THE DENTAL CLINICS OF NORTH AMERICA

Dent Clin N Am 46 (2002) 539–551

Handheld computing in dentistry

Mark H. Taylor, DDS, FACD

Department of Pediatric Dentistry, Creighton University School of Dentistry, 2500 California Plaza, Omaha, NE 68178 USA

During lunch break from the office, you receive a call from the receptionist on your cell phone. Your patient, Mrs. Jones, has a toothache and swelling. After talking to Mrs. Jones, she tells you she has just been diagnosed with some obscure disease that you remember precious little about and is currently taking a new prescription for her condition. You want to prescribe her an antibiotic, but you are justifiably hesitant to do so before knowing more about her condition and the medication she is taking.

Fortunately for you, your cell phone doubles as a handheld computer. You open your disease database to review the details regarding Mrs. Jones' condition, make a few taps on the screen to review her current medication, and tap a few more times to send your prescription to the preferred pharmacy.

The purpose of this scenario is to demonstrate the convenience and efficiency of handheld computing. I use my handheld computer for professional purposes on a daily basis, either at my private office or on the clinic floor at my university. I find that the handheld computers are extremely efficient in retrieving needed information fast. I have experience using both of the two most popular operating systems, the Palm (Palm, Inc, Santa Clara, CA) and PocketPC (Microsoft Corp, Redmond, WA).

The purpose of this article is to review basic handheld hardware and how it operates, discuss the different operating systems, and examine software applicable to dentistry for the handheld.

What is a handheld computer?

Handheld computers are ubiquitous, but they are not seen because they can be tucked into a pocket. According to a report from the market research firm International Data Corporation, sales of handheld information technology and communications devices will grow at 48% per year over the next 4 years to reach $26 billion per year by 2004 [1].

E-mail address: mtaylor@creighton.edu (M.H. Taylor).

PII: S0011-8532(02)00014-9

This same research firm estimates that 11.4 million "smart" handheld devices were sold worldwide in 2000, of which 70% were handheld computers or personal digital assistants (PDAs). This number is expected to increase to more than 61 million units in 2004. Another report indicated that total sales of PDAs reached 6.1 million units in 2000, and sales are expected to increase to 9.6 million units in 2001 [2]. The top sellers in terms of market share in 2000 were Palm (72%, down from 79% in 1999), Handspring, which has a Palm operating system (14%), Hewlett-Packard (2.3%), and Compaq (2%), both of which have the PocketPC operating system [3]. The PocketPC operating system is much newer and is making significant strides in gaining market share, however. Palm shipped approximately 622,000 units in the second quarter of 2001 as compared to 450,000 to 500,000 for Compaq, which only began shipping units in May 2000 [4].

Approximately 90,000 physicians in the United States (approximately 15%) use a PDA professionally [5]. For medical and dental purposes, three major operating systems are currently available: the Palm OS, the PocketPC, and the Psion. The Palm system is the oldest and boasts the greatest number of total users and available software. The PocketPC operating system has gained significantly in popularity in the past year. The Psion system has its niche in the medical community, but according to a July 2001 release, Psion announced that it will not develop next-generation PDA products for consumers. This article focuses on the Palm and PocketPC systems.

Although there is great variability, the most popular handheld computers are approximately the size of a thin wallet and weigh approximately 6 oz. They have several navigational buttons to access standard personal information management programs. Most of these devices have a stylus, a pen-like pointing and writing device, to enter information into the PDA and navigate through different software programs. Depending on the model, the screens are either in black and white or color and measure approximately 2.5×3 inches.

Manufacturers of Palm OS handheld computers include Palm, Handspring, Sony, and Handera. PocketPC manufacturers include Compaq, Hewlett-Packard, and Casio. With the official launch of Pocket PC 2002 comes a flurry of new PDAs from Compaq, Casio, and Toshiba.

What are the different features of a handheld computer?

To gain more familiarity, a perusal of the landmarks of a PDA is helpful. The model used for this demonstration is the Handera 330. Although their appearance may differ, other PDAs have similar functions.

