

# Study of the factors that promoted the implementation of Electronic Medical Record on iPads at Two Emergency Departments

Akhil Sanjay Rao, MS<sup>1</sup>; Terrence J. Adam, MD, PhD<sup>1,2</sup>; Raymond Gensinger, MD<sup>3</sup>; Bonnie L. Westra, PhD, RN, FAAN, FACMI<sup>1,4</sup>

<sup>1</sup>University of Minnesota, Institute for Health Informatics MN; <sup>2</sup>University of Minnesota, College of Pharmacy; <sup>3</sup>Fairview Health System, Minneapolis, MN; <sup>4</sup>University of Minnesota, School of Nursing

## Abstract

*The purpose of this study was to understand the factors which promoted the demand for iPads by physicians in two Emergency departments (ED) prior to a system wide implementation of an electronic medical record (EMR). A grounded theory design was employed and 14 semi-structured interviews conducted with ED physicians. Analysis of the interview transcripts was completed using Atlas.ti qualitative software, which revealed that physicians' perceptions of iPad use in the ED stemmed from their personal use of iPads along with three perceived ease of use factors. Physicians perceived that improved patient physician interaction, improved workflow and structural iPad benefits promoted their demand. Physicians perceived the structural benefits of iPads would improve patient physician interaction and improve workflow in the ED. As interest in handheld devices such as iPads increases, these findings could direct and encourage other iPad implementations at other hospital EDs'.*

## Introduction

iPads have ushered in a new era for overcoming barriers and resistance relating to electronic medical records (EMRs) use in busy settings such as emergency departments (EDs). In EDs, physicians are expected to rapidly assess, treat, educate, and discharge patients. Time delays are crucial concerns for patient care and can impact the patients' chances of recovery or potentially even survival. Hence, there is a strong need to reduce the response time associated with treating patients. In previous studies, concern has been expressed by physicians and other health care providers that EMRs can slow down patient care if not implemented thoughtfully.<sup>1,2</sup> Benefits to quality patient care through EMR's has been shown consistently by numerous studies, however, despite the quality improvement potential, physician buy in for the use of EMR's is relatively low.<sup>2,3</sup> Research on the use of hand held devices, such as Personal Digital Assistant (PDAs) show promising results to support patient care, however, the perceived benefits of using iPads at the point of care have not been clearly identified nor demonstrated.<sup>4,5,6,7</sup> Medical informatics researchers and health information technology (HIT) professionals still face considerable challenges in promoting the use of EMRs.<sup>6,8</sup>

Fairview Health Services purchased the commercially sold Epic ASAP™ application (Epic Systems®, Verona, WI) module which is Epic System's Emergency Care module. The emergency departments at two locations were scheduled to "go-live" with Epic ASAP™ in December 2010. During the pre-implementation discussion phase, the ED physicians made a strong request to introduce this software on iPads to the extent of refusing to use the EMR application if not implemented on iPads. The enthusiastic demand to implement EMRs on an atypical platform such as iPads is rare and previous informatics studies which studied implementations of other handheld tools have revealed that acceptance of such tools is low.<sup>9,10</sup> The clinician driven demand to implement EMR's on iPads is an unique and interesting phenomenon from an informatics research perspective.

The high expense associated with HIT coupled with the high rate of information technology (IT) evolution places an increasing emphasis on understanding physician needs for novel technologies. Chief Medical Information Officers (CMIOs) who initiate and lead implementations of EMRs across hospital systems need considerable evidence that physicians will utilize and generate value with such handheld technologies before they align long term plans to incorporate them.<sup>11</sup> More than 40% of IT developments in various sectors including the health sector have failed or

have been abandoned.<sup>12</sup> HIT is expensive and requires considerable resources to implement. Therefore, the purpose of this study was to answer the following research question –“What are the factors which promoted the demand for iPads by physicians at these two EDs?” Through data acquisition and analysis of this study, qualitative study methods are utilized to assess handheld HIT demand among providers. This study aimed to understand physicians’ perceptions about the usefulness of iPads in the ED that fueled the ardent demand by physicians to implement the Epic ASAP™ on iPads. The findings of this study are most useful for health administrators, CMIO’s and informatics researchers to direct implementation resources and identify an understanding of physician needs for a targeted technology.

