

PDAs FOR THE INFECTIOUS DISEASES PHYSICIAN

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PERSONAL DIGITAL ASSISTANTS (PDAs) are remarkable and versatile hand-held computers that are increasingly being used in contemporary medical practice [1]. They have numerous applications that can enhance the effectiveness of the practices of primary care doctors as well as infectious disease physicians. PDAs can provide databases for information (such as textbooks and guidelines) and serve as organizers for personal and business planning. The wireless models can also immediately access the Internet for even more information, news, and interaction.

The practice of infectious disease is a dynamic one in an environment where there are many demands, some related directly to patient care and some to the management of busy practices where many rules and regulations must be followed. Outbreaks of devastating illnesses, emerging infectious diseases such as SARS, the development of new drugs, and increasing resistance to antimicrobials require frequent updating of knowledge and intervention strategies. The global aspects of infectious diseases also make awareness of exotic infections an increasingly important issue. As the events surrounding September 11th suggest, increasing awareness of bioterrorism, particularly involving the use of infectious agents, requires increased monitoring and education of an anxious public. Many of these functions can be provided or complemented by PDAs in a single portable device that can be continually updated.

PDAs are essentially scaled-down versions of your desktop personal computer that perform similar though more limited tasks. They use handwriting recognition software with a stylus or input of data via a screen or attachable keyboard to help navigate through their functions. The screen may be monochrome or color and displays the programs and documents contained on the PDA just like a desktop. Tapping on their icons on the screen accesses the programs or documents. Fixed

buttons on the PDA allow quick access to functions such as the date book, address book, and notebook. Newer PDAs also have excellent graphics that allow the input of tables and graphs and the storage of high-resolution images.

PDAs are designed for convenience and ease of use, with intuitive programs that allow you to avoid reading the directions in most cases. At the moment the two most popular operating systems are the Palm OS (Palm, Inc., Milpitas, CA) and the Microsoft-based Pocket PC (updated version of Windows CE; Microsoft Corp., Redmond, WA). The Microsoft-based systems have the appearance and organization systems that may be familiar to those who have used other Microsoft programs such as Windows and Word.

Some of the advantages a PDA can bring to the infectious diseases specialist include the following.

Information Storage With Ready Access

A lot of information can be stored on PDAs, but they are clearly more limited than a desktop or laptop, especially when it comes to programs rather than just data. Although the memory of the newer PDAs is getting larger and there are memory cards up to 128 megabytes, they will never be able to store all you might like. For larger amounts of information, some of the PDA units come with wireless capabilities such that they can access an intranet or the Internet and the nearly limitless amount of information and programs you can find there.

An infectious diseases specialist may find immediate value in programs that contain drug databases that include antibiotics (Table 1). They show indications for use, recommended dosages, adverse effects, interactions, and cautions. ePocrates (ePocrates, Inc., San Mateo, CA) is a database that allows searching by drug name or class and even has information about recent cost figures. For quick information about a new prescription, a PDA in your pocket may be faster and more accessible than the old standard *Physicians Desk Reference* book, which has just been brought out in a PDA program as well. The PDR, however, is pharmaceutical

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TABLE 1. Basic information about drugs and antimicrobials

ePocrates www.epocrates.com	Database of drugs, dosing, costs, toxicity, pregnancy category; searchable by class of drug (free)
Lexi-Comp www.lexi.com	Use, usual dosage, drug interactions, warnings, pregnancy risk factors, adverse drug reactions, dosage forms, Palm and Pocket PC. (\$75 annual fee)
Mobile Micromedex www.micromedex.com	Over 1400 drug monographs, point of care information, alternative medicines, acute care data, toxicology information (\$78.95)
Mosby's Drug Consult www.mosbysdrugconsult.com	Drug information and interactions, search by indications, chemical name, trade name, international Brand names (\$64.95/yr)
PDRdrugs 2002 www.skyscape.com	Essential extracted indications, contraindications, warnings and precautions, adult and pediatric dosing, adverse reactions, drug-drug interactions, therapeutic class, Black Box warnings, how supplied, DEA class, pregnancy and nursing information, and manufacturer's name. Palm and Pocket PC (\$49.95)

company information with limits imposed by the U.S. Food and Drug Administration.

