

Persuasive Systems Design Features in Promoting Medication Management for Consumers

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Abstract

Medication safety continues to be a growing concern in the healthcare industry. Providing medication information to consumers and supporting self-management would help to reduce medication errors and to increase medication adherence. This paper reviews the persuasive systems design features used in current medication management applications for consumers. A database search was conducted to identify relevant articles, which were then reviewed using the Persuasive Systems Design model as a framework for analysis. The results highlighted the applicability of these features for the medication management information systems available to consumers. Primary task support and Dialogue support categories were highly cited in the articles. System credibility support category was moderately cited and the Social support category was cited least in the reviewed articles. Tailoring, monitoring and reminder features have been considered more than the other features in previous studies.

1. Introduction

Medication safety continues to be a growing concern in healthcare industry. Providing consumers with good quality medication information is one of the key factors which will help to reduce medication errors and improve the quality use of medicines. Well-informed consumers will better understand their medication management needs, which will ultimately promote safe medication self-management [1]. Since non-adherence to prescribed medication limits the success of treatment [2], it is important to ensure that consumers take their medication(s) as prescribed.

Previous studies have indicated that adherence monitoring should be performed routinely to ensure therapeutic efficacy and to avoid unnecessary dose and regimen changes in order to limit health care costs [3, 4].

Advancement in technology has increased the opportunity for healthcare solutions to be delivered online to consumers. There is evidence that supports the contention that online health information provision, education and management support can benefit health consumers[5]. Several medication management applications have been developed to assist consumers with their medication management and monitoring. To date, most of these applications have been developed ad hoc, rather than being systemically developed by taking into consideration the design features of the applications.

The effectiveness of the internet in modifying consumer behaviour has been reported in previous studies [6, 7]. A comprehensive framework, known as the Persuasive Systems Design (PSD) model has been developed to assist with designing and evaluating systems that influence the attitudes or behaviours of users [8]. The PSD model includes [8] (see Appendix 1):

1. Primary Task Support (Reduction, Tunneling, Tailoring, Personalization, Self-monitoring, Simulation, Rehearsal);
2. Dialogue Support (Praise, Rewards, Reminders, Suggestion, Similarity, Liking, Social Role);
3. System Credibility Support (Trustworthiness, Expertise, Surface credibility, Real-world feel, Authority, Third-party endorsements, Verifiability); and

4. Social Support (Social learning, Social comparison, Normative influence, Social facilitation, Cooperation, Competition, Recognition) [8]

To better understand the current design features of available medication management information systems and the applicability of the PSD model, targeted literature review on persuasive systems design features in consumers' medication management information systems is conducted.

2. Methods

2.1. Literature Search

A database search was conducted to identify relevant articles by using the following online databases; PubMed, PsycINFO, and Medline. The search was conducted in August 2015 and the search was limited to those published from 2005 through to 2015. A key word search was performed using the following search string: “(medication OR medic*) AND (patient OR care OR carer OR consum* OR pharmacy OR pharmacist) AND (manag* OR remind*) AND (web* OR computer* OR internet* OR online OR mobile OR mHealth OR digital OR technology OR SMS) NOT (electron* OR computeriz* OR record OR hospital OR physician OR CPOE OR EHR OR EMR)”.

2.1.1. Inclusion and Exclusion Criteria. To be considered for inclusion in the review, articles were required to meet the following criteria. Firstly, the article should have been in a peer reviewed academic journal or a peer reviewed paper from an international scientific conference. Secondly, the article must have discussed web-based applications or applications for a smartphone or similar wireless mobile device. Thirdly, the article must have discussed the design features that were used to promote medication management. Articles that focused on behaviours other than medication management, such as smoking cessation, nutritional interventions, or promoting physical activity were excluded from the review. In addition, articles which did not focus on consumers but applications intended to use only by health professionals, were also excluded.

