

# Diffusion of Mobile Technology in Healthcare

## Liz Burley

Faculty of Information and  
Communication Technologies  
Swinburne Univ.of Technology  
John Street, Hawthorn,  
VIC 3122, AUSTRALIA  
www.it.swin.edu.au/staff/lburley

## Helana Scheepers

School of Information  
Management and Sys.  
900 Dandenong Rd,  
Caulfield East  
VIC 3145, AUSTRALIA

## Julie Fisher

School of Information  
Management and Sys.  
900 Dandenong Rd  
Caulfield East,  
VIC 3145, AUSTRALIA

### E-mail addresses:

lburley@it.swin.edu.au  
Helana.Scheepers@infotech.monash.edu.au  
julie.fisher@infotech.monash.edu.au

**Abstract:** *The introduction of information technology in healthcare has a high probability for failure. We are however seeing an emerging trend of individual healthcare professionals adopting mobile technology. Previous studies in the diffusion of technology have identified four types of adoption decisions: optional innovation-decision, collective innovation-decision, authority innovation-decision or contingent innovation-decision. The innovation decision by healthcare professionals is studied through the content analysis of three medical forums which are utilized by the early adopters of mobile computing. The content analysis shows that mostly optional innovation-decisions are made by individual healthcare professionals. There is some evidence that some healthcare organizations are making authority innovation decisions for a group of healthcare professionals. The paper highlights further research needed in the adoption of mobile technology by healthcare professionals.*

**Keywords:** DOI, innovation decision, mobile computing, healthcare

## 1. Introduction

In the late 1970's and early 1980's the theme of much of the research on the implementation of information systems in Healthcare organisations was the apparent reluctance of Healthcare professionals to adopt IT (Friedman & Gustafson, 1977; Jay & Anderson, 1982; Walker, 1980). Many studies have referred to the computer-anxiety of healthcare professionals particularly nursing students (Henderson, Deane, & Ward, 1995; Wilson, 1991). Some studies have even described active resistance, to the point of interference, with the implementation of these systems (Dowling, 1980). As Kouroubali (2002) notes, technically good systems are not necessarily well-accepted in healthcare settings and she refers to Gardner's empirical evidence that 80% of the failure in the implementation of Healthcare Information systems is due to social and organisational factors (Kouroubali, 2002). Coiera (2000) said that "the capacity for clinicians to adopt technical innovations is often culturally limited, and the best technical solutions can flounder when those who are asked to use them perceive them as an imposition" (p 74, Coiera, 2000). The 'information space' in healthcare and the process of technology adoption is poorly understood, with between 60-80% of all information transactions occurring through person-to-person communication (Coiera, 2000).

According to Versel (2003a) we can now "take everything we have ever heard about technophobic physicians... and throw it out the window." According to a 2003 Modern Physician/Price

WaterhouseCoopers information technology survey, physician leaders and fellow doctors are joining the IT revolution (Versel, 2003a). Dorenfest & Associates, a Chicago healthcare IT research firm predict that the US market for healthcare IT will total \$23.6 billion in 2003 which is up from \$21.6 billion a year ago with a 9.3% increase predicted for 2004 (Versel, 2003b). Another study conducted by AvantGo in 2003 of 2,500 AvantGo users (physicians, physician assistants, pharmacists, nurses and nurse-practitioners worldwide) found that 35% of practicing physicians are actively using a PDA (Marsh & Bulanti, 2003).

## **1.1 Diffusion of Innovation**

Mobile computing, for the purposes of this paper, refers to technologies that ensure user mobility by providing access to data “anytime, anywhere”. Mobile computing involves services coming to the user wherever and whenever they require them in contrast to static computing where the user is required to go to a physical site to receive the service (Lyytinen & Yoo, 2002). Much of the trade literature is enthusiastically predicting that the trend of adoption of mobile computing by healthcare professionals will continue as it is seen as a “consumer-driven” phenomenon (Johnson, 2001). This paper considers mobile computing to be an example of an innovation as defined by Rogers (2003), where an innovation is “an idea, practice, or object that is perceived as new by the individual or other unit of adoption” (p 12, Rogers, 2003). The adoption and diffusion of innovations has been carefully studied by Rogers for over 40 years. He defines diffusion as the “process by which an *innovation* is *communicated* through certain *channels* over *time* among members of a *social system*” (p 11, Rogers, 2003).

