Handheld computers, also called personal digital assistants (PDAs), are increasingly used by physicians for a variety of tasks dealing with clinical and patient information. However, there is relatively little literature regarding handheld computer use in residency education, particularly family practice, compared with the medical literature regarding electronic medical records (EMRs). One study of a family practice residency described their use of handheld computers for resident procedure documentation. Implied in that article was an overall cost savings to the program due to increasing efficiency. The authors also indicat-
ed that the handheld computer was useful for providing ready access for conference scheduling and phone numbers. In a separate study, a hospital used handheld computers to develop laboratory and x-ray report tracking for inpatients. The authors indicated that 15 percent of U.S. physicians are currently using handheld computers. Potential benefits of handheld computer use described in the literature could be reduced prescribing errors and usefulness as research tools. Personal digital assistants are portable, are relatively inexpensive, and have the ability to interface with other electronic devices, including desktop computers.

The most popular brands of handheld computers are those equipped with either the Palm (Palm, Santa Clara, California) or the Windows CE (Microsoft, Redmond, Washington) operating system. The Palm is used in 88 percent of the handheld market in the United States. Ebell and Royner have published an article that fully describes available handheld computer hardware.

Since family practice residency training involves not only state-of-the-art clinical medicine but also training in useful technologic tools, including computers, an understanding of handheld computer use in family practice residencies would be helpful for planning future curricula and implementing new information technology. The objective of this study is to assess use of handheld computers in family practice residency programs, including actual use, factors influencing non-use, costs, handheld computer training, and types of handheld computer applications.

Methods

Data Source and Administration

A cross-sectional survey with a cover letter was mailed in mid November 2000 to directors of family practice residency programs in the United States and Puerto Rico. They included 493 directors of programs listed in the American Academy of Family Physicians (AAFP) 2000 Directory of Family Practice Programs and 117 directors of osteopathic family practice residency programs described in American College of Osteopathic Family Practice (ACOFP) materials. We obtained demographic data from the AAFP directory, consisting of the presence of a Web site, the type of program (program structure), the residency location (urban, suburban, rural), total number of beds, year of initial approval, number of graduates, and whether research by residents was required. Comparable demographic data for the ACOFP programs were not available.

Questionnaire Development

The questionnaire was developed and pilot tested on six physician faculty. The instrument included questions about handheld computer use or non-use. If non-use was indicated, we asked questions about organized plans to use and past experiences with handheld computers. If use was indicated, we asked questions about specific use. We also asked questions about operating systems, costs and budgets, upkeep and maintenance, and training, as well as questions about types of specific handheld computer applications. We included questions about wireless service use as well as the ability of the handheld computers to interface with computerized EMR applications. Finally, we asked the person completing the survey to identify their role in the program, and we asked whether they would be interested in participating in a LISTSERV dedicated to handheld computer application. The actual survey tool is shown in the Appendix.

Data Analysis

Descriptive data are shown as percentages or actual number counts for all nominal and ordinal data. We used the chi-square to test association between program demographics and survey responses with an alpha of 0.05. We evaluated the strength of these associations with a relative risk. Finally, we calculated a mean for annual budget and hours of handheld computer training.

Results

A total of 306 surveys, 257 from the AAFP residencies and 49 from the ACOFP residencies, were returned in the self-addressed stamped envelopes, giving a total response rate of 50 percent. As directed in the cover letter, the survey was to be completed by the department person regarded as having the most complete knowledge of handheld computers. Sixty percent of the program directors completed the survey, and the other 40 percent were completed by other faculty, residents, or staff (Figure 1). Categories of handheld computer use are shown in Table 1. Use of handheld computers either by an individual or group was reported in 67 percent (204 of 306) of the programs. Thirty percent of programs have required applications used uniformly by all users.
for discontinuance included lack of interest (3 programs), lack of support (3), lack of budget (1), or use found to be too complicated (1).