## **Research Design and Methods**

This study was a pre- and post-qualitative design to compare physician perceptions of the value of using an iPad for implementing an EMR in two EDs within one health system. Perceptions are physicians’ mental representation of how an iPad would work or the benefits that could be gained as compared with desktop computers or computers on wheels (COWS). Physicians’ perceptions about iPads were gathered through a series of semi-structured interviews; the pre-implementation phase is addressed in this article. The semi-structured interview instrument developed specifically for this study was derived from other published articles on the implementation of EMR’s utilizing handheld technologies and relevant research instruments that gathered perception and belief elicitation data.<sup>9,13-</sup>

<sup>15</sup>After approval by the institutional review board (IRB), the principal investigator (PI) contacted the physicians by email or by phone to schedule interviews. The PI conducted all interviews based on the semi-structured interview technique utilizing a planned discussion outline drawn from a focused literature review. The semi-structured interview questionnaire engages interviewees to describe their perceptions in their own words. This approach allowed for the emergence of unanticipated, but relevant issues and attitudes associated with the perceived use of iPads, while still ensuring consistent coverage of key topics identified and incorporated into the interview outline. The goal was to uncover each respondent’s views and perceptions in their own words and to allow the exploration, assessment and clarification of the answers as needed. Each interview started with a briefing of the purpose of the study and informed consent followed by the semi-structured interview. All subject interviews were audio recorded and transcribed for analysis. Pre-implementation data were collected from October through November 2010.

## **Data Analysis**

Data were analyzed using a qualitative software Atlas.ti to organize and summarize thematic data using a grounded theory approach. Grounded theory is a qualitative approach in which the researcher reviews, interviews and observes data, applies labels or codes to data which are considered important, and blends codes until the overall themes emerge from that data.<sup>16</sup> A grounded theory qualitative method of analysis was selected for this study because it can be useful for exploring social, technical, and organizational factors relevant to the focused context of the study.<sup>17</sup> iPad implementations can vary across these two study sites by unit size and staff size and grounded theory qualitative methods can account for variability in implementations, physician specialties, experiences, iPad use, and other factors across the two sites. Furthermore, the iterative nature of grounded theory qualitative methodology can provide opportunities for detailed investigation into issues that require follow-up and deeper understanding.<sup>15</sup> The grounded theory method has been used extensively in biomedical informatics to discover technology’s impact in such areas as provider order entry and clinical decision support.<sup>1,18</sup> Line by line descriptive coding or open coding was conducted and codes were hierarchically arranged such that a broader theme might contain subthemes. Hierarchically arranging codes allows investigators to structurally express broader themes which might contain subthemes contributing to the analysis. The primary investigator conducted the analysis and coding which was validated by a second investigator (BLW) to assure the trustworthiness of the findings. The principal investigator did a count of frequently occurring codes as the major themes and chose 35% as the cut off percentage to weed out inconsistent and non-continuous themes while ensuring coverage to all the significant and consistent findings.<sup>16,19</sup>

## **Findings**

Of the 22 ED physicians, 14 participated in the study. ED physicians were predominately male (86%), with 54% between the ages of 40 – 49. Nearly half (46%) the physicians specialized in the emergency medicine, 39% in family medicine and 15% had other specialties. ED physicians had considerable clinical experience with 54% having between 10 to 19 years of clinical experience and 31% between 20 and 29 years of experience. 92% of the ED physicians were experienced with iPads and 85% personally owned an iPad.

Analysis of the interview transcripts yielded **three major themes**: *Improved patient-physician interaction, improved workflow with iPads, and structural benefits of iPads*. Physicians described the patient-physician relationship as fundamental to providing excellent care and improving health outcomes due to the rapidly changing clinical environment. Physicians detailed how iPads would improve communication, facilitate and enhance patient education, increase patient satisfaction, and consequently improve patient-physician interaction. iPads' were perceived as a way to improve workflow by better matching natural clinical information flows and the manner in which care is performed in the ED, thereby improving information access, reducing redundancy, and providing mobility. Physicians were optimistic that the use of iPads along with future customization of the EMR software would lead them towards their ideal workflow. Physicians also enumerated structural benefits like the touch screen functionality of iPads by constantly comparing iPads to desktops and laptops. They cited various disadvantages to the use of desktops and laptops in the ED, whereas, in contrast, iPads could be used just like paper charts and some providers perceived that iPads would reduce the risk of air-borne infection by noting the lack of cooling fan. These themes and subthemes are described in detail in the following sections using the following conventions: theme names are in bold and sub themes are further categorized under the major theme. Quotes have been selected to depict the theme.

