Usability and Acceptability of Love Thyroid Application in Patients With Hyperthyroidism Receiving Radioactive Iodine Treatment

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Background: Telemedicine and e-health services are crucial tools to help patients undergo complex treatments, such as radioactive iodine treatment (RIT), during the COVID-19 pandemic. However, the efficacy of such tools in real-life practice in Thailand is unknown.

Objective: To investigate the usability, acceptability, and user needs for the Love Thyroid application and book among patients with hyperthyroidism.

Methods: A descriptive study, 120 patients with hyperthyroidism who received RIT were given the chance to use both the Love Thyroid application and book. Then, all patients completed the electronic questionnaire that gathers information, including the usability, acceptability and user needs for both media.

Results: The Love Thyroid application was more helpful in following patients up after RIT and has a more attractive design than the book ($P < .05$). The book was easier to search for information than the application ($P < .05$). Furthermore, the application had higher acceptability than the book in terms of the confidence in data security, ease of handling, and satisfaction ($P < .05$). The usefulness of the educational contents was comparable for both media. The application was more likely to be recommended by the patients to others than the book ($P < .05$).

Conclusions: Mobile applications, such as the Love Thyroid application, had good usability and acceptability as informative tools for patients with hyperthyroidism underwent RIT.

Keywords: Hyperthyroid, Patient care, Electronic book, Mobile application

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Introduction

The adaptations in nuclear thyroidology during the COVID-19 pandemic must focus on not only minimizing the spread of infection to the staff and patients but also maintaining patients' treatment outcomes and quality of life. A current review recommended nuclear medicine physicians to delay all radioactive iodine treatments (RITs) and alternatively use antithyroid drugs (ATDs) in cases of hyperthyroidism during the COVID-19 pandemic.[1] However, the postponement of RIT in patients with thyroid emergencies (thyroid storm), with critical signs and symptoms (pressure to the trachea and breathing difficulties), with an inadequate response to medical therapy, and at risk of complications of ATD (neutropenia and agranulocytosis) may contribute to their morbidity and mortality. The alternative approach for this crucial setting is telemedicine consultation and e-health services.

In 2016, we developed a community of practice for managing thyroid diseases in the Eastern Economic Corridor (EEC) region of Thailand, namely, Love Thyroid. We established a telemedicine consultation practice among multidisciplinary physicians of this community and used the Love Thyroid book, a printed book that guides, informs, and educates patients about RIT, to communicate with patients and collaborate our services among healthcare professionals. While the Love Thyroid book provides suitable information regarding the therapeutic procedures and standard radiation protection, which make patients and their caregivers feel unrestricted, reduces unnecessarily repeated visits, and decreases frequent follow-up appointments, this book still has some limitations. Patients criticized the book as it was inconvenient to carry and was often forgotten when patients visited their doctors. Additionally, obtaining copies of the book is considerably costly, and once the book is published, it is not possible to have updated data when new hyperthyroid management guidelines are available.

For the aforementioned reasons, we created the Love Thyroid application, an easy-to-use and friendly application, designed for patients with hyperthyroidism.

The application design and development processes consisted of studying user requirements, designing the application, creating application prototypes, implementing the program, and testing and deploying the application. After gathering the requirements from the users, we analyzed and designed the function of the Love Thyroid application into 4 roles; patients, nurses, doctors, and administrators. Each role has a different set of privileges that allow for different levels of data access while using the application. Using the role-based access control helps restrict access to certain parts of the application. For example, patients can only view their lab results, while doctors can edit them. For the prototyping process, we used Mockplus to design screen layouts and build interactive prototypes. Prototyping allows users to test the application and provide feedback to the developers. When the developers confirm the design document and feedback from the users, the implementation/coding process begins. The design of the application is converted into a source code. The Love Thyroid application was developed in a Visual Studio Code environment. When the code is finished, the testing process begins. In this step, the developed application is tested carefully, and any flaws detected are assigned to the developers to fix them. Once the application has been tested, it is deployed in the production environment. The Love Thyroid application was designed to empower patients by keeping up-to-date and easily accessible medical records while respecting their privacy and providing reminders for doctor appointments. Overall, the application was developed aiming it to become a key component in improving the quality of life of patients.

