Barriers and facilitators to the use of an immunization application: a qualitative study supplemented with Google Analytics data

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ABSTRACT

Background Barriers and facilitators of mobile app adoption are not known. This study examined usage of a new Pan-Canadian immunization app to identify factors that contributed to usage.

Methods Women in their third trimester of pregnancy or had given birth in the previous 3 months were recruited from a hospital obstetrical unit. Fifty-five participants were instructed to download the ImmunizeCA app. After at least 6 months, 10 interviews were conducted, transcribed and coded. Themes identified were compared with aggregate ImmunizeCA usage data (n = 74 212 users).

Results Facilitators included features that address logistical challenges, improved convenience and information access. Barriers included absence of system integration. Concerns regarding the privacy and security of personal health information were not an inhibitor as long as best practices are followed. Google Analytics data on usage supported qualitative findings.

Conclusion Future studies should evaluate the quantitative impact of factors we identified on app uptake and usage. Subsequent mobile app studies may benefit from the use of analytic data as they were found to be effective in helping to validate qualitative data derived from interviews with study participants.

Keywords immunization, mobile applications, public health, privacy, qualitative study

Introduction

Despite the growing number of mobile health applications (apps), there are comparatively few smartphone apps developed specifically for public health. Immunization practice is one aspect of public health that could potentially benefit from mobile apps.1–3 Mobile apps provide convenience for keeping track of immunizations received and receiving public health information, and offer the opportunity to communicate with public health officials with respect to adverse events.1,2 Importantly, mobile apps present a valuable platform for receiving quality information about vaccination, and may help to reduce vaccine hesitancy.1

ImmunizeCA is a pan-Canadian immunization app that allows users to track vaccine information for both themselves and their family members, access evidence-based vaccine fact sheets as well as outbreak alerts and synchronize their or their
child’s immunization record with their phone calendar to receive reminders for upcoming and overdue vaccines. This app may be particularly useful for new mothers and mothers of young children as it allows an opportunity to address concerns and barriers to immunization experienced by this population, such as a lack of awareness of the vaccine schedule.

Not unlike many health interventions, when a mobile technology offers functionalities that address a known barrier, intervention effectiveness is completely dependent on user acceptance and adoption. Therefore, understanding what influences app acceptance is essential for determining what potential, if any, the intervention has to create behavior change in any given population. While there are models that describe factors that influence adoption of technologies, their applicability for mobile health interventions is not well studied. Insight into mobile health-specific drivers of adoption and use is crucial to guide both the development and evaluation of digital health interventions.

As a part of a larger study on the ImmunizeCA’s effect on maternal attitudes and beliefs toward pediatric vaccination, we aimed to gain a deeper understanding into how and why new mothers use the ImmunizeCA app. We also sought to evaluate how their usage patterns compared with those of the general population of ImmunizeCA users, as shown through Google Analytics data. We discuss these findings in the context of the Technology Acceptance Model.

Methods
Design
In this study, we conducted semistructured qualitative interviews with new mothers. Themes identified were compared with data from ImmunizeCA app users obtained using Google Analytics. This study was approved by a research ethics board.

Participants and recruitment
A convenience sample of childbearing women were originally recruited to participate in a survey study evaluating attitudes, beliefs and behaviors toward pediatric vaccination. Expectant and post-partum mothers were recruited from the obstetrical unit at a tertiary care hospital. The study inclusion criteria were: English-speaking mothers in their third trimester of pregnancy or mothers who had given birth in a 3-month period prior. Women also were required to consent, and own a compatible smartphone device. Participants were then directed to download the ImmunizeCA app, complete a baseline survey at the time of recruitment and a follow-up survey 6 months later.

When reminded via e-mail to complete the follow-up survey, participants were asked if they were interested in participating in a follow-up interview. Participants who expressed interest in participating in an interview were provided with a second information sheet and consent form. Consenting participants were interviewed either in person or over the phone, depending on participant preference and availability.

Data collection
Interviews
The interviews were conducted by study staff using a semi-structured approach, involving the use of open-ended questions included in an interview guide. The guide was drafted and adjusted throughout the study to incorporate organically emerging themes. Key themes captured in the interview guide included: participant demographics, general app usage, use of specific app features and access to in-app information. The interviews were timed, recorded and then transcribed verbatim by an individual external to the study.