Demographic data—consisting of the type of family practice program, its location, age of the program, presence of a Web site, requirements for resident research, and size of the hospital affiliated with the program—were tabulated. Chi-square analyses showed that only the type of program was associated with use of handheld computers. Handheld computers were statistically more likely to be used in allopathic programs than in osteopathic programs. (chi-squared, 21.687; $P = 0.0006$.) Among allopathic programs, military programs were more likely to report handheld computer upkeep and maintenance in programs in which faculty or residents do not perform this service.

The most commonly used applications are the programs included with the handheld computer at time of purchase; these include the calendar, address, and memo applications. Figure 3 shows the percentage use of added application programs. Medication reference tools, medical textbooks, and clinical computational programs are the most common. Slightly less than half of the programs use handheld computers for inpatient tracking, resident procedure tracking, and the monitoring of drug interactions. Only two programs have handheld computers that integrate with the EMRs.

Fifty-one percent of the programs in which handheld computers are used provide initial training for users, percent use Windows CE either as the sole operating system or in combination with the Palm OS. Two programs use the PSION operating system.

Funding sources for handheld computers are shown in Figure 2. Programs that budget for the handheld hardware and software have an average annual budget per user of $461.58. One program indicated an annual budget per user of $15,000. (This amount was not used in computation. The top limit otherwise was $1,900 for annual budget per user). Faculty or residents, or both, performed the upkeep and maintenance of the handheld computer hardware and software in 72 percent of the programs in which handheld computers are used. Computer information services (27 percent) and others (1 percent) perform the handheld computer upkeep and maintenance in programs in which faculty or residents do not perform this service.

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Fifty-one percent of the programs in which handheld computers are used provide initial training for users,
with an average of 1.17 hours/year (range, 1–12 hours/year). Thirty-one percent of these programs provide ongoing training, with an average of 0.9 hours/year (range, 1 to 24 hours/year). A wireless service is used for their handheld computers by 3.5 percent of the programs.

Finally, 73 percent of the respondents indicated a desire to participate in a LISTSERV dedicated to handheld computers.

Discussion

Our results indicate that handheld computers are being used for any purpose in two thirds of the Family Practice Residency Programs, and use is mandatory in 30 percent of the programs. Prior to this study, there were no published estimates of handheld computer use in family practice residency programs. This finding is of interest in light of the fact that only 22 percent of family practice residencies currently make use of an EMR.* The use of handheld computers in family practice residencies is also considerably higher than the estimated use of handheld computers by U.S. physicians (15 percent).15 This may reflect demographic differences between physicians in residency training and the physician population at large. Even for programs not using handheld computers, almost half surveyed expect to implement use within 24 months, indicating growth.

There are several possible explanations for the adoption of handheld computers in family practice residencies. Handheld computers offer significant advantages over desktop computers. The costs per user are significantly lower. This is supported by the findings in this study that the purchase of handheld computers is often a non-budgeted expense. Our results also suggest that faculty and residents maintain the devices and applications, indicating familiarity and acceptance. Desktop computers and networks typically require computer information service personnel for maintenance. Another possible explanation for the adoption of handheld computers in family practice residencies is that the training requirement is low. Only half the programs require initial and ongoing training, at a rate of about 1 hour per user per year. Yet the handheld computers are being extensively used for numerous applications.

Family practice residencies may be adapting this technology to meet specific clinical and administrative needs.16 In virtually all the programs, the calendar, address, and memo type functions of the handheld computer are used either by individuals or groups. Although handheld computers are not as versatile as desktop computers and are more limited in graphics applications, our data suggest that handheld computers are being used in family practice residencies to perform specific point-of-care applications, such as prescription database-type applications, electronic textbooks, and medical formula-clinical computational type programs. Other applications, such as tracking resident procedures, inpatient information, and prescription writing, indicate specific targeted uses.

