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## Exploring the impact of tablet computers on medical training at an academic medical center

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### INTRODUCTION

Medicine trainees generate numerous clinical questions while caring for patients [1], but there are many obstacles to answering those questions, including lack of adequate training in where to find the answers, poor access to resources, and a nonsupportive culture [1–3]. Online retrieval systems can improve the quality of answers to questions [4] and can impact patient care decisions [5]. To find ways to improve access, many studies have investigated the role of mobile devices [6–11]. Tablet computers offer an improved user experience with better screen resolution, fast processing, and improvements in mobile web and application (app) design [12]. This exploratory study set out to determine whether using a tablet computer, preconfigured with medical resources, could enhance satisfaction for learners and improve access to educational resources during inpatient hospital rotations.

The study examined learner satisfaction and use of tablet computers, specifically the Apple iPad, loaned to patient care teams at a university hospital. The iPad was chosen because of early indications that it would be widely adopted by trainees and the ease with which it provides access to resources. The device can allow access to medical calculators, texts, journals, patient education materials, and patient information systems; however, tablets also require training, which could hinder

adoption and satisfaction. In addition to measuring the tablet experience, the study compared users to a control group who received supplementary education about computer-based resources for patient care.


### METHODS


#### Setting and study design

The study, which was approved by the Duke University Health System Institutional Review Board, took place over eight weeks in November to December 2010 and involved four patient care teams from the general medicine teaching service at Duke University Hospital. Teams were selected by the medicine chief resident, who was not part of any study team. Each team included an attending physician, one senior resident physician, and two first-year resident physicians (interns). Three of the teams included one or two medical students. Additionally, one assistant chief resident was included in the study because he played an active role in shaping the educational experience of users in the study. The teams were randomized using a random number generator into the two arms of the study: the tablet arm, which included two teams that received iPads and training in both device operations and in computer-based educational resources, and the computer-based resource arm, which included the other 2 teams that received only the computer-based educational resource training (Table 1, online only).

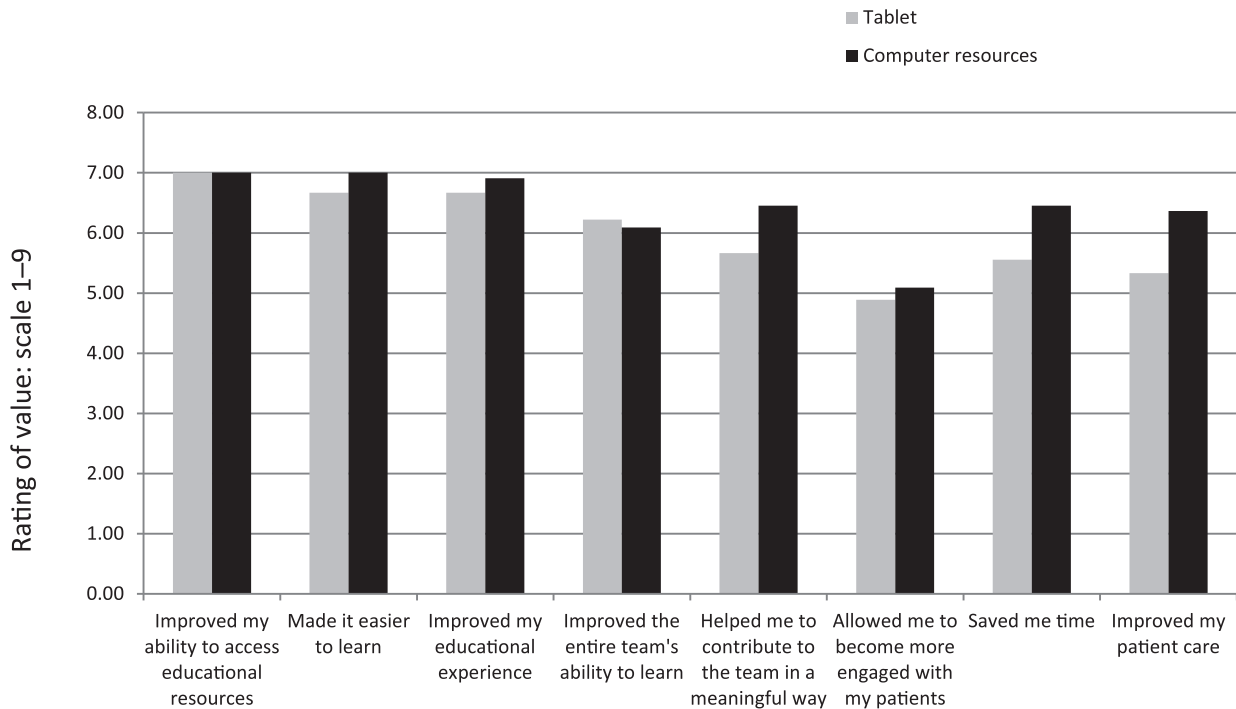
Before tablets were distributed, the medical librarian configured the devices with a preselected list of apps and shortcuts to websites, including the library's Clinical Tools page, which provides access to numerous information sources, and MedHub, which is a graduate medical education (GME) administrative tracking site frequently used by residents. Most of the apps were free, and two were purchased: Papers, which organizes portable document format (PDF) files, and Pages, which is an iPad-specific word processing program. Two publishers, Modality and Skyscape, granted free trial access to some resources for the study duration. Modality apps included those for studying for the US Medical Licensing Examination (USMLE), procedure videos, and anatomy atlases, while Skyscape included textbooks such as the *Harriet Lane Handbook*, *5-Minute Clinical Consult*, and *Harrison's*. While no money was made available to participants for downloading additional apps, no restrictions were made on participants purchasing and downloading their own apps during the project. Included among the free apps was Citrix Receiver, which provided secure access to the hospital's electronic medical records and other patient information systems.

