Use of Personal Digital Assistants (PDAs) in Clinical Education/Practice

Literature Review Report
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Joint project between the Education Development Unit (EDU) and the Centre for Educational Technology (CET)

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INTRODUCTION

Background

The faculty of Health Sciences (HS) at the University of Cape Town embarked on the new curriculum in 2001. The new HS programme is structured into two phases: the mainly pre-clinical phase where the biopsychosocial is predominant with limited clinical practice learning (1st – 3rd year: Semester 1-5) and the clinical phase where clinical practice learning is predominant (4th – 7th year: Semester 6-9). The clinical phase comprises more of service learning than the pre-clinical phase with students spending most of their time in hospitals and clinics etc. During the clinical phase students spend much less time on the HS campus and therefore do not have frequent access to the HS labs, and do not have access to Internet-connected computer facilities at sites.

Thus, a joint project was mooted between the Education Development Unit (EDU) and the Centre for Educational Technology to explore ways in which Information and Communication Technologies (ICTs) can support the challenges of teaching and learning in the clinical phase of the MBChB programme.

The project had two inter-related phases. The first phase aimed at the gaining a general overview based on literature on ICT usage trends in medical practice and education. The second phase was to build on the findings of the first phase to undertake a detailed study. The general overview involved desk research of the medical field in relation to ICTs. The following databases were consulted for their relevance in the medical field: EBSCOHost (= a search engine for a number of databases; the following were selected: MEDLINE, Academic Search Premier, Health Source, ERIC, CINAHL, Pre-CINAHL, General Science Abstracts, MLA International Bibliography, MLA Directory of Periodicals, EJS E-Journals); Pubmed (accessed from the Health Sciences Library site: http://www.lib.uct.ac.za/medical); MD Consult; Science Direct;

Silverplatte; Sabinet; Ovid (accessed from the Health Sciences Library site); Biblioline (African Health Anthology); Thomson Gale; ISI Web of Knowledge; JSTOR; Swetswise; Wisconsin Medical Society journal (www.wisconsinmedicalsociety.org/health-news); and National Library of Medicine (USA) (www.nlm.nih.org/). The results of the first phase were that "there is overwhelming evidence in the literature that the most widely recognized potential of technology both in medical education and clinical practice is in mobile technology – PDAs and other handheld computers; PDAs are regarded to have gained the same importance in medical practice as the stethoscope". As a consequence of the finding we began to wonder about the following: how much of the reported PDA usage is happening in resource poor environments? And in what ways are these technologies (PDAs) being effectively used in the varying contexts? The second phase was dedicated to finding answers to these questions, and this report is an outcome thereof.

Structure of Report

Chapter one reports on the findings of literature reviewed from the periods 2000 to 2005 and covers the theme of Personal Digital Assistants (PDA) and their adoption in clinical practise and specifically, in clinical education. Chapter two establishes the trends for the popular use of the PDA devices by considering the motivation of use, as well as the context of use. This chapter also considers experiences reported by clinicians. It then envisages projected future usage of the PDA by exploring alternatives. Chapter three explores PDA possible alternatives by contextualising its use in developing countries.

CHAPTER ONE

Introduction

By early 1997, many medical students' laboratory coat pockets were bulging with quick-reference books, index cards, and mini-medical libraries to help them survive the days and nights on the wards. Many of these bulky references were quickly replaced with the advent of the first Palm pilot (a mobile pocket PC). The first Palms were equipped with single megabyte RAM which filled up quickly.

The following is a summary of Dr. Willyard's experience of using a PDA in medical practice and his account constitutes the first corner stone for the theme of this report.

> "*During my residency in family medicine, I eventually reached the point where I carried nothing but my Palm handheld (by then a TRG Pro with 8 MB of RAM and a 32 MB CF card), a stethoscope, and a small stack of index cards for tracking hospital patients. My lab coat was ten pounds lighter, and information was now literally at my fingertips! With the help of some inexpensive tools, I learned to create Palm-readable documents and files out of practically anything. Using NS BASIC, I put my amateur programming skills to*

aim of this study was to trace the adoption of the use PDAs in clinical practice and education with particular focus on developing countries.

This chapter reviews literature on PDA use in the medical profession between the years 2000 to date. The theme is on PDA use in clinical practise. It should be noted that much of the contribution of the extensive use of PDA use, particularly for clinical, use has come from medical literature and thus it may be observed that a lot of medical terminology is used.

PDA adoption in Clinical Practise

It has been noted that at the onset of the year 2000, clinicians were actively engaging in the use of the PDA. According to Lapinsky et al (2001) who exemplified the role of technology and the PDA particularly in the healthcare industry, most were in agreement that the PDA showed potential for improving health care. One of the reasons for the early acceptance of gadgets was that there were seen as essential tools for managing patient data. At the time, however, Lapinsky et al (2001) noted that PDAs were equipped with the more rudimentary functions of software, medical reference information, schedules and contact numbers. In other words they served the rudimentary roles of simplifying administrative functions.

Before looking at the reason why many clinicians were initially captivated by the gadget, it would be important at this stage to understand the gadget in a bit more detail.

The Personal Digital Assistant (PDA)

Diagram 1

palmOne Tungsten T5

The Personal Digital Assistannt (PDA) has at times been referred to as the "Palm" or the "Palm Pilot" after an early PDA created by Palm, Inc. It is a convenient pocket size mobile device which has been designed to be carried around, at all times. (*See Diagram 1*)

According to Baumgart (2005), most PDAs run on either Palm OS (PalmSource Inc, Sunnyvale, CA, USA) or Microsoft Windows (Microsoft Corp, Redmond, WA, USA). PDAs running on Microsoft operating systems are usually referred to as '*Pocket PCs'*. The PDAs usually may be customized. by installing third-party software applications.

