HANDHELD COMPUTING IN RESIDENT EDUCATION: BENEFITS, BARRIERS, AND CONSIDERATIONS

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The Institute of Medicine has defined quality health care as care that is patient-centered, effective, safe, timely, efficient, and equitable [1]. Achieving this level of quality at the individual patient level requires retrieving and appraising relevant evidence from a massive and dispersed body of scientific literature and combining it with relevant, patient-specific data and clinical decision-support tools at the point of care. Decisions made and implemented must then be communicated to the patient and to the health care team in a coherent and timely manner.

Paper-based patient records and printed medical knowledge resources are considered inadequate for ensuring that quality care based on the best available evidence is consistently delivered to all patients [1]. It is neither reasonable nor wise to expect physicians to keep all relevant patient information, disease management protocols, formulary guidelines, and evidence-based practice resources in working memory or on paper. Physicians with the added responsibility of directing residency programs have information management needs even beyond those required for delivering quality care. Program directors must also deal with information related to budgets, schedules, curricula, resident experiences and procedures, scholarly activity, accreditation rules, and regulatory agency requirements.

Rapid progress in information technology has made mobile computing an increasingly practical and powerful alternative to print materials for health professionals who want to access information resources while on the go. Handheld devices that are roughly the size of a half-inch thick stack of index cards, weighing only a few ounces, now have many of the capabilities of full-featured, contemporary desktop computers [2]. These characteristics along with instant-on capability, expanding functionality, and an increasing variety of useful software applications have made handheld computing devices increasingly popular among residents and practicing physicians [3,4]. In January 2001, it was estimated that 20% U.S. physicians carried a handheld computing device and that 90,000 physicians had downloaded a single, free handheld drug reference [5]. At that time, more than 50 companies were producing handheld medical applications, accelerating the use of handheld devices by expanding the range of useful products available to meet the comprehensive mobile health information management needs of physicians.

The Accreditation Council for Graduate Medical Education (ACGME) recently underscored the importance of information management by making competence in the appropriate use of information technology an essential component of residency program accreditation [6]. Although handheld computers provide only some of the information management capabilities needed to support resident education and to ensure quality care, their relatively low cost, convenience, and expanding medical applications make them well suited for information technology training and use.

This article provides examples illustrating how handheld computing can be used in resident education to enhance patient care, facilitate training and evaluation of residents, and support program administration. We also outline major considerations and potential barriers in implementing handheld computing for residency programs that are contemplating incorporating this technology. For convention and convenience, the term *personal digital assistant* (PDA) is used when referring to a generic handheld computing device. Depending on the type of device, operating system, features, and functionality, handheld computing devices have also been referred to as *handheld organizers*, *palmtop computers*, *microcomputers*, or *pocket PCs*. An overview of PDAs on the market [7] and a detailed discussion of the major types of PDAs and available medical software applications [8] are available elsewhere.

Potential Uses and Benefits of PDAs in Resident Education

The expanding functionality of PDAs offers a range of potential uses and benefits in resident education. **Table 1** lists examples of PDA applications in key areas of patient care, education, and administration, which highlight the rationale for residency-wide PDA

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Table 1. Potential Uses and Benefits of PDA Applications in Residency Training Programs

Potential Use/Benefit	PDA Application
Patient care	
Evidence-based decision-making	Clinical decision-support tools (diagnosis and treatment protocols), Cochrane database abstracts, clinical pathways and guidelines (documents from the National Guideline Clearinghouse)
Medical error reduction	Diagnostic decision-support tools, drug interaction programs
Computerized physician order entry	Electronic medical record systems
Cost containment	Drug formularies with comparative cost information
Results reporting (lab, x-ray)	Electronic medical record systems
Patient identification (bar code scanning)	Bar code medication administration systems [18]
Patient monitoring (vital signs, telemetry)	Wireless vital sign telemetry [19]
Electronic prescribing	Electronic medical record systems
Patient education	Educational handouts, videos, audio files
Medical records documentation	Electronic medical record systems
Medical dictation	Voice recorder, speech recognition software
Education	
Curricula and learning objectives	Rotations, clinics, procedures
Specific educational content	Electronic texts, lecture handouts, journal abstracts
Conference presentations	Presentation software, slideshows
Audiovisual enhancements (sound, video)	Cardiac auscultation, invasive procedure techniques
"On-the-fly" teaching tools	Medical calculators, heart sound simulators
Library resources	Electronic textbooks
Image libraries	Gram stains, radiographs, endoscopic images, dermatologic slides
Online educational resources	Medical Web sites, online lessons courseware
Administration	
Information management and synchronization	Electronic calendars, documents, spreadsheets, databases
Communication	E-mail, instant messaging, cell phone, networking
Task management and delegation	To-do lists, communication tools
Rotation, clinic, and call scheduling	Web-based scheduling programs [20] with calendar synchronization
Automatic timed reminders	Electronic calendars
Documenting hours of duty	Calendar documentation, spreadsheet logs
ACGME program requirements	PDA document file
Evaluation tools	Web-based evaluation systems with PDA functionality [21]
Diagnosis and procedure documentation	Web-based evaluation systems with PDA functionality [22]

ACGME = Accreditation Council for Graduate Medical Education; PDA = personal digital assistant.

implementation. A few examples of PDA use are illustrated below, using scenarios drawn from our experience using PDAs in our internal medicine residency program.

