Smartphone Preventive Health Care: Parental Use of an Immunization Reminder System

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ABSTRACT

Introduction: This study examined the feasibility of using a smartphone application recall/reminder system for immunizations given in pediatric primary care.

Method: The study used a typical descriptive study design. A convenience sample of parents and caregivers was recruited from a primary care pediatric office in a middle-class suburban area. Participants used an Android smartphone application ("Call the Shots") that served as a reminder/recall system for vaccinations and offered an embedded tool kit to obtain reliable information about vaccines.

Results: A total of 262 persons accessed the application's Web site. The application was downloaded and used by 45 of those persons during the study; six persons completed the survey.

Discussion: Data are insufficient to fully evaluate the usefulness of the "Call the Shots" smartphone application. However, initial results and feedback have been positive, and the application should be launched in Apple's platform to reach a wider test audience. J Pediatr Health Care. (2014) *28*, 35-42.

KEY WORDS

Immunization, vaccination, reminder system, Health Belief Model

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Prevention of disease with immunization is one of the greatest achievements of modern medicine. In the United States, routine childhood immunizations have led to a decline of 96% to 100% in mortality resulting from vaccine-preventable diseases during the 20th century (Kempe et al., 2011). Misperceptions about vaccine safety have grown, along with concerns that the immunization schedule is crowded and complicated. Unscientific theories and heartbreaking stories with unproven correlations between vaccines and adverse health outcomes have fueled the debate over immunization mandates. As a result, increasing numbers of parents are refusing or delaying vaccines for their children (Kempe et al., 2011). Recently, media coverage of vaccine safety issues has fueled parental fears of immunization, prompting a need for intervention from pediatric health care providers (Niederhauser, 2010).

BOX. Definition of key terms

- **Smartphone:** A high-end mobile phone that includes more advanced computing ability, functionality and Internet connectivity than a traditional phone. Smartphones typically have the capacity to make phone calls, send text messages, play videos, communicate via e-mail, take and display photos, and surf the Internet.
- **Smartphone application:** Also known as an ''app''; a software application that runs in a smartphone. Applications make the functionality of a mobile phone literally limitless.
- **QR Code:** QR stands for ''quality response.'' A QR code is a two-dimensional bar code used to decode and download mobile applications at a high rate of speed.
- **Call the Shots (CTS):** A smartphone application that functions as a vaccination reminder system for parents of children < 18 years of age and also provides information regarding the vaccines recommended at each provider visit.
- **Android platform:** Also known as an Android operating system, a platform that permits application software to run on a mobile device. Many cellular providers use Android platforms. Other vendors include iPhone and Blackberry.

Extensive research has documented the efficacy of vaccine reminder systems in boosting immunization rates. Multiple studies in many venues with various populations and varied methods have repeatedly demonstrated that vaccine recall systems increase vaccination rates (Dombkowski, Harrington, Dong, & Clark, 2011; Hambidge, Phibbs, Chandramouli, Fairclogh, & Steiner, 2009; Lemstra, Rajakumar, Thompson, & Moraros, 2011; Minor et al., 2010; Pickering et al., 2009; Vora, Verber, Potts, Dozier, & Daum, 2009). However, most of these studies used traditional telephone calls, mailed paper reminder notices, or in-person home visits. Although effective, these methods also have been problematic, in part because vaccine recall systems are dependent upon having correct addresses, phone numbers, and other contact information. Dombkowski, Harrington, et al. (2011) found that 26% of 20,377 notifications (5182) were undeliverable because of incorrect or outdated information. In another study, Dombkowski, Reeves, Dong, Stevenson, and Clark (2011) found that 42.6% of enrollees had an undeliverable notification. Such problems reduce the efficacy of vaccine recall systems. The systems also can be very labor intensive. It has been recommended that for optimal effectiveness, one dedicated staff person should be assigned to a recall system. Providers therefore have expressed a need for alternative recall methods that are less time and labor intensive and less expensive (Saville et al., 2011). Some studies have used a text-message reminder system (Kharbanda et al., 2011; Stockwell et al., 2011), but none has reported use of other technology.

