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Journal of Medical Systems

ISSN 0148-5598

Volume 36

Number 5

J Med Syst (2012) 36:3135-3139

DOI 10.1007/s10916-011-9798-7

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Smartphone App Use Among Medical Providers in ACGME Training Programs

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Received: 29 August 2011 / Accepted: 19 October 2011 / Published online: 4 November 2011
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Abstract The past decade has witnessed the advent of the smartphone, a device armed with computing power, mobility and downloadable “apps,” that has become commonplace within the medical field as both a personal and professional tool. The popularity of medically-related apps suggests that physicians use mobile technology to assist with clinical decision making, yet usage patterns have never been quantified. A digital survey examining smartphone and associated app usage was administered via email to all ACGME training programs. Data regarding respondent specialty, level of training, use of smartphones, use of smartphone apps, desired apps, and commonly used apps were collected and analyzed. Greater than 85% of respondents used a smartphone, of which the iPhone was the most popular (56%). Over half of the respondents reported using apps in their clinical practice; the most commonly used app types were drug guides (79%), medical calculators (18%), coding and billing apps (4%) and pregnancy wheels (4%). The most frequently requested app types were textbook/reference materials (average response: 55%), classification/treatment algorithms (46%) and general medical knowledge (43%). The clinical use of smartphones and apps will likely

continue to increase, and we have demonstrated an absence of high-quality and popular apps despite a strong desire among physicians and trainees. This information should be used to guide the development of future healthcare delivery systems; expanded app functionality is almost certain but reliability and ease of use will likely remain major factors in determining the successful integration of apps into clinical practice.

Keywords Smartphone · App · Technology · Mobile computing

Introduction

Smartphone apps, such as those available in the Apple and Android app stores, are quickly becoming integrated into clinical practice by physicians [1]. Smartphone apps are self-contained software applications that can be downloaded by and run from advanced mobile phones, commonly referred to as smartphones. The leading smartphone operating systems include iPhone, Android, and Blackberry, and each has an associated app distribution store where individual users can select and download apps of interest [2].

The appeal of apps for consumers rests in their ability to store reference information, save critical data, perform complex calculations, access internet-based content, and present video and audio media, etc. all through an intuitive user interface. As such, apps have broadly appealed to consumers for both social and professional functions. Similarly, apps appeal to developers because app stores allow for widespread advertising and distribution of their product. Apps are usually available either for free or at a price typically ranging from \$0.99–\$4.99, with a percentage

Electronic supplementary material The online version of this article (doi:10.1007/s10916-011-9798-7) contains supplementary material, which is available to authorized users.

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of profits returned to the developers. This incentive for developers has resulted in an impressive and expanding number of high-quality and broadly-appealing applications. The most popular smartphone platform in the US market, the iPhone, has over 425,000 apps (as of July 29, 2011) available through its app store [3].

The general trend towards increased smartphone and app use has penetrated the medical community. The increased popularity of apps among health care providers resulted in a dedicated medical app category created in the Apple App Store in 2008 [4]. As further evidence of the increasing role that apps are playing in medical practitioners lives, websites have emerged devoted entirely to reviewing apps designed specifically for physicians [5–7]. While various reports have been published focusing on the utility of apps for various specialties or functions [8–11], no study has examined the prevalence and type of app use among all physicians, fellows, and residents nationwide.

The purpose of this study was to perform a prospective, nation-wide email survey evaluating the use of smartphones and smartphone apps among providers at medical centers recognized by the Accreditation Council for Graduate Medical Education (ACGME). We hypothesized that the current use of smartphones and their associated apps is prevalent among all specialties, and that providers desire additional apps for use in the medical setting.

Methods

Data collection for this study was performed via a national survey of ACGME-accredited residency and fellowship programs. Prior to initiating the study, approval was obtained from the sponsoring Institutional Review Board (IRB #110845XX). First, a novel, online, digital survey was developed to query respondents regarding their specialty, level of training, use of smartphones, and use of smartphone apps (see [Electronic Supplementary Material](#) for an example of the survey). In addition, using a free-response section, respondents were asked to list the apps that they currently find most useful. Once the digital survey was complete, contact information in the form of email addresses for all program directors was obtained from the ACGME website. This included 30 different department types and 118 program types among 678 institutions. The survey was then emailed to all programs with a letter asking the program director to forward the survey to all faculty, fellows, and residents in each respective department. Two additional reminder emails were subsequently sent 1 week apart to increase the response rate. The first email was sent on April 20, 2011 and responses were collected through June 20, 2011.