Patient Care

You are precepting at a residency clinic site away from the central campus. The site offers a broad patient base for resident education but lacks adequate computing resources.

A first-year resident has just seen a 56-year-old man who presented with an acute exacerbation of chronic obstructive pulmonary disease (COPD) characterized by increasing cough, dyspnea, and purulent sputum production without fever or progressive hypoxia. The patient continues to smoke and is also being treated for hypertension and hyperlipidemia with lisinopril and atorvastatin, respectively. He is already using inhaled beta-agonist, anticholinergic,

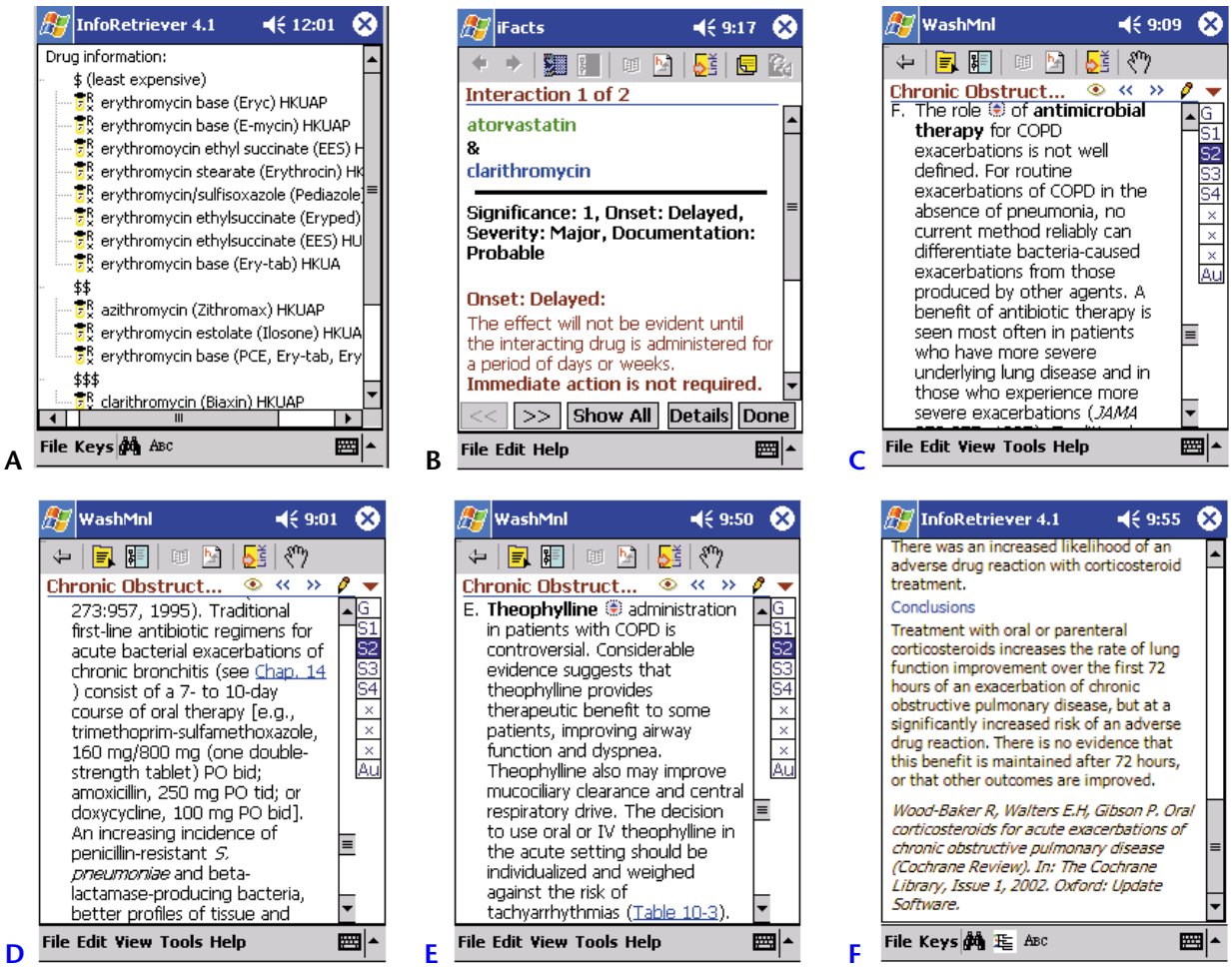

Figure 1. Using medical software on a personal digital assistant (PDA) to enhance patient care. **Panel A** shows a formulary cost comparison for several macrolide antibiotics, in which clarithromycin ($$$) is identified as more expensive than azithromycin ($$) or erythromycin base ($). **Panel B** highlights potential drug interactions in a patient who is taking atorvastatin and in whom treatment with a macrolide antibiotic is being considered. **Panels C and D** illustrate the uncertain role of antibiotic therapy for exacerbations of chronic obstructive pulmonary disease (COPD) and the comparatively inexpensive antibiotics that are recommended for uncomplicated cases. **Panel E** discusses the controversial status of oral theophylline therapy in a clinical circumstance in which benefit is small or marginal and potential risks are significant. **Panel F** shows an abstract from the Cochrane Library, summarizing the evidence that short-term oral glucocorticoid therapy enhances the rate of improvement in respiratory function in patients with acute exacerbations of COPD. (Panels A and F reproduced from Medical InfoRetriever©, version 4. Available at http://www.infopoems.com. Used with permission from InfoPOEMs©. Panels B, C, D, and E reproduced from the *Washington Manual.* Available at http://www.skyscape.com. Used with permission from Skyscape.)

and glucocorticoid inhalers. The resident proposes adding clarithromycin and oral theophylline to the treatment regimen. After some discussion of the case, the resident acknowledges uncertainty about the evidence supporting the use of antibiotics and theophylline for exacerbations of COPD. She also has not considered the cost of antimicrobial therapy, whether adverse drug interactions are a significant concern, or whether other short-term approaches would be of likely benefit. You briefly show the resident how to use several resources on your PDA to get answers to these questions and then turn your attention to another resident who is with a different patient.

When you return to the first resident a few minutes later, you find that she has already used the PDA to learn that clarithromycin is more costly than the other macrolides on this patient's formulary (**Figure 1A**) and that a significant drug interaction with the patient's other current medications is possible (**Figure 1B**). She has also learned that the role of antibiotic therapy for

COPD exacerbations is not well defined (**Figure 1C**) and that when antimicrobial therapy is used, less expensive antibiotics are recommended (**Figure 1D**). Furthermore, she has discovered that adding oral theophylline could be potentially hazardous (**Figure 1E**) and found good evidence that short-term therapy with oral corticosteroids is likely to enhance the rate of improvement in respiratory function (**Figure 1F**). You praise the resident on her ability to use the PDA to improve the care of this patient by avoiding potential overuse, underuse, and misuse problems. Together, you return to the examination room to discuss treatment recommendations with the patient.

