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Jason J. Saleem
University of Louisville, jason.saleem@louisville.edu

April Savoy
Richard L. Roudebush VA Medical Center

Gale Etherton
VA Nebraska-Western Iowa Health Care System

Jennifer Herout
Veterans Health Administration

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Investigating the need for clinicians to use tablet computers with a newly envisioned electronic health record

Jason J. Saleem[a,b,*], April Savoy[c], Gale Etherton[d], Jennifer Herout[e]

[a] Department of Industrial Engineering, University of Louisville, Louisville, KY, USA
[b] Center for Ergonomics, University of Louisville, Louisville, KY, USA
[c] Center for Health Information and Communication, Health Services Research and Development Service, Richard L. Roudebush VA Medical Center, Indianapolis, IN, USA
[d] Department of Internal Medicine, VA Nebraska-Western Iowa Health Care System, Omaha, NE, USA
[e] Human Factors Engineering, Health Informatics, Office of Informatics and Analytics, Veterans Health Administration, Washington, DC, USA

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ABSTRACT

Objective: The Veterans Health Administration (VHA) has deployed a large number of tablet computers in the last several years. However, little is known about how clinicians may use these devices with a newly planned Web-based electronic health record (EHR), as well as other clinical tools. The objective of this study was to understand the types of use that can be expected of tablet computers versus desktops.

Methods: Semi-structured interviews were conducted with 24 clinicians at a Veterans Health Administration (VHA) Medical Center.

Results: An inductive qualitative analysis resulted in findings organized around recurrent themes of: (1) Barriers, (2) Facilitators, (3) Current Use, (4) Anticipated Use, (5) Patient Interaction, and (6) Connection.

Conclusions: Our study generated several recommendations for the use of tablet computers with new health information technology tools being developed. Continuous connectivity for the mobile device is essential to avoid interruptions and clinician frustration. Also, making a physical keyboard available as an option for the tablet was a clear desire from the clinicians. Larger tablets (e.g., regular size iPad as compared to an iPad mini) were preferred. Being able to use secure messaging tools with the tablet computer was another consistent finding. Finally, more simplicity is needed for accessing patient data on mobile devices, while balancing the important need for adequate security.

1. Introduction

Handheld computers have for a long time held tremendous potential for improving communication, facilitating information access, and enhancing clinical workflow [1,2]. More recently, handheld computers, such as tablets, have become much more accessible in clinical care settings within urban and rural healthcare organizations [3]. A recent survey found that more than half of providers perceive the use of a tablet computer as having a positive effect on the following: patient communications, patient education, patient's perception of the provider, time spent interacting with patients, provider productivity, process of care, satisfaction with the electronic health record (EHR) when used together with the device, and patient care in general [4]. A study in the emergency department setting found that clinical use of a tablet computer was associated with a reduction in the number of times physicians logged into and used the EHR via a desktop computer workstation [5]. Another study focused on outpatient settings revealed that the use of tablet computers in the exam room was perceived positively by most patients [6]. On the inpatient side, one study found that implementation of iPads was associated with improvements in perceived and actual efficiency for resident physicians [7]. Another study showed that despite having read-only access on iPads, physicians were generally satisfied using iPads on ward rounds as a tool to access patient information [8]. Given the positive potential of tablet computers in clinical care settings, the Veterans Health Administration (VHA) recently deployed iPads at several VHA Medical Centers as part of a program known as the Mobile Health Provider Program.

The VHA's Mobile Health Provider Program is designed to equip VHA health care teams with mobile technology to enhance the way they deliver health care to Veterans. The program includes iPads, which enable care team members to access critical information whether they are at a clinic, in the local community, at a patient's home, or working remotely. Since being launched in 2014, VHA has issued iPads to more than 12,000 care team members at more than 60 VA sites. Anecdotally

* Corresponding author at: Department of Industrial Engineering, J.B. Speed School of Engineering, University of Louisville, Louisville, KY, USA.
E-mail address: jason.saleem@louisville.edu (J.J. Saleem).

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reported barriers and limitations to date have included: (1) lack of released VA-developed apps; (2) issues with typing on the iPad due to not having a physical keyboard; (3) using a small screen size to work in the EHR; and (4) the EHR frequently logging out and forcing the user to log in several times. The VHA is releasing a series of internally developed mobile apps that are designed to allow for access to real-time EHR data to inform clinical decisions. Other internally developed apps are designed to enable care teams to write progress notes, enter orders and support specific workflows. Examples of apps include: (1) Image Viewing Solution (diagnostic medical image viewing capabilities); (2) Patient Viewer (accessing read-only data from the patient's EHR); and (3) Scheduling Manager (sending messages about appointments and scheduling to patients who are using a corresponding app).