2.1.2. Data Extraction and Coding. Using the inclusion and exclusion criteria outlined above, selected articles were then reviewed using the PSD model as a framework for analysis. The persuasive design features were extracted in four categories: primary task support, dialogue support, system

credibility support, and social support. Each of these categories was further divided into seven sub-categories. An Excel spreadsheet was prepared with information of the final 13 selected articles for coding purposes. The coding of the full-text articles was initially conducted independently by two of the researchers. Once completed, the researchers selected a representative sample of the text coded according to one or more elements of the PSD model and discussed any discrepancies in coding until consensus was achieved.

Table 1: Reviewed articles

Article	Study type	Health condition	Technology	Name
1. [9]	Non-randomised trial	Schizophrenia	App.	FOCUS
2. [10]	Non-randomised	HIV	Web	Virtual intervention
3. [11]	System development	general	Web	Connection to health
4. [12]	Design and development	general	App	Wireless Pill box
5. [13]	Randomized controlled	Chronic disease	SMS	Text message reminder
6. [14]	System requirement	Cancer pain	App	Cancer pain management
7. [15]	Randomized controlled	kidney transplant	App	Electronic medication tray
8. [16]	Randomized controlled	Multiple medication	App	ALICE
9. [17]	Pilot evaluation of system	HIV	Web	Collaborative awareness system
10. [18]	Non-randomised controlled trial	Chronic pain	Web	Chronic pain management
11. [19]	Randomized controlled	Diabetes	Web	Diabetes Teen Talk
12. [20]	Initial feasibility study	HIV	Web	Youth Antiretroviral
13. [21]	Medication scheduler design	Child centered medication	App & SMS	MyMediHealth

Table 2: Persuasive system features in available medication management systems for consumers

Primary Task Support							Dialogue Support						System Credibility Support						Social Support						Article number			
Reduction	Tunneling	Tailoring	Personalization	Self-monitoring	Simulation	Rehearsal	Praise	Rewards	Reminders	Suggestion	Similarity	Liking	Social Role	Trustworthiness	Expertise	Surface Credibility	Real-World Feel	Authority	Third-Party Endorsement	Verifiability	Social Learning	Social Comparison	Normative Influence	Social Facilitation		Cooperation	Competition	Recognition
✓	✓	✓		✓					✓	✓		✓																1
	✓	✓					✓			✓			✓															2
✓	✓	✓		✓	✓									✓	✓	✓		✓										3
✓		✓	✓	✓					✓																			4
		✓	✓						✓																			5
		✓		✓					✓	✓												✓	✓					6
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✓									✓	✓				✓	✓		✓											8
	✓		✓	✓	✓				✓					✓	✓	✓	✓											9
		✓		✓					✓				✓															10
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3. Results

The initial database search yielded 17658 potentially relevant articles. From this set of articles, 17484 were excluded on the basis that the article title did not meet the inclusion criteria, and 15 duplicates were excluded. Of the remaining 174 articles, a further 109 articles were excluded on the basis that the article abstract did not meet the inclusion criteria. The full text of the remaining 65 articles was assessed and 52 articles were excluded on the basis that the article did not provide sufficient examination of persuasive design features. The resulting 13 articles were included in the review.

3.1. Primary Task Support

The primary task support category includes design principles that support the carrying out of the user's primary task [8]. Primary task support features assist the user in achieving the task for which they

are using the system, which for the purposes of this review was medication management.

Tailoring was the most cited feature (7 out of 13 articles), followed by self-monitoring in the Primary task support category.

3.1.1. Tailoring. Seven out of 13 articles reviewed included aspects relating to the principle of tailoring [9-14, 18]. Tailoring was implemented based on the medication and questionnaire answers, and feedback. For example, the "FOCUS" system [7] requires that users answer a series of multiple choice questions each day. The system provides tailored messages, based on the responses given by the user, encouraging the user to engage in medication self-management strategies. Furthermore, the system provides tailored intervention self-management content based on user selection [9].

Tailoring occurred in one system[10] via an interactive virtual nurse that provides feedback to the patient based on user input. The feedback is tailored to the patient using an algorithm. For instance, personal information is collected from the patient,

such as their medication intake, and on the basis of this information recommendations are made via video clips of the virtual nurse [10]. The Connection to Health Patient Self-Management System [11] on the other hand, includes an interactive module that facilitates patient's to select health behavior goals. Based on the user's input, the system provides a tailored action plan to help the patient identify and overcome barriers to success [11].