### **1.1.1 Innovation Decision**

Of particular interest for the researchers is the impact of the social system on the diffusion and adoption of the innovation. Rogers (2003) defines the social system as “a set of interrelated units that are engaged in joint problem solving to accomplish a common goal” (p 23, Rogers, 2003). Under the social system category he identifies three different types of innovation decision - *Optional innovation-decisions*, *Collective innovation-decisions* and *Authority innovation-decisions* (p 28, Rogers, 2003). The first type, *Optional innovation-decisions* is where the choice to adopt is made by the individual voluntarily. This was covered in the classic diffusion study of hybrid-corn adoption by Iowa farmers conducted by Ryan and Gross in 1947. The second type, *Collective innovation-decisions*, is where the choice to adopt is made on a consensual basis by all members of the social system and then each member is required to adopt the innovation. Finally the third type, *Authority innovation-decisions*, is where the choice to adopt is made by a few individuals on behalf of the entire social system and then each member is required to adopt the innovation. Rogers (2003) then goes on to acknowledge that there is a fourth type, called *Contingent innovation-decisions*, where the choice to adopt may be made only after another innovation decision has been made (Rogers, 2003). The third type – *Authority innovation-decisions* reflects the reality in most organisations where management makes the decision to adopt and then mandates that employees adopt the innovation.

So, how does the adoption of mobile computing by healthcare professionals fit into Rogers (2003) categories of innovation decision? At first it appears that it fits the *Optional innovation-decisions* type. Doctors and nurses are purchasing the PDAs and using them in their day-to-day activities and are even beginning to develop their own applications to run on their PDAs (Burley & Scheepers, 2003). If this is the case, Rogers (2003) suggests the research can be undertaken using the classical diffusion model as a lens to understand the diffusion and adoption of mobile computing in healthcare organisations. On initial analysis this would seem valid, but a closer look indicates that it is important to define the type of mobile computing

that is being studied. In earlier work we identified the different types of PDA mobile computing applications used by healthcare professionals (Burley & Scheepers, 2003). These were standalone PDA applications such as Personal Diary Contact List, Medical Reference databases through to highly sophisticated applications such as PatientKeeper, which integrate with backend hospital information systems. To date most of the growth in mobile computing use, by healthcare professionals, has been with the standalone applications used for information purposes only. This is supported by Davis, the Senior Director of Ambulatory Operations and Practice Management at John Hopkins University Hospital in the US, in a panel discussion held in 2001 where he commented that:

*“We are not using PDAs for any operational uses: laboratory data, registration data, ADT-type data, patient location, insurance. Those sorts of things we collect in the client server systems. Medical students, residents and a few faculty members are using PDAs for information purposes, to access drug databases, reference material for the Merck Manual, Harrison’s and other online databases.... Some residents and students have written programs for the PDA so that they can calculate somebody’s renal function and other tasks.”*

(Davis cited in PatientKeeperWhitepaper, 2001)

If the adoption of the standalone mobile computing applications by individual healthcare professionals appears to be an *Optional innovation-decision*, what about the adoption of enterprise wide mobile computing applications? Does the organic adoption by individuals then grow into the adoption of organisational mobile computing initiatives as often suggested optimistically in the trade literature?:

*“The use of handheld computers has exploded in healthcare organisations because of caregivers themselves. This has turned the traditional technology introduction model on its head. In the past, IT departments introduced systems designed to have business and clinical impacts, but the caregiver adoption and usage were often slow. Now, with industry estimates of 35-40% of caregivers using handheld computers, IT departments find themselves having to respond to adoption rather than encourage it. Healthcare organisations are being pressed to develop mobile strategies that answer caregivers’ call for even greater access and functionality while maintaining existing system and policy guidelines within their institutions”.*

(Lewis cited in Mobic.com, 2001)

From reviewing the literature the adoption of enterprise wide mobile computing applications appear to fit into the *Authority innovation-decision* category where management decides to adopt the enterprise-wide mobile computing application and then staff are expected to adopt it, independently of individual user’s use. At this stage it is not known whether the earlier adoption decision by the individual healthcare professional will then be followed by an organisational adoption decision by the management of the healthcare organisation.

