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ABSTRACT
This study aimed to evaluate the usability (ease of use) and utility (impact on user’s decision-making process) of a web-based patient decision aid (PDA) among older-age users. A pragmatic, qualitative research design was used. We recruited patients with type 2 diabetes who were at the point of making a decision about starting insulin from a tertiary teaching hospital in Malaysia in 2014. Computer screen recording software was used to record the website browsing session and in-depth interviews were conducted while playing back the website recording. The interviews were analyzed using the framework approach to identify usability and utility issues. Three cycles of iteration were conducted until no more major issues emerged. Thirteen patients participated: median age 65 years old, 10 men, and nine had secondary education/diploma, four were graduates/had postgraduate degree. Four usability issues were identified (navigation between pages and sections, a layout with open display, simple language, and equipment preferences). For utility, participants commented that the website influenced their decision about insulin in three ways: it had provided information about insulin, it helped them deliberate choices using the option-attribute matrix, and it allowed them to involve others in their decision making by sharing the PDA summary printout.

KEYWORDS
Diabetes; patient decision aids; insulin; usability; utility; website

Introduction

Shared decision making is a medical consultation model that advocates the discussion of information and values between doctors and patients when patients are faced with a preference-sensitive choice between two or more treatment options (1). Patient decision aids (PDAs) are practical tools that aim to facilitate this process. The content of these tools is most often based upon a set of standards known as the International Patient Decision Aids Standards (IPDASi), which outline the inclusion of information about options, presenting outcome probabilities, and helping patients clarify and express values (2). More than 650 PDAs have been developed to address a wide range of decisions (3). Evidence shows that the use of PDAs improves patient knowledge, increases congruence between decisions and personal values, reduces decisional conflict, and enhances patient–doctor communication (4).
The growth of the Internet has impacted the development and delivery of PDAs as more and more patients turn to the Internet for health information. In Malaysia, where this study was conducted, a survey done in 2010 reported that health-related information is the third-highest category of Internet information search after “goods and services” and “information about government organisations” (5). Worldwide, more than half of PDAs registered in the Decision Aid Library Inventory (a PDA database) have some form of Internet function (3, 6). The level of Internet functionality ranges from providing a downloadable copy of a booklet PDA to multimedia-heavy web-based PDAs.

One key feature that differentiates online PDAs from traditional book or pamphlet-type PDAs is the ability to modify the content to suit individual patients. Theoretical principles underline the value of using technology to deliver tailor-made information (6). For example, the Health Belief Model emphasizes that presenting personalized information increases engagement in healthcare (7), the Elaboration Likelihood Model states that patients are more likely to pay attention to something that is considered personally relevant (8), and the Stages of Change Theory supports the value of providing up-to-date information and deliberative exercises across various points in the decision-making cycle (6, 9).

Consequently, PDA developers have explored how information technology can be applied to PDAs (10). Areas in which PDAs can be innovated include using engaging audio-visual multimedia information presentation, incorporating patient’s clinical scores into risk score calculations, helping patients forecast their treatment option consequences during value clarification exercises, and tailoring the information to different cultural and linguistic contexts (11). Expert consensus of web-based PDA development noted that web-specific features such as audio voice-overs, interactive graphics, and touch-screen data entry require additional study (6). PDA usability studies have reported that qualitative usability testing of web-based PDAs is essential to identify important informational and navigational issues, which are not captured in usability questionnaires (12).

Shared decision making is closely related to the issue of aging and technology. In a review of aging and technology, Koch noted that the shift toward partnership-based practice models “will lead to a combination of formal and informal care giving, self-care and lifestyle management, both locally and at a distance, supported by technology and controlled by the patient/citizen” (13). Some key areas of ongoing aging-related technology research are ambient assisted living (e.g. using devices to monitor age-related health issues) (14–16) and developing older-person-friendly online information material (17). Decision support is another area in which technology plays an important role in healthy aging. Older patients are required to make numerous preference-sensitive choices across multiple overlapping chronic conditions and require the support of technology to provide information, plan shared care plans, and collaborate with caregivers and family on maintaining healthy living (13).