Some provide more detailed information about drug mechanism, pharmacokinetics, and toxicity. The Mosby handbook is available with a program that identifies potential drug interactions after you input a patient's medication list. Tarascon has created a PDA version of their tried and true pocket pharmacopoeia, which has been offered free at the Medscape Web site (www.medscape.com). This program is similar to the handbook but does not have cost information and has simplified versions of the tables [2]. Additional detailed information about antimicrobials is available in programs such as the ABX from Johns Hopkins and the Sanford Guide, but they do not have all the tables paper pocket handbooks do from Sanford or Bartlett.

National antimicrobial susceptibility information and even your local antibiogram can be added to your PDA database and provide ready information to help in decision-making. Wireless communication with the Internet and incorporating the local resistance information may be particularly helpful for difficult organisms or increasing antimicrobial resistance [3,4].

Guidelines for management of infectious diseases are also available for PDAs. They are incorporated in the Hopkins ABX and ACP-ASIM Web sites and available for many other diseases as well (Table 2). Managed care institutions and insurers may also provide programs for PDAs that incorporate their guidelines and formulary restrictions. Recommendations for vaccines can be easily downloaded from the Sanford guide for ready reference.

If you cannot find a site to download data you want directly into your PDA, you can take any digital information or image you wish and put it into your PDA with the help of iSILO (www.isilo.com). This may be worthwhile for the ACP-ASIM (www.acponline.org/pda/index.html) recommendations for adult immunization or Centers for Disease Control and Prevention (CDC) recommendations if desktop access is not convenient enough.

Real Time Information Access

Infectious diseases specialists are increasingly expected to keep up with the latest developments in the field—

TABLE 2. Guidelines for Management of Infectious Diseases

Program	Comments
ACP-ASIM www.acponline.org/pda/bioterrorism.htm	PALM/PC Downloadable info on bio-terrorism topics, other infectious agents
AMA www.ama-assn.org/ama/pub/category/1797.html	ID topic info and news, search by topic
AHRQ www.ahrq.org	Guidelines, healthcare system issues, funding opportunities
HIVINSITE http://hivinsite.ucsf.edu	HIV disease, epidemiology, treatments, trials
IDSA www.idsociety.org	Guidelines on clinical infections, therapy, specific agents
National Guidelines Clearinghouse www.guideline.gov	Guidelines on ID and other specialty topics

Table 3. Sources of Information for the PDA

Avantgo <i>www.avantgo.com</i>	Journal abstracts and news downloaded to your PDA at hotsync. (free for limited number)
Gideon <i>www.gideononline.com</i>	Large database of diagnostic, epidemiologic and therapeutic information based on infection, agent and country, (subscription)
Journal To Go <i>www.journaltogo.com</i>	Abstracts from selected fields automatically downloaded to your PDA and e-mail when you hotsync, (free)
Medfetch <i>www.medfetch.com</i>	Medline search results on your selected topic e-mailed, wireless access possible (free)

and to be able to respond. Textbooks and even the latest issues of prominent journals are often out of date when it comes to epidemics such as SARS. While television reports and sources such as *The New York Times* are often credible, the information available on the Web may be more authoritative, detailed, and accurate. It is now possible to access information that is updated daily, if not hourly, with a PDA. ProMED is a good example, with free daily e-mail reports on new infections or epidemics from around the world. Gideon is another example and includes programs for diagnosis as well as practice guidelines and microbiology information [5]. It is not yet available for PDA download but can be accessed with a wireless connection to the desktop version. Services such as Journal-to-Go (*www.journaltogo.com*) and AVANTGO (*www.avantgo.com*) provide free updates of selected new abstracts in infectious diseases and other fields (Table 3). These updates occur automatically when the PDA is connected to your desktop. New information can therefore be reviewed whenever you have a free moment.

With increased travel to and from many different countries, it is important to have access to information about infections occurring in cities and regions with which one may not be very familiar. This is particularly important in the case of outbreaks, such as West Nile virus, cholera, dengue, rickettsial infections, and the hemorrhagic fever viruses. Gideon can provide not only the latest update on endemic diseases in most

countries around the world but also diagnosis criteria, treatment guidelines, and microbiology information.

With the recent increased awareness of the threat of bioterrorism, there is also increased interest in and availability of specific information regarding the manifestations and treatment of potential biological weapons.

