Handheld Computers in Clinical Practice: Implementation Strategies and Challenges

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EXECUTIVE SUMMARY

Purpose

This study was designed to explore experiences with handheld computer use in clinical practice from the perspectives of both organizations and practicing physicians. The goal of this study was to develop a rich and useful understanding of organizational strategies for the use of handheld computers, and of the needs and concerns of physicians using these devices for patient care.

Research Questions

1. What specific applications and uses exist for handheld computers in the clinical setting?
2. What strategies and tactics are hospitals using to integrate handheld computers into their patient care delivery practices?
3. What are the attitudes, expectations, and needs of physicians with respect to the use of handheld computers in clinical practice?

Project Overview

Our comprehensive study included eight organizational case studies, nine focus groups, and an integrative review of the literature in order to answer our research questions. We held interviews with 67 organizational representatives as part of our case studies, and our focus groups included 55 physicians as well as 15 other clinicians (physician assistants, dieticians, physical therapists, and pharmacists) and 10 additional organizational informants (a total of nearly 150 respondents over the course of this study).

Key Findings and their Implications for Decision Makers

- **Finding 1:** *Uses of Handheld Computers in Clinical Practice*: There is a diverse and growing list of possible uses for handheld computers in clinical practice. Commonly cited uses include: 1) patient data access, 2) pharmaceutical reference, 3) guideline dissemination, 4) medical calculator functions, and 5) scheduling and appointment reminders. Innovative new uses may include: 1) collection of information about medical errors and near misses; 2) data acquisition through questionnaires or surveys; 3) distribution of databases such as formularies, consultant physician information, pharmacy phone numbers; 4) provider-directed patient education; and 5) clinical uses beyond physicians (e.g., nurse practitioners; nurses; dietary; physician assistants; pharmacy; inventory)

  Implications: *For Senior Management, Information Technology (IT) Directors, Clinical Managers, Researchers, Quality Improvement Directors:* As handheld computers become more widely utilized, administrators can leverage their use in a variety of ways to improve both care and service to patients. Administrators can work with interested clinicians to devise creative ways to

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collect data about patient care and outcomes, as well as appropriately provide information to health care providers in the form of databases, guidelines, and patient education materials. Beyond physicians, opportunities to use handheld computers are also expanding, although these applications may require institutional purchase of devices and software to support new endeavors.

- **Finding 2:** *Handheld Computer Use Patterns and Characteristics*: We were able to categorize handheld computer users into four different groups: 1) non-users (including former users); 2) niche users (restricted to a single application); 3) routine users; and 4) power users.

    Implications: *For Senior Management, IT Directors, IT Trainers, Clinical Leadership*
    Training and support of handheld computer use is best tailored to the needs and aptitudes of individual physicians. Different strategies are appropriate for different groups. Non-users may need to overcome fear and inexperience with computer technology while power users can be utilized (as peer champions) to help niche users and routine users maximize the benefits of handheld computers.

- **Finding 3:** *Organizational Implementation and Support Strategies:* We found three main approaches to organizational support: 1) active promotion, facilitation and support for broad-based applications and devices; 2) active support for niche applications; and 3) passive support for individual users.

    Implications: *For Senior Management, IT Directors, and Residency Directors*
    Depending on the selected organizational approach to supporting handheld computer use, requirements for investment in capital and information technology support will vary. In addition, the greater the level of support, the more likely handheld computer use can be leveraged for organizational purposes (e.g., access to clinical data; procedure documentation; medical education documentation; patient education; medical error reporting; reducing drug costs). A level of basic support is expected by all physicians, but not all organizations choose to move beyond this level. Interestingly, all eight of our focus groups included incidents when power and/or routine users were able to share tricks and capabilities of the handhelds with their physician peers. For organizations interested in active promotion and support, leveraging the enthusiasm of power users in similar open forums will likely be effective.

- **Finding 4:** *Barriers Hindering Handheld Computer Use*: Both device and personal barriers, including both physical and perceptual constraints, can affect physicians' adoption and use of handheld computers in clinical practice.

    Implications: *For Senior Management, IT Directors, and Medical Directors*
    While device issues are difficult to address, providing organizational support can help physicians overcome perceptual barriers to use such as comfort with

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technology and comfort with the device, as well as show dedication to serving physicians.

- **Finding 5:** *Physician Attitudes***:** Our study suggests that our physician handheld computer users are largely satisfied, even with limited use. The majority of physician respondents appear interested in leveraging handheld use. They often commented on how they felt they were not utilizing the handhelds to their greatest degree, and would like to gain additional benefit from the technology.

  Implications: *For Senior Management, IT Directors, Medical Directors*
  Organizations can look for opportunities to expand handheld use for both clinical and administrative processes.   Participant physicians suggested that organizations can promote handheld computer use by providing training and re-training to extend user knowledge, user support, and advice to build confidence in this and other information technologies.

- **Finding 6:** *Physician Needs:* Commitment to handheld computers requires low capital investment but a strong level of support; physicians particularly desire non-threatening, one-on-one support.

  Implications*: For Senior Management, IT Directors*
  Budget to support handheld computer use should include training, 24x7 help desk, and re-training. Nurse informaticists in IT work particularly well to support physicians one-on-one.

- **Finding 7:** *Physician Concerns***:** Physicians are concerned about both device reliability and dependence on the device.

  Implications: *For IT Directors, Clinical Leadership, Residency Directors*
  Availability of user support through IT may reduce physician anxiety about the device itself. Concern about dependence on the device may need to be acknowledged in the context of medical education and ever-increasing demands for medical knowledge and precision.

- **Finding 8:** *Physician Expectations:* Both organizational and physician participants expect handheld computers to become more useful and more common in the future.

  Implications: *For Senior Management, IT Directors, Medical Directors*
  Residency Directors
  Newly trained physicians are expected to be more and more comfortable with handheld computers, raising an expectation for organizations themselves to become more handheld-friendly. Developing strategies to leverage handheld computer use such as providing mobile access points to essential point-of-care information will help attract and retain providers who will also be effective users of other clinical information technologies.

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Conclusions: For organizations interested in supporting and promoting information technology solutions to improve clinical practice, understanding the implications of our work on handheld computers can help them in other technology implementation projects. In particular, the critical role of clinical change agents can be leveraged to promote and expand technology diffusion among physicians often uninterested in new information technologies. Further, findings from our study show how the relatively inexpensive option of accommodating handheld computers can successfully facilitate both organizational and individual change as organizations attempt to bring more IT to the point of care and support a digital patient care environment.

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I.   INTRODUCTION

Hospitals and health systems are under pressure to create a digital environment for
patient care delivery, while physicians are increasingly expected to adapt their work
routines to take advantage of clinical technology developments. There is a dearth of
research available to help health care executives understand how to leverage their
investments in health information and information technologies (IT), and how to enhance
the value of these investments at the clinical care delivery level of the organization.
Objective information and research results in these areas are particularly difficult to
obtain given the often-hyped, vendor-driven environment of much of healthcare IT.

In the context of developing a digital patient care environment, handheld computers stand
out as an emerging means for physicians to bring IT resources to their work. Other
names commonly used for this type of technology include personal digital assistants
(PDAs), handhelds, and Palms® or Palm Pilots®. These small devices are functionally
flexible, customizable, and easily portable to facilitate their use at the point of care. A
2002 survey found that approximately 35% of practicing physicians use a PDA for
personal or professional purposes, with two thirds of these using a pharmaceutical
reference database on their handheld computer.[1] Wireless handheld computers have the
dual functionality of connectivity to the Internet and other computer networks, as well as
mobility.

Little research has explicitly examined whether and how organizations are managing the
use of handheld computers as a critical component of their clinical information
management strategy, or how clinicians are using handhelds to bring electronic medical
record capabilities to the point of care. Published information about the clinical use of
handheld computers tends to originate from vendors, as informational overviews for
medical students and clinicians, or as a case study of a single organization's experience.
The aim of this research was to develop a rich and useful understanding of organizational
strategies for the use of handheld computers and of the needs and concerns of physicians
who use these devices.   This report describes the findings of our research study along
with recommendations, derived from these empirical findings, to assist health system
decision-makers in reducing barriers to successful adoption and utilization of handheld
computers by physicians in clinical practice, and, by extension to increase the likelihood
of a successful implementation of other point-of-care clinical information technologies.

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II.   RESEARCH QUESTIONS

Our study was designed to develop a rich and useful understanding of organizational strategies that can promote the adoption and use of handheld computers, and to explore the needs and concerns of physicians about using these devices in clinical practice. We had three primary questions:

1. What specific applications and uses exist for handheld computers in clinical practice?

2. What strategies and tactics are hospitals using to integrate handheld computers into their patient care delivery practices?

3. What are the attitudes, expectations, and needs of physicians with respect to the use of handheld computers in clinical practice?

This research examined handheld computer use in patient care delivery from both *organizational* and *individual* perspectives. The first two research questions primarily focused on the operational processes and management strategies of the organization. The second question was specifically focused on gaining a rich understanding of the processes by which organizations have, or have not, helped to successfully integrate handheld computers into clinicians' work flow and organizational operations. The third question was aimed at the level of the individual physician to determine what this critical group of technology consumers wants and expects from handheld computers and, to some extent, from clinical information technologies in general. As with other types of consumer research, this physician-specific research is intended to help organizations to design information management strategies and actions that are aligned with the needs and priorities of physicians.

