PDA Support for Outpatient Clinical Clerkships: Mobile Computing for Medical Education

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Abstract

This project provides educational support for students enrolled in a family practice clerkship by supplying PDA-based clinical references and tools to collect information about the patients they see and the seminars they attend. Each student is supplied with a Handspring Visor Deluxe to use during the clerkship. Supplied software includes a clinical reference (Five Minute Clinical Consult™) and Lexidrugs drug reference and a medical calculator. The data collection software consists of a patient log for recording simple demographic and diagnostic information about each patient seen during the clerkship, a seminar evaluation module for recording student feedback about each didactic presentation during the course, and an evaluation form where they students supply their reactions to the use of the Visor. Despite encountering a number of problems, the devices appear to be beneficial tools. The applications provide useful references for students who do not have access to the resources of the University in their family medicine clerkship. They also provide an improved, though not perfect, means to capture data regarding patient encounters and course evaluations. However, the challenge remains to better integrate the PDA with the student's workflow in the clinic.

Introduction

The information needs of medical students in clerkships are evidenced by the overstuffed pockets of their jackets. Note cards, brief references and calculators abound. A better way of managing information is needed. Students in outpatient clerkships are also frequently assigned to clinics outside of the academic health center. As a consequence they are further challenged by lack of access to normal library reference resources such as Medline, textbooks and other printed and electronic materials.

Medical students at the University of Minnesota must complete a Family Practice clerkship as part of their training. This is accomplished by the course entitled Clinical Medicine IV taught primarily by faculty members from the Department of Family Practice[1]. The clerkship lasts eight weeks and typically enrolls 25 to 35 students. Students work with preceptors at assigned clinics and office settings throughout the Minneapolis metropolitan area four days each week. Each Wednesday, the students return to campus for a day of seminars on a variety of topics related to outpatient medicine. The seminars encompass a variety of activities and topics from participatory exercises designed to teach students the physical difficulties experience by the elderly to disease and therapy updates. As part of the clerkship, students are required to maintain and submit a log of the patients they see as required by LCME accreditation standards[2]. In addition they are asked to periodically complete evaluations of their instructors. Since students are at scattered sites, remote from campus, they do not have ordinary access to the references and supportive literature available in on-campus experiences.

In prior years, the students collected patient encounter information using a paper log form with a set of 94 problems divided into 17 categories. The problem list was based on prior experience of the course directors and was not derived from any standard source. Students were asked to report the date of the encounter, the patient's initials, birth date, gender, whether or not this was a repeat encounter, one or two problem codes and optional additional notes.

Similarly, evaluations of teaching were unsystematically collected for various instructors who participated in the Wednesday seminars. Typically this was at the instigation of the individual instructor who distributed a questionnaire at the end of his or her session. The questions varied from session to session and some sessions had no evaluation.

The technology of personal digital assistants (PDAs) such as the Palm, the Handsprin Visor and Windows CE devices has advanced sufficiently that they now can provide a useful set of information tools for these students. With memories exceeding 8MB, battery life extending for weeks, simple touch screen interfaces and relatively large screens, options for use have greatly expanded.

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The use of PDAs in medicine has been an area of active interest in recent years and numerous articles have appeared in the literature. However the majority of these have been descriptive in nature. They provide an overview of the devices and suggest how they might be used either in medical education or in the practice of medicine[3,4,5]. One area where applications of the PDA appear to be particularly useful is for collecting data at the point of care. Several articles have been published that describe PDA use for collecting burn data[6], resident experience data[7], patient preferences[8], and resident procedure tracking[9,10].

Wake Forrest University Medical School has been engaged in a project for the last two years to explore use of PDAs in support of clerkships and residents in terms of patient tracking. They have successfully developed a system that allows students to track and report, via a network connection, information about patients that they encounter in several different clerkships[11].

A study by Marshall and Sumner focused specifically on documenting family practice clerkship patient encounters and compared the use of a paper and PDA-based log in capturing structured data[12]. They reported that students using the PDA captured data on significantly more patients but reported fewer problems per patient than those using a paper form of the same log. The results indicate that a PDA is a workable device for collecting encounter information though it may not capture a complete set of data.

