A pilot study on the use of a smartphone application to encourage emergency department patients to access preventive services: human papillomavirus vaccine as an example

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Abstract

Background: In General, emergency department (ED) personnel are expert in providing episodic care and are usually too busy to attend to patients' need for preventive care. This is the case in the area of administering vaccines particularly when the vaccine protocol requires multiple injections over several months. However, ED personnel recognize the importance of patients receiving preventive services. A possible way for ED personnel to direct patients to prevention services is to use smartphone apps. A pilot study was designed to explore the possibility of using an app to foster the receipt of human papilloma virus (HPV) vaccine.

Methods: Women who met the inclusion criteria of (1) Self-identified as African-American, (2) owned a smartphone, and (3) had been cleared for discharge from the ED were recruited to a study to determine their willingness to use a smartphone app with regard to the receipt of the HPV vaccine. They completed a 30 item questionnaire that included questions about demographics, smartphone based questions, HPV knowledge based questions and perception based variables dealing with the acceptability of HPV.

Results: Nine of the 19 respondents were willing to participate in a study that would use a smartphone app dealing with HPV. Willingness to participate was significantly related to: 1) participants having health insurance and 2) comfort with HPV messages on a personal phone 3) perceived availability of the HPV vaccine and 4) comfort with an STI smartphone app on their mobile phones.

Conclusions: While there is a need for additional research in this area, this pilot study suggest the potential for using smartphones to link ED patients to preventive services. If smartphones lead to additional uptake of vaccines, there is the potential of improving the public's health in other areas of vaccine preventable diseases such as measles, mumps and rubella (MMR), Hepatitis A and B, and influenza vaccines.

Keywords: Emergency department, preventive services, vaccines, human papilloma virus

Introduction

While vaccine coverage for children is widespread, uptake of vaccines by adults in the United States is quite poor. Only about 20% of 19-64 year olds, who are considered to be at high risk, have received the pneumococcal vaccine [1]. Persons aged 18-49 years had the lowest rate of influenza vaccine uptake [2]. Similarly, only 10% of persons in this age group have had the tetanus and pertussis vaccine in the last six years. A little over a third of these individuals received all three doses of the Hepatitis B vaccine. Only one of every eight persons in this age range received both doses of the Hepatitis A vaccine. For all of these vaccines, the rate of immunizations is lower for African Americans than for Whites, Hispanics or Asians [2,3].

There is also a racial disparity in uptake of the vaccine for pathogenic human papilloma viruses (HPV) with African American women being less likely to complete the three shot series [4-12]. The HPV vaccine is recommended to be given routinely to 11-or 12-year-old girls and boys. Vaccination is also recommended for 13-through 26-year-old females and 13-through 21-year-old males who have not completed the

vaccine series. The quadrivalent vaccine provides protection from HPV types 6 and 11 which cause genital warts and HPV types 16 and 18 which cause approximately 70% of cervical cancers [13]. It also prevents anal cancer, a condition that is twice as likely to occur in women than in men [14]. The vaccine has also been shown to be protective against oncogenic types of HPV in the oral cavities of women [15]. Low levels of catch-up HPV vaccine uptake by African Americans is particularly acute in 18-26 year old women with one study showing that college enrolled African American women were half as likely to be fully immunized against these strains of HPV as compared to White coeds. Other studies have shown that African American women between aged 18-26 years are less likely to initiate the catch-up vaccine than their White counterparts [3-5,16,17]. This disparity in immunization rates has significant public health implications. Young adult, African American women have the highest rates of these pathogenic strains of HPV, and are two times more likely to develop cervical cancers related to HPV infection than their White female counterparts. They are also two times more likely to die from cervical cancer than White

women [18-21].

Vaccine administration has traditionally been the province of primary care physicians as part of routine care. However, the United States is facing a growing shortage of primary care physicians which is creating access problems [22]. This shortage is particularly acute amongst minority populations and young people [23]. As a result, they seek episodic care in emergency departments (ED) which are usually far too busy dealing with acute conditions to deal with preventive measures. Still, efforts are needed to reduced missed opportunities for HPV vaccination when young adults interact with the health care system [24]. Even if emergency room providers were able to provide vaccines as part of an ED visit, there is usually no mechanism for assuring the additional injections for multi-shot vaccines for conditions like Hepatitis A, Hepatitis B and HPV.

