The Tablet Device in Hospital Neurology and in Neurology Graduate Medical Education: A Preliminary Study

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Pravin George, DO¹, Christopher R. Newey, DO, MS²,
and Adarsh Bhimraj, MD³

Abstract

Background and Purpose: There is limited literature on tablet devices for neurohospitalists and in neurological graduate medical education. This study evaluated utilization, benefits, and limitations of customized tablets on inpatient neurology practice and resident education. The hypothesis was the perception of the tablet would be positive, given their portability, convenience to accessing point-of-care reference, and accessibility to the electronic medical record. **Methods:** Second-generation iPads with neurology-specific applications and literature were provided to our in-hospital general, stroke, and consult neurology teams. After 1 year, residents on these teams were surveyed on demographic data, familiarity, and utilization of the iPad and their perceptions of the device. **Results:** All 27 residents responded to the survey. Most participants (23 of 27) used a tablet while on inpatient service. Twelve regularly utilized the neurology-specific apps and/or accessed scientific articles. Technologically savvy residents felt significantly more comfortable using tablets and were more quickly acquainted with the features. Thirteen respondents wanted a formal orientation on the advanced features of the tablet independent of their familiarity with the device or level of technological comfort. **Conclusion:** Overall, the perception was that the tablet was beneficial for inpatient clinical care and as an educational reference. Participants became easily familiarized with the device features quickly, regardless of whether they owned one previously or not. Most physicians indicated interest in advanced features of tablets; however, a formal orientation may be beneficial for optimal utilization. A reliable network connection is essential to in-hospital use of tablet devices. Additional research pertaining to patient outcomes, objective educational benefit, and cost-effectiveness is necessary.

Keywords

education, iPad, information technology, electronic medical records, tablet computing

Introduction

Around the release of the first-generation iPad (Apple Computer, Cupertino, California) in April 2010, it and other similar tablet computing devices have been adapted as innovative patient care tools by health care professionals.¹⁻³ Literature on the use of these devices on the neurological floors and in neurology graduate medical education is limited. There is some concern that physicians and residents in particular spend more time on documentation and order placement than on patient care.⁴ Most of the documentation and order placement takes place after rounds on traditional computers or during rounds on large computer-on-wheels units. Neurohospitalists and neurology residents oftentimes also wish to communicate laboratory data and neurological images with their patients at the bedside. A recent study from the University of Chicago showed that the introduction of first-generation iPads improved the efficiency of order entry by internal medical

residents.⁵ A pilot study of 12 residents in different specialties also showed that tablet devices contributed to increased clinical efficiency, reduced hours spent on administrative tasks, and enhanced educational opportunities for residents with minimal information technology support.⁶ Newer generation tablets are lighter, faster, improved in screen resolution, and

¹ Cerebrovascular Center, The Cleveland Clinic Foundation, Cleveland, OH, USA

² Neurological Intensive Care Unit, The University of Chicago, Chicago, IL, USA

³ Department of Infectious Diseases, The Cleveland Clinic Foundation, Cleveland, OH, USA

Corresponding Author:

Pravin George, The Cleveland Clinic Foundation, 9500 Euclid Avenue (S-100), Cleveland, OH 44195, USA.
Email: georgep2@ccf.org

include a front and back camera. Using centralized software, enterprise devices can also be customized with neurological applications, relevant literature, and other educational tools.

In April 2011, Neurology residents on inpatient services at our institution were provided with second-generation iPads as part of a quality assurance/quality improvement (QA/QI) project. The hypothesis of this study was that the perception of a neurologically customized tablet device would be positive, given its smooth technological learning curve, its portability, the convenient point-of-care reference materials it provides, and its easy accessibility to the electronic medical record (EMR).

Methods

Design

We surveyed adult neurology residents from the Cleveland Clinic Foundation regarding their utilization of the neurologically customized iPad, its usefulness in patient care, and its effectiveness as a point-of-care medical educational resource. These devices were preloaded with neurologically based apps, journal articles selected by attending staff and chief residents pertaining to the American Board of Psychiatry and Neurology syllabus, and the EMR. The survey was administered, after 1 year of use, using a confidential Research Electronic Data Capture (REDCap) (Vanderbilt University, Nashville, TN) questionnaire. Study data were collected and managed using REDCap electronic data capture tools hosted at the Cleveland Clinic Foundation.⁷ The REDCap is a secure, Web-based application designed to support data capture for research studies. Data were exported to a Microsoft Excel spreadsheet (Microsoft Corporation, Redmond, WA) and then imported into JMP Pro 9.0 for further statistical analysis.