This paper describes an analysis of interactions recorded on three healthcare internet forums to determine what types of innovation decision - *Optional innovation-decision*, *Collective innovation-decision* or *Authority innovation-decision* as described by Rogers (2003) are in evidence for the adoption and diffusion of mobile computing applications in healthcare.

## 2. Research Method

The methodological technique chosen for this study was content analysis which is suitable for “topics that involve the content of messages in cultural communication” (p 318, Neuman, 2003). Content Analysis is useful when studying large volumes of written communication and can be useful to reveal messages in the text which may not be obvious on initial reading (Neuman, 2003). It is nonreactive as the content of the material studied is not influenced by the researcher who is analyzing the text (Neuman, 2003). Content Analysis has been widely used in sociological studies but few studies have applied this method in IS literature. A recent IS example is a longitudinal study of the drivers for information technology and systems outsourcing (Goo, Kishore, & Rao, 2000).

To ensure a rigorous approach to the qualitative content analysis, the authors have followed and continue to follow the procedures outlined by Mayring (2000) which involve inductive category development and deductive category application (Mayring, 2000). The categories, that is, the “aspects of interpretation”, were derived from working through around 1,700 postings of the internet forums. As befitting the “qualitative framework” the categories were derived from the forums and expressed as much as possible in the terms used by the contributors to the forums. Each of the posts were logged and coded to the categories. This information was then stored in an Excel spreadsheet along with relevant quotes. As a new category emerged the earlier posts were recoded.

The forums explored were:

Table 1 – PDA Forums inspected

Forum Name	Date range covered by list	Total Number of posts (as at 18 Feb 2005)	Dates Inspected	Number of posts in date range inspected	Number of posts inspected	Description
pdaMD - PDAs in Healthcare forum	1999-current	6,256	28 June 2001 to 20 Jan 2005	3,460	1,153	“Discuss the use and uses of PDA devices in the healthcare environment”
Wireless Medical Applications	2001-current	3,618	13 Feb 2004 to 9 Jan 2005	280	70	“Discussion Group centered on discussing emerging wireless technologies and their application to medicine, with a particular focus on PDAs in clinical practice”
Docsboard – Handhelds forum	Feb 26, 2004 - current	552	28 Feb 2004 to 20 Jan 2005	534	534	“Docsboard is a non-commercial physician discussion forum aimed at practicing physicians and residents in training. . . . We aim to become one of the premier sites for information about Electronic Medical Records, Handheld device use in medicine and Practice Management”.

### 3. Early Results

The early results are organised and discussed according to the identified categories. Excerpts from the discussion lists are provided to illustrate the identified decision making.

#### 3.1 *Optional Innovation-Decision*

Initial analysis of the forums (covering around 1,700 postings to date) has indicated that doctors initiate the purchase of the mobile computing device themselves. This is consistent with findings of a 2004 study of US doctors and their experience with handheld computers in clinical practice (Scheck, Schweikhart, & Medow, 2004). A large number of postings on the PDA forums are requests for advice from their peers on which PDA would best suit their needs and there are just as many posts from enthusiastic doctors outlining their experience with their chosen PDA and the applications which they run on the device.

#### 3.2 *Authority Innovation-Decision*

Academic medical centres have begun purchasing mobile computing devices for their residents and expect these to be used as part of their ongoing training (Scheck et al., 2004). See for example the following posts from pdaMD.com:

*I'm in the process of purchasing handhelds (Palm OS) for our incoming residents. Last year we purchased Sony Clie PEG-T615C for our interns last year and they all complained about battery drainage and short duration. Any suggestions for this year. I'm considering Palm 515, Tungsten T, Zire 71? I'm also willing to entertain Sony again if I hear any good feedback.*

*Also, any good residency management software (procedures, schedules, etc) out there that is free or inexpensive.*

Respondent, 11 Jun 2003, pdaMD.com

*Hi, my institution is planning to purchase several handhelds for issuing to interns in an internal medicine program as a trial. These handhelds will not need to be integrated into any hospital network, and are essentially primarily for the intern's use. Palms are currently favoured over CE devices.*

*I would like to seek any advice on*

*(a) Ideal programs for interns (A search on Skyscape suggests that 5MCC 2002, A2ZDrugs and Ifacts are popular enough)*