The wireless pillbox medication self-management system [12] provides medication taking reminders, but only when the patient has forgotten to take their medication [12]. In another study, tailored messages based on the medication and frequency of medication use were sent to patients via their mobile phone [13].

A cancer pain management application [14] provided tailored patient recommendations based on their own preferences. For example, the application might recommend the patient listen to music, if they have selected this as a pain management strategy [14]. On the other hand a chronic pain management application [18] uses demographic patient information and their medical conditions to tailor an action plan for their medication management [18].

3.1.2. Reduction. Five out of 13 articles in the review included some aspects relating to the principle of reduction [9, 11, 12, 16, 21]. The reduction feature was presented for easy navigation, user friendliness, reduced complexity, identification and easy accessibility in the reviewed articles. The self-management system "FOCUS"[9] implements the principle of reduction in order to be more user-friendly for people with schizophrenia [9]. In this particular application, the number of steps required to access content is minimized and memory aids such as a visible 'continue' button is used to facilitate navigation. Furthermore, a simple screen layout and language is used to reduce complexity of the user experience. Glasgow et al. indicated in their article that The Connection to Health action plan [11] implements multimedia modules that guide the user through a planning process for modification of a number of health behaviors, including medication management [11]. These multimedia modules reduce the complexity of the planning process by facilitating patient goal setting behaviors and providing relevant supporting strategies. In addition, to reduce the number of steps required for the patient to maintain a record of medication use, a pill box was implemented using automatic wireless sensors to detect the opening and closing of the patient's pill box [12]. The sensor data was used to determine whether or not the patient had taken their medication, thus

eliminating the need for the patient to self-monitor medication usage.

Three of the systems used reduction by providing images of medication and medication packaging to the patient as part of their applications [12, 16, 21]. This allows the patient to identify the required medication without needing to read the label. One of these systems provides the image in a reminder message, another provided a text message that included a URL that linked to a webpage with an image of the medication [21].

3.1.3. Tunneling. Four out of 13 reviewed articles presented the principle of tunneling by providing necessary actions [9-11, 17]. The "FOCUS" system [9] used tunneling in the form of daily prompts for the user to answer multiple-choice questions. The answers to these questions resulted in the system guiding user to engage in self-management strategies [9]. The system which uses an interactive virtual nurse to guide the user through the learning process of taking their prescribed medicine [10], relies on the user's responses to the interactive process to guide the patient towards the target behavior [10]. The Connection to Health system [11] provides tunneling as a series of multimedia modules that guide the user through the steps of planning their health behaviour changes [11]. A collaborative awareness system for chronic disease medication adherence, used data collected from the patient to trigger the dispatching of messages, which provide useful advice to guide the patient [17].

3.1.4. Personalization. The principle of personalization feature is seen in three out of the 13 articles reviewed [12, 13, 16, 17]. One system displayed personalized information which included medication history, current prescriptions, medication-taking records, adherence rate and a record of the patient's condition [12]. In another study, reminder messages were sent to participants via their mobile phone. Information specific to the individual was included in the messages, such as appointment times and dates [13]. The ALICE application allows the user to input personal information, which is subsequently used by the system to provide tailored content for the patient [16]. Importantly however, the applications do not provide any personalized content to the user, and therefore doesn't satisfy the requirements of personalization. The collaborative awareness application provided visualization of user performance as graphs. Personalized information such as medication adherence performance or estimated plasma concentration was available to the patient [17].