Respondent characteristics (level of training, specialty, smartphone type, etc.) were collected and the data were analyzed based on these demographics. In the free-response section, many respondents reported the use of a variety of apps with similar functions, such as drug reference guides, medical calculators, and pregnancy wheels. Thus, analyses were performed separately for individual apps as well as based on groups of apps with functional similarities. When grouped together, drug reference apps included: Epocrates, mobilePDR® for Prescribers, Johns Hopkins ABX Guide, Lexicomp, Micromedex Drug Information, 2011 EMRA Antibiotic Guide, The Sanford Guide to Antimicrobial Therapy 2011; medical calculator apps included: MedCalc (medical calculator), BMI Calculators, Calculate (Medical Calculator) by QxMD, MedCalc 3000; pregnancy wheel apps included: Preg Wheel, Pregnancy Wheel, Perfect OB Wheel, Pregnancy Wheel; and coding and billing apps included any free response with the phrase “ICD,” “CPT,” “coding,” “billing,” or some combination thereof. Some respondents reported the use of mobile web apps that were also included in the analysis.

Chi-squared tests for independence (SPSS, Chicago, IL) were used to examine associations between various survey parameters, the strengths of which were quantified using Cramer's V.

Results

There were a total of 3,306 unique responses from 1,397 residents, 524 fellows, and 1,385 attending physicians among 27 different specialties (Table 1). Over 85% of respondents used some type of smartphone; iPhone was the most popular, followed by Android and Blackberry operating systems (Table 1 and Fig. 1). Among all respondents, 56% reported they currently use apps in their clinical practice and there was a qualitative trend towards decreasing app use with increased training level (Table 1 and Fig. 2). Chi-squared test of independence demonstrated that training level and app usage are not independent; $\chi^2(4, N=3,214)=164, p<0.0001, V=0.23$.

When asked to select the types of apps they would find most useful on a mobile device, the most requested app types included textbook/reference materials (average response: 55%), classification/treatment algorithms (46%) and general medical knowledge (43%); there was a greater desire for apps among residents relative to fellows and attending physicians, respectively (Fig. 3). Respondents were then asked which apps they currently find most useful. When grouped according to function, the four most commonly reported app types and their respective response rates were drug guides (79%), medical calculators (18%), coding and billing apps (4%) and pregnancy wheels (4%).

Table 1 Survey respondent demographics

	Respondents	% using smartphone	% using apps
Total Respondents	3,306	85.9	63.5
Level of Training			
Resident	1,397	88.4	68.1
Fellow	524	86.5	55.4
Attending for <5 years	287	88.8	52.1
Attending for 5–15 years	433	86.8	49.1
Attending for >15 years	665	78.2	39.2
Specialty			
Emergency Medicine	275	91.6	73.6
Family Medicine	368	82.1	73.8
Internal Medicine	299	83.3	60.9
Obstetrics/Gynecology	137	83.9	56.3
Pediatrics	387	78.0	49.4
Psychiatry	134	84.3	62.6
Radiology	141	77.3	30.7
Surgery and subspecialties	844	98.1	51.9
Other	721	80.5	51.3

The most popular individual apps, as reported by respondents, are listed in Table 2.

Discussion

The purpose of this study was to define the prevalence of smartphone and app use among providers at ACGME accredited training programs. The results demonstrate that a majority of physicians and trainees currently have smart-

