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A novel smartphone application for bladder cancer management (BCM App): Design, development, and usability evaluation

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Abstract:

BACKGROUND: Providing clinical guidelines to clinicians using innovative technologies seems practical and useful. This study aimed to design, develop, and evaluate a smartphone application to assist urologists in managing bladder cancer (BCM App).

MATERIALS AND METHODS: The study was conducted in three phases, following the user-centered design model, at the urology clinic of Khorshid Hospital (Isfahan, Iran) in 2021. Components and functionalities for BCM App were specified in three focus group sessions with urologists and urology residents using clinical guidelines. Adopting the Delphi technique, the participants completed a questionnaire addressing issues including educating and informing clinicians, performing clinical calculations, representing graphical information, and recording patient information. A conceptual model for the app was designed, and the final product was developed. The usability of the BCM App was evaluated using the think-aloud technique by usability experts and end-users.

RESULTS: The app's components were categorized into three groups: Patient evaluation, disease staging and management, and patient follow-up. The app's main components included "bladder cancer classification," "disease grading and staging," "management based on the disease stages," "principles of intravesical treatment," and "classifying follow-ups by disease stages." Moreover, the most prominent app's functionalities were "using staging and grading table," "using American Urological Association risk stratification," "calculating disease stages," "calculating patient's follow-up," and "recording patient information." The usability evaluation results revealed that the BCM App was at a "highly acceptable" level.

CONCLUSION: To design and develop a smartphone app for managing bladder cancer, the involvement of urologists is crucial. Apart from assisting urologists in effectively managing bladder cancer, the proposed app has the potential to enhance residents' knowledge and streamline their access to evidence.

Keywords:

Bladder cancer, mobile applications, mobile health, smartphone, user-centered design

Introduction

Bladder cancer, the most common cancer of the urinary system in the world, has an incidence ranging from less than 2.6 to more than 15 per 100,000 people in different countries.[1] In 2019, a study reported bladder cancer as the fourteenth most common cancer leading to death worldwide and the sixth most common cancer in Iran.[2] In this regard, the early diagnosis and management of the disease are of great importance.[1]

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Clinicians need continuing learning based on up-to-date resources and guidelines on bladder cancer to improve their clinical knowledge and skills.[3] Although evidence-based guidelines provide specified management guidance on points of care for clinicians, promote patient outcomes, and facilitate the effective use of clinical resources,[4] having access to high-quality resources is a challenge.[5] Providing clinical guidelines to clinicians using innovative technologies seems practical and useful. Nowadays, mobile health (mHealth) providing efficient tools to support clinical decision-making is increasingly used. The mHealth tools provide an opportunity for clinicians to acquire knowledge, have access to clinical guidelines quickly, perform required patient care calculations, and make clinical decisions.[6-8]

Some studies have examined the effects of new information technologies (IT) on clinician's access to clinical guidelines, which have shown different results.[9-11] Khan *et al.* claimed that a smartphone-based application (app) containing clinical guidelines would improve residents' knowledge of colon cancer screening.[10] According to another study, although point-of-care apps save time and enhance accuracy in medical diagnosis, clinicians are concerned about their inability to use them in dealing with their patients or peers.[11] Some other studies have also reported medical students' challenges in using smartphones for medical education, which encompassed superficial learning, concerns about the credibility of resources in the app, and distractions in clinical settings.[12,13]

As smartphone apps become more popular, there are increasing concerns about accuracy and safety due to the lack of legal oversight and non-involvement of healthcare professionals in their design.[14] Tapiero *et al.* assessed the current state of smartphone technology in urology and concluded that smartphones are constantly developing and can promote urology care and education.[15] Pereira-Azevedo *et al.* estimated that urology lags behind other medical areas in utilizing mHealth to deliver healthcare services. Furthermore, they showed that there is a lack of involvement of healthcare professionals in medical app development.[16]

Given the positive effects of smartphone apps on the knowledge of medical students and residents in areas such as antibiotics[17] and colorectal cancer screening,[10] as well as their improvements in accuracy for predicting prostate cancer[18] alongside the high prevalence of bladder cancer and challenges like clinicians' time constraints in accessing clinical resources, and the inadequacy of valid urology apps,[15] it is of great importance to developing a new model that facilitates clinicians' access to clinical guidelines for managing bladder cancer patients. The study aimed to design and develop a novel smartphone app based on urology guidelines, with the active participation of urologists, to help them manage bladder cancer (BCM App) and then to evaluate its usability.

Materials and Methods

Study design and setting

The study was conducted in 2021 in Khorshid Hospital, affiliated with the Esfahan University of Medical Sciences. The hospital is the referral center for bladder cancer patients in Isfahan province and adjacent provinces. With the active participation of urologists and residents, the study was performed in three phases based on the user-centered design (UCD) model [Figure 1].[19]

Phase 1 – Needs assessment

Identifying and selecting clinical guidelines

Study participants and sampling

Five faculty members of Isfahan University of Medical Sciences with a specialty in urology and at least three years of clinical work experience were selected using the convenient sampling method.

Data collection technique

The most recent clinical guidelines in bladder cancer management were searched on the electronic medical databases using appropriate combinations of the following keywords: Bladder cancer, clinical guideline, bladder mass, and bladder transitional cell carcinoma. The most suitable guideline(s) were selected from the searched ones, using focus-group discussion techniques.

Determining and specifying the components and functionalities of the app

Study participants and sampling

Five urologists, five urology residents, two medical informatics specialists, and two health information management specialists, were selected using the convenient sampling method.