Conceptual Framework

Conceptually, this study of handheld computer use was designed to examine technology-driven change in the patient care setting. The pace of technological development suggests that this type of change will continue to occur. Thus, our specific findings regarding handheld computers can inform strategies for implementing future innovations in clinical operations. Our study was framed by theory in the areas of organizational change[2-4] and diffusion of innovation, [5] supporting our primary research questions that explore issues related to implementing technology-driven change in individual and organizational work practices.

Our study considered the introduction and adoption of handheld computers in clinical practice as an innovation requiring and promoting organizational change. Variables in diffusion of innovation theory such as the type of innovation decision, communication channels, the nature of the social system, the extent of change agents' promotion efforts, and the perceived attributes of the innovation were consistent with the facets of the handheld computer use and support decisions under investigation. In addition, we were able to test the applicability of several organizational change models. First, because the

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nature of handheld computers calls for a dynamic approach to change management, Orlikoski and Hofman's[2] model was applied to determine how organizations proceeded with the change process. Second, given the unknown nature of handheld computer adoption as organizational change, Kaluzny and Vency's[3] model was used to classify this organizational change. Third, Smith and Kaluzny's[4] model was used to determine at which stage the organizational change of handheld computer adoption and use was within each case study site.

III.   RESEARCH METHODS

Our study was designed to explore experiences with handheld computer use in clinical practice from both an organizational and a practicing physician level. To that end, we designed a comprehensive, two-part qualitative study comprised of organizational case studies and physician focus groups, both parts of which were supported by a thorough review of the literature.

Literature Review

An increasing number of physicians are using handheld computers as a new electronic tool they carry, similar to their pagers and cell phones. Recent surveys have noted that as many as one-third of US physicians, currently use handhelds,[1] a result confirmed in a study of handheld computer use among US pediatricians.[6] Among Canadian physicians under age 35, 53% reportedly currently use handheld computers in clinical practice.[7]

Published literature on the topic of handheld computer use in medicine is fairly limited in quantity and scope, and much of this literature has been published in the past 2 years, since we began our study. Articles tend to describe handheld computer functions and software applications, either in the form of a literature review or as single case study. Researchers have described applications in general clinical use,[8] and specialty use, including infectious disease,[9] orthopedics,[10] medications[11] and family practice.[12] Several authors discuss the use of handheld computers for resident procedure tracking in different specialty areas;[13-15] while others describe how their organizations provide access to clinical data repositories and other electronic records for physician handheld computer-users.[16, 17] Additional authors provide general discussions of the handheld computer options, including opportunities, and limitations for medical practitioners.[8, 18-23]

A limited number of survey-based empirical studies of handheld computer use by physicians have been published, showing variability of use both by application and by physician type. In an on-line survey, over 900 users of the ePocrates pharmaceutical reference application reported that they used this handheld computer application because it saves time, is easy to use, and improves decision making.[24] A study of residents, subspecialty fellows and attending physicians in internal medicine at the Mayo Clinic found that trainees reported more frequent handheld computer use in the hospital setting and for direct patient care, while attending physicians reported more frequent handheld computer use in administrative settings and for calendar functions.[25] A study of handheld computer use by pediatricians found that handheld computer users, estimated to be one-third of practicing pediatricians, most often used handheld computers for drug reference (80%), followed by personal scheduling (67%) and medical calculations (61%).[6] This study also reported that pediatricians generally believe that handheld computers can decrease medical errors and increase practice efficiency.

While these surveys provide some empirical evidence about the different uses of handheld computers by physicians and the reasons for their use, the results are limited by the structured and restricted nature of written quantitative survey questions. Scant

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research has explicitly examined how practicing physicians are changing their work routines with handheld computers, and how clinicians perceive that this use is affecting their patient care practices. Moreover, research has not focused on the linkages, or potential linkages, between individual physician users of handheld computers and organizational strategies for information technology, patient safety, and other strategic priorities.

Organizational Case Studies

Our review of the literature and discussions with organizational representatives and vendors of software for clinical handheld computer use produced a small sample of organizations that enabled us to learn about how and why physicians were using handheld computers. Organizations reporting considerable use of handheld computers in clinical practice were contacted to participate in our study. We selected study organizations based on our joint goals of: 1) observing different organizational approaches to supporting and implementing handheld computer technology; and 2) obtaining interviews and focus groups with a large sample of physicians who represented a broad range of medical specialties and different levels of handheld computer usage. We also sought both geographic and institutional diversity.

The seven organizations we studied were:

- Rochester IPA (Rochester, NY; independent practice association)
- Summa Health (Akron, OH; community health system)
- Cedars-Sinai Medical Center (Los Angeles, CA; academic medical center)
- Sharp Healthcare (San Diego, CA; community health system)
- Humility of Mary Health System (Youngstown, OH; community health system)
- WakeMed (Raleigh, NC; community health system)
- Ohio State University Health System (Columbus, OH; academic medical center; pilot site)

For each case study organization, a key contact was established to identify appropriate individuals to interview and assist with interview scheduling. Interviews with practicing physicians were scheduled for 45 to 60 minutes, and interviews with administrative personnel were scheduled for 60 to 90 minutes. All interviews were audiotaped after obtaining the participant's permission. Two study investigators were present for most interviews, with the exception of occasional simultaneous interviews. At the conclusion of our case study visits, investigators reviewed and discussed their interview notes and recorded key observations and insights. Most site visits lasted two days, and at least two investigators participated in each of the case study visits.

We conducted 67 interviews with key informants as part of our organizational case studies. Key organizational informants held administrative, clinical, and information technology positions. The set of interviews held at a particular site depended on such organizational factors as the overall level of handheld computer activity, the nature of handheld computer activity (pockets of activity or organization-wide use), and the locus

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of handheld computer use and decisions (for example, the IT function, a particular process/application, or the residency programs/medical director).   At each site, interviews were typically held with the CIO and other senior IT executives, the medical director or other senior medical administrator, information technology staff involved with handheld computer applications and training, physicians and other clinicians in handheld computer application areas, and physician technology champions.   A list of the interview questions used for our organizational case studies is included as Appendix A.

Focus Groups

Focus groups with physicians, both users and non-users of handheld computers, were conducted to generate data on physicians' experiences, attitudes, and expectations about handheld computer use in clinical practice. A total of 55 physicians participated in 9 focus groups. One-third (30%) of our participants were women, and three-quarters (77%) were generalists, defined as practicing general internal medicine, pediatrics, general obstetrics/gynecology, or family medicine.   Nearly half (43%) of our participating physicians and surgeons were practicing full-time in a variety of different clinical settings, while the remainder were at some stage in their training as residents or fellows. Both non-users and users of handheld computers participated in the focus groups. Overall, one-third (31%) of participants were affiliated with academic medical centers while the remaining majority were affiliated with an independent practice association, community hospital, or children's hospital.

Focus groups were held at:
- Rochester IPA (Rochester, NY)
- Summa Health (Akron, OH)
- Sharp Healthcare (San Diego, CA)
- Humility of Mary Health System (Youngstown, OH)
- The Ohio State University Medical Center (Columbus, OH)
- Columbus Children's Hospital (Columbus, OH)
- WakeMed (Raleigh, NC)
- Society of General Internal Medicine Meeting (Chicago, IL; two focus groups)

Each session lasted 60-90 minutes, and participants received a small token of appreciation for their time at the beginning of the focus group. Participants were assured that their participation was voluntary. One study investigator moderated each focus group, with a co-moderator available to assist. To facilitate the discussion, an open-ended list of questions was used, including several questions probing for more detailed information. Each session was audiotaped, transcribed, and then verified and corrected by one study investigator. Questions used to guide the focus groups are provided as Appendix B.

Analyses

Analyses of the focus group and organizational interview data applied a combination of deductive and inductive methods.[26] Transcripts were imported into the qualitative data

analysis software package Atlas.ti for detailed coding. All three investigators read transcripts several times and then met to construct a preliminary coding frame. We applied this coding frame to two common transcripts which enabled us to compare coding decisions and clarify codes. Working from our codes, we then identified categories and constructed major themes. Periodic discussions among the investigators ensured consistency of coding, and helped us reach agreement about final themes emerging from the data. Further, an ongoing review of available literature about handheld computer use in clinical practice helped us compare, validate, and extend our findings.[27] Each of the three investigators participated in this multiple coding process and agreed upon final themes and evidence used to answer to our research questions.

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IV.   FINDINGS

Finding from this study pertain to both organizational strategies for handheld computers (acquisition, support, implementation, etc.) and physician perspectives surrounding handheld computer use.   Using our research questions to frame our results, we have organized our findings into the following eight sections:

<u>Research Question 1:</u> What specific applications and uses exist for handheld computers in the clinical setting?

> **Finding 1**: *Uses of Handheld Computers in Clinical Practice*

> **Finding 2:** *User Categorization*

<u>Research Question 2:</u> What strategies and tactics are hospitals using to integrate handheld computers into their patient care delivery practices?

