Mobile Device Trends in Orthopedic Surgery: Rapid Change and Future Implications

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abstract

Mobile devices are increasingly becoming integral communication and clinical tools. Monitoring the prevalence and utilization characteristics of surgeons and trainees is critical to understanding how these new technologies can be best used in practice. The authors conducted a prospective Internet-based survey over 7 time points from August 2010 to August 2014 at all nationwide American Council for Graduate Medical Education–accredited orthopedic programs. The survey questionnaire was designed to evaluate the use of devices and mobile applications (apps) among trainees and physicians in the clinical setting. Results were analyzed and summarized for orthopedic surgeons and trainees. During the 48-month period, there were 7 time points with 467, 622, 329, 223, 237, 111, and 134 responses. Mobile device use in the clinical setting increased across all fields and levels of training during the study period. Orthopedic trainees increased their use of Smartphone apps in the clinical setting from 60% to 84%, whereas attending use increased from 41% to 61%. During this time frame, use of Apple/Android platforms increased from 45%/13% to 85%/15%, respectively. At all time points, 70% of orthopedic surgeons believed their institution/hospital should support mobile device use. As measured over a 48-month period, mobile devices have become an ubiquitous tool in the clinical setting among orthopedic surgeons and trainees. The authors expect these trends to continue and encourage providers and trainees to be aware of the limitations and risks inherent with new technology. [*Orthopedics*. 2016; 39(1):e51-e56.]

The recent development and widespread adoption of mobile Smartphones and tablet computers is fundamentally changing the paradigm for how medicine, and orthopedic surgery in particular, is taught and practiced.[1-7] Specifically, many medical schools and residency training programs now incorporate tablets in lieu of paper textbooks and use virtual simulators to teach procedures and operations.[8-10] The fervor surrounding these new devices and their unprecedented ability to store entire textbooks, images, and videos in a pocket-size form-factor is easily recognized.[2,11-14] However, as adoption rates increase and mobile devices integrate with the clinical realm, potential risks and liabilities of using applications (apps) are becoming apparent, resulting in numerous calls for regulation and peer review.[11,12,15-20] Critics have identified the potential risks as contamination, lack of medical oversight, potential violations of patient privacy, and concerns regarding "distracted doctoring" when using these devices.[21-24]

It has been estimated that 30% of American adults report musculoskeletal complaints at any given time, which may explain the opportunity recognized by software developers to create orthopedic patient-centered apps for musculoskeletal providers.[25,26] As a result, orthopedic sur-

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Table

Demographic Information About Orthopedic Survey Respondents

Respondent	No.						
	August 2010	April 2011	December 2011	August 2012	April 2013	December 2013	August 2014
Resident	319	333	213	128	125	47	83
Fellow	12	78	20	34	40	22	19
Attending <5 years	24	44	21	15	20	12	4
Attending 5-15 years	44	62	22	20	18	13	14
Attending >15 years	68	105	49	25	32	14	14
Total	467	622	325	222	235	108	134

gery stands out as a specialty with the greatest number of publications on the topic of mobile apps and app validation.[4,6,7,27-33] These apps span the spectrum from patient education, point-of-care reference, medical device and implant information, and physical examination education.[6,7] The authors believe that the trend toward increased clinical app use reflects technologic progress, but also poses several potential risks with regard to patient safety and orthopedic trainee education. No authors have yet quantified the current trends for orthopedic surgeons in mobile device adoption, examined provider-identified barriers and benefits to using mobile apps, and discussed the implications of these results in a changing educational climate. The current study was designed to quantify the trends of Smartphone, tablet, and app use among orthopedic providers.

This study specifically addresses these concerns by analyzing the responses from 7 prospective nationwide surveys that were designed to examine the use and opinions of orthopedic physicians and trainees regarding Smartphone and tablet app use in a clinical setting, as well as evaluate opinions and perspectives regarding appropriate institutional support of these devices. The authors also review the current literature as it pertains to the risks of app use and potential future regulation and provide recommendations for safe integration.