Due to varying team member schedules, participants received tablets a few days before the teams came together. This time allowed individuals to become comfortable with the devices before they began on service. The study began with training sessions for mixed groups of participants from each study arm. The sessions featured thirty minutes of training on computer-based resources (e.g., DynaMed,

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 Supplemental Table 1, Figure 2, and Appendixes A, B, and C are available with the online version of this journal.

**Figure 1**  
Final survey: satisfaction by tablet cohort versus computer resources cohort



BMJ Point of Care, and Clinical Pharmacology). Members of iPad teams also received an additional thirty minutes of training on iPad operations, including how to set up email, an overview of apps, and how to access patient care systems. Participants in the iPad arm were given a white coat with a custom iPad-sized pocket sewn on the inside to facilitate carrying the device. There were no restrictions on what computer-based resources could be used by either group during the survey.

All participants were asked to complete an initial survey about their use of computer-based and mobile device-based educational resources and their expectations of either the resources or the iPad. Then, eight weekly surveys were sent to each participant. All members of the study who completed six out of eight weekly surveys were entered into a drawing to win one of two iPads. A neutral third party administered these surveys to ensure confidentiality. Study surveys are included as online only appendixes. At the conclusion of the study, participants from the iPad arm were invited to an informal feedback session to share qualitative experiences with the devices.

### Measures of interest

Primary measures included: (1) comparison of user satisfaction with the tablet or computer resources for the tablet and computer-based resource groups on a nine-point scale, (2) analysis of the effect of prior experience with mobile technology on user satisfaction, and (3) analysis of trends in use of the tablets. To

identify prior experience levels, the study designated participants in the tablet arm as either "early" or "late" adopters, depending on whether they fell above or below the group mean on any of three baseline prior experience questions.

To compare the user satisfaction of the tablet group against the computer-based resource group, the authors received assistance from a statistician who used the Wilcoxon rank-sum test, which compares groups on the mean of their ranked scores [13]. This statistical test was done on the satisfaction questions from the final surveys for both groups, and the data are reported in Figure 1.

### RESULTS

Composition of the 2 cohorts was similar with respect to role (Table 1, online only). There were no significant differences in prior experience with use of computer-based medical resources, mobile medical resources, and mobile nonmedical resources. In both groups, over 80% of participants (9 out of 11 in the computer resources group and 8 out of 10 in the tablet group) reported using computer resources once or more per day. Similarly, over 35% of participants (4 out of 11 in the computer resources group and 4 out of 10 in the tablet group) reported using medical resources on a web-enabled handheld device once or more per day. Finally, over 55% of participants (6 out of 11 in the computer resources group and 6 out of 10 in the tablet group) reported using nonmedical resources on a web-enabled handheld device once or

more per day. One medical student declined to participate prior to study initiation.

