HIS  
29 especially tailored to different user groups in health  
30 settings.

## 37 2. METHODOLOGICAL FRAMEWORK

### 38 2.1. Eliciting user requirements

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40 In any service adaptation including user interface  
41 adaptation, there are two tasks to be carried out; one  
42 is the adaptation of content or service, and the other  
43 is knowing the user and identification of user needs  
44 and preferences. Identifying the needs of users is like  
45 exploring an ancient castle; the more we work, the  
46 more we discover and the more we discover, the  
47 more we realize that there remains a lot to explore  
48 [41]. In addition to scientific literature, methods such  
49 as interviews with users, ethnography and  
50 observation of user interactions with the system were  
51 applied. Dialogue with users, their behavior and  
52 speech, and how they interact with the system during  
53 interviews and observations were recorded and  
54 employed. The main requirements for user interface  
55 design were then identified. Some identified

requirements were the use of simple and quick data  
entry devices for HIS [22], considering multiple  
methods for data entry and search (e.g., text entry  
fields, A-Z lists) [8, 31], using feedback requiring  
minimal attention, such as light and sound [23, 22],  
using general as well as specialized terminology for  
different users, designing mobile devices with semi-  
transparent screens, making pocket-sized devices  
[23], removing or hiding unnecessary information  
from the screen, showing confirmation to user for  
recorded data [31], using understandable icons and  
figures instead of just text in screen (form factor)  
[18].

### 2.2. Requirement Classification

For a more detailed study of user preferences, it  
was necessary to classify the requirements derived  
from previous studies and observations. This allowed  
classification of user preferences about HIS  
interfaces into the categories of data entry devices,  
system language and vocabulary, information  
presentation and help, warning and feedback as  
shown in Figure 1.

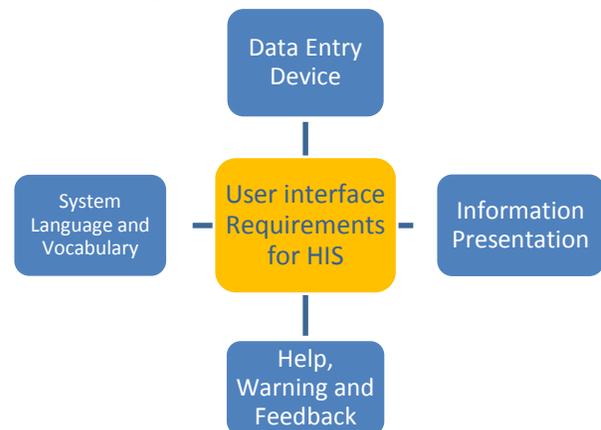


Figure 1. Proposed user interface requirements for HIS

### 2.3. User Classification

Age, sex, physical ability, education level,  
computer skills, medical knowledge, goals and  
motivations are the set of variables and aspects that  
impact end-user preferences. Vasilyeva et al. [3]  
pointed to “medical knowledge” as the main criterion  
for grouping users for user interface adaptation.

1  
2 Ramachandran [4] found that healthcare users range  
3 from having little computer knowledge to having  
4 expert computer knowledge. The observation of  
5 users interacting with HIS in the current study  
6 indicates that these two factors clearly influence user  
7 needs and preferences and how users interact with  
8 the system. It can be concluded both from literature  
9 and observation of HIS usage in clinics that there are  
10 two important aspects that distinguish end users,  
11 computer literacy and medical knowledge. Based on  
12 these two criteria, end users can be clustered in four  
13 groups: medical staff with computer skills (MSCS),  
14 medical staff without computer skills (MS), system  
15 administrators (SA) and clerks who are employed to  
16 work with HIS. The fourth user group comprises  
17 users without computer literacy and medical  
18 knowledge. Because this last group of users is very  
19 rare in clinical settings, they have not been included  
20 in this study. MS and MSCS groups can interact with  
21 information systems directly at the patient's bedside  
22 to view, record and search information related to the  
23 patient. The SA group transfers information from  
24 paper chart to electronic information systems.

### 3. EVALUATION METHOD

37 User requirements extracted from the first stage of  
38 research were evaluated using a qualitative method  
39 (focus group) and a quantitative method  
40 (questionnaire); hence, both qualitative and  
41 quantitative results were obtained.