Currently, many Palm OS or Pocket PCs have a Java runtime that allows the use of platform-independent, Java-based applications. Although Baumgart (2005), suggest that there are other platforms and technologies that can be used for purposes of this report, many of these technologies will not be considered in detail since they do not play any direct or major role in the health care market. These platforms and technologies include the *Newton* (Apple Computer, Cupertino, CA, USA), the *Psion* (Psion Teklogix, Mississauga, ON, Canada), BeOS (PalmSource Inc), Symbian OS (Symbian, London, UK), and the Blackberry (Research in Motion, Waterloo, ON, Canada).

Attributes of the PDA

A functionality attribute of the PDA, according to Baumgart (2005), has been the shirt-pocket-sized devices equipped with a touch-sensitive screen, dedicated input area or keyboard and customisable application buttons. Technological advancements have also necessitated the PDA to be equipped with a multi-way (button or mini joystick) navigator to browse information on the screen.

Many PDAs have designs that closely resemble the ordinary desktop PC and this has its own advantages. It is very common to have variants of popular Windows-based programs existing in PDA format. For example, Microsoft Word and Excel. These applications do exist specifically for the PDA format and allow for easier migration of documents from the desktop PC to the PDA and vice versa. In addition, many PDAs are now equipped with an expansion slot for memory cards or accessories, a built-in camera, headphone jacks, speaker, microphone, ports for infrared, Bluetooth, Wireless Fidelity (Wi-Fi), and built-in global positioning system (GPS) receivers (Baumgart, 2005). The PDAs are also generally equipped with a comprehensive suite of personal information management software. For the Medical profession, the software is varied and ranges from prescription-specific software e.g. *ePhysician*, *iScribe* and *PatientKeeper* which provide detailed information about drugs and their side effects (Neto 2005).

Other most widely used software resources for medical applications are drug database e.g. *ePocrates*; medical text books eg. *POEMs and Skyscape;* and the medical calculator variety e.g. *MedCalc* and *MedMath* (Neto 2005). The PDAs are equipped with the option to integrate with common brands of software, note-taking applications, and contact databases (Baumgart, 2005). PDAs are also able to connect to desktop computers and wireless local area networks (W-LAN) using infrared, Bluetooth or Wi-Fi communication technology (Neto 2005).

"The most commonly cited complaint is that the PocketPC machines require too many steps to accomplish even simple tasks…this means PocketPC machines are too slow at getting the work done" (report by the University of Rochester Medical Centre, 2004) The most important point noted in this report is that "Pocket PC machines have limited software availability when compared to PalmOS-based PDAs. Microsoft states they are working to correct PocketPC shortcomings so PocketPC may still remain a contender" (*ibid,* 2004).

Attributes of the Medical based PDAs

The University of Rochester's Report (2004) contends that there are many other uses of the PDA by the medical profession. The following is a summary of built-in functionalities of the advanced PDAs in the market specifically meant for the medical profession.

The built-in functionality features include; the built-in address book program which consist of resident, fellow, faculty, and staff phone and pager numbers; Date Book / Calendar program which gives reminders of important dates/meeting with an alarm sound.

Other programs include the built-in expense program which keeps track of various expenses; the built-in email program which allows one to read and write email from the PDA; the built-in memo pad program which allows for the quick writing of memos; built-in medical oriented calculators with many tools such as FEN, reticulocyte index, BMI, corrected Ca++, etc. MedCalc, MedMath; the built-in medical rules database which maintains a list of diagnoses and provides guidelines for reaching the correct diagnosis; the built-in pharmaceutical databases like ePocrates (the original drug guide for the PalmOS); the built-in Pregnancy Wheel like PregCalcPro which shows how many weeks gestation, etc; built-in patient tracking software e.g. PatientKeeper ; the built-in Growth Curve program e.g. STATGrowthCharts the built in billing program e.g. STATcoder the built-in web browser programs like AvantGo ; and finally built-in Database Programs like HanDbase

Pendragon's Forms . The latter allows the creation of in-house customized databases as well as sharing of other databases.

Customised PDAs for medical use could be much more popular if they were equipped with **pediatric applications** and **reference software** including “all applications that contain information for use at point-of-care such as

Studies have revealed that the clinical environment is changing as advances in the PDA and its use grow. . Knowledge was also growing and so did the complexity of the clinical work environment. There is increased responsibility bestowed on clinicians who operate in the growing complex environment.

The recognition and acceptance of the PDA is, therefore, driven by the complexity of information and also the nature of the clinicians' environment which is seen as complex and dynamic. As an illustration to this point, the clinician looks after emergency admission, carries out several patient clinics, sees patients in the ward, performs specialists' procedures and interacts with many other specialists in the care of patients". In this sense the clinician may be perceived as nomadic in their work environment never being stationed in one place (Turner et al 2005).

Dawson and Fisher (2004) give credence to the 'nomadic' attributes of the clinicians operating in this sort of environment. By this reference, they considered the immense time the clinician spends moving around with little opportunity to interact with a desktop PC. This latter aspect is seen to have provided the ideal opportunity for more specialised use of the PDA as documented in the many studies which will be discussed later on this report.

Revolutionising Health Care

The integration of mobile technologies like Personal Digital Assistant (PDA) into medicine and was meant to revolutionise healthcare. According to Lapinsky et al (2001) the previous computerised systems that comprised hardware and software for maintaining patient records required a major commitment by institutions for training and support. The PDA was perceived then not as a tool to replace the systems but as a complementary to the day-to-day operations. Lapinsky et al (2001) noted a gap that could be filled by the more practical adoption of PDA in clinical heath care. They observed that even though institutions still retained advanced computerised systems, "the

bedside clinician still relied on written notes for patient management and billing and referred to pocket textbooks or printed management algorithms".

The PDA proved to be an essential tool in bridging this gap by combining the benefits of electronic patient records and paper charts. Following this observation, the medical field saw a proliferation of clinicians authoring various articles describing PDA use in many medical situations. The year 2002 began with more use of hand held devices in many situations like laboratory and x-ray report tracking for inpatients (Criswell and Parchman 2002), support systems for preference-based care planning (Ruland 2002), using it as drug reference guides like ePocrates (Rosthchild et al 2002).