Surprisingly, only two programs have handheld computers that interface with their EMRs. This could reflect low use of EMRs, lack of need for both EMRs and handheld computers, or immaturity of the interfacing technology. Only 3.5 percent of the programs use a wireless service. This may represent a lack of need, lack of a wireless service, or lack of resources, in addition to other factors. The interest in this technology among users is strong, with almost three quarters

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of the respondents indicating a desire to participate in a LISTSERV dedicated to handheld computers.

The adoption of this technology may also have significant implications for how we teach or train residents to appropriately access and use available up-to-date clinical information to improve patient care. Readily available patient-specific or application-specific information at point-of-care allows for more complete and accurate information for the patient encounter. Drug dosages and clinical computational formulas that, prior to the advent of handheld computers, were accessible only by pencil-and-paper methods are immediately available on handheld computers, reducing potentials for errors or outdated information. Likewise, applications for up-to-date clinical information—from electronic textbooks and online sources like AvantGo and InfoRetriever to endless other clinical information sources—encourage users to continue as lifelong learners.

The rapid adoption of handheld computers in family practice residencies may also have implications for the future of generalist disciplines. Family practice, along with other “generalist” specialties, has been criticized for both poor quality of care for chronic illnesses like diabetes and for not keeping up with the rapidly expanding body of medical knowledge. In their recent report on the chasm that exists in the quality of health care, the Institute of Medicine\textsuperscript{17} stated: “What is perhaps most disturbing is the absence of real progress toward…applying advances in information technology to improving administrative and clinical processes.” Weed\textsuperscript{18} notes that “good medical practice requires tools to extend the human mind’s limited capacity to recall and process large numbers of relevant variables.”\textsuperscript{18} Yet from 1998 to 2000, the number of family practice residencies with EMRs increased from only 17 to 22 percent. In the meantime, two thirds of the programs have adopted handheld computer technology. Handheld computer technology may provide generalists with the tool they need to maintain their generalist practices and yet deliver optimal patient care for the diverse clinical problems they encounter. Our findings suggest that handheld computers seem to be widely accepted in family practice residencies and are being used as such a tool.

Limitations

Although the response rate of 50 percent creates the possibility of a response bias, this response rate is comparable with the average of 55.6 percent (SD, 19.7 percent) for academic research using questionnaires, as published by Baruch.\textsuperscript{19} Another limitation may be that these findings may be out-dated very quickly, because this technology is developing so rapidly. It is also important to note that the data are dependent on personal reporting and are subject to recall bias. For example, approximate rather than actual annual budget amounts for handheld computer users could have been reported, and specific handheld computer applications may have been assumed rather than precisely noted.

The initial question of the survey (“we use handheld computers in our program for any purpose”) was designed to be somewhat inclusive, and the responses may overestimate handheld computer use. Future surveys designed to specifically study use of handheld computers might define the word “use” more exclusively and specify types of uniform or mandatory use to quantify results. An attempt was made to limit potential confusion in terminology by operationally defining a handheld computer as a device “using the Palm(tm), Windows CE(tm) or EPOCH(tm) operating system running on a small individual handheld computer.” Assurance handheld computers are being used for more than just individual use is supported by thirty percent use for common uniform applications.

A particular strength of our study was the comprehensive scope, in that all U.S. allopathic and osteopathic family practice residency programs were surveyed.

Conclusions

Handheld computers are widely used in family practice residency programs in the United States. Family practice programs are funding and supporting this new technology and are using the devices for more than just the personal data function for which the devices were originally designed. Handheld computers may offer solutions to administrative and information management that are more realistic than those offered by desktop computers or traditional EMRs. Whether handheld computer adoption represents just the enthusiasm generated by new technology or whether handheld computers will actually prove uniformly useful in the practice of clinical medicine remains to be seen. It is possible that handheld computers will continue to evolve at a rapid pace and find many applications in all types of residency education settings. Additional research is needed to understand how best to integrate handheld computer technology into residency training curricula and to understand the potential effect of handheld computer use on patient care quality and outcomes.
The authors thank the entire staff of the Waco Faculty Development Center, especially Cindy Passmore for suggestions on statistical methods.