However there have been no published reports of using a PDA as a comprehensive supportive resource for a family practice clerkship. Our desire was to build on the experience of the residency procedure tracking reports, Marshall and Sumner and Wake Forrest University in creating a comprehensive PDA resource to meet the needs of our students.

Methods

The goal of this project was to support these students in their learning experiences using personal digital assistant (PDA) technology. There were three objectives: 1) provide easy-to-use, readily available reference materials for the students to use at their practice sites; and 2) provide a means for students to collect required patient encounter information at the point of care and 3) provide a method to record and submit evaluations of teaching for their instructors. Furthermore it was desirable that data be easily submitted to and analyzed by the course directors.

To accomplish these objectives the University of Minnesota Medical School initially equipped each of the students with a Handspring Visor Deluxe™ PDA with 8MB of RAM. The Visor uses the Palm OS operating system and is code-compatible with all Palm OS applications. Students were offered the option of using the Palm Desktop software that comes with the Visor on their own personal computer. The Visor was supplied with a Hotsync™ connector that required a USB connector and Windows 98. In December of 2000 the project also began supplying an 8MB Backup Module in the form of a Compact Flash plug-in module. This was done to cope with a problem of data loss that is discussed below. Basically most students did not have easy access to the required hardware to install the desktop and synchronization software so that an easy-to-use, always-available alternative means of backing up data was required. The Backup Module remains plugged into the Visor at all times and it is a simple, two-touch, two-minute process to copy the contents of Visor memory to the module at any time.

To meet the need for readily accessible reference materials two primary resources were provided. These were the Five Minute Clinical Consult (5MCC) and Lexidrugs from Skyscape.com[13]. The Five Minute Clinical Consult is based on *Griffiths: Five Minute Clinical Consult* published by Lippincott, Williams and Wilkins[14]. The electronic form of the 5MCC is a comprehensive and structured clinical resource for Palm OS PDAs that covers 1,000 clinical topics and is indexed with more than 7,500 terms. Skyscape has developed an indexing and navigation system that facilitates its use on a PDA. Lexidrugs is derived from Lexi-Comp's *Drug Information Handbook*[15]. It contains a database covering over 3,900 medications, over 1,250 drug monographs, and spans 500 different therapeutic classes. Skyscape's navigation technology is also used for this database and provides a means of moving quickly and precisely from Lexidrugs to 5MCC and back. The combination requires 6MB of PDA memory.

To meet the data reporting needs of the students, we developed two applications using Satellite Forms SE (SF-SE) from Pumatech[16]. This Palm OS applications development software was initially selected because it provides an intuitive, object-oriented, forms-based environment that combines database design with forms-based data acquisition and display. In addition it permits Visual Basic-like scripts that are executed in an event-driven environment on the PDA. It also provides the means to easily move data between a database such as Microsoft's Access and the PDA through a custom ActiveX control.

SF-SE was used to develop a patient log application that was designed to replace the paper log previously used in the course. As such, it was designed to collect the same data as the paper log and

use the same categories and problems. Figure 1 portrays the main patient encounter screen. It makes extensive use of Palm OS features such as pop-up keyboards and calendars to enter data. In addition, the entry of patient conditions uses a two-stage data filter that allows more efficiency location of a particular problem from the problem list.

The application provides other screens that collect the student's identification and clerkship rotation information for use in conjunction with the patient log. It provides a patient list screen that can be used to quickly navigate to previously entered patients and their data. Finally it includes a set of summary functions that can be used to obtain counts and percentages of patient demographic information and medical problems. At the end of each clerkship the data are uploaded to an Excel spreadsheet via an Access database for analysis purposes.

SF-SE was also used to develop the course evaluation application that is designed to collect student's evaluations of their instructors. It's driven by a table of seminar sessions containing the instructor's name, topic description and date of presentation. This table is downloaded to the PDA and is used in the main screen of the application to list all of the sessions the student can evaluate. These are present in list form with an indicator of whether or not a specific instructor's session has been evaluated. To perform an evaluation the student taps or selects the session they wish to evaluate. They are then lead through a series of forms with questions that are answered by tapping radio buttons, selecting from a drop-down list or entering free text notes. At the end of the clerkship each eight weeks, the data are uploaded to an Access database that is then used to produce a summary report for each instructor.