Data collection tool and technique

For the determination of components (mainly information content) in the subject of bladder cancer, three focus group meetings were held. Moreover, the related information content was found for each component from the validated medical references and the selected clinical guidelines.

For determination of the app's functionalities, in addition to holding meetings with urologists, urology residents, medical informatics specialists, and health information management specialists, the functionalities of similar apps for Android were assessed on the Google Play Store. To approve the determined components, their related content, and the determined functionalities, we used a researcher-made checklist. Face validity of

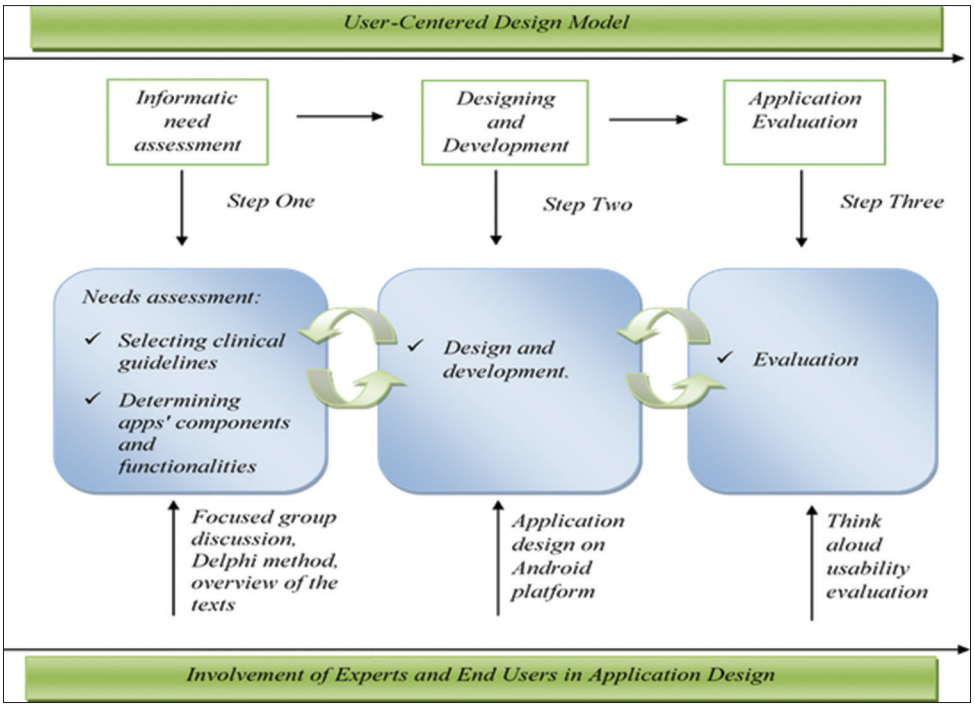

Figure 1: Involvement of stakeholders using User-Centered Design Model

the questionnaire was approved by health information management specialists (n = 2), medical informatics specialists (n = 2), and urologists (n = 4). The final version of the questionnaire consisted of five sections addressing five features, including teaching and informing physicians (22 items), calculation (2 items), graphical representation of information (4 items), recording patient information (1 item), and others (1 item).

According to the Delphi technique, the electronic questionnaire was distributed among five urologists and five urology residents selected using the convenience sampling method. The questionnaire was then returned after one week. Responses to the questionnaire items were scored from 1 to 5 (very low = 1 to very high = 5). The minimum score for acceptance of each item was 3.75. Items with a score of less than 2.5 were eliminated. To analyze the findings of the Delphi technique, descriptive statistics (i.e., frequency, relative frequency, and mean) were calculated, and the components were prioritized and analyzed using the mean scores.

Phase 2 – Design and development

After the app's components and functionalities by the experts, the app's prototype was developed using Extensible Markup Language (XML) and Kotlin programming languages in Android. Moreover, SQLite and JavaScript Object Notation (JSON) were used as the database management system and data storage format, respectively. The prototype was installed on the domain experts' smartphones (two medical informatics specialists, two urologists, and four urology residents); after receiving back-and-forth feedback, the final version of the app was developed (BCM App).

Phase 3 – Usability evaluation

Study participants and sampling

Four usability experts with at least three years of work experience (two medical informatics specialists and two health information management specialists), two urologists, and nine urology residents were selected using the convenient sampling method.

Data collection tool and technique

The final version of the app was installed on the Android-based smartphone of study participants. Users first received a brief description of how to use the app. They had two weeks to use the app, continuously. In case of any problem or question, they advised to contact the first author. The app's usability was evaluated using the think-aloud technique. To record the users' voice and their smartphone screens, A Z Recorder Screen software was used. Then the users were asked to use the app and simultaneously express aloud what they saw, thought, did, or felt. One researcher repeatedly reminded the users to express their thoughts aloud.

Using a form approved by two domain experts [Additional File 1], the researcher collected the users' data as long as saturation was achieved. The recorded data were then transcribed verbatim. The content analysis was performed in the next step to extract the app's strengths and weaknesses. To enhance the accuracy of this technique, the second researcher independently

reviewed the textual content and provided feedback. Finally, the two researchers reached an agreement. The final list of strengths and weaknesses was then submitted to the end-users (i.e., urologists and urology residents), and they assessed their accuracy. Furthermore, the researchers independently specified the severity of each problem in the app using a five-point scoring scale (0: not a problem; 1: cosmetic problem; 2: minor problem; 3: major problem; and 4: usability catastrophe) proposed by Nielsen.[20] Then another meeting (lasting 30 minutes) was held to calculate the average severity of problems, then the identified weaknesses were resolved. To evaluate the usability, the characteristics of the user interface (i.e., aesthetics and orientation, learning, efficiency, effectiveness, applicability, performance, educational content, users' satisfaction and dissatisfaction, and usability problems) were examined, according to the International Organization for Standardization usability standard and Nielsen.[20,21] Finally, the app was modified in terms of the usability problems reported by the experts and end-users, and its final version was released.