However, ED personnel could utilize other assets that young African Americans have in order to assist them in accessing preventive services. Young African Americans are quite likely to own a mobile phone and are frequent users of applications (apps) for them. Surprisingly, 71% of those with incomes of less than \$30,000 per year own a mobile phone [25]. Over 90% of persons between 18 and 29 years own a mobile phone; yet, research with this population is minimal [26]. Research findings confirm interest among young, healthy adults for apps designed to support health-related behavior change [26]. So, a potentially useful means of reaching African American women to encourage them to access preventive services is the mobile phone. The World Health Organization coined the term mobile health or mHealth for this purpose, as this technology allows the support for medical and public health practice via mobile devices [27,28]. However, there are privacy issues and concerns about receiving messages dealing with personal health issues. This is potentially a problem in dealing with sexually related issues.

This study contributes to the needed for formative research designed to better understand the interest of varied populations regarding apps and components most likely to influence acceptability, engagement, and consistent use [26]. Acceptability of using a mobile phone app to inform young African American women about a prevention issue was explored. It was decided to examine this question using the human papilloma virus vaccine as the preventive practice. If it was found acceptable for these women to use their smartphones for what is perceived as a sexually transmitted disease, it would suggest that smartphones could be a good tool for linking this population to vaccines and other preventive services.

Methods

Nineteen African American women aged 18-26 years were recruited from an emergency department (ED) of a Level I Trauma hospital. They had all sought non-emergent care. The inclusion criteria were: (1) Self-identified as African-American, (2) owned a smartphone, and (3) had been cleared for discharge

from the ED. These women were approached by a research associate and were asked to participate in the study. Informed consent was obtained through the participants signing a consent form. The study was approved by the University of Texas Health Science Center at Houston's Committee for the Protection of Human Subjects, the institutional review board. Those who provided informed consent were asked to complete a 30 question survey. Respondents completed the questionnaire in a private room. The research associate stepped outside of the room to give the participant privacy, yet was accessible if the participant had any questions.

The questionnaire was based on HPV literature and included measures from published sources assessing patient's knowledge [29,30], attitudes [30], beliefs [29], potential barriers to HPV vaccination [17], and acceptability of HPV vaccinations among young adults [31]. Questions noted in the methods section of these manuscripts were modified and tailored for the study population. Additional questions concerning comfort with a smartphone and acceptability of receiving HPV messages were added.

Measures

Dependent variable

The categorical value 'perceived willingness to participate in a smartphone app based research project encouraging HPV vaccine uptake' is designated as the outcome variable for this study. The question reads, 'If given the opportunity to participate in a research project where you would get a free, interactive mobile application on your mobile phone to evaluate your willingness to get the HPV vaccine (at no cost), would you participate? The response was a yes/no format.

Independent variables

Categorical variables included demographics: age, income, education, usual source of care, existing health insurance; smart phone based questions: comfort with an STI (HPV) app on smartphone, frequency of smart phone app use, comfort with HPV messages on smartphone; HPV knowledge based questions: knowledge of HPV-transmission, prevention, vaccine requirements; perception based variables: acceptability of HPV vaccine and influence of a smart phone on HPV vaccine uptake; HPV vaccine uptake questions: actual HPV vaccine uptake.

Results

The majority of subjects recruited from the ED were 20-21 years, monthly income of \$1-2K, had some college education, heterosexual orientation, utilized male condoms for contraception, had a consistent sexual partner, and reported 1 current sex partner (Table 1) of 19 participants, 47.4% were willing to use the app.

A chi-square analysis of relationships between willingness to participate in a research study that used an app for the HPV vaccine show significant relationships 1) participants having

Table1. Demographics of study population (n=19).

