Original Article

Development of a virtual patient record mobile app for pharmacy practice education

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ABSTRACT

Introduction: Healthcare students are generally not exposed in the school curriculum to the workings of electronic health records (EHRs) and the types of patient health information (PHI) from EHRs that are relevant to clinical practices. A prototype virtual patient record (VPR) mobile app was created on two Samsung Galaxy Tab tablets to educate pharmacy students on the types of PHI available from EHRs. **Materials and Methods:** A pilot study was conducted from March-April 2013, whereby students used the app to solve counseling case scenarios. Respondents' demographics, mobile app usage patterns, perceptions regarding the app's usefulness, and its relevance as an EHR simulation tool, were determined through an online 14-item survey. Descriptive statistics, Chi-square tests, Fisher's exact tests and Mann-Whitney U tests were used to analyze the results. **Results:** Response rate was 100% ($n = 31$). Medical and healthcare apps were most commonly used (93.5%), and 67.7% of students used apps more than 5 times a day over the past 6 months. The app had 4 features ("PHR", "Case Questions", "Statutes" and "Useful Links"). Most students felt that the app features were understandable and self-explanatory (96.7%). Majority agreed that "PHR" (100%) and "Case Questions" (83.9%) were the most useful features. Majority (90.3%) found the app useful as a teaching aid. **Conclusion:** A VPR app has been successfully created and implemented as a teaching aid. Future development will involve migrating its features to the mobile web. Resources for health-related and medication-related information will be added. Furthermore, the app will be introduced to lower-year undergraduates before their hospital preceptorship attachments.

INTRODUCTION

Smartphones and mobile apps have increasingly been adopted by healthcare professionals in their clinical practices, giving rise to the domain of mobile health (m-health).[1-3] The wireless capabilities of smartphones, their ease of use, portability, and ability to incorporate many different technical features have made these devices attractive to both healthcare professionals and patients.[4] There are over 38,000 healthcare and fitness apps and 24,000 medical apps available on the Apple iTunes and Android app stores, and it is expected that approximately 500 million smartphone users worldwide will be using a healthcare app by the end of 2015.[5,6] As more clinicians use smartphones and mobile apps as digital assistants, the process of health communication and access to various health information systems and clinical tools has become more enhanced at the point of care.[1,7,8] In addition, the use of mobile apps by patients has also encouraged them to participate in their own health by improving their knowledge on health and diseases, medications and treatment plans, and prevention/management strategies.

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In 2009, the Obama administration passed the Health Information Technology for Economic and Clinical Health Act, committing up to $27 billion of incentive payments to clinicians and hospitals over 10 years to encourage greater adoption and use of electronic health records (EHRs).[9] Although the benefits of EHRs, such as increased completeness and accuracy of patient information, better clinical decision support and electronic prescribing, and greater medical practice efficiency, were well documented, the same could not be said for its adoption and acceptance.[10] The poor adoption of EHR technology in clinical practice could be due to healthcare professionals not being trained to use them when they were students.[11,12] Many clinicians had difficulty extracting relevant and accurate patient information from EHRs during the time allocated for a clinic visit by a patient.[13] The implementation of EHRs disrupted the usual workflow processes in clinical environments instead. Although some apps had been developed as educational tools for healthcare students, none had any EHR features.[2,8,14,15] On the other hand, mobile apps with EHR features were intended for the actual storage of patient data for clinician and patient use at the point of care.[8,14] The lack of EHR training for transition from school to clinical practices resulted in the poor experience of healthcare professionals with information and communications technologies.[10] As such, it would be important to train healthcare students to be familiar with the workings of EHRs, and the types of patient-related and drug-related information that could be extracted to transit them towards being future healthcare professionals.

With a growing acceptance and adoption of smartphone technology among healthcare professionals and students, mobile apps could be a potential platform for healthcare education. As part of reviewing our pharmacy practice curriculum at our institution, the faculty felt a need to expose our students to the basic workings of an EHR and the types of patient-related and drug-related information that would be relevant for patient counseling and dispensing, so as to provide a smoother transition towards clinical practices. Therefore, the objective of this study was to develop a prototype virtual patient record (VPR) mobile app to educate students on the types of patient health information (PHI) available from EHRs to supplement their pharmacy practice curriculum. A cross-sectional study was conducted on a small group of pharmacy undergraduates to determine their perceptions regarding its usefulness as an educational tool.