One potential benefit of having robust health information resources at the point of care is the decreased inertia associated with obtaining answers to questions that impact the immediate management of individual patients. The busy pace of ambulatory care settings can leave little time to seek information regarding diagnoses, tests, and treatments. The inability to access information needed for patient care increases the likelihood of quality of care problems resulting from decisions made and acted upon that 1) are unnecessary (overuse), 2) fail to include appropriate or needed care (underuse), or 3) employ tests or treatments in inappropriate ways (misuse) [9].

Carrying a PDA with relevant medical knowledge bases and clinical decision-support tools enables physicians to quickly obtain answers to common questions arising at the bedside. In the example above, the PDA contained several resources that facilitated the delivery of evidence-based, cost-conscious care that was mindful of potentially harmful errors. Although data on the impact of handheld computing resources in improving bedside decision-making and reducing errors are sparse, survey data suggest that physician users find such tools beneficial [10]. The information technology competence of the user, computing power of the PDA, content and organization of the electronic information resources, and capacity to sort and present relevant information on-demand are all factors that influence the utility of medical PDA resources in patient care.

Education: Teaching Competence with Evidence

Now that the six general competencies identified by the ACGME Outcome Project Advisory Group are official accreditation requirements, residency programs face the challenge to ensure that the skills and knowledge underlying competence are taught and evaluated. A prominent theme of the new ACGME competencies is the application of evidence to practice. With their capacity to store a wide range of evidence sources as well as decision-support tools, PDAs can be used in many ways to support competency-based education. The following scenarios illustrate how PDAs can be applied to address three of the new competencies: medical knowledge, patient care, and practice-based learning and improvement.

You are attending morning report where a resident presents the case of a previously healthy 34-year-old man admitted yesterday from the emergency department (ED) after a vigorous day of snowboarding that included several falls. While driving home an hour later, the patient developed a persistent, aching discomfort in his right shoulder and arm, which spread broadly across his chest after several minutes. His physical examination and electrocardiogram in the ED were normal.

While discussing the diagnostic and therapeutic care plan, the resident indicates that he had already scheduled the patient for a radionuclide exercise stress test. When you ask him to estimate the likelihood of unstable angina or myocardial infarction as the cause of the patient's pain, he replies "about one-third, I guess." Numerical estimates solicited from the rest of the group range from "less than 1%" to "about 50:50."