Ethical consideration

This study was approved by the ethics review board of the Vice-chancellor for Research Affairs of Kashan University of Medical Sciences (IR.KAUMS.NUHEPM.REC.1400.016) and all methods were carried out according to the relevant guidelines and regulations or the Declaration of Helsinki. The informed consent was obtained from all subjects and/or their legal guardian(s).

Results

Phase 1 – Needs assessment

Identifying and selecting clinical guidelines

Four clinical guidelines and one book on bladder cancer treatment were selected following the search for specialized databases and medical texts. In a meeting with five urologists, the most appropriate guideline (NCCN Clinical Practice Guidelines in Oncology: Bladder Cancer)[22] and book (Campbell Walsh Wein Urology)[23] were selected, since the guideline was algorithmic and covered other medical resources [Additional File 2, Table 1].

The specified components and functionalities for BCM App

The urologists' mean age was 34.45 ± 5.59 years at the Delphi stage. The participants were mainly female (90%) and had maximum and minimum work experiences of 20 and three years with an average work experience of 8 ± 5.13 years. Table 1 presents the findings of the app's components needs assessment. Out of 22 components, only one required further modification, which was finally accepted after confirmation from three urologists. According to the urologists and urology residents, the app's components were categorized into three groups: Patient evaluation, disease staging and management, and patient follow-up. The app's main components included "classifying the disease into two groups of Muscle Invasive Bladder Cancer and Non-Muscle Invasive Bladder Cancer," "disease grading and staging," "management based on the disease stages," "principles of intravesical treatment," "classifying follow-ups by disease stages," and "high-risk patients follow-up."

Table 1 presents the findings on the app's functionalities. In this regard, the two functionalities of "using Computed Tomography scan images of bladder mass" and "using cystoscopy samples of bladder mass" were reviewed and then confirmed by the three urologists. The app's functionalities were categorized into four groups: Perform clinical calculations, graphical representation, patient information record, and others. The app's main functionalities included "using staging and grading table," "using the American Urological Association (AUA) risk stratification," "calculating disease stages," "calculating patient's follow-up," and "recording patient information." On the recommendation of experts and end-users in the open questions section of the needs assessment questionnaire, the following functionalities were added to the app: Providing educational content in the form of videos and images, providing clinical scenarios, and exams, searching information content, updating the app, recording patient information (e.g., patient demographic information, final diagnosis, date of last visit, date of last action performed, date of next visit, and date of next action), and the possibility of uploading patient imaging results.

Phase 2 – Design and development

Following the experts' feedback, the app's components and functionalities were implemented on the Android operating system. The app was in English language (based on experts' recommendations), interactive, and structured. By recording patient information, calculating the disease stage, and calculating the patient's follow-ups using his/her next actions and visit dates, the users could manage bladder cancer step-by-step from the preliminary assessment of the disease to follow-ups. The app's evidence-based educational content was prepared in the form of educational videos (presented by urologists), clinical scenarios, exams, clinical calculations, texts, images, and tables. The app was equipped with a content search feature to facilitate quick access to the information content. The app can be installed and run on Android smartphones. Additional File 3, Figures 1 to 6 show a few layouts of the app.

Phase3 – Usability evaluation

Participants in the usability evaluation (n = 15) were two urologists, nine urology residents, and four usability

Table 1: Urologists' and urology residents' views on BCM App's components and functionalities

Components	Groups		Mean	Decision
Components	Patient evaluation	Basic steps in the patient visit	4.73	Accept
		Post TURB management	4.73	Accept
		Imaging before TURBT	4.55	Accept
		Single Dose Intravesical Chemotherapy	4.55	Accept
		Mapping Biopsies Indication	4	Accept
		How to do the Bimanual Exam	3.82	Accept
		Estimate of the clinical stage by bimanual examination	3.73	Revise
	Disease staging and management	Classifying the disease into two groups: Muscle Invasive Bladder Cancer and Non-Muscle Invasive Bladder Cancer	5	Accept
		Disease grading and staging	4.82	Accept
		Management based on the disease stages	4.82	Accept
		Principles of intravesical treatment	4.82	Accept
		Necessary lab tests and imaging and staging	4.55	Accept
		Re-TURBT indication	4.55	Accept
	Patient follow-up	Classifying follow-up based on the disease stages	4.82	Accept
		High-risk patients follow up	4.82	Accept
		Intermediated risk patients' follow up	4.73	Accept
		Follow-up MIBC patients after cystectomy	4.64	Accept
		Follow-up MIBC patients after partial cystectomy	4.55	Accept
		Classification of NMIBC patients based on Risk Stratification	4.45	Accept
		Follow-up NMIBC patients after cystectomy	4.45	Accept
		Low-risk patients follow-up	4.45	Accept
		Patients follow up after chemo-radiation	4.18	Accept
Functionalities	Perform clinical calculations	Calculating disease stages	4	Accept
		Calculating patient's follow-up	4	Accept
	Graphical representation	Using staging and grading table	4.55	Accept
		Using the AUA risk stratification table	4.09	Accept
		Using sample CT scan images of bladder cancer	3.73	Revise
		Using sample cystoscopy images of bladder cancer	3.64	Revise
	Patient information record	Recording patient information	4	Accept
	Other	Access the original PDF version of the NCCN guideline	3.82	Accept

TURBT: transurethral resection of a bladder tumor, MIBS: muscle-invasive bladder cancer, NMIBS: Non-muscle invasive bladder cancer, AUA: American Urological Association, CT: computerized tomography

experts. The participants' mean age was 31.13 ± 3.18 years and 33.3% were female. The usability evaluation results revealed that the experts and end-users found the app to be at a "highly acceptable" level. A summary of the usability features and their descriptions are shown in Table 2, and the relevant quotes are presented in Additional File 4, Table 1.

