

Hand-held computers in health care: What is available and how are they best utilised?

W. Gillingham¹ & A. Holt²

¹ Health Informatics Group, University of Otago,
Wellington School of Medicine, New Zealand.

² Health Informatics Group, Department of Information Science,
University of Otago, Dunedin.

Corresponding Author

Alec Holt

Health Informatics Group

University of Otago

Dunedin

New Zealand

Email:aholt@infoscience.otago.ac.nz

Introduction

Palmtop computers are as to healthcare what the minicomputer was to banking. Finally computing power will be brought to the end user, the healthcare worker at point of patient contact. The term “Palmtop” has different interpretations therefore “Personal Digital Assistant” or “PDA” is a more correct generic term. The early PDA’s were hardly palmtops (see figures 1 and 2). This article outlines the types of PDA hardware and discusses the large variety of features available. Another major factor when considering PDA’s is the software available and this article specifically analyses the various categories of medical software available, its audience and utility.



Figure 1 Early PDA



Figure 2 Today's PDA: Truly palm sized Ericsson R380e PDA phone

What is a PDA?

PDA's are set apart from other computer systems by the fact they are “personal”. They are your diary, your watch, and your mobile phone. They are of limited use to others and tailored to your needs. In healthcare there are few workers who do exactly the same activities, unlike a desktop or laptop personal computer, a PDA can be tailored to suit each individual and improve productivity rather than restrict a workers characteristics to suit a standardised PC. The major argument for equipping each worker with a PDA rather than

having a pool of machines that are handed over each shift, is the fact they are personal, PDA's go home with you and fit in as part of your life.

Talking to your PDA

There are two main designs of PDA: keyboard or tablet forms. Keyboard designs resemble a traditional PC and are usually of clamshell design figure 3. Their size limits the usability of the keyboards but some allow 40-50 words per minute touch-typing such as the Psion 5mx (Figure 4). The tablet format is more common and most people have seen a Palm or Pocket PC (Figures 5 & 6).



Figure 3 Nokia 9210 clamshell design
Figure 4 Psion 5mx with touch type keyboard



Figure 5 Palm 3

Figure 6 HP Pocket PC machine

The next section of this article discusses the basic characteristics of PDA's and assesses the various what features available.

Input pathways

Handwriting recognition

All PDA's support handwriting recognition of either the Graffiti gesture type (Palm OS) where one learns to write in certain pen strokes, or the cursive system where the PDA recognises your normal handwriting (Pocket PC, EPOC32). Graffiti has an initial learning curve but most master it quickly. If writing more than one word, handwriting recognition is a slow form of entry, and many opt for the onscreen virtual keyboard. Extensive text entry is tiresome and users do not bother entering this type of data. Most tablet systems avoid the tedium by providing menu driven data entry.

Keyboards

The keyboard dictates the size of the machine and usability decreases as the keyboard shrinks. Most tablet machines have full size foldaway/rollaway keyboards (see figure 7.) available but this does defeat the original intent of the device. For those who do not need a device that slips into their shirt pocket or want to enter a lot of data then a keyboard-based machine provides significantly more functionality. Otherwise tablets work brilliantly for data recall and menu based applications that cater for the vast majority of uses.



Figure7 Palm foldaway keyboard

Voice

Most PDA's support voice notes where the onboard microphone digitally records notes. This is memory expensive but useful for those moments on the run or driving where you cannot stop and look at the screen. Limited voice recognition is available on the newer Operating systems, for example, Pocket PC 2002 and Symbian release 6 (EPOC32) but quite unreliable and difficult to operate in the noisy environment of the PDA. The phone-based machines with a hands free headset may show more promise.

Navigation keys

Tablet machines often have some keys in their casing for quick access to commonly used applications, scroll keys or simple arrow keys that allow for single-handed operation. There is usually a record button for voice notes.

Touch Screen

Most machines boast a touch screen as the main method of data entry. The touch sensitive overlay does decrease screen clarity but is less noticeable in the newer machines. The main problem is scratches to the screen and the accumulation of fingerprints, actual failure of the components of the screen is rare.

Expansion slots

Budget PDA's come self-contained with only a PC connection port. An essential feature for current PDA's is some sort of expansion slot. Usually Compact Flash type I or II slots which allow for additional memory or other hardware such as a webcam, wireless link, modems and spirometers! (see Figure 8). PC Card Spirometer, looks useful but PDA will still need external power supply. Normally only one slot is present and soon filled with a memory card, which makes the other accessories unusable. Compaq have an expansion sleeve that is described in a latter section of this article.

Some machines such as Casio offer a PC card slot that is the larger equivalent for laptops, the battery power required to run the card is far to high for a PDA. When using a Cassiopia and PC card modem with new batteries, for example, the authors were only able to dial a Internet service provider (ISP) number before the Cassiopia shut down, because the batteries had become flat. Smart media cards are smaller than CF cards (postage stamp size) and offer similar features to CF. CF and Smart media are both used in digital cameras and most PDA's can read the cards and allow you to manipulate the digital images. Sony provides proprietary Memory Sticks that are an expensive version of the CF card.



Figure 8. PC Card Spirometer, looks useful but PDA will still need external power supply

Modes of Output

Screen display

This is one of the major factors to consider with a PDA. Screen resolution ranges from 160x160 monochrome for Palm Pilots to 640x480 (VGA) in full colour. Colour PDA screen displays are either active matrix or passive matrix. Active matrix displays are easier to see, more responsive, faster, and can be viewed at larger angles than passive matrix

displays. Resolution and colour are not major factors in the current market as medical software does not make full use these factors. It should though as it would be really useful in some applications. Most applications are text based and the clarity of the screen in poor fluorescent lighting is the major factor, newer PDA's have a light sensor to correct contrast and backlighting to suit the ambient light. Colour is nice and newer software is starting to take advantage of this, viewing chest X-rays and histology slides on screen are all "just around the corner".

The screen shape is also important, reading large texts is easier and faster in a landscape fashion, but viewing charts and pictures easier in portrait.

Recent machines offer full motion video that is a useful teaching aid. The main limiting factors for this in the past have been memory and battery power (lots of CPU power drain).

Audio

Most have some type of miniature speaker output for alarms and voice notes. Some offer headphone output for hands free and listening to wav files. Audio does draw significant battery power, it is a trade-off to include the bells and whistles in PDA Software, they often are not heard in noisy environments and slow down operation considerably.

Vibration

Very few PDA's have vibration alert, which is odd. Some of the new Pocket PC tablets and only some of the PDA phones possess the ability. Programmers have tried to emulate vibration by having the speaker play a low-pitched noise with marginal success.

Talking to other machines

Excellent links to desktop machines is an absolute prerequisite for any PDA and can be a major factor in deciding on purchase, especially if you own a MAC that has less link software available. The methods of communicating electronically with your PDA are just starting to explode many of them are vapourware in that they never materialise. Psion developed a Bluetooth enabled PDA 2 years ago, for example, and it still not on the store shelf, some say because there was limited support for it from other platforms.

Serial Communications

Plugging into the RS232 COM port of your PC has been the standard for years; now due to much larger on board memory the serial transfer rate of 115kbps (twice as fast as a 56.6k modem) is too slow. It can take 2 hours to backup 32Mb of memory; many have 64 – 256Mb on their PDA. Apart from linking to other external devices such as a modem or printer, the RS232 serial port has no place on PDA's and its' presence signifies dated technology. Alternatively USB (Universal Serial Bus) and Firewire (IEEE 1394) serial connections are the new standard. USB is present on most new PC's and provides adequate speed for backups and transferring large files to the PDA. Firewire is faster again (400Mbps), included in most MACs but not present as standard on PC's.

Infrared

Most PDA's have infrared ports. They comply to the IRDA standard, meaning they can communicate with different operating systems at a maximum speed of 115kbps (same as RS232 serial). IR can be used to transfer data from PDA to PDA which is useful on the ward where handover lists and up to the minute data can be passed on to others while standing and talking. Most software (PDA, PC & Mac) adheres to an agreed standard allowing virtual business cards (vCard Standard), agenda appointments, documents etc to

be beamed between platforms. Many printers have IR links and provide a super convenient method of printing, point your PDA at the printer and within 20 seconds your page is printed often faster than doing the same on the PC (no setting up of printer drivers is necessary). Cell phones may have an IR link and this allows for phone book management, Internet access and text messaging. IR has limited range of approx 2 feet (battery considerations) that provides good security – others cannot easily eavesdrop on your transmissions. The IR link will only link with one machine at a time. The new Sony PDA has boosted it's range to 15 feet to allow it to operate as an IR remote control for TV and Stereo, a long overdue feature.

Radio / Microwave / Wireless

This is a booming technology. Until recently wireless communication was difficult due to battery life and size of transmitters. Now all PDA's have some method of wireless communication either integrated or plug in.