At this point, you remind the residents that they have a program (**Figure 2**) installed on their PDAs to generate an evidence-based estimate of the pretest probability of acute cardiac ischemia in this patient. You demonstrate by opening up the program on your PDA and accessing the acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) to estimate the likelihood of acute coronary ischemia in a similar population of patients [11]. After watching your demonstration, the residents do likewise on their own PDAs, entering the patient-specific data for this case (**Figure 2A-2B**). The ACI-TIPI clinical calculator estimate of the probability of acute cardiac ischemia in this patient is 3.1% (**Figure 2C**). When the "More Info" button is pressed, a summary and reference citation is provided, and the residents learn that use of this clinical prediction rule is supported by level 1a evidence (**Figure 2D**).

Medical knowledge and patient care. PDAs populated with appropriate medical software applications are well suited for addressing clinical questions that cannot be readily answered by referring to a medical textbook. Although electronic textbooks stored on PDAs represent large, searchable, and potentially linked repositories of useful information, electronic clinical decision-support tools have advantages in their ability to

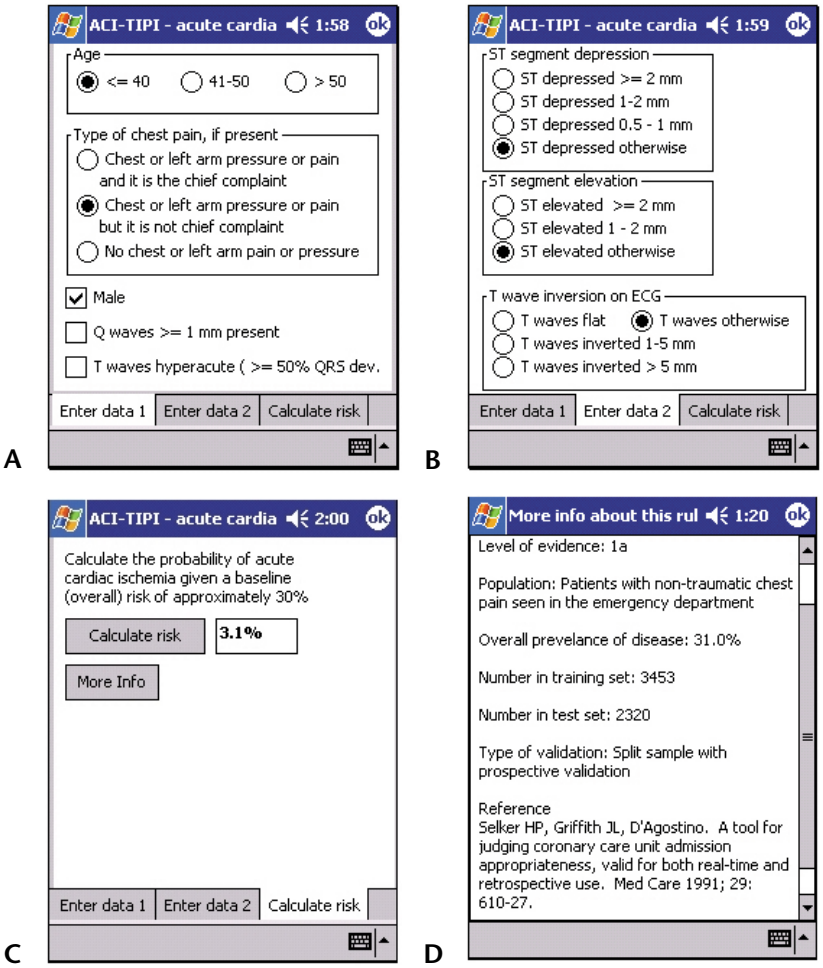

Figure 2. Using a personal digital assistant (PDA) to teach evidence-based diagnosis during a morning report discussion of acute chest pain. **Panels A and B** show patient-specific data entered into the acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) clinical calculator. **Panel C** shows the calculated probability estimate of acute cardiac ischemia for the patient discussed. **Panel D** shows the evidence base for the prediction tool, which is displayed when the user presses the "More Info" button. (Reproduced from Medical InfoRetriever©, version 4. Available at http://www.infopoems.com. Used with permission from InfoPOEMs©.)

represent, combine, and give weight to multiple patient-specific characteristics based on good evidence from studies involving similar populations. Such electronic tools can help ensure that the current best evidence is available when and where it is needed to support decisions regarding diagnosis, therapy, risk, and prognosis. Used appropriately, tools such as clinical calculators for pretest and post-test probabilities, likelihood ratios, decision analyses, physiologic parameters, and therapeutic dosing can promote patient care decisions that reflect best practices while decreasing the potential for medical errors. Available data on the effects of computer-based clinical decision-support systems on clinician performance and patient outcomes strongly suggest physician performance improvements [12,13], although the effects on patient outcomes are unclear.