Seven problems with an average severity of 1.75 ± 1.035 were identified [Table 3]. The users reported no other problems with the app.

Discussion

In this study, we developed a bladder cancer management app based on clinical guidelines and valid references using the active participation of clinicians. This app could educate and inform physicians, perform clinical calculations, represent information graphically, and record patient information. According to the participant urologists and residents, the app's components were categorized into three groups: Patient evaluation, disease staging and management, and patient follow-up. The usability evaluation revealed that the usability experts and end-users found the app to be at a "highly acceptable" level.

The app's components and functionalities were determined using clinical practice guidelines and with the active participation of the urologists and residents. Khan *et al*. reported that clinical guidelines and experts' opinions used to extract the app's information content improved residents' knowledge.[10] Preparing the components for the app determining its functionalities under the supervision of experts and assessing end-users' needs can lead to the development of an app tailored to the end-users' preferences.[10] In another study assessed healthcare professionals and urology scientific communities' involvement in developing urology applications. The study revealed that with the increment of available apps, concerns have been expressed regarding their quality and safety since there are no scientific standards and guidelines in their design.[16] As one of the main stakeholders, clinical specialists should

Table 2: Usability features and users' statements and quotations

Usability features	Statements and quotations
Aesthetics and orientation	All participants (*n*=15) evaluated the app's user interface in terms of aesthetics and orientation and stated that the screen had an acceptable resolution and attractive graphic components, with one separate icon for each section. Videos and images were explicit, the videos were acceptable, and they could be quickly downloaded. The fonts were legible, and the words were obvious. "*The color of the app's introduction page and the home page could be improved*," two residents said. "*The sample images made the app attractive*" stated one resident. "*When I go through the next pages, there is no button at the top of the page to allow me to go back directly to the home page as such, I have to press the back button at the top of the pages several times to reach home*" noted one health information management expert. "*It was better to provide an instruction for each page, the sub-pages were more specific, and the titles were more expressing*" mentioned one medical informatics expert. From the perspective of other participants, working with the app and moving through its different sections was simple
Learning	The participants noted that the arrangement of the app's different sections could well reflect its objectives, thereby promoting the learning of the sections. The content presentation order was well observed in the app, leading to step-by-step and easier access to educational content. In general, the users found the app not challenging to work with, and they could easily perform their tasks.
Efficiency	All residents and urologists (*n*=11) noted that the items and content were exact and coordinated, thereby allowing quick access to different sections of the app. According to the residents, the app quickly answered their questions about the patient at the point of care and the settings. According to all evaluators, the functionality of searching through the content allows quick access to the content.
Effectiveness	All residents and urologists (*n*=11) commented that the app's features allow them to perform tasks properly, encompassing quick access to up-to-date scientific content (in the form of educational video, tests, texts, images), recording and saving patient information, calculating the disease stage, and following up with patients.
Applicability	This section contained the participants' comments on the usefulness and relevance of the different sections of the app. The app is highly practical, effective, and helpful to all participants (*n*=15). For all residents (*n*=9), features such as patient information records, calculating disease stages, calculating patient follow-up, providing instructional videos, searching content, and updating content have made this app a practical tool. All residents (*n*=9) agreed that these two calculators could speed up their operation in clinical settings. The patient information record feature allows the archiving of patient documents' information and images from the viewpoints of residents as a unique idea. One of the residents suggested, "*This feature is highly useful. It would be great if each user with a username and a password had access to one's stored information on different devices. This would improve the longevity of information, making the user be motivated to record and retain more information*." All participants (*n*=15) believe it is a highly appealing idea to record instructional videos by experienced physicians and professors. All urologists and residents (*n*=11) declared, "*The function to update the content made it a highly efficient and up-to-date tool, which can be used in different periods*."
Performance	The participants (*n*=15) mentioned that the app was highly interactive and well performed using its features going beyond a traditional text-based format in different ways (such as tests, clinical scenarios, clinical calculations, videos, images, texts, and tables).
Educational content	The participants (*n*=15) generally considered the app's content scientific and valuable. They assumed it covered a wide range of bladder cancer management topics. The residents (*n*=9) stated that "*the topics covered in the videos by the urologists and the textual content provided following the guidelines and textbooks have made it a highly efficient tool*." From the perspective of six participants (i.e., two residents, two medical informatics experts, and two health information management experts), "*presenting the educational content in the form of scenarios promoted our understanding of the content*." All participants approved updating the scientific content of the app since they assumed that today the speed of updating guidelines and scientific references is high, and the app's content needs to be updated.
Satisfaction	In general, all participants expressed their satisfaction with the bladder cancer treatment app. Seven participants (two medical informatics experts, two urology experts, and three residents) hoped that such apps would be used in other fields of urology and other specialized disciplines and that these tools could have a significant impact on the education system.
Dissatisfaction	According to the participants, no dissatisfaction was expressed with the app.
Usability problems	Two residents disapproved the color of the Home page. A health information management expert also suggested placing the home button on the top of all sub-pages to return to the home page. A medical informatics specialist also suggested that the titles of the program pages be more eloquent. According to the feedback, these three problems were fixed, and the app was re-presented to the users. The two residents commented on adding instructional videos in English or with English subtitles and increasing the number of videos. A medical informatics specialist also suggested that all pages of the app should have a guide and sub-pages are more specific.

participate in the design and development of such apps to enhance their validity and usability.

