

Knowledge in the Palm of your hands: PDAs in the clinical setting

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Abstract

Objective: To explore the impact of hand-held computers on patient care by identifying: (i) how often clinical staff accessed resources on hand-held computers to inform their clinical decision making; (ii) Which hand-held resources were thought to be most useful in the clinical setting; (iii) the barriers to using hand-held resources to support patient care.

Design: A descriptive study comparing aspects of Personal Digital Assistant (PDA) resource use in two phases, between August 2002 and December 2003. There was variability in the way that resources were accessed between the two studies.

Setting: University Hospitals of Leicester NHS Trust, an acute teaching hospital, and one primary care practice.

Participants: A purposive sample of 14 clinical and librarian staff participated in phase one and 14 in phase two of the study. Participants consisted of consultants, nurses, pharmacist, junior doctors, clinical librarians, and a general practitioner.

Main outcome measures: Baseline Data Questionnaire to identify the participants' level of knowledge and use of hand-helds on entering the study. End-of-phase questionnaire with self-reported measures of use of the hand-held and PDA resources during the study.

Results: All of the participants used hand-helds in their clinical setting to support evidence-based practice and education, but with varying frequency. More staff reported using the hand-held to answer specific patient questions in phase two than phase one of the study. UK resources were preferred to American resources. The 'plug-in and go' method using Secure Digital (SD) cards was preferred to downloading resources from the Internet.

Conclusions: Hand-held technology is emerging as an effective clinical tool to aid evidence-based practice and support the educational needs of clinical staff. The hand-held can provide a critical mass of information that is relevant, quickly accessible and in a coherent format: delivering clinical information at the point of need with a resulting benefit to patient safety.

Introduction

Personal Digital Assistants (PDAs) are hand-held computers that originally were designed as personal

organizers. The basic features of a PDA are an address book, notepad, clock, calculator and e-mail.

Analysts have found that over half of American doctors own a PDA but only 6% regularly used them to access patient records, and 5% to check laboratory results.¹ Many clinicians and information

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technology professionals are unaware of the variety of potential uses.²

Although, traditionally, desktop and laptop computers have provided access to evidence-based resources, recently, content providers have started exploring hand-held computers as a delivery method. The key point in providing evidence at the point of care is the speed at which information can be delivered. Information needs to be available within seconds if it is to be incorporated into busy clinical rounds³ and general practitioners (GPs) will spend no longer than 2 min looking for answers to questions that arose in consultations.⁴ Previous studies have found that hand-held computers containing concise summaries of evidence and decision-making tools can improve learning in evidence-based medicine.^{5,6} Research has identified the type of information clinicians wanted on a PDA as:

- the clinical 'bottom-line' from pre-appraised resources;
- management algorithms;
- drug dosages;
- numerical summaries.

Traditional practice guidelines are not valued.⁷ In addition to this point-of-care assistance, research has found that doctors are using hand-held computers to access patient information, administrative functions such as electronic prescribing, coding, tracking schedules, research activities such as data collection and medical education to store lecture notes, presentations, photographs and diagrams.⁸

Aims

We conducted this study on the impact of hand-held computers on patient care to identify:

- how often clinical staff accessed the resources on hand-held computers to inform their clinical decision making;
- which hand-held resources were most useful in the clinical setting;
- barriers to using hand-held resources to support patient care.

Methods

Recruitment was purposive, to ensure that a range of professionals' views were obtained. A 'snowball'

method was used to identify potential recruits, as well as targeted approaches to clinical staff. It was important to select staff who expressed an interest in using PDAs to access clinical/research information as some technical hurdles were anticipated. However, expertise in using PDAs was not a requirement for recruitment.

The study ran from August 2002 to December 2003 and was split into two phases. Phase one took place over 6 months and phase two over 3 months.

Participant numbers were limited by the funding available, 14 Palm™ m515 PDAs were provided for phase one and 14 Palm™ Tungsten Ts (recommended by Dr Companion™ for use with their product) for phase two.

The participants were issued with a Palm™ and asked to download and use the resources in the clinical setting and to evaluate their impact on patient care.