Google analytics data
Aggregated app usage data for all ImmunizeCA sessions between 20 March 2014 and 20 March 2015 were retrieved from Google Analytics. These data report on all app sessions on iOS or Android operating systems (n = 264 797) for 74 212 app users. For each app function tracked, the total number of unique events (a session where the event occurred at least once time), recorded by Google Analytics, was compared with the total number of sessions. This allowed us to determine the percentage of total sessions that accessed each function. The use of the following app functions was measured: vaccine tracking, appointment reminders, general information (information on vaccines, fact sheets and FAQ) and specialized information (outbreak information, banners, pain prevention).

Analysis
Coding
The interview transcripts were manually coded by a reviewer and then verified by a second reviewer. Any discrepancies in the coding were resolved through discussion until consensus was reached. The coded data were organized into categories created in an excel spreadsheet as themes from the interviews became apparent, and new categories were added when additional content themes emerged.

The technology acceptance model
One model that describes behavioral intention for technology system use is the Technology Acceptance Model (TAM).

Through the TAM, two facets of a technology have consistently been identified as influencers of behavioral intention for use: perceived usefulness (PU) and perceived ease of use (PEOU).

PU is defined as ‘the degree to which a person believes that using a particular system would enhance their performance
on a job’ and PEOU is defined as ‘the degree to which a person believes that using a particular system would be free from effort’. For the purposes of this study, we have described PU as ‘the extent to which an individual believed that the app enhanced the task of tracking vaccinations’, while PEOU has been defined as ‘the degree to which an individual believes that using the app was an experience of ease and effortlessness compared to tracking using paper-based methods’. Importantly, the influence of features that encourage and discourage ImmunizeCA app usage (facilitators and barriers) can be understood within this framework.

Building on the original TAM, Shin found that in addition to PU and PEOU, intention-to-use technology can be influenced by a perceived sense of security and trust in the technology. Perceived security has been defined as ‘the degree to which a customer believes that using a particular mobile payment procedure will be secure’. Importantly, concern about security has been found to influence individuals to not use apps requiring sensitive information. For the purposes of this study, we defined perceived security as ‘the degree to which one believes their immunization information will be secure while residing on a mobile device’.

Results

A total of 62 women contacted study staff expressing interest in participating in the larger study. One woman was deemed ineligible due to an incompatible smartphone (Blackberry Q10) and an additional six women did not provide consent to participate. In total, 55 women provided consent and completed the first survey. When it was time to complete the follow-up survey, three participants failed to initiate the survey online, and two more initiated, but did not complete. Therefore, we had access to a sample of 50 participants for this study. Of those, 12 did not offer to participate in an interview, 9 did not reply to the request, 2 declined, one offered but expressed they would rather not and the rest were willing. On the basis of availabilities, we began interviews reaching thematic saturation after 10 participants.

Data included in this study came from two distinct groups: 10 mothers who participated in semistructured interviews (Fig. 1) and aggregate Google Analytics data from 74,212 ImmunizeCA app users.

Participant demographics

The mean age of the 10 mothers who participated in interviews was 31.6 years old (Table 1). Average interview length was 21.5 min. First-time mothers comprised 60% of participants, while only one participant had more than one child previously. Of the total participants, 90% reported that they were either married or in a common law relationship, and all of the participants indicated that they had completed either an undergraduate or graduate degree (30 and 70%, respectively). Forty percent of all participants indicated that they would seek health care from more than one source. When asked to select all that apply, the majority of mothers indicated that they would seek health care from a family doctor (70%) or a pediatrician (50%), while only 20% of participants reported that they would involve a nurse practitioner or a complementary medicine provider in the
health care for their child. More than half of participants (60%) were employed full-time.

**Themes**

Through analysis of the interviews, factors that have the potential to act as facilitators and barriers to app use were identified. Facilitators of app use included features that address logistical challenges, improved convenience and information access. Concerns regarding the privacy and security of personal health information residing on a mobile device were hypothesized to present as a barrier, but this was not found to be an inhibitor to use, as long as best practices are followed. Barriers to use were identified as features that were not currently present in the app, but would reportedly encourage use.

**Facilitators**

**Logistical and convenience factors**

Interviews revealed three common reasons for using ImmunizeCA: documenting vaccines, receiving appointment reminders and ease of use compared with paper-based methods.