The present study revealed that the components required for designing the app were categorized into three groups: Patient evaluation, disease staging and disease management, and patient follow-up. From the perspective of urologists and urology residents in this study, the app's potential for patient information records received a high score. In another study, the most prominent functionalities of a clinical decision-making app for diagnosing primary deficiency diseases

Table 3: Applicability problems and their severity

Row	Usability problems	Severity*
1	Home screen colour	3
2	Return to the main page of all sub-pages	3
3	A more eloquent title for the app pages	3
4	A more specific sub-pages	1
5	Insert help on all pages of the app	1
6	Provide educational videos in the English language	1
7	Increase the number of educational videos	1
SD±Mean		1.035±1.75

*Severity rating scale; 0: not a problem; 1: cosmetic problem; 2: minor problem; 3: major problem; and 4: usability catastrophe

were recording patient information step-by-step and then displaying the diseases associated with this information.[24] Similarly, the app proposed in the present study could record patient information; however, this app could record the patient's demographic information, final diagnosis, date of the last visit, date of the last action taken, date of next visit, and date of next action, provided the possibility of uploading patients' imaging results for physicians. Since urologists and residents visit many patients daily in hospitals, the functionality "patient information record" allows recording patients' clinical information at the point of care and re-accessing this information.

In this study, the proposed app can calculate the bladder cancer stage and the time and action required to follow up with the patient. Similarly, De Nunzio *et al.* stated that the feature "calculating the risk of Rotterdam and Coral prostate cancer" in a smartphone app could facilitate the identification of patients at prostate cancer risk and help physicians act quickly and accurately.[18] Since residents should be trained in clinical settings and experience trials and errors, this functionality should not make residents dependent on apps. In addition to clinical calculations by the app, some educational content was also included in the app to facilitate mental calculations by clinicians.

The usability evaluation revealed that the features related to the app's user interface were remarkably at an acceptable level. In a similar study on design preferences and user experience in a smartphone app to manage migraines, the think-aloud technique showed that about 70% of the participants assumed the overall appearance of the app to be acceptable.[25] Since apps' design may affect potential users' preferences to interact with the intervention, the clinical apps should be visually appealing to their specific target group.

From the perspective of 73.3% of the evaluators, learning how to use the app was not challenging, since there was step-by-step and easy access to the functionalities, and symbols consistent with each option's function. Another study similarly suggested that improving graphic symbols promotes learning via mobile devices.[26] It is recommended that future studies facilitate easy access to the content in apps by arranging their content and symbols.

According to the findings, the app's efficiency was remarkably acceptable. Frzandipour *et al.* noted that the irrational arrangement of icons in menus results in a system's slow performance and increases the time required to work with the app.[27] Similar to another study,[28] the present study showed that the easy learning of the app decreases the time to perform tasks. In this study, the effectiveness of the app was acceptable, and the urologists claimed that the proposed app provided them with an opportunity to perform different tasks appropriately. To maximize the efficiency and effectiveness of apps, it is suggested that the tasks in clinical apps follow the procedures of task performance to enable users to complete more tasks correctly.

In the evaluation phase, all participants considered the app useful for its scientific content and educational value. In the present study, the users and experts assumed clinical scenarios, exams, and feedback provision as critical interactive functionalities included in the app to facilitate understanding of the scientific content. The users stated that the proposed app covered a wide range of topics associated with bladder cancer management and that the feature "updating content" made it an up-to-date tool. Zhang *et al.* declared that there will be detrimental consequences if users make their clinical decisions based on incorrect or outdated information in medical apps.[29] Other studies have also concluded that medical apps with up-to-date and interactive content using various educational methods can improve education quality and promote their involvement in interventions.[25,30]

Furthermore, all evaluators (i.e., urologists, urology residents, and usability experts) were satisfied with the BCM App. Bhatheja *et al.* noted that accepting an app by users depends on its design, content accuracy, and ease of learning.[31] In Minen *et al.* study, the research team constantly developed an app for users according to the participants' feedback as such, the app was tailored to the users' needs and thus was satisfactory to them.[25] Users will be satisfied if the apps are organized using the interface and created following users' basic and logical need assessments and continuous feedback from this target group.

Strengths and limitations

Our review of the literature revealed that the mobile apps had not been used by urologists in Iran. The other strengths of the present study are using comprehensive guidelines and scientific books on bladder cancer management and developing an app based on experts'

and end users' opinions (the user-centered design model). However, the study had a limitation. Urologists and urology residents at one university evaluated the app; hence, it is recommended to evaluate such apps with a larger sample size and in a broader range for the findings to be more generalizable.

Implications for future research

Regarding the evidence indicating the urologists and urology residents' satisfaction with the app's functionalities, in all stages of design, development, and evaluation, the active participation of clinicians and end-users should be considered to promote the acceptance of such tools. It is also suggested that interactive information systems with different functionalities are developed to provide up-to-date information content and methods beyond a traditional text-based format; hence, physicians can use such apps to support their decisions on patient management. Since valid guidelines and resources were used to provide knowledge to the urologists and urology residents in this study, and given the use of invalid resources in some clinical apps, it seems necessary to involve regulatory agencies in the quality control of the mHealth apps.