Therefore, we conducted an experimental study to assess the usability and acceptability of the Love Thyroid application, including patients' desires, and compare them with those of the Love Thyroid book.

Methods

Development of the Love Thyroid Application

The main features of the Love Thyroid application comprised 2 sections. The first section provided educational

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media (infographics and video clips) for patients via their mobile phones or tablets (Figure 1A). Because most patients with hyperthyroidism are misinformed about the management of hyperthyroid diseases from inaccurate online information, we obtained up-to-date data from the international guidelines for the management of hyperthyroidism.[2] We also translated the material to simple Thai, making the material easier to understand. Our content includes images and video clips allowing easy access to the information.
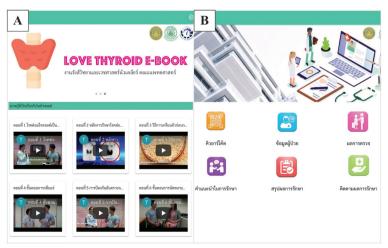
In the second section, we designed an e-medical record to assist patients undergoing RIT and to aid the healthcare professionals managing their treatment plans (Figure 1B). This section composed of 3 panels. In the Nurse and Doctor Info panels, the nurse and specialist physician can record patients' information, the results of treatment, and the follow-up visit data. Information includes hospital number, name, surname, username, password, email address, code, phone number, address, gender, age at diagnosis, clinical data, thyroid function tests before and after RIT, thyroid gland size using ultrasound, preparation for RIT (duration of ATD withdrawal and low-iodine diet), date and dose of RIT, radiation protection guideline, and follow-up appointments, including thyroid function tests after radioactive iodine administration. The Patient Info panel enables patients to view their clinical data to keep a portable medical record. Patients can access their data using their username and password set by themselves. Nurses can add new patients and their data from their personal computers.

Participants

We enrolled 121 patients with hyperthyroidism aged more than or equal to 18 years attending the thyroid clinic of the Division of Radiology and Nuclear Medicine, Burapha University Hospital, Chonburi, Thailand. The inclusion criteria were as follows: patients who have undergone RIT, those who possessed a mobile phone or tablet that supports Android or iOS software, those who can use mobile applications, and those who understand Thai. One patient was excluded because her mobile phone could not download the Love Thyroid application.

We calculated the sample size for this study using G*Power, version 3.1.9.4. As for the rationale for this sample size, this study was designed to compare the usability and acceptability between the Love Thyroid application and the Love Thyroid book according to the rating scale of patients. We used the Wilcoxon signed rank test (matched paired) and defined a power of test at 95%, and the effect size (d) was 0.35.[3] Assuming a dropout rate of 5%, the planned sample size was 120.

Figure 1. Screenshot of the Love Thyroid Application

A, Educational media.

B, E-medical record.

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Ethics

This study was approved by the Institutional Review Board of Burapha University. The number of approval decision was HS 057/2020 on October 15, 2020.

Study Design

For this descriptive study, we assessed the usability, acceptability, and users' needs of either the Love Thyroid application or book among patients with hyperthyroidism.

Data Collection

We explained to the patients for the details of the research method and asked them to use their data in a statistically aggregate manner while keeping their data privacy securely. All voluntary patients signed a consent form before starting the experiment. Each patient could test both the Love Thyroid book and application. First, our nurse instructed the patients to read the book. Then, the patients will have an invitation sent to download an application via QR code A in the project poster. For data security, each patient will register via their username and password.