Rothschild et al (2002) postulated the idea that physicians would rapidly accept technology that they perceive would improve the quality or efficiency of their practice. They saw the primary driver for the early acceptance as resulting from the continuous challenges created by the increasing information demands required to safely prescribe, and monitor both health care and medication. Not long afterwards the acceptance of the Personal Digital Assistant (PDA) as mobile device best suited for the navigation process soon gained recognition particularly within the medical fraternity (Ruland, 2002).

The year 2003 began with the renewed interest in the PDA use, not just from the practical clinician perspective but also from the educationist perspective.. Brown (2003) steered thinking towards the educational direction. Much of his work (2003) dwelt on the software angle of the PDA. The work premised on identifying the applications within the PDA technologies that could contribute to the optimising of teaching and learning in new environments, and focused on the ability for the educationists to design and develop didactical sound m-learning opportunities that could enhance learning.

By end of 2003 several studies showed an increased popularity of the PDA particularly by family physicians. Studies by Fischer et al (2003) shows that in a survey sent to the program directors of all American Academy of Family

Physicians and the American College of Osteopathic Family residency programs two-thirds of those who responded were using the handheld devices in their residency programs.

Luchini (2003) also supports much of Browns (2003) work and took the idea of the PDAs use in supporting learning slightly further. He suggested its ability to support learners in creating concept maps (a type of visual outline) to enhance learning activities and saw gaps in classroom learning where the use of PDAs could support traditional learning methods like brainstorming, writing, and peer editing.

While Brown (2003) had laid the foundation, Luchini's (2003) work focuses on specialist software called 'scaffolds' used to augment new knowledge in the learning process. Much of what this work entails will be covered in the next section which deals with the use of PDA in learning.

Other more advanced uses of the PDA were noted by clinicians.. Kneebone et al (2003) wrote on the PDA use in scenario-based formative assessments aimed at developing clinical procedure skills. Torre and Write (2003) wrote on the use of PDAs to track patient encounters and procedures during medical school rotations and residency training. Engum (2003) wrote on the use of PDAs to allow for easy transfer and tabulation of database information by electronic email. Martinez and Alemañy (2004) further documented the usefulness of the PDA in enhancing a pediatric practice by providing "an effective means of storing, retrieving, analyzing, and sharing large volumes of information pertinent to patient care". They agreed that the utility software helped "reduce medication error rates by comparing contraindications of medications prescribed".

The most recent studies agree on the specialised uses of the PDA which range from students recording clinical experiences during clerkship rotations (Hartfeild and Bangert 2005) to content management e.g. for research in radiology (Nakata et al 2005).

Institutional and Commercial Support for PDA Medical Use

In 2005 the health care industry started showing signs of drastic change Baumgart (2005) observed interesting development taking place and noted the overzealous manner in which documentation was done. There was also overzealousness in the coding and billing requirements for managed care. Theother change taking place was the “constantly overworked health-care professionals causing an increasing number of treatment and management errors, because the time available to spend with patients was sadly diminishing” (Baumgart 2005).

This disturbing trend caused the physicians, medical students, and other health-care professionals to review the changing work place and particularly the ever-increasing amount of changing information about their patients. New methods were devised which could support these complexities in a positive way. The PDA became a tool of choice to specifically aid the collection of information about patients (sometimes several times a day) and correlate the data with the most recent diagnostic and therapeutic recommendations and management options to make sound decisions (Baumgart 2005).

Neto (2005) demonstrated successfully that PDAs could help practitioners reduce medical errors from the diagnosis stage through to prescribing treatment. The idea of reducing medical error using PDA is also supported by Martinez and Alemañy (2004). Neto (2005) agreed that medical PDA software could be used “to provide full descriptions of signs and symptoms and would be capable of predicting the likelihood of a person developing an illness”.

Commercialising the Process

The support clinicians needed to address complexities of information came from a variety of sources, mostly from medical organisations and vendors. The support for PDA medical use was more focused on provision of

specialised medical software and resources. Soon there were proliferations of organisations many of which were simply commercial vendors hoping to cash in on these new opportunities. These vendors have been offering many varieties of medical PDA solutions for house staff and medical students. Online sites such as www.studentdoc.com, www.med**pda**.net, www.**medical**softwarefor**pda**s.com soon become popular. Many other online sites were developed to support the medical use of the PDA.

Commercial vendors also started selling a variety of medical software, many of which are Java MIDP based. For instance products from DataViz (www.dataviz.com) include powerOne Medical Calculator, and the Pocket Medical Encyclopedia. The products from PDAMediSoft (www.pdamedisoft.com) include Blood Pressure Journal 2.0, and Pandemic Flu Survival Guide Pocket PC Edition 2.0.

The table below (**Table a**) illustrates the many resources available where clinicians and students can download drug reference guides and other specialist software. For a more comprehensive list refer to Appendix 1: List of Online resources for medical PDA use.

Table a

American College of Physicians	http://www.acponline.org/pda
British Medical Journal (*BMJ*) PDA webpages	http://bmj.bmjjournals.com/cgi/content/full/324/7334/DC2
Ectopic Brain	http://pbrain.hypermart.net/medapps.html
Medical Piloteer Webring	http://w.webring.com/hub?ring=medpilot
Mobile Medica	http://www.apprisor.com

Use of PDA in Clinical Education

Various authors have suggested ways in which students can take advantage of hand held devices to support learning while mobile. The advantages include enhancing interaction with classmates as they simulate phenomena (Luchini 2003), providing students with immediate and cumulative feedback of performance (Kneebone et al 2003), tracking patient encounters and procedures done during medical school rotation (Torre and Wright 2003) and monitoring students' experiences of cardiac auscultation which needless to say is an important skill to master for medical students (Torre et al 2005).

Lack of Mechanisms to Monitor Trainee Progress

It may be difficult to assess trainee needs before clinical experience, contrasted with experiences during actual clinical work. This is because in many ways the changes, particularly technological changes, seem to influence how clinical work is carried out before the same experience can be shared in a classroom platform.