Power button

This button is used to turn the unit off and on. Unlike a desktop computer, however, which can take considerable time to boot, a PDA turns on and off almost instantaneously. This is important to the practicing dentist

because it is inefficient to wait for boot up to retrieve information in the midst of a busy patient schedule (Figs. 1, 2).

Microphone

One of the most convenient features included in many PDAs is the microphone function. The user presses the record button and the PDA digitally records the user's voice. This sound file can be replayed at any time. The microphone can be helpful to create reminders when using a stylus is impractical (see Fig. 1).

Screen

There are substantial differences in screen resolutions, so if maintaining clinical photos on your handheld is important to you, a high-resolution color screen may justify the added expense. For example, the iPAQ H3635 Pocket PC has a resolution of 240 × 320 pixels and displays 4086 colors. The noncolor Palm screens are 160 × 160 pixels; the Handera 330 is noncolor but has a resolution of 320 × 240 pixels (see Fig. 1).

Writing area

The writing area is called the "graffiti" area in the Palm operating system and the "character recognizer" in the PocketPC system. The user writes in a

Fig. 1. Front view of a PDA. Features include (a) the power button, (b) microphone, (c) screen, (d) writing area, (e) quick access buttons, and (f) jog wheel.

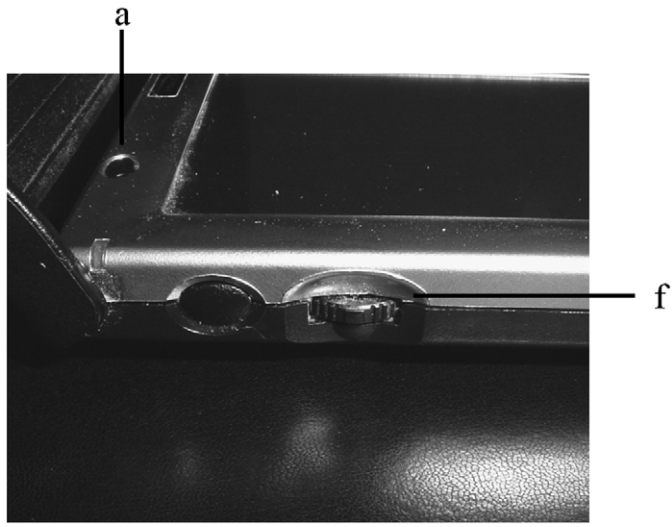

Fig. 2. Side view of a PDA. Features include (a) the power button and (f) jog wheel.

printing style in this area with the stylus and the computer reads the movements of the stylus and prints text to the screen. The Palm's "graffiti" requires the user to print each letter a certain way, but the system is easy to learn and is highly accurate. Both systems also have a pop-up keyboard that allows the user to hunt and peck with the stylus for inputing data. This method, although accurate, tends to be slower for the experienced user. In the Palm system, this area also has icons that can be tapped for the application launcher, menu, calculator, and find program. Tapping the application launcher area with the stylus opens the applications program, where all the PDA's programs and data can be accessed. The article also discusses some software applications (see Fig. 1).

Quick access buttons

These buttons allow the user to access frequently used programs, such as the calendar, contacts, to-do list, and memos. The user pushes the button of choice and the PDA opens immediately to that application without initially pushing the on/off button.

These buttons are also customizable to open to the user's most frequent applications. For example, I customized my handheld computer to open directly to my favorite drug database instead of the to-do list. This feature is convenient and saves a few keystrokes during a busy day. This area also has scroll buttons that allow the user to scroll through a document or a menu list of choices (see Fig. 1).

Jog wheel

The jog wheel is an additional, more recent feature that some PDAs promote. The jog wheel allows the user to navigate through an application by acting as a scroll wheel up or down through a list or table. It also serves as a selection device for an entry when depressing the jog wheel (see Figs. 1, 2).

Infrared port

The infrared port on a handheld is used to "beam" information to another handheld or peripheral device, such as a printer, that is also equipped with infrared. The following is an example of using this technology: I entered the American Dental Association recommended fluoride supplementation schedule into my PDA. A colleague was interested in having this information on her PDA also. The beaming procedure was as simple as lining up the infrared ports to each other and instructing my PDA to beam the information. The receiving PDA was instructed to accept the information and within a couple of seconds, the file was transferred. Many different kinds of files and entire applications may be transferred, as long as the application is not copy protected. For a detailed review of copyrighting and education, please refer to the article by Spallek and Schleyer [6] (Fig. 3).