### **Theme 1: Improved Physician – Patient Interaction**

When asked about the benefits of using iPads' many ED physicians mentioned that it would help them interact with their patients by utilizing the benefits of technology. One physician who extolled the use of iPads in the ED said "... *realistically when you are trying to turn towards the patient [using a desktop], you are not having that direct kind of face-to-face conversation, I think the whole purpose is lost but I think with iPads I will be still be able to maintain my present interaction if not make it better.*" Another physician said "... *I felt very strongly that we needed some sort of portable touch screen device that would give us the best face-to-face [contact] with the patient.*" Another ED physician mentioned "*I'm a kind of guy who will look at everything involved and like to get a word from the patient. I [would] like to discuss and show the patient his scans and discuss what we'll do with him. I'd like my patient involved with the medical decision making process a great deal and with the iPad it's easier to interact and do that.*" Described below are three sub themes viz. enhanced communication with patients, improved patient education, and higher patient satisfaction which are covered within the umbrella theme of improved physician – patient interaction. This theme provides an understanding of how physicians perceive their interaction with patients after the implementation of iPads with EMR's and its benefits on patient- physician interaction in a clinical setting.

#### ***Subtheme 1: Maintaining effective communication with patients.***

Physicians emphasized the importance of good communication with patients and indicated that face-to-face communication is essential to maintain an efficient physician and patient interaction. A physician mentioned "*I did a fellowship in patient communication from the Mayo Clinic and so I keep reading about how patient interaction is hindered when we use computers in front of patients and I can totally see that happening. But from the looks of it now, iPads wouldn't be really bad and won't impede communication*". Another physician mentioned "*Patient communication is very important for me. I will not trade that with anything. So I think with iPads it wouldn't be as bad as computers. I think I'll use the iPad but not the computer when I'm with my patients.*" One physician mentioned "*I think that we will be able to communicate in a more meaningful way with the patients' when we have iPads.*"

#### ***Subtheme 2: iPads' enhance patient education.***

Physicians envisioned using iPads for patient education. As one physician put it "...*another piece could be patient education. We can pull up some things [referring to images] and show patients [while] in the room. Now you can argue that you can do the same using computer workstations but I think showing images to patients will be a lot easier using iPads*". Another physician said, "...*we get so many different kinds of people and some who don't care, I would like pull images and show these guys what's their deal,[indicating health condition]*". He also added "*I will take full advantage of the screen and other media applications on the iPad. I hope to display images from my personal medical image library or X-ray scans or something to the patient or eventually if I can get some software which can even play heart murmur or lung sound recordings of my patients.*" Another example of patient education is "*Well I see a lot of patients who smoke like 2 to 3 packs of cigarettes a day and if I can I pull up some images on my iPad about the consequences of smoking and even tobacco addiction*".

### ***Subtheme 3: Improving patient satisfaction.***

Physicians expected cutting edge technology use would increase patient satisfaction. One physician mentioned “*You sit down with the patient with the iPad– you have a saazzy tool. They think you are making use of the latest tools while treating them – I think with HCAPS [Hospital Consumer Assessment of Health Care Providers - the patient satisfaction survey] and everything it’ll add to our plus points.*” One of the physicians mentioned “*...with iPads we will have more face-to-face time which I think will improve patient satisfaction greatly.*” Another physician mentioned “*I think it is more the face-to-face time with iPads that will ...make the patient feel good.*”

## **Theme 2: Improved Workflow with iPads**

Under the theme *Improved workflow with iPads*, physicians mentioned the benefits of iPads in the ED. In the following paragraphs six sub themes are described which constitute the theme – improved workflow with iPads. Physicians’ perceived iPads would contribute towards improving access to information in patient rooms, reducing redundancy by eliminating non clinical tasks, providing mobility, fastening ED workflow, help future customization of the EMR and bring ED physicians closer to their ideal workflow.