Our nurse instructed the patients on how to use the application. An electronic questionnaire was used to gather information about (1) age, (2) sex, (3) educational level, (4) occupation, (5) mobile operating systems, (6) a rating of the usability, (7) a rating of the acceptability, and (8) users' needs for both tools. The patients rated the usability and acceptability of both tools on a 5-point Likert scale, where 1 is poor, 2 is fair, 3 is good, 4 is very good, and 5 is excellent. The usability included 7 concept questions, and the acceptability consisted of 5 questions.

Finally, our nurse instructed the patients to use the application and download the same questionnaire via QR code B in the project poster to complete the questionnaire any time after using the application.

Statistical Analysis

All data were downloaded and stored in Statistical Package for the Social Sciences. Descriptive statistics were used to characterize the overall sample, study usability and acceptability, and users' needs, expressed by mean and standard deviation (SD). To examine differences in usability and acceptability, we used the Wilcoxon signed rank test (matched paired) because of the data in this study is a nonparametric data, at the level of significance of P less than .05($P < .05$), as appropriate. All statistical analyses were performed using SPSS version 24.0 (IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp; 2016).

Results

In this study, 120 patients with hyperthyroidism were included. The mean (SD) age of patients was 39.0 (12.1) years. Most patients were female (74.0%) and used smartphones run on the Android operating system (80.0%) (Table 1).

Table 1. Baseline Characteristics of Participants

Variable	No. (%)
Age, mean (SD), y	39.0 (12.1)
Gender	
Male	31 (25.8)
Female	89 (74.2)
Educational level	
Less than primary education	2 (1.7)
Primary education	15 (12.5)
Secondary education	55 (45.8)
Bachelor's degree	42 (35.0)
Master's degree or above	6 (5.0)
Occupation	
Government services and state enterprises	10 (8.3)
Freelancer	28 (23.3)
Private business	22 (18.3)
Private employees	34 (28.3)
Others	26 (21.7)
Mobile operating systems	
iOS	24 (20)
Android	96 (80)

Abbreviation: SD, standard deviation.

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The usability of the Love Thyroid application and book was determined. The educational content in both tools is easy to understand and can be implemented easily. They can help patients understand the treatments of hyperthyroidism and correctly prepare for RIT. The performance of the application and book are comparable, and both have good scores. However, the application is more helpful in guiding patients in the follow-up phase after RIT ($P = .01$), and the design of the application is also more attractive ($P = .01$). The ease of downloading, ease of using and understanding, and various health educational media are all in the good level or above. Searching for information was easier using the book ($P = .01$) (Table 2)

The acceptability of the Love Thyroid application and book was presented. Patients rated the acceptability of the Love Thyroid application as good or above in all topics. Confidence in data security, ease of handling, level of satisfaction, and recommendation for using this tool are all rated statistically significantly better for the application ($P < .05$) (Table 3). The usefulness of the educational contents was comparable between both media. Additional user's needs of either the application or book were presented (Table 4.)

Table 2. Usability of the Love Thyroid Application and Book

Topic	Means (SD)		P Value[*]
	Application	Book	
Education contents would			
Let you know the treatments of hyperthyroidism	4.68 (0.55)	4.74 (0.48)	.27
Be helpful for your preparation before RIT	4.73 (0.55)	4.75 (0.51)	.72
Be helpful for your follow-up after RIT	4.68 (0.55)	4.47 (0.71)	.01
Education contents are easy to understand and ease of implementation	4.70 (0.53)	4.68 (0.65)	.96
The information is easy to search	4.53 (0.61)	4.65 (0.67)	.01
Design was attractive	4.77 (0.53)	4.61 (0.71)	.01
Ease of downloading the application	4.63 (0.59)	-	-
Application commands were easy to understand and use	4.73 (0.56)	-	-
A variety of health education medias in the application	4.61 (0.64)	-	-

Abbreviations: SD, standard deviation; RIT, radioactive iodine treatment.
Usability of both tools varied from 1 (poor) to 5 (excellent).
[*]The statistical significance was determined at $P < .05$.