Compact flash expansion slot

Compact flash expansion cards are small cards (approximately the size of a matchbook) that are capable of storing an almost unbelievable amount of information. These cards range in storage capability from 8 megabytes to 1 gigabyte with the IBM microdrive. This ability is of great importance to the

Fig. 3. Top view of a PDA. Features include (g) the infrared port, (h) compact flash expansion slot, (i) secure digital expansion slot, and (j) stylus.

practitioner because it allows much greater storage of medical information and patient data that are readily available to the dentist. The slot also accepts add-on peripherals, such as modems, wireless modems, Ethernet, and laser scanners (see Fig. 3).

Secure digital expansion slot

This slot accepts either a secure digital memory card or a MultiMediaCard. Secure digital cards can be used for storage of files or other uses, such as electronic books, MP3 music, or maps. MultiMediaCards also can be used for applications such as photos, music, and games (see Fig. 3).

Stylus

The stylus is the user's link to the information contained in the PDA and a primary method by which information is put into the PDA. The stylus is used in a similar fashion as a pen and a computer mouse. The instrument is approximately 4 inches long and resides in a holder on the PDA when not in use (Figs. 3, 4).

Battery

Personal digital assistants are powered either by a rechargeable battery, such as a lithium ion, or by standard batteries, such as AAAs. Rechargeable batteries are desirable from the standpoint that the user avoids purchasing multiple packs of batteries; however, recharging the battery typically means that the unit must sit in the handheld computer's cradle for a period of time,

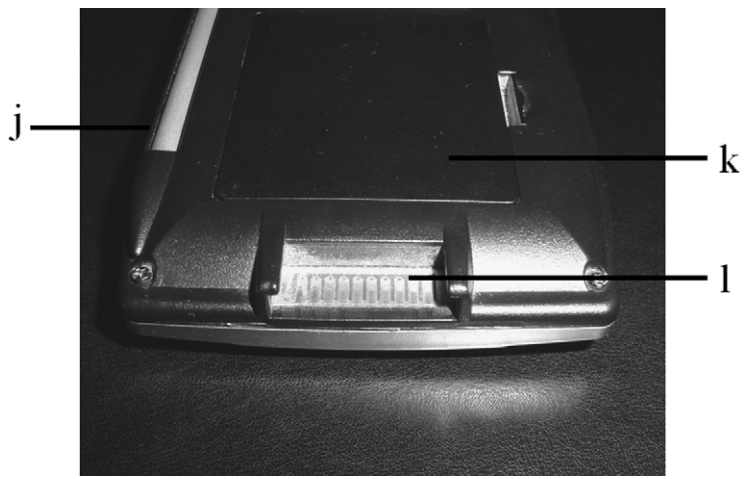

Fig. 4. Bottom view of a PDA. Features include (j) the stylus, (k) battery, and (l) communication port.

usually 1 to 5 hours depending on model, which may be inconvenient. Rechargeable batteries also may be expensive to replace. The advantage of standard batteries is that they can be replaced quickly at any time, which is especially important on a busy day of practicing dentistry (see Fig. 4).

Communication port

The communication port allows the PDA and the computer to "talk" to each other. The PDA is attached to the cradle at the communication port, and the cradle is attached to the computer by a universal serial bus (USB) or serial connection. The synchronization process allows data on the handheld computer and the computer to be updated. In other words, any changes made on the handheld computer or the desktop computer appear in both computers after the synchronization process (see Fig. 4).

Internal RAM/ROM memory

Memory allows for storage of applications and data. The standard amount of random access memory (RAM) on most handheld computers using the Palm operating system is 8 megabytes and either 16 or 32 megabytes for the PocketPC system. At first blush, it seems that the PocketPC systems offer much more for the money. This perception is misleading, however, because the Palm operating system and many Palm software programs are simpler in nature and require less memory.