> **Finding 3:** *Organizational Strategies to Support Handheld Computer Use*

> **Finding 4:** *Barriers Hindering Handheld Computer Use*

<u>Research Question 3:</u> What are the attitudes, expectations, and needs of physicians with respect to the use of handheld computers in clinical practice?

> **Finding 5:** *Physician Attitudes*

> **Finding 6:** *Physician Needs*

> **Finding 7:** *Physician Concerns*

> **Finding 8:** *Physician Expectations*

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Finding 1:   Uses of Handheld Computers in Clinical Practice

Handheld computer use by physicians continues to grow and to attract the attention of the popular press and well as health management publications. As previously mentioned, a 2002 survey found that approximately 35% of practicing physicians use a handheld computer for personal or professional purposes, with two thirds of these using a pharmaceutical reference database on their handheld computer.[1] Given that handheld computers are generally purchased and owned by physicians themselves, this high level of handheld computer usage speaks to the value these physicians place on the devices.

In Table 1 we summarize the most common physician uses of handheld computers, based on both our data and our review of the literature.

Table 1: Common Physician Uses of Handheld Computers in Clinical Practice

• **Point of Care Assistance**
     o Pharmacy reference
     o Clinical reference literature
     o Clinical guidelines
     o Medical calculators
     o Decision aids
     o Patient education
 • **Patient Information**
     o Patient tracking
     o Patient clinical results
     o Individually-developed data bases
	• **Administrative Clinical Functions**
	     o Electronic prescribing
	     o Coding
	     o Charge capture
	     o Schedules
	 • **Research Activities**
	     o Data collection
	     o Participant education
	     o Articles, evidence, literature
	 • **Medical Education**
	     o Lecture notes, presentations
	     o Photographs, diagrams

Application Use Levels

When asked about their experience with handheld computers, physicians in our study reported considerable variability in both their use of different handheld computer applications, and their expressed interest in potentially using such applications in the future. Among physician handheld computer users, the single application most often used by physicians was a pharmacy reference, with ePocrates mentioned as the preferred pharmacy reference software. We summarize our findings about different applications and the proposed benefits associated with each application according to our study physicians in Table 2.

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Table 2: **Primary Handheld Computer Applications Used and Their Use Levels, as Reported by Study Physicians**

Handheld Application	Proposed Benefits for Physicians	Proposed Benefits for Patients	Current Use Among Study Physicians	Interest in Future Use Among Study Physicians
Patient tracking	Productivity	Fewer interruptions	Very low	Low
E-prescribing	Productivity, Quality	Timely prescriptions	Low	Moderate to High
Patient clinical results	Productivity	Timely results Quality of care	Low	High
Formulary compliance	Avoid call-backs	Accuracy	Low	Low
Research database	Data collection, Data accuracy	Societal benefit	Moderate	Low
Pharmacy reference	Productivity, Quality	Streamlined visit Quality of care	High	High
Medical reference	Productivity, Quality of care	Uninterrupted visits	High	Moderate
Decision Aid	Quality of care	Quality of care	Moderate	Low
Clinical Guidelines	Quality	Quality of care	Low	Low
Medical Calculator	Productivity, Quality of care	Quality of care, Timeliness	High	Moderate
Coding and Charge capture	Revenue capture System productivity	Accuracy	Very Low	Moderate to High
Calendar	Productivity	Timeliness	High	High

New and Potential Uses of Handheld Computers in Clinical Practice
Our research also uncovered a number of innovative new uses that organizations could consider for using handheld computers in clinical practice. These included the following:
- Collection of information about medical errors and near misses;
- Data acquisition through questionnaires or surveys;
- Distribution of databases such as formularies, consultant physician information, pharmacy phone numbers;
- Provider-directed patient education;

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- Clinical uses beyond physicians (e.g., nurse practitioners; nurses; dietary; physician assistants; pharmacy; inventory).

Device Selection and Purchase

Handheld computers are atypical clinical technologies in the sense that they are relatively low-cost and can be used independently, regardless of organizational information infrastructure (networks, databases, etc.). In addition, they are very often purchased by users themselves.

Most practicing physicians pay for their own devices, although they may rely on a healthcare organization to help them with various aspects of the purchases process. Such purchase support may range from simple advice about which device to purchase to conducting the entire purchase transaction and installing initial software to make the device "ready to go out of the box".

Medical schools and residency programs often purchase handheld computers for their students, based on the assumption that these devices are critical to the learning experience or are a way to advance their image as a technologically advanced training program. Similarly, health systems may purchase handheld computers for non-physician personnel who are obligated to use the devices to perform certain work tasks (pharmacists, nurses, OR techs, etc.).

Handheld computers cover a very broad range of functionality, ranging from simple devices that are basically electronic organizers, to high-power products that rival the functionality of laptops. The first major decision faced by handheld computer purchasers is the selection of one of two operating systems: Palm OS and Pocket PC (a Microsoft product). The majority of handheld computers used in medicine run on the Palm OS. Organizations participating in our study generally acknowledged that ideal organizational support for handheld computers is independent of operating system. However these organizations tended to build an infrastructure that favors one or another operating system. Operating system choice subsequently affects options for a variety of other handheld computer features including software availability, data input options, and power requirements/battery life. For this reason, the decision to purchase a particular device manufacturer and model is secondary to operating system selection. We have included a list of factors to be considered in choosing a handheld computer in Appendix C. In addition, many websites devoted to handheld computers provide extensive information relevant to selection and purchase, among other handheld computer topics, and we have included a list of suggested websites as Appendix D.

Finding 2: Handheld Computer Use Patterns and Characteristics

Our focus group physician participants varied with respect to the frequency and intensity of their use of handheld computers, and our analyses of the data supported the development of categories to classify these physicians (Table 3). First, 17 percent of our participants were *non-users*, including physicians who had never used handheld computers and those who had used the devices for some period of time and then abandoned them. Second, *niche users* (20%) included those physicians whose handheld computer use was restricted to a single application. Niche users reported that this limited functionality was sufficiently valuable such that they would continue use, but they had not expanded use to multiple applications. Our third and largest group we defined as *routine users* (50%). These physicians had integrated their use of handheld computers into their clinical workflow and daily life, using multiple applications on a regular basis. Fourth, we identified a small but vocal group of *power users* (13%). These users were self described *"technophiles,"* eager to showcase their latest and greatest device, and all the tricks that were possible.

Figure 1: Handheld Computer Use Patterns Among Focus Group Physicians
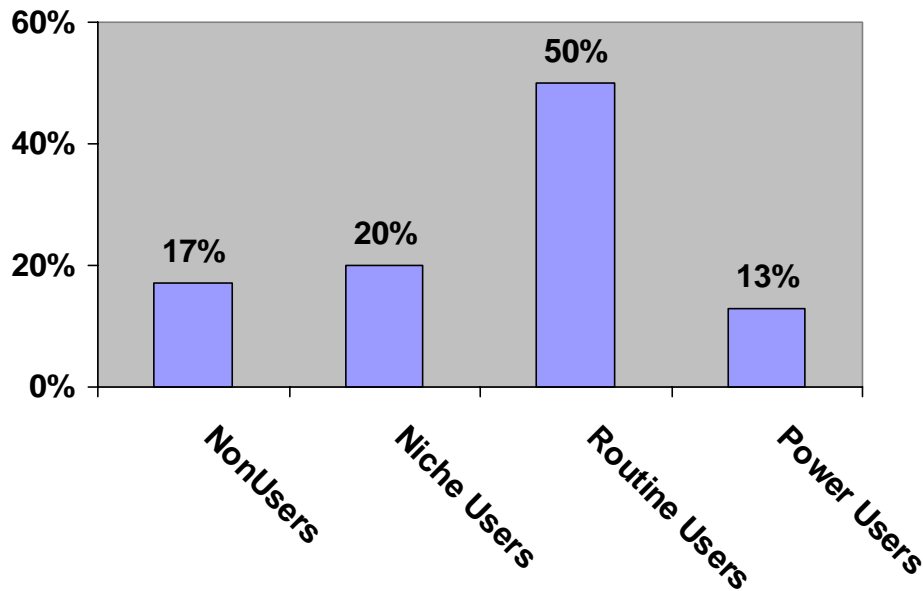
Table 3: Handheld Computer Use Patterns and Characteristics

Use Category	Non-Users	Niche Users	Routine Users	Power Users
Representation in Focus Groups	17%	20%	50%	13%
Use Pattern	Had never used or had used but abandoned handheld computers	Regular use limited to single application; popular uses include ePocrates, MercuryMD, or scheduling function	Regular use integrated into clinical workflow and daily life; use of multiple applications for different purposes	Constant use characterized by desire to push device to its functional limits; often developed original programs or data bases; described frequent upgrades
Usage Replaces	Nothing	• Some paper references • "*It replaces the PDR*"	• Most paper references • "*I no longer carry a calendar or most of my reference books*"	• All paper • It replaces "*everything in my pocket*"
User Characteristics	• Skeptical • Uninterested in change • Relatively uninterested in new technologies • Perceive little or no value in handheld computers	• Busy but list-oriented • Curious but hesitant • Low or limited expectations • Committed with one application	• Willing to experiment gradually • Open to new information about handhelds • Can be peer champions • Recognize greater potential	• Technophiles • Peer champions • Active promoters • Like to show off latest and greatest devices and functions
Representative Comments	• "*Paper references and nurses are quicker*" • "*I don't have time to figure that out*"	• "*I don't have a lot of extra time*" • "*For ePocrates, it's great*"	• "*I know it can do more*" • "*I think this is great!*"	• "*It's my life*" • "*I've always loved technology and gadgets*"

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How Handheld Computers Can Change Clinical Practice: A Case Example
Given the variety of handheld computer features and software applications available,
handheld computers can quickly become indispensable to a physician's work. As
discussed, our research showed that many physician users are content to use their
handheld computer for only one application. We developed Table 4 to show how the
handheld computer can change the workflow of a hypothetical office-based physician,
based on our study interviews. A similar level of seamless integration for handheld
computer use in clinical workflow is also possible for hospital-based practitioners
including internists, hospitalists, and most specialists.

