Introducing Handheld Computing into a Residency Program: Preliminary Results from Qualitative and Quantitative Inquiry

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ABSTRACT

Although published reports describe specific handheld computer applications in medical training, we know very little yet about how, and how well, handheld computing fits into the spectrum of information resources available for patient care and physician training. This paper reports preliminary quantitative and qualitative results from an evaluation study designed to track changes in computer usage patterns and computer-related attitudes before and after introduction of handheld computing. Pre-implementation differences between residents' and faculty's usage patterns are interpreted in terms of a "work role" construct. We hypothesize that over time residents and faculty will adopt, adapt, or abandon handheld computing according to how, and how well, this technology supports their successful completion of work role-related tasks. This hypothesis will be tested in the second phase of this pre- and post-implementation study.

INTRODUCTION

Undergraduate and graduate medical education programs across the country are exploring the utility and desirability of using handheld computers in patient care and teaching[1-2]. Because handheld computing is relatively new, many published reports are descriptive reviews and recommendations of hardware and software capabilities.[3] It seems likely that research about handheld computing in academic medicine will develop along a path similar to that of electronic medical records (EMR), which are now being rigorously evaluated in the contexts of teaching and patient care.[4-5]

Organizational context itself may prove to be important in understanding how handheld computing fits into patient care and medical training. Because of the need to understand context, evaluation research should include qualitative as well as quantitative components.[6]

SETTING

This study is being conducted at UPMC St. Margaret, a community-based hospital with associated outpatient health centers which is part of the UPMC Health System integrated delivery network in Pittsburgh, Pennsylvania region. The hospital is home to a three-year Family Practice residency program founded in 1969, as well as the region's only family practice faculty development fellowship program.

Three factors contributed to the decision to invest in handheld computing: (1) the residency's and fellowship's strong commitment to using up-to-date information technologies for patient care, research, teaching, and life-long learning (2) an active resident, faculty, and staff Medical Informatics Committee which evaluates and recommends information technology options, and (3) consensus among faculty and residents that learning to integrate handheld computing into patient care, research, and teaching would increase the organization's readiness to adapt to electronic medical records (EMR) when a system become available to us.

Under the guidance of our Director of Medical Informatics, our "Handheld Computing Initiative" began in spring 2000. Interested faculty, residents and fellows researched different handheld devices, operating systems, options, and available software and shared this information in weekly meetings (called "Palm Readings"), resulting in selection of a Palm-operating-system handheld device with add-on memory. The group also selected six software packages to be loaded as "standard" software in addition to the computer's built-in software functions. As a final preparatory step, all faculty, fellows and residents attended a 1-hour "Introduction to Handheld Computing" workshop prior to receiving a handheld computer. After the devices were distributed, all participants attended three additional training workshops, "Introduction to Palm Operating System," "Introduction to Basic Handheld

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Applications," and "Advanced Handheld Applications." These small-group workshops were taught by fellows and faculty using didactic instruction and hands-on practice and were evaluated by 10-item multiple-choice quizzes.

This study is part of a multi-strategy evaluation of the impact of handheld computing upon this residency program. Our objective is to identify changes in physician computer usage practices, electronic information resource utilization patterns, and computer-related attitudes resulting from the introduction of handheld computing, within the context of the residency training program and patient care in both hospital and outpatient settings.

METHODS

This evaluation of the introduction of handheld computing into a residency program will use the following quantitative and qualitative methods: 1) pre-implementation survey of all physician and non-physician clinical faculty and housestaff (n=60), 2) post-implementation survey of the same subjects at 7-8 months, 3) brief interviews with a judgment sample (n=8) of residents and faculty conducted between 8-12 weeks after initial distribution of the handheld computers, and 4) follow-up longer interviews with the same sample of residents and faculty at 7-8 months. *For this preliminary analysis, we had results only from (1) the pre-implementation survey and (3) the brief interviews.*

Fifty-three subjects (35 residents and 18 faculty) completed the pre-implementation survey in October 2000. All of the subjects completed the four required training workshops and were still working at UPMC St. Margaret at the time of the brief interviews in December 2000-January 2001. Subject anonymity was maintained by assignment of a unique identifier code to each subject. Statistical analysis was performed using the Statistix statistical package. The independent variable was group (resident or faculty); ordinal dependent variables were analyzed using the Kruskal-Wallis non-parametric AOV, while nominal dependent variables were analyzed using chi-square.