Processor

Efficiency in using a handheld computer is partially related to processor speed; the faster the computer works, the faster the dentist can retrieve the needed information. Most Palm system machines run from 16 to 33 MHz, and Pocket PC machines run from 70 to 206 MHz. Again, a first impression would be that the PocketPC products would be much faster. Because the operating system is more complicated in the PocketPC, however, the normal operation of applications may not be significantly different. I have had extensive experience with three handheld computers: the TRG Pro with a 16-MHz processor, the Handera 330 with a 33-MHz processor, and the Compaq iPAQ H3650 with a 206-MHz processor. In my experience, the speed differences are minimal, if at all, when opening and using similar programs on these various machines.

What can be done with a handheld computer?

Basic handheld functions

The most common applications found in a PDA are a calendar, an address book, some kind of note pad, a to-do list, e-mail, and a calculator.

The calendar is basically for scheduling appointments. It may be seen in daily, weekly, or monthly views; repetitive scheduling is simple, as is setting audible alarms for reminders. The address book records include several fields, such as name, title, company, work, home, fax, and other phone numbers, e-mail, address, customizable fields, and a note section for each entry. The to-do list is a reminder list for the user, and he or she may may prioritize items on the list, assign due dates, and record the date of completion. A note pad stores information to which the user wants quick access. In addition to maintaining the fluoride supplementation table in my memo pad, I also keep common prescriptions for children of varying weights for subacute bacterial endocarditis (SBE) prophylaxis, oral infections, topical and systemic fluoride, and drug effects and precautions of many commonly prescribed drugs. These listings are convenient and save valuable time in the office. E-mail can be read, replied to, composed, and even deleted on the PDA.

Synchronizing the PDA with the desktop PC ensures that all functions, including notes, schedules, phone numbers, and addresses, are updated appropriately. For example, if the user reads an e-mail on the PDA, the next time synchronization occurs with the desktop e-mail application, the e-mail is marked as ''read'' on the desktop PC.

Other software

The abundance of software for the PDA is overwhelming, and much of the software is either freeware, which is free of charge, or shareware, which means that the user can try out the software at no cost then pay a reasonable fee if the program continues to be used. The following list is a sometimes serious, sometimes frivolous, brief smattering of available software for the PDA.

Quickword and Quicksheet are Palm applications that are compatible with Microsoft Word and Microsoft Excel. Word and Excel files may be created, altered, and synchronized between the PDA and the desktop system.

DiddleBug is a Palm program that allows the user to draw, scribble, and take notes and maintain them for future reference. This software could be used in explaining a dental condition to a patient then beaming the notes to his or her PDA.

Pocket SlideShow is a PocketPC program that is capable of showing PowerPoint presentations. The user synchronizes a PowerPoint presentation with the handheld computer, and the program scales and optimizes for the PocketPC color display. It is possible to have common dental condition presentations preloaded on the PDA and show them to a patient or parent to aid in explaining a condition. It is also possible to take a digital photograph of the patient for use in demonstrations.

The Noah Lite dictionary has definitions for 122,000 words and is freeware for the Palm OS.

HanDBase is an easy-to-use database program in which one can create databases to suit his or her own needs. The HanDBase web site has hundreds of free applets, however, including many medical and dental applets.

AvantGo Web Client gives the user the capability of choosing from more than 1500 Web pages and downloading them to the PDA during the synchronization process. For example, I subscribe to FoxNews.com, FoxSports.com, the New York Times front page, and the New York Times technology section. For general health information, I subscribe to thehealthchannel.com and biomedcentral.com. If I need driving directions, I go to mapquest.com, enter my origin and destination locations, and download the detailed directions to my PDA through AvantGo.

OmniRemote is a universal remote control that uses the PDAs infrared to control a television and VCR. ChaCha also uses the infrared feature, but users chat back and forth with this program using "graffiti."

Adobe Acrobat Reader lets the user view Adobe Portable Document Format files on the PDA. It has styled text, images, bookmarks, and a search function.