Smartphone applications (Box) are not dependent on having correct contact information to function, giving them a distinct advantage. Also, beyond the initial set-up, smartphone applications are not labor intensive, making them an interesting candidate for communication between patients and providers. Potential drawbacks are loss of provider control and knowledge of which patients have been identified. The strategy reported here used a smartphone application to inform parents about the risks and benefits of vaccination and to remind them of scheduled vaccinations.

REVIEW OF THE LITERATURE

According to Zhao and Luman (2010), ironically, the success of public vaccination has led to a decreased perception of disease risk. Because of this situation, many parents of young children have not personally seen the devastating effects of communicable diseases that childhood vaccines prevent, and many providers have never treated children with diphtheria, measles, mumps, or rubella. However, during an outbreak an unvaccinated group can put an entire community at risk for acquiring such communicable diseases (Zhao & Luman, 2010). A recent press release by the Centers for Disease Control and Prevention (CDC) stated that although most U.S. kindergartners are receiving recommended immunizations, ''local clusters of unvaccinated children still pose a health risk'' (Beasley, 2012). For example, the United States experienced a measles outbreak of 131 cases in 2008, and the rapid transmission that occurred was attributed to unvaccinated children (Zhao & Luman, 2010). In 2011, there were 222 reported cases and 17 outbreaks of measles, the highest since 1996 (Beasley, 2012).

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All states require vaccination for school entry, but 48 states allow nonmedical exemptions, and the percentage of parents applying for these exemptions is on the rise. Children with a nonmedical exemption are at increased risk for both acquiring and transmitting vaccine-preventable diseases such as pertussis and measles (Salmon et al., 2009). The risk for measles is 35 times greater for an exempt child, and the risk of

pertussis is 23 times greater. Nine thousand cases of pertussis were reported in California in 2010, the highest rate since 1947 (Zacharyczuk, 2011a). Vaccination coverage rates for measles, mumps, and rubella have fallen just shy of the 95% goal set by Healthy People 2020. Because exemptions tend to cluster geographically, national vaccination levels that appear to be on target can "mask substantial vulnerability at the local level" (CDC, 2012). Although altered schedules arbitrarily selected either by the parent or provider are becoming increasingly popular, they are not advisable because they prolong the child's time of vulnerability to vaccine-preventable disease (Zacharyczuk, 2011b). A recent Pediatric Infectious Disease Society position statement "…opposes any legislation that would allow children to be exempted from mandatory immunizations based simply on their parents or, in the case of adolescents, their own secular personal beliefs" (Zacharyczuk, 2011b). Washington State has one of the highest numbers of nonmedical exemptions in the country, and the state's health department has begun to explore alternative methods such as the use of provider-patient dialogue within social media to address parental concerns. Clearly, innovative and multifaceted approaches are needed to address the growing trend toward individualizing immunization schedules (Zacharyczuk, 2011b).

Research has begun to examine the feasibility of using smartphone applications in preventive health care. As of 2010, there were 234 million wireless subscribers in the United States, and 45.5 million of these subscribers owned smartphones. This number is expected to rise to 194 million by the year 2015. This number of mobile users provides a large pool of subjects who can be included in research. In addition, mobile application downloads are expected to increase tenfold between 2009 and 2013 (Chickowski, 2010). As of 2010, close to 6000 consumer health applications were available, and the number is dramatically increasing (Kritz, 2010). A 2010 study (Kaewkungawal et al., 2010) used a smartphone application in the "Better Border Healthcare Program" to increase compliance with routine visits to providers for immunizations. In a more recent study by Clark, Butchart, Kennedy, and Dombkowski (2011), more than half of parents surveyed were willing to register their cell phone numbers with their child's immunization provider. This same study found that one in four parents reported a preference for newer technologies for vaccine reminder systems and suggested focusing future research efforts on this willing population.