Continuing with morning report, you ask the resident to discuss the initial management of the patient with chest pain. The resident had ordered sublingual nitroglycerin in the ED, which not only failed to relieve the patient's pain but also precipitated a severe headache and symptomatic hypotension requiring Trendelenberg positioning and an intravenous saline bolus. The resident spontaneously offers that his now lower estimate of the pretest probability of acute cardiac ischemia in this patient will prompt him to reconsider his habit of routinely giving sublingual nitroglycerin as a "therapeutic trial" for angina in most adults presenting to the ED with chest pain.

The other residents at morning report concur that they too are now more likely to use the evidence-based tools on their PDAs to estimate pretest probability in uncertain cases before using therapy that may present more potential risks than benefits. They also recognize their need for more information about the "threshold for testing" for coronary artery disease, the most cost-effective diagnostic approach across a

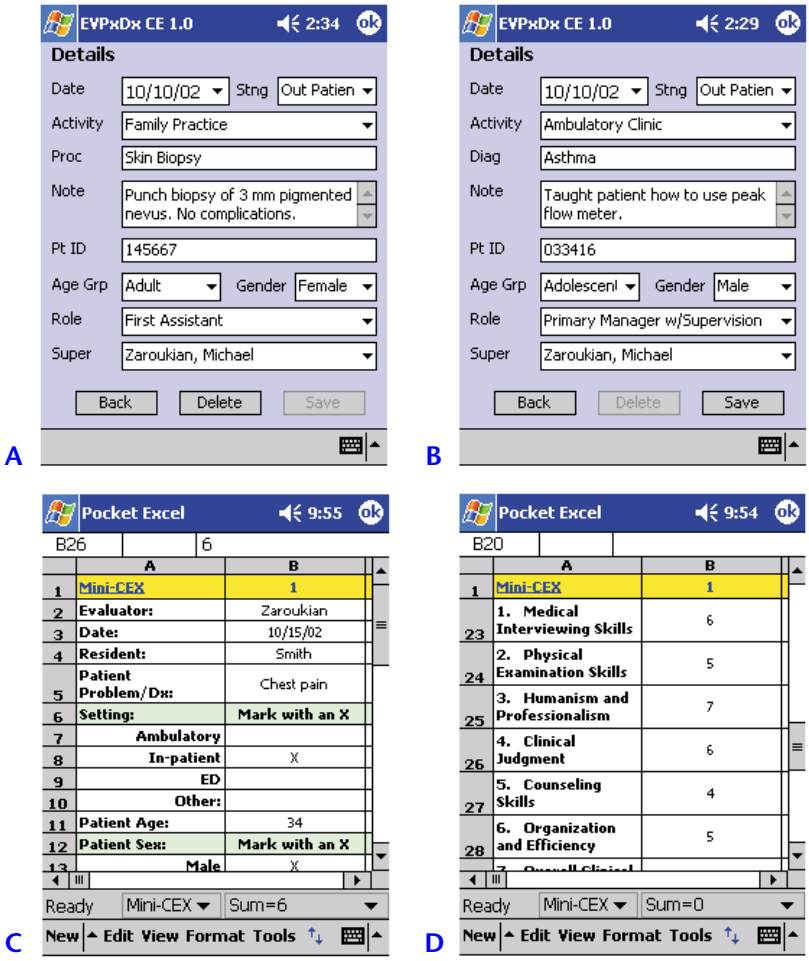

Figure 3. Recording diagnoses, procedures, and evaluations on a personal digital assistant (PDA). **Panels A and B** show examples of how diagnoses and procedures, respectively, can be documented on a PDA for subsequent uploading to a Web-based evaluation system. (Reproduced from E*Value. Available at http://www.advancedinformatics.com. Used with permission from Advanced Informatics, LLC.) **Panels C and D** illustrate how a spreadsheet template for recording observations at the point of care can be used for resident assessment. Evaluations can be saved and printed for resident feedback or uploaded to a PC for transfer to an evaluation database. (Reproduced from Microsoft Pocket PC; Pocket Excel. Available at http://www.microsoft.com/mobile/pocketpc/learnmore/software/excel.asp. Used with permission from Microsoft Corporation.)

range of pretest probabilities, and the incidence of headache and hypotension complicating nitroglycerin use. An educational prescription is given to each resident and medical student to discuss at the following day's morning report.

Practice-based learning and improvement. In the scenario above, the residents engaged in several aspects of practice-based learning and improvement, including analyzing their practice experiences and working together to identify, appraise, and incorporate evidence on diagnostic and therapeutic effectiveness from scientific studies related to their patients' health problems. They also gained competence in using information technology to manage information, support their own education, and facilitate student learning.

The immediate availability of a PDA containing evidence-based resources [14] allowed the attending physician in the preceding scenarios to serve as an educational role model for the use of information technology to advance medical knowledge, improve processes of care, engage trainees in practice-based learning and improvement, and lower the inertia for use of information management tools. The success of such an effort depends on identifying, carefully appraising, and distributing appropriate handheld computing resources for use by educators and trainees, followed by PDA training and modeling PDA use in actual patient care decision-making.