At the moment, the hardware constraints of PDAs make the Web page resources somewhat limited. Update services with abstracts of recent articles and conference reports specific to infectious diseases are also available via e-mail through list serves. If your PDA can download your e-mail from your desktop, you can read the latest hot items at your convenience. A list of some of the options is presented in Table 4. Weekly reports specific to infectious diseases can be obtained through IDLinx.com (*www.idlinx.com*) and monthly ones from Medscape (*www.medscape.com*).

Some journals have begun to offer limited versions of their latest issues with tables of contents and abstracts that can automatically be transferred to your PDA when you periodically "hot-sync" your files. Certain Web-based services are now available that will provide limited Web pages (text only) of journals. *The New England Journal of Medicine* offers a service by which your wireless connected PDA can be used to select certain articles from a database of specific topics and e-mail them to your desktop for review. The major infectious diseases journals do not have this service

TABLE 4. Web pages with list serves for infectious diseases

Source	Address	Comments
IDLinx	<i>www.idlinx.com</i>	News, reviews, links
Infectious diseases in clinical practice	<i>www.infectdis.com</i>	Links, articles and news
Medical matrix	<i>www.Medmatrix.org</i>	Search engine for selected websites and journals, many links \$79.00/year
Medscape	<i>www.medscape.com</i>	ID journals scan, news, guidelines by subject
National Institutes of Allergy and Infectious diseases	<i>www.niaid.nih.gov</i>	Info on research programs, national panel reports, epidemiology
National Center for Infectious Diseases	<i>www.cdc.gov/ncidod</i>	General ID info, epidemiology, vaccines
ProMED	<i>www.isid.org</i>	Up to date info on epidemics worldwide
WHO Infectious Diseases	<i>www.who.int</i>	Epidemiology, traveler's info

at this time. With advancements in technology, these Web sites will become more sophisticated.

In the future, wireless technology such as Bluetooth will allow access to an intranet network or the Internet. Intranet resources may contain a wealth of information specifically designed for and subscribed to by your organization or network.

Diagnosis and Treatment Assistance

The number of infectious diseases and treatment modalities seems infinite at times, and, like the universe, seems to somehow be expanding. Keeping track of all these data is beyond the internal hardware mental capacities of the average physician and even most infectious diseases specialists. A PDA can help in analysis and management of uncommon problems.

Interactive programs are also available for infectious diseases. Assistance with antibiotic decision-making is also available [6]. Four commonly used programs are listed in Table 5 with a description of their features. The ePocrates-ID program was available for free but is now part of the Rx-Pro package, available for \$49.95 on the ePocrates Web site. It allows a search by infection (bone, joint, respiratory, etc.), with recommendations for antibiotic selection [7]. It also connects to drug information through ePocrates. The ABX program is available free through the Johns Hopkins Web site and contains an equally useful program that works with both the Palm OS and the Pocket PC. The ABX program has detailed information about idiosyncratic issues in the use of specific antibiotics and a lot of information about a long list of pathogens.

The Sanford guide is available for both Palm OS and Pocket PC, with detailed information on specific infections and organisms. It also has additional information about vaccine schedules, renal dosing of certain antibiotics, and some abbreviated guidelines. The Sanford guide contains a wide variety of information from

the paper edition that the other programs do not but costs \$25 for each program [8]. The Antibiotic Assistant is available through the MerckMedicus Web page (www.merckmedicus.com). These programs are self-explanatory and easy to use. While ePocrates-ID, ABX, Sanford, and the Antibiotic Assistant do not always agree on antibiotic choice, they are handy resources and often incorporate information about the adverse effects of various antibiotics as well. These programs are frequently updated and can provide assistance to any doctor treating an infection. Whether they will replace the need for an infectious diseases consultation is debatable but probably not a risk these days, as the challenges become more and more complex.

Some of the newer PDAs have the capacity to store high-resolution color images or photographs of uncommon physical or pathologic findings that may be important for diagnosis (such as a characteristic rash, malaria in an RBC, or the physical findings with anthrax). With access to a digital camera, the physical findings of a particular patient can also be recorded for future comparison or for addition to a chart when referring to a consultant, such as a dermatologist.