### ***Subtheme 1: Improving access to information.***

Improving access to vital patient and clinical information seemed to emerge as an important sub theme. One physician subject pointed out “*... well with the iPad I hope I can pull up stuff in the patient rooms which will reduce some running around a bit, so on the workflow piece, I’d say access to patient information would be great*”. Another physician mentioned “*I am excited about having access to patient information inpatient rooms. I think we need it .....and iPads would be a nice way to view the records.*” One of ED physicians mentioned “*....in the patient room I think I would be more apt to order on the go in the room if I had an iPad.*”

### ***Subtheme 2: iPads reduce redundancy.***

Majority of the physicians perceived that iPads would reduce redundancy in the ED. One physician stated, “*Access to information where and when we need it will definitely reduce redundancy because it will remove extraneous work which take us away from treating patients... I think the iPads will help us with that.*” Another physician mentioned “*... One of the redundant activities I’d say is the number of times you log into and out, which I think for an iPad is lesser than what I have seen [with]a few desktops with.*”

### ***Subtheme 3: Mobility.***

Mobility was a frequently mentioned factor influencing the request for iPads and potentially providing a better fit of technology to the application setting. One physician mentioned “*How the iPad would work is, you know, it is portable.... It lets you be mobile.*” Another ED physician explained the importance of mobility in the emergency department “*because we are constantly moving. We don’t do our work in front of a desk... [We] do our work in front of patients and in front of other people, we are continually moving from one room another and from one part of the hospital to another.*” Yet another physician noted “*...it would be really handy to have all the patient information in the room and be able to take [it] where ever you’re going [and] if you are in one room and you are running to the code in the other room, it would be nice to have it right there and know that it is there. The iPad will help me do that and that’s why I would like to use it.*”

### ***Subtheme 4: iPads make the workflow faster.***

Majority of physicians perceived that their workflow would be faster with the implementation of iPads, as an ER physician put it “*These iPads with their touch screens are just so fast. I own an iPad and a desktop and I can tell you from that they are faster.*” Another physician said “*... and [the iPads] retrieve data more efficiently kind of on the go and instead of being so categorical or herky-jerky, I think with the iPad if I take it to the patients, I am hoping that this makes things flow a little bit easier and faster.*” One of the physicians explaining the benefit of iPads on workflows said “*I think the iPad will at least help me save some time, make things more faster as we go since it will be more efficient as far as orders go, and at some point I would ideally like to use the iPad purely as my workstation.*”

### ***Subtheme 5: Future customization of EMR.***

Future customization of the EMR software was a common motif which emerged as the interviews progressed. One of the ED physicians said *“I feel like in the future I will be able to customize the iPad, EMR, and my workflow [which would be] extremely easy.”* Another physician put it *“I would foresee that if Epic electronic medical record with all its upgrades and iPads’ would integrate in a seamless fashion, then I would be able to customize the way the data is accessible on an iPad.”* Another physician mentioned *“I think the iPad will fit better in our workflow if we can get it customized to our workflow and also get more software’s or an improved Epic suite to kind of fill in the gaps of using the iPad.”* The physicians could definitely see a number of future applications of the iPad in a clinical setting with integration of its platform with other clinical applications.

### ***Subtheme 6: Closer towards an ideal clinical workflow.***

Throughout the interviews physicians mentioned that iPads would bring them closer towards their ideal clinical workflow as one physician mentioned *“iPads bring us one step to our ideal workflow and eventually with time we will get more pieces of software which will inch us closer to that workflow.”* Another physician mentioned *“I think it [iPads] will make my job more efficient. I am near maximizing my time and patient care and I would like to improve my efficiency in workflow that way and so I am looking for ways to make things easier and smoother and in my ideal world, I would talk to patients and use my little iPad to put in orders and meds and they could run around with me and then I’ll know when I get my results back and let me know when things are available and I just say okay we need to discharge this person and off they go with a touch of a finger by the bedside. That is my ideal world and so this is a step closer to that.”* Some providers have a view that the iPad be a tool to fill a number of currently unmet needs in the clinical workflow and it could do so in ways not currently available.