Conclusion

In the present study, an app for bladder cancer management for urology specialists (BCM App) was developed with the active participation of the experts and end-users, which considered clinical guidelines. Given the highly acceptable results of the app's usability and the inclusion of all usability dimensions mentioned by different participants, this app is recommended as a novel tool to help urologists manage the disease. Future studies are also suggested to investigate the effectiveness of such apps in improving urologists' and urology residents' knowledge and patients' outcomes.

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Ethical statement

This study was approved by the ethics committee of Kashan University of Medical Sciences (IR.KAUMS.NUHEPM.REC.1400.016). All methods were performed according to the relevant guidelines and regulations.

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Conflicts of interest

There are no conflicts of interest.

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Additional File 1. Application's Usability Evaluation Guidelines

In His Name

A guide on "Usability evaluation of a SEA for bladder cancer treatment using the think-aloud technique"

Greetings,

Dear Colleague,

We sincerely appreciate your valuable time in evaluating the usability of the educational application. This guide is part of a research project developed to evaluate the usability of SEA. This application is developed to teach urological residents how to treat bladder cancer. Your valuable comments would be of great help in advancing the project's goals and pave the way for adopting appropriate measures to improve urological residents' training in terms of bladder cancer treatment and management.

Procedures

The think-aloud technique is used to evaluate the usability of this application. In this technique, you are supposed to use the application and express out loud what you see, think, do, or feel while using the application. Please do not care about our feelings since this phase is planned to improve the application. In other words, we need to hear your honest responses to detect which parts of this application are either effective or disturbing for urologists. During this evaluation phase, you are voice-recorded, which would only help us figure out how to improve the application and is only available to those involved in the project. Please sign the informed consent form if you wish to participate in this study. Signing this form allows us to record your voice, and the recorded information is only available to those involved in the project.

Section I: Demographic Information

Gender: Female/Male

Age (years):

Field of study:

Grade: First-year resident/second-year resident/third-year resident/fourth-year resident

Section II: A guide on "Usability evaluation of a SEA for bladder cancer treatment "

You are now supposed to start working with the application. After entering the application, pay attention to the following items and present your inferences from these sentences. If you try to think aloud while using the application and reviewing the items below, it helps us a lot.

- Check the ease of going to the next or previous pages and express your thoughts aloud.
- Express what you think about the application's flexibility and skills to work with the concerned application.
- Check the appropriateness of graphic components, buttons, and colors and express your thoughts aloud.
- Check the clarity of the page design and express your thoughts aloud.
- Check the clarity of the application's videos and images and express your thoughts aloud.
- Check the readability of the fonts and express your thoughts aloud.
- Review the application's user-friendliness and express your thoughts aloud.

Please state your other valuable comments.

Additional File 2. The clinical guidelines and books

Table 1: Search results for clinical guidelines and books

Clinical guidelines and books	Year of publication	Place of publication
NCCN Clinical Practice Guidelines in Oncology (NCCN Guidelines): Bladder Cancer	2020	America
Diagnosis and Treatment of Non-Muscle Invasive Bladder Cancer: AUA/SUO Guideline	2016	America
National Institute for Health and Care Excellence: Bladder cancer Overview	2021	Europe
Bladder Cancer Esmo Practice Guidelines for Diagnosis Treatment and Follow-up	2020	Europe
Campbell Walsh Wein Urology, E-Book: Elsevier Health Sciences, Twelfth Edition	2020	America