### Satisfaction

The final survey revealed no significant differences across 8 different measures of learner satisfaction between tablet users and those referencing resources at the desktop workstation (Figure 1). The measures of learner satisfaction included: access to educational resources ( $P=0.844$ ), ease of learning ( $P=0.492$ ), improved educational experience ( $P=0.702$ ), team's ability to learn ( $P=0.848$ ), ability to contribute to the team ( $P=0.365$ ), patient engagement ( $P=0.970$ ), improved time saving ( $P=0.349$ ), and improved patient care ( $P=0.3846$ ). The authors observed that tablet users were more satisfied with the tablet in the areas of access to educational information and improved educational experience (measures 1–3) than they were in the device's ability to improve interactions with patients, save time, or improve patient care (measures 6–8). In the tablet group, those identified as early adopters reported greater satisfaction on every one of the 8 satisfaction measures compared to late adopters (Figure 2, online only). The median overall satisfaction rating for early adopters was 6.25 and for late adopters 5.7 (median difference=0.55; range=0.3–0.65). The difference was not statistically significant.

### Trends in usage

Usage data were self-reported. Among tablet users, individuals reported using a combination of apps and websites during the study, representing a mixture of resources that were highlighted during the training and others discovered individually. For tablet users, the tools reported most frequently used overall were PubMed and the library's Clinical Tools website [14]. For computer-based resource users, the tools reported most frequently used overall were PubMed and DynaMed (UpToDate was not available institutionally at the time of the study). These online resources are commonly used and promoted across the medical center during orientations and training sessions, and likely have the lowest learning curve of any of the available apps or online resources. For the tablet group, the third and fourth most commonly used resources were apps: MedCalc and Skyscape, an app which contained a set of well-known textbooks. For the computer-based resource group, the third and fourth most commonly used resources were UpToDate, presumably through personal subscriptions, and Clinical Pharmacology.

### Qualitative comments

During the feedback session for tablet users, participants commented that they found the device especially appealing when looking to access educational information for patient care because they could access the content quickly. One resident noted the tablet was most beneficial during teaching conferences, because

it enabled easy access to information that augmented his educational experience.

Comments also reflected barriers to integrating the device into the daily clinical workflow. Just carrying the device was cumbersome, and the teams worried about theft. In general, desktop computers at Duke University Hospital are ubiquitous and easier to use for patient information systems, minimizing the need for the tablet. Many users reported technical problems and usability difficulties with data entry into patient information systems through Citrix Receiver, as the medical center's information systems were not optimized for touch screen and tablet access. Participants reported that wireless connectivity was available throughout Duke University Hospital; however, connections could be dropped if users moved between floors or "too quickly" while using the device. If an off-campus clinical location, such as the VA hospital, did not offer wireless connectivity, then many apps and all websites were inaccessible.

### DISCUSSION

Tablets are affordable and present an opportunity to interact with electronic information in novel ways. As devices improve, the opportunity to integrate them into our daily practice is appealing. Surprisingly, the study shows that clinician and learner satisfaction might not be improved by the simple addition of tablets into daily workflow.

This study is not in opposition to other literature on handheld computers. Similar to other studies [9, 11], this study found that medical references, drug references, and medical textbooks were the most popular uses for tablet computers. The current study, however, also showed high usage of PubMed and other web-based clinical resources, likely due to the larger screen size and more consistent display of websites on tablets as opposed to personal digital assistants (PDAs). While the study failed to show increased satisfaction in using tablets over computer-based resources, it should be noted that most other studies evaluating usage of and satisfaction with handheld computers did not compare these tools against resources accessed on a desktop [7, 9, 11]. By comparing iPads against easily accessible and familiar resources on desktop computers, the burden of proof was higher in this study.

This study has limitations, perhaps the most significant are the small sample size and the study's short duration. It is not always feasible to hand out dozens of devices for exploratory studies, and this meant our sample size was low. During and since the study, there have been important upgrades to the tablet operating system and the app for accessing patient information. While this is true for any study evaluating devices and applications, it does make it difficult to extrapolate results to a different time when new applications and features, such as multitasking, are available. The short duration also made it difficult for participants to integrate the devices into their

workflow; integration requires dedication. Because devices had to be returned at the end of the study, participants may not have expended the necessary effort to incorporate the device into their clinical practice.

Our exploratory study did not show that tablets offer improved user satisfaction among physicians and learners at Duke University Hospital. Further studies should continue to explore the role of tablets in clinical medicine with larger numbers of participants for additional statistical power. The study did uncover potential barriers that should be considered by institutions contemplating tablet implementations: feasibility of carrying the device in insecure environments, wireless inconsistencies, and accessibility and usability of electronic medical records on the touch screen. Ideally, access to clinical systems should be tailored for use on handheld devices so that the availability of educational resources can be coupled with improved efficiency of daily clinical responsibilities [15].

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