Table 4:   How Handheld Computers Can Change Clinical Practice:
A Case Example of a Patient Visit to a Family Practitioner

Physician Activity	*Paper-based Activity*	*Handheld Computer-Supported Activity*	*Benefit from Handheld Computer Use*
"Your symptoms bring to mind a couple of possibilities. I'd like to check my references…"	...so I will have to run down the hall."	….so let me see what we have here…"	MD stays in room. *Patient service is improved and time is saved*
"Just one more question about your symptoms…. is the pain greater in the morning or the evening?"	Works from memory to avoid leaving the room again	Taps in answer and confirms memory-based response	Allows check with decision aid. *Improved quality of care*
"I'm considering a couple different medications for you."	…so I will leave just one more time and be right back." Leave room to search for, and check, PDR	…it says here that we have a couple of equally good options for you."	MD stays in room. *Patient service is improved, time is saved*
"What kind of medical insurance do you have? I want to make sure this is covered."	"…we only have a few patients covered by that company. Let me see if my nurse knows about this."	"…I see here that your company's formulary has a higher co-pay for one of these options."	Eliminates surprises at the pharmacy and a possible call to the physician. *Saves patient money and improves convenience*

Physician Activity	Paper-based Activity	Handheld Computer-Supported Activity	Benefit from Handheld Computer Use
"Before I say good-bye, I wanted to check on your exercise. Last time you were here, we discussed the benefits of daily walks."	"I'm pleased to hear that. Keep up the good work."	Types a few numbers into a CVD risk algorithm. "Terrific. You can see here that your exercise level means a 20% decrease in your risk of …."	Patient given data to support behavior change. *Improved quality of care*
Writes prescription.	"Here's your prescription."	"Which pharmacy do you prefer? I'll just send this directly to the pharmacy. You can pick it up in 2 hours."	Patients records available electronically prescriptions can be sent electronically. *Improved service to patient and saves patient time*
Code office visit for billing	Fill out paper form and submit to clerical staff	Fill out paper form and submit electronically to third-party billing service	Quicker process. *Fewer days in accounts receivable*
At her son's soccer game, the physician's cell phone rings: "Hello, Mr. Jones."	"I'm sorry, could you refresh my memory…..And, what dose are you taking?	"I see here that I prescribed 40 mg….so, yes, those side effects are to be expected"	Saves physician time and embarrassment of needing to ask multiple questions. *Improved quality of care and patient peace of mind* (my doctor know me)

Finding 3: Organizational Implementation and Support Strategies

The importance of successful implementation of clinical information technology has never been greater. Nearly every hospital and health system is the U.S. considers the implementation of Computerized Physician Order Entry (CPOE or COE) to be a top strategic priority, and improvements in patient safety and quality are increasingly seen as contingent on clinical IT initiatives. Technology spending has become a substantial contributor to health systems' capital budget growth, causing boards of directors to emphasize management accountability for this increased spending. In turn, managers struggle to produce the notoriously murky return on investment (ROI) calculations for many types of IT investments. Further, depending on one's view of the role of clinical IT in patient care, some suggest that excessive concern about ROI may prevent health care organizations from making necessary investments in clinical technology infrastructure or conducting technology "experiments" that promote organizational learning.[28]

In this dynamic and pressured environment, it is not surprising that organizations show great variety in their approaches to adopting, implementing, and supporting handheld computers. Chief Information Officers (CIOs) differ in their perspectives about the significance of handheld computers as a mobile access point for emerging CPOE and web-based clinical data systems. In practice, handheld computer support and implementation strategies reflect an organization's strategic IT priorities, its position on the clinical information systems and CPOE implementation curve, and its physicians' need for, and interest in, handheld computer technology.

The organizations we studied followed one or more of three strategies with respect to handling handheld computer use in their organization. These are listed below and described in further detail in Table 5:
- *Active promotion, facilitation and support* for broad-based applications
- *Active support* for handheld computer niche applications
- *Passive support* for individual handheld computer users

In addition, we found several specific circumstances that could cause organizations to select a particular support strategy. These included:
- An increase in requests to purchase handheld computers may prompt an organization to standardize technical requirements, device and applications support resources, handheld computer patient data restrictions, and other handheld computer use policies.
- An increase in handheld computer requests in a certain operating function may lead to development of a niche application.
- A clinical champion, typically a technically savvy and politically influential physician, may provide vision, energy, and pressure for a particular approach.
- An organizational history of early adoption of new technologies or processes may result in the selection of an active handheld computer strategy to promote organizational learning.
- Abundant availability of laptops and other PCs in patient rooms and care delivery areas may reduce interest in handheld computers and lead to a passive strategy.

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Table 5: Organizational Approaches to Handheld Computer Support

Handheld Computer Strategy	Description	Strategy Rationale
Active promotion, facilitation and support for broad-based handheld computer applications	Organization invests in infrastructure to facilitate broad-based handheld computer use, including purchasing consultation, training, software installation, device maintenance, providing infrared printers and equipment for syncing to download data.	Investment justified by position that handheld computers are an effective means for providing information technology at the point of care and will continue to be a critical access point to the organization's clinical data systems.
Active support for handheld computer niche applications	Organization pursues one or more targeted application projects tied to measurable process improvement, such as hospitalist charge capture, patient information hand-offs at resident shift change, or data tracking in a specific clinical setting.	Investment in handheld computers is justified by expected outcomes (such as cost reduction, regulatory compliance, or improved timeliness) of targeted handheld computer applications. Added benefits may include organizational learning about handheld computer technology.
Passive support for individual handheld computer users	Organization provides a basic level of IT support for those seeking handheld computer assistance, but does not actively promote handheld computer use. Support may include purchasing guidelines, software installation, and limited syncing equipment.	Investment justified by avoiding risks to IT network functionality and security given the need to ensure that all handheld computer use is appropriate for the organization's technology infrastructure and complies with information security and privacy policies. Added benefits may include maintaining IT customer service expectations.

Organizational Opportunities Fostered by Handheld Computer Support
Organizational support for handheld computers can extend beyond the value associated with handheld computer use itself (i.e., productivity gains or quality improvements from using ePocrates instead of looking for a PDR or guessing about correct dosage). Three such opportunities were observed in this study:

- *Handheld computer-friendly organizations can be attractive to recruiting new physicians and retaining technologically proficient physicians*. Several of the participant resident physicians mentioned that handheld computer support can be a

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marker for an organization's commitment to technology innovations and would be viewed positively in a decision to affiliate with the organization. Other physicians noted that the level of their organization's support of handheld computer use influenced their perceptions of the organization overall.

- *Promote physicians and clinicians learning from each other*.   Handheld computers provide a means for physicians to discuss and share their clinical and IT knowledge. In every focus group we held, at least one physician had an "ah-ha" moment in which they learned about handheld computer capabilities from one another.

- *Handheld computer use as a stepping stone to other technologies.* Several physicians in our study expressed the feeling that handheld computers helped them become more comfortable with information technology in their clinical practice.

Finding 4: Barriers Hindering Handheld Computer Use

The wide range of applications available and benefits possible speak to the potential for handheld computers in clinical settings. Written materials and conference presentations are often advertisements for handheld computer applications. Vendors highlight the theoretical benefits of their applications, and authors of published case studies are often technophiles enamored with their own use of the device. However, the potential usefulness of handheld computer applications can be overshadowed by many types of barriers associated with this device.

Barriers that are specific to the individual user or to the device itself play a role in the likelihood of successfully introducing a handheld computer into any physician's work routines. These types of barriers are summarized in Table 6. We have included further detail about these personal issues in the form of representative comments from our study physicians regarding both the physical and perceptual constraints associated with using handheld computers in Box 1.

