IPAD USAGE AND IMPACT ON PEDIATRIC MEDICAL
STUDENTS’ LEARNING AND PATIENT CARE

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Background and Aims: The advent of mobile technologies has stimulated an academic shift in medical education from traditional methods to mobile teaching and learning. This study investigated medical students’ current and anticipated iPad usage as well as perceived impact of iPads on their learning and patient care. The ultimate purpose of the inquiry was to improve future implementation processes.

Methods: Twenty-three iPads were loaded with applications including Cerner Citrix Receiver, question banks, review texts, DynaMed, and the iTunes U application that contained clerkship curriculum. Fifty-eight students used the iPads during a Pediatrics rotation and filled out a survey upon completion. Descriptive statistics were generated from quantitative responses while thematic analysis was used to summarize ideas from qualitative responses. An exploratory mixed methods approach was used to integrate qualitative and quantitative findings. T-tests were used to determine differential usage as a function of prior iPad ownership and experience.

Results and Conclusions: Students variably used iPads to access question banks, didactics and review texts, conduct internet searches, and monitor patient information. IPads were most used compared to other electronic and print sources with cited advantages of portability, convenience, instant accessibility, enhancement of professional conduct, and time management. Respondents proposed other areas in which iPads could be used in the rotation. This highlighted the need to expand our iPad initiative to cover other aspects of learning. Given that prior iPad ownership and experience did not determine differences in usage, the observed variability in iPad usage suggests mere diversity of baseline needs.

Introduction
The advent of mobile technologies in recent years has stimulated an academic shift in medical education from traditional methods to mobile teaching and learning. This has significant implications on medical students’ ability to function in the increasingly evolving healthcare environment. To date, several medical schools worldwide have integrated electronic devices in their curricula. Of the several mobile technologies currently used, the iPad appears...
to be the most popular.\textsuperscript{2-4} For example, Baum et al. cited by Omori et al.\textsuperscript{3} estimated that by the year 2012, nearly 25% of medical schools in the United States had incorporated iPads as teaching and learning tools. Some medical schools provide iPads to students for use while others make it mandatory for students to have iPads. Undoubtedly, most medical schools will integrate iPads into their curricula in the near future.

In spite of this reported widespread integration and use of iPads in medical education curricula, there is little published research on trends in iPad usage and perceived effectiveness.\textsuperscript{4} The limited available research has shown conflicting results. On one hand, research has shown high frequency in iPad use by medical students especially during clinical years to access medical references, eBooks, patient information, and to study for board exams.\textsuperscript{3} Prior research has also shown positive attributes of iPad use, which include portability and efficiency,\textsuperscript{1} instant access to information,\textsuperscript{4} and stimulation of learning.\textsuperscript{5} Not surprisingly, iPad usage has been linked with better test performance. For example, a study by Comstock, cited by Robinson and Burk\textsuperscript{1} at the University of California Irvine showed that medical students who were given iPads scored 23% higher on national examinations than previous classes. On the contrary, other studies have shown limitations and underutilization of iPads in educational matters by medical students. For example, a study by Vafa and Chico\textsuperscript{6} with medical students at two medical schools in the United States revealed that only half of the students used iPads for education purposes.

Another study by Curtis and Cranmer\textsuperscript{7} at the University of Manchester revealed similar limitations in understanding, capabilities, and subsequent use of iPads by medical students for educational purposes.

Given reported variations in iPad usage and perceived impact on students’ overall learning, it is clear that we cannot extrapolate findings from one medical school and apply it to another. We, therefore, sought to evaluate how our own students used and perceived the iPad technology in relation to their learning and patient care. We found it crucial to evaluate the initiative during the early stages in order to improve future implementation processes.

**Methods**

This study was conducted at the University of Missouri-Kansas City (UMKC) medical school. UMKC is one of the few medical schools in the United States that offer an accelerated combined BA/MD program based on a six-year curriculum. The Department of Pediatrics first integrated iPads into their curriculum in November, 2013. We purchased twenty-three second and third generation iPads for students to use during the Pediatrics rotation. Following literature searches and feedback from students, we paired the iPads with individual Apple user accounts and loaded them with several applications that we believed would enhance students’ learning and efficiency in patient care. Added applications included Cerner Citrix Receiver, question banks (e.g. U-World) and review texts (e.g. Blue Prints), Milestones, DynaMed, X-ray cases, and VisualDx. We also loaded the iTunes U application that contained clerkship curriculum such as the syllabus, lectures, video tutorials, articles, and helpful website links. Due to budget constraints, Case Files, Heartpedia, Socrative, and PubMed on Tap were added eight months after the initial launch. All students who were taking the Pediatrics rotation were encouraged to check out an iPad. Students signed an agreement on understanding appropriate usage, to be Health Insurance Portability and Accountability Act compliant, and also to take responsibility of replacing the iPad should damage be done. Thereafter, students were given an orientation on how to use the iPad and its applications. However, they would use the loaded applications at their own discretion.

