

“Palm reading”: 1. Handheld hardware and operating systems

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Case 1

Joanna is a third-year medical student getting ready to start her clinical clerkship. She has seen other clerks and residents using their handheld computers to look up drug dosages and medical reference information on the wards. She feels that a handheld computer would be a useful aide for her clinical training. She envisions using a handheld primarily as an information resource, but she worries that she is limited by a narrow budget. Which handhelds would best meet Joanna's needs?

Case 2

Dr. Edwards is a family physician with a busy practice in Northern Ontario. Although he uses a personal computer in his office for word processing and email messaging, he does not regard himself as technologically savvy and is skeptical about using a new electronic gadget in his practice. After hearing from colleagues at a conference about how they use their handheld computers to log their billing claims, he is interested in finding out if a handheld could improve his billing efficiency. What benefits could a handheld computer bring to him? What models would best suit his needs through being functional, yet small and elegant?

Although handheld computers have yet to take their place alongside the stethoscope and the reflex hammer as essential tools in the practising doctor's armamentarium, they are becoming increasingly popular in medical practice. According to a recent survey of 834 US physicians, about 26% of physicians now use handhelds and an estimated 50% will use the devices by 2005.¹ Physicians are using handheld computers in their practices today for a variety of routine tasks: from accessing medical textbooks and making medical calculations using laboratory test results to tracking patient data and billing for patient encounters. Recent data suggest that handheld computers may not only enable clinicians to practise more efficiently,² they may even reduce medical errors and improve patient outcomes. For instance, in a recent Canadian study, the introduction of handheld computers in an intensive care unit (ICU) in a teaching hospital led to improved communication of patient information among ICU staff.³ Research presented at a meeting of the American Society of Anesthesiologists suggests that handhelds can facilitate screening for drug interactions and can be used to improve postsurgical pain control through recording each patient's pain ratings and response to analgesics.⁴

Recognizing that familiarity with information technology will be as important to the future physician as knowledge of the pathophysiology and treatment of common diseases, many medical schools in the United States, including Wake Forest University, NC, and Stanford University, Calif., are providing their undergraduate students with handheld computers.^{5,6} Medical students are using handheld computers to keep track of clinical encounters and facilitate evidence-based decision-making.⁷⁻⁹ At the postgrad-

uate level, a recent survey of family practice residency programs in the United States indicated that handhelds were used by 67% of residency programs that responded to the survey.¹⁰ Medical training programs are integrating handheld computers in their curricula to meet the changing information needs of their trainees.¹¹ Given the growing volume of medical information, and the increasing expectation for practitioners to adhere to standards of evidence-based care, physicians and trainees increasingly require ready access to medical information at the bedside. The appeal of the handheld computer is that it can function as a compact, portable medical information resource that can be accessed at the point of care. Moreover, it can be easily updated to incorporate emerging research and evolving clinical practice guidelines.

Although the handheld computer offers the promise of bringing evidence-based medicine to the bedside in everyday practice, most physicians today either do not own a handheld computer or use their handheld computers solely as a day planner for keeping track of important appointments and contact information. There are a number of reasons why many practitioners are reticent about using handheld computers: data entry through the “Graffiti” character recognition pad on a handheld, although fairly easy to learn, can be tedious for entering large quantities of data; handhelds have small screens that are less than ideal for reading long volumes of text and for displaying graphics; when compared with personal computers (PCs), handhelds have limited memory and slower processing speeds and, finally, many physicians have raised questions about the security of storing confidential patient information on handhelds.¹²

In spite of these concerns, many practitioners are interested in purchasing their first handheld computer or upgrading their current handheld model. For non-computer-savvy physicians, the handheld industry's excess of technical jargon and its rapidly expanding array of available gadgets can be dizzying. The aim of this article is to introduce novice handheld users to the range of hardware options that are available and the important features that should be considered when purchasing a handheld for medical use. A second article will describe software applications relevant to medical practice.

Considerations when buying

Before determining which handheld is best for you, it is important to first decide upon which features would best suit your needs. There are a number of important considerations to keep in mind: the type of operating system, the availability of software, memory, expansion support, processor speed, size and weight, screen resolution, availability of peripheral devices, text entry options, convergence features, and price and support (Table 1). (An expanded version of Table 1 may be found on the *CMAJ* Web site.)