Bluetooth (www.bluetooth.com) is the most marketed, developed by a group of companies with agreed protocols, importantly it's royalty free which almost guarantee's it's adoption. It is a short range radio signal (max 10 metres) which allows for voice and data broadcast at 2.4 GHz, it's frequency hopping nature allows for up to seven devices to be linked simultaneously, that is, your printer, PC, LAN connection, colleague's PDA, mobile and still room for 2 more devices. It effectively removes the need for cables and runs at speeds of 700kbps but is planned to increase to 2 and 10 Mbps. 2.4 GHz is an unlicensed band and many different devices, for example, cordless phones, microwave ovens and baby monitors may also use this frequency – there may be significant problems with interference in a modern hospital, although Bluetooth is quite robust. Bluetooth is the next generation replacement for IRDA and offers improved functionality in the healthcare setting. It can replace the need for security cards, where ever you walk machines with in a ten metre radius will know who you are and adjust their settings to suit you or you can access them directly from your PDA , for example, walk onto your ward and all patients' lab results are automatically dumped onto your PDA. In practise it does require the operator to stay within ten metres while the download occurs this may be difficult for many frantic House Surgeons.

Wi-Fi or IEEE 802.11 (is a faster longer-range wireless system designed to replace Ethernet cables (See figure 9). It is seen as supposedly complimentary to Bluetooth but it's likely the user will just have one or the other. Its range is approx 100m for a PDA transmitter and transfer rate of around 11Mbps.



Figure 9 Compact Flash Wi-Fi device <http://www.symbol.com/wirelessflash/>

It operates on the same frequency as Bluetooth. The difference is Bluetooth gives direct access to peripheral devices, as well as the LAN, WiFi gives direct fast access to the LAN that will then access other devices. Places such as airport lounges already offer WiFi. The following are several innovative research projects that attempt to address network service problems. (See <http://www.research.ibm.com/journal/sj/384/zimmerman.html> for full text on wireless technology and specifications)

Jini

Jini**22 is a research project started in 1994 by Bill Joy and Jim Waldo of Sun Microsystems, Inc. Jini allows devices to create "spontaneous networks" when plugged in to each other. "Plugging in" can include two devices coming into wireless proximity. Jini is a networking infrastructure running on top of Java** to allow devices running Java Virtual Machines (JVMs) to announce and share services across a network. Jini is Java code (about 48 kilobyte core) consisting of class library forms and conventions. A goal of the project is to eliminate device configuration and driver installation. When a device needs a service (for example, a digital camera needs a printer), the device looks up the relevant services on the network.

JavaSpaces

JavaSpaces23 is an event-driven system written in Java using remote method invocation (RMI) to allow "buying" and "selling" requests to be fulfilled. RMI is a set of application programming interfaces and a model for remote object communication to allow distributed computing. Java RMI includes a method to negotiate use of resources, to commit to a set of operations, and to notify objects of state changes. Some anticipated applications of JavaSpaces include reservation and trading services.

Hive

Hive24 is a research project at the Massachusetts Institute of Technology (MIT) Media Laboratory to allow the construction and operation of distributed systems through networked computers. Hive provides a structure for communication and control of devices

and Java applications. It uses RMI and object serialization to call and move Java objects running on other JVMs.

TSpaces*

TSpaces²⁵ is a research project at IBM's Almaden Research Center led by Toby Lehman. TSpaces is written in Java and provides group communication, databases, URL-based file transfer, and event notification services. TSpaces provides a foundation for client applications that can be downloaded by proximity. By providing a common platform of data exchange, TSpaces can be used as a universal print, e-mail, and pager service.

GinJo

GinJo²⁶ is a research project at IBM's Tokyo Research Laboratory. GinJo (geographical interaction network for jumping objects) is an ad hoc wireless network where messages and code can hop from one wireless device to another when the devices meet on the street, in a building, or in vehicles. GinJo will allow advertisements to beam down from billboards, handing out electronic coupons for restaurants or free parking for events.

Cellular Networks

Most mobile phones have dial up Internet access of some type, PDA's can access the Internet through the mobile phone. For the PDA to communicate with the phone wires, infrared or Bluetooth can be used. The rate-limiting step is the cellular data transfer speed. GSM is 9600 bps – that is 0.96 kbps i.e. very slow. Newer systems are offering higher speeds such as CDMA and GPRS at approx 45 kbps that is fine for most applications. GPRS, WCDMA, EDGE are all early developments for 3G. 3G is a third Generation cellular protocol (Analogue was first and Digital PCS second generation) which allows current GSM, TDMA & CDMA networks to transfer data at up to 384 Kbps when a device is stationary or moving at pedestrian speed, 128 Kbps in a car, and 2 Mbps in fixed applications. Devices that incorporate cellular and PDA technology currently tend not to appeal to the broad market. Varying specifications among countries and individual American States makes mobile phones individual in their specifications and therefore makes production expensive. Integrated phones such as the Nokia 9210) or Kyocera QCP 6035 smartphone (see figure 10), which incorporates a Palm O/S are some of the first widely accepted phones. The Nokia offers GPRS that is “Always online internet” and the user only pays for data volume rather than time online. For healthcare that is not located in a large hospital such as a mobile nurse practitioner, this would be an excellent solution as they would have direct access to the hospital system including clinical notes, lab results and make appointments. High-speed transmission is not crucial for this but GPRS type systems would make the process seamless. Carrying a Bluetooth enabled digital camera would allow a nurse to transmit information to the PDA and then to the supervising doctor for any concerns about wound management or unusual pathology. This technology is currently omnipresent and has been available for 2 years, what is different is the reduction in price.



Figure 10 Kyocera QCP 6035 Smartphone / Palm

What features to assess when appraising a PDA

Hardware

Screen Display

The type of screen required is dependent on its intended use. The higher resolution and more colours result in a trade off for memory, battery life and speed. The success of the low resolution, fast, crystal clear display of the Palm is testament to the fact colour is not essential. Most information is textual or in line drawings, but with the advent of high-speed data exchange full colour will be more useful. In terms of a teaching resource with multimedia it would be essential, in terms of an active house surgeon who just needs the data then a simple text screen, showing lab values on a monochrome screen that will run all day, without need for recharging batteries is essential. The size and clarity are the important factors, the user's requirements is what will determine the choice, in the near future it is likely all PDA's will be colour as battery consumption will be much improved.

Battery life

A battery life greater than six hours is acceptable. Considering PDA's are only on for a few minutes at a time then six hours equates to two or three days of heavy use. With the advent of video, audio and colour the life of the battery may be 30 minutes. PDA's come either with rechargeable batteries hardwired in which saves in space and weight or replaceable battery designs. The hardwired PDA needs to be charged like a cell phone and is often backed up to the PC at the same time. This system suits the vast majority of users and also removes the need for separate backup batteries etc. Alternatively the batteries can be removable, for example, 2x AA batteries, this allows the user who constantly has the PDA

in use to flick out one set of batteries and replace them instantly with a new set of recharged or alkaline batteries. Users who are away for more than a few days or travel find this works well. Built in batteries last approx 18 months (like mobile phones) and then require replacement which can be a significant cost compared to the minimal cost of a new set of rechargeable batteries.

As a rough guide alkaline batteries last 12 to 14 hours of continuous use in a monochrome device. NiCads last approximately six hours, Nickel Metal hydride batteries are in between. Lithium Ion built in batteries offer approx ten hours of use.

Memory

16Mb is the bare minimum. Palm have long survived on much less than this (2 – 8mb) but with Microsoft in the PDA market and people wanting audio players and wireless data exchange means user want more memory.

The operating system ROM may be on flash RAM, therefore you can upgrade to the latest operating system with out having to buy a new machine and is an excellent feature to look for, especially on a Pocket PC machine. Built in ROM applications like an Office Suite or word processor and web browser save large amounts of memory. A trap for young players is to buy a Palm with 4 Mb of RAM and then have to load on a spreadsheet and other applications which halve the available RAM. Volatile RAM memory requires constant power supply to maintain itself. PDA's either have a separate backup button battery or power down when batteries are low to preserve the memory for up to 3 weeks. The separate battery solution has problems if the device is dropped and contacts to the main batteries and backup are disrupted for a second or two. In reality data loss from battery failure is rare if the user is a regular (weekly) user.

Flash Memory is usually available as additional memory in the form of a Compact Flash card or Smart Media card, the same as used in digital camera's. These do not require constant power to maintain integrity but require more power to write to and are significantly slower to access than volatile RAM. CF size ranges from 8 Mb to 340Mb upwards. Microdrives (miniature hard disc drives) fit into CF card ports and can provide upwards of 1 Gb of memory, power consumption is higher. The amount of memory available is Operating System relative. Palm and EPOC32 can have fully functioning programs of 500 byte size, one can't even turn on a Pocket PC with that. This is becoming less relevant as memory and battery life balloon but the efficiency of the operating system can be well evaluated by it's memory efficiency.

Physical size and ease of use

The size of the device is individual preference. Pagers and a pen are clipped to the stethoscope around their neck. Having a shirt pocket sized device is irrelevant and there are multiple accessories available to attach a PDA. Therefore size is not as important as the thickness of the device. Greater than one inch thick and the machine becomes cumbersome and difficult to hold in one hand, which is a problem with the Compaq iPaq systems with their slide on sleeves or "Sledges" see figure 11). Weight is another consideration but most PDA's are acceptable.



Figure 11 The black slide on expansion sleeve increases size of the Compaq iPaq

The keyboard clamshell based devices have a problem with moving parts. The hinges do fail and the screen cables running through the hinge also fail. Due to size requirements the cable is integrated into the screen therefore the entire screen unit needs to be replaced at some cost. Mean time between failures is estimated at approx two years of heavy use. The useful life of a PDA is probably three to four years. A wide range of individuals use PDA's and their designs vary considerably. There is a remarkable difference in the physical functionality of the machines and the individuals choice is largely dependent on their proposed use. The "Form factor" is considered later.