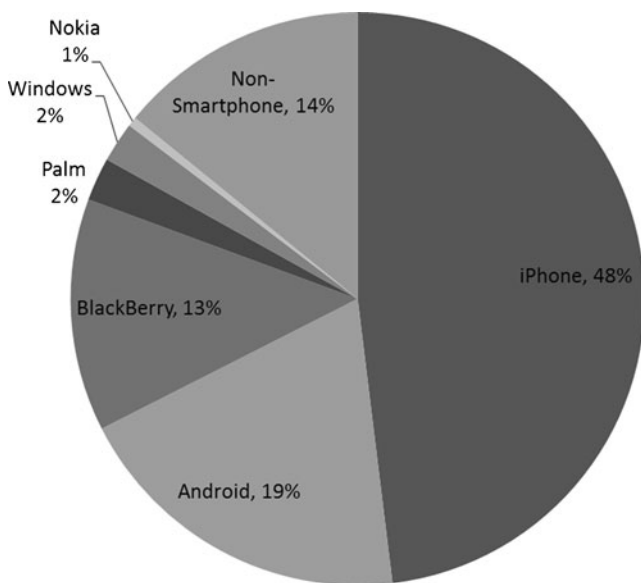


Fig. 1 Phone operating system of choice across survey population

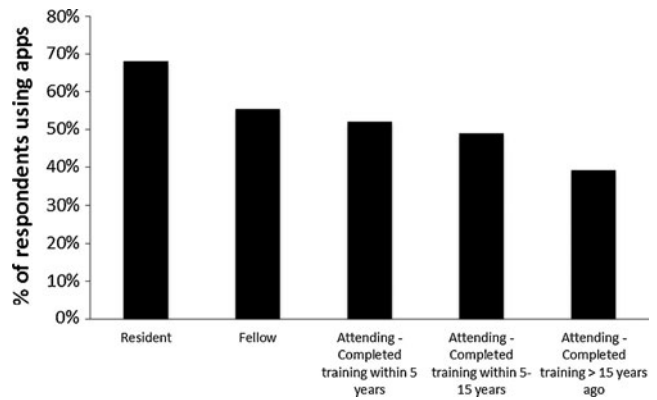


Fig. 2 Percentage of respondents reporting use of smartphone apps in clinical practice

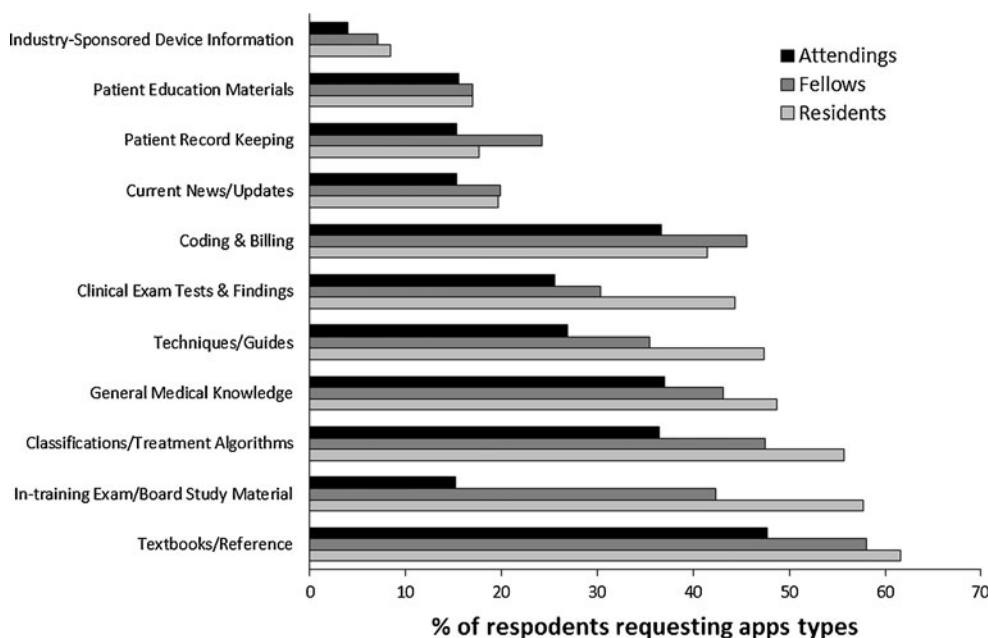
phones and use apps with a trend towards increasing app use that inversely correlates with level of training. The strength of this relationship, as measured by Cramer's V, was 0.23. Using Cohen's criteria [12], this coefficient is indicative of a medium effect size of the association between training level and app usage. This indicates the presence of other important factors, yet to be described, that determine whether physicians with smartphones are using apps in their medical practice. Further, these results can shed light on the adoption of technology by physicians and may motivate medical teaching institutions to educate their trainees on the appropriate way to incorporate new technology into medical practice.

The results from this study are not surprising. Prior reports focusing on smaller segments of the medical community suggest that the use of smartphones and apps are popular among providers. However, it also seems that the utility of apps differs between specialists. This is reflected by the variable use of apps among different specialists (Table 2), as well as those reported by other authors [9–11].

We feel that one major limitation that guides app use is their typical sales model. Most apps must be purchased in full before a user has a chance to try them out. As a result, potential buyers must rely on screenshots, user reviews, and brand loyalty to make their purchasing decisions. We suspect that one of the reasons that Epocrates has been so successful in accessing the physician market is a longtime marketplace presence ever since early versions in the early 2000s were available on the Palm device [13]. In addition, by offering free access for medical students, they have focused their advertising at the medical community's youngest members.