Variable	Categories of Variable	Total N (%) 19 subjects
Age	18-19 years	3 (15.8%)
	20-21 years	9 (47.4%)
	22-23 years	5 (26.3%)
	24-26 years	2 (10.5%)
	Less than \$1,000	6 (31.6%)
Income	\$1,001-\$2,000	9 (47.4%)
	\$2,001 and more	4 (21.1%)
Income (collapsed)	No income source	5 (26.3%)
	Available income source	14 (73.7%)
Education	Junior high school	3 (15.8%)
	High school or GED	5 (26.3%)
	Some college	10 (52.6%)
	College	1 (5.3%)
	Graduate school	0 (0.0%)
Sexual preference	Women	0 (0.0%)
	Men	19 (100%)
Contraception use	Birth Control Pill	1 (5.3%)
	Male condom	9 (47.4%)
	IUD	3 (15.8%)
	Other	2 (10.5%)
	None	4 (21.1%)
Contraception use (collapsed)	Yes	15 (78.9%)
	No	4 (21.1%)
Consistent sexual partner	Yes	15 (78.9%)
	No	4 (21.1%)
Sex partners (N)	0	4 (21.1%)
	1	9 (47.4%)
	2	6 (31.6%)
	> 5	0 (0.0%)
History of a sexually transmitted infection	Yes	3 (15.8%)
	No	16 (84.2%)
Variable	Categories of Variable	Total N (%) 19 subjects
Age at sexual debut	< 16	2 (10.5%)
	16	6 (31.6%)
	17	5 (26.3%)
	18	2 (10.5%)
	19	0 (0.0%)
	20	2 (10.5%)
	21	1 (5.3%)
	23	0 (0.0%)

Continuation of Table 1.

Variable	Categories of Variable	Total N (%) 19 subjects
24		0 (0.0%)
History of HIV/STI testing	Yes	13 (68.4%)
	No	6 (31.6%)
Usual source of care	Yes	14 (73.7%)
	No	5 (26.3%)
Existing Health Insurance	Medicaid	9 (47.4%)
	Gold Card	0 (0.0%)
	Private Insurance	6 (31.6%)
	Medicare	0 (0.0%)
	No insurance	4 (21.1%)

health insurance and 2) comfort with HPV messages on a personal phone 3) perceived availability of the HPV vaccine and 4) comfort with an STI smartphone app on their mobile phones. (**Table 2**).

Table 2. Comparison of characteristics of those who were willing versus those who were unwilling to participate in a smart phone application based research project.

Independent variable	Pearson's χ^2	p-value	Fisher's exacttest
Participants with existing health insurance	13.49	.009	.005
Comfort with HPV messages on mobile phone	16.36	.037	.002
Perceived availability of the HPV vaccine, excluding cost as a confounder	15.31	.053	.001
Participants who previously received the HPV vaccine	5.63	.060	.108
Use of contraception	5.63	.060	.108
Existence of a consistent sexual partner	5.63	.060	.108
Age at participant's sexual onset	16.93	.076	.084
Comfort with an STI (HPV) mobile application on mobile phone	13.37	.100	.023

*bold-p<.05 level

Italics-p<.10 and approaches significance at the p<.05 level.

Discussion

Willingness to use the apps and contributing factors related to interest in apps has been assessed previously; however, few reports exist detailing developments of app based interventions for young adult, minority populations [26]. This study showed the potential for using smartphone apps as a means of directing ED patients to preventive services. Almost half of the respondents were willing to use an app that had

sexual behavior overtones. It is quite likely that, if the app had been less emotionally charged, the willingness would have been higher. This is seen by the fact that the question dealing with willingness to participate was strongly influenced by the respondents' willingness to have an app that dealt with what was perceived to be a sexually transmitted infection. This finding is supported by the literature, as young adults viewed health apps as slightly embarrassing and being seen using one appeared socially undesirable [26].