Software

Operating systems

There are 3 main operating systems for PDA's. They have all evolved from earlier basic systems and there is almost a cult like behaviour of users towards their system. Palm OS occupies a large share (estimated 60 – 75%) of the market. Pocket PC and EPOC32 follow sharing 15% each. The Linux OS is still in Beta release.

Palm OS

Palm OS is a quick, no fuss intuitive system that requires very little hardware and processing power. It is robust and it does what most users want. It maintains a phone/address book, simple agenda and allows easy recall of data. The vast majority of users only use the first two features. It has a massive third party and enthusiast software library with an estimated 70,000 programs, almost anything you could dream of doing with your palm will be available if you search the web. A winner for the Palm OS is its excellent PC connectivity and synchronization. The basic tasks of a PDA are done well on Palm OS but it does lack the sophistication of the other operating systems for high-end tasks.

Pocket PC 2002

Microsoft released Windows CE or WinCE back in the mid 1990's. It has had a major upgrade and a new release PDA WinCE version 3 to Pocket PC2002 brings a Windows feel to the PDA. Most reviews agree that this is a good operating system. Pocket PC makes it

easy for those familiar with MS Windows to adapt to a PDA environment, and it has the best connectivity and compatibility with Windows PC's. It is important to note that Pocket PC2002 is not a scaled version of MS Windows, it is as different as Palm OS is, and Windows software will not run on the PDA. Documents and data files use the same format on a reduced scale so can be transferred easily, although this is not a problem with the other O/S's either. One principle flaw in the design is the fact MS Windows was not designed for a PDA format and this causes some notable differences to the other O/S's. Windows is processor and memory hungry; it is less stable and has many bells and whistles. In practice this results in reduced productivity; if operating systems are trailed side by side and asked to perform a task. Pocket PC users will tend to lag behind the others, for example, make an agenda entry and have it repeat every first Monday of the month or enter a New Contact then cut and paste this to a word document. The reset button is usually well worn on the back of a Pocket PC machine due to their frequent crashes, although data is rarely lost.

In favour of Pocket PC, it's seamless integration with MS Windows is a major asset and it's production by Compaq, HP, Sony and other large companies bodes well. There is minimal enthusiast input and little good will, but many commercial software developers that is an important issue for healthcare. When PDA's are adopted by the health industry, they can't rely on third party software written by an enthusiastic clinician, they need full time support, reliability and systems that lives can depend on. The leap from fragmented developers accepting no responsibility for their software to commercial companies providing hospital wide integrated computer solutions is most likely to occur with Pocket PC machines.

EPOC32

EPOC32 is a generic term for the Symbian Operating System. Unlike the other two systems it has English origins and is very popular in Europe. The main Symbian PDA producer was Psion (www.pSION.com) that produced some of the earliest PDA's. Symbian O/S was developed for PDA's, has been used for the last 15 years and has always been ahead of the pack, and continues to do so producing the most technically advanced and intuitive O/S. Psion is a small company and with the advent of Pocket PC it pulled out of the PDA market last year. It still produces larger sub notebook sized machines and tablet based tailor made corporate solutions. The last production PDA's produced by Psion were the 5mx and Psion Revo. Symbian on the other hand realized that the last ten-year total turnover on the PDA market is equivalent to a few weeks on the mobile phone market. Hence it has started producing PDA / Phone combinations such as the Nokia 9210 (www.nokia.com) and Ericsson R380 (www.ericsson.com) which run the Symbian v6 O/S. This was a good move as evidenced by their first quarter of sales increasing Symbian market share from 6% to 38% of all PDA's sold in Europe (the US version is not available yet), palm was next with 25%. The Symbian O/S delivers more than the average user requires and most Symbian PDA's can replace the need for a laptop. As above the PDA / Phone combination may suit certain users and the need for maintaining a wireless infrastructure is obviated as it uses the cellular network.

The Symbian O/S has the weakest PC Connectivity of the three platforms but this has been rectified in the newer versions. Both keyboard and tablet devices are produced. The many features of the Symbian phones would be excess to average requirements but would suit some situations perfectly – especially those based outside a large institution.

Linux OS

Apparently some manufacturers are about to produce Linux PDA's. Sharp is the first with the Sharp SL-5000D due out 2Q 2002 see figure 12). The hardware specifications are impressive but the available software is scarce. The linux machine will run JAVA. There is very limited information available but the fact the PDA has been produced suggests that OS has something to offer. See <http://developer.sharpsec.com/> for more information.



Figure 12 Sharp SL-5000D Linux PDA

Operation System independent solutions are a sensible approach, such as Java or Internet based products that will run on all PDA's, leaving the choice of machine to the individual. Running on a wireless and/or cellular system would allow great diversity that may suit the health care setting. Internet banking, for example, which can be accessed from WAP phones, web browsers on PDA's or PC's and security is acceptable. This helps with future compatibility and follows the mainstream technology rather than creating ones own mini system and standards at much greater cost.

Bundled Software

Pocket PC & Symbian come with an office suite installed. Other software can access these programs and saves developers having to reinvent the wheel each time they wish to include a simple word processor or database manager in their third party software. Palm OS has only basic software included and extras must be purchased which take up valuable memory, for example, a spreadsheet or database management system.

Summary

The way you communicate with your PDA, it's physical characteristics and software all get bundled together and is called "*form factor*". Each PDA model is unique and has their own form factor that is not easily changed. PDA's are an individual personal choice and two people doing the same job may prefer different machines. A pragmatic approach is essential: One needs to define what tasks they will be using their PDA for, find the appropriate software, then consider the form factor and make a choice, if there is one.

Uses for PDA's in health care

The software available defines the uses for PDA's for them. There are five main categories of Healthcare software with subgroups:

Categories of Healthcare Software

Reference / Text book

The obvious example is a drug formulary such as the British National Formulary (BNF) transferred to electronic format. These are very popular among PDA users, most are free and carry disclaimers about content. The most well known is ePocrates for the Palm figure 13 which is updated weekly on the Internet. Textbooks in medicine, surgery and anatomy

are popular as are lists of definitions, procedure codes and laboratory reference values. Most reference material is managed with additional viewing software that compresses the data, see category five.

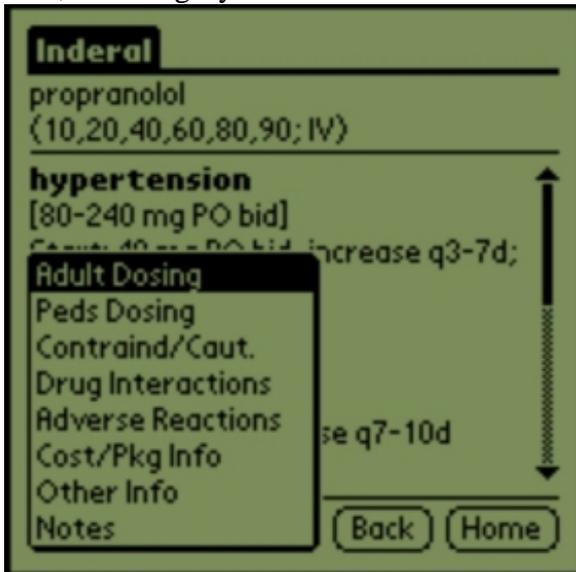


Figure 13 ePocrates Drug Database for the Palm

Calculators

Either simple single calculation type programs such as re-warfarinisation tables or multiple calculation type programs are available which work out blood gases to Mini Mental State exams (See figure 14). Often these are combined with a database to allow monitoring of successive values, for example, diabetic blood sugars on the one patient. Drug formularies can be combined with calculators to work out dosage regimes. Calculation software is an essential part of any health workers PDA even if just for conversion of pounds to kilograms.

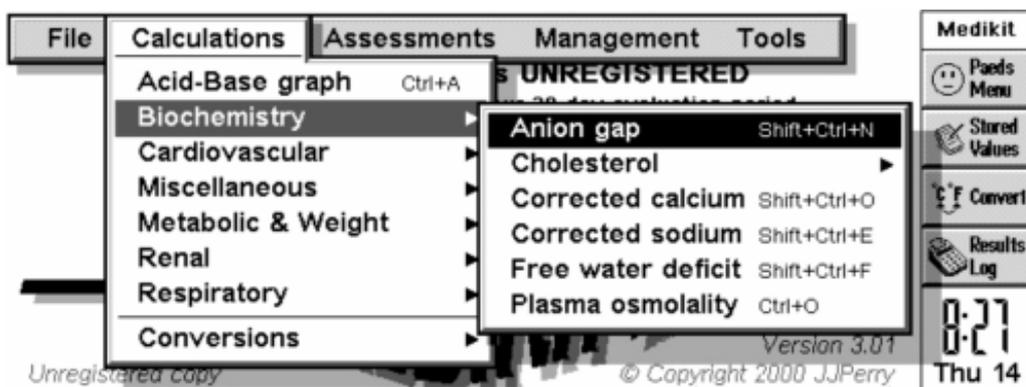


Figure 14 Medikit Calculation Software for EPOC32

Patient Management / Logbook

Patient information Management systems are big business. On a smaller scale most PDA's are not integrated into the system so they act more as a replacement for the scraps of paper a busy House Surgeon carries around with patient stickers attached. This type of ward management software is popular and some organised wards transfer the data from PDA to PDA as a type of electronic handover. More advanced packages allow a clinical record to be kept as well. For example the lab tests ordered – the results, X-ray findings and billing. This can all be printed out as a discharge summary and can save time scanning back

through notes for salient points. In anticipation of SNOMED Clinical Terms coding system due this year (replaces READ CT, ICD10 & 9, OPCSv4 and other systems), an international system will be recognised and universally adopted (UK, USA, Australia and New Zealand) which will aid in standardised software development. Unfortunately the coding system is massive and wireless links with PDA's acting as terminals may be required. There are many problems with keeping a *collective* clinical record on computer, it is unlikely to be fully realised for many years yet, unlike the general practioners system that works well. Logbook systems are commonplace and PDA's perform this task very well. Logbooks can be used for training purposes see figure 15. or Clinical Audit. Nothing beats a PDA and they soon become essential as a logbook of some type for every health care worker.