However, older users are often perceived to be averse to using information technology (18, 19). This belief has been countered in the West, where the Internet is quite ubiquitous and studies have reported that Internet use can be as high as two-thirds of the 55–74-year-old population in Sweden (20). Numbers remain lower in non-Western environments and even a developed country like Japan has reported that 67% of the older people have no Internet access (21). However, the proportion of older Internet users is expected to increase as more and more technology-savvy users are entering the older-age population (22). There is a requirement to adapt technology to older users’ needs as deteriorating cognitive function, macular degeneration, and decreased locomotor ability may inhibit screen reading ability, information retention, and the use of the computer mouse or touch pad (23, 24).

Our study explored the use of a website for insulin initiation amongst patients with type 2 diabetes in an urban Malaysian healthcare setting. Malaysia has the highest prevalence of diabetes in the Southeast Asian region at 22.9% (25). Insulin is recommended in the Malaysian clinical practice guideline for type 2 diabetes if maximum oral and lifestyle interventions fail to control a patient’s glycemic control (26). However, Malaysian patients are often hesitant to step up to insulin injection from oral medications, have misconceptions about the safety and side-effects of insulin, and are restricted by sociocultural and religious beliefs (27–29). Patients who are
recommended to start insulin are generally older people as type 2 diabetes is a progressive disease. Although physicians may prescribe insulin, patients have to do the daily injections themselves. It is thus important to have adequate information support for patients on insulin initiation to allow them to make an informed decision. This study aimed to evaluate the usability (ease of use) and utility (impact on user’s decision-making process) of a web-based PDA on insulin initiation among older-age users.

Methods

Study design

An iterative, pragmatic qualitative research approach was used in this study (30). Pragmatism orients itself toward solving practical problems in the real world, and was appropriate for the iterative development of the web-based PDA. User testing of the website utilized a retrospective think-aloud process to capture users’ thoughts on the usability and utility of the website. The recruitment, website testing, interviews, and analysis were repeated over three cycles until minimal usability issues were encountered.

Setting

The study was conducted in 2014 at an urban tertiary teaching hospital outpatient clinic in Malaysia. In this setting, most patients are from a middle-class background, with some access to health information through books or the Internet. Insulin is initiated by primary care physicians and supported by nurses, but there is a lack of decision support tools and information available.

Website design

The website content and flow on the PDA on insulin initiation were developed based on stakeholder interviews with clinicians, patients, and policy makers, literature review, and the IPDASi criteria (27, 31). Table 1 summarizes the content and design features of the eight website sections.

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The website design features were interactive and included a personalized HbA1c chart, an attribute-selectable option matrix, and an interactive weighing scale graphic (Table 1). Pros and cons were given for six treatment options for type 2 diabetes:

- Do nothing
- Follow stricter diet and exercise
- Start insulin injection
- Add another type of diabetes tablet
- Start another type of injection (non-insulin)
- Use alternative treatment

Sampling

We recruited n=13 patients in total. The inclusion criteria were (i) patients with type 2 diabetes, (ii) patients had been advised by doctors to start insulin, (iii) patients were familiar with using computers, and (iv) patients were English-language literate. In Malaysia, persons aged 50 and above are considered older (32); one participant aged 49 was included as they were only one year below the inclusion bracket. Each user was only involved in a single test cycle.
**Data collection**

All patients answered a demographic questionnaire before using the website. The participants then used the website unaided. A researcher was present to assist the participant only if necessary (e.g. the participant could not navigate any further). During the website session, the computer screen activity (typing and mouse movement) and the users’ facial expressions were recorded simultaneously throughout the browsing activities, using screen recording software and webcam. After finishing the website session, the researchers used a topic guide to interview the users on their views and experiences of using the website while watching the recordings together (retrospective think-aloud). It has been suggested that retrospective think-aloud is better for older adults as the ability to perform dual tasks (i.e. concurrent think-aloud, which involves using the website while verbalizing thoughts) decreases with age (17). The interviews were recorded using audio recorders and field notes were taken during each session on issues that were observed when participants used the website.