*(a) type of handhelds recommended (I understand that standard memory is 8 MB, but the previous list of 3 programs require 9.6 MB?)*

*Appreciate advice.*

Respondent, 10 Mar 2002, pdaMD.com

*At the Greenville SC Family Practice Residency program, we have been using Palm devices since 1997.*

Respondent, 18 Dec 2001, pdaMD.com

Hospitals and healthcare government services have also begun trials for mobile computing initiatives. See for example the following post from pdaMD.com:

*BRITAIN'S National Health Service (NHS) has signed a multi-million pound deal for a substantial number of new handheld computers from UK-based computer company Psion Teklogix.*

*The initial NHS pilot trials were with district nurses, who used the laptops [Psion Netbooks] to connect with mobile phone networks to access patients' medical records while visiting them.*

The key for acceptance of enterprise Health Information systems in hospitals is to ensure that the healthcare professionals see value to them in their day-to-day work. This is highlighted by the posting to pdaMD.com below:

*"It's all how the incentives are alligned. I work for a large HMO. It seems to me that in my setting you have to:*

- 1. Save the Physician Time*
- 2. Improve Quality of Care*
- 3. Automate a significant enough chunk of the workflow*

*4. And then by the way, do the organization benefit in cost control;*

*The key area is #3: What pieces of the workflow are sufficient to make it worthwhile to leave pen and paper.*

*E prescribing alone - I'm not so sure by itself*

*Medical Info Look Up like Epocrates getting closer*

*Printing patient education material - Coding capture, Guideline delivery*

*Again, various vendors are trying to do pieces - some several pieces.*

*The only PALM Application I've ever used that is Medical that has saved me time as compared to the non computer process - has been EPOCRATES - it's faster and easier to look up the information I need with Epocrates than it is to look it up in the PDR.*

*NOBODY in the industry probably knows the answer to Number 3 today. But I'm optimistic we'll get there essentially through trial and error in the marketplace."*

Respondent , 11 March 2001, pdaMD.com

#### **4. Discussion**

Much IS literature has explored the acceptance of technology by end users in corporate and academic organizations using the Technology Acceptance Model (TAM) developed by Davis in 1989. Most of the research relied on students as substitutes for users in an organizational setting. The one notable exception is the recently published Unified Theory of Acceptance and Utilisation of Technology (UTAUT) model (Venkatesh, Morris, Davis, & David, 2003) which combines a number of adoption models including TAM. Very few studies have applied TAM in a healthcare setting. Of the few who have used TAM in healthcare, all have found TAM was partially supported. For example, Chau and Hu (2002) investigated the acceptance of telemedicine by 408 physicians using TAM, the Theory of Planned Behaviour and an integrated model. They found that only Perceived Usefulness had significant influence on intention to use. Ease of Use, the other key construct in TAM, was not supported. This is consistent with findings of another study using

TAM in a healthcare setting (Jayasuriya, 1998). A study of physician's acceptance of Internet-based health applications using the extended model TAM2 also found the Ease of Use construct unsupported (Chismar & Wiley-Patton, 2002). Chau and Hu (2002) suggested that 'Physicians may exhibit interesting or fundamental differences from ordinary business user groups, in part because of their professional training' (p 297, Chau & Hu, 2002). The Diffusion of Innovation model was chosen because it has been used to study the adoption and diffusion of technology across an industry and was considered particularly useful in studying the adoption and diffusion across a professional group. It also specifically addresses a key construct of importance to healthcare professionals, namely compatibility with physician values. It is noted, however, that the latest technology acceptance model UTAUT has added to TAM "Compatibility" under the "Facilitating Conditions" construct and therefore may also be a useful framework to explore in further research (Venkatesh, Morris, Davis, & David, 2003). UTAUT however specifically concentrates on the organizational environment and would thus not be as useful as the diffusion of innovation model.