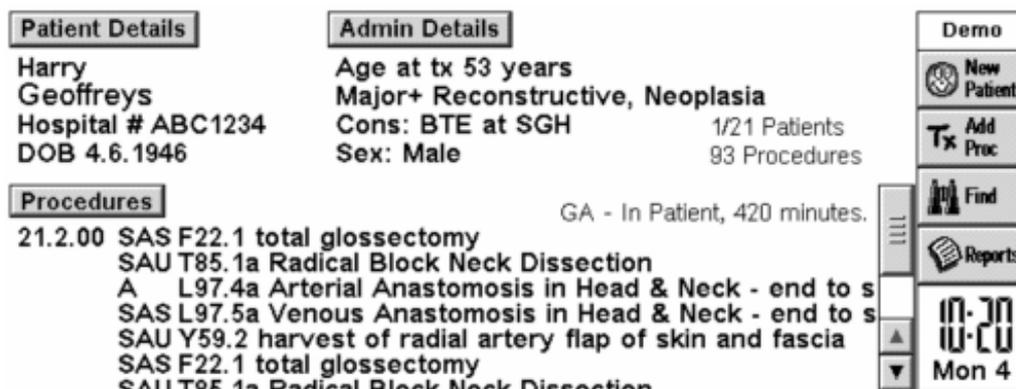


Figure 15 Screen shot for Trainee Surgical Logbook for EPOC32

Personal Clinical or Study Notebook

Each health worker has a notebook of some type where they create their own dataset, whether it is surgeons glove size or good ideas for a research project. Most PDA's come equipped with on board software to allow personal organisation either using agenda entries or a jotter pad. Specific healthcare notebooks fall into three subcategories: Citation managers allow for download or entry of journal and other referenced material see figure 16, they are very handy for clinicians as the facts are readily at hand. Although wireless communication to medical resources is more commonplace, a personal database of choice articles is still useful. Brain mapping or project planning software with a healthcare focus is uncommon but useful to those who know how to use them especially those who think on the run. Simple Medical Notebooks or database systems offer little over non-medical systems, but there is always someone trying to make a few dollars re-inventing the wheel.



Figure 16 Reference Pocketer for the Palm, Citation Manager

Utility Software

For healthcare workers the main utility software is that of document viewers. They either offer conversion and viewing of PC or Internet based documents or compression of documents. Web page viewers such as Avantgo (www.Avantgo.com) allow for updates of pages each time one synchronises with the PC, which can then be viewed offline later in spare time. In the healthcare setting wireless updates can provide X-ray reports to appear when they are available or updated patient lists as you walk about the hospital, this type of technology is commonplace. Downloading the days lecture notes for reading later on the train may seem great, but in practice it doesn't happen. The level of demand for this service is quite different than for lab results or referral letters, despite the underlying utility software being identical.

The Healthcare Audience

The PDA audience can also be broadly divided into three.

- Those who can see a use for a PDA, find the software they want and the PDA becomes a part of them.
- The other audience are those who use a PDA for other things then discover uses for it in healthcare and move laterally. Both these groups are focussed and have an enthusiastic and gradual introduction to PDA use, these people work well with PDA's.
- The third group are those who are given a PDA to use, for example, a house surgeon is given a PDA to record clinical audit; or see others using it and think they might try it out. A consultant, for example, might like the titanium finish and the idea of the electronic BNF. This third audience group are destined to fail in PDA use, they do not have a *personal* need for a PDA and the PDA ends up sitting in the desk drawer and treated like a desktop PC.

Therefore PDA's do not suit all people, and indiscriminately implementing them hospital wide may be a mistake.

PDA Software Study

If software is the primary step for introducing PDA's to the healthcare system then a review of available software for healthcare is the first step.

The Internet was searched for healthcare related PDA software and the software was organised into relevant categories. In particular, characteristics, features and benefits to healthcare workers and teaching and learning in clinical practise were analysed. High-ranking applications that require further investigation were highlighted.

Internet Search

Popular Medical PDA software sites were used to initiate the searches (see database for a list). Sites tended to favour either commercial or shareware type software and were often biased towards one Operating System. The sites were useful as they allowed sorting by most recent software and also by number of downloads. Most well organised sites offered the software for purchase through their credit card service and it was difficult to find the home page of the actual software. This presented a problem as occasionally software was still for sale but the software house had ceased to operate, for example Raphael Patient Management by Ichorsoft, resulting in the purchase of out of production software. Search engines were used to find the actual software homepage and also to find other software not listed in PDA sites.

Notably many smaller titles were found which performed a simple task; these instantly fell under the “nothing special” category and were normally ignored. Two or three are included as examples but most were skipped.

Database Entry

The software was reviewed and entered into a MS Access Database see figure 17 under the following headings:

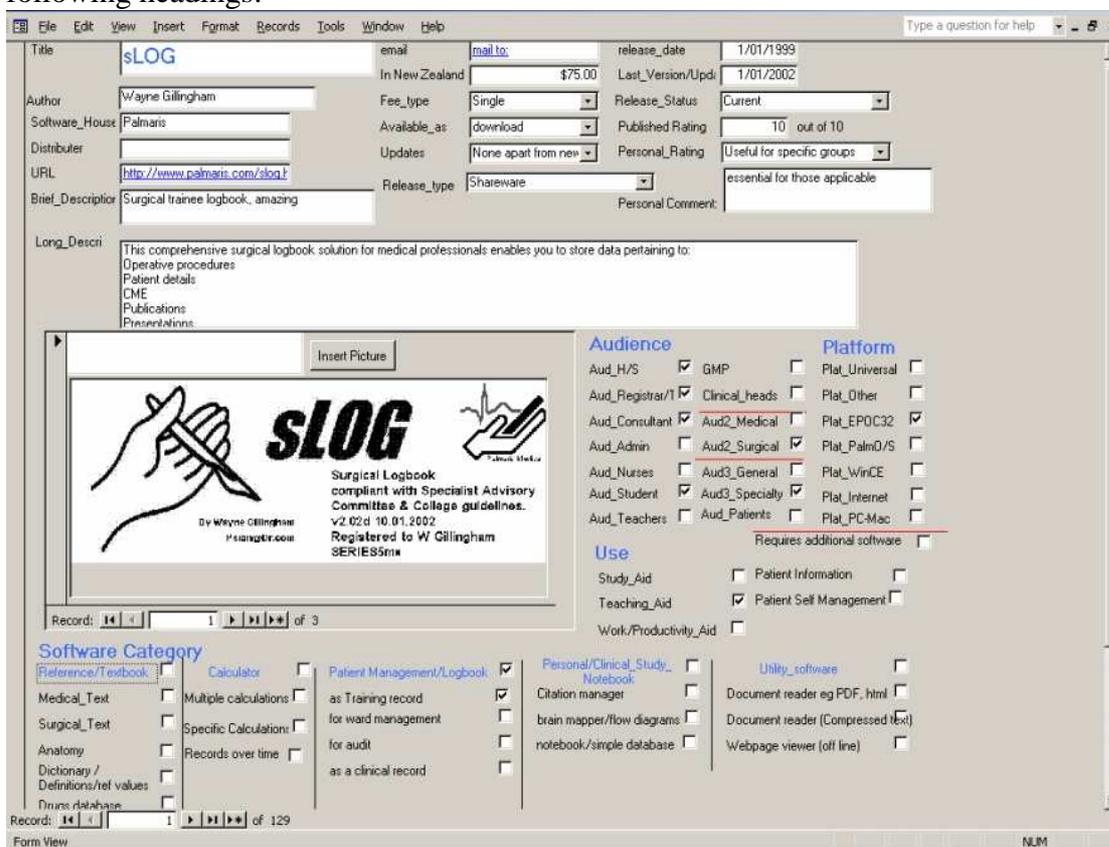


Figure 17 Screenshot of Software Database

Software Information

Includes the title, distributor, URL and brief description as often the advertising blurb contained in the Long description made the product appear more than it really was. The cost of software is important and there are various fee systems. The fee type is self explanatory, the most common is a single fee, but note the difference between shareware and commercial ware: new versions of shareware are often free, whereas commercial ware attract another fee. Commercial software updates may also incur a charge although often the first year of updates is free. Some software such as drug databases are updated daily for example Parkstone Med (<http://www.parkstonemed.com/v2001/htm/pages/index.asp>) and charge an initial then annual fee. Foreign currency rates were calculated at USD\$1 to New ZealandD\$2 and UKP£1 to New ZealandD\$3.