Other potentially mediating factors influencing comfort with an HPV vaccine application on a smartphone include 1) culture, 2) caution about research and 3) vaccine history. Reports suggest that smartphone ownership not only involves our way of communicating but also augments our sense of culture, community, identity, and relationships [32,33]. African Americans routinely note a culture of mistrust of the health care system, which contributes to barriers to health care access and routine vaccine uptake [2]. Comfort with HPV messages on a personal smartphone may reflect cultural acceptance in accessing related sensitive prevention services, including contraception, STI prevention, and HIV testing. An additional confounder with regard to participation was related to the dependent variable's use of the term "research." The unethical practices experienced by African Americans in the infamous Tuskegee Experiment lead them to be cautious of participating research projects [34]. Vaccine history is a known predictor of willingness to initiate and complete the HPV vaccine among women aged 18-26 years [35]. Study findings revealed 56% of women who initiated the HPV vaccine completed it and regression analysis found completion rates to be linked with a history of obtaining the influenza vaccine and lifetime vaccines [10,35]. Smartphones potentially provide an ideal medium for interventions encouraging uptake of vaccines.

Although over 40,000 apps that address prevention and care exist [27], their effectiveness as a delivery channel has not been well established. This pilot study suggests that there is real potential for developing apps in other preventive areas. HPV vaccination may be the most difficult vaccine today to acquire societal buy-in. Barriers to vaccine uptake include concern about vaccine safety [10,36,37] and health insurance [16,38]. Research has shown that uptake and completion of the HPV vaccine is poor among people of the African American race [16,35,39-42], and those with an uninsured status [35], and low income. Although barriers to vaccine uptake are well documented in the literature, particularly among African American females, our study population reported willingness to receive the vaccine when people perceived the vaccine as available at no cost. Reported facilitators of HPV vaccine uptake are knowledge of HPV vaccine [43], higher perceived severity of HPV infection [43-45], and having private health insurance [46,47]. Facilitators for both uptake and series completion include unmarried status [35], vaccine history [35,44,46], and subjective norms endorsing HPV vaccination uptake [42,44,47-49].

Limitations

The primary limitation of the study is the small sample size. Clearly this pilot study needs to be replicated with a larger sample size and at other EDs. Another study limitation is that the data was based on self-report. Additional survey questions assessing comfort with using smartphones for prevention apps and acceptability have not been validated. Inherent limitations of the inclusion criteria, related to age and gender, may have impacted participant willingness, or the lack thereof, regarding use of an app on their smartphone.

Conclusions

While there is a need for additional research in this area, this pilot study suggests young adults are willing to download an app on their smartphone with messages about STIs, substantiating the potential for using smartphones to link ED patients to preventive services. If smartphones lead to additional uptake of vaccines, there is the potential of improving the public's health in other areas of vaccine preventable diseases such as measles, mumps and rubella (MMR), Hepatitis A and B, and influenza vaccines.

Future research

The majority of healthcare apps available today are simple and provide basic information [27], which likely contributes to many apps having few downloads and inconsistent use [27]. Gaining and sustaining the interest of app users is a key component to the success of mobile health interventions. A previous study reported participants found apps that integrate well with the way they used their smartphones naturally were most appealing and useful [26]. Findings support two key components in app development: 1) ease of use and 2) appealing features. The way users choose to use or discontinue use of apps on their phones reflect these two components [26]. An app promoting HPV vaccine uptake and series completion should *inform* vaccine eligible women about the vaccine, *guide* them towards series completion, *remind/alert* them when the next date of vaccination approaches, and *communicate* with them consistently regarding the vaccine and the importance of series completion [27]. An app encompassing all of these components, while aligning with the natural use of the phone, has a sound likelihood of success.

Future academicians, ED clinicians and other health care providers with an interest in app development should explore the following variables: age, gender, user expectation of entertainment/engagement, user expectation of high 'production values', health behavior modification through 'gaming', and related costs (i.e., development, maintenance, and marketing). Consideration of these elements of app development is critical to acceptance of mobile health interventions designed to engage young adults into their own healthy behavioral changes.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	MJH	MG	RP	CM	MR	RMG
Research concept and design	✓	✓	✓	✓	✓	---
Collection and/or assembly of data	✓	✓	✓	---	---	---
Data analysis and interpretation	✓	✓	---	---	---	✓
Writing the article	✓	---	---	---	---	✓
Critical revision of the article	✓	---	---	---	---	✓
Final approval of article	✓	---	---	---	---	✓
Statistical analysis	✓	---	---	---	---	---

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