Rogers introduced the concept of adopter categories in the first edition of Diffusion of Innovations (Rogers, 1962). The categories Innovators (2.5%), Early Adopters (13.5%), Early Majority (34%), Late Majority (34%) and Laggards (16%) are based on innovativeness and follow a normal frequency distribution where the Innovators, Early Adopters and the Early Majority are to the left of the mean time of adoption on the curve (Rogers, 2003). From analysis of the internet forums there is evidence that the adoption and use of mobile computing for individual use (ie calendars, medical calculators, medical references, pharmacopaedia and so on) has begun to move into the Early Majority stage. The innovators for this adoption curve were the doctors who began to develop applications for PDAs and some provided that software freely to their peers (Burley & Scheepers, 2003). These innovators then became the "gurus" on the internet forums (for example, Andre Chen - Statcoder, Kent Willyard - Shots, C M Wilkerson - Digital-Doc Software), the opinion leaders for the group, providing advice freely to peers wanting to begin using the devices themselves. The key facet of this adoption curve is that the decision to adopt is an *Optional Innovation decision*.

An analysis of the literature in the Pharmacy sector of the US, suggests that there is another adoption curve for mobile computing in healthcare. This curve represents the adoption and diffusion of mobile computing applications at the enterprise level instigated by the departments within hospitals. Pharmacy departments have been using Mobile computing (ie PDA applications) to document interventions and recommendations made by pharmacists to physicians (Brody, Camano, & Malony, 2001; Lau, Balen, & Lam, 2001; Lynx, Brockmiller, Connelly, & Crawford, 2003; Reilly, Wallace, & Campbell, 2001). They have also begun using mobile computing (ie PDA applications) to support peer reviews on clinical performance and competency assessments (Minnard et al cited in Lynx et al 2003) and to support CQI (Continuous Quality Improvement) initiatives for the provision of therapeutic monitoring services (Collins, 2004). It appears that the adoption curve for Pharmacy department enterprise computing applications is at the Early Adopter stage. The key facet of this adoption curve is that the decision to adopt is an *Authority Innovation decision*. The pharmacists are expected to use the mobile computing applications.

There is evidence in the literature that hospitals are also introducing enterprise applications to support peer reviews on clinical performance for physicians (Kohli & Kettinger, 2004). Although the application referred to in Kohli and Kettinger's study was not a mobile computing application, it does raise some interesting parallels for those considering introducing enterprise mobile computing applications in a hospital setting. The challenge for introducing enterprise healthcare applications is to ensure that they fit the underlying values of the healthcare professionals expected to use them. As Rogers (2003) states one of the key factors for adoption of an innovation is the innovation's fit with the adopters values (referred to as Compatibility). Kohli and Kettinger (2004) identified four sets of physician values: Economic Values, Status Values, Altruistic Values and Legalistic Values. Economic Values – the IS application must provide economic value to the physician personally and/or to their practice group. The Status Values "stem from the competitive desires to excel and perform better than one's colleagues" (p 385, Kohli and Kettinger, 2004).

The Altruistic Values refer to the physicians desire to put the patient's best interests first and finally Legalistic Values – the ever present concern of malpractice and malfeasant litigation.

Initial analysis of the forums indicates that most of these values are evident in the internet forums. Another value which seems to be evident in the internet forums is the value of autonomy, particularly with regard to their decision making power with regard to their patient and to choices of treatment including prescriptions. Physicians do not appreciate any interference in their interaction with their patient as shown in the following post, when discussing ePrescribing:

*"I can't think of anything I would want less than to allow a PBM (Pharmacy Benefits Manager) another channel into my practice. I already get mail and phone calls every day from them asking me to switch patient's medications."*  
Respondent, 23 Feb 2001, pdaMD.com

It is proposed that further analysis includes these five value sets in the coding of the remaining postings of the three internet forums.

## 5. Conclusions

The paper studied the adoption decision made by healthcare professionals taking part in three PDA forums. The study makes three main contributions. First, we show that the main adoption decision is made by individual healthcare professionals on a voluntary basis (optional innovation-decision). Second, the analysis of the forums also indicates that the early majority stage of adoption has been reached. Third, an emerging trend of authority innovation-decisions is also evident, but is outweighed by the individual healthcare professionals.

The study highlights the need for further research to understand the possible developments in the adoption of mobile technology in the future. First, how will the early adopters of mobile technology influence the adoption of mobile technology by institutions (such as hospitals)? How will this impact on the individual adoption of mobile technology by healthcare professionals? Second, how will the unique aspects associated with healthcare professionals influence the authority innovation-decision? For example how will the four physician values (economic values, status values, altruistic values and legalistic values) be accommodated in the authority innovation-decision?