**Documentation.** Every mother who was interviewed, with the exception of one who did not use the app, reported using the app to track appointments (Table 2).

So I just found it really convenient because those yellow books are really easy to misplace and it’s just very convenient to look up in advance how many shots he was going to get . . . and just expect at the appointment, especially when you’re preparing a little baby to get shots.

This was the most used app feature of all features tracked, as confirmed by Google Analytics data, with 47.6% of all app sessions accessing this feature (Table 3).
Calendar. After tracking, the appointment reminder and calendar features were reported as the second most used feature (80% of participants interviewed). One mother explained the benefit of the calendar features, as follows:

I found it really helpful that it gave you the timeline and it connected to your calendar so you wouldn't forget when you need the vaccination and... this is my first child so I wasn't quite sure what the schedule was.

Google Analytics data indicated that this feature was accessed in 9.5% of app sessions.

Ease of use. For both mothers who were interviewed, a major draw to using the app is its ease of use compared with paper-based methods. Mothers mentioned this in 80% during their interview:

...it was much easier to just look on your phone than to use like the book or to look it up online or that type of thing.

This idea was echoed by another participant stating that the app:

[w]as ‘comprehensive’ and saved time by having everything in one place.

Information access
Common themes that emerged through discussion about information access included credibility, information sources and the use of general versus specialized information.

Credibility
Language around the credibility of the app emerged in several (60%) interviews, with participants describing the app as a trustworthy and a legitimate source of information.

...it’s a proper legitimate source so I don’t need to double and triple check that. [It’s] a good source I trust it.

Reasons that were mentioned for this included branding from the Canadian Public Health Association branding, affiliation with a tertiary care hospital, and that it appeared to be medically based/approved by doctors.

Information sources. While one mother noted that she liked that the app provided a ‘...disease one-stop-shop’... for information’, 70% of the mothers who were interviewed listed more than one information source that they rely upon, demonstrating a trend of using multiple sources to verify information on immunization.

I think I remember it being easy to understand it was pretty accessible to read but I Googled it again just because I wanted to have a couple of sources... not because I didn’t trust the quality of the information or anything like that.

General versus specialized information. Although the app may not be used as a sole, or even primary, information source for general users, 80% of mothers interviewed reported using the app for information on vaccines, and one mother in particular expressed its value.

...I’d go in just before her first visit just to see again what we were actually going in for an what they were for... because it’s not something that the doctors talk to you about... so that was helpful to read up a little bit about it before...

...I found it really useful. I like having that information I like having it in my phone and I like having kind of a little source for all that kind of stuff.

Meanwhile, Google Analytics data revealed that 4.9% of app sessions accessed this feature.

Access to specialized information in the app was more limited compared with that to general information. Three mothers who were interviewed reported using the outbreak feature, while only one accessed pain management information.

### Table 3 Google Analytics app data

<table>
<thead>
<tr>
<th>App functions used, n (%)</th>
<th>Description of action</th>
<th>Total sessions (n = 264 797)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking</td>
<td>Accessing an immunization record</td>
<td>126 190 (47.6)</td>
</tr>
<tr>
<td>Appointment reminders/calendar</td>
<td>Adding an upcoming visit to the calendar</td>
<td>25 073 (9.5)</td>
</tr>
<tr>
<td>Information on vaccines</td>
<td>Reading a summary of what the vaccine is and who should get it</td>
<td>13 008 (4.9)</td>
</tr>
<tr>
<td>Outbreaks</td>
<td>Accessing the outbreak HealthMap</td>
<td>1014 (0.4)</td>
</tr>
<tr>
<td>Fact sheets</td>
<td>Looking at the provincial/territorial fact sheets</td>
<td>7119 (2.7)</td>
</tr>
<tr>
<td>Banners</td>
<td>Tapping on one of the scrolling banners to learn more</td>
<td>18 762 (7.1)</td>
</tr>
<tr>
<td>FAQ</td>
<td>Looking at the FAQs related to vaccines, vaccination and immunization records</td>
<td>2010 (0.3)</td>
</tr>
<tr>
<td>Pain prevention</td>
<td>Reading tips or watching videos on how to manage pain from vaccination</td>
<td>5375 (2.0)</td>
</tr>
<tr>
<td>Password protected app</td>
<td>When a password is set for the app</td>
<td>17 004 (6.4)</td>
</tr>
</tbody>
</table>
Google Analytics data also support these findings, as the pain management and outbreak features were accessed by 2.0 and 0.4% of general users, respectively. However, in the interviews it became apparent that some mothers were not aware of these features, and one mother who was aware expressed the practicality of this feature.