The release type is important; freeware implies no support from the developer. Shareware allows the user to trial a limited version of the software. The limit is a limited free use time, limited patient entries or limited features, for example printing is disabled. The software is enabled by paying for it and receiving an unlock code. This works well for PDA's which each have a unique machine ID number and allows for an unlock code that only works on the one machine. Shareware gets support from the developer but it is limited, the small fee paid is more an acknowledgement by the user that the software is useful and encourages them to produce more. Commercial software is fully supported and is a large leap from shareware. The quality of the software may be no better and is not infrequently worse than shareware but the developers *accept responsibility for their software*. Drug databases are to be relied on, medical calculations must be correct and patient management software should not crash the hospital computer system. When making the shift from fragmented individuals running their own PDA software to an integrated PDA system adopted by the hospital, the hospital needs assurances on the reliability of the software. Only commercial developers can give this. Nevertheless, less vital functions such as document viewing, lecture notes, anatomical diagrams and other features can be provided by shareware software. Users who do not play a vital role in health care decisions such as students may find the shareware software to keep track of interesting patients, help them with calculations and look up drugs quite useful and affordable. Therefore the utility of the types of software varies with audience.

Most software does not publish a release date on the webpages but require download before information is available. Nor can the published ratings be trusted, as only polarised groups tend to submit their assessment.

Personal Ratings

Each package is reviewed and read through, including reviews by various critics from other websites, the critique may be found at the end of the Long Description. Software is put into one of four groups; note these are not rankings but groups. *Nothing special* equates to software that is commonplace or not good, such as a drug database and poorly designed. The sort of program someone could do himself or herself, for example copy across an advanced life support protocol or produce a simple database. The palm OS was the most prolific, with literally hundreds of useless software titles, produced by eager medics wanting \$2 per copy. "Data quality is worth what you pay it" for holds true in the Palm world. Some software is *useful for specific groups* such as an anaesthetic logbook or gene-mapping database. They are worth looking at if you are in that specialty. Some software had evolved from a specific specialty, commonly the Emergency Department and then broadened to suite other hospital users. Sometimes this works but usually the software is

still only suitable for its' original intent (for example Digital Assist Palm Medical Charting, <http://www.digitalassist.net>) and so still classified for a specific group. Software is rarely grouped into *widespread use*, of the few; ePocrates Drug database for the palm (<http://www.epocrates.com>) fits the bill well, it is fully supported commercial software updated weekly and FREE! The final winning category is software that stands out from the rest *software worth further investigation* may be unique or excellent.

The Audience

There are three categories to describe the audience. The job title of the health worker applies to the New Zealand system. The activities of health work for a consultant or nurse are quite different than an equivalent American or British worker. For example clinical audit is sadly not a major feature of most health work, private insurance schemes and nurses that prescribe differ. A lot of software is available for patients and caregivers at home, such as diabetes management or drug administrators, our searches did not focus on this but some are included in the database as examples. Note students are fourth and fifth year medical students that spend most of their time in clinics observing and not making clinical decisions. Trainee Interns would more fit into the house surgeon category. The second category of medical or surgical only has relevance if one box is ticked. This also applies to category three; general or specialty.

The Platform

Most is self-explanatory, Internet based software obviously requires a viewer and a means of downloading information. Many palm applications required additional software to run.

Software Category

Some software was hard to place in a particular box and others did almost everything! Patient management software was most tricky. A training record is that used by registrars on a training program for submission as their logbook. Ward management software helps organise a person in their daily work, usually attempting to replace the ubiquitous sheet of scrap paper with patient stickers plastered on it. By comparison a clinical record is something that can be printed out and pasted in the patients notes. Most patient management software did one or the other. A clinical record is not an audit tool; software must be specifically designed and planned for audit. Other software that claimed to be patient management were in fact simple databases or notebooks which fell under the clinical notebook category. The software was only a simple jot and recall system and provided no computing power for example generating to-do lists or analysing lab values.

Results & Discussion

Reference / Textbook

By far the majority (>60%) of healthcare software is reference software with medical, reference values and drugs databases being equally popular. Surgical and anatomical texts or illustrations are uncommon. Reference software is almost exclusive and doesn't offer other features apart from some drug databases that offer drug dosage calculations. The plethora of data reflects the ease at which documents can be converted and stored on a PDA rather than the demand for such software. The size of some texts is reduced by using a compression program such as Tomeraider (www.tomeraider.com all platforms) or iSilo (www.isilo.com – Palm OS). Most commercial software use proprietary reader software to avoid piracy or ease development. Only one in four of the commercial reference software had any type of regular update service (see table 1)

	Updates		
	Daily	Weekly	Monthly
Medical Text		Clinical Update Biweekly	Clinical Guidelines Clinical Medicine Consult 2.0 Infectious Diseases MyDoktor 3.0 PEPID '99 (Portable Emergency Physician Information Database)
Drug database	Parkstone Med	ePocrates Rx & ID (Freeware)	

Table 1 Commercial reference software updates

What is reference software used for? The most popular audience is junior staff and they use it for clinical management decisions. Commercial drug databases are of limited use to New Zealand hospitals as each provides their own "Preferred Medicines List or PML", this can be easily converted to any PDA format and used as a portable reference text. PML's may not contain other drug information such as methods of action and alternative brand names; free drug databases are useful for this. Our own experience is when the drug is easy to lookup we will look them up and peruse their various characteristics, over time you became familiar with most main drugs and realise how useful a drug database is a learning tool. Medical texts and handbooks are useful for Interns and house surgeons to aid learning. These people do not make most vital management decisions and it is unlikely they need weekly or monthly updated medical texts, therefore any of the other less expensive or free medical texts would be adequate. Most of this type of learning is done with traditional textbooks although handbook type files are useful. As with drug databases, users will avail themselves of the service if it is easy to access for example; current students will go to the computer lab and read *Harrisons Online* as it is easier searching the textbook. In hospital practice registrars make the majority of clinical decisions, often after discussion with their consultant. The current trends towards *Evidence Based Medicine* are questioning this relationship as traditionally management decisions were made on consultant preference rather than best evidence. Ideally the registrar should research the topic find the best management for their patient and then discuss it with the consultant. It is impossible to do this in the time constraints, and in practice the registrar is guided by the consultant via telephone or ward round. But now there are subscription services that provide *Best Evidence* services on the Internet, such as, the Cochrane database and Best Evidence. Others such as Prodigy for primary care (<http://www.prodigy.nhs.uk/>) and Best Bets EBM for ED (<http://www.bestbets.org/>) are useful free sites. A Pilot trial is being performed by the University of Toronto (<http://www.cebm.utoronto.ca/projects/>) with their own EBM database. One of the best subscription sites is www.uptodate.com which supplies best practice, and another highly recommended though untested site is www.mentor-update.com which is part of the Oxford Clinical Handbook system. In in a New Zealand hospital where the Registrar uses the ward PC to look up the best evidence for treatment, then discusses this with the consultant, placed a print out of the evidence in the file and treated the patient. This process saved at least an hour or two of research in the library (often involving textbooks 5-8 years out of date) and all parties benefited. Having the data to hand on a PDA with highspeed wireless link makes the data more readily available, ward PC's are usually not sitting free and may have Internet access blocked. With trouble-free availability of data more patients will benefit and health workers will wonder what they did without it.

EBM is the next step in modern healthcare, and PDA's can deliver it. Registrars are the most appropriate link in the chain to introduce a PDA combined with Internet based EBM resources.

Calculators

Calculators suited three types of audience; patients, juniors and specialists. There are many available for patients to manage their self-medication, most commonly diabetes. The patient orientated software was not fully investigated, as it was not the focus of the research, some are included as examples only and may not be representative. Few commercial calculators (see table 2) were solely calculators the better ones were involved in drug dosing calculations combined with a formulary. Notably most comprehensive products are shareware or free, which is great for junior staff but as mentioned becomes a problem when life and death decisions are made on software that is not rigorously checked for accuracy. Possible solutions for New Zealand would be for a specialist to review the non-commercial calculation software and accredit it for use in the hospital, updates would have to undergo the same accreditation. It is unlikely that automated drug prescribing will occur in the next few years in New Zealand public hospitals. This system is driven by the need for billing to private insurance companies and so exists in the USA health market, for example Parkstone Med has daily updates of insurance policies.

	Recommended Calculators	Other Commercial Software
Shareware	MediKit v 3.01 Chartnote 3.13 Medcalc 3.91 Medmath	
Commercial	ePatient 2000 Parkstone Med PEPID '99	Pedisuite ER Suite CE On-Call Professional Doxuite

Table 2 Calculation Software

It is notable that few calculators combined intuitive usability and comprehensiveness and so the recommended applications stood out. An accredited calculator and Preferred Medicines list on a PDA would suit the student to registrar audience and increase PDA desirability as a useful tool.

A recent innovation is evidence-based calculators such as Medrules and MD EBM 2.01 for Palm OS, and Inforetriever 3.0 for WinCE. These help analyse data using Bayesian theory to give the best clinical decision. Although excellent clinical tools the Palm versions carry disclaimers and should not be used for clinical decisions but as teaching software. All provide journal references and are excellent teaching aids. Inforetriever (See figure 18) is commercial and has regular monthly updates, a very useful tool that works very well in PDA format.