Operating system

Just as PCs have different operating systems, so do handhelds. In the handheld arena, the major operating systems are the Palm, Microsoft Pocket PC and Psion/EPOC. Although devices that run the Psion/EPOC and Microsoft Pocket PC (formerly Windows CE) operating systems are certainly in wide use, the Palm Operating System (OS) is the industry leader, with 85% of sales in Canada and 87.2% of sales in the United States.^{13,14}

Although Palm originally designed the Palm OS, there are a number of other manufacturers — including Handspring, Sony and HandEra — with licences to produce devices that run the Palm OS. This is akin to PCs made by different manufacturers like Dell, IBM and Compaq all running the Windows OS.

With regard to software availability, the Palm OS currently has about 14 thousand different program titles and the largest selection of medical applications available for any handheld OS.¹⁵ More than 97% of handheld software

titles sold in the United States last year were for the Palm OS.¹⁶ Because most medical personnel currently use Palm OS devices, this article focuses on hardware models that support the Palm OS.

Memory and expansion support

The capacity to store information is fundamental to the operation of any computing device. A handheld's internal random access memory (RAM) is akin to the hard drive of a PC. Most currently available handheld models feature either 8 or 16 MB of internal RAM. Generally, this amount of memory is sufficient to support all of the personal information management programs on Palm OS devices, along with one or two more space-intensive medical reference tools, such as pharmacopoeias and electronic textbooks.

Many of the newer models allow users to increase the storage capacity of their handhelds through expansion memory cards. These handhelds have either a Compact Flash, Secure Digital, Memory Stick or a Springboard expansion slot that allows users to add an additional 8–128 MB of expansion memory to their devices.

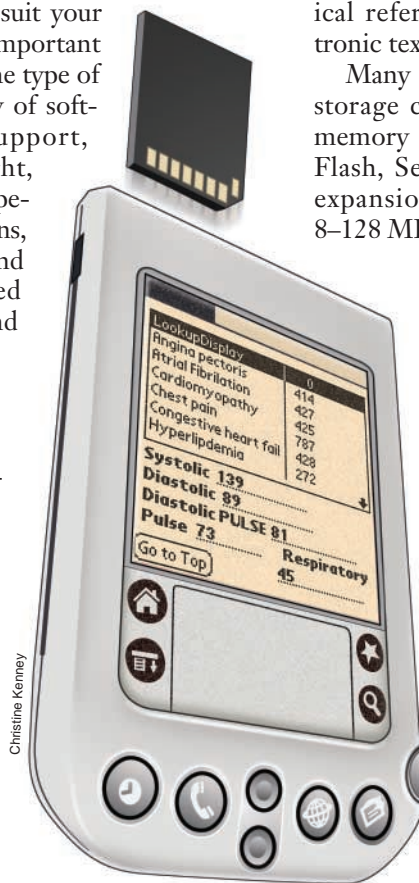
Processor speeds

Processor speeds determine how quickly a handheld is able to retrieve information. Point-of-care access to information is only helpful if it is efficient enough to allow you to find the relevant information rapidly. For instance, all currently available handhelds are fast enough to look up a drug in a fraction of the time it would take to turn the pages of the *Compendium of Pharmaceuticals (CPS)*. Most currently available handhelds use the same 33-MHz Dragonball processor. Newer handhelds from Sony, the T665 and the NR70, are the first devices to employ the SuperDragonball 66-MHz processor. With the release of the new Palm OS 5 operating system, it is anticipated that new handhelds will be able to support processors that are 5-10 times faster than currently available models.

Size and weight

The general trend in the handheld arena has been toward smaller devices.

Some of the smallest devices, such as Palm's m500 series, Sony's T series, Handspring's Visor Edge or the new Handspring Treo 90, can fit comfortably into a shirt pocket. Larger devices can fit comfortably into a lab-coat pocket. Ultimately, handheld size is a matter of personal preference. There are 2 main factors to take into consideration when contemplating the size of a handheld: price and



Expansion memory can be used to store large databases and medical texts that can be retrieved quickly at the bedside.