MATERIALS AND METHODS

Creation of the VPR mobile app

The graphical user interface of the prototype was conceptualized on storyboards using Microsoft PowerPoint 2013. Based on the storyboards, an Android version of the app was created using Titanium Studio (v3.1.0) (Appcelerator Inc., Mountain View, CA), with JavaScript as the main coding language. Mock patient records created for training purposes were populated into a local backend database using the SQLite Manager program (v0.8.1) and integrated into the "Patient Health Records" (PHR) feature to simulate an EHR. In addition, 4 other features ("About Us", "Case Questions", "Statutes" and "Useful Links") were also created. The prototype app was then installed locally on 2 Samsung Galaxy Tab tablets for the pilot study.

Study setting and design

The cross-sectional study was conducted as part of action research, by a facilitator within a pharmacy practice module, in an undergraduate class for 4 weeks, from March to April 2013. Classes were held once every week in the Department of Pharmacy, National University of Singapore (NUS), where students had to participate in one-to-one role-play counseling sessions with a facilitator mimicking real-life patient encounters, and use the app to solve these cases. Final-year undergraduate students enrolled in the pharmacy practice module were split into groups of 7-8 and then allocated to a different facilitator by the module coordinator every week. Seven to 8 students had access to the app each week.

Ethics approval was obtained from the NUS Institutional Review Board to conduct a survey to obtain feedback from students regarding the VPR app. A 14-item survey was administered online on www.eSurveyspro.com to determine the respondents' demographics and mobile app usage patterns (types of mobile apps used, frequency of use in the past 6 months and time of day that mobile apps were used), their perceptions regarding the usefulness of the app for pharmacy education, and the relevance of the app as an EHR simulation tool. Overall usability of the VPR app was assessed based on a scale of 1 (not useful at all) to 10 (extremely useful). Additionally, qualitative feedback was sought on how the app could be improved.

Statistical analysis

Results were collated using IBM Statistical Package for the Social Sciences software (SPSS version 20.0) and analyzed using descriptive statistics. Pearson's Chi-square and Fisher's exact tests were used to test for associations between gender and the types of mobile apps used, and the period of day of mobile app usage; whereas the Mann-Whitney U test was used to test for associations between gender and mobile app usage frequency over the past 6 months. *P* values below 0.05 were considered statistically significant.

RESULTS

VPR mobile app

The mobile app prototype was made up of 2 core features ("PHR" and "Case Questions") and 2 supporting features ("Statutes" and "Useful Links") [Figure 1]. Fictional patient records containing PHI were incorporated in the "PHR" feature. The PHI was categorized into "Social Data", "Medical History", "Prescription History" and "Lab Data" [Table 1] while the "Case Questions" feature contained clinical case scenarios. Web-links to the governmental statutes of Singapore (e.g. Medicines Act, Poisons Act, and Misuse of Drugs Act) were built into the "Statutes" feature. Web-links to other professional websites (e.g. Singapore Pharmacy Council, Pharmaceutical Society of Singapore, and our pharmacy department) were incorporated into the "Useful Links" feature.

Table 1: Types of PHI contained in the PHR feature of the app

PHR/VPR parameter	Patient Biodata	Medical History	Prescription History	Lab Data
Contents	Patient's full name NRIC number Home Address Occupation Date of Birth Smoking and Alcohol Consumption	Known drug allergies Past medical history	Known drug prescriptions in the past Indications of quantity, dosage and consumption instructions	Fictional results of laboratory tests conducted on patients

PHR: Patient health records, VPR: Virtual patient record, NRIC: National Registration Identity Card

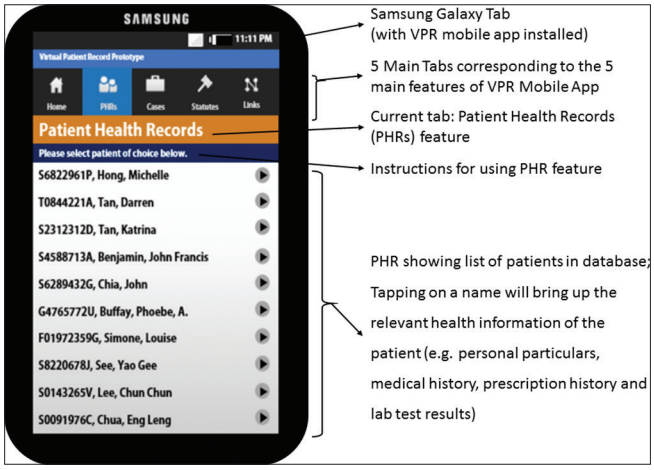

Figure 1: Graphical-user interface of mobile app prototype on the Samsung Galaxy Tabs