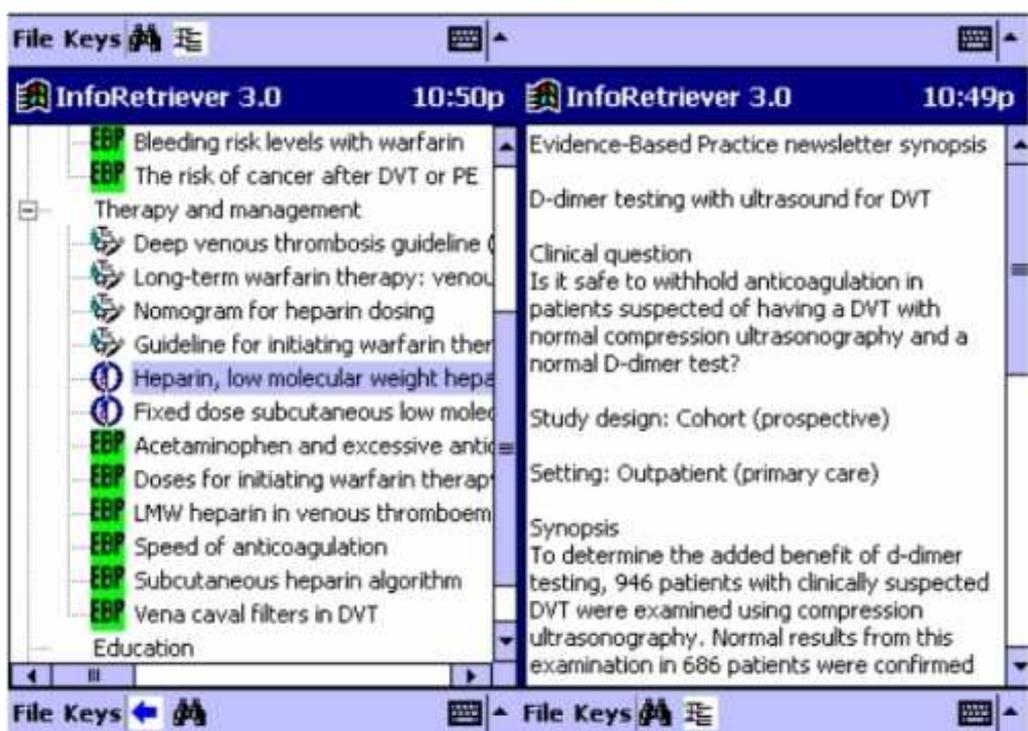
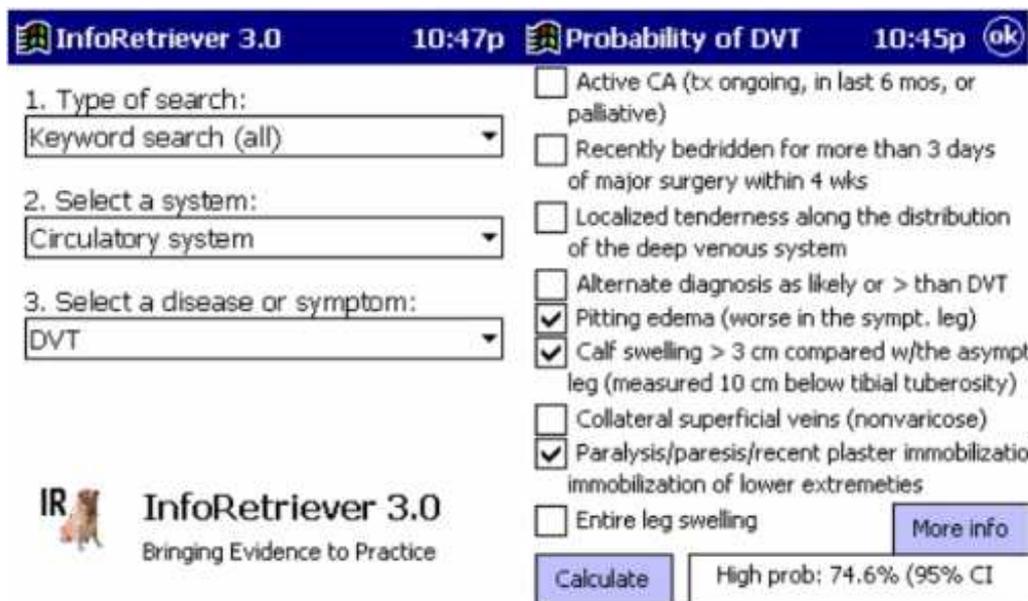


Figure 18 Screen shots for EBM calculator InfoRetriever

Patient Management / Logbook

There were seven titles in the Training record category, which were essentially surgical logbooks (See table 3). There are many more titles due to the fact most logbooks are individual to the specialty and often to the region. For some reason anaesthetists were the first off the mark and produced palmtop anaesthetic logbooks literally years before any others. Logbooks are either a stand-alone package or just the data entry part and the actual computing power is done on the PC. Most logbooks are the transfer of a paper based system to a computer and they are often flawed, as a computer system can collect much more detail and manage relational databases. The choice of logbook is made by whether one is available for your specialist-training field and suits the requirements. Commercial software offered no benefits over shareware.

Release type	Title	EPOC32	PalmO/S	WinCE	PC-Mac
Commercial	Anesthesia Assistant 3	No	Yes	No	No
Commercial	prologger	No	Yes	No	Yes
Shareware	AnaeStats	No	Yes	No	No
Shareware	Ob/Gyn Stat Tracker	No	Yes	No	No
Shareware	sLOG	Yes	No	No	No

Table 3 Training Record / Logbook software worth considering

Ward Management Software

As previously explained it is important to differentiate Ward management from clinical records. Ward management helps with day to day running of the ward, it provides ability to record blood results and create to do lists. Notably WinCE software features in most of the worthy software (See table 4)

Release type	Title	EPOC32	PalmO/S	WinCE	PC-Mac
Commercial	Patient Tracker 5.1	No	Yes	Yes	Yes
Commercial	Doxuite	No	No	Yes	No
Commercial	ePatient 2000	No	Yes	Yes	Yes
Commercial	Mobile MedData Charts	No	Yes	Yes	No
Commercial	Mobilephysician.net	No	Yes	Yes	Yes
Commercial	PatientKeeper	No	Yes	Yes	Yes
Commercial	PocketChart	No	No	Yes	No
Commercial	PocketPractitioner 2002 Office V2.0	No	Yes	No	Yes
Commercial	Touchbase	No	No	Yes	No
Fully supported commercial	Parkstone Med	No	No	Yes	No
Shareware	WardWatch v2.5	No	Yes	No	No
Shareware	Chartnote 3.13	Yes	No	No	No
Shareware	Client_L 4.02	Yes	No	No	No

Table 4 Ward management software worth considering

The acknowledged problem with ward management software is the lack of integration into the ward computer system. Shareware and some of the commercial software require the manual entry of patient data such as name, address and lab results. One of the authors used Client_L in a busy UK hospital and found it useful, but after 2 months he returned to using a piece of paper and patient stickers. The reason was the time it took to enter all the initial data. He would only manage patients for one or maybe two days due to the 1:4 daily rota. More than a day's management and his piece of paper would have filled up, he thinks a PDA would be helpful after three to four days of same patient contact. Commercial software such as PatientKeeper and Touchbase synchronise via wireless or Internet links to

autopopulate themselves with the doctors' patient demographics and lab results. This is the ideal system but hard to imagine occurring overnight in a New Zealand public hospital, particularly considering the focus of these programs is often to improve insurance billing and coding. Mobilephysician.net shifts the hospital data onto the Internet so it can be accessed remotely or by any platform, patients can also access the information and schedule appointments etc.

Software tends to be either low spec or very high spec but modular software such as Touchbase allows you to purchase only the features you want, such as ward management and autopopulation. Most commercial software overlaps as a clinical record and there is no easy solution or half way step for ward management.

One suggestion is to use one of the readily available PDA telnet programs and/or Internet browser, depending on the hospital, with wireless access to the LAN. A page or screen can be set up by IT to generate current patient lists and lab / imaging results for each logged on user. This would provide most of the available hospital computer services onto the PDA. Additional services are available at some hospitals such as online Imaging/Xray booking at Wellington, New Zealand, electronic discharge summaries at Invercargill, New Zealand. No proprietary software would have to be produced for the PDA and nor would the solution be platform specific. The availability of data in ones hand really does save time and aids productivity. WinCE solutions are popular because scaled down versions of Microsoft products are included in the operating system as well as the ability to write in Visual Basic rather than learn a proprietary PDA language. Therefore WinCE PDAs are most likely to make the jump from a dumb terminal to a basic integrated ward management package in New Zealand. MediHPC performs some of the above tasks by facilitating integration of a WinCE machine with hospital enterprise systems.

Clinical Audit is not funded in New Zealand; it is unlikely that any hospital is going to action PDA software for audit. Nevertheless some departments have done this at their own personal cost. All Oral and Maxillofacial Surgery departments, for example, south of Auckland, New Zealand have introduced a standardised Palmtop Logging system for Casualty attendances (www.geocities.com/gillinghamw/CasLog.htm). This has proved very worthwhile and some of their data is certainly changing and improving practice. Note that clinical audit is quite different to a computerised clinical record.