...I was only concerned because I was going to a swimming pool...my mom said well there’s a measles outbreak so you might not want to go and that’s when I looked it up a bit more to see if I was taking any risks by going to the swimming pool.

**Barriers**

**Privacy and security**

A common theme that emerged through discussion with all participants pertained to sharing immunization data, and personal health information such as Ontario Health Insurance Plan number, with a partner, and/or local public health officials. Concerns regarding privacy and security of personal health information residing on mobile devices were hypothesized to present a barrier to app adoption, but interviews revealed that the majority (90%) of mothers were comfortable with storing this information on the mobile device, as long as that data were encrypted.

When discussing the idea of being able to send their child’s immunization information to their local public health unit via their mobile device as proof of immunization, all participants interviewed reported feeling favorable toward the idea, as long as best practices were followed.

...And I just thought it would have been really good to ...be able to...send it or...be able to share it with somebody instead of me having to ...I think in this day and age it would be a good thing to have that information at your fingertips and then be able to send it to people, whether it be your doctor or other organizations, such as their play group or daycare...something like that would be good.

Comfort with security and privacy of information stored in the app was also reflected by Google Analytics data, whereby only 6.4% of app sessions have enabled in-app password protection.

**System integration**

Discussion around future possibilities for the app occurred in 60% of the interviews, and surrounded the concept of system integration. As these features discussed are not currently included in the app, their absence may present as barriers to widespread app adoption and use. The first suggestion was to have a complementary web-portal for the app, which could be accessed by a computer and could include additional information.

...if it would have linked you know like a bit more information with the vaccines that would be interesting...it would be kind of cool if it brought up like we could see a page on them or something...it would have been cool if it went to somewhere like substantive information. Sometimes I like to look into that would be kind of a neat linking feature.

...if you wanted to put in more information it would be better if it was viewable on a bigger screen.

Similar to this interest in having a web portal for additional information, another common future idea that mothers expressed interest in having was information about adverse reactions to vaccinations, including what to look to for and what to do.

...so maybe on the app if there was either something to go to for a little something to click on for side-effects or just a link to a website which tells you what to look out for would be interesting...and then obviously what to do in case they have that...

**Discussion**

**Main finding of this study**

Four major themes reflecting facilitator and barrier factors to app use were identified through the qualitative interviews and were substantiated by Google Analytics data: logistical and convenience, information access, privacy and security and system integration.

The first facilitators of app usage are the logistical and convenience factors associated using a mobile app instead of traditional paper-based record keeping. It was reported by participants that the documentation and appointment scheduling/reminder features were the major drivers of app utilization (Table 2). These features are directly associated with an enhanced ability to track immunizations, compared with paper-based methods. This reinforces the importance of features that contribute to PU. The data from Google Analytics echoed the use of documentation with 47.6% of app sessions accessing this feature at least once. While record keeping events were present in almost half of all sessions, calendar entries and appointment reminders occurred only in 9.5% of app sessions. The discrepancy between data collected in our study versus the larger ImmunizeCA user base may reflect demographic differences between the new groups. New mothers in the process of vaccinating their children may be more diligent about keeping up with the required vaccination schedule, and aware of the need to vaccinate for school
entry for their child, while parents of older children may not perceive an immediate need having already completed part of the immunization course and thus have less need for this feature compared with simple record keeping features.23,24

The second factor found to act as a facilitator to app use was information access. While 70% of mothers reported using multiple sources of information to learn about pediatric vaccination, 80% mentioned using the app for information, be it as a primary source, or to verify information from other sources. Interestingly, some participants were only aware of general information in the app and did not know that specialized information existed. Google Analytics data are consistent with this hypothesis, as aggregate app sessions accessed general vaccine information (4.9%) more often than specialized information, such as the outbreak feature (0.4%) (Table 3). Nevertheless, participants reported liking that they could access vaccine information on-the-go, referring to the process as ‘convenient’, indicating that this feature may contribute to the app’s PEOU compared with traditional methods of tracking and accessing information.