Table 1: Palm OS hardware comparison list

| Model | Processor speed (MHz) | OS | ROM (MB)* | RAM (MB) | Expansion slot | Power | Screen | |
|--|-----------------------|-----------|-----------|----------|-------------------|----------------|---------------------|----------------------|
| | | | | | | | Resolution (pixels) | Monochrome or colour |
| Palm (www.palm.com) | | | | | | | | |
| m125 | 33 | 4.0.1 | No Flash | 8 | SD | 2AAA | 160 × 160 | 16 grey† |
| m130 | 33 | 4.1 | No Flash | 8 | SD | Li-Ion | 160 × 160 | 4000 colours |
| m500 | 33 | 4 | 4 | 8 | SD | Li-Ion | 160 × 160 | 16 grey |
| m505 | 33 | 4 | 4 | 8 | SD | Li-Ion | 160 × 160 | 65 000 colours |
| m515 | 33 | 4.1 | 4 | 16 | SD | Li-Ion | 160 × 160 | 65 000 colours |
| HandEra (www.handera.com) | | | | | | | | |
| 330 | 33 | 3.5.2 | 2 | 8 | CF Type II and SD | 4AAA or Li-Ion | 240 × 320 | 16 grey |
| TRGpro | 16 | 3.3 | 2 | 8 | CF Type II | 2AAA | 160 × 160 | 16 grey |
| Sony CLIÉ PEG- (www.sony.com) | | | | | | | | |
| SL10 | 33 | 4.1 | 4 | 8 | Memory Stick | 2AAA | 320 × 320 | 16 grey |
| SJ20 | 33 | 4.1 | 4 | 16 | Memory Stick | Li-Ion | 320 × 320 | 16 grey |
| SJ30 | 33 | 4.1 | 4 | 16 | Memory Stick | Li-Ion | 320 × 320 | 65 000 colours |
| S320 | 33 | 4 | 4 | 8 | Memory Stick | Li-Ion | 160 × 160 | 16 grey |
| S360 | 33 | 4 | 4 | 16 | Memory Stick | Li-Ion | 160 × 160 | 16 grey |
| T415 | 33 | 4.1 | 4 | 8 | Memory Stick | Li-Ion | 320 × 320 | 16 grey |
| T615 | 33 | 4.1 | 4 | 16 | Memory Stick | Li-Ion | 320 × 320 | 65 000 colours |
| T665C‡ | 66 | 4.1 | 8 | 16 | Memory Stick | Li-Ion | 320 × 320 | 65 000 colours |
| N610C | 33 | 4 | 4 | 8 | Memory Stick | Li-Ion | 320 × 320 | 65 000 colours |
| N710C‡ | 33 | 3.5.2 | 4 | 8 | Memory Stick | Li-Ion | 320 × 320 | 4000 colours |
| N760C‡ | 33 | 4.1 | 4 | 8 | Memory Stick | Li-Ion | 320 × 320 | 65 000 colours |
| NR70V‡§ | 66 | 4.1 | 8 | 16 | Memory Stick | Li-Ion | 320 × 480 | 65 000 colours |
| Handspring (www.handspring.com) | | | | | | | | |
| Visor Deluxe | 16 | 3.1H | No Flash | 8 | Springboard | 2AAA | 160 × 160 | 16 grey |
| Visor Platinum | 33 | 3.5.2H | No Flash | 8 | Springboard | 2AAA | 160 × 160 | 16 grey |
| Visor Prism | 33 | 3.5.2H | No Flash | 8 | Springboard | Li-Ion | 160 × 160 | 65 000 colours |
| Visor Edge | 33 | 3.5.2H2.0 | No Flash | 8 | Springboard | Li-Ion | 160 × 160 | 16 grey |
| Visor Neo | 33 | 3.5.2H3.0 | No Flash | 8 | Springboard | 2AAA | 160 × 160 | 16 grey |
| Visor Pro | 33 | 3.5.2H3.0 | No Flash | 16 | Springboard | Li-Ion | 160 × 160 | 16 grey |
| Treo 90 | 33 | 4.1 | No Flash | 16 | SD | Li-Ion | 160 × 160 | 4000 colours |

Note: OS = operating system, ROM = read-only memory, RAM = random access memory, SD = Secure Digital, CF = Compact Flash.

*ROM or Flash memory allows users to upgrade the operating system on their handheld device.

†16 shades of grey.

‡With built-in MP3 audio player.

§With built-in camera.

portability. Smaller models tend to more expensive. However, smaller models may also tend to be the ones that people continue to keep with them and use once the novelty of having a handheld wears off.

Screen resolution

Handhelds feature either a monochrome or a colour screen. Devices with a monochrome screen feature a backlight that can be used in dim lighting conditions. However,

not all monochrome screens are identical; some offer much sharper resolution that makes for easier reading of text. Similarly, like digital cameras, colour handhelds differ in the number of colours that are supported and the screen resolution. Currently, all colour models by Palm and Handspring support resolution of 160 by 160 pixels, the HandEra 330 supports 240 by 320 pixels and Sony has models that range from 160 by 160 pixels to 320 by 480 pixels. When weighing the importance of screen resolution, you should test the models yourself. If you intend to

use your handheld primarily for reading text, then screen resolution may not be a particularly important consideration. However, if you would like to use your handheld to store graphics and even pictures of patients with particular conditions, it may be worthwhile to invest in a model with higher resolution. Screen brightness should also be taken into account when determining how well images are viewed on a screen. It is helpful to test the models with the backlight on.