Administration

Residency program administration requires effective and timely management, delegation, communication, documentation, reporting, and archiving of important information and events. The following scenario illustrates the use of PDAs for resident performance evaluation as well as a strategy for facilitating PDA product enhancement.

In your role as program director, you recently led a successful initiative to implement a Web-based evaluation system for all of your institution's residency programs. This has allowed the evaluation process to become virtually paperless system-wide, dramatically improving the efficiency and cycle time for evaluations of residents, faculty, rotations, and sites. The only exceptions appear to be evaluations for chart audits and "mini-clinical evaluation exercises" (mini-CEX), even though they are also included in your Web-based evaluation system. The faculty, including you, found that detailed assessments at the point of care were harder to document than end-of-rotation evaluations, because a Web-enabled PC was generally not available to record observations as they were occurring. The vendor of your evaluation system recently developed a PDA tool for recording procedures and diagnoses (**Figure 3A-3B**) but does not yet offer a PDA-based evaluation solution or wireless handheld compatibility at its Web site.

As an initial step to improve compliance with these evaluations, you create a mini-CEX spreadsheet template on your desktop PC and transfer it to your PDA (**Figure 3C**). In initial testing, you find the spreadsheet convenient for recording your observations of demonstrated resident competencies on your PDA in real-time (**Figure 3D**). This allows you to give each resident immediate feedback and to print a paper copy for residents on request using the infrared port on your PDA. Each time you place your PDA in its synchronization cradle for charging, the evaluations are copied to your office computer, where your secretary transfers the data into the Web-based evaluation system. Your program administrator distributes the spreadsheet templates to faculty to use on their PDAs, then contacts the vendor of your Web-based evaluation system to request product enhancements that allow evaluation completion on the PDA with synchronization to the vendor's Web site or direct online entry using the PDA's Web browser over a wireless network.

Recording resident performance evaluations in real-time. Another potential benefit of PDAs is the ability to document events, observations, and decisions whenever and wherever they occur. In the above scenario, an electronic instrument that facilitated documentation of resident performance in real-time lowered the inertia to formal assessment. Other resources that can be made available on the PDA for faculty and residents to use to support residency administrative functions include 1) curricular materials, 2) tasks and assignments (eg, rotation, clinic, and call schedules), 3) phone lists, 4) conference schedules, 5) educational handouts, 6) policy manuals, and 7) meeting reminders and agendas.

Calendar, appointment, contact, and to-do list functions were included in the earliest handheld organizers and remain central features of most PDAs today. The ability to organize and store calendar information, appointments, schedules, and tasks with automatic timed reminders means that residency office staff can assist program directors by providing relevant and up-to-date information on a desktop PC that can be synchronized with their PDAs to help them get to where they need to be, on time and with the right information in hand. Using automatic data synchronization can help program directors stay electronically connected with residency office staff while saving time and effort.

Wireless networking using radiofrequency technology is becoming increasingly common for secure communication between computing devices, including PDAs, without evidence of interference with hospital electronic equipment and with evidence of high physician acceptance [15,16]. An important advantage over infrared data transmission is the much greater range over which high-speed wireless communication can occur. As integrated wireless PDAs and networks become more common in graduate medical education settings, educators and trainees will have predictable access to comprehensive Web resources without needing to purchase large amounts of storage memory for their PDAs. In a high-speed wireless environment, instant messaging is also likely to become a convenient and efficient alternative to paging systems for simple communications (eg, *"Attending rounds in 5 minutes on 4-South. Thanks, Mary"*).

Implementing PDAs into Residency Programs

Although the potential benefits of PDAs are compelling, appropriate incorporation of this technology into graduate medical education settings requires consideration of many factors, including barriers to implementation and use. The extent to which the potential benefits of PDAs outlined in Table 1 can be realized depends on the degree to which the implementation issues are successfully addressed.

Factors Influencing Ease of Implementation

Incorporating new technology is advisable when it can be expected to improve quality at a satisfactory cost or to maintain quality at a lower cost than is possible using currently implemented technology [17]. Like many other physician decisions, choosing whether and when to use handheld computing technology involves

Table 2. Factors Likely to Influence Physician PDA Use

Factors Making PDA Use More Likely	Factors Making PDA Use Less Likely
Easy to learn, use, and maintain	High financial cost (hardware, software)
Affordable	High time cost
Reliable	Learning curve for users
Ubiquitously portable	Device maintenance
Useful software tools	High "activation energy" for institutional change
Improves patient care quality and safety	Insufficient vision
Saves time	Inadequate institutional support
Improves organization and task management	Too few:
Facilitates communication	Physician champions
Provides helpful reminders and alerts	Change agents
Adds value outside of medicine (games, finances)	Role models
Becomes the standard of care [16]	

PDA = personal digital assistant.

weighing anticipated benefits with the potential costs, problems, and risks associated with PDA use. Handheld computing devices have evolved significantly, yet device failure, breakage, data loss, compatibility issues, support requirements, and variability in the quality of medical software applications for PDAs remain significant issues.