## **Theme 3: Structural Benefits of iPads**

Physicians perceived that the structure of iPads had benefits when compared to other traditional devices on which EMR’s are implemented. This theme uncovers factors which help explain the functional and structural facets of iPads that primarily drove the demand for iPads.

### ***Subtheme 1: Touch Screens enable ease of use.***

Physicians associated ease of use with being able to touch the screen as opposed to clicking and checking options or using the keyboard and the mouse. One of the physicians’ mentioned that *“Using the touch screen is so much simpler; you simply point at what you want. I had never used an iPad before but I really liked it when I used it a few days back.”* Thus physicians associated the ease of use with the touch screen functionality of iPads. Another relatively vocal physician said, *“Touch screen displays are a lot easier to navigate than even using a traditional mouse... with the touch of a finger it is easier to coordinate than moving a mouse”.* One of the ED physicians’ mentioned *“...these screens make everyone an expert user from the first touch – you just know how to use them.”* While another physician said *“With a touch screen, you simply have to touch what you want to select or interact with and it’s done.”* Another physician said *“I just bought an iPad a few weeks back and I don’t use an iPhone or an iPod nor was I all gung ho about these iPads at our unit. But then I think the touch screen allows some instinctive thinking about how to handle it.”* It is well known that the ability to hold and manipulate an item can help encourage the use of the item. Tactile-oriented applications such as the iPad may help encourage device use by removing barriers between the device and the user.

### ***Subtheme 2: Similarity to paper.***

Similarity to paper was one of the strong themes which arose from interviews *“With these iPads they are so slick like paper. I can write on it like the way I do on paper.”* Another physician said *“...it hardly feels like a computer or a system, it just feels like paper -its light [and] I can use my fingers the way I do when I use paper.”* The similarity to paper was further exemplified by a comment, *“I can carry that iPad around just like I did previously the actual clip board chart and bring it in and sit down with the patient.”* Another physician noted, *“... using it [iPads] will be like using smart paper.”* Again the tactile experience may have the additional benefit of replicating the familiarity of the paper interface.

### ***Subtheme 3: iPads Improve Infection Control***

Physicians believed that iPads would help improve infection control within the ED *“...the plus points I think is from an infection control risk that... the screens can be wiped down easily.”* Another mentioned *“These iPads do not require a keyboard and that’s why I think they will collect less dust. And also there are no keyboards. So it has one less surface for dust to collect on.”* One ED physician mentioned *“Well, it does not have a fan and therefore you are*

*not aiding the spread of germs. I think that is a very valid thing because fans circulate air and I wonder sometimes if computers pose an infection risk”.*

## **Discussion**

Using a qualitative approach, the major factors associated with the demand of iPads by the physicians at two EDs were identified. Physicians perceived the use of iPads would improve patient physician interaction and enhance workflow. They associated these advantages to structural benefits of iPads which likely resulted from a high sense of familiarity from using their personal iPads. More than 80% of the physicians from both ED's owned and used iPads for their personal use, which likely accounts for their request for an iPad and not a different table or device. The typical providers in the study fall into the 40-49 years age group and had significant clinical experience which focused primarily of using paper at work for most of their professional careers, yet they still demanded iPads as the device on which EMR's were to be implemented due to the perceived benefits of practice.

There is a large body of literature which has addressed the importance of physician patient interaction and its importance towards delivering good healthcare. Physicians regard their interaction with the patient as an important part of the care giving process with prior research showing - EMR's have adversely affected patient EMR's have been shown to adversely affect patient physician interaction.<sup>20,21</sup> As the findings indicate, physicians are cognizant about the negative impacts of desktops, laptops, COWs and wall mounted computers on patient interaction and perceive these as preventing them from having a meaningful conversation with the patient. Based on their personal experience using iPads, physicians were able to see the inherent benefits of using iPads in the emergency care environment. Throughout the interviews, physicians discussed specific ideas and different ways in which iPads could be used in the patient room to maintain a conducive, healthy and meaningful patient physician interaction.