Baumgart's (2005) highlights the concern that "no simple and reliable mechanisms currently exist for directors of junior doctor programmes to assess how well their trainees are being exposed to teaching in their specialties and what curriculum weaknesses need to be addressed".

Documentation

With regard to the themes of drug reference and treatment safety, patient scheduling, tracking, charting and coding and particularly when looked at from a perspective of those in clerkship, Baumgart (2005) has suggested that the PDA use could reduce discrepancies in progress note documentation.

Progress note documentation, and documentation in general, is taken seriously particularly since “training programme accreditation authorities and medical specialty boards demand an ever-increasing documentation of patient exposure and procedural performance, to maintain and improve training standards” (Baumgart 2005) .

Gaps in Learning Experiences

The PDA has been found to be a practical and feasible way to identify gaps in students’ education and experiences so that action can be taken. It has been pointed out earlier that handheld computers can be used to support learners in creating concept maps (Luchini 2003). Students can successfully complete learning activities using hand held tools, and that specialised supports known as “*scaffolds*” can be used to help students create better concept maps (Luchini 2003). This process has put the student at the centre of the learning process. The foundation for this particular line of thinking stems from *situated learning theory* which emphasises the learner/student as centric to the learning process.

A student can use a range of resources on hand as and when needed. These resources create a number of different learning pathways and possibilities. The emphasis here is the social nature of cognition and the importance of

authentic situations and activities as ways of embedded learning (Ward et al 2001).

Arguments have been laid forth which give credence to the idea that hand held devices can be tailored into the learning process by providing '*scaffold*' teaching and support that respond to the learners' immediate needs (Luchini 2003). Context learner centred tools use a variety of scaffolding techniques which allow the students to engage in unfamiliar work that would otherwise be too difficult or too complex for them to complete without the scaffold.

To better understand the value scaffolds techniques can give, Luchini (2003) argues that the single environment may provide the learners resources needed to mindfully engage in learning activities. This is best illustrated with the concept of Personal Knowledge Management (PKM). According to Clement and Pollara (2005) PKM put the learner as centric to the learning process quit similar to the scaffold technique. The emphasis in the PKM approach is on personal inquiry- "*an individual's quest to find connects, learn and explore*".

It has been acknowledged early in this paper that the medical practitioners have to wade through an immense and complex information space. PKM tools may be created to scaffold the whole process of knowledge acquisition in the complex medical environment and help them evaluate what they know in a given situation then seek ways to fill in the knowledge gaps, which is critical to the learning process. The PKM tools for instance have specialised software embedded in a PDA device which may function by modifying and improving the learner's conceptual model of a subject or path of inquiry that includes graphical, multimedia modelling capabilities (Clement and Pollara 2005). The PDA may have embedded extraction tools which are easy to use and flexible enough to let users build their own intuitive models that they would find personally useful.

CHAPTER TWO

Introduction

The preceding chapter highlighted advances in clinical use of mobile technology in particular the PDA, and how it has been infused into the medical profession. Chapter two explains the reasons the PDA has been popular and explores possible reasons for such popularity especially by considering the context of use, and the devices used. This chapter considers the PDA from a user's perspective, in more detail. This chapter explores literature that gives personal accounts from members of the medical profession themselves about their experiences in using the PDA. Lastly, this

The possible reasons for these sentiments could be best explained by the activities that encompass a clinician's work and how they go along doing it. Many studies (e.g. Lapinsky et al 2001; Dawson and Fisher 2004) on clinicians who have used the PDA at regular basis, the primary motivation for use of the PDA has been the size. Lapinski et al (2001) stressed the importance of versatility and the idea that the PDA would contribute to overall cost savings in the long run.

A clinician's work would be guided by systems that provide decision support, reference, and information retrieval. The easier these systems are to handle the better it is for the clinician. Baumgart (2005) has suggested that the PDA, because of its size and innate complexities, can basically achieve such capability much more efficiently than other systems. He gives an illustration of how the quality of care can be improved, for instance with the implementation of CDSS evidence-based medicine (EBM) or other critically appraised publications with alerting systems in hand-held computers (PDAs).

Baumgart (2005) has also demonstrated in his work on PDA-based outcome research and how this has been used to improve quality of care. The general idea held is that "the quality assessment and outcomes research in large medical associations require the acquisition, analysis of, and response to point-of-care data which could be easily simplified and accelerated by PDA use".

Other motivations for use of PDA have been the screen display of information. According to Turner et al (2005), clinicians have been attracted with the presentation of information in a clear, meaningful and accessible ways on a small screen. They also attribute the enthusiasm shown by users from the moment the PDA is introduced to the work place as stemming from the fact that "information is presented in a meaningful and accessible way".

Functionality, an important PDA attribute, has also been pointed out by Fischer et al (2003) who has noted that various clinicians favour PDA with larger memory requirements particularly if the larger memory capacity is

meant to replace clinical references. Fischer et al (2003) also stresses the importance of wireless capability and the ability for the device to integrate with other hospital systems. Other functional requirements which are accounted for by Fischer et al (2003) include memory size which is bound to increase usage. Audio recording, built-in cameras, map functionality and the more recent cell phone functionality have proved very popular with clinicians.

Closely related to functionality are the Non-Functional Requirements (NFRs) which serve as magnets to popular use. These are more pronounced since they influence usability. They include battery life and data entry methods. Dawson and Fischer (2004) have argued that NFRs should provide a way of describing the context in which the devices are used.

Synchronisation of data on the PDA with that of the home or work PC has generated deep interest and has made the PDA a versatile candidate to provide health care to remote areas (Katz 2005). This attribute coupled with the idea that the PDA can be customised for personal use strengthens its popularity for clinical use. Synchronisation has been perceived as a way of effectively utilising the PDA and Turner et al (2005) has stressed the need for clinicians and students to learn much about the feature. As an illustration Cimino and Bakken (2005) have acknowledged that the synchronisation mode has been beneficial to educators who have exploited this feature to monitor clinical experiences of trainees, since it allows for updates in a two-way-communication between the PDA and external resources.