Pre-implementation survey. Participants were required to complete their pre-implementation surveys before receiving their handheld computers. Ninety percent of surveys were completed on the first day the devices were available. Our survey instrument was adapted from the Gadd and Penrod[7] version of a validated instrument developed by Cork, et al.[8], (itself rooted in the original work of Teach and Shortfliffe[9]). Survey items asked about demographics; clinicians' current patterns of computer use for specified tasks relevant to patient care, teaching and learning, research, and communication; frequency of use of e-mail, personal productivity software, the internet, on-line university health sciences library resources, and remote access from home; subjects' previous training or experience with computers; and subjects' opinions regarding the potential effects of computers on medicine and health care in general as well as potential effects of handheld computing in their practice. The "potential effects" items were adapted for handheld computing from Gadd and Penrod.

The survey also included a "feature demand" section that asked how "necessary" subjects thought specified "capabilities" would be in a handheld computer (paralleling the "feature demand" attribute identified in the Cork et al. study). The "capabilities," chosen in consultation with expert handheld computer users, included the capability to: access Internet and e-mail; enter data; protect personal and patient data; automatic updating of patient orders or data; learn user's handwriting; access available drug formulary drug interaction database, and personal organization software; ease of use; ability to send and receive documents; be used as a pager or calculator, and fit into shirt or lab-coat pocket.

Based upon the Cork et al. finding that self-assessed "computer sophistication" was highly correlated with the "computer knowledge" questions asked in that study, we used a single "computer sophistication" self-assessment question (*"On the whole, how sophisticated a computer user do you consider yourself?"*) with a Likert scale response option (1=very sophisticated; 5=very unsophisticated) as a proxy for computer knowledge. This step allowed us to reduce the size and complexity of the questionnaire and to legitimately present it as an "attitude study" to subjects (which reduced anxiety for those subjects who perceived themselves as not very knowledgeable about computers).

Brief interviews. Several months after the pre-implementation survey was completed, brief interviews were conducted with a judgment sample of two faculty and six residents (two from each resident class). The sample was designed by a clinical faculty member who reviewed each interviewee's quiz and self-evaluation scores from the four workshops. The sample included residents and faculty who appeared, in this faculty member's judgment, to be <u>most</u> and <u>least</u> experienced, comfortable and knowledgeable with handheld computing. (Subsequently, we assessed the construct

validity[10] for this sample using the pre-implementation survey results for the "self-assessed computer sophistication" item. The mean "self-assessed computer sophistication" score (1="very sophisticated," 5="very unsophisticated") was 2.75 for the "most sophisticated" group and 4.25 for the "least sophisticated" group.) Interviews were conducted one-on-one in a private conference room and were not video or audiotaped; rather, the interviewer took detailed handwritten notes. Each subject was asked:. "*At this point, what are you finding most and least useful about your handheld computer*?"; "*What do you think is the potential of handheld computing for improving your clinical practice*?"; "*What do you think is the potential of handheld computing for improving your own learning and teaching about medicine*?"; *"How will handheld computing change the residency education experience*?"; "*Overall, do you think handheld computing will pay off? If so, what are the most important advantages? The most important disadvantages*?" Content analysis was performed on the interview notes[11] focusing on: (1) names of software applications used; (2) descriptive statements about how the handheld computer or specific software applications were used in practice, teaching or other ways, (3) evaluative statements about the utility, enjoyability, or desirability of the handheld computer or specific software applications and (4) evaluative references to influence of the handheld computer or specific software applications upon the residency program as a whole. For this preliminary inquiry, only the researcher analyzed the transcripts.

RESULTS

Pre-implementation survey. Residents and faculty reported different pre-implementation computer usage patterns and training experiences; however, only differences in uses of e-mail and in accessing clinical data using a computer were statistically significant (Table 1); the two groups also differed significantly in several of their expectations about the potential impact of handheld computing upon their practices (Table 2).