Even when these issues are not limiting, the potential remains for overuse, underuse, or misuse of PDA resources in education and patient care. Adopting handheld computing technology prematurely risks having electronic paperweights—PDAs that go unused because they fail to meet user expectations or because buy-in was not achieved. Failure to incorporate advantageous new technology in a timely manner means that the quality and value of resident education and patient care will be suboptimal. Finally, misuse of PDAs can compromise patient data security and privacy, engender excessive user dependency on technology, and interfere with psychosocial dimensions of the physician-patient encounter.

Discussions of the legal and ethical implications of physician use of PDAs have also considered whether PDA use should simply be considered a matter of physician preference. In approaching this question, De Ville [17] advanced the view that there is little to mandate physician use of a given technology if 1) the benefit of the technology is trivial or uncertain, 2) the risks are poorly understood, 3) inappropriate use is common or likely, 4) the information is not needed by others, or 5) the technology is used primarily for individual convenience. In contrast, mandating use is more justifiable if the technology 1) has clear and important advantages over current practices, 2) contains costs, 3) improves the quality and accessibility of information needed by others in a usable form for quality care, or 4) improves the efficiency of the health care system [17]. Electronic medical resources were felt to raise few ethical or legal concerns when they constituted complete reproductions of corresponding paper-based publications. However, additional critical appraisal was recommended for distilled versions of more comprehensive texts and for resources produced with industry sponsorship that creates potential conflicts of interest. As with printed information resources, users must recognized the limits of each electronic resource and update the software to keep it current.

Common personal and institutional factors that can increase or decrease the likelihood of PDA use are listed in **Table 2**. We recommend that program directors prospectively determine which of the benefits and factors affecting physician PDA use are important to them. Residency-wide implementation of handheld computing technology is more complicated because users vary considerably in their computing experience, perceived needs, preferences, skills, and attitudes regarding change.

Questions and Potential Barriers

The major issues to consider in moving forward with residency-wide implementation of handheld computing technology are listed in **Table 3**. Questions arising from these issues involve local assessments of the benefits and challenges to PDA use, technical support,

Table 3. Residency-wide PDA Implementation: Questions and Potential Barriers to Consider

Consideration	Comments and Suggestions
Do the expected benefits of PDA use outweigh the anticipated implementation costs, risks, and challenges?	Investigate PDA options and potentially useful software applications. Compare to your program's existing information resources and workflows to determine whether PDA use will add value in your program.
How many different types of PDAs will you support?	The more platforms and brands of PDAs you support, the greater the time and costs required for training and device maintenance.
What programs should be included?	Depending on intended uses, consider 1) drug information and interactions programs, 2) clinical calculators, 3) electronic texts, 4) distilled literature resources, 5) evidence-based medicine tools, 6) clinical decision-support software, 7) personal information management tools, and 8) communication and wireless networking applications.
Is the culture of your residency program ready for change?	Identify problems or opportunities that PDA use would address. Assemble a leadership team. Create a vision and communicate it. Develop a plan and address potential barriers. Start with one or a few simple but powerful tools; build on your successes. Make appropriate PDA use part of your residency culture [23].
Who will be your champions, change agents, and role models?	Identify physician leaders who are current PDA users willing to work as part of a team. Provide hardware and software as needed to support the change process.
Who will "pay" for 1) hardware, 2) software, 3) training, 4) insurance, 5) maintenance, 6) technical support, 7) upgrades, and 8) replacement?	Communicate the vision repeatedly to institutional leaders capable of underwriting desired changes using all means available. Work with IS staff to support purchase decisions, set up, software installation, networking, upgrades, and technical support. If cost is a significant barrier, create a business plan that outlines the 1) rationale; 2) anticipated costs; 3) potential benefits; 4) research opportunities, information access, and management alternatives (eg, library access at night); and 5) potential funding sources.

(table continued on next page)

IS = information systems; PDA = personal digital assistant.

leadership considerations, human factors, institutional financial and systems support, software selection, and principles of change management. Understanding the relative importance of each of these issues and addressing them systematically during implementation will promote successful and stable incorporation of handheld information technology.

Several other implementation issues determine exactly how and for what purposes PDAs will be used in residency programs. This is particularly true when resident and teaching physicians use PDAs for managing patient-specific information, which raises important technical, legal, and ethical considerations. Because these issues are closely related to the specific benefits that residents can expect from PDA use and the knowledge residents must have to use PDAs appropriately for clinical care, patient-specific PDA use will be addressed in a future article. **Table 4** includes a list of potentially useful Web sites for residency programs interested in additional information related to the tools and technology described in this article.