Context Use of the PDA

PDAs have increasingly being used by physicians for a variety of functions, such as scheduling, accessing drug reference information, patient data storage and billing (Lapinsky et al (2001). In one study for instance, where serious medication errors in inpatients were assessed, dissemination of drug knowledge was the leading category of system failures underlying the errors. (Rothschild et al 2002).

Dawson and Fisher (2004) have shown in their studies that the PDA has a positive impact on error reduction, particularly when the underlying system failures mentioned above are considered. They have argued that the issue of data entry and the impact it has on data integrity is crucial. They point out that using the PDA as a data entry tool at point-of-care is a step in the right direction.

Literature has also pointed out that the possibility of taking a PDA into a health care setting where clinicians in clerkship and those in practise can use it to access real time information at *point-of-care* can provide the clinicians with access to knowledge at its critical point (Fischer et al 2003; Van DenKerkhof 2003; Drury 2005).

Criswell and Parchman (2002) have observed the use of PDA particularly in family practice residency programs in the United States where a wide range of uses have been documented. These include medication reference tools, electronic textbooks, and clinical computational programs to track activities that were previously associated with desktop database applications.

Fischer et al (2003) has pointed to other uses of PDA in medical practise to include, electronic pharmacopoeias, patient tracking, medical education, research, business management, e-prescribing, and patient confidentiality.

Ruland (2002) gives a unique perspective to the use of PDAs as useful tools for shared decision making and the incorporation of patients' preferences into health care decision making process. He sees the PDA as an enabler for clinicians to elicit and integrate patients' preferences into patient care. He calls them "*decision aids*," and proceeds to give cumulative evidence that supports their effectiveness. In support of Lapinsky et al (2001), Van DenKerkhof (2003) points to the use of PDAs as providing "a unique opportunity for health care professionals to access real-time or near real-time patient information and evidence-based resources at the point-of-care"

Generally, PDA medical application may be grouped into the following categories; decision making tools; tools for administrative support; and tools to facilitate learning and research.

PDAs as a decision making tool

Clinical recommendations are crafted on the basis of the best available evidence and published recommendation to help in the decision making process (Merrell et al 2004). The decision support process will usually rely on vast databases. Software may provide a full description of signs and symptoms and assist in predicting the likelihood of a person developing an illness (Neto 2005). PDAs can help practitioners' reduce medical errors from the diagnosis stage through to treatment.

Ruland (2002) has argued that "*Decision aids*", that is the Decision Support Software (DSS) embedded in PDAs, create more active and satisfying participation in decision making. He argues that, on average, better scores were reported on general health perceptions and improved clinicians' knowledge, which also contributed to reduced decisional conflicts.

PDAs as Administration tools

De Groote (2004) points to the use of PDAs as 'rudimentary,' with many health professionals using their PDAs primarily as organisers, address books and date books. Bakken et al (2004) concurs that the PDA has been useful in documenting clinical encounters and to retrieve patient safety-related information at the point-of-care by students. They consider the tool a driver to "enhancing informatics competencies of students and faculty". This observation was also noted by Kneebone et al (2003) who believed that a lot more benefits could be derived from its use, ranging from "streamlining the process of data collection, entry and retrieval, thereby reducing data loss and providing learners with immediate and cumulative feedback on their performance".

PDA as Educational and research tools

Cimino and Bakken (2005) have classified the various support functions of the PDA on the basis of modes of operations; namely stand alone mode, synchronised mode and wireless mode. In stand alone mode, software is loaded onto the PDA and users access information at will. In the mode, studies have shown that the PDA can replace the reference books. In synchronised mode, information and requests for additional information can be exchanged between the PDA and a database using wire or infrared. Synchronisation allows for updating the device, and this mode has been exploited by educators to monitor clinical experiences of trainees (Cimino and Bakken 2005).

In wireless mode, the PDA maintains a continuous connection using Wireless Fidelity (Wi-Fi) standards and allows internet connectivity. This mode simplifies co-ordination with external information resources. As an illustration the wireless mode has been used successfully in tele-medicine in remote regions of Eastern Africa, Kenya, where there was no power or phone connections.In this context, the wireless PDA mode was used by students to evaluate patients in 4 villages. Students used software for decision support and this resulted in very few tele-medicine consults being made. In the event that tele-medicine consultations were made, clinical data from the PDAs was loaded via wireless connection to the consulting physicians located in New York. The PDA was found most useful in keeping data records. The decision support system on a wireless PDA allowed the project to cost only $0.28 per patient per visit, with nearly 500 patients daily, on peak days (Merrell et al 2004). There was significant cost savings in this project.

The Tele-mentoring Approach

Baumgart (2005) has attested to the PDA device for the successful use of tele-mentoring junior doctors by their senior compatriots, thus, helping reduce discrepancies in progress note documentation of patient records.

The tele-metoring approach has helped reduce the time taken by students to complete lengthy assessments typical with the medical profession, therefore, allowing for a timely feedback and balanced learning. The electronic records and procedure logs are easily accessible to students on their PDAs and these can be synchronised with the mentor's systems. According to Baumgart (2005) this interesting approach will generally allow for identification of gaps in basic clinical skills and this provides an easy mutual feedback between the students and the mentor during the clinical clerkship.

Other noted benefits of the tele-mentoring approach have involved improving the computer literacy levels of the students coupled with increased history-taking skills (Baumgart 2005).

Practical Use and Experiences

Speedie et al (2001), has documented experiences of students using PDAs. A common finding was that the embedded software in the PDA "was useful, and that there has been a significant improvement in the number of patient encounters reported".

Experiences in teaching with PDAs have also been documented by Speedie et al (2001) who notes that the evaluations of teaching have been systematized. From an instructor's perspective feedbacks were "received more frequently and regularly"

Envisaging Future Use: Looking at Alternatives

Librarian involvement in PDA Training

The general trend in many medical schools is that the schools require matriculating

medical schools expect their students to use electronic media to access library information and other electronic resources (Merrell et al 2004). As explained in the earlier chapter, the media of choice in the medical professional, for the mobile practitioner, has been the PDA. Chapter one has also highlighted that many resources available in PDA format, may be obtained directly from the web or from many medical library resources.