Participants

All postgraduate year 2, 3, and 4 level adult neurology residents at the Cleveland Clinic Foundation from 2011 to 2012 were surveyed. Median and mean age information and medical school graduation country was taken as aggregate data from the residency database. No personal information was released. No compensation was given for participation.

Measures

A confidential REDCap online 30-question survey (Table 1) was designed as a query tool to assess resident's perception of the device. Questions focused on demographic data, familiarity and utilization of the iPad and perception pertaining to clinical care, education, and usability. All questions were in the form of yes/no, multiple-choice, and Likert-like continuous visual sliding scale (LSS) between 1 and 100. For LSS statistics, a 95% confidence interval (CI) was measured. This study was reviewed by the institutional review board but was felt to be exempt, as it was considered part of an internal QA/QI project with no/minimal risk to the participants.

Setting

Second-generation iPad devices were obtained by a grant from the Cleveland Clinic House Staff Association for adult neurology resident's use while on inpatient service. There was no formal orientation or needs assessment prior to delivery of the devices. The devices were all preloaded with stroke and general neurological literature which was stored on a cloud-based DropBox (Dropbox Inc, San Francisco, CA) server and through the American Academy of Neurology (AAN) Neurology application (Wolters Kluwer Health, Alphen aan den Rijn, The Netherlands). Each tablet also included a variety of neurologically specific applications (Table 2) selected by the chief-neurology residents. The devices were incorporated onto the campus-wide secured wireless network for full access to EMR (Epic; Venora, Wisconsin via Citrix Receiver (Citrix, Ft. Lauderdale, FL)) radiology (AGFA, Greenville, South Carolina), sign-out tool (Cleveland Clinic Foundation, Cleveland, Ohio), electronic mail (via Web-access), and library resources including a link to the UpToDate medical reference (Wolters Kluwer Health, Alphen aan den Rijn, The Netherlands). After a 1-year period of use, all residents anonymously completed the REDCap survey. Participants were only able to complete the survey once. Afterward, the investigators had an open forum with the participants to discuss benefits and limitations further.

Results

Twenty-seven (100%) neurology residents completed the REDCap survey. (Table 3) The average age of the participants was 30.68 (standard deviation of 3.4 years). The median age was 30 (oldest 39, youngest 26). Ten (37%) of the residents in this study graduated from a foreign medical school.

Familiarity

Of the 27 participants, 17 (63%) reported previously owning an iPhone or an iPad. Familiarity with the device's operating system, after 1 year of participation in the study, for those who owned an iPad or an iPhone LSS between 0 (completely unfamiliar) and 100 (most familiar) was mean 70 (CI 56.5, 83.5) compared with 57.2 (CI 39.6, 74.8) in those who did not own either device. This value was not statistically significant ($P < .25$). Bivariate fit analysis showed that neurology residents who felt they were more technologically savvy felt significantly more comfortable using the device's mobile operating system ($P < .03$) and reported being more quickly acquainted with the its features ($P < .02$). It also showed that residents who felt more comfortable with the operating system used it significantly more often to access clinical data ($P < .02$). Of the 27 residents, 13 (48%) indicated that they would want a formal orientation on the tablet's use in neurology independent of their familiarity with the operating system or technological comfort. There was no statistical difference in the self-perceived technological ability or device comfort level between residents who were foreign and domestically trained or by resident level of training.

Table 1. RedCap Survey Questionnaire.