**Data analysis**

The qualitative data was analyzed using a framework approach based on Li et al.’s usability modification categories (12). After each user testing session, the researcher listened to the audio recording and listed issues or user-comments into the analysis framework according to issues of usability (information delivery, language, navigation, layout, equipment preference, aesthetic) and utility (useful information, decisional preferences, deliberation about options, involving others in the decision). The researchers then met to discuss the suggested changes, which were compiled for the website developer’s action for the next round of website testing.
**Ethics**

This study was approved by the University of Malaya Medical Center Ethics Committee (Reference No: 1038.4).

**Results**

We conducted three cycles of website testing with 13 patients (cycle 1, n=6; cycle 2, n=4; cycle 3, n=3). The patients' profiles were as follows: age (median 65 years, range 49–75), gender (10 men, 3 women), and education level (nine secondary/diploma, four graduate/postgraduate degree). The time taken for each website session ranged from 16 to 50 minutes.

**Usability testing**

For navigability of the website there were issues concerning the use of words and symbols. The users preferred words to symbols to help them navigate through the website (e.g. use the word “next” instead of an arrow symbol). The users wanted simple instructions, which explained step-by-step what they were expected to do (e.g. “click here”).

> *I didn’t know I had to click the arrow, that’s why I kept on clicking here and it kept on repeating again and again. So somewhere you got to advise “Click the arrow.”* (Patient B, 73 years old (y.o.), Cycle 1)

A wide range of duration was spent by participants in navigating the website (16–50 minutes). This was because earlier versions of the website allowed the user to navigate freely between pages; this led to a lot of users skipping pages. The final version used constrained linear navigation, which forced the user to follow a set page sequence.

In terms of layout, a simple layout with all information displayed on the screen was preferred. This was because users found it difficult to use features such as a “drop-down” menu and a hide-show function. In terms of color, the older patients preferred a brighter background with sharp contrast.

> *Oh I didn’t know that the answer (on insulin concerns) will pop up.* (Patient B, 73 y.o., Cycle 1)

> *The contrast is not there. The dark green and the black doesn’t come out.* (Patient G, 56 y.o., Cycle 1)

When it came to language, users preferred simple language for information, a bigger font size, and more illustrations or pictures (and fewer words).

> *I think the font is quite small, I am already quite old.* (Patient A, 49 y.o., Cycle 2).

**Specific usability issues**

A number of usability issues were related to the section on elicitation of patient values (“Knowing what is important to you”). Patients found it challenging to use a drag-and-drop ranking function to indicate which concerns were important to them and to rank these from the most important to the least. As a result, the function was eventually listed as a tick-box of concerns without any ranking. Another issue was related to type of equipment used to access the web. Some users struggled with using a notebook or a laptop and preferred to use a desktop computer, something they were more familiar with.

Most usability issues were resolved by the third and final iteration (Figure 1).

**Utility testing (impact on decision-making process)**

Participants commented that the website influenced their decision in three ways: it provided them with information, it allowed them to deliberate between options, and to involve others in their decision making.
Providing information

Participants viewed that the website had provided them with useful information that they previously lacked such as possible side effects of insulin and different types of modern insulin pen designs.

No, I'm not aware. Insulin may cause hypo (hypoglycaemia), yes I've taken some tablets and became hypo, my sugar level dropped to 2.4, 2.5, 2.3, so my concern is once you use insulin, you might become hypo. (Patient B, 73 y.o., Cycle 1)

The personalized chart on blood glucose trend helped them understand their blood glucose control over time. For those who preferred insulin therapy, it served as an evidence to support their decision to initiate insulin.

I think, the HbA1c chart, my risk and the weighing scales... gives me a summary of my results. [So I am clear] on certain terms, based on my result, why I should start insulin. (Patient W, 65 y.o., Cycle 2)

At least you can highlight are you at the dangerous zone or moderate. You know where you stand. (Patient O, 61 y.o., Cycle 1)

However, some compared the content of the website to information available on the Internet and felt that the information provided on the website was not adequate.