Use of the iPads through this program, however, has been limited to date due to a lack of currently available and clinically relevant VHA applications built specifically for the iPad's iOS platform and the requirement to go through the Citrix Access Gateway (CAG) to access the VHA's EHR. One purpose of this study was to better understand why there was a low rate of iPad adoption, including barriers to use. However, our main objective was to understand expected variations in use among tablet computers and desktops when relevant mobile applications and a single sign-on portal are fully implemented.

2. Methods

We conducted an investigation at one of the VHA Medical Centers where iPads had been deployed. We used semi-structured interview technique to explore the current and anticipated use of tablet computers with a sample of clinicians across multiple care settings. The legacy EHR, Computerized Patient Record System (CPRS), is still currently in use at all VHA Medical Centers, including the one in this study, with plans to transition to a new EHR.

2.1. Participants

Twenty-four (24) clinicians participated in the study. They had an average of nine years of experience with the Department of Veterans Affairs (VA). Their clinical backgrounds were: eight physicians, three nurse practitioners (NPs), three pharmacists, six registered nurses (RNs), two licensed practical nurses (LPNs), one medical assistant (MA), and one social worker. They represented the following services: eleven from primary care, two from home-based primary care, five from inpatient care, two from telehealth, one from rehabilitation, one from surgery, one from mental health, and one clinician who was part of administration/risk management.

2.2. Semi-structured interviews

The purpose of the semi-structured interviews was to formally interview as many clinicians as possible from different services to understand expectations for mobile device use in care settings. The development of the semi-structured interview guide (Table 1), including the prompts, were informed by relevant literature on mobile technology use in other hospital settings, where clinically relevant tasks were currently executed with mobile devices [7–11]. The semi-structured interviews provided the flexibility for the interviewer (JS) to ask related, follow-up questions on particular topics of interest, while also providing the same set of core questions for each participant. All interviews were audio recorded and transcribed for analysis.

2.3. Analysis

Data analysis for the interview data followed an established process of upward abstraction of qualitative field data [12,13], where the data are represented at a higher level of abstraction such that the data can be integrated across participants to show recurrent patterns related to the objectives of the study. An inductive coding strategy was used by the first author (JS), (i.e., allowing codes to emerge from the data rather than using a pre-determined coding scheme) with an independent audit of all coding by a co-author (JH). This type of auditing procedure by a second analysist is considered an acceptable alternative to using independent coders for ensuring validity of the analysis [14]. Coding included a primary code and secondary code to further categorize each data point. A series of consensus calls to review the coding were held by two authors (JS and JH) to resolve questions raised by the coding audit. After the coding of all data from each of the 24 participants was finalized, the first author performed a secondary analysis of sorted subcodes for each primary code. In other words, for the primary code 'Barrier', the first author then summarized the different types of barriers as sub-codes under this primary code.

3. Results

Findings are organized around the following recurrent themes: (1) Barriers, (2) Facilitators, (3) Current Use, (4) Anticipated Use, (5) Patient Interaction, and (6) Connection.

3.1. Barriers

Barriers included connectivity, time to access CPRS, typing/keyboard, and screen navigation/screen size. Each one is described in detail.

3.1.1. Connectivity

Fourteen (14) data points related to connectivity issues when using mobile devices. Participants described experiences where the Citrix Access Gateway (CAG) connection needed for the iPad to access CPRS often dropped or timed out. In addition, participants noted loss of Wi-Fi signal or insufficient Wi-Fi, such as "dead zones" within the hospital. The amount of time needed to stay signed into CAG is not consistent with actual clinical work. For example, clinicians may sign into CAG to view patient data before seeing the patient and then engage in a patient interview. However, by the time the patient interview has concluded, the CAG connection has timed out. This slows the clinicians down and makes their tasks more arduous, having to sign back in to complete their clinical work, or in some cases to start over because their work was lost.

3.1.2. Time to access CPRS

Sixteen (16) data points related to time to access patient data in CPRS. The need for multiple sign-ons, Personal Identity Verification (PIV) card requirement, and MobilePASS all contributed to frustration with the time required to access patient data during patient care tasks. The VA now requires a two-factor authentication for logging in. This two-factor authentication requirement is not standardized in the healthcare community, although it is considered to be a best practice for protecting information. Assuming two-factor authentication becomes a healthcare standard, other healthcare organizations may experience similar frustrations from clinicians with regard to the time to access patient information.