The study has the following limitations. As noted in section 2, the initial data for this paper was obtained from three internet forums for healthcare professionals discussing their experiences and questions regarding mobile and wireless technology in healthcare. The contributors to the forums, simply by contributing, have already shown their interest in the technology and have some expertise in this area. As noted in the quote shown below, on the whole the contributors to the forums "like toys, like to play and will try new things". This needs to be kept in mind when interpreting the data from this type of source.

There are around 4-5 contributors to the forum who are considered the gurus of the group. They have earned the respect of the entire forum, particularly as most of them have developed and provided software for mobile computing in healthcare and have been using mobile computing devices (ie PDAs) since the mid 1990s. They are the "opinion leaders" (Rogers, 2003) for the group and offer their expertise and advice generously. Most of the contributors to the forums are based in the US although there are some lone voices from the UK and Australia.

The forums are therefore not indicative of the opinions and attitudes of healthcare professionals as a whole. However, it is fair to say that they are indicative of the opinions and attitudes of the early adopters of mobile computing in healthcare in the US.

*“The key, however, is making it seamless and second nature. It needs to be as easy and readily accessible as paper. The people we need to convince are not the ones on this forum. We like toys, like to play, and will try new things. It's all the other health professionals out there that need to see it as better than what they have now. So, every little step brings us a bit closer. Now almost all the residents and some of my attending colleagues carry PDA's. Is this because they work perfectly? No. It's because they were easy enough to use to meet their current needs. (No more handbooks, little black books in their pockets). Little things like TRG's expansion slot, medical software that was easy to read and use, ease of use of Palm OS, and free availability all contributed to this small but still ongoing revolution. I think WiFi is one more step in the right direction.*

*In terms of security, are the paper charts on my desk or at the nurses' station any more secure. Less actually. Yes, some hospitals and offices are way way behind, but as prices come down and current systems age, changes are inevitably being made and the more small steps have been made the bigger the change that is possible.*

*Tablets, yes, they are probably the eventual way to go for full patient interactions in the exam room or hospital ward. I don't want to carry one with me all the time, though.*

Respondent, 30 April 2003, pdaMD.com

## References

- Brody, J., Camano, J., & Malony, M. (2001). Implementing a personal digital assistant to document clinical interventions by pharmacy residents. *American Journal of Health-System Pharmacy*, 58, pp 1520-1522.
- Burley, L., & Scheepers, H. (2003). Emerging trends in mobile technology development: from Healthcare Professional to System Developer. *Int. J. Healthcare Technology and Management*, 6(1/2), p. 179-193.
- Chau, P. Y. K., & Hu, P. J.-H. (2002). Investigating healthcare professional's decisions to accept telemedicine technology: an empirical test of competing theories. *Information & Management*, 39(4), p297-311.
- Chismar, W., & Wiley-Patton, S. (2002). *Does the Extended Technology Acceptance Model apply to Physicians*. Paper presented at the 36th Hawaii International Conference on System Sciences (HICSS'03).
- Coiera, J. D. (2000, 3-4 August 2000). *Research and Development the way forward*. Paper presented at the Proceedings from the National Health Online Summit, Adelaide.
- Collins, M. (2004). Measuring performance indicators in clinical pharmacy services with a personal digital assistant. *American Journal of Health-System Pharmacy*, 61, pp 498-501.
- Dowling, A. F. (1980). Do hospital staff interfere with computer system implementation. *Health Care Management Review*.
- Friedman, R., & Gustafson, D. (1977). Computers in clinical medicine: a critical review. *Computers and Biomedical Research*, 10, pp 199-204.
- Goo, J., Kishore, R., & Rao, H. (2000). *A Content-Analytic longitudinal study of the drivers for information technology and systems outsourcing*. Paper presented at the Twenty-First International Conference on Information Systems, 10-13 Dec 2000, Brisbane, Australia.