The implication of providing medical information via a mobile device must be considered, as providing certain types of immunization information has actually been found to be counterproductive.25,26 While information can reduce misperceptions about vaccines in some populations, it can also decrease intent to vaccinate for those with strong opposition toward vaccination.

The first potential barrier to app adoption identified surrounded privacy and security of personal health information being stored on a mobile device. Our study did not identify privacy and security concerns as a barrier to app adoption. Participants reported that they were not generally concerned about inputting sensitive information into the app as long as best practices were followed. This attitude was also inferred from only 6.4% of general app users password protecting the app. Mothers also expressed interest in sharing data with public health officials via ImmunizeCA. This may be a mechanism by which information may be streamlined into immunization information systems.27 Furthermore, this interest in sharing immunization information with public health via mobile device demonstrates that the PU of a data flow feature may outweigh any privacy and security concerns associated with sharing personal health information. While mothers reported not being concerned with sharing sensitive information, such as their health insurance number, it has been reported that one’s willingness to install an app decreases as more of their information is required,28 and as such, limiting required data fields may be an important consideration for app design.

Lastly, participants identified two features that would make the app more useful for them: system integration and managing the pre- and post-immunization experience. As these are not currently features of the ImmunizeCA app, their absence may present as a barrier currently, but a facilitator if added to the app in future versions. It was suggested that having a complementary web portal accessible by desktop computers, featuring additional information would improve the ability to read more about vaccinations, as it would provide greater screen real estate compared with mobile devices.

This study has several strengths, as follows. We used qualitative, semistructured interviews in combination with quantitative data from Google Analytics to improve the user representation in the results. The use of Google Analytics data is particularly powerful as it captures aggregate data on all of ImmunizeCA sessions worldwide. Furthermore, this is the first qualitative study evaluating new mothers’ vaccination experience using an immunization app.

Limitations of this study

The primary limitation of this study is generalizability; both in attitudes toward technology and in vaccination. Both cohorts examined are early adopters of a new technology. Participants either consented to participate in this study or were a part of the cohort who utilized ImmunizeCA during its first year on the market. In addition, since a small sample size of 10 participants was used for the interviews, it was not expected to be representative of the general population. In particular, most of the participants were first-time mothers. Further, as less than one-third of mothers contacted consented to participate in the follow-up interviews, possibly due to the time commitment required and the busy nature of life with a new baby, future studies with this age group should consider how to accommodate these factors to improve involvement. As app usage was not tracked for the subset of mothers interviewed, this presents another limitation with respect to the generalizability of their responses to the general ImmunizeCA users. Furthermore, as app usage patterns for the mothers specifically was not tracked, it is unclear as to whether they continued to use ImmunizeCA after being interviewed. Accordingly, future research would benefit from the use of Google Analytics to monitor possible attrition of ImmunizeCA usage over time, and to validate the representativeness of study participants to the general population of ImmunizeCA users.

It is also important to consider that as many of the mothers (60%) interviewed were first-time mothers (Table 1), they likely lacked experience with using the paper-based vaccination record, compared with mothers with previous children. While this does not negate the reported convenience of using ImmunizeCA for tracking vaccinations, it may be beneficial to evaluate this in subset of mothers who have used both ImmunizeCA and the traditional paper-based method over an extended period of time.
We also cannot be certain that thematic saturation was reached. However, the fact that the themes identified by the interviewees were reflected in app usage patterns of the entire user base raises our confidence in the internal validity of our findings. Another notable limitation is that pro-vaccine individuals may be more likely to download and use an app for immunization than those with less favorable attitudes. As such, the efficacy of ImmunizeCA to improve vaccination rates and on-time vaccination may be limited.

Developers and researchers should always consider understanding a mobile intervention’s scope to affect behavior change in a target population. Our study supports the TAM model that PU and to a lesser extent, PEOU are important considerations that drive adoption of a mobile health app in early adopters of ImmunizeCA. Further studies are needed to understand factors influencing app uptake in other demographics, and what can reduce these barriers to adoption.

**Conclusion**

As the adoption of smartphones has rapidly increased, there has also been a surge in the development of mobile-health applications. Although the majority of medical apps are reference-based, studies suggest that mobile users show a strong preference for health apps that provide the ability to record and track information, access information wherever one is, and that appear legitimate and secure, findings that are reflected in our study. The results of this study could inform other jurisdictions that are considering implementing a mobile solution to enhance their immunization information systems.

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