3.1.3. Typing/keyboard

Twenty (20) data points related to typing or using the keyboard with a tablet computer. Clinicians expressed that a virtual keyboard with the iPad is insufficient; a real, physical keyboard is needed for clinical documentation. Clinicians cited having a physical keyboard as a major advantage to using a laptop instead of a tablet. The lack of a physical keyboard prohibited any type of substantial clinical documentation for most users. However, some noted that an iPad was useful for looking up patient information and checking email. One participant bought a case for his VA-issued iPad mini with an integrated keyboard using his personal funds. When he opens the case, the device

Table 1
Semi-structured interview guide.

Questions	Prompts, if needed*
1. Do you currently use a tablet computer or other mobile devices for clinical tasks or support?	(for barriers)
If yes, how often and in what ways?	Lack of appropriate or useful applications available for download?
What mobile apps do you currently use?	Lack of integration with VA information systems?
What are the barriers to you using it?	Information security and privacy concerns?
If no, was a tablet computer offered to you for official VA use?	Tablets may contribute to hospital infections?
2. Do you feel that a tablet computer or other mobile devices would enhance or interfere with clinician-patient interactions? Why?	(none)
3. Assuming the desktop computer and CPRS and all other applications would still be available to you, if you were to also use a tablet computer, what type of future clinical applications or uses would be helpful to you for the tablet?	Showing images or graphs to the patient?; Showing patients a list of their current medications?; CPRS access?; Ordering medications or procedures?; Point of care references (e.g., Up-To-Date, medical journals, textbooks)?; Patient education?; Real-time data capture?; Bedside treatment algorithms (inpatient)?; Handoff review?; Rapid response (inpatient, ER)?
4. Can you think of any other potential advantages to using a tablet computer or other mobile device during your clinical work?	Better integration of computing into your clinical workflow? Efficiency?

* Prompts were used as needed when the participant wanted clarification or examples for a given question.

looks more like a mini laptop, with the screen up and the keyboard integrated in the bottom of the case. He found the iPad much more usable with the physical keyboard.

3.1.4. Screen navigation and screen size

Thirteen (13) data points related to screen navigation (10) and screen size (3). Navigating CPRS on an iPad via a CAG connection is challenging. This was even more apparent with the iPad mini. Three out of nine participants who were assigned an iPad mini noted that they would prefer the larger screen of a regular iPad compared to the iPad mini. Future applications that are intentionally designed to be used with a tablet may alleviate this problem. CPRS was not designed specifically for use on mobile devices.

3.2. Facilitators

Three facilitators for tablet use related to the portability, weight, and efficiency of the device. Six (6) data points related to portability, including clinicians liking the ability to easily take the device with them anywhere as well as being able to take the device to the patient to show the patient information. One physician administrator highly valued the ability to take the iPad into long meetings he was "stuck" in so that he could access CPRS and get work done. Three (3) data points related to the light weight of the iPad as being an advantage compared to other portable devices: laptops and computer on wheels (COWS). Finally, four (4) data points related to efficiency; three of which referred to entering orders while rounding using the iPad.

3.3. Current use

Current use of the iPad was very limited. Clinicians used it to access CPRS, to check email, for patient education (showing videos), for sharing information with the patient (showing images, graphs), for ordering, for very isolated cases of documentation (starting a progress note), and for video conferencing (telehealth). When clinicians access CPRS through an iPad, they are primarily using it to view patient information (all parts of CPRS − notes, labs, medication list, etc.), rather than to document. Although the VHA has a mobile application specifically designed for viewing patient information, no one in our sample was using it because they did not seem to be aware of its existence. Five (5) clinicians specifically noted that they use a VA-issued iPad for email (mostly VA email for work-related tasks).

3.4. Anticipated use

There was a large number of data points related to anticipated use of the iPad and mobile devices in general. In other words, barriers to using the iPad or lack of available clinical apps prevented clinicians from using the iPad in ways they wanted or envisioned. The following describes all the ways clinicians could anticipate using the iPad and other mobile devices.