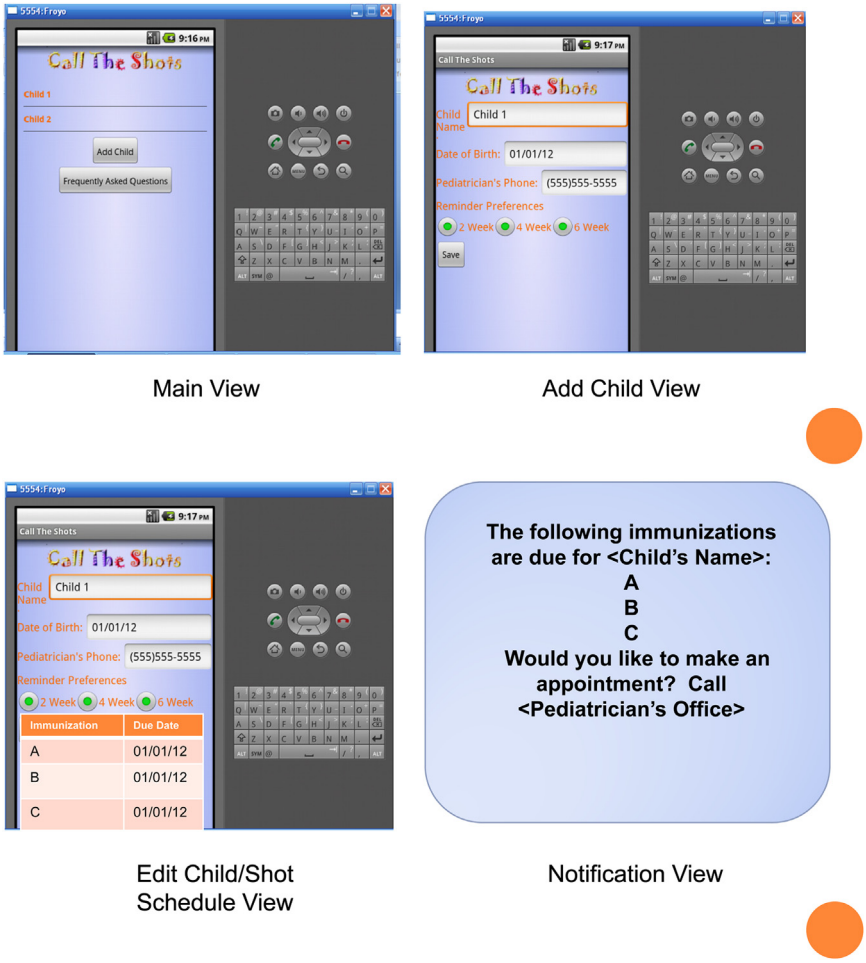
The Robert Wood Johnson Foundation (2011) has information on its Web site to inform consumers about the use of health applications, and many applications are available from entities such as Poison Control, the New York City Department of Health, the American Heart Association, and the CDC. The Robert Wood Johnson Foundation (2011) has suggested some criteria for judging public health care applications: (a) they should reflect evidence-based guidelines for behavior change; (b) they should offer periodic message alerts to guide behavior change; (c) they should offer the option of linking to social support resources for behavior change; and (d) they should provide links to proven services. "Call the Shots" (CTS), the application used in this study, adheres to these criteria in the following ways. The application (a) is based on the Health Belief Model, a widely used theory of behavior change; (b) offers message alerts with reminders to schedule immunizations; (c) offers links to social networking sites to communicate with other parents facing the same immunization decisions; and (d) provides links to multiple services, including the CDC and the child's own pediatric provider.

THEORETICAL FRAMEWORK

The Health Belief Model (HBM) has been extensively studied and is considered one of the most influential models used in the field of health promotion (Roden, 2004). Many effective health interventions have been successful by targeting messages at the HBM variables to effect change in health behaviors (Carpenter, 2010). The HBM postulates that people are ready to take action to prevent illness if they believe that they are susceptible to the condition (*perceived susceptibility*); the condition has grave repercussions (*perceived severity*); taking action would reduce susceptibility and/or severity *(perceived benefits*); the costs of taking action (*perceived barriers*) are overshadowed by the benefits; and if they are exposure to an impetus for response (*cue to action*) and are convinced that they will be able to favorably accomplish the selected action (*self-efficacy*; Butts & Rich, 2011). Self-efficacy is a predictive theory that addresses the belief that one is capable of accomplishing a specified behavior (Bastable, 2008). For parents/caregivers, this process entails (a) previous mastery of similar tasks (i.e., repeated well check-ups with immunizations); (b) observing others modeling successful behaviors (i.e., seeing other parents in the clinic who are having their child immunized); (c) verbal persuasion by others (i.e., a health care provider recommends immunization), and (d) emotional arousal (i.e., feeling satisfied about the decision to vaccinate).