The information that is on this website is limited. Maybe they can put a link click here and then go to Google. (Patient G, 56 y.o., Cycle 1)

The accessibility of the website was valuable as they could refer to it at any time.

It gives an added value because you don’t have to go and see a doctor all the time. (Patient B, 73 y.o., Cycle 1)

Deliberating options

Second, the website helped them deliberate on options. The website helped clarify their options by allowing them to compare between the attributes of different options in the options matrix.

It helps me to understand that I need insulin as I have taken maximum tablets. (Patient C, 68 y.o., Cycle 3)
It is useful to show how the sugar goes up and down with different options (in the Pros and Cons of Options matrix). (Patient A, 53 y.o, Cycle 3)

Eight of the 13 patients felt the website was biased toward the insulin option because most of the information was about insulin. Three indicated it was slanted toward stricter diet and exercise and one indicated it was slanting toward adding another type of tablet. One participant viewed the website as being balanced between options as they felt they were allowed to make their own choice and were not persuaded toward insulin.

I think you are trying to persuade me to start insulin. Most of the information is towards that. (Patient N, 71 y.o., Cycle 2)

[The website is] Balanced. It [starting insulin] is our choice. We go through it and make own choice. It is fair. (Patient A, 53 y.o., Cycle 3)

The participants found the personalized summary report useful as it provided a record of the choices they had made and an overview of their deliberation process for choosing an option.

Yes, it is useful because it gives me the summary of what I have entered. (Patient W, 65 y.o., Cycle 2)

Involving others in decision making

Third, participants commented that the website would help them involve others in the decision-making process. They wanted to share the website with family members to involve them in the decision making. They would save the summary report for discussion with their doctor too.

Frankly speaking, my wife will say “No, why do you want to go on insulin, it’s so troublesome.” They think its best you can do without it… You see you need to make the next person to understand that you need insulin, they don’t know, they are not patient. (Patient G, 56 y.o., Cycle 1)

I would keep the print out for reference and show to the doctor and discuss (with the doctor). (Patient C, 68 y.o., Cycle 3)

Discussion

Website design issues for older users

This study contributes to the larger body of research linking the successful implementation of technology with the need to prioritize and incorporate older adults’ needs and wishes during the development of technology (24, 33). In general, the website became simpler, in terms of both content and navigation, as test cycles progressed. This shift agrees favorably with two (of six) principles from the ARCHIE design framework, which advocates that technology needs to be 1) ANCHORED in a shared understanding of what matters to the user; and 2) CO-CREATIVE, evolving and adapting solutions with users (34). Indeed, Greenhalgh et al., writing on the concept of quality in telehealth, have warned that design of technological interventions is often driven by a focus on the product itself, instead of how it performs in the hands of the user (34, 35). In this study, the temptation to incorporate more interactivity into the website was offset by the realization that a complex website was not as navigable to older-age users.

Usability was affected by the navigation and layout of the website. This study highlighted the importance of addressing issues on usability, especially for older people for better website use. Thus, we changed the navigation from an unconstrained to a fixed linear navigation at the expense of freedom of navigation to ensure patients had considered all the necessary information before making a decision. In previous studies, options for website navigation styles were limited to hierarchy-based (i.e. navigating through clustered topics) versus tag-based (i.e. free search) navigation (24). Our study adds a third possible style (fixed linear navigation), which, although offering limited navigability, may be more suited to older adults with poorer visual spatialization and orientation abilities (24).
One key advantage of the website format was the ability to provide individualized risk communication to inform patients about the risk of diabetes complications at their own HbA1c levels. Although it was a simple rule-based risk score, the HbA1c chart and personalized information on risk made patients view it as their personal risk. This use of personalized features as a feature of online PDAs is supported by the Elaboration Likelihood Model, which proposes that people pay attention to and actively process information more if it is perceived as personally relevant (6, 36).

However, the personalized feel of the website could be a reason why some patients reported the website was a means to persuade them to start insulin. Patient’s perceptions could have been influenced by their previous experience with doctors; we have previously reported how Malaysian doctors tended to use persuasive techniques such as providing biased information towards the benefits of insulin when counseling patients (37). The provision of balanced and structured information in the PDA needs to be performed alongside training of healthcare professionals to provide unbiased support during consultations.