PDAs can also provide a database on the epidemiology of a variety of diseases with easy access in the office or examination room. The list of these databases available to infectious diseases physicians is growing. Some good databases available now include Gideon, a large database and program that is organized by disease states and contains a large amount of information that is searchable by country. It has a feature that allows the clinician to enter the epidemiological and clinical data on a specific patient, which the program will then use to generate a differential diagnosis. Gideon can also generate a differential diagnosis of possible diseases on the basis of signs, symptoms, and epidemiological data for a particular patient. Epidemiological information is also available in the form of handbooks and manuals now available for the PDA. Franklin Medical Publishing has the *2000 Redbook*, available at no charge (www.handheldmed.com).

TABLE 5. Interactive programs for therapeutic decision-making

Program	Comments
ABX Hopkins www.hopkins-abxguide.org	Antimicrobial therapy by organism and infection with recommendations, Palm and Pocket PC, (free)
Antibiotic Assistant www.theradoc.com	Antimicrobial recommendation after brief survey of patient demographic, clinical disease, organism/susceptibility, drug allergies; Palm and Pocket PC, (free via MerckMedicus)
ePocrates-ID www.epocrates.com	Antimicrobial therapy by infection and drug, side effects, mechanism of clearance. Palm OS only. (part of package for \$49.95)
Sanford Guide www.sanfordguide.com	Antimicrobial therapy by infection, organism, recommendations on prophylaxis. Palm and Pocket PC, (\$25 each)

Other portable databases of information include the *Pocket Book of Infectious Disease Therapy 2002*, the *Johns Hopkins Hospital 2002 Guide to Medical Care of Patients With HIV Infection*, and the *5-Minute Infectious Disease Consult* (www.skyscape.com).

Prescribing

Remote prescribing is also available for PDAs so that a prescription can be written in the examination room and automatically faxed to the appropriate pharmacy before the patient gets there. These programs can also be developed to show the formularies of different insurance plans. This reduces confusion and call-backs and allows the doctor to know about substitutions that will be made, if any. According to the national center for policy analysis (www.ncpa.org/pi/health), one third of the 3 billion prescriptions written each year must be revised because the drugs written for are not covered by insurance or the handwriting is illegible. The programs described above can circumvent both of these problems. The cost of the medication can also be displayed before the prescription is written. Hospital pharmacists can use specially designed software to ensure appropriate dosing and follow-up of drug levels at appropriate intervals [9].

Practice Management

Within the setting of clinical practice, the PDA can serve many roles. It can serve as a database of patient information that is easier to read and may be better organized than the patient chart. PDAs have also been used to access lists of ICD-9 codes and billing codes that save the step of transferring such data from paper to computer databases. Software packages such as those available through Allscripts (www.allscripts.com) use PDA-based note-writing, dictation, prescription-forwarding, and coding.

The wireless PDA can also be used to gain access to previous patient records when the physician is outside the office, saving time in phone calls and pulling of office charts.

Patient-tracking programs may be used to enter information from consultations and follow-up visits in standard formats. These data can include laboratory and culture results as well as imaging findings that can then be easily accessed for comparisons.

Most PDAs have infrared ports available that make it possible to transfer and receive data from other PDAs rapidly and easily. This allows transfer of information regarding specific medical information about patients,

although it must be confidential. Information about patients for cross-coverage can be easily transferred from one physician to another. Patient-tracking programs for PDAs allow easy access to well-organized databases. Some of the programs will create a to-do list at the end of rounds as a reminder. Many of these programs are easy to use and are either inexpensive or free.

Patient education information can also be stored in a PDA. With use of printers with infrared ports, PDAs can be used to print pertinent patient handouts regarding specific diseases or medications for the patient to take home.

Data Collection Tool

Easy data collection is another potential application of PDAs. With simple programs available for either the Palm OS or Microsoft devices, it is possible to gather data at the bedside and enter it in a standard format to be downloaded into a desktop later. This may be useful for infection control or vascular access information. Using newly available programs such as the epitool version 1.0, available at the Johns Hopkins Hospital epidemiology Web site (www.hopkins-beic.org/epitool), makes it possible to directly input pooled data into a statistical program. Such survey tools are already being applied in the hospital by pharmacists to track drug usage and could be used to monitor antibiotic usage. For the Satellife program, workers who had a brief period of training conducted surveys of measles immunization in populations in Kenya, Ghana, and Uganda. This information was then compiled at a central location by communication via low-earth-orbit satellites and conventional Internet connections (www.healthnet.org). The use of PDAs would allow mobile evaluation and allocation of valuable resources to assist allocation in a timely manner, although the initial cost of these may be a burden [10].