Data was collected at baseline and at the end of each phase of the study using questionnaires allowing multiple-choice, Likert-scale and free-text responses. The data collected was descriptive, self-reported use of the PDA before and during each phase of the study. Informal discussions with participants supplemented the information gathering.

Phase one ran for 6 months from August 2002. Palm™ m515s were purchased for the participants of phase one of the study as most medical software was available in Palm™ operating system format in 2002.⁹ Resources that were available for the Palm™ were downloaded from the web during the synchronization of the hand-held and computer (hot sync'ing). OVID@Hand (see Table 1) was purchased for the participants. Users required access to a computer with a USB port and connection to the Internet. Apart from OVID, users could download other free material from the Web and, as this was identified, the websites were added to the library Palm webpage and other participants were encouraged to use these resources. See Table 1 for a full list of resources used during phase one. The 14 participants in phase one consisted of:

- four consultants;
- four nurses;
- one pharmacist;
- two junior doctors;
- one GP;
- two clinical librarians.

Table 1 Hand-held resources used during phase one of the study

Application	Comment
OVID@Hand: http://www.ovid.com/site/products/tools/ovidhand/	The product has both a hand-held component and a web-based 'personal library' delivering some content to the users PDA and linking that content back to the larger OVID resources on the web. Access to over 500 journal table of contents on the hand-held and full-text on the Web, an American drug handbook, <i>A-Z Drug Facts</i> , drug interaction information, <i>Drug Interaction Facts Module</i> , an American nursing drug handbook, <i>Lippincotts Nursing Drug Guide. Q → A module</i> to collect questions in the clinical setting the searches are sent to the users web-based personal library where <i>OVID Smart Search</i> runs a search in MEDLINE.
Mobile Micromedex: http://www.micromedex.com/products/mobilemicromedex/	Drug database mobile edition free with institutional subscription.
Isilo: http://www.isilox.com/	Converts html, text and common image file formats.
Epocrates: http://www2.epocrates.com/	American free drug reference application.
Dataviz Documents to Go: http://www.dataviz.com/	Used to import, view and edit Word, Excel and Powerpoint documents.
Medcalc: http://medcalc.med-ia.net/desc.html	Free medical calculator for Palm.
Clinical Evidence and British Medical Journal specialist journals via CogniQ: http://www.unboundmedicine.com/store/ub?cmd=catdetail&action=viewentry&eid=27	Clinical Evidence is a monthly, updated directory of evidence on the effects of common clinical interventions. British Medical Journal specialist journals table of contents with some full-text articles.
Eponyms: http://eponyms.net/eponyms.htm	A list of over 1350 common and obscure medical eponyms (e.g. Rovsing's sign, Virchow's node) with descriptions.
MDLinx: http://www.mdlinx.com/	Journal news filtered for you daily (registration free)—sent by e-mail, hotsync'ed to your Palm.
JournalsToGo: http://www.journaltogo.com/	Free service that delivers peer-reviewed journal abstracts from the National Library of Medicine and news articles from Reuters to your hand-held device. Select topics from a number of predefined channels.
John Hopkins Antibiotic Guide: http://www.hopkins-abxguide.org/	Antibiotic reference guide. Free.
Avantgo: http://www.avantgo.com/	Free program to capture websites for the hand-held.
Highwire journals: http://highwire.stanford.edu/customize/	Table of contents for journals available via HighWire, e.g. British Medical Journal.

The second phase ran for 3 months from November 2003 as a result of recommendations made at the end of phase one. PDAs do not have a hard drive but store programs and information in their memory. The advantage of this is that when the PDA is turned on the programs do not need to be loaded into the memory but are instantly available. The disadvantage is that there is a limit to memory space. This was found with the participants of phase one of the trial once the OVID databases were loaded onto the Palm™ m515s. Suppliers sometimes overcome this problem by storing information on a separate secure digital (SD)

card which plugs into the hand-held computer. Phase two tested a resource called Dr Companion™ that was loaded onto an SD card and interrogated on the hand-held away from the main computer. Dr Companion™ was in beta testing stage and not available on the open market at the time. The GP was given access to the mobile version of his primary care patient information system. See Table 2 for more details of the resources used during phase two.