While describing the benefits of iPads to the patient physician interaction, physicians described the benefits of iPads towards enhancing patient communication, improving patient education and increasing patient satisfaction. The average patient-physician interaction time in the emergency department is around 7 minutes 31 seconds.<sup>22</sup> During this short time, physicians introduce themselves, collect and verify medical information and carry out subjective and physical examinations putting intense time pressure on providers to effectively communicate with the patient during the short interaction. Adjusting the workstation screen on desktops and laptops; and pushing the COWs in and out of rooms' causes considerable distress to the patient and occupies the physician with non-clinically relevant work hindering their interaction with the patient. On the contrary, if a physician carries an iPad, it can be easily slid away while communicating with the patient and pulled out when they need to document information. Physicians cannot slide away workstations, laptops and COWs in the same manner. Thus, physicians believe that iPads had certain structural benefits which make it possible for physicians to engage in a direct, face to face, meaningful communication with their patients while at the same time benefitting from the use of EMRs.

Patient education is an integral part of the physicians' care giving activities. Approximately 65% of ED patients are discharged home, thus making patient education during ED discharge a high priority.<sup>23</sup> In this study, physicians gave immense importance to patient education and hence pushed for the need to have easy access to state of the art, effective tools like video applications, digital image galleries and access to medical references and dictionaries to give accurate and timely medical advice. With the increased importance of quality initiatives, physicians realize that improving the quality of care is more vital now than ever. Patient satisfaction scores reflect the opportunities for improvement and physicians don't want factors contributing to low scores because of EMR's. Physicians perceived that the use of iPads would enhance patient satisfaction levels. Findings in this study indicated that this perception of physicians arose from two factors. Factor one was that physicians perceived that patient satisfaction would improve if patients felt their providers were making use of cutting edge technology for their treatment. Factor two was that iPads would help maintain, if not improve patient physician interaction as physicians would be able to concentrate on giving their patients their full attention during their interaction resulting in improvements in patient satisfaction.

Physicians perceived better workflow from improvements in access to information, reductions in redundancy by eliminating non clinical value added tasks an increased pace to work processes in the ED and better physician mobility. Physicians' perceived that iPads brought them closer towards an ideal ER workflow and with future customization of the EMR software this goal would be reached. In 2006 a landmark report in the United States showed that the average wait time for patients to be treated by an ED provider was 37 minutes, well above the

recommended maximum of 15 minutes.<sup>23</sup> With iPads, physicians could access this information anywhere, in the patient rooms, computer stations, call rooms or even in the physician lounge. Hence physicians perceived that improved access to patient information would improve physician workflow as it would prevent physicians from shuttling between patient rooms and the computer stations. Numerous studies have shown wait times improvements in ED setting by initiating improvements in triage care and improving access to vital patient or clinical information.<sup>22,23</sup> Thus, physicians understand the importance of having access to vital information, which is a key component to reduce ED wait times and lengths of stay and they strongly believed that iPads would improve information access.

Physicians view desktops and laptops as having considerable non-clinically relevant liabilities when compared to the iPad. Physicians believe that iPads would reduce redundancy by eliminating tasks such as shuttling between patient rooms and the computer station to document and view patient information, adjusting the computer screen on wall mounted computers or pushing the COW's or laptops between patient rooms. It is conceivably difficult to convince physicians to use and adopt a technology which adds more perceived physical work and adds less clinically relevant value to their practice. The iPad eliminates the necessity of carrying out these non-value adding tasks and was a strong factor which promoted the demand of iPads. Physicians are always moving around in the ED between patient rooms, chart racks, the physician station, talking to pharmacists, nurses, care managers and health unit coordinators, printing out orders and a plethora of other tasks which makes them a very mobile group. iPads' allow physicians to be mobile and lets them maintain a portable workflow and still benefit from the benefits of EMR's thus strongly influencing physicians to request the implementation of EMR's on iPads.

Across the nation, an ambulance is diverted away from a crowded ED approximately once every minute.<sup>1</sup> The emergency department has turned into a fast-paced environment that requires rapid patient throughput and high bed capacity to reduce the ED backlog. ED Physicians are willing to adopt and use any device which will help them speed up work processes. Wall mounted workstations require physicians to log in and log out of them in every room every time they want to access patient information or input any information. Desktops require physicians to frequently shuttle between patient rooms and the physician workstation. COWs slow physicians down as they have to push the carts along with them through the unit and in and out of patient rooms. However, with iPads, physicians could hold them in their hands and move around easily. They could directly input orders from the patient rooms without necessarily logging in and out of the system which would also result in the faster turnover of orders and providing support to the use of single log-in clinical applications. Physicians perceived this to be of great benefit in a time strapped environment. Physicians also stated that functionally iPads are faster than computers and laptops; and they based this perception on their personal use of iPads and may be an important factor to assess in more detail.