Peripherals and add-on devices

Handhelds can communicate with other devices in 3 ways: through their docking port, where a cradle or cable attaches to allow the device to “hotsync,” or exchange information with a desktop or laptop PC; by “beaming” information through infrared waves to another handheld device, TV receiver or printer; or through a separate expansion slot included in newer models. There is a variety of expansion products available for handhelds. Perhaps the most popular expansion products are portable keyboards and expansion cards.

Text entry options: Graffiti, thumbboards and keyboards

There are many means of inputting data into a handheld. Graffiti, which is a set of characters very similar to the printed alphabet, provides a reliable and easy way to learn text entry into handheld computers. However, some people find it daunting to learn a new way of writing letters. As a result, “thumbboards” — miniature keyboards that are designed for thumb-directed text entry — are becoming more popular. These thumbboards are similar to the keypads on the popular RIM Blackberry devices. In fact, 2 of the newest handheld computers, the Treo 90 and the Sony NR70, are equipped with built-in thumbboards. Furthermore, many of the existing handhelds are able to support add-on thumbboards. Seiko makes a thumbboard for the

Palm Vs, m500s and Handspring devices that fits snugly over the Graffiti area.¹⁷ Palm’s mini keyboard, with models compatible with the i705 and m500 series, is a thumbboard similar to that made by Seiko.^{18,19} Acer also offers a thumbboard for the Palm Vs. However, unlike other models, Acer’s thumbboard does not fit over the Graffiti area, extending the length of the device.²⁰ Finally, Fellowes offers a keyboard integrated into a case for various Palm and Handspring devices.

External keyboards are also a great accessory for typing long memos or text documents. When combined with word processing software, such as Documents to Go,²¹ a program that is bundled with many handhelds and allows for the synchronization of documents with Microsoft Word, Excel and Powerpoint, text documents can easily be created on a handheld computer and transferred to a PC.

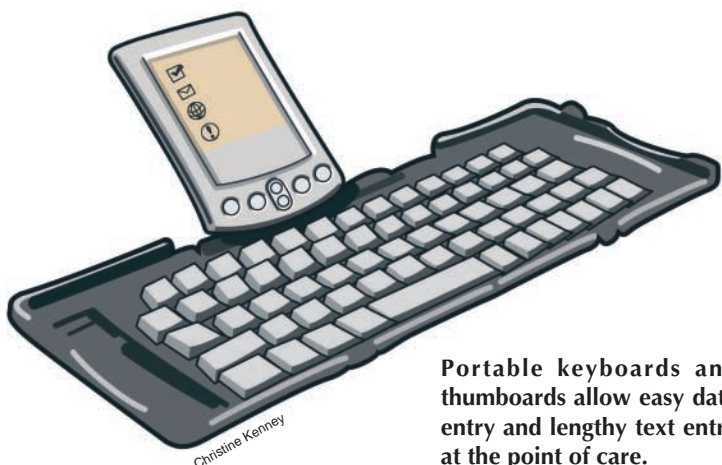
Think Outside’s Stowaway Portable Keyboard is a full-sized keyboard that can be folded up to allow for portability. Think Outside manufactures keyboards for most Palm, Handspring and Sony devices.²² Palm also produce a similar fold-up full-sized keyboard that is compatible with their handhelds.²³

Expansion cards

The m125, m130, m500 series and the i705 from Palm, as well as the Treo 90 from Handspring, feature a Secure Digital (SD) expansion card slot. An SD expansion card is roughly the size of a postage stamp with the thickness of a credit card. Media stored on an SD card can also be used with a number of other SD-enabled electronic devices, including MP3 players, automotive multimedia systems, video and digital still cameras, and even Pocket PCs. The SD slot on handhelds is also compatible with MultiMedia Cards (MMC), which are now mostly used in cellular telephones.