In the section on handheld computing's "capabilities," residents differed significantly from faculty only on the "ability to recognize a user's handwriting with few or no errors" ($p<=.10$). No significant differences were found on the basis of gender. Age group was slightly negatively correlated (-0.50) with frequency of accessing clinical data using a computer and preparing presentations using a computer. All of the resident and faculty subjects who had used a handheld computer prior to the Handheld Initiative Program were in the youngest age group (25-34 years old).

Brief interviews. Residents and faculty alike labeled "most useful"" the diagnosis, dose calculator, and drug database software applications, along with the built-in address and datebook functions. Judged "least useful" in these early interviews were the drug interaction database and the memo/money manager. The procedures database was considered to be potentially very useful but more difficult to use.

In response to the question about "improving clinical practice," residents cited the ability to look up drug and diagnosis information "*on the fly*." Residents' comments about the role of handheld computing in teaching and learning, its impact upon the residency program, and its overall "payoff" reflected a range of ideas about learning and the residency program as a training environment: "*You use it differently, more formulas, in the hospital, in outpatient more for drug doses*"; "*I definitely learn more if I look up one thing about each thing I see in the clinic*"; "*If I need to know something, especially when on call, can look things up ... before, going so fast can't get to details*"; "*Having information available at the point of care might change interaction with preceptors, because I can say 'I look it up and I already know ... it isn't ... sinusitis*"; "*Having a lot of information more ready at point-of-care really can't be overestimated; it's a huge difference in the hospital.*"

Faculty were more reserved about point-of-care advantages, describing the drug database and diagnosis software more as optional reference material than dynamic additions to real-time diagnosis and management. Faculty also expressed more training program-related thoughts: "*These skills will be transferable ... positively changed comfort about transition to EMR*"; "*I will now expect that drug dosages will be checked.*" Neither residents nor faculty saw many disadvantages other than training time and hardware/software problems, primarily system "crashes."

DISCUSSION

Looked at together, survey and interview findings suggest a pattern of differences in how these two groups perceive and use the handheld computer as an information resource. We hypothesize that these differences are rooted in different *work roles*. Work role is a complex concept that constellates elements of *task* and *stage of professional development.*[12] Residents' primary tasks include caring for patients in the hospital and outpatient health center,

Table 1. Selected Pre-implementation Computer Usage & Experience Items, Faculty and Residents

Pre-Implementation Profile	Residents	Faculty
Number of respondents	35	18
Modal age group	25-34 (91%)	45-54 (39%)
Percent female	57%	39%
Mean, self-assessed "computer sophistication" (1="very sophisticated, 5="very unsophisticated")[1]	**3.26 (SD .92)**	**3.72 (SD.96)**
Mean, "hands-on" hours per week of computer use	7.62 (SD 6.06)	7.56 (SD 4.34)
Percent using web-based e-mail[4]	**51%**	**6%**
Percent communicating with clinical colleagues via e-mail[3]	**35%**	**83%**
Percent communicating with patients via e-mail[2]	**0%**	**17%**
Percent communicating with faculty via e-mail[4]	**29%**	**83%**
Percent accessing user groups or listservs via e-mail[3]	**18%**	**56%**
Percent who have attended workshops or conferences on computers for which CME credit was *not* awarded[3]	**23%**	**67%**
Mean, frequency of accessing clinical data (e.g. laboratory tests, radiology reports) using a computer (1=never, 4=always)[4]	**3.0 (SD .66)**	**1.9 (SD .86)**

[1]Difference significant <.10 [2]Difference significant <.05 [3]Difference significant <.01 [4]Difference significant, =.001

Table 2. "Potential Effects of Handheld Computing on Your Practice" Survey Items, Faculty and Residents
(Mean scores; 1=highly detrimental, 5=highly beneficial)