Question	Answer Category
Basic demographics	
Medical school attended	Fill in blank—analyzed for international vs domestic
PGY year	Single selection (PGY-II, PGY-III, PGY-IV)
Technological comfort assessment	
Do you currently own an iPad?	Yes/no
How comfortable are you with the iOS mobile operating system and the iPad after one year of use?	LSS 0-100 (most uncomfortable—most comfortable)
How technologically savvy do you feel you are?	LSS 0-100 (no tech experience/tech averse—extremely tech savvy)
What is your knowledge of what the iPad can do?	LSS 0-100 (know nothing—know everything)
Would you want a formal orientation on iPad use?	Yes/no
How quickly do you feel you became acquainted with the iPad?	LSS 0-100 (still not acquainted—extremely quickly acquainted)
After an orientation, how likely would you use the iPad?	LSS 0-100 (not likely at all—likely will use all of the time)
Basic utilization of the iPad	
Did you use the iPad regularly while on service?	Yes/no
Have you used the iPad as a senior resident?	Yes/no
How often did you use the iPad?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
Did you check e-mail on the iPad?	Yes/no
Clinical utilization of the iPad	
How often did you utilize the neurological apps?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
How often did you access journal articles through the library website or through the AAN neurology app?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
How often did you access journal articles using Dropbox?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
How often did you access the sign-out tool on the iPad?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
How often did you access patient records using the iPad?	Single selection (extremely often, very often, somewhat often, not very often, rarely, never)
Did you use imaging at the bedside with the patient?	Yes/no (comment: if “no” because you did not know about this ability, are you interested in learning more about it?)
Advanced features of the newer generation iPad	
Have you given a presentation using the iPad?	Yes/no (comment: if “no” because you did not know about this ability, are you interested in learning more about it?)
Have you used FaceTime (Apple Corporation, Cupertino, CA)?	Yes/no (comment: if “no” because you did not know about this ability, are you interested in learning more about it?)
Have you used iMessage?	Yes/no (comment: if “no” because you did not know about this ability, are you interested in learning more about it?)
Perception and benefits of the iPad	
How much did the iPad improve your clinical care?	LSS 0-100 (no improvement—largest improvement)
How useful did you find the iPad in your overall clinical care?	LSS 0-100 (not useful at all—most useful clinical tool)
How useful did you find the iPad in providing point-of-care educational reference materials?	LSS 0-100 (not useful at all—most useful point of care reference tool)
How portable did you feel the iPad was while on service?	LSS 0-100 (not portable at all—most portable device)
If funding could either go for an iPad with an E-text or the hard copy of the same textbook, which would you prefer?	LSS 0-100 (hard copy text—iPad with electronic version of the same textbook)
How likely are you to misplace your iPad?	LSS 0-100 (will not misplace—will definitely misplace)
Do you believe tablet devices such as the iPad are the wave of the future in neurology?	LSS 0-100 (not at all—definitely)
If given an iPad at the beginning of residency, how likely are you to use it for clinical activities?	LSS 0-100 (not likely at all—definitely will use for clinical activities)

Abbreviation: LSS, Likert-like continuous visual sliding scale.

Usage

Of the 27 (85%) respondents, 23 reported using the tablet device regularly while on inpatient service months. In all,

12 (44%) of the residents used the preloaded neurological applications either “very often” or “extremely often” every day, while 9 (33%) of the participants reported that they “rarely” or “never” used them. Six (22%) indicated that they

Table 2. Customized iPad Neurological Applications.

Application	Description and Cost Derived From iTunes.com	
	AAN Neurology Journal Application	Free with membership to AAN
	AHA Stroke Journal Application	Free with membership to AHA
	Thomson Reuters Micromedex Drugs	Evidence-based clinical drug reference (free)
	Qx Calculate by QxMD	Clinical calculator, point-of-care reference (free)
	Kent Ellington's Neuro ToolKit	Number of widely used grading scales (US\$2.99)
	George Kong's eyeTestFree	Color testing plates, eye charts (free)
	Cold Spring Harbor Laboratory 3D Brain	Brain structures for patient education (free)
	Amazon Kindle app	Read/store full volume neurological texts (free)
	Scott Guelich's TextPage	Sends text pages to alpha pagers (free)

Abbreviations: AAN, American Academy of Neurology; AHA, American Heart Association.

did not know that there were preloaded neurological apps. Of the residents, 56% accessed journal articles “very often” or “extremely often” from the device through the integrated Web browser and secured intranet, using the AAN Neurology app and/or directly through UpToDate references. Thirteen (48%) used DropBox “very often” or “extremely often” to access preloaded neurologic journal articles. In all, 14 (52%) utilized the tablet “extremely often” or “very often” to access and update the sign-out list of patients and 7 (26%) reported

that they used the device to show magnetic resonance and computed tomography imaging to patients at the bedside. An additional 12 (44%) expressed interest in but did not know how to access imaging using the device.

Advanced Feature Usage

Three (11%) neurology residents used iPad “air-play mirroring” to give an educational presentation during or shortly after rounds. Nineteen (70%) of the respondents indicated that they did not know that they could display presentations utilizing iPad “air-play mirroring” to a projector or monitor, a feature limited to the second-generation iPad and newer, but were interested in this capability. Three (11%) residents used FaceTime, a secure video chat feature that is also unique to the newer generation devices. Two residents did not know about FaceTime and how they could potentially utilize the feature.