Physicians believe that implementation of iPads in the ED was the first step towards achieving their ideal workflow. They perceived that future innovations in the EMR software along with future customization and development of tools like iMedical applications would lead them in the right direction. Physicians' sense of an ideal clinical workflow includes iPads with a fully customized EMR where the software seamlessly integrates with the iPad leading to smooth information management. Physicians believed that investing in iPads was one of the first steps towards achieving their ideal workflow.

iPads have certain inherent structural benefits due to its design. Some of its structural features include a touch screen interface which serves as an input and output device along with their light weight and sleek structure. The structural features of iPads add value to its use in the ED since physicians felt comfortable using the touch screen feature which could be attributed to two factors. One, the fact that more than 80% of ED physicians' interviewed owned and used iPads personally. And second, they perceived a sense of ease in using them in a clinical environment since they used them regularly for their personal use. Those physicians who did not own or use iPads perceived that learning to use iPads was instinctive due to touch screen functionality. Physicians' perceived a sense of ease of use and a perception of instinctive learning associated with iPads' touch screens.

Many prior studies have documented physicians' resistance to change.<sup>24,25</sup> A striking reflection of resistance to change comes from an unusual theme where physicians constantly drew parallels between iPads and paper. Physicians perceived less change associated with iPads since iPads and paper are structurally similar, physicians' were more comfortable using iPads than desktops, laptops or COW's as they perceived it would keep the level of change associated to a minimum. Physicians perceived that change management associated with the incorporation of iPads into their daily clinical practice to be easier than incorporating computers. Hospital acquired infections associated with the delivery of care are among the leading causes of death and cause significant morbidity among patients who receive health care. Physicians were particularly interested in the ease with which iPad screens could

be cleaned as compared to a laptop or desktop. Physicians' perceived that iPads don't have an inbuilt fan to cool its processing unit which would considerably limit the circulation of air compared to laptops and desktops. Future infection control studies of handheld devices will be needed to validate these perceptions of physicians.

## Conclusion

To summarize, physicians perceived that iPads would enhance patient-physician interactions by enhancing patient communication, improving patient education and increasing patient satisfaction. They also felt iPads would improve their workflow by improving access to vital information, reducing redundancy, enabling physician mobility and helping to speed up work processes within the ED. Physicians perceived iPads as an integral part of their ideal workflow and were optimistic about future developments in the EMR software which would enable customization to suit their needs. Based on their personal experience using iPads, physicians were able to discern structural benefits of iPads over desktops and laptops like the touch screen functionality and ability for instinctive learning. Physicians were able to easily grasp the concept of touch screen systems and perceived it as easier to use compared to computers and desktops and also believed that iPads may have certain benefits from an infection control perspective. More than 80% of the physicians from both ED's owned and used iPads for their personal use. Satisfaction from personal use of a particular technology is a strong impetus for users to employ the same technology for their professional use. Furthermore, with tablet technology, Apple has been the leader for many years controlling 73% of the global market share.<sup>26,27</sup> By 2012, analysts predict global tablet sales to hit 88 million units, with Apple selling at least 64 million iPad tablets.<sup>27</sup> iPads' are thus by far the most famous of handheld tablets which have been informally tested and adopted by physicians by their personal use. Due to all these factors ED physicians perceived that iPads would integrate in an easier and smoother fashion in an emergency care setting. The introduction of iPads with EMR's has the potential to become a fruitful realm for research within the field of biomedical informatics.