3.4.1. Sharing information with patients; patient education, and images

Twenty-three (23) data points related to sharing information with patients, including eight (8) that specifically related to showing images to the patient with the iPad, such as radiology pictures. Patient education was mentioned fifteen (15) times. Clinicians mentioned sharing videos with the patient, showing them a simplified version of their medication list, and showing charts (graphs). One clinician noted that the VA has developed a YouTube channel that shows patients how to give themselves injections, how to take certain medications, etc., and so using the iPad for this purpose is very useful. The form factor of the iPad (size, weight, portability) affords this type of positive patient interaction and information sharing.

3.4.2. Handoffs, check-out, and printing

Several (5) clinicians talked about how the iPad could be useful as a handoff tool. Clinicians thought the iPad could be used during a handoff review. One participant noted that the entire iPad could be handed off as part of the handover, not just using it to review patient information together during the handoff review. Several data points (4) also related to the potential usefulness of the iPad for patient checkout. For example, one primary care nurse noted that it would be useful to complete the check-out order with the iPad, link the iPad to a printer, and then print the checkout paperwork for the patient; this would be easier than having to leave the patient, complete chart where there happens to be an available desktop, and then come back to the patient. Four (4) clinicians expressed a desire to be able to print from a tablet computer to print lab results, computerized tomography (CT) scans, and up to date medication lists.

3.4.3. Medication list/medication reconciliation

Eight (8) data points related to use of the iPad for viewing medication lists or performing medication reconciliation. One clinician thought using an iPad would be useful for conducting a medication review with the patient. Another clinician thought medication reconciliation would be much easier on a tablet versus taking two or more lists from other sources and comparing them. In either of these cases,

clinicians envisioned an app designed to help present a simplified medication list to the patient or to help with presenting lists side by side for medication reconciliation (e.g., inpatient vs. outpatient). One clinician emphasized that the medication list should be interactive, with the ability to add/subtract medications on the list and create medication orders through the interactive list.

3.4.4. Ordering

Eleven (11) data points related to ordering on an iPad, with nine (9) of them specific to ordering while rounding on the inpatient wards. The ability to enter orders in real-time during rounds, without having to wait until being back at a desktop, or without having to push around a large "computer-on-wheels", was seen as a tremendous efficiency advantage. In addition to being efficient, one clinician noted that entering orders using the iPad lessens the opportunity for forgetting orders after rounding as one travels to the desktop. Home-based primary care was another setting where ordering on an iPad was seen as useful.

3.4.5. Videoconferencing

Eight (8) data points were about using an iPad for videoconferencing purposes. A clinician from the Telehealth Office noted that it was advantageous to "Facetime" (videoconferencing app that comes with iOS devices like the iPad) a physician to talk to a patient or show anything visual to a practitioner and get real-time feedback. The Telehealth clinician also noted they use Facetime on the iPad for nutrition visits with patients. Another clinician outside of Telehealth noted that it would be good to be allowed to communicate in other forms with patients, including with video conferencing.

3.4.6. Real-time data capture

Eleven (11) data points related to real-time data capture. Clinician expressed a desire to use an iPad for real time data capture of vitals, pain ratings, fluid inputs and outputs (I's & O's), weights, entering orders while rounding, conducting patient audits (e.g., fall risk), taking pictures of rashes or other patient data, etc. One clinician noted that they should be able to capture data in real time as part of the medical record, rather than just transferring information from one device to another. Another clinician expressed a desire to capture vitals information in real time with an iPad, rather than jotting down those data on paper and then taking those paper notes back to a desktop to enter into CPRS.

3.4.7. Future applications

Thirty-five (35) data points related to the desire for an application not currently available to the participants. Some of the applications are more futuristic, while others are relatively simple and potentially available (but not through the VA). Clinicians expressed a desire to use an iPad for several envisioned applications listed in Table 2.

3.5. Patient interaction

Nine (9) participants expressed that using a tablet computer would have a positive impact on clinician-patient interactions; four (4) participants expressed neutral views on this question. No participants expressed that using a tablet would have a negative impact on clinician-patient interactions. One key reason clinicians felt it may positively impact patient interaction is that a tablet computer could be easily used to share information with patients, such as educational videos and other resources. Others felt it would be easier to communicate with the patient while using a tablet vs. a desktop computer, perhaps as a result of the form factor or placement of the device.