References


Appendix

Handheld Computer Use Questionnaire

The following questions are intended to obtain factual information regarding use of handheld computers in your residency. For purposes of discussion, handheld computers are defined as devices using the Palm, EPOCH, or Windows CE operating system running on a small, individual handheld computer with the capacity to interface with a desktop computer.

1. We use handheld computers in our program (for any purpose).
   ___ YES (go to question 2)
   ___ NO
   a. Are there any organized plans to include use?
      ___ YES
         When do you plan to implement use?
         __(months) __ (years)
      ___ NO
   b. Has your program had prior experience with handheld computers?
      ___ YES
         Why did you cease using them? (check all that apply):
         ___ Lack of interest
         ___ Lack of support
         ___ Lack of budget
         ___ Too complicated
         ___ Did not prove useful
         ___ Hassle factor(s) outweighed benefit
         ___ Other
         (Please go to question 16.)
   2. Is the usage by individual residents/ Y N faculty?
   3. Are there specific required handheld Y N computer applications used uniformly by all users (calendar, scheduling, log-procedure, patient tracking)?
   4. Which operating system(s) are in use for the handheld units used in your department (check all that apply)?
      ___ Palm OS
      ___ Windows CE
      ___ Other (specify) ________________
   5. Does your program provide handheld computers (check all that apply)?
      ___ To the faculty
      ___ To the residents
      ___ To other staff

continued
6. If so, how is the cost for hardware/software budgeted?
   ___ Non-budgeted
   ___ Deducted from annual faculty/residents book allowance
   ___ Provided under a separate budget for handheld hardware/software.
      If so, what is your annual budget per user? $ ___
   ___ Other

7. Who provides the upkeep and maintenance for hardware/software (check all that apply)?
   ___ Representative of computer information services department
   ___ Interested faculty
   ___ Interested resident(s)
   ___ Other (identify) _____________________________

8. Please indicate which handheld applications are in use. If the use is individually only, please check all
   that apply. However, if the use is common as referenced in Question 3, please underline each specific
   application as well as checking.
   ___ Calendar
   ___ Address
   ___ Memo pad
   ___ Medical textbooks
   ___ Database
      ___ In-patient tracking
      ___ Outpatient tracking
      ___ Resident procedure tracking
      ___ Resident hour tracking
      ___ Patient demographics
      ___ Telephone message tracking
      ___ Call scheduling
      ___ Practice-based research
   ___ Medication
   ___ Databases (e.g., PDR-type programs)
      ___ Prescription-writing programs
      ___ Monitor drug interactions
   ___ Medical computational programs (i.e., formula-type computational programs)
   ___ E-mail
   ___ Web browsing
   ___ Direct infrared printing from handheld computers
   ___ Integrated function with electronic medical records
   ___ Other ________________________________

9. Do you provide initial training for users? Y N
   If so, how many hours/year? ____________

10. Do you provide ongoing training for users? Y N
    If so, how many hours/year? ______________

11. Do you use a wireless service for the handheld computers? Y N

12. If your program uses a computerized electronic medical record (EMR), do your handheld units interface?
    If so, how?
       ___ Proprietary with the EMR
       ___ Customized application

13. The person completing this questionnaire is:
    ___ The program director
    ___ Other clinical faculty
    ___ A resident
    ___ An information service department representative
    ___ Other staff

14. I wish to receive a copy of the results of this survey Y N

15. I would like to participate in a LISTSERV dedicated to handheld computer applications in family practice residency education.

16. E-mail address of person completing this portion: ______________________________.

Thank you for your time and effort. If anyone wishes to contact me about this survey or for another purpose, please direct correspondence to dan-criswell@ouhsc.edu.