Clinical Record

Title	PalmO/S	WinCE	PC-Mac	In New Zealand Dollars
ePatient 2000	Yes	Yes	Yes	\$160.00
Mobile MedData Charts	Yes	Yes	No	\$70.00
Mobilephysician.net	Yes	Yes	Yes	\$1,200.00
Palm Electronic Medical Records 8.1	Yes	No	No	Unknown
PatientKeeper	Yes	Yes	Yes	\$70.00
PocketChart	No	Yes	No	Unknown
PocketPractitioner 2002 Office V2.0	Yes	No	Yes	\$200.00
Touchbase	No	Yes	No	Unknown
Digital Assist Palm Medical Charting	Yes	No	No	\$4,500.00

Table 5 Worthwhile Clinical Record Software

PocketPractitioner 2002 Office V2.0 and patient keeper have their own open programming language to allow third party developers to add their own influence. It links with the hospital system and does most things required. Mobile MedData Charts is effectively the patients notes in your hand plus all lab and pharmacy facilities. Touchbase has the novel feature of dictation that is then transmitted for typing, each module of touchbase covers a need in healthcare such as wireless receipt and acknowledgement of lab results. Digital Assist Palm Medical Charting is what seems to be an ED charting program, although there must be more to it for the price, most reviews are not kind to it.

These software are a pipedream for New Zealand systems, even if a small hospital adopted them as a trial we are still faced with the problem that not all workers will suit a PDA, resulting in other methods for these users to access and enter data, either through secretaries or desktop PC's.

In saying this there are some visionaries in New Zealand. The school dental services in Wellington, Christchurch & Taranaki have equipped all School Dental Therapists with palmtop computers and complete patient records are kept on them (Molaris School Dental System). Wellington has kept this data for almost ten years and can do world leading analysis on child dental health at the touch of a button. Palmtops obviously suit the mobile needs of a Dental Therapist, even start and finish times for each patient are kept to help plan allotment of resources. Taranaki has linked their system to the national hospital patient register and it is notable that the School Dental Service has cleaned up large parts of the database by eliminating double ups and other coding errors with patients.

Proceed with Caution...

Adoption of patient management software will likely come from PDA's doing current tasks more easily, such as lab results transmitted to the PDA screen. The introduction of new technology and new processes such as electronic clinical records are likely to fail in some way, and PDA's take some of the blame. It is better to have users saying "this is great, now what I want next is this" rather than being faced with mastering an entirely new system and deciding not to try.

I have noticed with computerisation, workers can spend their time doing tasks they should not really be doing. It is more productive for a doctor to see more patients in an outpatient clinic and dictate notes, than spend time writing notes. A painful example of this is the torture one endures when they attend their local GP and watch them single finger type notes into the practice computer. PDA's could engage doctors in menial tasks such as entering lab results into written clinical notes when someone else may be better employed to do this.

If PDA's prove themselves indispensable then they may be their own undoing. If only the registrar possessed a PDA it may occur that house surgeons, nurses, students availed themselves of the easy data access. The PDA would be handed around the ward or department like a drug formulary and lose its valuable personal attributes.

Personal Clinical or Study Notebook

Citation managers were few and so if one is available then use it (See Table 7.) Databases could be created from the inbuilt software but features such as import from Medline and Web synching are useful features in the shareware versions, and hard to write yourself.

Study Notebooks were available but offered nothing of any value. Making ones own simple database or word file to build up a knowledge base is simple to do on the in built applications. Tablet based systems may not favour this due to their slow data input.

Citation Managers	
Qcite	EPOC32
Reference Pocketeer	Palm OS

Table 7. Available Citation Software

Utility Software

Many palm OS based solutions require additional software to run. Some of the additional software such as Tomeraider (www.tomeraider.com) is available on all platforms, and makes good sense. Tomeraider compresses text files into a flat database format and is very fast. There are conversion programs and readers for the various platforms, but they are often less than perfect. Palm has the most medical reference data but as mentioned a lot of it is unnecessary, most is stored in iSilo or hanDBase format, which can be read by EPOC32 but not WinCE as yet. All three platforms have PDF and HTML viewers as well as telnet and web browsers. Palm OS is the weakest in terms of web browsing due to it's low resolution screen and limited processing power. Software such as AvantGo for the palm and WinCE takes the web page and converts it into an offline format for later viewing. It features an automated synchronisation system so each time the palm is synched with the PC the selected webpages are checked and new developments are updated to the palm. This is an excellent feature for clinical updates, newsletters, timetables and memo's.

Other Considerations

Teaching / study / learning aids.

There is limited software available for teaching purposes. There are many titles available which would be great learning aids due the easy access of information such as drugs databases. They can be useful for quickly accessing data such as eponyms, references and drugs but the size and format of textbooks makes them superior. Flash card equivalent software is available and they would be great.

Problems with study

Data Collection.

Software is not only rapidly developing but we estimate 2000 Medical PDA software titles are available. Most are nothing special but with such a number fragmented across websites with maybe 2 or 3 resellers and then 3 or 4 reviews (which date) it becomes difficult to completely collate and find all software. Few hospitals use PDA's hospital-wide and there is a lot of enthusiast software written and used in departments that is not published on the web. The data collected is therefore not complete but we hope it is representative.

Operator Bias

My experience is based on the EPOC32 and Win CE operating systems.

Superficial assessment

We could not download and experiment with software due to the shear numbers and different platforms. Software was assessed from website information and reviews which is less than desirable. Downloading would not be a complete solution as our experience is the software needs to be used in the field for at least 6 weeks before an opinion can be formed.

Summary

To search the Internet for healthcare related PDA software and organise it into relevant categories.

There is an enormous resource on the Internet for healthcare related PDA software. The current software has been categorised into five categories and eighteen subcategories. Half the software fits into more than one category, in particular the use of computational features on reference data for example calculating drug doses from drug formularies and best treatments from Evidence based texts.

Look at the characteristics, features and benefits to healthcare workers and in particular teaching and learning in clinical practise.

Healthcare workers have varied roles and the suitability of software to different audiences has been recorded.

Teaching and learning on computer systems is still at early stages in healthcare education. Most learning for students is either by formal study or on the job experience. PDA's bridge this gap by providing formal study references traditionally bound to the library, in the palm of their hand – while “on the job”. Each category of software improves productivity and so allows for more experience. Benefits have been outlined in the text, one disadvantage not mentioned is the need for juniors is to do “the hard yards”: PDA's allow for menu choices and list options but nothing beats having to formulate ones own history, examination, investigations and problem list onto a blank piece of paper. Juniors need to be proficient at this as it helps consolidate a lot of knowledge, teachers need to be aware of the pitfalls and supervise carefully.

Identify high ranking applications that require further investigation

High ranking applications are grouped on the database and many mentioned in the text. The choice of applications should not be made *only* on their features but on what will sell the best. To have PDA's readily adopted by healthcare workers they need to be instantly usable and fill a need. Therefore Preferred Medicine Lists and Lab results on hand are great “sales tactics”.

Definite hit software (see table 8)

This is our opinion on what would immediately appeal to the audience and make them want to incorporate a PDA into their lives. It is based on the “buy it and have it working tomorrow” principle. For example wireless dictation may appeal but it's not likely to be immediately available in New Zealand, so is not mentioned. The table is different to the groupings in the software database that state if the software may *suit* that audience rather than *seduce* them.

	Student	House Surgeons	Registrar / Trainee	GMP	Consultant	Clinical heads
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Reference / Textbook	Drugs Database + PML. Half the suitable software is non commercial	Drugs + PML, Medical & Lab Reference	EBM literature or online EBM eg. Uptodate.com		Drugs + PML EBM software	
Calculator	Appealing by should do this manually to understand the process	A definite				
Patient Management / Logbook			Training Logbook	Clinical record that syncs with PDA – most GMP's have PC		Audit Logbook (To supply to the clinical staff.)
Personal Clinical / Study / Notebook					Citation Manager	
Utility Software	Document viewer, Web browser & Email					
Other		Wireless access to Hospital Lab results and ordering.	Wireless access to Hospital Lab results and ordering.			