Patient surveys have been done with PDAs. They are easy to use, and many patients prefer them to paper. Programs are available for the easy design of such surveys. Hospital pharmacies are using palm-based devices to help monitor usage of certain medications and are using palm-based databases in the follow-up of patients who require drug-level monitoring or monitoring of specific toxicities [9,11,12].

Additional Programs and Tools

Programs such as i-SILO and Aportis allow conversion of the text of Web-based articles in normal and pdf format

to a PDA format for storage in a PDA. This may be particularly useful for the storage of guidelines, such as those published by the Infectious Diseases Society of America.

For those infectious diseases specialists involved in teaching residents or fellows, lectures or other data can easily be transferred among PDAs by infrared and then be available to another within moments. The new palm devices also have excellent color graphics that allow the transfer of photographs or charts and graphs. With the Windows-based palm systems it is possible to use Power Point to make slide presentations, which can be stored on the PDA and connected directly to a Power Point projector.

In addition to the medical applications of PDAs, there is a plethora of additional personal uses—from storage of contact information to appointment calendars (including alarms for your anniversary), e-mail, and digital images.

More Information on PDAs

Table 6 displays some of the Web sites you may find useful in selecting a PDA for purchase or the programs available. In general, the PalmOS programs are free or less expensive than the Pocket PC ones. The Pocket PC programs, however, are more sophisticated and can easily integrate with other Windows software. There are numerous useful applications for PDAs in the life of a busy infectious diseases practitioner. Their power lies in the portability of a vast amount of information, which is at your fingertips. They allow you to perform functions of patient care and practice on the go. Learning to use PDAs is actually simpler than learning to use a desktop PC, but it is important to have some rudi-

mentary computer skills. Many of the uses of PDAs can be customized to your needs. Most PDAs have functions that allow e-mail to be sent automatically after you connect with the desktop or immediately from the PDA if you are connected via a wireless connection.

The price of PDAs varies from \$100 to \$600, depending on capabilities, memory, and quality of the LCD screen. The higher-end PDAs have color screens, higher resolution graphics, more memory, sound capability, and the ability to run many of the programs that can be run on your desktop (e.g., word processors, Power Point). Some of the units have dictation capabilities as well. The more basic PDAs are still powerful tools that will run almost all of the software that is available. There are numerous good Web sites that discuss the specifics of PDAs and are even helpful in making the decision to purchase a PDA. Web resources for PDAs are listed in Table 6.

The Future

What role PDAs will play in medicine is being explored, but it is clear that they have tremendous potential to store and synthesize information—and may even be able to save time in some situations. They will certainly get better and better and evolve in response to the needs and advances in technology. Wireless connections in clinics and hospitals are already being set up. PDAs are already being incorporated into cellular phones, which allow ready connection to the Internet. For those who consider the screen hard to read or too small, there are now “Tablet PCs” available, which are considerably larger and are similar to a half-sized laptop computer, with the ability to enter data by touch screen as well as keyboard.

TABLE 6. Web sites with useful information about PDAs

Website	Comments
American Thoracic Society www.thoracic.org/palm/palmtips.asp	Useful, brief reviews of PDA programs and FAQ's
HandheldMED www.handheldmed.com	Software, handbooks, info on hardware
Healthy Palm Pilot www.healthypalmpilot.com	Downloadable free software
Palmgear www.palmgear.com	Many free programs and info
PDA cortex www.pdacortex.com	Handbooks and reference, patient tracking, coding, free software, calculators with common medical formulas
pdaMD www.pdamd.com	Software, hardware, articles about applications
PDA street www.pdastreet.com	Info on PDAs and accessories, software

Summary

PDAs offer a new tool for the infectious diseases specialist. They can bring a remarkable amount of information and assistance in decision-making to the bedside. While it may take some time to become familiar with them, the opportunities for improving patient care are great and expanding. The PDA will continue to evolve with time and become more and more user-friendly.

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