The concern for the medical schools centres on the best ways to utilise the resources available within the schools. De Groote (2004) has focused on how the university can best utilise its resources in ensuring the students are up-to-scratch with the latest technological developments and specifically with the use of technology (computers and related technologies). They have concluded that the library would best be positioned to address this need.

De Groote (2004) observed that some of the resources currently available for use on PDAs have traditionally been provided by the library. These resources include the Harrison's Principles of Internal Medicine, the 5 Minute Clinical Consult, and the Physicians' Desk Reference. He sees the importance of understanding how to use these resources while addressing the skills gap that lies between proper training and support.

One solution offered by De Groote (2004) is for medical schools to determine the various PDA training needs of the different health sciences students, faculty, and professionals providing them with focused instruction, that meet the wide range of needs.

Libraries and Capacity

Librarians have begun to write about why it is imperative that libraries provide PDA services and training (De Groote (2004). They have argued that “training and information needs related to PDAs vary among colleges and status, that is, academic faculty, clinical faculty, resident etc”. They see themselves as

having the ability to “break the barriers that exist between them and the various colleges to promote the abilities and resources of the library”. De Groote (2004) agrees that “librarians need to take a more proactive approach for faculty and residents, which goes beyond offering workshops in the library”.

He further suggests that librarians should “negotiate time at faculty departmental meetings or medical resident journal clubs to highlight PDA software available through the library.” He concludes that librarians “should: provide consistent and knowledgeable PDA support; develop uniform competency across the various colleges by offering training sessions; develop more structured program to foster PDA use and expertise by the librarians; and lastly, to develop a formal liaison program, where each information services librarian provides outreach services specific to a college”.

CHAPTER THREE

PDA Use: The Developing Country's Context

The use of PDA may be beneficial to both clinicians at clerkship and those in practise in developing countries. However, before its use in clinical practise can be considered in detail, it may be worth mentioning that in 2004, the Commission for Africa commissioned a report on data collection capabilities in Africa - data quality and its use. The results have were analysed and issued by the Poverty Analysis and Monitoring Team Report (2004). The report recognised that currently the "advances in technology are continuously providing new possibilities for presenting and analysing data, increasing its value." The report points out that the Commission for Africa need to re-focus its energy on specifically promoting "new and innovative uses which have so far been relatively unexploited" It follows to describe ways in which this could be done. The report considers;

> "Making use of new analytical methods and technologies to improve the use of data in policy making – PSIA, poverty mapping, service accessibility mapping, DevInfo
>
> Taking full advantage of the existence of robust, regular information on the country to attract external investment"

The report stresses new "forms of information technology that can be combined and used in innovative ways to support many purposes". It mentions the example in Senegal where pastoralists have been using mobile phones and Global Positioning Systems to exchange information (The Poverty Analysis and Monitoring Team Report 2004).

Policy

The problem seen in many sub-Saharan countries is that the quality of data systems, particularly national data systems is dismal. Accordingly the

Poverty Analysis and Monitoring Team observes that "numerous governments and organisations have made commitments and put forward recommendations to address this need, both at national and international level, but many are yet to be implemented." Their report proposes that the Commission for Africa be the ideal organ to spearhead this commitment. The team envisages the commission creating a supporting IT infrastructure through developing "an enabling regulatory framework for software and telecommunications use".

The team report envisages a cost of up to $1 million for creating an enabling telecommunications framework, through specialised consultancies that would help in re-drafting legislation and a further $ 6 billion for the cost of doubling the number of computers currently used in Sub-Saharan Africa, as well as internet access points, mobile telephones and PDAs.

At this stage it would therefore be important to understand the enormity of the scale of resources required, particularly since the effective and efficient use of the PDA use in this region would require the above infrastructures to be in place. At micro level the current operative use of the PDA would operate outside of a national or regional infrastructure and this evidently translates to problems associated with e fw[t)4.8(c7.6(si5.3(l)64(ed)n7.6(o)29(o)4.3(l))7.6(s.0.8(8.3

*achieving this goal. Against this backdrop, the Uganda Health Information Network (UHIN), was set up aimed at expanding the current health information system in Uganda and providing nationwide access to health and medical information. As part of this programme handheld computers will be available to health professionals connected via the existing GSM cellular telephone network. The basic handheld will have local reference material and one international medical textbook pre-loaded. It will also have a program that will enable the units to be used for data collection" (*Poverty Analysis and Monitoring Team Report 2004).

The report concludes that favourable conditions are in place for cell phones and even PDAs to be viable tools that can battle against the digital divide but warns that there is much to learn about the use of this particular technology.

Africa and Penetration of Technology

The report cites Uganda as an example where practicing physicians, affiliated with Makerere University Faculty of Medicine, were given handheld units containing basic reference materials. Issues considered included functionality, efficient use and content, in respect to serving practical needs.

The report also cites a Ghana project where a pilot program yielded compelling evidence of the value of handheld computers for data collection and reporting. It illustrates the use of Ghanaian Red Cross volunteers (thirty volunteers), to conduct surveys on outreach efforts for a measles vaccination campaign, where data from over 2,400 surveys was assessed.

The report also mentions the Kenya project which demonstrated the value of using handheld computers for information dissemination. It this project, sixth-year medical students at Moi University received handhelds loaded with customized packages of content including:

- Country-specific malaria, tuberculosis, and HIV/AIDS treatment guidelines from the national Ministry of Health and/or the World Health Organization (WHO)
- WHO Essential Drug list
- Country-specific essential drug lists
- Medical references and textbooks
- Medical calculators (Poverty Analysis and Monitoring Team Report 2004)

Health Organisations

Satellife, a company based in Watertown, MA USA, is a health information organization which has detailed its experiences of PDA use in African and Asian countries. The organization has been working to improve the health conditions of the world's poor by using information and communications technologies (ICT) to carry the message of health and give voice to those working in challenging and resource-poor settings (Satellife Report 2005).