Participant characteristics and mobile app usage patterns

At the end of 4 weeks, there were 31 final-year undergraduate students (100%) in the pharmacy practice module who had used the app. Two-thirds (61.3%) were female. Generally, medical and healthcare apps were most commonly used (93.5%) [Table 2]. The frequency of app usage among the students over the past 6 months was more than 5 times a day (67.7%). Most students used mobile apps in the evenings from 7-9 pm (77.4%). Most types of mobile apps used by the respondents were independent of gender, except for communication and email apps, and females were significantly more likely to use communication apps (72.0% *versus* 28.0%, $P = 0.022$) and email apps (78.9% *versus* 21.1%, $P = 0.022$). The time of the day whereby mobile apps were used and the usage frequencies were independent of gender, except the period between 12-4 pm ($P = 0.001$).

Perceptions of students on usefulness of the VPR app as an educational tool

In general, the response towards the app was positive, with all students agreeing that it was easy to search for PHI relevant to the case questions. Most of them felt that the design of the app features were also understandable and self-explanatory (96.7%), and that it was easy to navigate around (93.5%). Furthermore, all of the students found the "PHR" feature to be the most useful feature, followed by "Case Questions" (83.9%), "Statutes" (57.1%) and "Useful Links" (48.4%). Overall, 28 students (90.3%) found the app useful as a teaching aid and most of them (87.1%) gave a rating of at least 7 out of 10 for the usefulness of the app prototype as a teaching aid for pharmacy practice education.

Majority of students indicated that the app had the most potential to be implemented in their pharmacology and pharmacotherapy (90.0%), and pharmacy law (81.0%) modules, followed by health communications skills (74.0%) and pharmacokinetics modules (58.0%). Over half wanted revision and supplementary materials from lectures (61.3%), practice quizzes/questions and lesson updates (54.8% each) to be included in the app.

DISCUSSION

Table 2: Results of pilot usability study showing the distribution of respondents with their mobile app usage patterns

Question	Options available	Number of respondents (%), *n*=31			*P* value[a]
		Males	Females	Total	
Types of mobile apps most commonly used	Medical and Healthcare	11 (35.5)	18 (58.1)	29 (93.5)	1.000
	Browsers (e.g. Safari, Firefox, Chrome)	11 (35.5)	17 (54.8)	28 (90.3)	1.000
	Communication (e.g. WhatsApp, Messages)	7 (22.6)	18 (58.1)	25 (80.6)	0.022
	Social Networking (e.g. Facebook, Twitter)	8 (25.8)	16 (51.6)	24 (77.4)	0.380
	Email	4 (12.9)	15 (48.4)	19 (61.3)	0.022
Mobile app usage frequency over the past 6 months[b]	Once a week	2 (6.5)	0 (0.0)	2 (6.5)	Mean rank: Male=12.920 Female=17.950 *P* value=0.690
	Once a day	3 (9.7)	3 (9.7)	6 (19.4)	
	More than twice, but less than 5 times per day	1 (3.2)	1 (3.2)	2 (6.5)	
	More than 5 times a day	6 (19.4)	15 (48.4)	21 (67.7)	
Most common period of mobile app usage during a day	6 am to 10 am	7 (22.6)	12 (38.7)	19 (61.3)	1.000
	10 am to 12 pm	8 (25.8)	10 (32.3)	18 (58.1)	0.600
	12 pm to 4 pm	7 (22.6)	11 (35.5)	18 (58.1)	0.001
	4 pm to 7 pm	8 (25.8)	9 (29.0)	17 (54.8)	1.106
	7 pm to 9 pm	9 (29.0)	15 (48.4)	24 (77.4)	1.000
	9 pm to 12 am	10 (32.3)	12 (38.7)	22 (71.0)	0.418
	12 am to 6 am	3 (9.7)	4 (12.9)	7 (22.6)	1.000

[a]Chi-square and Fisher's exact tests were performed to test for associations between the variables and gender. Statistical significance was set at $P<0.05$.
[b]Mann-Whitney U test was performed to test for significant relationships between the responses from males and females. Statistical significance was set at $P<0.05$

In this study, the VPR app was used in a final-year undergraduate module, whereby students had to conduct one-to-one role-play sessions with a facilitator mimicking real-life patient counseling and dispensing scenarios. In these sessions, students had to extract relevant PHI from the medical and prescription histories of the mock patients from the "PHR" feature to solve the clinical case scenarios available through the "Case Questions" feature. These features were well received, with 100% and 83.9% of students agreeing that the "PHR" and "Case Questions" features were useful respectively.