Although clinical staff were invited to participate in both phases of the study, there was some drop out during phase one as a result of junior doctor rotations and nurse practitioners being relocated.

Table 2 Hand-held resources used during phase two of the study

Application	Comment
Medhand International's Dr Companion™ UK: http://www.drcompanion.com	Information sources loaded onto the beta version of this card were the BNF, Swedish Drug Interaction Module, Oxford Handbook of Clinical Medicine and Oxford Concise Medical Dictionary, Whittaker's Instant Pictorial Anatomy, EBM Guidelines with links to Cochrane reviews, NICE guidelines, OPSC IV (classification of surgical procedures), eMedicines Compendium (full encyclopaedia of drugs registered in the UK), medical calculators from MedCalc, and the Leicestershire Prescribing Guide.
EMIS: PalmGP	Primary care patient information system with mobile patient record viewing and consultation recording with access to the full, up-to-date patient record on the Palm. All current and past drug lists, immunizations, allergies and attachments (e.g. radiographs) are synchronized to the Palm and a secure log-on/auto lockout is in operation. Users require access to a PC with a USB port and the local EMIS system and a hand-held computer with a Palm operating system.
HanDBase: http://www.ddhsoftware.com/	Create forms for lists, logbooks, etc.

Some new participants were recruited for phase two, giving a total of 14 participants:

- two nurses;
- five consultants;
- two junior doctors;
- one pharmacist;
- one GP;
- three clinical librarians.

They were issued with the Tungsten Ts and Dr Companion™ SD card for 3 months during phase two and again asked to use the resource in the clinical setting.

Results

Data was collected at the beginning and at the end of each phase of the study. Baseline questionnaires were administered in August 2002 for phase one ($n = 14$) and in November 2003 for phase two ($n = 14$). 'End-of-phase' questionnaires were completed in February 2003 for phase one ($n = 9$) and in February 2004 for phase two ($n = 12$). Response rates for phases one and two of the study were 64% (9/14) and 86% (12/14), respectively.

The baseline questionnaire examined participants' previous use of PDAs, see Table 3.

Were hand-held resources used in the clinical setting?

Participants, on entering each phase, were asked to identify how often they carried out certain tasks

before they were given a hand-held computer. At the end of each phase the participants were asked to identify which tasks they had transferred to their hand-held computer. All of the participants used hand-helds in their clinical setting, but with varying frequency. See Table 4 for a summary of responses.

Informal interviews have indicated that to engage in evidence-based practice (EBP) clinicians need additional time to digest information identified in EBP resources.

To what extent had the resources assisted in patient care?

The end-of-phase questionnaire asked if, in the last 6 weeks, any clinical questions had arisen regarding a specific patient where an immediate search on the

Table 3 Length of time PDA used by participants on entering phase one and phase two

Length of time participants have used a PDA	No. of phase one participants	No. of phase two participants
Never	8	2
Under 6 months	3	2
Six months to 1 year	1	4
One to 2 years	1	4
Two to 3 years	0	1
Over 3 years	1	1

Table 4 Frequency key tasks performed at baseline and on hand-held computer at end of phases one and two

Task	Phase one Frequency task performed at baseline/on hand-held computer at end of phase				Phase two Frequency task performed at baseline/on hand-held computer at end of phase			
	Never	Once/month	Once/week	Daily	Never	Once/month	Once/week	Daily
Look up drug information	2/2	4/2	5/3	3/2	1/1	1/0	5/7	7/4
Read health journals	0/2	4/3	6/4	4/0	1/8	2/1	7/1	4/2
Read health textbooks	1/6	5/1	7/2	1/0	2/3	3/1	8/5	1/3
View practice guidelines	0/5	8/3	4/1	2/0	3/3	5/3	5/6	1/0
Use medical calculators	7/7	3/0	2/2	2/0	5/4	2/4	5/3	1/1
Access patient data	3/9	0/0	1/0	10/0	5/9	1/0	1/0	7/3
Write prescriptions	6/9	1/0	2/0	5/0	7/11	1/0	1/21	7/0
Search research databases, e.g. MEDLINE	0/4	6/3	5/2	3/0	2/8	3/2	6/1	3/2
Search summaries of evidence e.g. Clinical Evidence	0/3	9/5	3/1	2/0	0/3	6/6	6/2	2/1
Read/write e-mails	0/3	0/1	0/3	14/2	2/6	0/3	1/1	11/2
Use diary	2/2	0/1	1/1	11/5	0/2	1/0	0/0	13/10
Connect to the Web	0/2	1/3	1/2	12/2	1/6	1/2	1/1	11/3