Additional File 3. The layouts of the app

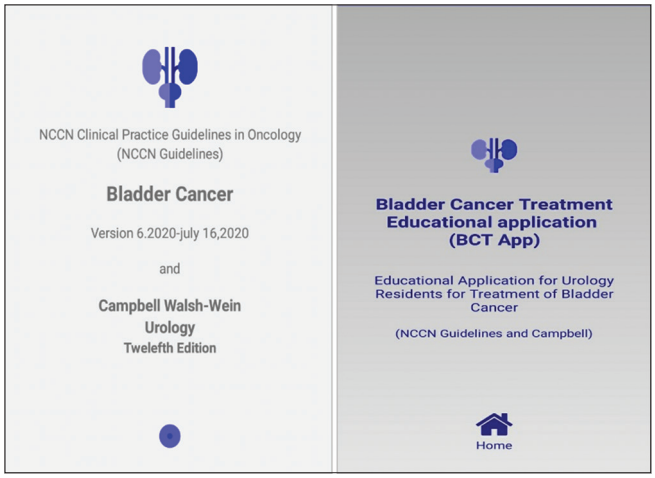

Figure 1: First pages and application introduction

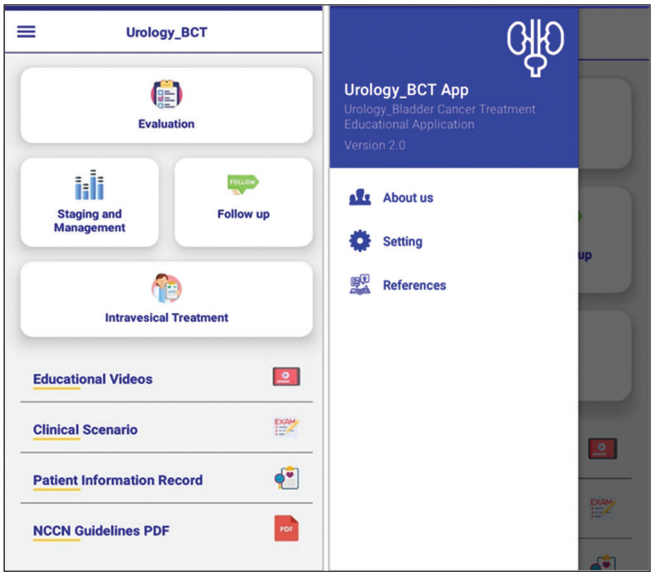

Figure 2: Application's main menu

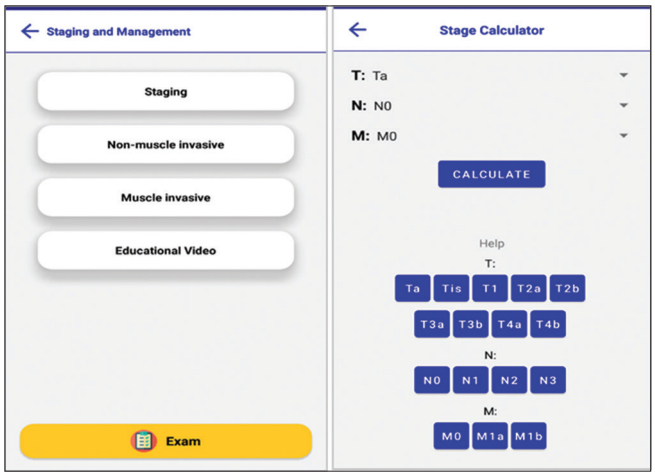

Figure 3: Staging and management page and disease stage calculator page

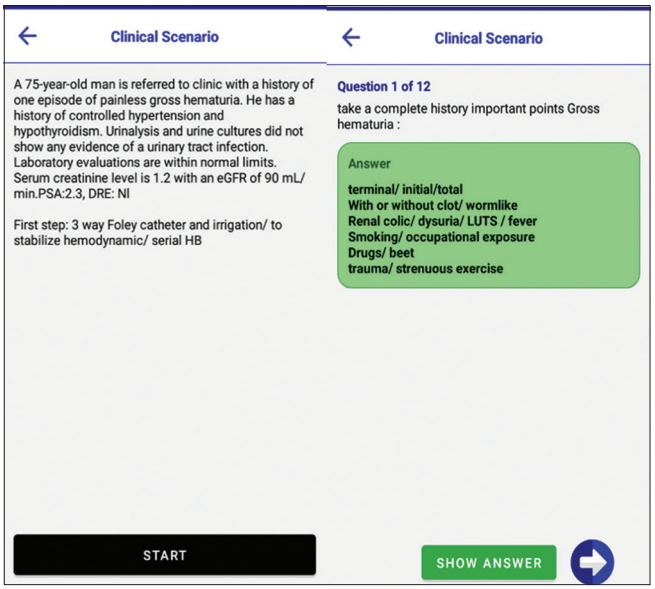

Figure 4: Clinical Scenarios Pages

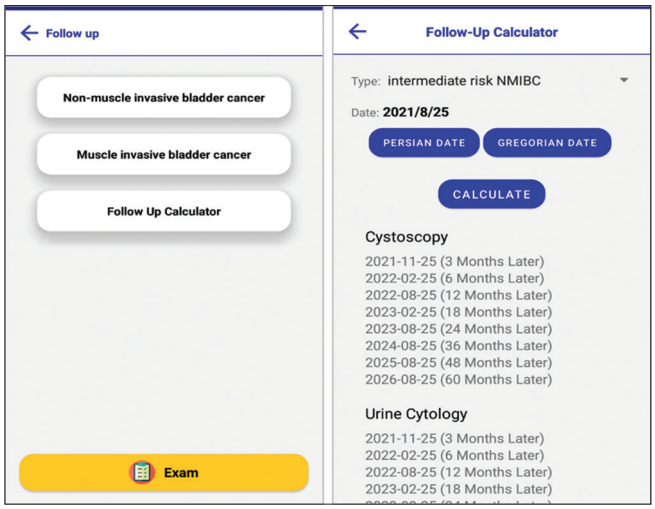

Figure 5: Patient follow up and follow-up calculator pages

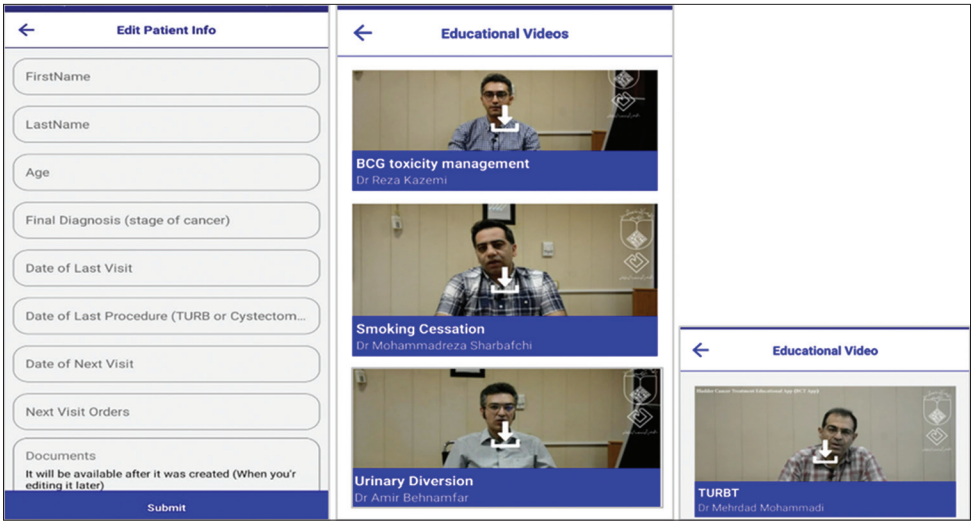

Figure 6: Patient information record and educational videos pages

Additional File 4. Usability Features, participants' statements, and quotations during the evaluation phase