Table 3. Acceptability of the Love Thyroid Application and Book

Topic	Means (SD)		P Value[*]
	Application	Book	
Usefulness of the education contents	4.73 (0.51)	4.72 (0.52)	.82
Rate of confidence in data security	4.56 (0.67)	4.31 (0.83)	.0006
Ease of handling	4.85 (0.40)	4.04 (1.01)	< .0001
Level of satisfaction	4.68 (0.53)	4.31 (0.80)	< .0001
Recommend using this tool	4.66 (0.53)	4.10 (1.00)	< .0001

Abbreviation: SD, standard deviation.
Acceptability of both tools varied from 1 (poor) to 5 (excellent).
[*]The statistical significance was determined at $P < .05$.

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Table 4. Additional Users' Needs of Both Media Improvement

Topic	No. (%)
Love Thyroid application	51 (42.5)
More educational contents regarding both hyperthyroidism and general health	6 (5)
More simplicity of login/user authentication	3 (2.5)
Additional reminder of appointment date/time	1 (0.8)
Additional ways to send questions/contact healthcare personnel	1 (0.8)
Improvement of user interface	1 (0.8)
Love Thyroid book	30 (25.0)
Improve clarity/understandability of educational content	2 (1.7)
Size of book too big/small	4 (3.3)

Discussion

Nowadays, mobile applications have gained more widespread usage to improve the quality of healthcare, including disease screening, preparation before treatment, self-care, and disease progression monitoring. Many diseases now have a dedicated mobile application for helping patients cope with their diseases, such as dementia,[4] osteoporosis,[5] diabetes mellitus,[6] burns,[7] heart disease,[8] hypertension,[9] and asthma.[10]

For the successful treatment of hyperthyroidism by radioactive iodine, the important part is not only the administrative dose of radioactive iodine but also good knowledge regarding the disease and the well-planned preparation of patients. The development of the "Love Thyroid" application is important to facilitate the success of RIT. In this study, 120 patients who used both the application and book agreed that the educational contents are very useful in understanding how to care for their disease with a mean score of 4.7 equally for both media because the contents were the same. All patients also had adequate knowledge of RIT and could correctly prepare themselves for their treatment. This correlated

with the results from previous studies on the use of mobile applications in patients taking oral anticoagulants and children with asthma showing that using mobile applications leads to better outcomes of their respective diseases.[10] Interestingly, the Love Thyroid application has better performance regarding helping healthcare professionals follow patients up after RIT than the book. The design of the application is more attractive; however, using the book made finding information easier because there were not many pages; in contrast, the users of the application must take multiple steps to reach the same information. For the educational content, the patients using both media needed more data regarding the preparation for RIT (eg, which food to avoid during the treatment period, and which medicine that can be taken during this period) and more data on the general healthcare for patients with hyperthyroidism, such as diet and exercise.

Regarding the performance of the Love Thyroid application, it is easy to download and can be installed on smartphones running both Android and iOS operating systems. This application is easy to use and has various educational contents. However, some patients suggested that they should be able to set their own username instead of using citizen ID and use a simpler password for user authentication. Despite supporting almost all smartphones presently in use, some patients lose their chance to use this application because their smartphones cannot support the application. In the future, we must solve the inaccessibility of the application.

Overall, the Love Thyroid application also has good acceptability among the patients. The application has advantages over the book in terms of data privacy (to access data, the user needs authentication) and portability (patients are more likely to have a smartphone on them all the time than them having the book). Overall, these benefits lead to a better overall level of satisfaction with the application, and the users of the application are more likely to recommend this tool to other patients.

Regarding the users' feedback, they required more interactive functions for the application, such as appointment reminders and a channel to communicate

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with their healthcare providers, reflecting that the users need better technology, which can be achieved using smartphones compared with using traditional media. They also requested to improve the user interface, as the user interface was too small in some pages.