PDA was useful. In phase one, four participants responded yes and five participants responded no to this question. In phase two, 11 participants responded yes and one participant responded no to the question. In addition, in phase two, participants were asked if they had found a PDA search useful in the last 6 weeks to support their educational needs; 11 out of 12 participants responded yes.

The end-of-phase questionnaire examined the impact of the hand-helds on patient care by asking the participants to score the extent that each resource assisted in patient care/clinical practice on a four point scale from Significantly (1) to Not at all (4). See Table 5 for participants' ratings of the resources and comments on each resource.

Barriers and technical issues

The specification of the computers available to the participants in their workplace varied enormously. The set-up process was time intensive and placed heavy demand on the technical staff at the Trust, as each user needed administration rights for a computer to ensure they could load software onto the machine, and occasionally an upgrade of the operating system on the computer to run the software. This was often compounded by cross-site working with the users needing to be able to

'hot sync' their Palm on more than one hospital site. It took several months to get all 14 participants of phase one connected to a computer that was fit for the purpose, which is why this phase of the study took 6 months compared with the 3 months of phase two.

The participants were not technical experts and many asked the library staff to download the information sources on to their PDAs. It took 3 h per PDA via NHSnet cable to install OVID@Hand. For users choosing to download data from home using dial-up Internet connection via telephone lines, the process took longer. There was a long registration process followed by a large amount of data to load from the web onto the hand-held computer. In addition to this Clinical Evidence via Avantgo™ did not work.

As all the participants were busy clinical staff, only a handful of enthusiasts had the time to identify Internet freeware resources to load and trial on the PDA. As each resource required a separate registration and download process, users were deterred from participating in this element of the study.

The limit to memory space of the Palm™ m515 struggled with the amount of data available with the OVID@Hand products. Because of the large amount of information loaded on the OVID resource, the daily synchronization process would

Table 5 Participants rating of resource on assisting patient care and comments on each resource

Resource	Extent it assisted in patient care/clinical practice—no. of responses in each category	Comments	
Clinical Evidence CogniQ	Significantly	1	Felt more up to date with current literature and could read when it was convenient without having to carry various things around on the off chance I would get time
	Moderately	1	
	Marginally	2	
Journals Table of Contents via CogniQ	Significantly	1	Found titles that were interesting but no full text—need full text on the palm
	Marginally	1	
	Not at all	2	
John Hopkins antibiotic guide	Moderately	1	Excellent
	Not at all	2	
Dataviz	Moderately	2	May not be relevant as prescribing is limited by the hospital formulary
	Marginally	1	
	Not at all	1	
Micromedex	Significant	1	Too easy not to use Saved protocols to access in the clinical setting Copies of files for meetings mobileMicromedex can be accessed without having to turn on a PC, wait for it to load up, log on to Internet, access website and search for information. This has had a significant impact on my patient care.
OVID A-Z drug facts	Moderately	2	Couldn't find the drugs I was looking for as American Need local prescribing guide and BNF
	Marginally	1	
	Not at all	3	
OVID drug interactions	Marginally	1	American, it would be more beneficial to have the BNF
	Not at all	5	
OVID Lippincotts Nursing drug reference guide:	Marginally	1	Disease profile not in enough detail for clinicians
	Moderately	2	
	Not at all	3	
OVID Medweaver Diseases profile	Moderately	1	Results seemed reasonable but had to Hot sync with PC to get them—might as well have used Internet MEDLINE Felt had limited control of search results, which always hit about 900 with no clarity about how they are ranked. Limited ways of refining them
	Marginally	1	
	Not at all	4	
OVID MEDLINE	Marginally	3	In PDN role look for relevant articles that will have an impact on patient care and educate other nurses or give them material to assist their own current project/audit work. Need more nursing journals. Could not use search function only browse titles. Full text would be good—don't find TOCs helpful
	Not at all	3	
OVID Table of Contents	Moderately	2	Whittakers Anatomy: I used the anatomy to illustrate a couple of points when teaching colleagues and junior members of staff. If this were a little larger and of slightly higher resolution/quality it would be helpful for teaching patients. Too small and not useful. Too simple. Difficult to use zooming facility. Good for teaching students. Print too small BNF46: I used the BNF on a regular basis. Good but search engine poor—quicker at times to look up in book. Lacks Paediatric information. Useful. Much more difficult to search than the paper copy. Would like instant updates over the web. Good
	Marginally	2	
	Not at all	2	
Dr Companion™	Significantly	1	
	Moderately	5	
	Marginally	4	
	Not at all	1	