Materials and Methods

Data were collected anonymously and prospectively at 7 time points over a 48-month period from an institutional review board–approved national survey of all American Council for Graduate Medical Education (ACGME)–accredited residency and fellowship programs using a previously described methodology.[6,34] A novel, Internet-based, digital survey was developed to query respondents regarding their specialty, level of training, use of mobile devices, and use of mobile device apps (https://docs.google.com/forms/d/1Y7NZ75Q8tBvzYwiDYJ18jDaZC6vQ8FmeqlxF2e30T1w/viewform?formkey=dElCcmh0dFhyNE9HNjJNNHBERU9WZGc6MA&edit_requested=true). Once the digital survey design was complete, contact information in the form of e-mail addresses for all program directors and coordinators was obtained from the ACGME website. This included 118 program types among 678 institutions. The survey was then e-mailed 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 e-mails were subsequently sent 1 week apart to increase the response rate. The same survey technique was performed in August 2010, April 2011, December 2011, August 2012, April 2013, December 2013, and August 2014. Minor improvements and additions were made to each interval survey based on newly released products and trends. For example, tablet-specific questions were only included starting in August 2012 in response to the release of the new devices. The most recent version of the survey can be found at https://docs.google.com/forms/d/1Y7NZ75Q8tBvzYwiDYJ18jDaZC6vQ8FmeqlxF2e30T1w/viewform?formkey=dElCcmh0dFhyNE9HNjJNNHBERU9WZGc6MA&edit_requested=true.

Data were segmented based on respondent specialty and the following levels of training: resident, fellow, faculty with fewer than 5 years of practice, faculty with 5 to 15 years of practice, and faculty with greater than 15 years of practice. For this analysis, data were analyzed based on respondents who selected "orthopedic surgery" as their specialty vs all other specialties.

Data are reported as percentages. Pearson's chi-square tests for independence were used to examine associations between various survey parameters.

Results

Demographics

Surveys distributed in August 2010, April 2011, December 2011, August 2012, April 2013, December 2013, and August 2014 received 467, 622, 329, 223, 237, 111, and 134 orthopedic caregiver responses, respectively. Demographics of respondents across time points are shown in the **Table**. For the purposes of reporting trends, resident and fellow respondents are referred to as trainees, and attendings of all levels of experience are grouped together.

Smartphone Use

Over the past 4 years, there has been rapid increase in the number of providers

with Smartphone devices. For orthopedic trainees, Smartphone use increased from 61% in 2010 to 100% in 2014 and attending use increased from 52% in 2010 to 100% in 2014. The percentage of trainees who use Smartphone apps within their practice has steadily increased from 59% in 2010 to 84% in 2014, whereas attendings use increased from 41% to 62% during 2010-2011 and then maintained rates around 55% to 60% through 2014 (**Figure 1**). Chi-square results demonstrated a statistically significant difference between trainees and attending (all *P* values <.01), as well as among attendings when separated by years in practice (all *P* values <.01) (**Figure 1**).

Device brand was characterized at each time point. Together, Android and Apple device use accounted for 59% of Smartphones used by orthopedic surgeons as of the 2010 survey. Apple remained the most dominant Smartphone platform and increased from 46% in 2010 to 86% in 2014, and Android, the second most popular Smartphone operating system, remained relatively constant at 15% to 20% (**Figure 2**).

The categories of Smartphone apps found most useful did not change during the study period. The top 5 apps that are most desirable included the following: classification/treatment (27%), textbooks/reference (32%), coding and billing (34%), Orthopaedic In-Training Exam/board study material (28%), and technique guides (35%).