In contrast, "Statutes" and "Useful Links" were deemed less useful by students (compared to "PHR" and "Case Questions"); with only 57.1% and 48.4% agreeing that these features were useful, respectively. This observation could be because the final-year students would have previously undergone several modules on pharmacy-related law and good clinical practices in their curriculum and were more likely to refer to their lecture notes instead. Nevertheless, half-of-them felt that these were still useful features for the app. Feedback from a respondent suggested that the app should be implemented in modules in their earlier years, so as to introduce the undergraduates to the concept of EHRs and application of the relevant legislations to clinical practices before their hospital preceptorship attachments (occurring during the mid-term holidays in year three). The direct relevance of the app's usefulness to pharmacy education would then be more obvious to the students. This feedback was brought up to the department for their consideration. A potential module to introduce the VPR app would be the "Pharmacy Law" module taught in the undergraduate second year, so that students would be able to refer to and apply the relevant laws and legislations during their dispensing sessions.

The "Useful Links" tab was the least used, probably because the content within this feature was not comprehensive enough. For example, hyperlinks were only provided to relevant pharmacy organizations in Singapore. In order to make the "Useful Links" feature more useful and relevant in the module, websites that provide relevant health-related and medication-related information (e.g. Medscape), and useful material for continuing professional education (e.g. American Society of Health-system Pharmacists and Royal Pharmaceutical Society of Great Britain) will be added, so that the students can keep abreast with updated news and information. Furthermore, other reference sources will include drug databases, such as Micromedex®, UpToDate®, Drugs.com, DoubleCheckMD.com and DailyMed.org (a product information database set up by the US National Institutes of Health). In addition, revision and supplementary educational materials will be incorporated in future versions of the app.

There were 3 main limitations in this study. Firstly, the VPR app was developed on the Android platform. Thus, students who were familiar with Apple's iOS (operating system) platform on iPhones/iPads might not be familiar with using the Samsung Galaxy Tab

interface. This could have affected their overall learning experience of the app and consequently resulted in some negative reviews. Secondly, the app lacked a security login feature to prevent unauthorized access to the case questions, thus it was not published in the Apple or Android stores for download by students. Instead, it was installed locally on 2 tablet devices owned and provided by the facilitator. This meant that only a small group of students could utilize the app at any one time during the counseling sessions. As a result, this prevented us from obtaining a larger sample size, which would have made the study more robust. Lastly, the VPR app was in its alpha-testing phase in this pilot study; and therefore, could not be evaluated for its validity and reliability. Therefore, the results of this study might not be applicable to other batches of pharmacy students or other medical and allied health students.

Future development of the app will consider its use in a variety of platforms, including Android, Apple's iOS and the newer Microsoft Windows 8 platforms. One possible direction is to migrate the app features to a cross-platform-based medium, such as the mobile web, to cater towards the general student population and address the issue of students' unfamiliarity with the app. Catering the VPR app for multiple platforms offer the advantages of having a greater reach to its target audience (in this case, pharmacy students), and having a uniform look and feel (which can impact students' usability experience). It is also easier to maintain and sync any updates to the app across all platforms (saving on logistics and manpower).[16] Most smartphones are now capable of accessing mobile web content; therefore, students can access the VPR app from their phone browsers (e.g. Google Chrome, Safari, Internet Explorer) without the need to download the app. In addition, a login function, which is tagged to the institutional login identities of students and facilitators, is intended for securing access to the app. Furthermore, the number of case questions and the comprehensiveness of the content provided by the app will be increased, so as to allow monitoring of the students' use of the app to identify and address any potential reliability issues. In order to ascertain the internal and external validity of the app, it is also intended that the app be tested in other pharmacy practice modules with various groups of end-users, such as third-year students, before they go for their hospital preceptorship attachments and among pre-registration pharmacists.

CONCLUSION

Technological advances and innovations in the educational arena are changing the landscape of pharmacy education. The lack of EHR-related learning objectives in the pharmacy curriculum of many institutions presents itself as a potential aspect for pharmacy education to be improved.[11,12] With the increasingly tech-savvy younger generations, there is great potential for mobile apps to be used as a learning tool for students.[17,18] The VPR app developed in this study has successfully been implemented as a teaching aid to expose pharmacy students to the workings of an EHR and the types of PHI that are relevant when dealing with clinical patient encounters. Effective patient management in clinical practice relies upon an individual's competency in his/her practical skills. Thus, students' exposure to EHRs should be implemented early in the curriculum, so as to ease their transition to working life as healthcare professionals. Although, the option for improvement for some features of the VPR app still exists, we hope to incorporate its use in other pharmacy practice modules, and ultimately integrate it in the clinical pharmacy and pharmacy practice curriculum at our institution.

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