One contradiction found within the data was the fact that the most requested apps categories: reference materials, treatment algorithms, and general medical knowledge, are apparently already available from the app store in various formats. We believe the interpretation of this finding

Fig. 3 Categories of apps desired by smartphone users



consists of multiple conclusions. First, it seems that app developers recognize the desire for reference applications and have focused their efforts in this realm. However, the continued desire for more apps by physicians suggests that the reference apps currently available do not yet meet the needs of physicians, thereby leaving much room for improvement. User interface is of utmost importance for smartphone users, and merely porting all information from a textbook into a mobile version may not provide the optimal experience due to screen size or other restrictions. In addition, because physicians may not regularly search for apps and because apps are continuously updated, physicians may be unaware of the complete library of apps that are currently available. Lastly, many reference materials cost nearly as much as equivalent print versions; in order for an app to be successful in reaching common use by physicians, it

must be easy to use and reasonably priced. All of these reasons might explain the apparent mismatch between app availability and physician desire.

Despite the increasing popularity of apps, concerns exist regarding how the use of apps will influence future medical practice. No organizations or governing bodies currently exist to review or validate the content contained within these apps. While the FDA has considered regulating iPhones and apps as medical devices, this is not currently performed [14]. Although our results suggest that apps are widely used among US-based medical providers, the information contained within those apps may not be based on validated or peer-reviewed information. Considering the desire among providers for more apps, as well as the incentive for companies to sell apps for profit or marketing purposes, the availability of apps is likely to increase. Thus, providers must be aware of this significant limitation and potential liability when utilizing apps to make medical decisions. It will likely become the responsibility of physicians to self-regulate and self-educate regarding the appropriate and prudent use of apps in clinical practice.

We designed our study to examine app use among a specific population: providers and trainees at ACGME affiliated institutions and training programs. We assumed that this study population would be more likely to adopt new technologies, and thus our study was designed to increase the number of useful responses. In addition, by contacting ACGME programs via emails to program directors, we captured a broad and diverse population of potential respondents. However, we recognize the limitations to this study design. One limitation of this study is that the survey response rate is unknown. As stated in the methods, a variety of programs at 678 institutions were

Table 2 Most commonly used smartphone apps

Ranking	App Name	% of respondents reporting use
1	Epocrates	75
2	Medscape	17
3	MedCalc (medical calculator)	13
4	Skyscape Medical Resources	4
5	Lexicomp	3
6	BMI Calculator	2
7	Micromedex Drug Information	2
8	DynaMed	2
9	Citrix Receiver	2
10	Red Book	2

included in the study, resulting in a total of 8,353 emailed survey requests. Unfortunately, no method exists to reliably track the number of emails that were delivered, opened, deleted or forwarded. This is an unfortunate limitation of email-based surveys. A second limitation is the potential selection bias inherent in any form of subjective survey. We cannot control for the possibility that physicians with an interest in technology may have been more likely to complete the online survey. As a result, our results may be artificially inflated. However, these results appear consistent with other prior reports and the habits of users, as observed by the authors. Another limitation of our report was based in the app classification system we adopted to simplify and clarify the analysis. While some apps are easy to classify because they serve a single function, others are multifunctional and seem to fall into more than one category. For example, Epocrates contains drug information as well as some medical calculation tools. When this occurred, we selected the primary app function. In the case of Epocrates, it was classified as a drug reference app. While this redundancy in function for some programs may result in a decreased accuracy of reported app use, the reported trend for commonly used apps is likely still valid due to the large difference in reported use. In addition, there are some functions (such as pregnancy wheel calculations) for which many apps exist; it is thereby possible that some apps reported in the free response section should have fallen into one of the broader categories (drug reference, medical calculators, pregnancy wheels) but were instead only counted individually. A final limitation is that this study only examined the use of apps at academic medical centers and may not reflect trends among all physicians. As noted above, providers at teaching institutions may be more likely to be younger practitioners and “early adopters” of new technology, thereby inflating the prevalence of smartphone and app use. A larger, broader study focused on examining a cross-section of all practicing physicians may more accurately reflect the prevalence of app use nationwide. Nevertheless, the results from this report suggest that apps are widely used among practitioners in all specialties and these limitations should not minimize the concerns that exist regarding the validity of app content.

If current trends continue, smartphone and app use are likely to increase at an accelerated rate. App availability has exploded in recent years and we have shown that the desire

for more high quality apps is strong with much space for further development. We recommend that information such as that reported in this study be used to guide the development of forthcoming healthcare delivery systems and their integration with smartphone apps. The future will likely bring expanded app functionality but reliability and ease of use will likely remain major factors in determining the successful integration of apps into clinical practice.

Disclosures The authors declare that they have no conflict of interest.

Funding None.

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