Table 6: Potential Barriers to Using Handheld Computers in Clinical Practice

Personal Issues	Device Issues
Physical Constraints - Physical Factors: eyesight, finger size - Age: time to retirement ***Perceptual Constraints*** - Comfort with technology - Comfort with device - Perception that handheld computers are not easy to use - Prefer paper - Prefer personal computers	- Size of screen, buttons, device - Lack of keyboard, difficult data entry - Lack of voice dictation - Limited memory - Limited battery life - Need to synchronize with PC - Speed of data exchange - Lack of integration with existing IS - Coordination with other devices such as pagers, cell phones

Box 1: Personal Factors Creating Barriers to Handheld Computer Use

Physical Constraints

Physical Factors
- *"My fingers are just too big for those buttons."*
- *"I think it will get worse as we start to pull in legacy systems results, and more and more with wireless. I'm not going to be able to see. And I doubt that people without 20/20 vision will be able to read this when we start pulling in information from everywhere."*

Age
- *"The problem is that it is hard for me to carry it around. So, I forget it all the time or I don't utilize it and I'm getting old."*
- *"...to what extent do people our age actually need to do it? So, if the records aren't all automated and it's a pain in the xxx for you, and you've got your list, you know."*
- *"how many years is it until you retire?"*

Perceptual Constraints

Comfort with Technology
- *"I've talked to a lot of people who have been really disappointed and I think it's just because of lack of experience with computers, and they don't feel comfortable."*
- *"If it doesn't work right, the first time or the second time, it's over."*

Comfort with Device
- *"But they don't fit in shirt pockets. This thing is just the wrong size for shirt pockets. It fits pants pockets. But it goes on and off. The on/off switch, so I'm sitting here clicking all day long and wondering what's wrong with my heart valve."*
- *"I found it was cumbersome. I just wasn't really comfortable with it. Heavy. I carried in my suit pocket and was uncomfortable. I carried it in my lab coat and it was uncomfortable."*

Perception that Handheld Computer is Not Easy to Use
- *"My partner tried to get it synched, took it home, tried to get it to work the first night. Couldn't do it, quit."*

Prefer Paper
- *"I'm using paper during the day. Because if you take notes, it's much more practical to take notes on a paper print-out and keep your to-do list on that than it is on a palm. Because you can just do it quicker and it's all right there."*
- *"But I played with it and basically what I think we found is that people like to be able to annotate, they like to have paper. It's tangible. You know, I can write on there "check Mrs. Jones' second potassium," and I can hand that off to someone and they'll do it for me and I can check off if I need to do something. It is very hard to annotate stuff on the Palm yet, I think. That is a problem I see across all the applications."*

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> **Prefer Personal Computers to Access Information**
> - *"I used it, but I have not found it convenient enough to go and buy one. Where I work we have computers everywhere and I prefer using a keyboard. I have not gotten used to using graffiti. The real estate is so limited on a Palm. I get to the point where it's like, you know, I will just go and use the PC [personal computer]."*

Finding 5: Physician Attitudes

Our study suggests that our physician handheld computer users are largely satisfied, even with limited use, and the majority of our physician respondents appeared interested in leveraging handheld use. In terms of attitudes and perceptions toward handheld computers, the typical physician in our study:
- Is satisfied with the purchase of his or her own handheld computer;
- Is content to use his or her handheld computer for a single application;
- Views handheld computer use as a substitute for paper references;
- Is unconcerned with security issues;
- Views handheld computer use as a personal choice;
- Desires organizational support for handheld computer use, but without pressure to use a handheld computer;
- Perceives that handheld computer use enhances his or her image as being "current" to patients and housestaff; and
- Feels dependent on his or her handheld computer.

Physician-Perceived Benefits From Handheld Computer Use
Physicians in our study cited five main reasons for using handheld computers in clinical practice: 1) productivity; 2) convenience; 3) improved quality of care; 4) improved patient interactions; and 5) the perception that they are able to be a better doctor by using the device. These benefits were not considered mutually exclusive, but were often noted as synergistic. For example, productivity- and convenience-oriented benefits were also perceived to improve care and service to patients. Our findings are supported by other studies of clinical information systems that have also highlighted the importance of productivity and patient care related-factors to physicians.[24, 29]

The primary reasons that physicians in our study use their handheld computers are time savings, convenience and quality of care. Some applications are perceived as providing all three of these main benefits. For example pharmacy reference applications, such as ePocrates, can provide all three benefits when it enables the user to not leave the patient to search for the PDR (convenience), avoid flipping through a book (time savings), and look up the side effects and dosage rather than work from memory (quality). This may explain why ePocrates is the "killer app" that convinced many of the physicians we spoke to continue to carry a handheld computer.

We have included representative comments from our respondents about these benefits from using handheld computers in Box 2. Although mostly self explanatory, these quotes

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reveal that doctors we spoke with are very much aware of how they come across to patients, and how handheld devices can help these interactions.   The particular theme of handheld computers allowing physicians to be better doctors is set apart from the related concepts of quality and patient interactions in that physicians spoke of how using their handheld computer changes their own clinical practices and self image as doctors. This level of honesty and self-reflection by physician participants was observed independently by all three investigators.

Box 2: Physician-Perceived Benefits of Handheld Computer Use

Productivity Gains

- *"It beats going through or finding a PDR or formulary or something so it really saves time, and half the time you can't even find the reference you're looking for, you know the physical book, and you know you have it on your Palm."*
- *"I feel like it saves me time so I don't have to step out of a room and look something up. I feel that I can make decisions right there at the bedside versus stepping out of a room and saying 'OK, I will talk to you about this at the next visit.'"*
- *"Anything where you don't have to wait for somebody to finish at the terminal and wait in a long line of doctors who don't have handheld devices, and they're all waiting to put their orders in. You've got your handheld device, you put your orders in and walk away while the other guy is still waiting. You've got an advantage."*
- *"I feel like it saves me time so I don't have to step out of a room and look something up. I feel that I can make decisions right there at the bedside versus stepping out of a room and saying "OK, I will talk to you about this at the next visit."*
- *"For me, to be able to sync my Palm before I make rounds and have all that information with me, then I don't have to run around and ask the nurse who says, 'I'm not a nurse, I'm a respiratory therapist'."*

Convenience

- *"It really saves you the aggravation of looking for something and not being able to find it that minute."*
- *"I like having it in the busier situations...I mean you don't have to leave the patient at all. That's really convenient."*

Improved Quality of Care

- *"I think the way to approach it is quality, and the service you are offering, and the timeliness of the information."*
- *"I think it is convenient and sometimes it allows you to do more things that you'd probably otherwise just bag."*

Improved Patient Interactions

- *"You get a phone call from somebody. You have a clue. Right here, right now, right this minute I have a clue as opposed to as if "Hi Mrs. Jones. How is that problem?" in hopes that she'll spill the beans and remind you that it is headaches*

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or something. You know that is an embarrassing situation then."
- *"Initially I was afraid that if I had to use a device, they would think I was stupid. But I don't. It doesn't seem that they feel that way. I think I get credit for having devices, which is trendy, so they think I'm smarter."*
- *"I think the way to approach it is quality, and the service you are offering, and the timeliness of the information."*
- *Most patients that have seen me use this in front of them are very appreciative that they can get their questions answered in a more timely fashion rather than saying, "let me get back to you on that. I don't have the time to go in and look that up for you".*

Ability to Be a Better Doctor
- *"I don't guess that something is not interacting with warfarin and cross my fingers and hope. That's my biggest thing, I don't guess. Or say I will look that up later and not get to it."*
- *"I know I look things up more, medication-wise, only because in my kind of practice, my patients have side effects from medicines, and I prescribe a lot of things."*
- *"I've looked up somebody's rare diagnosis, something that no one knew quite what it was and it had a little blurb about it, and it turned out to be helpful then."*
- *"I think it is convenient and sometimes it allows you to do more things that you'd probably otherwise just bag."*
- *"...it reminds me to do things that I might forget to do. Not just be at this meeting, but I can get a glance and see that I haven't done the stool occult blood on that patient because they are in front of me."*
- *"I check up on medications all the time because it is quick and easy."*

Finding 6: Physician Needs

An organizational commitment to promoting handheld computers in clinical practice requires low capital investment but considerable support, especially from IT. Physicians particularly desire non-threatening, one-on-one support, and the best organizational models of IT support of handhelds observed in this study used nurse informaticists to help interested physicians.

Box 3: Physician-Perceived Needs to Support Handheld Computer Adoption & Use

Assistance with Handheld Computer Selection and Set-Up
- *"Make it ready to go out of the box: Set up PDAs with software and software for synching to PC [personal computer]."*
- *"I mean that's what a lot of physicians want. They want to just turn it on, start using it. They don't want to have to mess with any of that."*
- *"It would be helpful to know what is best. Is there something already out there or is it better to start from scratch and create your own?"*
- *"...it is so confusing because there are so many different devices out there. You know Palm operating system or Windows based system. (How do) you know*

> *which devices would be the best for you?"*
>
> - *"You have got to make sure that it is easy to use and easy to learn. It can't be something that is going to take, sit down and read the manual for 10 or 20 hours. It has got to be reliable. It can't be going down all the time. It has got to be simple. For example, the Palm is pretty simple."*
> - *"I think that cost is not an issue. I think it's more being reliable, being able to pick it up easy so it doesn't take a lot of time to learn how use it and just making them aware of what the advantages are."*
>
> **Training and Retraining**
> - *"But you know orientations just stink. Too much information. ..You know, we had our palms for like half a day when we had that session. So you hadn't really gotten a chance to do anything with it or look through everything at all."*
> - *"I guess personally, I would want instructions."*
> - *"I don't know how to use it to its fullest potential. It's my fault rather than machine's fault. But I haven't been educated enough to use it to fullest potential."*
>
> **Local Expert or Help Desk**
> - *"It's gotta be something where you can go back and dialogue with people and say I'm having a problem here or I'm not getting full the full advantage of this thing."*
> - *"And you know, when it doesn't, when it stops working for some reason, there has to be someone who can do it..."*
> - *"So I guess what we're saying is that maybe there should be like a first aid station ... somewhere I can go to, sit down and say this is what I'm trying to do. Why can't I do it? What did I do wrong? How can you help me make it right?"*
>
> **Handheld Computer-Friendly Environment**
> - *"It would be nice to have more sync cradles too I think, rather than having to walk all the way over to the chief's office."*
> - *"I think once we get the wireless then that could really save time."*