According to Satellife report the organisation has worked with the ACQUIRE (Access, Quality and Use in Reproductive Health) Project to introduce the use of handheld computers in its Bangladesh Country Office (BCO). ACQUIRE is a global, five-year USAID-funded project led by EngenderHealth, an international NGO that works with governments and agencies to make reproductive health services safe and accessible for women and men in forty countries.

In the ACQUIRE project, the information held about the training of healthcare providers, including information about the facilities, infrastructure, logistics,

and infection prevention, needed to be revised for the handheld format. At the end the project it was reported that the PDA "improved the quality of the data collected and reduced the time it takes to process the data" (Satellife Report 2005).

High-Tech Concept in a Low-Tech Environment

Some projects in developing countries have demonstrated viability and the possibility of incorporating digital networking of geographically dispersed handheld computers via the local GSM cellular telephone network. The Uganda Health Information Network (UHIN) in joint effort with the Uganda Chartered HealthNet (UCH), Makerere University Faculty of Medicine, SATELLIFE and Connectivity Africa, have developed the infrastructure that supports two-way transmission of information and data

The infrastructure consists of PDA end users connecting to the caching device using the infrared beam of their handheld units. The caching devices in turn communicate with a central server via the GSM cellular network. Data collected in the field on a handheld computer can be uploaded to the caching device via infrared beam, stored on the cache until a regularly scheduled off-peak call is initiated. After initiation, data is transmitted to the central server via the cellular network.

The Satellife report (2005) noted that "the network delivered a 24 per cent savings per unit of spending over the traditional manual data collection and transmission approaches".

Summary of Finding; PDA Use

The Satellife report (2005) is summarised as follows:

Project Name	Institution	Objectives	What's been done	What's being used	Lessons learnt
Uganda Health Information Network (Mbale District Health Services) **Uganda**	SATELLIFE	lay the foundation for meeting rural health care demand by constantly building the capacity of local institutions and local people to manage their own healthcare systems proactively build institutions and infrastructure which foster the free exchange of ideas and information among the worldwide community of healthcare providers	make diagnosis that might otherwise have missed by consulting the reference material on a handheld; design and develop indigenous technology educate and employ own healthcare providers Carry out own academic and medical research to develop content	medical textbooks, references, and newsletters drug databases national and international essential drug lists national and international disease treatment guidelines medical calculators diagnostic tools	The fundamental lesson is that people who have never used an electronic device can easily and proficiently learn to use a handheld computer in a short period of time and can employ it

Project Name	Institution	Objectives	What's been done	What's being used	Lessons learnt
			relevant to indigenous communities.	continuing provider development (CPD) and continuing medical education (CME) materials training materials local, national, and international news	
ACQUIRE (Access, Quality and Use in Reproductive Health) Project	SATELLIFE, USAID and Engender-Health	Ease documentation and checklist of doctors and the local Government of Bangladesh to conduct routine visits with health supervisors.	Re-designed content for electronic format, and then installed the revised and reformatted versions on PDAs	training materials	Recognition of the human organizational side and just technology.

Project Name	Institution	Objectives	What's been done	What's being used	Lessons learnt
Bangladesh					
The Uganda Health Information Network (UHIN) **Uganda**	Makerere University Faculty of Medicine Government of Uganda	Increase the ability to collect and analyze data accurately	Expanding the current health information system in Uganda and providing nationwide access to health and medical information.	medical textbooks, references, and newsletters drug databases national and international essential drug lists	conditions are rife for cell phones and even PDAs to be viable tools that can battle against the digital divide.
Moi University **Kenya**	Moi University	Increase the ability to collect and analyze data accurately	sixth-year medical students at Moi University received handhelds loaded with customized packages of content	medical textbooks, references, and newsletters drug databases national and international essential drug lists	Efficient use and content in respect to serving practical needs.

Project Name	Institution	Objectives	What's been done	What's being used	Lessons learnt
The UHIN Project	1) SATELLIFE 2) Uganda Chartered HealthNet (UCH) 3) Makerere University Faculty of Medicine and 4)Connectivity Africa3 of the International Development Research Center (IDRC) of Canada	Demonstrate viability of incorporating digital networking of geographically dispersed handheld computers via the local GSM cellular telephone network	the network was used for both information dissemination and data collection;	training materials PDAs andGPS units	Cost savings per unit of spending compared with he traditional manual data collection and transmission approaches,

In developing countries, the approach to patient-held records while not being a new concept is at its rudimentary paper based stages. However, Drury (2005) has pointed out that the adoption of PDAs or mobile phone hybrids is likely to change this assessment.

It may also be noted that in developing countries, students tend to be prepared using the older traditional methods where the curriculum is marked by fact retention and clinical training. Collaborative learning also becomes a focal point to the learning process.

Situations do occur where medical students find themselves in health care environments with limited information sources and thus their effectiveness may be affected adversely. Indeed, even in the more advanced countries, authors have pointed out the complexity of the health care environment. Cimino and Bakken (2005) concur with suggestions that students exposed to intense and complex healthcare environments be equipped with devices that provide access to resources in a timely manner.

In this context, it has been pointed out by many authors that the PDA may be an ideal information support system (e.g.Torre and Wright 2003; Engum 2003). Cimino and Bakken (2005) agree with this proposal and further suggest that the PDAs offer the potential for “just-in-time” education extending the ability of educators in monitoring and instructing students.

Students should first learn the use of electronic media to access information (Merrell et al 2004). These skills position students to be effective managers as well as repositories of medical facts. Once they have sound grounding on basic electronic media skills, they may enhance their ability to access information with more advanced techniques and artefacts.

Tele-medicine

An important technological resource, tele-medicine, allows an electro-cardiogram to be stored in one PDA and to be downloaded into another cardiologist's PDA for analysis and prescription of treatment.