#### 3.1. Qualitative Analysis by Focus Group

47 Three focus group sessions were held with end  
48 users of HIS at three hospitals in Tehran, Iran.  
49 Sixteen persons from the different hospitals were  
50 invited to attend. The first meeting was held with  
51 eight users from the SA group. Four persons from the  
52 MS group attended the second session and four  
53 physicians from the MSCS group were invited to the  
54 third session. The mean age of participants was 33.7  
55 years and the average work experience was on  
56 average 7 years. The educational level of the  
57 participants comprised 12% associate degrees, 50%

undergraduates, 31.25% general physicians and  
12.5% specialist physicians.

User requirements were identified for initial  
adaptation of the user interface. To achieve this,  
unstructured and semi-structured questions were  
developed based on the requirements (section 3.2).  
Discussions in each session began with opening and  
introductory questions so that participants could gain  
insight into the topic and express their opinions. The  
agenda was the same for all three focus groups. All  
sessions lasted for approximately two hours. During  
each session, topics were accompanied by a visual  
display in Microsoft PowerPoint. Each session was  
recorded for later transcription and analysis. In  
addition, all statements, comments and gestures of  
the participants were recorded by an assistant. The  
researcher noted the key points as the meeting  
facilitator.

#### 3.2. Quantitative Analysis by Questionnaire

Two questionnaires were developed. The first  
questionnaire was given to participants at the  
beginning of the session and covered areas such as  
demographic data, work experience and consent to  
participate in the session. The second questionnaire  
contained structured questions about the main topics  
of research. It was validated by 10 experts in user  
interfaces design and HCI. Experts commented on  
the relevancy, simplicity, clarity and necessity of  
items in accordance with the recommended range.  
The final questionnaire with 42 questions was  
designed using a five-point Likert scale. This  
questionnaire was completed by participants and  
delivered to the meeting facilitator at the end of the  
focus groups session.

## 4. RESULTS

The results of the focus groups and questionnaires  
were made available for qualitative and quantitative  
analysis, respectively, for each group of  
requirements discussed below. Comments from  
participants are shown in italics.

#### 4.1. Data Entry Device

Data entry device selection was one of the topics discussed with end users. The keyboard, mouse, barcode reader, digital pen, touch technology, voice and radio frequency identification (RFID) are data entry types used for HIS that were introduced to the users. The SA group suggested different criteria for selecting the type of data entry device, because they worked in different parts of the hospitals. For example, reception and operation ward users considered use of the barcode reader to facilitate data entry to be suitable; however, a user with many years of work experience stated that a mouse and keyboard are the best devices for data entry. Clinic secretaries prefer touch technology for recording patient visits because it is less tiring compared to long hours of working with a keyboard and mouse.

One physician in the MS group remarked that the keyboard is the hardest data entry device. On the other hand, the best tool for data entry, according to the physicians, are voice and digital pens. Physicians in the MSCS group considered RFID as a necessary and appropriate technology at bedside to automate and facilitate the process of entering patient records. One participant stated that input through voice, especially in large patient referral centers, significantly reduces mistakes during data entry.

In addition to the qualitative survey, a questionnaire was also made available to participants that showed willingness to use different types of input devices on a scale ranging from of *strongly agree* to *strongly disagree*. Figure 2 compares the group preferences for choice of data entry device. The mean responder score for each type of data entry device was calculated. Table 1 shows the priority data entry device by group based on the average rating of participant responses.

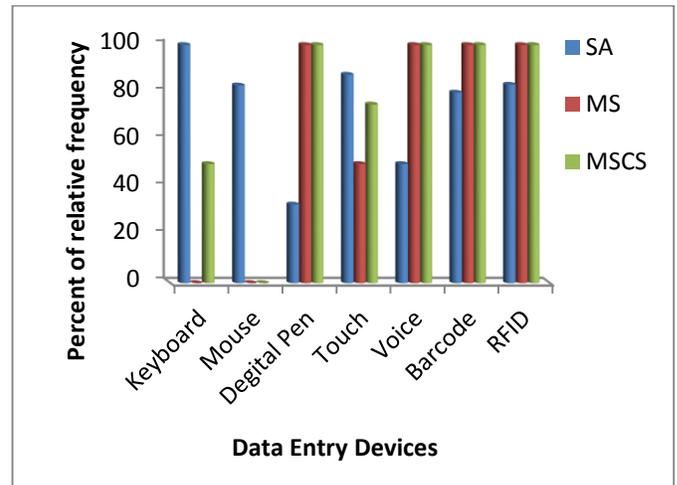


Figure 2. Comparison of group tendency to choose data entry technology, data entry device/percent of relative frequency  
SA: System administrator, MS: Medical staff without computer skills, MSCS: Medical staff with computer skills

Table 1: Priority choice of data entry device in groups based on the average rating of the participants' answers.