Benefit of the Tablet

Overall point-of-care educational reference LSS mean between 0 (not useful) and 100 (most useful) was 72.15 (CI 62.9, 81.4). Resident perception of tablet usefulness in clinical care LSS mean score between 0 (not useful) and 100 (most useful) was 64.3 (CI 58.1, 70.6), and they reported a mean improvement of 62.1 (CI 53.0, 71.3) in clinical care on a scale from 0 (no improvement) to 100 (largest improvement). When asked whether after being educated on how to use the tablet device in medicine, the likeliness of usage LSS mean was 77.3 (CI 67.9, 86.7) between 0 (not likely to use) and 100 (likely to use always). Of note, 25 (93%) of the 27 residents responded on the LSS toward the side (>70) that they would prefer a tablet device with a preloaded electronic copy of a textbook to a hard copy of the same textbook.

Limitations to the Tablet

The biggest reported limitation to the tablet was its connectivity to our in-hospital wireless network. Twenty-four (89%) of the respondents reported frequent network issues which at times made their devices unusable.

Discussion

The role of tablet devices on the neurology inpatient services is still yet to be fully determined. When compared to previous touch devices used by clinicians such as the Palm Pilot, the tablet's size, interface, and simplicity may prove more useful for the modern neurologist. It should also be noted that trainees are in large part moving toward tablet-based medical education. Several medical schools are moving to complete digital access courses and are eliminating paper-based learning media. Likewise, several residency programs are giving tablet devices to residents in an effort to increase the efficiency of in-hospital care, improve the training of residents, and enhance physician communication. Although there is some trepidation in moving to a

Table 3. Resident Perceptions of the iPad.

Overall Familiarity	Number	Percentage	
Total participants	27	100	
Residents who owned an iPhone or iPad	17	63	
Residents who want a formal iPad orientation	13	48	
Familiarity after 1 year (with respect to owning an iPhone/iPad)	LSS Mean	Confidence Interval (Low, High)	P Value
Familiarity with iPad operating system after 1 year (own iPad/iPhone)	70	56.5, 83.5	
Familiarity with iPad operating system after 1 year (do not own iPad/iPhone)	57.2	39.6, 74.8	<.25
Clinical/academic iPad usage	Number	Percentage	
Residents who used the iPad regularly on service	23	85	
Residents who used the preloaded neurological apps "very often" or "extremely often"	12	44	
Residents who accessed web-based or AAN Neurology journal articles "very often" or "extremely often"	15	56	
Residents who used DropBox "very often" or "extremely often" to access preloaded neurological journal articles	13	48	
Utilized iPad "extremely often" or "very often" to access and update the sign-out list	14	52	
Used iPad to show radiological images to patients at bedside	7	26	
New feature usage			
Used FaceTime	3	11	
Used iPad mirroring	3	11	
Perceived benefit of the iPad	LSS Mean	Confidence Interval (Low, High)	
Overall point of care educational reference	72.15	62.9, 81.4	
Perception of iPad usefulness in clinical care	64.3	58.1, 71.3	
Improvement in clinical care	62.1	53.0, 71.3	
Likelihood of usage after formal orientation	77.3	67.8, 86.7	

Abbreviations: AAN, American Academy of Neurology; LSS, Likert-like continuous visual sliding scale.

digital platform by neurologists both old and young due to inexperience, in our study, it was seen that even neurology trainees who felt the least technologically savvy were still able to utilize this new technology with relative ease and over a quick learning curve. Although the devices in our study were used mainly by trainees in an academic institution for this study, given the demographic breakdown of our residents, the study is potentially generalizable to hospital neurologists in a variety of settings.

As utilized in this particular study, the tablet provided point-of-care access to educational and clinically oriented materials. Apps such as the 3D Brain (Cold Spring Harbor Laboratories, DNA Learning Center, AXS Studio, Vivid Apps 2009, Cold Spring Harbor, NY), MedCalc (Mathias Tschopp, MD, France), MicroMedex Drug Information (Truven Health Analytics, Ann Arbor, MI), and Qx Calculate QxMD.com provided quick access information and medical calculations, while the Kindle Amazon.Com, Seattle, WA and iBooks apps (Apple Corporation, Cupertino, CA) allowed residents to carry around several full-volume textbooks and journal articles in portable document file format. Our stroke team was able to utilize the Neurology Toolkit app (Kent Ellington, MD, Austin, TX) to quickly calculate a National Institute of Health stroke scale (NIHSS) on patients while in the emergency department and rapidly review relative and absolute contraindications to intravenous thrombolytics. The NIHSS could