The interaction with PDA devices could start with simple use and develop to the more advanced access to drug information databases known as pharmacopoeias, for instance ePocrates which is one of the most popular drug databases (Fischer et al 2003). The illustration of this instance is a study in the remote region of Kenya where the PDA drug and disease reference software enabled medical students to find acceptable substitutes that were locally available when drugs were in short supply (Merrell et al 2004).

Once the students are comfortable with the use of PDAs as electronic repositories, they may move into using the mobile devices to enhance their research capabilities (Criswell and Parchman 2002) .

Challenges and Future Outlook

The Palmomental Reflex

Medical students and physicians in the mental disposition have been cautioned against using the PDAs as peripherals to understanding the cognitive process. In view of that, "the increasing incidence of the so-called *palmomental* reflex by residents and medical students should remind clinical educators that PDAs are not peripheral brains and are a poor substitute for ad-hoc clinical knowledge" (Baumgart 2005).

21ST Century Technology in the Making

Baumgart (2005) is optimistic about the future outlook for the PDA. He especially points out to the evident signs of PDAs advancing technologically. He observes the industry's development in new frontiers of advanced semi-conductor technology that allows hand-held computers to be equipped with faster processors. With these fast processes, the capabilities of handling very complex work loads faster than the best desktop systems currently available will be available at the palm of people's hands.

Baumgart also notes that the technological advances on the best possible means of achieving less power consumption and longer battery life are no longer pipe dreams but rather, fast becoming a reality. Furthermore, he observes developments and advances in network storage systems which will make problems associated with memory non-issues in the near future, because data will be mainly kept in these network storage systems.

Speed will also be a future attribute for the future PDA. Baumgart (2005) concludes by saying that high network speeds will "provide immediate access to clinical and administrative data, including imaging information such as procedural movies; three-dimensional ultrasonography; CT, MRI, or PET scans; histological slides; microbial cultures; and institutional and remote reference systems at any place and time". Speech processing will also be a reality, replacing many dictation methods currently used, Baumgart further asserts.

Security

In the future, "authorised, secure logons to the PDA and data entry will be done with combined speech and fingerprint recognition by sophisticated audio hardware and a new high-resolution generation of touch-sensitive screens" (Baumgart 2005).

Conclusion

This report has shown that PDA usage in the health profession and clinical practise has been practical, profound and positive. The report argues that based on the many studies and ongoing research, PDAs are sound and practical devices in the medical field. This report has shown that PDAs have been used successfully under very challenging conditions to disseminate information and facilitate data collection therefore saving time, reducing costs, and delivering better results than traditional paper-and-pencil methods.

The report has also shown that users can in less time master basic functions of the PDA even though the human issues surrounding the introduction of new technology were seen to be problematic. The report has demonstrated that the role ICTs (handheld devices, email, cell phones, satellite broadcasts) in clinical practise plays a paramount role in getting information into the right hands and at the right time.

The report envisages an even wider range of ICT tools, especially handheld or mobile devices available for use for clinical practise. The report has shown how medical students, using handheld devices will leave medical school with enhanced ability to access resources. For these students, new capabilities and expectations about the role that wireless and PDA technology can play in their continued education and profession is enormous.

This report has shown that there is widespread consensus in the literature on the increasingly critical role of technology and information technology in designing safe and effective health care. Literature suggests that enormous potential for mobile technology, in particular handheld devices in both medical education and clinical practice. PDAs are reported to become as indispensable in medical practice as the stethoscope. The core driver of the proliferation of the PDA usage is the increasing need to take health care to

people rather than people coming to health care centres. This need is compounded by the increasing mobility required of today's students in training (many different locations at medical school and throughout the community), and of health care practitioners. Mobile technology has been shown to provide the most cost effective solution to the common challenges faced by medical schools and medical practice in developing countries.

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Appendices

Appendix 1a

List of Online resources for medical PDA use: Source Baumgart (2005)

American College of Physicians	http://www.acponline.org/pda
British Medical Journal (*BMJ*) PDA webpages	http://bmj.bmjjournals.com/cgi/content/full/324/7334/DC2
Ectopic Brain	http://pbrain.hypermart.net/medapps.html
Medical Piloteer Webring	http://w.webring.com/hub?ring=medpilot
Mobile Medica	http://www.apprisor.com
Pediatrics on Hand	http://www.pediatricsonhand.com
Journal of Mobile Informatics	http://www.pdacortex.com
Uniformed Services Academy of Family Physicians	http://www.usafp.org
University of Connecticut	http://library.uchc.edu/pda/
Vertical PDA Network	http://www.pdamd.com
American Academy of Family Physicians (AAFP)	http://www.apprisor.com
American College of Cardiology (ACC)	http://www.acc.org/clinical/palm_download.htm
American College of Chest Physicians	http://www.chestnet.org/education/guidelines/currentGuidelines
American College of Physicians (ACP)	http://www.acponline.org/annalspdaservices/collections/index.ht
American Heart Association (AHA)	http://www.apprisor.com
DHHS HIV and AIDS medical practice guidelines	http://www.aidsinfo.nih.gov/guidelines/
DHSS AIDS Info drug database and HIV/AIDS glossary	http://aidsinfo.nih.gov/mobile/
National Asthma Education Prevention Expert Panel (NAEPP)	http://hin.nhlbi.nih.gov/as_palm.htm
National Cholesterol Education Program (NCEP)	http://hin.nhlbi.nih.gov/atpiii/atp3palm.htm

National Guideline Clearinghouse (NGC) PDA documents	http://www.guideline.gov
Obesity Education Initiative (OEI) Guidelines on Overweight and Obesity in Adults	http://hin.nhlbi.nih.gov/obgdpalm.htm
The National Quality Measures Clearinghouse	http://www.qualitymeasures.ahrq.gov/about/pdadownload.aspx
US Agency for Healthcare Research and Quality (AHRQ) Pneumonia tool	http://pda.ahrq.gov/clinic/psi/psi.htm
US Preventive Services Task Force (USPSTF) Guidelines	http://www.acponline.org/annalspdaservices/collections/index.ht
USPSTF clinical preventive services PDA programme	http://198.76.191.14/ipss/ipss.htm