SF-SE was also used to develop a forms-based survey concerning the use of the PDA in the clerkship. Students were asked questions about the utility of the various PDA applications; were asked to comment on the best and worse features of the project and to provide suggestions for improvement.

Two addition items were supplied. Phillip Cheng's MedMath freeware medical calculator is a program that performs calculations of common equations used in adult internal medicine and is capable of calculating complex quantities without resorting to external libraries. The final item was the course seminar schedule that was inserted into Datebook of the PDA.

On the first day of each clerkship rotation, the students attend an orientation session where they received their Visor and signed an agreement to abide by the rules of the project, protect the Visor from abuse and to return it at the end of the clerkship. Students are offered the option of using their own Palm OS unit and about 20% regularly chose to do so. The orientation conducts a basic review of the Visor's functions and demonstrates the operation of each application. Students are instructed to maintain their patient log on a daily basis and to complete their course evaluation forms at the end of each Wednesday seminar. They are also encouraged to back up their data to the Backup Module on a daily basis to protect against software crashes and to synchronize their PDA with the class laptop each Wednesday. Just prior to the end of his or her clerkship, each student is asked to complete the project evaluation module.

Results

The project has been in operation since March of 2000 and these results are reported as of March 1, 2001. During that time 125 students have generated 3,875 student-days of use. In that same period, out of the original 42 Visors, two machines experienced repeated hardware failures and were retired, two have experienced broken screens and one was lost. Approximately 20% of the students experienced a system crash at some point in their clerkship. Frequently this resulted in a loss of some or all of their data. These crashes have been of a random nature and may be due to a variety of problems including loading of unauthorized software such as games, low batteries, possibly defective units and shortcomings of the Palm OS. As a result of these continuing problems, Backup Modules were purchased and distributed to the students in December 2000. Since that time there has been a dramatic drop in the number of complaints about lost data. We do not expect that the incidence of system crashes has declined but rather that students now are better able to recover most of their data when a crash does occurs.

Since inception of the project these students have reported 17,308 patient encounters – likely an undercount due to the problems described above. The patients in these encounters consisted of 54% women, 46% men, 23% children and adolescents and 16% over 65. Most frequent problems seen were in the areas of health maintenance (22%), repiratory/ENT (16%), musculoskeletal (12%), dermatology (8%) and cardiology (7%). The course director reports that this represents a dramatic increase in the number of patient encountered reported by the students.

Course evaluations were completed by 56% of students. Those using the course evaluation forms judged them comparable to paper-based evaluation systems in utility and ease of use. However course evaluation results are now available to instructors

immediately after the data is downloaded from the Visor.

Project evaluations were completed by 69% of students. Utility of applications was rated on a three point scale from Very Helpful to Not Helpful with allowance made for no use. Lexidrugs and 5MCC has a median rating of Very Helpful while the Medical Calculator was rated as Somewhat Helpful. Many of the students did not use the built-in functions of the Date book, Address book and To Do list. 53% reported no problems with the patient log while 47% experienced one or more problems, 55% reported using the log immediately after seeing the patient, 33% used it later that same day, while 12% completed it once a week or less. 42% added their own programs. 36% installed the supplied desktop software. A surprising 48% of those responding purchased their own PDA either before or during the clerkship. The written comments indicated that while students encountered some problems with the Visor and the patient log application unit (crashes and software errors since corrected). One particularly frequent comment was that the data entry took too much time. They also reported the clinical reference to be very useful. They indicated that the course evaluations were more useful than mark sense sheets for course evaluations. The reactions of their preceptors was almost uniformly positive and supportive. Their primary suggestion for additional software was games. Though we did not supply any games, almost every unit was found to have at least one game upon return at the end of the clerkship.

Discussion

This project is best characterized as an on-going learning experience. It has provided evidence that leads us to believe in the utility of PDAs for an outpatient clerkship. Students find the software useful, there has been a significant improvement in the number of patient encounters reported, evaluations of teaching have been systematized and instructors receive more frequent and regular feedback. Some students were sufficiently enthusiastic about the project to purchase their own PDA after their clerkship ended. We recognize that this has not yet been demonstrated in a controlled trial, but the evidence to this point is favorable. Yet a number of problems have come to light which indicate that further exploration and development is needed to reach the goal of providing a high quality, effective resource for these students.