We then conducted a survey to determine participants’ experiences with the iPad initiative. Survey items solicited participants’ prior ownership and experiences with iPads, current uses in comparison to other electronic and print sources, anticipated uses, perceived impact of iPad use on learning and patient care, as well as challenges experienced with iPad use during the rotation. Following approval by the UMKC Institutional Review Board; study ID: 13-971, we distributed the survey to prospective participants via email at the end of each two-month rotation. Completion of the survey was voluntary and anonymous. Data was collected from November, 2013 to January, 2015.

Quantitative data were analyzed using Statistical Package for Social Scientists (SPSS) version 21. We first calculated frequency distributions and obtained data are presented as percentages. We then conducted t-tests to determine whether current and anticipated uses were dependent on prior ownership and experience in iPad use. To examine the efficacy of the iPad initiative, we further conducted t-tests to determine statistical differences in NBME subject
exam scores between the pre-implementation and implementation periods.

We also collected qualitative data through free writing where participants were asked in the survey to describe their experiences of using iPads in relation to their learning and patient care. Free writing provided more sentiments that were not captured by quantitative responses. Data generated from free-writing were analyzed through thematic content analysis, which quantified qualitative data by identifying consistencies. We used emergent coding in which we analyzed phrases from a few participants to formulate categories upon which data from the remaining participants were coded.

Results

This study investigated medical students’ current and anticipated iPad usage as well as perceived impact of iPad usage on learning and patient care in a Pediatrics clerkship. A total of 129 students were issued iPads over a 14-month period. We distributed the survey to all 129 students upon completion of the rotation and 58 students completed the survey for a 45% response rate. All the 58 participants provided both quantitative and qualitative responses. Sixty percent of the participants owned an iPad and had substantial experience using iPads prior to the rotation whereas 70% found iPads to be very easy to use for the rotation.

Patterns in iPad usage

We explored the frequency within which participants had used iPads for various tasks throughout the rotation. Quantitative results showed that participants used iPads most frequently to access question banks. iPads were, however, moderately used for internet searches, reviewing texts, and accessing didactics from instructors. Journal articles were least accessed through iPads. Figure 1 summarizes our quantitative findings on iPad usage. Other iPad uses were expressed through qualitative responses. Respondents accessed patient information at the beginning of the rounds and continuously used iPads to monitor updated information:

I liked having Cerner on the iPad because there were not always computers available to look up patient information or the patient list or schedule. . . . I thought it was also helpful on rounds to look up any new consult notes on the patient that was not in before rounds started.

In addition to searching for information, other participants reportedly used iPads for emailing and note-taking:

I used [the iPad] often to write notes for patients during down time. I really enjoyed having the syllabus on the tablet, and the ability to email myself the forms that we needed to complete.

We also determined participants’ iPad usage in comparison to other electronic devices (e.g. desktop/laptops, smart phones) and print sources. To that effect, we asked respondents to indicate in the survey the means through which they had accessed various resources for the clerkship during the rotation and responses ranged from Did Not Use = 0, to Very Often Used = 3. Results showed that participants accessed question banks most often through iPads followed by desktop/laptops.

Figure 1: Percentages of iPad usage for accessing outlined clerkship resources, N = 58
and smart phones whereas hard copies were least used. However, when it came to internet searches, they most often used desktop/laptops followed by iPads and smart phones. Access to review texts and didactics through iPads was moderate whereas hard copies were also moderately used. Desktop/laptops and phones were least used to access review texts. Participants rarely accessed journal articles through all the devices (See Table 1).

We further examined whether usage of devices was dependent on prior ownership and experience. Our results did not show major differences except that participants who owned iPads prior to the rotation tended to use smart phones to access didactics significantly more than those who did not (t = 2.311, p = .027). Furthermore, participants who were more experienced with iPad use prior to the rotation used desktop/laptops to access journal articles more frequently than the less experienced ones (t = 2.015, p = .049). However, when Bonferroni corrections were applied to correct for multiple comparisons, none of these differences were statistically significant.

Perceived impact and advantages of iPad usage

We identified five main advantages from both quantitative and qualitative responses pertaining to the positive impact and advantages of iPad usage on learning and patient care, namely: portability, convenience and ease of use, instant and constant accessibility of information and resources, enhancement of professional conduct, and time management. Each of these perceived advantages are elaborated in sections below.