Table 5 Continued

Resource	Extent it assisted in patient care/clinical practice—no. of responses in each category	Comments
EMIS—PalmGP	Moderate 1	<p><i>Medical calculators</i>: Useful in critically ill patients medication. Useful, e.g. BMI calculations in maternal medicine clinic. Creatinine clearance calculation useful. Oxygen index good</p> <p><i>Chem Lab</i>: Three people used and found this useful. No neonatal reference ranges.</p> <p><i>Leicestershire Prescribing Guide</i>: Used and good. Difficult to read small fonts. Difficult to use because of indexing. Good</p> <p><i>DSMIV</i>: Not used by any of the participants</p> <p><i>EBM Guide</i>: Easy to read. Useful. Very useful. In practice didn't use it very much. Would like to print out the information but can't</p> <p><i>Emedicines compendium</i>: good but searching is poor. Very good for detailed enquiries that I would previously have had to refer to pharmacy, e.g. off-license use of drugs. Very useful. Easier to navigate than the BNF</p> <p><i>ICD 10</i>: Only used by Psychiatric SHO</p> <p><i>Drug Interactions (Swedish database)</i>: Not comprehensive enough—domperidone not listed. Good. Useful. Would feel happier using a UK database</p> <p><i>NICE Guidelines</i>: good, useful, helpful to have such easy access, very useful, good.</p> <p><i>OPCS-4</i>: Not used at all</p> <p><i>Oxford Handbooks</i>: Good but impossible to search. Easy to read and make notes. Useful. The most valuable resource and referred to on a daily basis. Really good to have these in psychiatry when faced with a purely medical situation. Very handy and useful for answering basic medicine questions. Useful. Difficult to access and read. Needs a better indexing system. Good as a general resource</p> <p>A GP is at their desk during consultation so doesn't need a PDA, however, it becomes very useful for visits. It gives you the patient's address, previous history, if admitting to hospital you have immediate access to a list of medication and previous medical history. Notes can be added in real time so nothing is forgotten</p>

take at least 1 h and also resulted in the OVID search function crashing, which meant participants had to browse the OVID resources by title. Table 6 summarizes some of the free-text comments received about technological issues.

During phase two, Dr Companion™ was stored on an SD card, which did not require a PC (except for re-charging) or Internet connection. There was no online registration required, no downloading from the web, and no need for the IT department.

Users just plugged in the card and the software ran immediately. This 'plug-in and go' method meant that initial acceptance and use of the software was high.

Discussion

During phase one, five participants were using their diary daily. During phase two, 10 participants were using their diary daily. With the British National

Table 6 Participants comments on technical issues

Have you encountered any problems?

Needed operating system on PC upgrading
 Had to swap PCs with a colleague to use a USB port
 It took 4 months before I was able to run properly with it.
 The instructions on the Palm were very poor. The online ones were of some help. Needed lots of help to get it working properly. Computer not compatible at first.
 Spent many hours at home trying to get it to work
 My knowledge and ability to download and grasp full capabilities has been slow
 It was not originally connecting with the PC software
 Could not access Clinical Evidence via Avantgo

Formulary (BNF) loaded on the Palms during phase two, four participants were referring to drug information daily and six participants weekly, compared with only two participants referring to the American drug databases on a daily basis and three participants on a weekly basis during phase one. The OVID American drug databases had a reported moderate-to-none impact on patient care.