3.1.5. Self-monitoring. In the articles reviewed, six of the 13 include some aspect that is related to the principle of self-monitoring [9, 11, 12, 14, 17, 18]. The FOCUS system [9] prompts the user to engage in a brief self-assessment each day. This system presents multi-choice response options to questions presented to the user regarding their status in their target domains [9]. The Connection to Health Patient Self-Management System [11] requires the patient to develop an action plan by selecting goals for health behaviors. This system also provides ongoing access to the plan for continued self-monitoring by the patient [11]. For the wireless pillbox system [12], self-monitoring was provided automatically in a medication monitoring system that incorporated an electronic pill-box. Wireless sensors monitored the opening and closing of the pill box [12]. The cancer pain management application uses self-monitoring to allow the patient to self-assess and log their pain levels over time based on their pain medication intake [14]. The collaborative awareness system [17] which promotes self-monitored medication adherence for HIV patients, allows patients to self-report adherence and keep an updated record of their performance [17]. The chronic pain management program [18] incorporates a questionnaire about demographics, medical and psychological conditions, pain, general well-being, and daily functioning, used as a base line measure for self-monitoring and self-reporting health outcomes [18].

3.1.6. Simulation. In the articles reviewed, two out of the 13 included some aspect that is related to the principle of simulation [11, 17]. The Connection to Health system [11] includes modules that guide the patient through an action planning process and provides simulation of outcomes. This system allows the user to self-select goals for health behavior change and provides them with relevant benefits, barriers to success, and strategies. The HIV medication management application [17] on the other hand, provides a personalized simulation based on the patient's data. The simulation represents a drop of the patient's blood, and displays to the patient a visualization of their cell count and viral load.

3.2. Dialogue Support

The dialogue support category includes design principles that support human-computer interactions in a way that users would consider to be social or interpersonal interactions. These interactions incorporate feedback to the user in the form of

dialogue, such as prompts, suggestions and reminders.

3.2.1. Praise. In the articles reviewed, one out of 13 articles included aspects that related to the principle of praise [10]. This praise principle was only evident in the application which used 'virtual nurse' who provided vocal assistance to the patient, including positive reinforcement [10].

3.2.2. Reminders. Nine of the 13 articles reviewed, included aspects that related to the principle of reminders [9, 12-18, 21]. Reminders were included as: auditory signals and visual notifications to prompt daily self-assessment task [9, 16] medication reminders when patients have forgotten [12, 15]; as well as SMS's for medication dosage and times [13]. In some cases, the program only provided reminders while the patient was using the system and the MyMediHealth medication management system [21] sent text message reminders to patients containing a webpage link to record if the medication was taken [21].

3.2.3. Suggestion. In the 13 articles reviewed, four included aspects relating to the principle of suggestion [9, 10, 14, 16]. The FOCUS system [9] provided suggestions to the patient as the 'Quick Tips' function [9]. As part of this application, patients receive a brief text suggestion, either by pressing the 'Quick tips' icon or in response to feedback given by the patient. In the virtual intervention study tailored suggestions, based on feedback, were provided to the patient by the virtual nurse guiding them through the medication taking process [10]. In contrast, the cancer pain management system provided suggestions based on the patient data for different pain management techniques [14], and the ALICE application provided suggestions and advised patients on how to take and store their medications [16].

3.2.4. Liking. Two of the 13 articles reviewed, included aspects that related to the principle of liking [9, 20]. The FOCUS application used imagery to engage the user, such as cartoons and messages that visually simulate hand written notes [9]. Whereas, the HIV application (ref) in an attempt to appeal to young people with HIV included interactions with an animated character mimicking conversational interpersonal interactions [20].

3.2.5. Social Role. In the articles reviewed, two of the 13 articles included aspects that related to the principle of social role [10, 18]. The virtual nurse

intervention in the HIV application, performed a social role by providing feedback and reinforcement to the patient [10]. While, the digital coaching in the pain management program emulates an interaction with a real pain management expert and delivers this 'social role' by using text, images and videos.

3.3. System Credibility Support

System credibility support abides by the principle whereby the persuasive capability of a system can be improved by incorporating features that indicate to the user that the system is credible.

3.3.1. Trustworthiness. In the 13 articles reviewed, three included aspects relating to the principle of trustworthiness [11, 16, 17]. The Connection to Health provides a welcome message to the user that includes a message from the patient's practitioner indicating that the program is part of their care plan. The ALICE application provides images of each medication and its packaging and the Collaborative awareness system for HIV patients provides graphs and simulations of patient health data in real-time, all of which may be perceived as trustworthy by the patients.