then be communicated by secure e-mail to the rest of the treatment team. Electronic medical record and the radiology interface also aided physician communication by making it possible to display and review medications, laboratory test results, and imaging directly with the patient at the bedside. The high-definition camera was also utilized to record several interesting neurological findings that were securely backed up to an Health Insurance Portability and Accountability Act (HIPAA)-compliant database on the hospital network for later retrieval in the training of residents. We are currently piloting the applicability of a front and back camera, now a feature on most tablet devices, which has the potential to improve stroke care through direct neurologist to emergency medical technician interaction. Our pilot study utilizes the dual cameras on a long-term evolution wireless-enabled iPad as a fully enabled telestroke platform. Usage and interest in features of the newer generation tablet devices such as "air-play mirroring," which allows for direct presentation to a screen may also prove useful if physicians are given a formal orientation.

Utilizing the Kirkpatrick learning evaluation model of an educational program, our study serves as a reaction measure of the impact of the tablet on the training neurologist and is one of the first to report perception and utilization of a "customized" device with preloaded neurological applications and journal articles.⁸ Our study confirms the observed

improvements in perceived efficiency seen in the University of Chicago and University of Virginia studies^{4,5} and suggests that participants not only felt they benefited from portable EMR access and rapid ability for order entry but also from the point-of-care education they received from the preloaded neurologically based applications and articles. The overall perception in the academic clinical setting was positive with an overwhelming majority of the residents preferring a tablet device with a preloaded text to the hard copy textbook alone, regardless of their familiarity with the device. The study also suggests that during tablet device implementation into a neurohospitalist position or residency program, a formal orientation may be necessary to optimize the usage of some of the more advanced features.

There are several concerns and limitations to the use of tablet device in the health care field. In our study, one of the biggest concerns by the participants was a poor network connection while on the hospital campus. Although the devices were placed on the secured wireless network at our institution, for technical reasons that are still being addressed there were frequent “network drop-offs.” Health professionals in all fields of medicine often also worry about protected health information and the security of such devices in the growing field of medical technology. Many advanced academic health care centers, such as ours, have designed security “profiles” for use on networked tablet devices to ensure complete monitoring and protection of each unit. Introduction of these network policies may be necessary for a hospital that is considering implementation of tablet devices. We are also aiming to solve some concerns of loss or theft through the use of software such as the “Find My iPad” application and the mobile device management system Zenprise (Zenprise Inc, Redwood City, CA), which improves the ability to locate a lost or stolen device utilizing the built-in assisted global positioning system among other resources. These application solutions also allow for the remote deletion of data from the device in the event of loss and provide some malware protection. To combat infectious disease spread, we are also currently piloting a new carrying case to improve portability and ease of carrying the device while maintaining safe, hygienic standards during patient care activities. An internal cost analysis prior to our study showed that the tablet could potentially save money by limiting the unnecessary printing of sign-out lists and other printable material as well as through the utilization of online textbook access instead of bulk purchasing of paper textbooks and through the use of multiple book licensing.

Using the Kirkpatrick evaluation model, we are currently studying an “increase in knowledge” assessment, where trainees are completing an objective pre and posttest learning assessment using the tablet in a clinical rotation. Future studies would include completing a prospective study on patient length of stay and overall satisfaction with the device as well as a comprehensive tablet device cost analysis.

There are some limitations to our study. As this was a survey study, it relies on self-reported data and the

perception of receiving a tablet device may have influenced some of those surveyed. Although it was perceived by the study participants that there was an improvement in overall efficiency, the study design does not objectively measure improvements in timing or efficiency. Also, although by its design the tablet device does provide point-of-care access to clinical tools and educational materials and it was perceived as a useful point-of-care access tool, the study did not objectively measure clinician point-of-care utilization. This study was also completed at a single academic center with a relatively small sample size. The diversity of our residency program may however help generalize the data.

Conclusion

The tablet device preloaded with neurology-specific applications and research articles improved the user’s perceived efficiency and was largely felt to be beneficial for patient care and trainee education. Regardless of technological comfort, the device’s interface and overall usability was observed as easy to use. A formal orientation may aid in better utilization of newer generation devices with regard to advanced features. Further study is needed to assess patient communication and satisfaction with the tablet device and its cost analysis in the clinical setting.

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