In this study, we switched from an open, freely navigable website to a closed, linear design to avoid users from unknowingly skipping sections. Besides improved navigability, this change helped avoid them making biased decisions; patients who had decided against starting insulin tend to search for information that supported their decision (risks and side effects of insulin), and avoid information that discussed advantages of insulin. Thus, the website’s linear design and compulsory fields "forced" the users to read both the pros and cons of insulin so that they could make an informed decision.

With reference to the IPDASi criteria, two areas of the insulin initiation PDA content were challenging to implement in this study: the risks and benefits of options, and the elicitation of patient values. The risks and benefits of tailoring the amount of treatment option information proved a challenge as there was a large number of type 2 diabetes treatment options (six options) and important attributes to be considered (seven attributes). A matrix layout was chosen to display the information, but the table was too large if all the information was displayed. After cycles of iteration, by allowing patients to select the attributes of interest to them, and screening out options patients were not interested in beforehand, patients were able to reduce the size of the matrix. This also gave them a more precise focus on their own information needs.

The second challenge was on choosing an appropriate technique for value elicitation. There are three common techniques of eliciting values: using a balance sheet (listing the pros versus cons of the each treatment option); rating and ranking choices (prioritizing between options or attributes); and discrete choice experiments (measuring the relative importance of attributes such as willingness-to-pay or quality-adjusted-life-years) (38). In this study, the ranking method was chosen and patients were asked to rank their concerns about insulin. However, patients found the task of ranking their concerns difficult. This could be because participants are unfamiliar with the idea of values elicitation, despite a brief introductory paragraph at the beginning of the section. Eventually the values elicitation section was replaced with a simpler tick-box list of concerns, which is similar to the balance sheet method. Future research on elicitation of patient values in web-based PDAs should explore the use of multimedia to allow more interactive and intuitive elicitation of patient values. For example, using graphical representations of value weights (e.g. darker/lighter shades, smaller/bigger area) or an interactive weighing scale, which reacts in real time to indicate patient concerns.

In our website, after eliciting patient’s values (concerns), the corresponding concerns were displayed on a weighing scale graphic of “for or against insulin.” This graphical information was explicitly expressed by at least one patient as playing a part in his decision-making process. Icons, or Graphical User Interfaces, are easy to recognize and enable users to quickly grasp that they can use the icon to perform a function (39). Given that most web-based PDAs follow a standard format, a standardized set of well-designed icons that is easily recognizable would be useful in pictographically representing the important functions of web-based PDAs.
to patients. This should be tested against some users’ preferences for more text-based symbols as in this study.

**Usability testing among older adults**

Retrospective think-aloud was a practical tool for evaluating the website with older people. Besides catering to older users’ ability to perform dual tasks (i.e. using the website and verbalizing thoughts) (17), the use of retrospective think-aloud was suitable as this first prototype of the insulin website had many unforeseen navigability issues. These issues were better explored retrospectively as users were able to tell us why they were unable to navigate between sections. A suggested rule of thumb is to use concurrent think-aloud if researchers are interested in richer, more emotional verbal commentary and to use retrospective think-aloud if researchers seek to know the users’ insight on issues they faced when using the website (40).

**Limitations**

One limitation was that most of the participants in the study were better educated, with at least a secondary level of education. This was because the website was developed in English, which is not the mother tongue of most Malaysians. Therefore, this study is unable to shed insight on Malaysian website users who access the Internet in other languages. In addition, the patients were those who already had some degree of computer literacy and we are unable to report the usability of the website with computer-illiterate users.

**Conclusion**

Navigation and layout were key issues in the usability of the web-based PDA for older-age users. These were addressed using senior-friendly modifications such as removing hidden functions and using simple language. With regard to the PDA criteria, sections requiring patient input such as patient values elicitation and personalized risk communication could be improved with the use of interactive web functions.

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**Conflicts of interest**

The authors report no conflicts of interest.

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