### Portability

Consistent with findings from previous studies, participants in this study cited portability as one major advantage of using iPads especially during clinical rounds. These sentiments are echoed in the excerpts below:

> Having everything we needed in one spot from the syllabus and schedules to study materials to being able to access patient charts from Cerner. All of this provided for many and all opportunities to facilitate my learning with each patient case we had on rounds.

> I liked that many questions banks such as pretest and books like case files were on it. It was easier to carry the iPad everywhere I went rather than carry a couple of books and plus the iPads had many other resources that were useful for rounds.

### Convenience and ease of use

In addition to portability, respondents cited convenience and ease of use as another major advantage of using iPads. This is what one participant had to say:

> Quite honestly, the iPad on this rotation made me realize how much better it is to do questions on a tablet than a desktop or one's phone. I did significantly more questions than I would have without the iPad.

### Instant and constant accessibility of information and resources

Participants also expressed how iPads had made relevant information and resources instantly and constantly accessible. This is what some respondents had to say:

> … It makes it a lot easier to put in orders if we ever needed to or to look up something about a patient if we needed to know something right away such as whether a

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*Table 1: Percentages of iPad usage in comparison to other electronic and print sources, N = 58*
specific lab had come back, if a consult team had written
a note, etc. It was extremely helpful and makes the
rotation run very smoothly.

I thought it was also helpful on rounds to look up any
new consult notes on the patient that was not in before
rounds started. It was also helpful to monitor lab and
imaging results during rounds if the results were not
available before rounds.

**Time management**

Given the reported instant and constant accessi-
bility of information, it was not surprising that a
number of participants expressed that the iPads had
greatly eased their time management. One of the
quantitative survey items asked participants to rate
the overall impact of iPad use on their study time
and 60% attested that the use of iPads had increased
their study time. The positive impact of iPad use on
time management was reiterated in the following
qualitative responses:

- It increased my study time during down time during the
  rotation. Usually I would have just sat around and tried
to look busy, but having a study source allowed me to
  utilize this time.
- Having the iPad allowed me to always have access to my
  study materials, causing me to study in any down time
  that I had rather than just wasting it.

**Professional conduct**

It was interesting for participants to express that the
use of iPads in clinical rounds had enhanced their
professional conduct as compared to using other
mobile devices like iPhones:

- Ability to look up things on iPad during rounds that I
  would normally have done on my own phone, but now, it
doesn’t look so bad doing that on an iPad versus it looks
like I’m texting and not paying attention if I do it on my
phone.
- iPad provided multiple resources at the touch of a finger
  and also seemed more professional to use during rounds
  than phones.

We also wanted to determine if the reported
advantages of iPad use expressed in the survey
would correlate with students’ performance. Using
t-tests, we compared mean scores of two-month
rotations of the iPad implementation period with
the corresponding rotations of the previous years
prior to the iPad initiative. Results showed a
significantly higher mean score only for the May/
June rotation of the implementation year compared
to the corresponding May/June rotation of the pre-
implementation year ($t = 1.960$, $p = .05$).

**Perceived challenges of iPad usage**

Participants also identified some challenges with the
use of iPads during the Pediatrics rotation. One
recurrent issue was the difficulty posed by the iPads
when taking notes due to absence of the keyboard.
One participant said:

- I did not like using the iPad to write notes. It was very
difficult without a keyboard to write patient notes, or
take any other notes during didactics.

Although a majority of participants found the iPad to
be portable, a few others found it burdensome to carry
during clinical rounds especially given that it did not fit
in their pockets. One participant reiterated:

- The case that the iPad was in was quite bulky and thus
cumbersome to carry around the hospital. Also, because
there was not safe storage available at the hospital, it
became a hassle to carry around the iPad at all times.

While a majority of participants found the iPad to be
convenient, some felt it made text difficult to read.
Other participants, however, as a matter of mere
preference, accessed hard copies of some of the
clerkship resources regardless of their availability
on their iPads:

- I just really only used it for questions and internet access
to look things up. While I appreciate that Blueprints and
Case Files were on there, I’m not an e-text kind of person, I
prefer printed versions to highlight and take notes.

**Anticipated iPad uses**

We also solicited participants’ anticipated iPad
usage. As shown on (Figure 2), most participants
proposed to use iPads for reviewing several video
tutorials. A significant majority also preferred to use
iPads for reviewing simulation videos and accessing
videotaped didactics. A moderate to high number of
participants preferred to use iPads to evaluate peers,
watch video tutorials on how to write an effective
patient note, and also as a presentation tool. Note-
taking was the least anticipated use (See Figure 2).