## References

1. Ash JS, Sittig DF, Campbell EM, Guappone KP, Dykstra RH. Some unintended consequences of clinical decision support systems. . 2007;2007:26.
2. Ash JS, Sittig DF, Poon EG, Guappone K, Campbell E, Dykstra RH. The extent and importance of unintended consequences related to computerized provider order entry. *Journal of the American Medical Informatics Association*. 2007;14(4):415-423.
3. Burton LC, Anderson GF, Kues IW. Using electronic health records to help coordinate care. *Milbank Q*. 2004;82(3):457-481.
4. Garvin R, Otto F, McRae D. Using handheld computers to document family practice resident procedure experience. *FAMILY MEDICINE-KANSAS CITY*-. 2000;32(2):115-118.
5. Lu YC, Xiao Y, Sears A, Jacko JA. A review and a framework of handheld computer adoption in healthcare. *Int J Med Inf*. 2005;74(5):409-422.
6. McLeod TG, Ebbert JO, Lymp JF. Survey assessment of personal digital assistant use among trainees and attending physicians. *Journal of the American Medical Informatics Association*. 2003;10(6):605.
7. Vishwanath A, Brodsky L, Shaha S, Leonard M, Cimino M. Patterns and changes in prescriber attitudes toward PDA prescription-assistive technology. *Int J Med Inf*. 2009;78(5):330-339.
8. DesRoches CM, Campbell EG, Rao SR, et al. Electronic health records in ambulatory care—a national survey of physicians. *N Engl J Med*. 2008;359(1):50-60.
9. Prgomet M, Georgiou A, Westbrook JI. The impact of mobile handheld technology on hospital physicians' work practices and patient care: A systematic review. *Journal of the American Medical Informatics Association*. 2009;16(6):792-801.
10. Buchauer A, Pohl U, Kurzel N, Haux R. Mobilizing a health professional's workstation--results of an evaluation study. *Int J Med Inf*. 1999;54(2):105-114.
11. Hersh W. A stimulus to define informatics and health information technology. *BMC Med Inform Decis Mak*. 2009;9:24. doi: 10.1186/1472-6947-9-24.
12. Beynon-Davies P. Human error and information systems failure: The case of the london ambulance service computer-aided despatch system project. *Interact Comput*. 1999;11(6):699-720.



13. Francis JJ, Eccles MP, Johnston M, et al. Constructing questionnaires based on the theory of planned behaviour. *A manual for health services researchers*. 2004.
14. Embi PJ, Yackel TR, Logan JR, Bowen JL, Cooney TG, Gorman PN. Impacts of computerized physician documentation in a teaching hospital: Perceptions of faculty and resident physicians. *Journal of the American Medical Informatics Association*. 2004;11(4):300-309.
15. Richardson JE, Ash JS. The effects of hands-free communication device systems: Communication changes in hospital organizations. *Journal of the American Medical Informatics Association*. 2010;17(1):91.
16. Glaser BG, Strauss AL. *The discovery of grounded theory: Strategies for qualitative research*. Aldine; 1967.
17. Friedman CP, Wyatt J. *Evaluation methods in biomedical informatics*. Springer Verlag; 2006.
18. Ash JS, Gorman PN, Lavelle M, Lyman J. Multiple perspectives on physician order entry. . 2000:27.
19. Strauss A, Corbin JM. *Basics of qualitative research: Grounded theory procedures and techniques*. Sage Publications, Inc; 1990.
20. Hsu J, Huang J, Fung V, Robertson N, Jimison H, Frankel R. Health information technology and physician-patient interactions: Impact of computers on communication during outpatient primary care visits. *Journal of the American Medical Informatics Association*. 2005;12(4):474-480.
21. Ball MJ, Lillis J. E-health: Transforming the physician/patient relationship. *Int J Med Inf*. 2001;61(1):1-10.
22. Rhodes KV, Vieth T, He T, et al. Resuscitating the physician-patient relationship: Emergency department communication in an academic medical center. *Ann Emerg Med*. 2004;44(3):262-267.
23. Horwitz LI, Green J, Bradley EH. US emergency department performance on wait time and length of visit. *Ann Emerg Med*. 2010;55(2):133-141.
24. Bhattacharjee A, Hikmet N. Physicians' resistance toward healthcare information technology: A theoretical model and empirical test. *European Journal of Information Systems*. 2007;16(6):725-737.
25. Lapointe L, Rivard S. A multilevel model of resistance to information technology implementation. *Mis Quarterly*. 2005;29(3):461-491.
26. Kolakowski N. *Apple iPad, iPhone Expected to Boost Quarterly Numbers*. *eWeek*, April 18, 2010. 2010.
27. Hung G. *Apple iPad user analysis*. Retrieved October. 2010;23:2011.