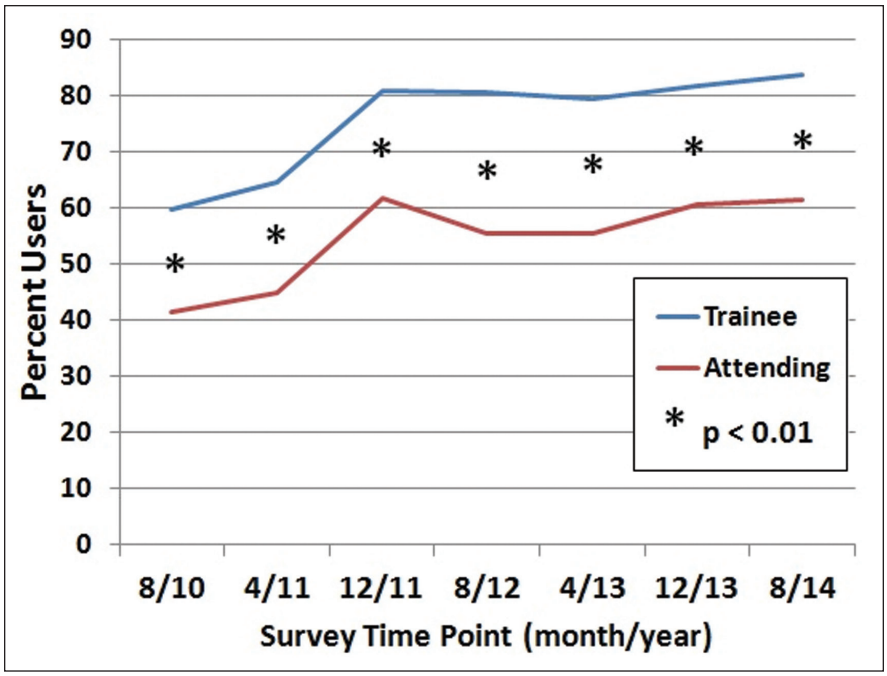

Figure 1: Line graph showing the respondent prevalence of Smartphone use from 2010 to 2014.

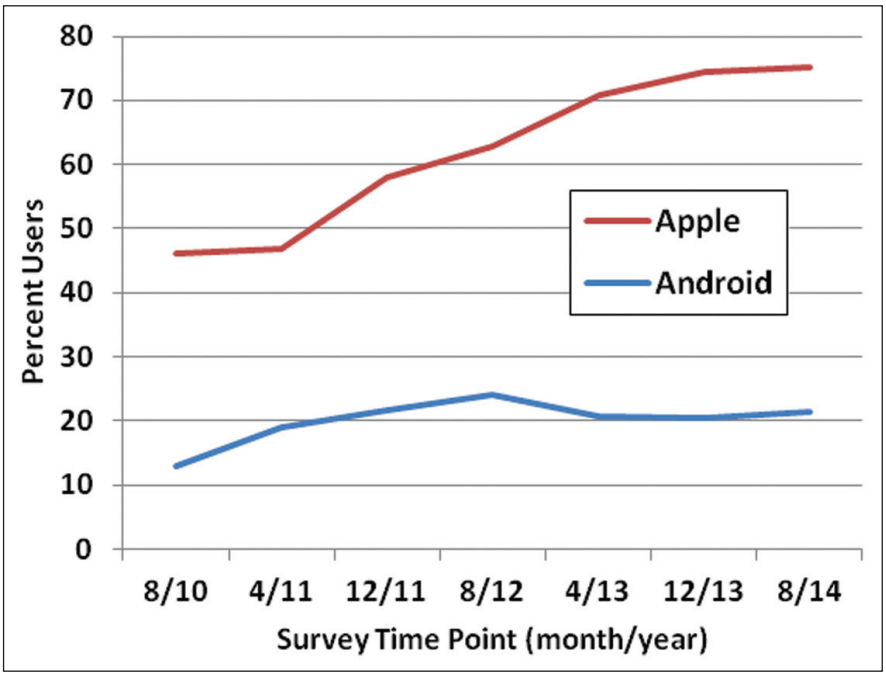

Figure 2: Line graph showing the Smartphone operating system prevalence from 2010 to 2014.

Tablet Use

Information regarding tablet ownership and use was collected from December 2011 through August 2014. During this interval, tablet ownership increased from 64% to 93% among orthopedic trainees and remained steady at approximately 65% for orthopedic attendings. The majority of trainees and attendings use an Apple device, with a penetration of approximately 90%. During this same period, trainees' use of tablets for medical decisions ranged from 43% to 51%, whereas attendings' use ranged from 31% to 39% (chi-square results *P*<.01 at all time points). In August 2012, only 15% of respondents reported that all or most of their tablet apps were peer reviewed, whereas 45% did not know how many were; the remainder selected "none," "less than half," or "about half" being peer reviewed.