3.6. Connection

Participants expressed a desire for universal Wi-Fi access, whether in the VA facility (no dead spots) or outside of facility (hotspots). A cellular connection was mentioned as an acceptable alternative to Wi-Fi. A Remote Desktop connection was being promoted by an inpatient pharmacist as a positive 'workaround' to having to connect with the "cumbersome" Citrix/VPN connection. That is, the pharmacist could remote into any desktop computer using the iPad. He needed to download the Microsoft Remote Desktop app onto the iPad and be approved as a remote desktop user in order to make it work; however, once implemented, the iPad was much more efficient in connecting to CPRS, as well as to use once connected.

4. Discussion

Future mobile computing use with the new EHR should carefully consider the outlined barriers and facilitators, use and anticipated use, device type, connections, location, impact on patient interaction, and transitions across multiple form factors. The barriers to iPad use revealed by our study are not all specific to the VHA. Varying network coverage caused prolonged load times of medical data in another study where the use of iPad minis was investigated [15]. However, the authors considered this issue to be of a temporary nature considering the rapid advance of network infrastructure and technology. In fact, in another study, clinicians rated iPad network connectivity relatively high [3]. As technology and infrastructure improve over time within the VHA, we suspect this barrier will be overcome. Time to access the EHR was mixed in previous studies; one study reported this as a barrier to using mobile computing [16]. However, another study actually found that EHR log in times decreased as a result of using a tablet computer [4]. Factors related to this variation may be specific to the mobile device used, as well as the number of required sign-ons needed to reach EHR data from the tablet computer. The VHA is moving to simplify access to the EHR with a single sign-on, including from iPads.

The barrier of difficulty typing related to lack of an adequate keyboard is a broad barrier also reported from other studies that evaluated tablet computing in healthcare settings. A substantial proportion of participants reported difficulty with entering text as an obstacle in one study of iPad use [11]. In another study, users rated the iPad virtual keyboard as 3.25/5 (moderate) on a benefits/barrier scale [3]. Use of a physical keyboard (e.g., via a Bluetooth connection) was desired by clinicians for tasks using a tablet computer that required text entry [11], which is consistent with our study. This barrier is highly related to the applications or EHR functions used. If the intended use is simply viewing patient data from previous progress notes or lab results, then this barrier is not relevant since little to no typing is needed. However, if the intended use is for ordering or documentation tasks, such as renewing medications or documenting a new progress note, then there was a desire for a real, physical keyboard. Finally, screen navigation and screen size as barriers to tablet computer use have also been reported in the literature [11]; in terms of screen navigation, the CAG interface on the iPad to use the EHR was especially an obstacle, since the EHR was not specifically designed for use on a small screen. Our participants reported the same obstacle and desired a more usable interaction with the EHR through the tablet computer.

The literature describes the current clinical use of tablet computers, including accessing the EHR [9], point of care references (e.g., Up-To-Date, medical journals, textbooks) [9], patient education [3,4], administrative support (e.g., billing and scheduling) [10], and clinical decision support [9,10]. Consistent with the literature, our participants also used the iPad for these reasons, except for administrative support and clinical decision support as there were no internally-developed apps specifically designed for those purposes. In addition, participants used the iPad for ordering (clinical pharmacists) and teleconferencing (telehealth staff). Our participants had a strong desire for using the iPad in more advanced ways with future envisioned applications (Table 2), such as an app that would allow for an intuitive way to search for specific data in an information-dense EHR. The VHA plans to release a series of internally developed apps that will allow for mobile-optimized

Table 2
Desired future applications for tablet computing, organized by complexity.

Complexity	Envisioned Future use of Tablet Computing
Advanced	A computerized "paper trifold" for a quick overview of a patient (medication changes, fluid inputs and outputs, titration changes, etc.). "Siri EHR"-type application with verbal search commands Intuitive search Apps that enable real-time data collection (e.g., live feeds) App for seamless data integration (remote data sources) Patient preparation (ability to quickly to pull up all the previous information − images, tests, notes, other items from remote data)
Simple (relative to the "advanced" applications)	App for two-way communication with feedback (message delivery confirmation) Voice-to-text application (e.g., Dragon) for iPad Medication app with an interactive list of medications with the ability to add/subtract medications, the ability to create a medication reconciliation list, and ability to create medication orders through the interactive list. Patient medication list to show patients without all the extraneous information found in the lists from CPRS and other clinical information systems. To-do list or electronic sticky-notes ("A to-do list that follows with the patient… Maybe not even linked to the patient but a to-do list that could follow me from the iPad to the desktop…") Patient images (easier to access) Accessing references (e.g., pharmacy databases) SharePoint-type application Appointment scheduler Navigation program to plan patient visits (to avoid backtracking)

access to real-time EHR data to inform clinical decisions. As these apps become available, we expect the use of iPads will increase with VHA clinicians.