In a study by Flood and colleagues (2010), the interventions identified as most effective in improving vaccination rates in the context of the HBM were health care provider recommendations and dissemination of information on the efficacy and safety of the vaccination. Another study using the HBM as a framework of parental decision found that the strongest predictor was vaccine safety. If caregivers were convinced of vaccine safety, they were more likely to vaccinate (Chen et al., 2011).

FIGURE 1. Screen shots of the Call The Shots smartphone application. This figure appears in color online at www.jpedhc.org.



The literature demonstrates that providers need to talk to their patients about the safety of immunizations in order to increase vaccine compliance. However, significant barriers exist to this seemingly simple intervention. Most physicians report using information sheets to inform their patients about the severity of vaccine-preventable illness, but very few physicians use other methods such as Web sites or pictures or address parents' specific concerns (Kempe et al., 2011). In a recent study, physicians reported that the main barrier to educating patients on vaccine-preventable illness was the amount of time the discussions took. Physicians also reported feeling that they did not know enough about vaccine safety issues to properly address them. They noted that parental concerns over vaccine safety are growing and that requests to delay vaccinations are increasing (Zacharyczuk, 2011b). Parents of vaccinated children are more likely to have obtained information from medical or public health sources than are parents of exempt children. In a study by Salmon and colleagues (2009), 24% to 34% of parents had concerns about vaccine safety that were not supported by current research. A clear need exists for novel approaches to increase the effectiveness of communication interventions in which empirically validated information is used to inform parents about the risks and benefits of immunization.

With research findings showing that parents need both an effective recall system and better communication regarding vaccine safety—a major predictor of immunization compliance—that is delivered in more innovative ways, a step-by-step health program can be implemented with the HBM. An original smartphone application, CTS, was designed and developed specifically for the purpose of this study by using the HBM as a conceptual framework. The application ("app"; see Box) serves as a reminder and information system, providing reliable information resources to parents and caregivers. The app may be downloaded from the Internet site (www.familyhealthshield.com) or by using the quality response (QR) code (see Box) posted in the provider's office and on the aforementioned Web site.

Once the application is downloaded, parents/caregivers are prompted to enter their child's name and birth date into the application, which releases a series of informational options. Users may choose to be reminded of upcoming immunizations at 2-, 4-, and/or 6-week time intervals before the dates of recommended vaccines. The application stores the phone number and name of the child's provider so that when the reminder prompt occurs, users may click on the provider number to call immediately for an appointment. When the reminder prompt appears, it reads, "(*Child's Name*) *is due for immunizations. Would you like to call (Provider's Name) to schedule an appointment?*" The prompt is followed by a list of the immunizations that are recommended for the upcoming visit. The app is programmed to provide the most current immunization schedule as recommended by the Texas Department of Health (the population for which this study was designed). Each immunization is hyperlinked to current Vaccine Information Statements provided by the CDC so that parents/caregivers may access information and potentially assimilate a list of questions before the provider visit. The app also has an extensive tool kit embedded with a "Frequently Asked Questions" page that discusses common parental immunization concerns. The app also provides links to social media sites so parents/caregivers can dialogue with others who are making similar vaccination decisions. In addition, links are provided to the Immunization Conversation Video series, which was produced by the National Association of Pediatric Nurse Practitioners and can be accessed at http://www.napnap.org/PNPResources/practice/practiceresources/immunizationconversations.aspx. These videos can be viewed by using the smartphone's mobile browser. The app also has the capacity for the parent to keep a log of immunizations administered to each child. Figure 1 displays selected screen shots of the application. CTS addresses each factor in the HBM in the context of pediatric immunization, as demonstrated in Table 1.