Table 8 Software Seduction Table

Release type	Title	Platform				Category				
		EPOC32	PalmO/S	WinCE	PC-Mac	Reference/Textbook	Calculator	Patient Management/Logbook	Personal/Clinical_Study_Notebook	Utility_software
Commercial	5 Minute series ID, Paeds, Ortho, Sports, Toxicology, A2z of drugs		☺	☺	☺	☺				
Commercial	Cardiology eHandbook		☺		☺	☺				
Commercial	Documents To Go Professional 4.0		☺							☺
Commercial	Doxuite			☺		☺	☺	☺		
Commercial	EMS Gold 1.3 / Pocket Trauma 1.2		☺			☺				
Commercial	Infectious Diseases		☺			☺				
Commercial	Medical Dictionary Bundle /Beiks/ 2.0		☺			☺				
Commercial	Obstetrics for Primary Care Physicians		☺		☺	☺				
Commercial	PDATox		☺	☺		☺	☺			
Commercial	Pedisuite		☺	☺		☺	☺			

Release type	Title	Platform				Category				
		EPOC32	PalmO/S	WinCE	PC-Mac	Reference/Textbook	Calculator	Patient Management/Logbook	Personal/Clinical_Study_Notebook	Utility_software
Commercial	PocketMedicine Series		☺	☺		☺				
Freeware	Cancer Staging and Treatment** 1.9		☺			☺				
Freeware	Drugs Database (BNF)	☺	☺		☺	☺				
Freeware	SurgicalDB 1.0	☺				☺				
Fully supported commercial	Digital Assist Palm Medical Charting		☺					☺		
Shareware	MD EBM 2.01		☺				☺			
Shareware	MiniRD 1.0		☺				☺			
Shareware	Orth v1	☺				☺	☺			
Shareware	PregCalc Pro PregCalc Pro		☺				☺			
Shareware	sLOG	☺						☺		
Shareware	USMLE 1: Review (Demo) 1.1		☺			☺				
Shareware	WardWatch v2.5		☺					☺		
Commercial	5 Minute Medical Consult		☺	☺	☺	☺				
Commercial	MyDoktor 3.0	☺	☺	☺		☺				
Commercial	Wash Mnl™ (The Washington Manual of Medical Therapeutics, 30th Edition)		☺	☺	☺	☺				
Freeware	eDrugsDatabase 1.0		☺			☺				
Freeware	MedCalc 3.91		☺				☺			
Freeware	MedMath		☺				☺			
Shareware	MediKit v 3.01	☺					☺			
Commercial	Clinical Guidelines		☺			☺				
Commercial	Clinical Medicine Consult 2.0		☺	☺		☺				
Commercial	Clinical Update Biweekly		☺			☺				
Commercial	ePatient 2000		☺	☺	☺	☺	☺	☺		
Commercial	Inforetriever 3.0			☺	☺	☺	☺			
Commercial	Mobilephysician.net		☺	☺	☺			☺		
Commercial	PatientKeeper		☺	☺	☺			☺		
Commercial	PEPID '99 (Portable Emergency Physician Information Database)		☺	☺	☺	☺	☺			
Commercial	Touchbase			☺		☺		☺		
Freeware	ePocrates Rx & ID		☺			☺				
Freeware	MedRules		☺				☺			
Fully supported commercial	Uptodate.com	☺	☺	☺	☺	☺				
Shareware	Client_L 4.02	☺						☺		
Shareware	Qcite	☺							☺	
Shareware	Reference Pocketer 2.2		☺						☺	

Table 9 Reference Software suitable for Students

Release type	Title	Student	H/S	Registrar/Trainee	GMP	Consultant	Admin	Clinical heads	Teachers	Patients	Reference/Textbook	Calculator	Patient Management / Logbook	Personal / Clinical Study Notebook	Utility software	Brief Description
Shareware	AnesthesiaDrugs 4.0.4			●		●					●					
Shareware	CodeMeister 2.02		●	●	●	●					●					ICD9 codes for USA
Shareware	Orth v1	●	●	●							●	●				orthopaedic coding, scoring, classifications
Shareware	USMLE 1: Review (Demo) 1.1	●	●								●					US med exams flash cards
Fully supported commercial	Parkstone Med		●	●	●	●					●	●	●			Drug prescriber, biller, referrer
Fully supported commercial	Uptodate.com	●	●	●	●	●		●	●	●	●					Online EBM database
Freeware	Cancer Staging and Treatment** 1.9	●	●	●	●	●					●					staging and tx text
Freeware	Drugs Database (BNF)	●	●	●	●	●					●					BNF on palmtop
Freeware	eDrugsDatabase 1.0	●	●	●	●	●					●					drugs database
Freeware	ePocrates Rx & ID	●	●	●	●	●					●					drugs and infectious diseases database
Freeware	SurgicalDB 1.0	●	●	●							●					Surgical Database
Commercial	5 Minute Medical Consult	●	●	●	●						●					Oxford handbook type
Commercial	5 Minute series ID, Paeds, Ortho, Sports, Toxicology, A2z of drugs	●	●	●	●	●			●		●					Medical Handbooks on any topic, pay for each individually
Commercial	Cardiology eHandbook	●	●	●		●					●					Cardiology text
Commercial	Clinical Guidelines	●	●	●		●		●			●					Clinical guidelines text
Commercial	Clinical Medicine Consult 2.0	●	●	●	●	●					●					medical ref oxford handbook style, can buy just one specialty or all (this package) clinical medicine series
Commercial	Clinical Update Biweekly	●	●	●	●	●		●	●		●					biweekly medical update email sent to the palm
Commercial	Doxuite	●	●	●							●	●	●			Patient management
Commercial	EMS Gold 1.3 / Pocket Trauma 1.2	●	●	●							●					Trauma and ACLS guide
Commercial	ePatient 2000	●	●	●	●	●	●	●			●	●	●			Patient management
Commercial	ER Suite		●	●	●						●	●				combines pedisuite, drip calculator, fluid wizard and PDA Tox
Commercial	Infectious Diseases	●	●	●	●	●					●					infectious diseases text
Commercial	Inforetriever 3.0	●	●	●	●	●			●		●	●				Clinical Decision making tool based on EBM
Commercial	Medical Dictionary Bundle /Beiks/ 2.0	●	●							●	●					Medical Dictionary 38000 defns
Commercial	Mobile MedData Charts		●	●	●	●	●	●			●		●			Patient Management System links to hospital system
Commercial	MyDoktor 3.0	●	●	●	●	●			●		●					Medical database over 1500 entries
Commercial	Obstetrics for Primary Care Physicians	●	●	●	●						●					Obstetrics handbook text
Commercial	PDATox	●	●	●	●	●					●	●				Drug poisoning guide
Commercial	Pedisuite	●	●	●							●	●				Paediatric guide and calculator
Commercial	PEPID '99 (Portable Emergency Physician Information Database)	●	●	●	●	●			●		●	●				Medical & drug reference and calculator Editions are Emerg Med, Student, Medicine, Nurses, Paramedic, pharmacy
Commercial	PocketChart			●	●	●	●	●			●		●			Patient management clinical record

Release type	Title	Student	H/S	Registrar/Trainee	GMP	Consultant	Admin	Clinical heads	Teachers	Patients	Reference/Textbook	Calculator	Patient Management / Logbook	Personal / Clinical Study Notebook	Utility software	Brief Description
Commercial	PocketMedicine Series	●	●	●	●	●			●		●					medical texts almost any topic, each a separate purchase
Commercial	Touchbase	●	●	●	●	●	●	●			●		●			Modular patient management, drugs, billing and reference system
Commercial	Wash Mnl™ (The Washington Manual of Medical Therapeutics, 30th Edition)	●	●	●	●	●					●					Medical text USA

Table 10 Notable Reference Software

Release type	Title	Student	H/S	Registrar/Trainee	GMP	Consultant	Admin	Clinical heads	Teachers	Patients	Reference/Textbook	Calculator	Patient Management/Logbook	Personal / Clinical Study Notebook	Utility software	Brief Description
Shareware	Chartnote 3.13		●	●	●	●						●	●			Patient management software for physicians
Shareware	Diabetes Manager 2.23									●		●				Diabetes tracker manager with food database
Shareware	MD EBM 2.01	●	●	●	●	●						●				Evidence Based Medicine Stats Calculator
Shareware	MediKit v 3.01	●	●	●	●	●						●				Advanced comprehensive medical calculator
Shareware	MiniRD 1.0	●	●									●				dietitians calculator
Shareware	Orth v1	●	●	●								●	●			orthopaedic coding, scoring, classifications
Shareware	PregCalc Pro PregCalc Pro	●	●	●		●						●				Pregnancy Calculator
Fully supported commercial	Parkstone Med		●	●	●	●					●	●	●			Drug prescriber, biller, referrer
Freeware	MedCalc 3.91	●	●	●								●				Medical Calculator - many calcs
Freeware	MedMath	●	●	●								●				Medical Calculator Multiple
Freeware	MedRules	●	●	●	●							●				EBM calculator
Commercial	Doxuite	●	●	●	●	●					●	●	●			Patient management
Commercial	ePatient 2000	●	●	●	●	●	●	●			●	●	●			Patient management
Commercial	ER Suite		●	●	●	●					●	●				combines pedisuite, drip calculator, fluid wizard and PDA Tox
Commercial	Inforetriever 3.0	●	●	●	●	●			●		●	●				ClinicalDecision making tool based on EBM
Commercial	PDATox	●	●	●	●	●					●	●				Drug poisoning guide
Commercial	Pedisuite	●	●	●	●	●					●	●				Paediatric guide and calculator
Commercial	PEPID '99 (Portable)	●	●	●	●	●			●		●	●				Medical & drug reference and calculator

Release type	Title	Student	H/S	Registrar/Trainee	GMP	Consultant	Admin	Clinical heads	Teachers	Patients	Reference/Textbook	Calculator	Patient Management/Logbook	Personal/Clinical Study Notebook	Utility software	Brief Description
Shareware	Qcite	☺	☺	☺	☺	☺			☺					☺		Citation manager like endnote but more useful, imports from medline
Shareware	Reference Pocketer 2.2	☺	☺	☺	☺	☺			☺					☺		citation manager
Commercial	Anesthesia Assistant 3			☺		☺							☺	☺		Anaesthetics Logbook
	MedCheck 1.3				☺					☺			☺	☺		Monitors care giver administration of meds

Table 13 Notable Notebook Software