Finding 7: Physician Concerns

Physicians are concerned about both device reliability and dependence on the device itself. With respect to device reliability, physicians are concerned about forgetting the device, or having trouble with back-ups, system crashes, and so forth. As one physician summarized for most users, *"I was surprised how dependent upon it I've become…its very insidious."*

While physicians' concern about dependency might have been expected, we were surprised to hear many physicians express concern about their potential over-reliance on the device. In each focus group, the issue of over-reliance emerged in the form of discussions about using handheld computers as a *"peripheral brain,"* or commenting on the potential for practitioners to get so focused on the details of tracking and checking

with their handheld computers that they might *"lose the forest for the trees."*
Representative comments about each of these concerns are included in Box 4.

Box 4: Physician Concerns about Dependency on Handheld Computers

Concerns about Dependency on the Device and Its Functions…

- *"I am chairman of medicine, director of medical intensive care. I frankly break out in a cold sweat when I lose my Palm. I do. The residents know."*
- *"If I lose this, I get very nervous, very nervous."*
- *"I have had them crash before. I don't have another place to look up medications so I get very dependent on it."*
- *"There is a telephone number, I created an incredible list, and in fact I was pretty well incapacitated when my last Palm went down which also had email."*
- *"I think we all appreciate the convenience, but there's certainly a certain amount of fear underlying it that says, "Hey, what if somebody tampers with the system. What if the system goes down.""*
- *"I thought I had forgotten my Palm, I thought I left it at home. And I literally panicked. I took a deep breath, and I thought, wait, I left it in my car…I just thought, I need my Palm."*
- *"I think the back up disk is huge, because I use that and I feel like I can depend on it a little bit more."*
- *"…I slowly become more dependent on it and umm, I don't know if that's good or bad, but I'm kind of surprised actually how I made it more functional in my life as a whole and not just a menace. I didn't think I would actually."*
- *"The Palm runs my life- if I lost it! Ugh. It keeps track of all my appointments. I have had day planners and all kinds of other things. It is the printing feature that gives us the dependence on it. When I sat on mine and cracked it, I didn't have any of the records that I had in there about what I was supposed to be doing, I lost a lot of data. That was traumatic. Now I back up daily. Well, almost daily."*

Concerns about Over-reliance…

- *"I think …there is a part of me that worries that if I become too reliant on the calculator to do all my calculations for me that I will get to the point where I don't have to really remember any formulas and how you look at Ph."*
- *"One thing I'm worried about is the fact that I think more and more people are using the Palm as a crutch to a certain extent. And I do the same thing."*
- *"Certain skills you just lose by disuse, basically. Certain things would go away. I mean you would not need to remember. If it's a little esoteric from your mundane use, you will not need to remember it. You won't even try to remember it…"*

Finding 8: Physician Expectations

Both organizational and physician participants expect handheld computers to become more useful and more common in the future, if not ubiquitous in clinical practice. When asked about what they would like to see in terms of future handheld computer capabilities and uses, our respondents were, for the most part, enthusiastic and creative. The majority of physicians noted that they perceived an inevitable trend towards the incorporation of new electronic technologies in medicine. Further, participants in every focus group remarked on how new physicians are more and more comfortable with electronic technologies, especially as such devices proliferate. This point has been supported by recent surveys.[7] As summarized by one practicing physician, *"The residents coming out right now aren't at that stage right now, but very soon. Not far behind is a group that will only know computers."* The contrasting viewpoint, however, was also expressed. One participant approaching retirement explained, *"So the question is, how fast does everybody have to change? ... A lot of people are going to get away with not learning."*

The typical physician handheld computer user in our study expects:
- To continue to use his or her handheld computer;
- That technology will improve and further facilitate the use of handheld computers;
- Handheld computers to be faster to use than paper tools;
- Handheld computers to save time, once they get along the learning curve
- That his or her organization will provide support—instantaneously and comprehensively; and
- That healthcare organizations will move toward wireless capabilities and that this will improve handheld computer effectiveness.

Several participants in each focus group expressed the opinion that handheld computers were destined to become critical because of their potential to improve patient safety and the quality of care. Even when faced with the prospect of sacrificing personal autonomy, the optimistic view for the future of handheld computers was that it is more important to be right and to be safe:

> *"So in a lot of ways, our world has been our personal autonomy at getting things right. And more and more that paradigm is moving away. And the requirement of precision is much greater. So I'm not really allowed anymore to get the drug interactions wrong. So, I have to have a device that makes it right. … So, if you're going to be held to that standard, then you have to have the tools to be held to that standard. So we're talking about standard of care now, which affects all of us. So, whether you're in medical school and everyone has their Palm Pilot and they're whizzes at it, as opposed to somebody like me who's struggling and wants learn to be able to access and to benefit from this technology, we have to do it.…writing illegibly is not going to do it anymore."*

Additional positive expectations for change in the future are shared in Box 5.

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Box 5: Expectations for Change in the Future

- *"And I think what it all boils down too is just the time that it takes too long to manually enter everything. And we've also just talked about it before today, that you know if it could do it automatically, I think everybody would do it."*
- *"The day will come when people will think you are absolutely ludicrous to dictate anything because it's not checking your values and not checking your databases and ensuring your data entry, real-time."*
- *"Once we go to electronic medical records and vital signs and everything is entered in there and you can be wireless and get everything... You wouldn't need to get the cardex, you wouldn't need to get the vital signs, if all that is electronic, you could get that off the PDA."*
- *"I think every day in medicine there is more stuff that you gotta know and things are more complex. I think electronics is going to be our savior for our sanity and for medical errors and all that kind of stuff. I think there just has to be a place to deposit data and retrieve it fast. I think it is just inevitable. I think more and more of these requirements are going to come down the pike and everyone is going to have to rely on them. Think about when you got to search, screen people who have DVTs. What the hell do you do for somebody who has their first DVT? What things should you order and all that kind of stuff. I hope it is on PDA pretty soon."*

However, while many users were wildly enthusiastic about the potential for handheld computers in clinical practice, most maintained a sense of balance in their perspective. As one physician summarized for the group, *"Just like anything else, it's a tool, it's not the end-all-be-all. It has its pros and its cons, and you just have to learn get used to it. In some ways it's made our lives easier, and in others it's a bit more cumbersome."*

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V.   IMPLICATIONS FOR DECISION MAKERS

The findings from this study are applicable to a variety of individuals within hospitals and health systems. Targeted findings for different audiences within CHMR organizations are summarized below.

A. Actionable Findings for Administrative Decision Makers

1.   *Hospital and Health System Executives*

Investment
- Unlike typical IT initiatives, commitment to support handheld computers is characterized by budget commitment to personnel (training, user support) rather than heavy capital investment

Administrative Benefits
- Handheld computers can have numerous administrative benefits, and these potential benefits were among those mentioned by administrators explaining their rationale for supporting the devices. These administrative benefits include the potential to:
    1. Improve care and service to patients;
    2. Improve organizational work processes;
    3. Reduce drug costs;
    4. Improve documentation; and
    5. Reduce paper and printing costs.
- Representative comments from organizational decision-makers about these potential benefits are included in Box 6.

Box 6: Potential Administrative Benefits of Support for Handheld Computers

Improve Care and Service to Patients
- *"So the benefit here is that their patient is getting the treatment that they prescribed obviously faster and that has cumulative benefits, of course better care for their patient, but ultimately also some impact on length of stay and the longer their stay in the hospital the greater their propensity they are going to be exposed to infection and all kinds of other risks that we all know about."*
- *"The main driver of the program was to put information into the hands of the physician or practitioner that would allow them to make their point of care with that patient more valuable."*
- *"We've noticed a difference in doctors, especially in documentation in a physician who is interviewing you and he's got his pad of paper there and he is writing all these notes there is very little eye contact because he is writing all this stuff down."*
- *"One of the things we talk about is cultural competence… And what you'll do is you'll take some educational program in, [and on the] Palm what you'll provide them is the bullet point of what are they ways that a Korean female over the age of 50 might look at their relationship with their physician."*

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- *"It is to provide our patients the best care period. And our goal in IS to the organization is to facilitate that information distribution and exchange and ability to glean knowledge from the information that is out there and put it in front of that physician in such as way to make it if it is out there because the bottom line is it could be my neighbor or it could be someone in my family or myself."*