PURPOSE

This exploratory study examined the feasibility of using a smartphone application designed as a vaccine reminder and information system for parents of children ages 18 years and younger. Specifically, the study was designed to determine whether parents/caregivers of children aged 18 years or younger would (a) be willing to try a smartphone application vaccine reminder system (CTS), (b) find CTS to be helpful, (c) access the vaccine information resources within CTS and to what extent, (d) use the date reminder system within CTS and to what extent, (e) perceive the date reminder system to be useful, (f) perceive the vaccine information provided to be helpful, and (g) find CTS to be easy to use (i.e., user friendly).

METHODS

Setting and Sample

This study was conducted at a large, five-physician, primary care pediatric clinic that had been in practice for more than 35 years in a middle-class, ethnically diverse suburban area just outside of Houston, Texas. The clinic had an average daily patient census of 100 patients. Parents and guardians of children aged 18 years and younger were recruited using convenience sampling strategy. Parents could recruit other subjects via word of mouth or by sharing the QR code.

Data Collection Procedures

Posters with information about CTS were displayed in the clinic for a 2-month period. These posters contained a QR code that parents could scan with their smartphone to access information about the study, the informed consent form, and the application itself. Parents also could access the application by visiting the following Web site: www.familyhealthshield.com. Business-sized cards with the CTS QR code and Web links to study information also were distributed to patients during office visits. Inclusion criteria included being parent or guardian to a child aged 18 years or younger and possession of a smartphone with an Android operating system (see Box). Before downloading the application, parents were required to give informed consent via an electronic prompt on their smartphone. If parents wished to use the smartphone application on a trial basis after reviewing the information, they had the option of using the QR code to access the application. Once it was downloaded onto their phone, an informed consent message screen appeared for the parent to read. If parents consented to the terms of use, they selected the prompt that read "By downloading this application I accept the terms of use and consent to participate in this study" button and proceeded to download the application.

Parents had the option of using any or all of the resources in CTS. They could use the date reminder system, in which they entered their child's birth date and chose a 2-, 4-, or 6-week reminder prompt for immunizations that also included a link to the pediatric provider's phone number. The reminder prompt listed scheduled immunizations and provided a hyperlink to information resources about each particular vaccine (including the Vaccine Information Sheets published by the CDC). Parents also had the option to use any, all, or none of the information resources included in the tool kit in CTS. After use, a prompt was given to an electronic survey asking about parental experiences with use of the application.

RESULTS

During the period of April 1 to May 31, 2012, approximately 2000 appointments were scheduled in the clinic.

TABLE 1. How the Call the Shots application correlates to the Health Belief Model construct

HBM construct	HBM link to CTS	Embedded Web link examples
Perceived Susceptibility and Severity	CTS links to the Texas State Department of Health Web site, which can be used to view rates of vaccine-preventable disease locally, along with morbidity and mortality statistics; CTS links to social networking sites with stories from families who have experienced vaccine-preventable disease	http://www.dshs.state.tx.us/idcu/disease/pertussis/
Perceived Benefits and Barriers	CTS links to an extensive tool kit with multiple sources and formats of information to answer frequently asked questions about the risks and benefits of vaccination	http://familyhealthshield.com/?page_id=12
Cue to Action	CTS links to videos produced by the CDC and NAPNAP that feature conversations about immunizations between health care providers and parents	http://www.napnap.org/PNPResources/practice/practiceresources/immunizationconversations.aspx
Self-Efficacy	CTS links to a recommended immunization schedule for the child's age group, including links to each Vaccine Information Statement published by the CDC, along with a prompt to call the provider's office to schedule an appointment	http://www.cdc.gov/vaccines/pubs/vis/downloads/vis-flu.pdf

CDC, Centers for Disease Control and Prevention; CTS, Call the Shots; HBM, Health Belief Model; NAPNAP, National Association of Pediatric Nurse Practitioners.

Many of these appointments included multiple children from the same family and repeat visits. During this 2-month period, the Web site page (www.familyhealthshield.com) had 536 visits by 262 unique visitors through either a Web or mobile browser. These 262 persons accessed a cumulative total of 3223 pages on the Web site. A total of 77 persons scanned the QR code to access the application (CTS). Of those 77 persons, 45 individuals downloaded CTS onto their individual Android smartphone. Of the 45 persons who downloaded and used CTS, six persons completed the survey (Figure 2). All six respondents chose a smartphone application as their preferred method of communication. The average age of the respondents was 34 to 35 years. Sixty-seven percent had a bachelor's degree or higher.