ACDSee Mobile is an image-viewing program in which nine different kinds of image types may be transferred from the desktop PC to the PDA. The user also may search for the images by name or description. This software could be of value when explaining procedures to patients.

Other possibilities of using a PDA involve adding attachments or peripherals, examples of which follow.

Type

If one must enter a significant amount of data or if a user writes a lot on the handheld, an attachable, collapsible keyboard may be helpful. These keyboards generally cost from $60 to $100.

Take photos

Specially designed, small, lightweight digital cameras plug into the PDA and give the user the capability to take photos at any time. Pictures can be stored in the PDA and can be beamed to another Palm or "hotsynced" to a computer. Imagine placing a beautiful new veneer, taking a digital photo of it, and beaming it to a patient's PDA. The patient could take it home and transfer it to his or her personal computer and print out a new smile.

Listen to music

Some modules store music files and play them through earphones.

Use real-time direction and mapping services

Global positioning devices that are battery powered attach to the PDA and integrate with mapping programs that are displayed on screen. These

devices allow users to locate their position accurately and have directions to a location.

Make a phone call

Some PDAs have phone modules that attach, and some cell phones have PDAs integrated with the phone. For example, the Handspring VisorPhone plugs directly into the unit's Springboard slot and operates as a phone and two-way messaging system that accesses the Internet and operates as a wireless modem. The Kyocera SmartPhone is a tri-mode phone that contains a Palm OS PDA.

Other attachments for the PDA include a bar code scanner, a business card scanner, scientific sensors for temperature, acceleration, acids, and bases, a digital voice recorder, and an alphanumeric pager.

What dental applications are available?

In this section, I provide a brief review of several examples of software that would be of interest to the practicing dentist. This is a small sample of the vast amount of information available to the practitioner.

ePocrates qRx

This software is a comprehensive, free drug database. Unfortunately, as of this writing, it is available only for the Palm OS. For each drug, information regarding adult and pediatric dosing, contraindications, drug interactions, adverse reactions, cost and packaging information, and other information, such as metabolism, excretion, Drug Enforcement Agency classification, drug classification, and mechanism of action, is listed. The user also may keep personal individual notes for each drug. The listing at ePocrates is complete and may be updated with each synchronization (Fig. 5).

ePocrates QID

This program is an infectious disease database in which information can be searched by location, microbe, or drug. This program also launches into ePocrates qRx, if needed, when a drug is listed.

DocAlert

DocAlert is another free program from ePocrates. When one's PDA is synchronized, it automatically downloads medical news. For example, recently my DocAlerts were (1) "This week in medical history," (2) "Federal report documents top patient safety practices," and (3) "Institute for Safe Medication Practices (ISMP) alert: dangerous possible mix-up between Avandia and Coumadin."

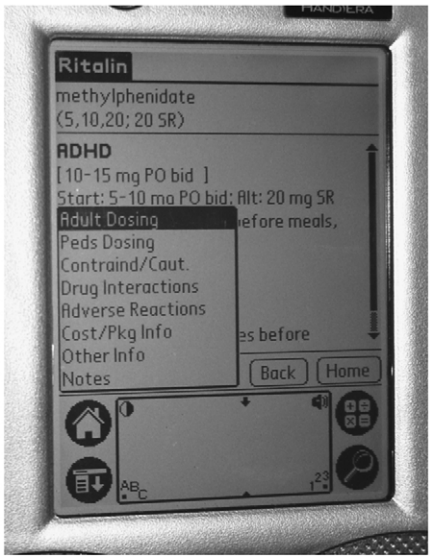

Fig. 5. Software of interest to the practicing dentist is available for PDAs. The example shown is from a drug database (ePocrates qRx).

Dental Lexi-Drugs

This drug database has more than 5000 drugs, gives information on dosage, drug interactions, dosage forms, effects on dental treatment, and local anesthetic and vasoconstrictor precautions, and provides general warnings and precautions.

Five-minute Clinical Consult

Having this program is like having a pathology reference book in a shirt pocket. This program covers 1000 clinical topics and is cross-referenced with Lexi-Drugs and the Apothecarium, which is a drug interactions program. For example, if a user is reading an entry on a disease in the 5-minute clinical consult, he or she may click on the drugs used in treatment and then is switched to the Lexi-Drugs.