Improve Organizational Work Processes
- *"We have already seen a fairly significant improvement in the number of charges being done – the correct way that the charges are being done."*
- *"We've looked back at the ROI and saw that yeah there is a significant difference in savings in reducing these 50 steps… But the physicians are the ones who are using this and they don't really care about that stuff. That is not an incentive for them to use this. It is to reduce the amount of time that they actually work, and this reduces the amount of rework, which is sort of our goal right now."*
- *"And then of course the operational piece…of improving their billing and charging skills, just by the process of using this as opposed to the paperwork process. With paper you can check whatever you want or check nothing. This requires you to do this and this. There is learning that goes on."*

Reduce Drug Costs
- *"One of the drivers was lowering prescription costs."*
- *"Well, that was our original goal is to provide that application so that it can provide additional information to reduce expenses on drugs."*

Improve Documentation
- *"Using a documentation system that uses structured text or something like that, he is doing a whole lot less with his pen to accomplish the same kind of work."*

Reduce Paper and Printing Costs
- *"But looking at the decreasing in printing costs and paper being used, because we can actually query how many times people have run rounds reports versus how many times people have done it electronically."*

Potential Help with Other Clinical Information Technology Adoption, Use
- Another implication for hospital and health system executives is the potential for handheld computers to help in organizational initiatives to encourage physician adoption and utilization of all clinical information technologies. While not a guarantee, as one physician respondent noted, handheld computers can help:

   "I mean it's very different from COE (Computer Order Entry), but it's still the idea of using computer, using a handheld device, to do medicine. You know, five years ago here there were no palms and it was all paper orders and now we're much more electronic than actually a lot of places.… And I think it kind of just helps scooch us in that direction."

- Additional comments from study participants are included in Box 7.

Box 7: How Handheld Computers Can Assist with other Clinical Information Technology Adoption and Utilization

- *"I think that what we want to do is attract the physician to the use and development of the EMR and give the physician a number of venues to access that information."*
- *"Electronic medical records was our goal and while this does not get us there day one, it starts us down that road to that goal."*
- *"We have to change the culture so when they think about getting the information they don't try and chase down the piece of paper, they just go to the nearest PC or they have it in their hand and it is cultural kind of thing."*
- *"So it does a number of things, one is obviously incentivizes physician participation and collaboration in the development and tailoring of our EMR; two is it encourages physician input and ownership for the EMR; three it facilitates usability of physician order entry; and, it obviously exposes physicians to handheld."*
- *"I think it's more on the institutional side. Like when people first get it, there's only a few people who know, but as more and more people are exposed, it kind of spreads and the information diffuses out."*

2. Information Technology Executives and Technology Management

- While handheld computers require low capital investment, their integration may require new skill development among IT staff
- Handheld computer introduction creates ongoing demand for user support
- Investment in training will impact handheld computer use
- Increasingly handheld computer-savvy housestaff will demand more sophisticated IT support
- Trends in handheld computer use will likely be affected by availability of PCs in patient care areas
- The training and development processes required for handheld computers are different from those of other clinical information technologies. As one CIO explained,

  > *"The other thing is the development curve is shaped a different way – the way is it concave. Basically, the development curve for most of these [technologies involves] a lot of work and lot of development ramping up to a live event and then tapering off into a production system. This [handhelds] has a curve shaped …where the effort to get it out there is minimal, and it is a very incremental, you know give an enhancement and here is a new tool to do such and such."*

- A variety of approaches to training can be effective for handheld computers. Box 8 includes representative comments describing training strategies used at the organizations we studied.

Box 8: Training Strategies to Facilitate Handheld Computer Adoption and Utilization

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Training Strategies

- *"We are providing sort of a series, a menu of options, for training of our medical staff as we roll out POE. One being obviously a traditional classroom setting, two being personalized one on one support, three being fairly interactive web-based training program and through that program we are providing both obviously content in terms of the POE, but in addition to that, almost apparently providing computer literacy support for those physicians who have yet to master just mousing and basic computer skills, but that is a barrier."*

- *"I actually staffed the physician lounge this week…And, I stood around in there and when they came in I forced them to use the new version and talked them through it. It was a lot of fun."*

- *"There is the physical I-pac training. How do you use the I-pac itself even if you didn't do this application.   How do you use this thing, what are the tools and what is it capable of doing."*

- *"We are doing a train-the-trainer type scenario."*

- *"And those consisted of two pieces, one was a small folding paper and I can give this to you, that explained the basics of the palm such as this is how you enter it, this I how you do a soft sync, hard sync, things like that. And then they were given an introduction …saying this is essentially their palm and these are the things you should do and these are the things you shouldn't do."*

- *"The web based training program is also complete in its development."*

- *"High level support for our medical staff. To start with a group of early adopters and core group of physicians who will champion the implementation and usability across their medical staff departments. But our plan is … an 80-20 approach to training those physicians initially you have the highest, either high risk or high volume characteristics, and then sort of penetrate the medical staff from within."*

- *"We have been providing our medical staff demonstrations pretty much on a monthly basis. We call them open houses."*

- *"And we've also created what we refer to as a sandbox which is a place physicians can go play without getting hurt. It basically is a test environment where physicians have to be able to experience POE and also be more comfortable with using a computer. And that work has gone very well."*

- *"We have been showing some of this content to some of our medical staff leadership to sort of get their feel. And they are extremely pleased with what they have seen so far with the content. …The approach we take is pretty much …a very flexible and comprehensive approach to training our medical staff."*

- Organizations committed to expanding device adoption used creative approaches including: 1) randomly giving away handheld computers; 2) including games on handhelds when they were set up; and 3) holding open houses and forums including power users. Representative quotes describing these tactics are shared in Box 9.

Box 9: Innovative Tactics to Promote Utilization

- *"One of the things we have done with our executive physician advisory group…is giving away an I-pac to a physician randomly selected at every meeting."*
- *"When I deliver them is load games on it, to get them used to it, pushing buttons…"*
- *"I think that my giving them out early and allowing them to play with it which is really what I've driven."*

B. Actionable Findings Clinical Decision Makers: Physicians and Managers in Clinical Settings

1. Medical Directors

- More visible use of handheld computers by senior medical leadership will help expand physician use:
  Clinical Leaders as Organizational Champions
  - *"I think that probably… the thing that sticks out in my mind the most is when the chairmen of the medical staff went to the board and said, … "The best thing that you guys have ever done for me is this [give me a handheld computer]."*
  - *"There are some steps that must be taken and you need to have a medical director or whoever is in charge of making the decisions be able to say, 'okay we're excited, we've identified this product, now these are the steps we need to take before we even begin.'"*
- Community-based attending physicians may have little incentive to adopt handheld computers
- The recruitment and retention of new physicians may be facilitated by handheld computer-friendly environments
- Handheld computers offer a low-cost, mobile solution for various types of data collection:
  Collecting Data About Medical Errors and Near Misses
  - *"Another interesting thing … some of the hospitals may focus on is reporting of events or errors and trying to really increase compliance of that. That would be nice is something relatively anonymously could report an error via this way and it is fed into the hospital information system without having to go find the nurse manager, fill out the form."*
  Collecting Provider, Research, and Patient Data
  - *"the ability to add questionnaires and things like that. They will work with us to add the questionnaires, but what we did was they had a pretty standard clinic office questionnaire form that they fill out every time they see the patient."*

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2. *Residency Directors*

- Demand for institutions to be "handheld computer friendly" will increase in coming years
    - *"I think it's been nice to get them in residents' and students' hands. I think they appreciate it, so I think it's been positive for the spirit of the place."*
- New residents have likely been exposed to handheld computers as medical students and a growing number own a handheld computer
    - *"with the medical students as a whole... They'll try anything on them. You know, as soon as they get it to work, they spread it to everybody."*
- Handheld computer-using residents expect to continue to use handheld computers in their clinical work routines
- Two handheld computer applications with exceptional potential are resident case logs, as required by ACGME, and patient information transfer, for handoffs that occur with resident shift changes required by new work rules

3. *Performance Improvement and Clinical Effectiveness Directors*

- The potential for handheld computer applications that translate to clinical process improvement appears limitless but barely tapped. As an example, the infrared beaming capability of handheld computers can be used to improve hand-offs and information sharing among care team members, yet physicians rarely use this option to coordinate with other clinicians.
- The potential to effectively use handheld computers in non-physician care processes is substantial, with pharmacy, nutrition, therapy, nursing, and care management activities as prime opportunities
- Developing this area may involve greater investment in devices, institutional infrastructure, and user support, as compared to physician handheld computer use.
- New companies and applications are increasingly being developed (e.g., www.infopoems for evidence-based medical practice).
- Key to successful applications development and deployment will involve engaging interested physician users, collaborating with health services researchers

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VI.   DISSEMINATION OF FINDINGS

Dissemination To CHMR Corporate Members
The results of this study have been presented to the Center for Health Management Research in the form of periodic progress reports and biannual presentations to the corporate members. We have also made a formal presentation to the Midwest VA Network, sharing our findings with a broad organizational audience. If additional corporate members are interested in having us present our results, please do not hesitate to contact us.

Dissemination through Publication
At the present time, the following manuscript is under consideration for publication:

> McAlearney, A.S., Schweikhart, S.B., Medow, M.A. "Physicians' Experience Using Handheld Computers in Clinical Practice: A Qualitative Study." Under review by *The British Medical Journal*.