Interaction of Mobile Devices and the Practice of Orthopedics/Medicine

In December 2011, the authors started collecting information asking survey responders about their concerns with using mobile devices. Most surgeons (91% to 95%) believed that their hospital/institution should support Smartphone use. However, when asking orthopedic surgeons whether their hospitals/institutions actually supported mobile devices in the clinical setting, only 50% responded positively in 2014.

In addition, between 2011 and 2014, an average of 70% believed that medical schools should incorporate mobile/tablet training in clinical education. Between December 2011 and August 2014, only an average of 46% of trainees and 31% of attendings thought that mobile computing was likely to improve patient interactions. However, between December 2011 and August 2014, an average of 87% of trainees and 58% of attendings believed that mobile computing allowed them to be a better physician.

Obstacles to mobile device use included a lack of funds (49%), security concerns (45%), and a lack of institutional support (33%). In contrast, concerns regarding peer review and validation of apps as a primary obstacle to device integration only accounted for 9% of orthopedic respondents. Interestingly, a lack of value or benefit and a lack of interest by providers was only mentioned by 7% and 9%, respectively, of all respondents as an obstacle to adoption, suggesting a high level of acceptance among physicians in the United States. These data were unchanged over the prior 2 years.

In August 2012, only 27% of respondents reported that all or most of their Smartphone apps were peer reviewed, leaving 73% of respondents primarily using apps without confirmed validity or review.

Discussion

The results from this study definitively establish the increasing trend toward mobile app use in the orthopedic clinical setting in academic training programs. Respondents suggest that mobile app use is considered valuable and improves the delivery of medical care but falls short of adequate institutional support and peer review. The current authors believe that app regulation is imperative to ensure appropriate physician training and patient safety.

The current study had several limitations. First, this was an e-mail survey and assumes the inherent limitations of this design. Because the number of surveys ultimately sent and opened was not able to be tracked, a reliable response rate cannot be reported. Second, there is the potential for respondent bias among physicians who are already technologically savvy and thus are more comfortable with completing surveys via e-mail, although the authors contend that nearly all practicing physicians are comfortable with e-mail use. Third, the survey distribution was exclusively provided to ACGME-accredited training programs. Most of the programs are at centers of education and advancement and may not reflect the general orthopedic population. Thus, it is possible that the numbers may overestimate the actual implementation of mobile technologies nationwide. Fourth, the authors note that there was an attrition of respondents over time, possibly due to survey fatigue; however, due to the study design, there is no way of tracking whether the participants were the same or unique survey responders.

The use of mobile apps is part of the "mHealth" movement, defined by the World Health Organization[35] as the "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices." Previous research has predicted that 81% of physicians would be using Smartphones by 2012[11]; however, previous clinical surveys have already demonstrated adoption rates upward of 85% by mid-2011.[34]

The current results reveal that Smartphone clinical app use in orthopedics is 84% among trainees and 60% among attending providers (**Figure 1**). With evidence to demonstrate the potential for benefit, physicians must also be aware of the inherent risks and limitations associated with the rapid adoption of these yet unregulated tools.[12,19,20,36] The potential for mobile devices to result in patient harm has been documented with regard to bacterial contamination,[37-38] smoking promotion and poor guideline adherence,[18] and lack of physician involvement in app development.[16,20,36,39]

In addition, the current results demonstrate that only 27% of providers use a majority of peer-reviewed or validated apps, further increasing the potential for harm. Although Smartphone and tablet use has increased across all fields and levels of training, current orthopedic trainees have demonstrated the greatest increase in this regard, with impressive increases from 50% to 84% in clinical Smartphone use over 48 months and from 60% to 90% in clinical tablet use over 24 months. With this brisk growth, orthopedic trainees in particular must be especially cautious when integrating app use into practice due to its high prevalence and low rates of validation.