- Henderson, R., Deane, F., & Ward, M. (1995). Occupational differences in computer-related anxiety: implications for the implementation of a computerized patient management information system. *Behaviour and Information technology*, 14(1), pp 23-31.
- Jay, S. J., & Anderson, J. G. (1982). Computerized hospital information systems: their future role in medicine. *Journal of the Royal society of medicine*, 75, pp 303-305.
- Jayasuriya, R. (1998). Determinants of microcomputer technology use: implications for education and training of health staff. *International Journal of Medical Informatics*, 50(1-3), pp 187-194.
- Johnson, T. (2001). *Integrating the PDA into Hospital IT: a panel discussion*, from <http://www.patientkeeper.com>
- Kohli, R., & Kettinger, W. (2004). Informating the Clan: Controlling Physicians' Costs and Outcomes. *MIS Quarterly*, 28(3), pp 363-394.
- Kouroubali, A. (2002). *Structuration Theory and Conception-Reality Gaps: Addressing Cause and Effect of Implementation Outcomes in Healthcare Information Systems*. Paper presented at the Proceedings of the 35th Hawaii International Conference on System Sciences - 2002.
- Lau, A., Balen, R., & Lam, R. (2001). Using a personal digital assistant to document clinical pharmacy services in an intensive care unit. *American Journal of Health-System Pharmacy*, 58, pp 1229-1232.
- Lynx, D., Brockmiller, H., Connelly, R., & Crawford, S. (2003). Use of a PDA-based pharmacist intervention system. *American Journal of Health-System Pharmacy*, 60, pp 2341-2344.
- Lyytinen, K., & Yoo, Y. (2002). Research Commentary: The Next Wave of Nomadic Computing. *Information Systems Research*, 13(4), pp 377-388.
- Marsh, M., & Bulanti, R. (2003). *Doctor Recommended: PDAs are Good Medicine*, from [http://www.ianywhere.com/press\\_releases/doctors\\_pdas.html](http://www.ianywhere.com/press_releases/doctors_pdas.html), accessed on 19 August 2004
- Mayring, P. (2000). *Qualitative Content Analysis [28 paragraphs]*, from Forum Qualitative Sozialforschung / Forum: Qualitative Social Research [On-line Journal], 1(2). Available at: <http://www.qualitative-research.net/fqs-texte/2-00/2-00mayring-e.htm>, accessed 6 Jan 2005
- Mobic.com. (2001). *PatientKeeper, Palm and Analysts International partner to Explore benefits of mobile and wireless technology in healthcare*, from <http://www.mobic.com/oldnews/2001/04/patientkeeper.htm> accessed 20 August 2004
- Neuman, W. (2003). *Social Research Methods - Qualitative and Quantitative approaches, 5th edition*: Pearson Education.
- PatientKeeperWhitepaper. (2001). *Integrating the PDA into Hospital IT: a panel discussion*, from <http://www.patientkeeper.com> available at [http://www.cedarcreek.org/mgma\\_panel.pdf](http://www.cedarcreek.org/mgma_panel.pdf)
- Reilly, J., Wallace, M., & Campbell, M. (2001). Tracking Pharmacist interventions with a hand-held computer. *American Journal of Health-System Pharmacy*, 58, pp 158-161.
- Rogers, E. (2003). *Diffusion of Innovations, 5th Edition*: New York: Free Press.
- Scheck, A., Schweikhart, S., & Medow, M. (2004). Doctor's experience with handheld computers in clinical practice: qualitative study. *British Medical Journal*, 328, pp 1162-1166.
- Venkatesh, V., Morris, M., Davis, G., & David, F. (2003). User Acceptance of Information Technology: Toward a Unified View. *MIS Quarterly*, 27(3), pp 425-478.
- Versel, N. (2003a). *Performance driving investment up*, from [www.modernphysician.com/printwindow.cms?articleId=2005&pageType=article](http://www.modernphysician.com/printwindow.cms?articleId=2005&pageType=article), accessed 10 Nov 2003
- Versel, N. (2003b). *Tech spending growth fastest in healthcare*, from [www.modernphysician.com/printwindow.cms?newsId=1494&pageType=news](http://www.modernphysician.com/printwindow.cms?newsId=1494&pageType=news), accessed 20 Nov 2003
- Walker, C. H. (1980). 'Batch' or 'On-line' for child health: a review. *British Medical Journal*, 281, pp 90-92.
- Wilson, A. A. (1991). Computer anxiety in nursing students. *Journal of Nursing Education*, 30, pp 52-56.