Although the use of tablet computers has become widespread in healthcare institutions [17], studies on their impact on provider-patient interaction and communication are limited. Available evidence is in the form of survey studies that show providers having a perception that tablet devices have a positive effect on patient interaction and communication [4,9] and patients having a mostly positive perception of provider use of tablet computers in the exam room [6]. Similarly, clinicians in our study, overall, expressed that using a tablet computer would have a positive impact on patient interactions. Through our interview methodology, we were able to pinpoint reasons for this positive perception: (1) tablet computer could be easily used to share information with patients; and (2) communication with the patient while using a tablet vs. a desktop computer may be easier as a result of the form factor or placement of the device.

Specific recommendations, supported by the results of this study, are listed in Table 3. These recommendations have been routed to the VHA office that oversees the roll-out of mobile devices. The results and recommendations should be interpreted within the context of the limitations of this study. The primary limitation of this study is that it was restricted to a single VHA Medical Center. Also, the sample of participants was a convenience sample of clinicians who were willing to participate, regardless of clinical background or service, rather than a random sample. However, participants were part of the trial deployment of iPads and thus ideal interviewees for this study.

Although this study was originally carried out for internal VA purposes, many of the findings and recommendations are broadly relevant to other healthcare institutions. For example, continuous connectivity for the mobile device is essential to avoid interruptions and clinician frustration. Also, making a physical keyboard available as an option for the tablet was a clear desire from the clinicians. Larger tablets (regular size iPad as compared to an iPad mini) were preferred. Being able to use secure messaging tools with the tablet computer was another consistent finding.

More simplicity is needed for accessing patient data on mobile devices, while balancing the important need for adequate security. In the realm of mobile device use within VA, there seems to be an imbalance, with a skew toward blanket security without regard to efficient clinical work. If computerized tools and devices take too long to use effectively for clinical purposes, clinicians will abandon them. Conceptually, clinicians seem positive about the notion of using tablet computers and see their potential in supporting patient care-tasks. However, care must be taken with integrating them into clinical workflow and making them clinically useful, considering form factor, connectivity, and supporting applications.

Table 3
Actionable recommendations.

	Recommendations
1	The time-out issue is perhaps a necessary tradeoff with VA security standards. However, patient-care areas of a medical center or community-based outpatient clinic (CBOC) should be equipped with a sufficient WiFi signal such that a mobile device's connection is continuous.
2	Better balance the security needs for more efficient use of mobile devices; a single sign-on would reduce clinician frustration when using a mobile device to access patient data.
3	A consistent desire was expressed for a real, physical keyboard; VA should consider options for making physical keyboards available as an accessory to VA-issued tablets for devices that do not already have them (e.g., iPads).
4	Larger tablets than an iPad mini are recommended until clinical applications that are intentionally designed for tablet use are available and being used by VHA clinicians. This recommendation for a standard sized iPad compared to an iPad mini is consistent with a separate, independent VA study [18]. Applications that are intentionally designed for tablet use should also reduce the screen navigation criticisms.
5	The deployment of VA-issued mobile devices should also support wireless connection of these devices to appropriate printers.
6	The desire for messaging tools was clear; there needs to be secure messaging options available on VA-issued mobile devices.
7	Based on the feedback from study participants, new VA clinical applications for mobile devices should consider the items in 'future applications' list (see Table 2).

Author contributions

JJS, AS, GE, and JH conceived and designed the study. JJS was solely responsible for the data collection. JJS and JH contributed to the analysis and interpretation of the data. JJS, AS, GE, and JH assisted with the interpretation of data and revised the manuscript critically for important intellectual content. JJS had principal responsibility for drafting the manuscript. All authors critically edited the manuscript and approved the final version.

Conflict of interest statement

The authors report no conflicts of interest.

SUMMARY TABLE

What is already known on this subject?

- Handheld computers have for a long time held tremendous potential for improving communication, facilitating information access, and enhancing workflow in clinical care settings.
- Handheld computers such as tablets have become much more accessible in clinical care settings within urban and rural healthcare organizations.

What this study added to our knowledge?

- This study reveals the types of use that can be expected of tablet computers versus desktops as barriers to using tablets are removed and/or mitigated.
- Participants outlined several desired applications for tablet computers, currently unavailable to them, that would be helpful for their clinical work.

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