In the current study, a majority of respondents believed that mobile device use made them better physicians. Answers relied significantly on the level of training, which may be explained by the greater foundation of knowledge among more experienced surgeons and therefore less reliance on point-of-care references. Other factors may include a greater receptiveness toward new technology and/or a greater ease of incorporating this new technology in the younger cohort.[40] Thus, the adoption of mobile technologies may mirror previous findings of physicians closer to their training and further from retirement being able to more readily adopt new medical/surgical procedures.[41] However, only 46% of trainees and 31% of attendings believed that mobile computing was likely to im-

prove interactions with patients, alluding to a relevant concern that technology may cause physicians to be less engaged with patients.

Within orthopedics, the most desired apps over a 2½-year sampling have been consistent and included both educational (eg, textbooks/references and techniques guides) and clinical (eg, coding/billing and in-training/board studying) categories. This compares favorably with a survey of young doctors in the United Kingdom that revealed app use for both clinical and procedural purposes.[3] Thus, app use has the potential to concurrently improve patient care and physician quality of life.

On average, 70% of respondents support an incorporation of mobile device training into the current medical school curriculum. Over the past few decades, many curricula have evolved to teach critical review skills for the interpretation of evidence-based medicine, as well as proper online literature database search skills to obtain the strongest, most relevant, and most up-to-date results. Subsequent studies have predominantly revealed the success of such programs.[42-44]

A similar need now exists for mobile device education. For example, a recent survey of third-year medical students found a relatively low degree of agreement over whether various hypothetical Smartphone-related scenarios presented a serious privacy/security concern[45]; this represents an opportunity for education. The current findings suggest a similar opportunity on the subject of peer review and validation. The authors have demonstrated that assurance of peer-reviewed or validated material was only a priority for a minority of respondents, whereas 45% of orthopedic tablet users did not even know the validation status of their apps. Despite not knowing this information, only 9% of orthopedic respondents quote peer review/validation as a major obstacle to mobile device use. Thus, a large divide exists between the rate of nonvalidated app use (>50%) and the recognition of lack of validation as a major obstacle to clinical use (<10%). This highlights the potential danger that mobile device apps may pose in the dissemination of inaccurate medical information without proper education.

In the current study, respondents identified the most substantial obstacles to mobile integration as matters of feasibility (eg, security, cost, institutional support) rather than a lack of value, benefit, or interest. The majority of respondents believed that their institutions/hospitals should encourage and support clinical mobile device integration, whereas only half of respondents believed that this support was currently being provided.

As security improves, costs decrease, and institutional support increases, one should expect mobile device use to continue to increase dramatically. In addition, as trainees matriculate and establish their own practices, any current issues surrounding mobile device use in orthopedics will only be magnified. As such, it is paramount to recognize the potential risks and benefits of such devices to anticipate and mitigate any potential liabilities early on in this evolution.

The call for increased regulation of apps has been well documented in the literature,[12,16,19,20,36,37,46] and there exists the recognition that established organizations such as the US Food and Drug Administration (FDA), the Australian Therapeutic Goods Administration, and the International Federation of Clinical Chemistry may be unable to manage this task.[11] Although the FDA has taken early steps by proposing draft guidance in July 2011 for the development of medical apps, not all apps will be regulated and how these recommendations will be enforced remains unknown.[12,47]

The trends toward increased mobile technology use, as reported here, will likely continue. Orthopedic surgeons, trainees, and app developers have already identified musculoskeletal injuries as a prominent subject that presents a great opportunity for the development of apps to improve patient care and to streamline many of the arduous tasks of a busy surgeon. However, with new technology comes responsibility, and regulatory bodies are too large and too slow to regulate content. Thus, physician educators must work toward adapting current institutional regulation and education for safe and proper use of these apps. As such reforms occur and barriers to use dissipate, mobile devices will continue to forge a substantial role into the daily life of an orthopedic surgeon. The authors hope that the orthopedic community will embrace this change and work together to maintain appropriate resident education and patient safety.

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