SA	MS	MSCS
Keyboard (3.37)	Voice (4.00)	RFID (4.00)
Barcode reader (3.20)	RFID (3.60)	Voice (3.75)
Touch (3.12)	Digital Pen (3.60)	Digital Pen (3.00)
Mouse (3.00)	Barcode reader (3.50)	Barcode reader (3.00)
Voice (2.66)	Touch (2.50)	Touch (2.75)
Digital Pen (2.50)		Keyboard (2.50)

SA: System administrator, MS: Medical staff without computer skills, MSCS: Medical staff with computer skills

#### 4.2. System Language and Vocabulary

Another example of adaptation is the ability to choose between the languages used to explain the elements on a page. Each user can select the desired language (Persian or English) with which to interact with the system. The selection of a particular choice several times by a user will result in automatic selection of that choice by the system; however, users can manually change the system language during interaction if desired. All participants agreed to a combination of Persian and English with the ability to change the language.

The vocabulary used in the system is different for the different user groups. The reason for the difference in vocabulary is that words used by different user groups differ in terms of users' knowledge and experience and should be adapted to

1  
2 the target users. The use of scientific vocabulary,  
3 standard codes, abbreviations and non-academic  
4 words in the content of HIS was discussed. Doctors  
5 and nurses sometimes use non-academic vocabulary  
6 for drug names or required actions at the bedside  
7 when recording clinical data in paper charts. The SA  
8 group's preference is to provide non-academic words  
9 along with scientific words to transfer data to the  
10 electronic system. They believe it can be done easily  
11 and quickly. One participant from the MS group  
12 stated "*the use of abbreviations will increase the*  
13 *speed of data entry*". In contrast, some MSCS and  
14 MS group participants were opposed to the use of  
15 abbreviations. Lack of standardization and several  
16 possible meanings for an abbreviation were  
17 mentioned as reasons for opposing this idea. They  
18 insisted on the use of full scientific terms to preserve  
19 high accuracy in the system.

20  
21 The use of standard codes was also a matter of  
22 disagreement. One participant said: "*The probability*  
23 *of error due to the conversion of a disease to a*  
24 *standard code is high*". An opponent of the use of  
25 standard codes stated: "*Not all codes assigned to all*  
26 *diseases, diagnoses or actions are unique.*  
27 *Sometimes we are forced to use codes having the*  
28 *greatest similarity to the diagnosis, which it is not*  
29 *accurate enough and could be much generalized and*  
30 *not include sufficient detail*".

#### 31 32 4.3. Information Presentation

33  
34 Adaptive presentation can be implemented to hide  
35 some of the content on the page or provide different  
36 information and links on a particular page based on  
37 the user's knowledge of related concepts. Adaptive  
38 presentation techniques must focus on multimedia  
39 items such as images, videos, and audio in addition  
40 to text for each page. For example, for a complete  
41 patient record, if the user is a medical staff member  
42 from the MS or MSCS groups, the user interface can  
43 display advanced medical details that can be entered  
44 or obtained from the patient. If the user is in the SA  
45 group and has limited medical knowledge, those  
46 fields can be hidden and later displayed to medical  
47 staff for complete details.

The management of icons and objects in the  
interface by the software is an example of an  
automatic adaptive user interface. Re-arranging or  
highlighting user interface objects and icons based  
on user activity is another type of adaptation in a user  
interface. This was discussed with participants.  
Some believed that reordering may confuse users and  
that consistency is better because users learn the  
places of objects on pages and operate according to  
what they have learned to more easily select them.

Object manipulation on pages by users was also  
discussed. Some of the medical staff (MS/MSCS  
groups) liked this idea, while others believed that  
consistency is better. All participants of the SA group  
agreed and knew that this is a step towards  
customization. Table 2 compares the response  
frequency to information presentation of the groups.

#### 44 45 4.4. Help, Warning and Feedback

46  
47 Help can be provided differently to the different  
48 user groups or individuals. Novice users need more  
49 guidance while expert users may not require  
50 guidance. Helps can be designed for beginner users  
51 and then adapted for expert ones [8].