Dentalog

It is common practice for physicians to keep track of several patients during rounds, and many programs exist to enable physicians to do so. There is a PDA-based program for dental patient management for the Palm OS. It maintains patient demographics, insurance information, clinical information (eg, periodontics, pathology, pain, occlusion, and cosmetics), medical and dental history, prioritized treatment planning, prescriptions, and a clinical note section.

Palm Corporate Dental Application

Palm Corporate Dental Application is an interesting treatment-rendered program for dentistry. The program was developed by Major Lillian Landrigan (US Army) at Fort Hood, TX. Patient demographic information is entered via a barcode scanning module, and the patient's treatment-rendered information is entered on the PDA with a few taps of the stylus. The practitioner may select from more than 600 dental procedures. The treatment-rendered information can be downloaded to a desktop PC loaded with the computer-based version of Corporate Dental Application. It is claimed that a basic Palm handheld computer can store approximately 6000 patient records.

STAT growth charts

Based on the Centers for Disease Control growth charts, this program calculates growth percentiles and includes body mass index-for-age charts, which could be handy for pediatric dental patients.

Literally hundreds of other useful programs or files may be downloaded from the Internet. Examples of information I have downloaded for my PDA include the following: an immunization guide, a medical English-to-Spanish file in which the practitioner easily can find common terms and phrases for Spanish-speaking patients, a pediatric database that has information on hundreds of pediatric conditions, a differential diagnosis program in which the practitioner searches for a symptom and the program lists various conditions to consider in establishing a diagnosis, a metric converter, comprehensive laboratory values for adults and children, advanced cardiac life support protocols, an herbal medicine database, common pediatric developmental milestones, guidelines for prenatal care, American sign language manual alphabet with common medical words, and pediatric advanced life support. This information is in addition to the handy files that I personally placed in my PDA: oral infection prescriptions for different weights and drugs, a fluoride supplementation table, SBE prophylaxis prescriptions for different weights and drugs, and fluoride prescriptions for topical and systemic fluorides.

Some office management software programs currently include integration with a PDA. Dental.com Offsite, a mobile version of Dental.com Frontdesk, uses PocketPC technology and provides the user information on the patient record, alerts, prescriptions, history, patient financial information, patient photos, appointment schedule, patient search, call list, pharmacy list, intraoral camera images, and digital radiographs.

SoftDent2001 features PractiGo, which is a Palm OS program that allows the dentist to track treatment plans, laboratory cases, and more. PracticeWorks' PracticeToGo provides appointment schedules, patient information, referral data and statistics, and a night call report function. According to the company, these functions can be used on any electronic organizer. Ace

Dental Software uses the Palm system and makes available patient, appointment, follow-up, pharmacy, referring doctor, and to-do information on the dentist's PDA. Dentrix 8.0 practice management software offers DXMobile, which includes "modules": office journal, prescriptions, and appointment list.

Practice management software companies and their customers recognize the value and potential advantages of integrating the handheld computer with the office computer.

References

[1] Legard S. Smart handheld market to reach $26B in 2004. 20:12. Available at: http://www.e-commerceworld.com/english/crd_smart_455122.html. Accessed: February 27, 2001.
[2] Toward WADL. Available at: http://cyberatlas.internet.com/markets/wireless/article/0,10094_592491,00.html. Accessed: February 16, 2001.
[3] Who needs a PC? Handheld market doubles. Available at: http://www.zdnet.com/zdnn/stories/news/0,4586,2678265,00.html. Accessed: January 25, 2001.
[4] Shim R. Palm losing sales race to Compaq. Available at: http://www.zdnet.com/zdnn/stories/news/0,4586,5092810,00.html. Accessed: June 18, 2001.
[5] Rae-Dupree J. Hand-held computers get second life with new features. Available at: http://www.usnews.com/usnews/issue/010618/tech/pda.html. Accessed: June 18, 2001.
[6] Spallek H, Schleyer T. Educational implications for copyright in a digital world. J Dent Educ 1999;63:673–81.