Sony’s complete lineup of Handheld computers is equipped with a Memory Stick expansion slot, which allows users to store software and use media recorded from other Sony products, such as digital cameras, audio players and camcorders, on their Sony CLIE handhelds. Compact Flash memory cards used by HandEra’s lineup and Springboard expansion slot devices used by most of Handspring’s models tend to be larger than the newer SD and Memory Stick cards. Memory cards with 128-MB capacity are in general circulation. A number of expansion-card manufacturers have announced plans to release much larger cards in the near future, with a 4-GB card due by the year 2005.^{24,25}

To date there are more than 75 available add-on modules for Handspring’s Springboard expansion slot, which include cellular telephones, wireless modems, digital cameras, MP3 audio players, voice recorders, Global Positioning System (GPS) units and expansion memory cards.²⁶ However, with the move to smaller devices, Handspring’s latest model, the Treo 90, has the SD card slot, leading



Portable keyboards and thumbboards allow easy data entry and lengthy text entry at the point of care.

many analysts to predict that this switch to SD cards will mark the end of Handspring's groundbreaking Springboard expansion slot.

Other peripherals

Cases, car chargers and travel kits are some of the other peripherals that can be purchased for handhelds. Of note is the dual charger and hotsync cable from iConcept. This cable connects a handheld to a PC through a USB connection and allows the handheld to charge through this connection as well as hotsync.

Convergence features: MP3 players, cameras and cellular telephones

Although peripherals allow users to greatly expand the functionality of a handheld, the newer trend has been to develop devices that have additional built-in multimedia hardware. Sony's CLIÉ NR70V houses a thumbboard that swivels out for easy use, a built-in digital camera, an MP3 player and a Memory Stick expansion slot. Palm's i705 and Handspring's Treo line of Communicators also allow for secure wireless email, instant messaging and Internet connectivity.^{27,28} Handspring's Treo 180 and 270 integrate a Palm OS device with a mobile telephone. Samsung and Kyocera have released similar devices, with Nokia also holding a licence to use the Palm OS for a similar device.²⁹ Unfortunately, none of the currently existing handheld telephones contains an expansion slot, limiting their use in medicine if users intend to store large medical textbooks or pharmacopoeias.

Price and support

Currently available handheld computers range in price from Can\$200 to Can\$1000. The newer devices with colour screens are roughly twice the price of monochrome handhelds. In addition, when considering the price of a handheld, it is important to ask about customer and warranty support in Canada.

The cases revisited

Case 1

Joanna envisions using her handheld computer to further her learning around interesting cases that she encounters in her clinical training. There are several entry-level models that would allow her the most expandable memory for the price. Palm's newly released m125 and m130, as well as specials on discontinued models such as the m505, would suit her needs. Sony's S320/360 series or the new SL10/SJ20 are popular choices, and Handspring has also recently reduced the prices of most of its handheld models.

Case 2

Dr. Edwards may feel that 8–16 MB of internal RAM alone is adequate for his needs. With a busy practice, he does not feel that he will have the time to use his handheld computer to look up reference information between patient visits and does not envision using additional memory capacity. Instead, he would like to use his handheld to keep track of his appointments, to check drug interactions, to capture photographs of patients with interesting findings for his teaching files, and to replace his bulky laptop computer on his travels to conferences. As a result, he may prefer one of the newer models with multimedia versatility, such as Handspring's Treo Communicator or the Sony NR70. Palm's m500 series also provides a very popular and elegant option for a more standard handheld.

Future directions

With the advent of memory expandability, the handheld has made enormous strides toward increased functionality for the physician by allowing the storage of large databases and medical texts that can be retrieved quickly at the bedside. In the near future, handhelds promise to be even more useful to physicians by providing even faster access to greater volumes of information, improved security, support for wireless networks, better screen resolution, and audio playback and recording abilities. However, it will be up to licensees of the OS to decide which features they want to include in their products.^{30,31}

For the medical practitioner, the next major gain in handheld functionality will be realized when wireless connectivity for handhelds becomes widely available. Wireless networking technology, such as the Bluetooth networks now in use, will allow MDs to link their handheld computers, PCs, cellular telephones and other multimedia devices without a need for cables.³² This will allow medical practitioners access to the latest medical research and evidence-based clinical practice guidelines through the Internet on their handhelds.

In addition, with devices offering improved audio playback and recording support, it is conceivable that a device will come to market in the near future that would allow physicians to dictate their patient notes directly into their handheld and then transmit the audio file directly to the desktop computer of their secretary through wireless net-



Newer handhelds can also function as cellular telephones.

Handhelds with a built-in digital camera are useful for storing pictures of patients with particular conditions.



working. With the emergence of expandable devices and the potential of wireless access, the handheld may move from being a novel gadget with a devoted following among technologically savvy users to a standard physician's companion.

This article has been peer reviewed.

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Competing interests: None declared.

Contributors: Both authors contributed to the writing and revising of this article. They both approved the version to be published.

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