3.3.2. Expertise. In the articles reviewed, three of the 13 articles included aspects that related to the principle of expertise [11, 16, 17]. The Connection to Health system (ref) demonstrates expertise in the principle of trustworthiness by providing a welcome message from the practice [11]. This message suggests that the clinician is involved in the application and is sharing his expertise with the user. The ALICE indicates expertise by providing a complete list of doctors and caregivers associated with each prescription managed by the patient. Whereas, to demonstrate expertise. the collaborative awareness system provides a function for the clinician to send video messages to the patients [17], thereby improving the persuasiveness of the system by including expert advice.

3.3.3. Surface Credibility. In the articles reviewed, three included aspects that related to the principle of surface credibility [11, 17, 19]. Many of the qualities that create surface credibility are not features, but rather the absence of features that would reduce credibility, such as advertisements [8]. The Connection to Health system provides well designed and engaging multimedia modules that appear credible, and support this with video messages from the medical practice to further lend credibility [11].

The collaborative awareness system [17] include features that provide evidence of credibility such as graphs and visualization of data that give the impression of scientific credibility, and the Diabetes Teen Talk website provide regular date-stamped message posts lending credibility to a system by demonstrating that the system has currency.

3.3.4. Real World Feel. Two of the 13 articles reviewed included aspects that related to the principle of real-world feel [16, 17]. The ALICE application provides a list of all the caregivers involved with the patient's medication prescriptions. Whereas, the collaborative awareness system (ref) allows clinicians to send video messages directly to the patients [17].

3.3.5. Authority. In the articles reviewed, one out of 13 articles included aspects that related to the principle of authority [11]. The Connection to Health system uses authority when it includes a welcome message from the clinic [11]. The message makes reference to the clinician that is providing care to the patient.

3.4. Social Support

Social support is the persuasive design principle that can be used to motivate users.

3.4.1. Social Learning. In the 13 articles reviewed, one included aspects that related to the principle of social learning [19]. The Diabetes Teen Talk system (19) encourages patients to participate in discussion forums, chat rooms and blogs, all of which facilitate social support and learning.

3.4.2. Social Comparison. In the articles reviewed, two of the 13 articles included aspects relating to the principle of social comparison [14, 19]. The cancer pain management application included features that allow patients to connect through the system to other patients. Similarly, Diabetes Teen Talk includes social comparison by way of introducing users to forums and blogs [19].

3.4.3. Normative Influence. Two of the 13 articles reviewed, included aspects that related to the principle of normative influence [14, 19]. Both the Diabetes Teen Talk [19] and the cancer pain management application [14] implement normative influence by allowing users to communicate through discussion forums, chat rooms and/or blogs.

Overall, PSD features to assist consumers with medication self-management have been identified in

the 13 reviewed articles. Some of the articles reviewed in this study identified PSD features, but they are still in the phase of analysing the system requirements [14] or in the designed stage [9, 11]. The effectiveness and outcomes of these studies need to be further investigated in the future. However, usability, effectiveness and improved medication adherence have also been reported in the some of the articles reviewed [10, 12, 13, 15-17] and that reinforces the support of PSD features in consumer behaviour change perspectives. It was also reported in the studies that computer-based intervention motivated the participants to be more involved in their health management and the aware of their disease [20].

4. Discussion and Conclusion

Persuasive features in medication management information for consumers could be seen in the articles reviewed. This study identifies PSD model applied in practice by reviewing features present in randomised/non-randomised controlled trial, feasibility studies, design and development. Although not all features are presented in the articles reviewed, the results highlighted the applicability of these features in the medication management information systems for consumers. That poses the question, whether those features not seen are not applicable for medication management for consumers or the applications have not considered these features as applications were developed ad hoc without applying on theoretical framework. Oinas-Kukkonen and Harjuma also noted in their article that systems do not necessarily need to include all PSD features in the application [8]. However, one cannot argue that all features presented were relevant to medication management information provision to consumers. Tailoring, self-monitoring and reminder features are the most cited features for medication management applications reviewed. These features support the consumer self-management for medication and would promote medication adherence.