Participants also provided valuable suggestions that
greatly improved our implementation process. For
example, a few of them raised logistical concerns
such as internet connectivity and hygiene issues
associated with iPad use. Others suggested to have
the applications loaded on their personal iPads
instead of having to check out an iPad from the
department:

- Because I also own an iPad, I carried around two iPads
for a lot of the rotation. It would be nice if there was an
option to put the resources on to our personal iPads at least for the duration of the rotation.

We further investigated whether anticipated iPad usage was different as a function of prior ownership and experience in iPad use. Our results showed no major significant differences except that participants who owned iPads prior to the rotation anticipated to use them for note-taking significantly more than those who did not (t = 2.134, p = .037). Similar trends were observed with experienced and less experienced users (t = 2.058, p = .046). However, the differences became statistically insignificant when we applied Bonferroni corrections for multiple comparisons.

Discussion

This study investigated medical students’ current and anticipated uses as well as perceived impact of iPad use on learning and patient care in a Pediatrics clerkship. Consistent with prior findings, we observed high to moderate iPad usage to access question banks, review texts and didactics, conduct internet searches, and monitor patient information.

The observed variability in iPad usage may have emanated from the fact that loaded applications were to be used at the students’ discretion. Given that prior ownership and experience did not determine much variability, differences in current and preferred uses possibly stresses the need for an increased awareness of the diversity of baseline needs and interests of the users.8

Participants in this study used iPads to access updated patient and research-based information for informed decision-making during their clinical rounds. Given the contributory role of inadequate access to information on medical errors, having readily available information at the point of care through iPads, as reported in this study, may undoubtedly enhance medical students’ efficiency in patient care.10

Our comparison of iPad use with other electronic devices and hard copies revealed a general preference of digital devices, preferably iPads, over print sources. This is consistent with findings by Lombardo2 and Omori et al.,3 which showed high frequency in tablet usage over print sources, with iPads being most popular. This suggests that iPads may be important tools for medical educators to consider. Undoubtedly, medical students are inclining towards the digital age; however, the fact that a third of the participants still preferred and accessed hard copies of review texts regardless of their availability on iPads implies that print resources still remain useful.

Participants outlined various ways in which iPads contributed to their learning and efficiency in patient care. Specifically, they perceived iPads as having eased their time management. This is consistent with findings from a previous study by Korbage11 where iPad use was generally linked with increase in study time. Portability, convenience, and ease of use were cited as main contributions of iPads on time.
management. Differences in opinion about the impact of iPad use on study time reported could be a result of the differential use of self-selected applications.

Participants in this study cited enhancement of professional conduct as one positive contribution of iPads to patient care. Prior research has noted concerns over professionalism with iPhone usage during clinical rounds. Not surprisingly, participants expressed that the replacement of iPhones with iPads had enhanced their patient care during clinical rounds by allowing them to learn from iPads without fear of being perceived as unprofessional.

Findings from this study unveiled other anticipated iPad uses, which include reviewing several video tutorials and videoconferencing. With more innovation, our current iPad initiative can, thus, be broadened to cover several other aspects of learning. Additionally, while a substantial number of participants showed strong desire to use iPads for note-taking, some raised concerns on the difficulties faced when using iPads for note-taking and typing of patient notes. This can be overcome by supplementing the iPads with external keyboards to facilitate easier typing. Further, with the upgrading of iPad models and the cerner electronic medical record app, there is an improved dictation function which may allow students to dictate their notes and patient documents, eradicating the need for a keyboard altogether. Downsizing to the iPad Mini may address student concerns of the current iPads being heavy due to size. Importantly, a few participants raised hygiene issues with the use of iPads during clinical rounds. Studies have since documented the possibilities of mobile devices acting as vehicles of pathogen contaminants in clinical rounds. It is, therefore, advisable to make students more aware of currently available decontamination programs suitable for cleaning iPads. At this time, we will encourage our students to use isopropanol alcohol wipes daily on used devices which have been shown to substantially decrease the bacterial load acquired from use in patient care.

**Conclusion**

Findings from this study should be considered in light of potential limitations. The study was conducted at one medical school with a sample of 58 participants, which potentially limits the generalizability of the findings. Although this limitation precludes wider generalizations, the findings have unveiled several trends in iPad usage as well as additional ways in which we could broaden our iPad initiative to cover several other aspects of learning. Findings from this study may, thus, provide helpful insights especially to other clerkships within and outside our institution who may want to launch similar initiatives.

Of note, All authors have completed the Unified Competing Interest form at www.icmje.org/coi-disclosure.pdf (available on request from the corresponding author) and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work.

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