Individuals are permitted to provide a rating of applications they download in the Google Play Android Market. Three users gave the application a 5-star rating (out of 5 stars). Comments included "Great organizational tool for busy parents" and "Great app. Very informative. Easy to use."

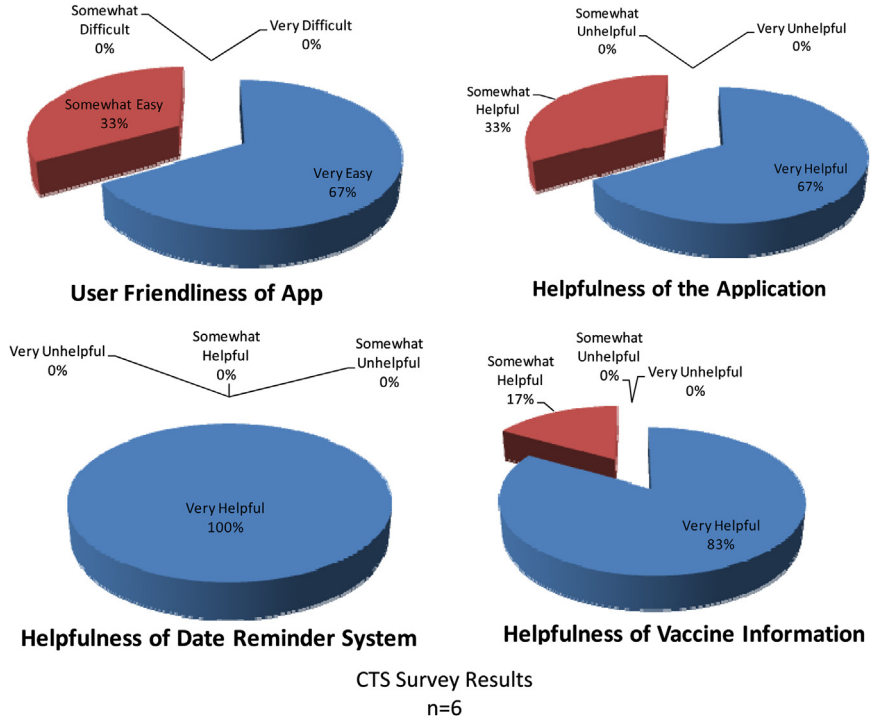
DISCUSSION

During 2011, Google's Android operating system held a major global market share of the smartphone market. Third-quarter reports from 2011 showed that Android accounted for more than 50% of smartphones sold in the United States, with Apple's iPhone lagging behind at ~15%. During the study design, it was determined that for a feasibility study, the application would first be launched in the Android market because of its wide appeal and broad market share. However, the smartphone market has changed tremendously during the past 12 months. Apple's iPhone has made a significant resurgence to capture 43% of the smartphone market in the first 3 months of 2012 (Blodget, 2012). During the study, many potential subjects expressed a desire to try the application but said that they possessed an Apple iPhone. More than 100 e-mail messages and phone calls were received from parents who asked to be notified when the application was available for the iPhone.

> Pediatric providers need to seek innovative ways to communicate effectively with patients and their families to help them make informed and responsible choices about immunizations.

Thus it would be useful to launch the application in the Apple market and run the study again, comparing results. At the conclusion of this study, it was unclear whether the lower than expected number of application downloads was attributable to a skewed distribution of iPhones in the subject population or lack of willingness to try the application. Recent studies have indicated that parents are interested in using newer forms of technology for receiving communication from their

FIGURE 2. Call the Shots survey results. This figure appears in color online at www.jpedhc.org.



providers about vaccination (Clark et al., 2011; Stockwell et al., 2012). However, at this point data are insufficient to accurately evaluate the usefulness of the CTS smartphone application. Initial results and feedback have been positive, and the application should be launched in more mobile platforms to reach a wider test audience. Pediatric providers need to seek innovative ways to communicate effectively with patients and their families to help them make informed and responsible choices about immunizations.

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