Seven participants accessed Clinical Evidence either weekly or monthly during phase one and phase two. Its reported impact on patient care varied from significant to marginal. The addition of the National Institute for Clinical Excellence (NICE) guidelines during phase two increased the participants' use of guidelines in the clinical setting. Four participants were using the guidelines weekly and three participants were using the guidelines daily in phase two compared with only four participants using guidelines on a monthly or weekly basis in phase one.

During phase one, seven participants were accessing journals on a weekly or monthly basis, during phase two three participants were accessing journals on a daily or weekly basis. One comment pointed out that you still had to go to the journal website to read specifics.

Three clinical staff were accessing patient information on a daily basis in phase two compared with none in phase one. One participant was using the EMIS system PalmGP™ and two participants were using HandBase™ software to record details. The resource had a moderate effect on patient care and was used daily. See Table 4 for more usage information.

Conclusions

Revisiting the aims of the study—we conducted this study on the impact of hand-held computers on patient care to identify:

How often clinical staff accessed the resources on hand-held computers to inform their clinical decision making. All of the participants in both phases of this study used hand-helds in their clinical setting, but with varying frequency.

In phase two, respondents were more definite about the benefits of hand-held resources in answering specific patient queries immediately (11/12 who answered the question reported an immediate search as useful in phase two, compared with 4/9 in phase one).

In addition, 11/12 participants in phase two found the PDA useful in the previous 6 weeks to support their educational needs.

The key point in providing evidence at the point of care is the speed at which information can be delivered. Information needs to be available within seconds if it is to be incorporated into busy clinical rounds¹⁰ and this is reiterated in primary care where research has found that GPs will spend no longer than 2 min looking for answers to questions that arose in consultations.⁴

Which hand-held resources were most useful in the clinical setting. The best-suited resources for hand-helds were identified as British drug information, medical calculations, guideline information, and administrative tasks such as a diary reiterating previous findings.¹¹ In addition to these content resources, the use of patient information data from a patient information system, either created by the clinical staff (using HandBase™) or from a provider (EMIS) ensured that the PDA was used on a daily basis.

Barriers to using hand-held resources to support patient care. Although clinical staff were overwhelmingly positive about the benefits of hand-held computers for health care, they also experienced various problems and difficulties. It was acknowledged that experts in the field could identify and utilize resources to enable them to do virtually anything they wanted to on a PDA. However, most clinical

staff are not technical experts and they have time pressures that require them to be given the information sources and told how to use them. The conclusion of the set-up process was that the quicker and easier this process was the higher the acceptance and use of the resources.

Hand-held technology is emerging as an effective clinical tool to aid evidence-based practice and support the educational needs of clinical staff. Through the use of hand-held computers, it is now possible to search for information at the bedside, enabling information to be checked before decisions are taken with a resulting benefit to patient safety. The hand-held provides a critical mass of information that is relevant, quickly accessible and in a coherent format: delivering clinical information at the point of need.

Future developments

Hand-held software could work exceedingly well in the clinical setting to manage the local departmental administrative procedures such as on-call schedules, induction material, the dissemination of local practice guidelines and protocols, departmental handbooks, educational and clinical training material, recording clinical trial data and adverse events. The possibilities are endless but the key is to ensure the seamless integration of information resources and administrative tasks to transfer administrative time into direct patient care.

Note

Readers wishing to see the questionnaire may obtain a copy from the author.

Key Messages

Implications for Policy

- Further research is required to explore the educational potential of these tools.

Implications for Practice

- Hand-held technology is emerging as an effective clinical tool to aid evidence-based

practice and support the educational needs of clinical staff.

- Through the use of hand-held computers it is now possible to search for information at the bedside, enabling information to be checked before decisions are taken, with a resulting benefit to patient safety.
- The key to successful implementation is selecting the right technology and the right software.

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