Important aspects in behavior change interventions such as goal setting and self-management [22] have been seen in the primary task support category of reviewed articles. Goal setting have been provided in The Connection to Health Patient Self-Management System and self-monitoring features could be seen in several systems [9, 11, 12, 14, 17, 18].

Apart from the social support category, most features in other categories have been applied in the medication management application. Possibility of

social support features not included in these applications could be that medication information is considered as sensitive information. Privacy and confidentiality are the important aspects for health information [23]. However, having consumer self-management support is important in medication management and having social support features in the system would assist caregivers, family and friends of elderly be involved in their medication management.

With the advancement of social media, motivating users have been conducted through these media. Social support feature probably has not been covered in the reviewed articles as the sensitivity of the health information sharing. It is in contrast to, some of the applications, having more social support features such as physical activity applications[24] and application targeted for smoking intervention [25].

Rehearsal feature in primary task support category is not seen in the medication management systems reviewed. Although this feature was seen in some of the well being applications as presented in [26], breathing exercise supported by application. This feature has not been applicable in the medication management studies reviewed.

It could also be that the emphases of disease focus on the reviewed articles are different from each other, HIV (Human Immunodeficiency Virus), kidney failure, diabetes, pain management etc. Further study is needed to explore more on disease specific or medication specific features for PSD. Although the initial search revealed high numbers of articles, there are not many articles on medication management information system for consumers. Most studies emphasised on medication management in hospitals, healthcare organisations and health professional perspectives and there are very few articles on consumer self-management of medication. Although the search period is for past 10 years, most of the reviewed articles were from those published in the past 5 years. It could be due to the emphasis of patient centered healthcare in recent years, more research in consumer involvement in their healthcare, advancement in information technology and applications in healthcare.

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Appendix

Table A1: Persuasive Systems Design Features [8]

<i>Cat egory</i>	<i>Persuasiv e feature</i>	<i>Definition</i>
Pri mar y Tas k Sup port	Reductio n	System should reduce steps users take when performing target behaviour
	Tunnelin g	System should guide users in attitude/behaviour change process by providing means for action
	Tailoring	System should provide tailored info for user groups
	Personali zation	System should offer personalized content and services for individual users
	Self- monitorin g	System should provide means for users to track their performance or status
	Simulatio n	System should provide means for observing link between cause & effect with regard to users' behaviour
	Rehearsal	System should provide means for rehearsing target behaviour
Dial ogu e Sup port	Praise	System should use praise to provide user feedback based on behaviours
	Rewards	System should provide virtual rewards for users to give credit for performing target behaviour
	Reminder s	System should remind users of their target behaviour while using the system
	Suggesti on	System should suggest users carry out behaviours while using the system
	Similarit y	System should imitate its users in some specific way
	Liking	System should have a look & feel that appeals to users
	Social	System should adopt a social role
Syst em Cre dibil ity Sup port	Trustwort hiness	System should provide info that is truthful, fair & unbiased
	Expertise	System should provide info showing knowledge, experience & competence
	Surface Credibilit y	System should have competent and truthful look & feel
	Real- World Feel	System should provide info of the organization/actual people behind it content & services
	Authority	System should refer to people in the role of authority
	3rd-Party Endorsed	System should provide endorsements from external sources
	Verifiabil ity	System should provide means to verify accuracy of site content via outside sources
Soci al Sup port	Social Learning	System should provide means to observe others performing their target behaviours
	Social Comparis on	System should provide means for comparing performance with the performance of others
	Normativ	System should provide means for

	e Influence	gathering people who have same goal & make them feel norms
	Social Facilitati on	System should provide means for discerning others who are performing the behaviour
	Cooperati on	System should provide means for co-operation
	Competit ion	System should provide means for competing with others
	Recogniti on	System should provide public recognition for users who perform their target behaviour