52  
53 Participants in all three sessions agreed to guidance  
54 and alarms in the system to help users and reduce  
55 errors in data entry. Users without computer skills  
56 and the MS group need a multimedia form of help  
57 because they are unable to work the system correctly  
58 and need more guidance. One participant from the  
59 MS group pointed out that "*help that requires us to*  
60 *read text to work with the system is not interesting*  
61 *and it is better to have guidance in ways other than*  
62 *reading text*". For users of the MSCS and SA groups,  
63 shortcut keys for help are sufficient; when they need  
64 it, they can click a button.

65  
66 While recording incorrect, duplicate or irrelevant  
67 information, the system should give good tips in  
68 addition to alerts. Guidance to users should be given  
69 upon request, even if information is properly  
70 recorded. For example, tips including information on  
71 dosage and time of medication use are embedded on  
72 the same page for the user when recording patient

prescriptions. The interface should show the consequence of an act to the user and state whether or not an action has been done successfully by use of indicators [8, 31]. Feedback should be informative for the user. Changing in the color, text, light, vibration or sound are examples of system feedback for different devices. In medicine, feedback requiring minimal attention, such as light and voice [23, 22] are recommended.

All participants of the MSCS group believed that system feedback to physicians' mistakes in

interaction with the system, using text and color changes is sufficient and that light, voice or any other type of feedback that draws a patient's attention can endanger the perception of the physician and have serious negative effects on patient confidence in the medical staff. Some MS work group participants prefer system feedback that draws less attention to the interface and a combination of multiple feedbacks including text with color changes, voice and light.

Table 2: Comparison of frequency of response to information presentation between groups

	USER GROUP	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
Ability to manipulate objects in interface by user	SA	3	4	0	0	0	7
	MS	0	2	1	1	0	4
	MSCS	0	2	0	1	1	4
	<b>Total</b>	<b>3</b>	<b>8</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>15</b>
Ability to show relevant information to each user group and hide the rest (e.g. according to the user's level of knowledge)	SA	0	0	0	0	0	0
	MS	2	2	0	0	0	4
	MSCS	2	2	0	0	0	4
	<b>Total</b>	<b>4</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>8</b>
Automatic link management (activating, inactivating, deleting or reordering a link)	SA	0	0	0	0	0	0
	MS	2	1	0	1	0	4
	MSCS	0	2	0	2	0	4
	<b>Total</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>3</b>	<b>0</b>	<b>8</b>

Differences in the total amount of data occur because of missing data

Table3: Comparison of frequency of response to help, warning and feedback

	USER GROUP	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
Provide the key to Help to be used if needed (Such as F1)	SA	7	1	0	0	0	8
	MS	2	2	0	0	0	4
	MSCS	1	2	1	0	0	4
	<b>Total</b>	<b>10</b>	<b>5</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>16</b>
Provide guidance when registering false, duplicate or irrelevant information in addition to warnings.	SA	4	4	0	0	0	8
	MS	3	1	0	0	0	4
	MSCS	2	1	1	0	0	4
	<b>Total</b>	<b>9</b>	<b>6</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>16</b>
Embedded help on the same page when recording information (show help for information on medicine for nurses on medical record page)	SA	3	5	0	0	0	8
	MS	2	1	0	0	0	3
	MSCS	1	2	1	0	0	4
	<b>Total</b>	<b>6</b>	<b>8</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>15</b>
A combination of above features	SA	7	1	0	0	0	8
	MS	3	0	0	0	0	3
	MSCS	3	1	0	0	0	4
	<b>Total</b>	<b>13</b>	<b>2</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>15</b>

Differences in the total amount of data occur because of missing data

1  
2 In the SA work group, some participants preferred  
3 voice feedback and others preferred feedback with  
4 text, color and images. One preferred images for  
5 better understanding of feedback. Another said that  
6 it is better to first attract the attention of the user with  
7 a color change, then open text boxes to express the  
8 details. The opinions of the majority of participants  
9 indicated that, because the attention of an SA group  
10 user is on the information system monitor for data  
11 entry, using text, color and image feedback is most  
12 effective. Table 3 compares the response frequency  
13 for help, warning and feedback.  
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## 20 **5. CONCLUSION AND FUTURE WORK**