Conclusion

Information technology is rapidly changing the face of medical education and patient care. Used to their best advantage, handheld computing devices and applications

Table 3. Residency-wide PDA Implementation: Questions and Potential Barriers to Consider (continued)

Consideration	Comments and Suggestions
How will you address institutional concerns regarding information exchange standards and data security?	Work closely with the IS leadership of all relevant stakeholder institutions to develop agreed-upon hardware, software, and procedural standards to ensure that data exchange is reliable, accurate, and secure. Anticipate the flow of patient-specific data and adopt standards that ensure continuous compliance with HIPAA regulations. Identify PDA uses that help resolve issues of importance to the IS group.
For whom will you provide PDAs?	Cultural change is facilitated by regular PDA use by all trainees and their core faculty supervising physicians. Include interested department chairs and division chiefs. Try to secure institutional resources to provide PDAs and software to these individuals at a minimum.
How will you get faculty and resident buy-in?	Demonstrate PDA utility and model use in daily practice. Solicit and value the opinions, concerns, and suggestions of others. Commit to accommodating all reasonable requests for enhancements and support.
How will you jump-start the process?	Put PDAs and useful software in the hands of department chairs, division chiefs, program directors, change agents, and role models early on, preferably during the planning process. Provide training so early adopters are facile. Encourage regular and visible daily use so others can see that change is taking place and that PDA resources can add value.
Will residents invest the time to learn how to use a PDA if they do not own the device?	The PDAs will be depreciated by the time new residents complete the program; encourage resident investment of time and energy by giving rather than lending PDAs.
Can you install some obvious time-savers to encourage use?	Consider starting with 1) drug information and drug interactions programs, 2) medical calculators, and 3) distilled electronic textbooks.
Can you identify and install a powerful PDA medical application that is simple to use?	Work with leadership team to select and implement a suitable software program. Gather data on use and user satisfaction; report results to relevant stakeholders.
Can you making training easy, convenient, and practically unnecessary?	Select PDAs and software that are easy to learn and use for those without much computing experience. Integrate training and use into conference series and division or department meetings. Create Web-based self-instructional lessons.

HIPAA = Health Information Privacy and Accountablility Act; IS = information systems; PDA = personal digital assistant.

have the potential to add value for program directors in their roles as clinicians, educators, and administrators. At the same time, program directors should be mindful of the issues that can affect the utility of PDAs and the likelihood of successfully implementing handheld computing technology in graduate medical education settings. When PDA use is considered desirable in a given setting, program directors can then serve as opinion leaders and role models for faculty and residents in the use of these devices to improve quality, contain costs, and demonstrate the competencies needed for the practice of medicine in the 21st century.

Table 4. Some Handheld Computing Web Resources for Residency Programs

Handheld technology overviews

http://educ.ahsl.arizona.edu/pda/index.htm
http://www.digital-doc.com/why.html

Comprehensive bibliographies of PDA health care literature

http://educ.ahsl.arizona.edu/pda/art.htm
http://www.cs.umbc.edu/~mikeg/palm.html
http://www.library.uthscsa.edu/internet/pdabibliography.cfm
http://www.welch.jhu.edu/internet/pdabiblio.html
http://www.library.vcu.edu/tml/bibs/pdabibliography.html

General resources for medical PDA content and purchase on the Internet

http://www.collectivemed.com/pdasource.shtml
http://www.handheldmed.com
http://www.informatics-review.com/handheld.html
http://www.medicalpocketpc.com
http://www.newmediamedicine.com/doctorsgadgets
http://palmtops.about.com
http://www.pdamd.com
http://www.skyscape.com

Medical resources specifically for Palm™ OS PDAs

http://www.epocrates.com
http://www.healthypalmpilot.com
http://www.mdtool.com/palm.html

Evidence-based medicine PDA resources

http://www.infopoems.com/tour.cfm
http://medcalc3000.com
http://www.ils.unc.edu/~caham/ebmtools/ebmtools.html
http://www.pediatricsonhand.com
http://www.skyscape.com/products/productinfo.asp?id=373&os=ce
https://ami.avantgo.com/channels/search_results.html?match=Clinical%2Bevidenc&region_id=223

Patient care delivery software suites

http://www.allscripts.com
http://www.altapoint.com/altamed.htm
http://www.digital-doc.com
http://www.ephysician.com
http://www.gemedicalsystems.com/it_solutions/pocketchart.html
http://www.iscribe.com
http://www.mdeverywhere.com
http://www.mdpad.com
http://www.micromed.com/sub/whole_pro_pda.htm
http://www.parkstonemed.com

Physical examination: digital analysis of heart and lung sounds

http://www.stethographics.com/frames/products_pda.html

Push technology: downloading Web content to the PDA

http://avantgo.com/products/individuals/basic.html
http://www.mazingo.net

Electronic medical records

http://www.fphandheld.com/EMR.htm
http://www.gemedicalsystems.com/it_solutions/pocketchart.html
http://www.cerner.com/products/enterprisewide_systems/emr/pocket_powerchart_tour.asp

Medical education links

http://www.healthmgttech.com/archives/h0202teaching.htm
http://www.digital-doc.com/links.html

Miscellaneous sites of interest

http://www.hopkins-abxguide.org
http://www.microsoft.com/mobile

PDA = personal digital assistant.

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