In the realm of hardware, it is evident that a number of students experienced difficulties with battery life. A pair of AAA batteries powers the Visors. With the use experienced by our students, batteries often lasted less than thirty days. Unfortunately, the battery indicator was not always present on the screen if the patient log was used heavily and the unit did not give a warning when the battery was low. In addition, Handspring announced in November of 2000 that some of their units suffered from a manufacturing defect that could lead to system crashes when most of memory was being used. We have not been able to definitively link this problem with our crashes but suspect that it might be a contributing factor.

Another hardware problem frequently encountered was the inability of students to use the Graffitti gesture recognition software to enter data. Anecdotal reports indicate that very few students used this method. Entry tended to be faster and more accurate when using the software keyboards. This is confirmed by the work of Wright et al.[17]

We found the Visors to be of somewhat questionable stability as evidenced by the relative frequency of crashes that were experienced. Unfortunately these crashes have been of a random nature and as of the date of this publication we have not been able reproducibly create them so as to identify the source of the problem.

All of the support materials for the Visor and other Palm OS units repeatedly state the desirability and utility of synchronization as a method of protecting data on the PDA. Unfortunately most of our students were unable to make use of desktop synchronization on their own home computers because of the requirements for support of a USB connector. While we provided a laptop for periodic synchronization when the students attended classes, only a relatively small number took advantage of it. However the Backup Module seems to finally have provided a better solution for protecting data on the handheld. We suspect that this is because of it relative convenience and ease of use since it is always with the unit.

It has become evident from the comments we received from students that we only partially solved the problem of fitting the PDA into the workflow of the clinic. In settings where the patient load is low to moderate, students may have the opportunity to both consult the PDA as a reference and to enter encounter data after a patient visit. However in higher volume settings, there is simply insufficient time for students to do either of these things. Our survey results indicate that many of these students entered encounter data into their PDA in the evenings or once a week using paper notes or memory thus defeating our intention of point-of-care data entry.

A problem that we did encounter with the drug reference is that it quickly becomes out-of-date as new drugs are released. Alternative PDA references

with continuously updated information would be preferable.

In summary, these PDA applications provide useful references for students who do not have access to the resources of the University in their family medicine clerkship. They also provide an improved, though not perfect means to capture data regarding patient encounters and course evaluations. However, the challenge remains to better integrate the PDA with the student's workflow in the clinic.

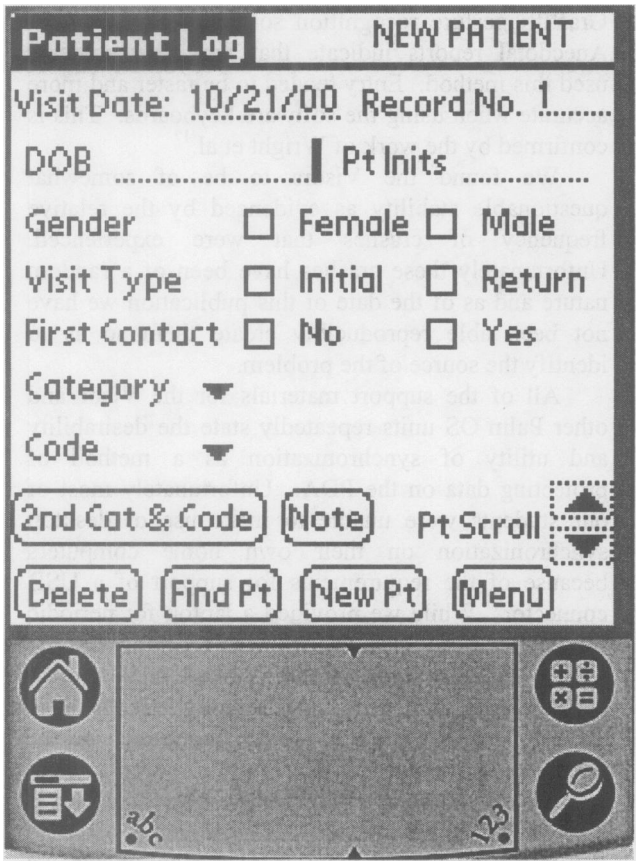

Figure 1. Patient Encounter Data Entry Form.

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