21  
22 In order to adapt the interface to users during data  
23 entry into the system, user needs and requirements  
24 must first be identified. System designers must  
25 understand user interactions with the system and  
26 identify their needs and preferences. Interface design  
27 cannot be adapted to users otherwise; as a result, they  
28 will not be comfortable with the system, will avoid  
29 using it and the system will eventually be abandoned  
30 or underused.  
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34 The present study observed user interactions,  
35 interviewed users about their interactions with HIS  
36 and studied resources about user interface design  
37 principles. It was concluded that a data entry device  
38 has a significant impact on user interactions with the  
39 system. The medical staff preferred data entry  
40 devices that do not require typing. The lack of such  
41 devices in medical settings is a major obstacle to  
42 medical staff interactions with HIS; however, data  
43 entry by typing is not difficult for system  
44 administrators. The differences in the features  
45 desired and preferences of the various user groups  
46 are crucial to usability and user interface design.  
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50 To ensure the accuracy of identification of user  
51 requirements, several focus group sessions were held  
52 with users of the HIS to discuss user preferences  
53 when interacting with the system. Sixteen end users  
54 from different hospitals that have worked with HIS  
55 attended three focus groups. They ranged in age from  
56 25 to 47 years and recorded average work experience  
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of 7 years on average. In addition to open-ended  
questions about user preferences in interface design,  
a questionnaire was also designed for detailed  
analysis. The questionnaire focused on participant  
preferences expressed using a Likert scale (strongly  
agree, agree, neither agree nor disagree, disagree,  
strongly disagree).

The results obtained from the discussions with  
users were expected in some cases and unexpected in  
others, or conflicting with results of previous studies.  
Most users chose a combination of Persian and  
English for system language, which was predicted.  
The use of light and sound feedback was advocated  
for HIS in the literature, though the medical staff  
participants in the current study were opposed to the  
use of sound and light. It was possible to identify the  
features and preferences of different groups of users  
from the results. These can be applied for HIS  
interface design so that during user interaction with  
HIS, the interface is in accordance with user  
requirements, needs and preferences.

The novelty of this research is that end users of HIS  
were involved in the first step of the design and their  
requirements were evaluated using both qualitative  
and quantitative methods. User preferences were  
obtained in accordance with the user group to which  
they belong. This study provides guidelines based on  
UI requirements gathered from focus groups.  
Designers can benefit from these guidelines for  
adaptive HIS interface design. This is a major  
contribution to the field of user interface design in  
HIS settings.

This research study has several implications. First,  
the results indicate different preferences for different  
HIS user groups. Preference difference, even without  
considering the priority list of preferences obtained  
by this specific study, is a confirmation of the  
necessity for adaptive user interfaces in health  
settings. Adaptive user interfaces can provide better  
usability and user experiences for each user group.

A second important implication of the study is  
that it derives from the findings on priority choices  
of data entry devices, information presentation, help,  
warning, feedback, system language and vocabulary  
in three groups of HIS users. Adaptive interface  
design for three groups of users will become possible

1  
2 by considering the identified user requirements for  
3 each group. Users will become more comfortable  
4 using an adaptive interface and a major obstacle to  
5 the acceptance and routine use of HISs will be  
6 removed.

7  
8 As an example, priority choices for data entry  
9 devices in groups based on the average rating of the  
10 participants' answers indicates a similarity of  
11 choices by medical staff with or without computer  
12 skills and a difference with the system administrator  
13 group. This means that two sets of devices are  
14 sufficient for all three HIS user groups. This is a  
15 valuable piece of information for choosing and  
16 buying devices for different user groups in HIS  
17 settings. There is no need for adaptation in the form  
18 of providing help and multimedia help is interesting.  
19 Help content can be adapted based on users' domain  
20 knowledge. Different choices for information  
21 presentation emphasize the necessity for adaptation,  
22 however user groups are not decisive in such matters  
23 and it is better to give more control to each user rather  
24 than implement automatic adaptation by the  
25 software.

26  
27 The third important implication of this study is that  
28 some interface design choices have direct impact on  
29 patient health and at times on the physician-patient  
30 relationship. The choice of language and vocabulary,  
31 including use of standard codes, influences the  
32 probability of error and consequently will have a  
33 direct impact on patient health. In some cases, such  
34 as feedback about physicians' mistakes when  
35 interacting with the system, voice or any other type  
36 of feedback that draws a patient's attention can  
37 endanger patient perceptions about the physician and  
38 have serious negative effects on patient confidence  
39 in the medical staff.

40  
41 Directions for future research include the design  
42 evaluation of an adaptive user interface for HIS  
43 based on the results of this study. It is also possible  
44 to use the results of this study to improve user  
45 experience about existing user interfaces in HIS. In  
46 addition, another method can be used to gather user  
47 requirements and compare requirements obtained by  
48 applying different research methods. The design  
49 guidelines resulting from this study can also be tested  
50 and evaluated one-by one in HIS.

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