This study has some limitations, including the underrepresentation of migrant workers who cannot understand Thai and those who might be less motivated to use a smartphone application, which may hinder the generalizability of this application to other populations. This study is a cross-sectional study, so it has no data regarding long term engagement. Many things can be improved in later versions of this application, such as revising the content to be more up to date, adding more infographics and animation videos to better explain to the patients their disease and the treatment procedure, and adding function to help patients contact healthcare providers directly to ask their questions regarding their disease that are not included in the application.

Subsequent studies can be done to further evaluate other data such as the quality of life, efficacy of the media, whether different baseline characteristics of patients effecting outcome or not and to apply the results in a larger patient population.

Conclusions

This study showed that the use of a mobile application, such as the Love Thyroid application, has good usability and acceptability and can fulfill users' needs better than the use of traditional media, such as books, among patients with hyperthyroidism underwent RIT.

Acknowledgments

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การใช้งานและการยอมรับแอปพลิเคชันทางมือถือสำหรับการให้ความรู้และการดูแลรักษาผู้ป่วยโรคต่อมไทรอยด์เป็นพิษที่ได้รับการรักษาด้วยการกลืนแร่กัมมันตรังสีไอโอดีน

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บทนำ: การแพทย์ทางไกลและการให้บริการทางสุขภาพผ่านสื่ออิเล็กทรอนิกส์เป็นเครื่องมือที่นิยมนำมาใช้ในการดูแลรักษาผู้ป่วยที่ต้องได้รับการรักษาที่ซับซ้อนในช่วงที่มีการแพร่ระบาดของโรคโควิด-19 เช่น การรักษาด้วยการกลืนแร่กัมมันตรังสีไอโอดีน แต่ประสิทธิผลของเครื่องมือเหล่านั้นในประเทศไทยยังไม่ทราบแน่ชัด

วัตถุประสงค์: เพื่อสำรวจการใช้งาน การยอมรับ และความต้องการของผู้ใช้ของแอปพลิเคชัน Love Thyroid และสมุดประจำตัวผู้ป่วย สำหรับผู้ป่วยโรคต่อมไทรอยด์เป็นพิษ

วิธีการศึกษา: การศึกษาเชิงพรรณนาในผู้ป่วยโรคต่อมไทรอยด์เป็นพิษที่เข้ารับการรักษาด้วยการกลืนแร่ ณ คลินิกไทรอยด์ โรงพยาบาลมหาวิทยาลัยบูรพา จำนวน 120 คน โดยให้ผู้ป่วยใช้งานทั้งแอปพลิเคชัน Love Thyroid และสมุดประจำตัวผู้ป่วย และให้ผู้ป่วยตอบแบบสอบถามอิเล็กทรอนิกส์เพื่อประเมินประสิทธิภาพด้านการใช้งานและด้านการยอมรับของสื่อทั้ง 2 แบบ

ผลการศึกษา: แอปพลิเคชันช่วยให้ผู้ป่วยได้รับการติดตามการรักษาได้อย่างมีประสิทธิภาพสูงกว่า ($P < .05$) การออกแบบมีความน่าสนใจมากกว่า ($P < .05$) สะดวกต่อการพกพามากกว่า ($P < .05$) และมั่นใจในความปลอดภัยของข้อมูลส่วนตัวสูงกว่า ($P < .05$) ความพึงพอใจในการใช้งานของแอปพลิเคชันมากกว่า ($P < .05$) และยังแนะนำผู้อื่นให้ใช้แอปพลิเคชันมากกว่าสมุดประจำตัวผู้ป่วย ($P < .05$)

สรุป: แอปพลิเคชัน Love Thyroid ตอบสนองต่อความต้องการของผู้ป่วยโรคต่อมไทรอยด์เป็นพิษที่เข้ารับการกลืนแร่ได้ดีทั้งในแง่การใช้งานและการยอมรับ

คำสำคัญ: โรคต่อมไทรอยด์เป็นพิษ การดูแลรักษาโรค หนังสืออิเล็กทรอนิกส์ แอปพลิเคชันทางมือถือ

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