Table 1: Usability Features, participants' statements, and quotations during the evaluation phase

Usability features	Statements and quotations
Aesthetics and orientation	All participants (*n*=15) evaluated the app's user interface in terms of aesthetics and orientation and stated that the screen had an acceptable resolution and attractive graphic components, with one separate icon for each section. Videos and images were explicit, the videos' sizes were acceptable, and they could be quickly downloaded. Fonts were legible, and the words were obvious. "The color of the app' introduction page and the home page could be improved," the two residents said. "The sample images made the application attractive," stated one resident. "When I go through the next pages, there is no button at the top of the page to allow me to go back directly to the home page as such, I have to press the back button at the top of the pages several times to reach home," noted one health information management expert. "It was better to provide an instruction for each page, the sub-pages were more specific, and the titles were more expressing," mentioned one medical informatics expert. From the perspective of other participants, working with the app and moving through its different sections was simple.
Learning	The participants noted that the arrangement of the app's different sections could well reflect its objectives, thereby promoting the learning of the sections. The content presentation order was well observed the app, leading to step-by-step and easier access to educational content. In general, the users found the app not challenging to work with, and they could easily perform their tasks.
Efficiency	All residents and urologists noted that the items and content were exact and coordinated, thereby allowing quick access to different sections of the app. According to the residents, the app quickly answered their questions about the patient in the point of care and the clinical setting. According to all evaluators, the potential of searching through the content allows quick access to the content.
Effectiveness	All residents and urologists commented that the app's features allow them to perform tasks properly, encompassing quick access to up-to-date scientific content, recording and saving patient information, calculating the disease stage, and following up with patients.
Applicability	This section contained the participants' comments on the usefulness and relevance of the different sections of the app. The app was highly practical, effective, and helpful to all participants (*n*=15). For all residents (*n*=9), features such as patient information records, calculating disease stages, calculating patient follow-up, providing instructional videos, searching content, and updating content have made this app practical tool. Accordingly, three components (namely T, N, and M) should be considered and put together to calculate the disease stage. The residents also added that the option 'Help' in the disease stage section was beneficial and could help know the T, N, and M concepts and definitions, "The images in the disease staging section promote understanding and reduce subsequent errors." stated two residents. A resident also stated, "Bladder cancer follow-up is a runaway issue, and even professionals with several years of experience may forget it at the moment. However, by entering data and then selecting a follow-up calculator, the patient's next measures and visits can be viewed by this application as such they would no further be forgotten." All residents (*n*=9) agreed that these two calculators could speed up their operation in clinical settings. The patient information record feature allows for the archiving of patient documents' information and images from the viewpoints of residents as a unique idea. One of the residents suggested, "This feature is highly useful. It would be great if each user with a username and a password had access to one's stored information on different devices. This would improve the longevity of information, making the user be motivated to record and retain more information." All participants (*n*=15) believe it is a highly appealing idea to record instructional videos by experienced physicians and professors. "The experts in these videos explain the topics clearly, and the videos would remove the physicians' errors" said one resident. He also added that the videos improved teaching. "The videos have appropriate timing and size, making them downloadable and accessible to be referred to before surgery," said another resident. "The videos are excellent; however, I think they are not enough and could have been more, to cover everything from approach to treatment and follow-up," one of the residents said. According to another resident, "the videos were great; however, if they were in English or accompanied with English subtitles, the app would be used internationally." All urologists and residents declared, "The app's feature to update the content made it a highly efficient and up-to-date tool, which can be used in different periods."
Performance	The participants mentioned that the program was highly interactive and well performs using its features going beyond a traditional text-based format in different ways (such as tests, clinical scenarios, clinical calculations, videos, images, texts, and tables).
Educational content	The participants generally considered the app's content scientific and valuable. They assumed it covered a wide range of bladder cancer management topics (from patient evaluation to staging and management, follow-ups, and next treatments). The residents (*n*=9) stated that "the topics covered in the videos by the urology experts and the textual content provided following the guidelines and textbooks have made it a highly efficient tool." Most of the residents agreed that the app's content was well chosen so that it contributed to understanding how to deal with patients in the examination and history section, what points should be considered in this phase, and what the diagnosis should be. The disease stage calculator and the included guidelines helped them to diagnose the disease stage. The points are expressed clearly to help us know what treatment to consider for the patient. Using the patient follow-up calculator and tables, we are provided with the patient's subsequent measures and dates. From the perspective of six participants (i.e., two residents, two medical informatics experts, and two health information management experts), "presenting the educational content in the form of scenarios promoted our understanding of the content." All participants approved

Contd...

Table 1: Contd...

Usability features	Statements and quotations
	updating the scientific content of the app, since they assumed that today the speed of updating guidelines and scientific references is high, and the app's content needs to be updated."
Satisfaction	In general, all participants expressed their satisfaction with the bladder cancer treatment app. Seven participants hoped that such apps would be used in other fields of urology and other specialized disciplines and that these tools could have a significant impact on the education system.
Dissatisfaction	According to the participants, no dissatisfaction was expressed with the app.
Usability problems	Two residents disapproved of the color of the Home page. A health information management expert also suggested placing the home button on the top of all sub-pages to return to the home page. According to the feedback, these two problems were fixed, and the app was re-presented to the users. The two residents commented on adding instructional videos in English or with English subtitles and increasing the number of videos. The implementation of these comments required a long time and as such, the researchers failed to do so.