Pre-Implementation Profile	Residents	Faculty
Time required for documentation (e.g., progress notes)[2]	**3.66 (SD .91)**	**3.11 (SD .83)**
Quality of health care	3.89 (SD .58)	3.78 (SD.55)
Communication within the health care team[2]	**4.00 (SD .59)**	**3.61 (SD .50)**
Accuracy of patient data	3.97 (SD .62)	3.72 (SD .46)
Availability of patient data	4.17 (SD .51)	4.06 (SD .54)
Care plan follow-up between patient encounters	3.77 (SD .77)	3.76 (SD .75)
Patient privacy[1]	**3.17 (SD .82)**	**2.78 (SD .65)**
Clinicians' accountability for care provided	3.40 (SD .65)	3.33 (SD .69)
Rapport between clinicians and patients	3.20 (SD .68)	3.22 (SD .73)
Patient satisfaction	3.43 (SD .65)	3.22 (SD .73)
Clinicians' access to up-to-date knowledge	4.46 (SD .45)	4.22 (SD .55)
Actual & potential prescribing errors[3]	**4.37 (SD .60)**	**3.89 (SD .47)**

[1]Difference significant <.10 [2]Difference significant <.05 [3]Difference significant <.01

presenting outpatient cases for precepting (one-on-one teaching about individual patients) by faculty, independent learning, and teaching junior residents and medical students on call, in lectures, etc. Thus it is not surprising that residents hoped for help from handheld computers on four urgent patient care issues: "availability of patient data"" "communication within the health care team," "access to up-to-date knowledge," and "actual and potential prescribing errors" (Table 2). Faculty's primary tasks include in- and outpatient precepting, continued independent learning, and teaching residents and medical students on inpatient rounds, in lectures, etc. as well as patient care. The faculty's "handheld potential" wishlist resembles the residents', but "quality of health care," and "care plan follow-up"" are high on their list too (Table 2). Although faculty and residents have some tasks (patient care and teaching) in common, residents and faculty are at different stages of professional development so their focus is different: although both residents and faculty provide patient care, the resident's focus is to learn while the faculty's focus is to teach the resident to be a good doctor.

The work-role perspective helps explain why residents are so much more likely than faculty to access clinical data using a computer (Table 1): residents are the front line of care in the hospital where laboratory data and radiology reports are available on-line. Faculty do see these reports, but are more likely to see them on work or teaching rounds

after a resident has accessed them. The work-role perspective also offers a possible explanation for the observed --- counter-intuitive --- differences between faculty' and residents' use of e-mail to communicate with clinical colleagues, patients, and faculty: faculty have longer continuity relationships with all three audiences than do residents, thus they are more likely to establish appropriate e-mail uses with these audiences. Residents rely on pagers for needed synchronous communication with their clinical colleagues, who are fellow residents.

Data from the brief interviews are generally consistent with the hypothesis that residents and faculty employ their handheld computers differently as they go about their work. For example, having diagnosis and drug information resources at the point of care seems to alter residents' interactions with patients, faculty and other residents by helping them generate better questions and answers, often more quickly: "*I can look up stuff between patients, this makes me quicker, can ask more targeted questions to the patient*"; "*You can pull up side effects profiles right there with the patient*"; "*It's a huge difference in the hospital ... listening, writing, and looking up simultaneously.*"

Faculty respondents' perception of the handheld as a reference resource and training-program focus are consistent with the higher stage of professional development and type of responsibility inherent in the faculty work-role. Faculty comments expressed more theoretical and normative concerns about teaching, learning, and residency training in general: "'*Making me learn how to do it myself' is a key principle of teaching and learning*"; "*What I liked is that residents and faculty got the same education at the same time ... back to school, kind of fun*"; "*Will pay off in the 'big picture' sense --- positive change in using information technologies.*"

CONCLUSIONS

Quantitative and qualitative data suggest that residents and faculty in a primary care residency program may have different patterns of adoption of handheld computing into their workflow due to work-role differences. This study was limited by its focus upon primary care faculty and residents, the small sample size and the brief nature of interviews. It is entirely possible that both faculty and resident responses will change over time. Future research should continue to explore ways that physicians' work roles, expectations, and previous computer experiences interact to influence their use of computer information resources.

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