Additional manuscripts under development and their intended publication targets include the following:
- "Use of Handheld Computers in Clinical Practice: A Qualitative Study." Submission planned to: *Journal of the American Medical Association*.
- "Organizational Perspectives on Clinical Use of Handheld Computers." Submission planned to: *Health Services Research.*
- "Adoption and Use of Handheld Computers in Clinical Practice." Submission planned to: *Journal of the American Medical Informatics Association*.

All publications will be shared with CHMR members as soon as they are available

Dissemination at National Meetings
For further dissemination of research results, we will also be making presentations at several national meetings, at which credit for research sponsorship and participation will be given to CHMR and the Corporate Members. These include:
1. McAlearney, A.S., Schweikhart, S.B., Medow, M.A. "Handheld Computer Use in Clinical Practice: A Qualitative Study." Academy of Management Annual Research Meeting, New Orleans, Louisiana: August 2004 (forthcoming).
2. McAlearney, A.S**.,** Schweikhart, S.B., Medow, M.A. "Handheld Computers as Technology Innovation in Clinical Practice" Academy Health Annual Research Meeting, San Diego, California: June 2004 (forthcoming).
3. McAlearney, A.S**.,** Schweikhart, S.B., Medow, M.A. "Adoption and Use of Handheld Computers in Clinical Practice" Academy Health Annual Research Meeting, San Diego, California: June 2004 (forthcoming).
4. McAlearney, A.S. "Handheld Devices in Patient Care Delivery." University of Chicago, Department of Health Studies; Chicago, Illinois: Fall 2004 (forthcoming).

Further, the following presentations of findings previously presented at CHMR Industry Advisory Board meetings have already been made:

- McAlearney, A.S. "Handheld Devices in Patient Care Delivery." Videoconference Presentation to CHMR Member, Midwest Regional VA, January 2004.
- Schweikhart, S.B. McAlearney, A.S., Medow, M.A., "Organizational Strategies for Handheld Devices in Patient Care," Annual Meeting of the Decision Sciences Institute, Washington, D.C., November 2003.

If additional presentations of general or specific findings are of interest to CHMR member organizations, please contact us directly (Ann McAlearney, mcalearney.1@osu.edu; 614-292-0662; or Sharon Schweikhart, schweikhart.1@osu.edu; 614-292-9708).

VII. CONCLUSIONS

What These Findings Add to What Is Known About the Topic

Numerous descriptive articles have categorized options for physician use of handheld computers and physical issues related to device use. However, little research has explicitly examined either physician or organizational perspectives about handheld computer use in clinical practice. In particular, it has not been understood how physicians across practice settings view or value handheld computers, and what concerns they have about device use. Further, little has been known about organizational strategies to promote device use, and any barriers or facilitators to device adoption.

Our study suggests that our physician handheld computer users are largely satisfied, even with limited use. Both organizational and physician participants expect handheld computers to become more useful, and the majority of physician respondents appear interested in leveraging handheld use. Physician participants were concerned about device reliability, and expressed particular concern about becoming too dependent on the devices. These concerns had not been previously uncovered or explored. Participant physicians suggested that organizations can promote handheld computer use by providing training and re-training to extend user knowledge, user support and advice to build confidence in the technology, and institutional options to leverage handheld computer use such as mobile access points to essential point-of-care information; physician-proposed ideas had not been sought or explored in prior research.

Conclusions

For organizations interested in supporting and promoting information technology solutions to improve clinical practice, understanding the implications of our work on handheld computers can help them in other technology implementation projects. In particular, the critical role of clinical change agents can be leveraged to promote and expand technology diffusion among physicians often uninterested in new information technologies. Further, findings from our study show how the relatively inexpensive option of accommodating handheld computers can successfully facilitate both organizational and individual change as organizations attempt to bring more IT to the point of care and support a digital patient care environment.

Final Thoughts

This study has produced a tremendous amount of new and interesting information about how handheld computers are used and perceived in clinical practice. As previously mentioned, if any CHMR members are interested in discussing these findings further or determining how these findings can be specifically applied at their institutions, please feel free to contact us directly (Ann McAlearney, 614-438-6869, mcalearney.1@osu.edu; Sharon Schweikhart, 614-292-9708, schweikhart.1@osu.edu).

We thank CHMR and the corporate members for your generous support of and participation in this exciting management research project. We are extremely grateful for the opportunity to conduct this study, and for the access we have been provided to both the institutions and advice of the CHMR corporate members.

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IX.   APPENDICES

A. Case Study Interview Guide

B. Focus Group Questions

C. Handheld Computer Selection Factors

D. Suggested Web Sites

E. Additional References

Appendix A: Case Study Interview Guide

A. Handheld Use

- **How are handhelds used at in your organization? (clinical, administrative) – get historical perspective**

- What motivated you to initiate using handhelds?

- Was there a specific individual who introduced the idea of using handhelds?

- Who uses handhelds? (Administrative, Clinical) (further specificity: physicians, residents, students, nurses, pharmacy, nutrition, administrators, supply, laboratory, etc.) How do they use handhelds?

- What about the use of laptops or PCs? Is this coordinated with use of handhelds?

B. Handheld Use in Patient Care Delivery

- **How are handhelds used in clinical practice?**

- How were handhelds introduced in the patient care setting?

- Who uses handhelds (following from first answers)?

- How do nurses use handhelds?

- Are handhelds used primarily by individual physicians or is there coordinated use within patient care teams? (Could you provide examples of such use?)

- What hardware is involved/what software? (What vendor applications do you know are in use? What are planned?)

- Are you working on any projects with specific vendors?

- What are the sources of handheld data? Are data entered by staff (e.g., for PatientKeeper)?

- Outside the facility, are handhelds used by residents or others for clinical care purposes?

C. Physician Attitudes, Expectations, Needs, Behaviors

- **How do you think physicians feel about the use of handhelds in clinical practice?**

- What resistance (if any) have you experienced from physicians?

- Do physicians/clinicians have expectations of you to provide support for their use of handhelds?

- How do you support clinical use of handhelds?

- Could you describe any instances of physician champions promoting the use of handhelds?

- Are there examples of physicians providing resistance to the use of handhelds in patient care delivery? Please describe

- What types of concerns have you heard physicians express about using handhelds in patient care delivery?

D. Implementation: Barriers/Challenges and Facilitators

- **What strategies have you used to integrate the use of handheld devices into patient care delivery?**

- How do you promote the use of handhelds in the organization? (software upgrades, training, mandatory distribution of devices, etc.)

- What education have you provided? (has this been different for different groups in the organization (physicians vs. others?)?

- What training have you offered?

- What techniques have been used?

- What types of activities are planned with respect to training and education?

- **What challenges have you experienced promoting the use of handhelds?**

- **What barriers do you anticipate might be problems affecting the future use of handhelds in your organization?**

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E. Organizational Change and Learning

1. **THEORY: Planned vs. emergent changes (Orlikowski and Hofman, 1997)**

    One of the theoretical constructs we are assessing in this research study is the notion of planned versus organic change in organizations. To this end, there are three types of change that we are considering:
    - **Anticipated Change**: changes planned ahead of time, occur as intended
    - **Emergent Change**: changes arising spontaneously, local innovation, changes that are not originally anticipated or intended
    - **Opportunity-Based Change**: changes not anticipated ahead of time but purposefully and intentionally introduced throughout the change process; in response to opportunities, events, or breakdowns that are unexpected

    - Given these three options, can you give examples of the types of changes that the use of handheld devices has fostered in your organization?

    - What changes in clinical activities could you describe that have occurred?

    - Can you describe any changes in institutional operations as a result of using handhelds?

2. **THEORY: Classifying the type of organizational change (Kaluzny and Vency, 1977)**

    Another means of categorizing organizational change it so consider the type of change occurring in an organization. This organizational change model notes the distinction between change processes that are aimed to change the activities of an organization (Technical) versus those that truly involve the goals and products of an organization (Transitional). Organizations that are involved in both of these types of change would be considered Transformational.

    Along these lines, there are three types of change processes that could be occurring, distinct from the differences between planned and emergent changes.
    - **Technical change**: change of the means, typical organizational activities
    - **Transitional change**: changing the goals of the organization, keeping the structure the same
    - **Transformational change**: changing both the means and the ends within an organization; dramatic change affecting structure and process, goals and outcomes

- Thinking about the type of changes involved in introducing handheld devices in patient care delivery, how would you classify this change? Why?

3. THEORY: Stages of organizational change (Smith and Kaluzny, 1986)

Thinking further about organizational change, there are different stage models of change for organizations. One of these is a four-stage model with the following components:
- **Awareness**: of need for change
- **Identification**: of specific opportunities for change
- **Implementation**: of specific change
- **Institutionalization**: incorporation of change throughout organization; reflected in a changed organizational culture

Thinking about the use of handhelds in your organization, which stage of organizational change would you say you are in? Why? How did you progress through the other stages? When did the other stages happen (how long did they take)?

Assuming you are not yet to institutionalization, how long do you think it will take to get there? Is this a goal?

4. THEORY: Change Implementation (Kanter, et al., 1992)

Another area to consider in organizational change is that of the theory surrounding enabling and implementing a change. Six enabling factors have been identified for implementing organizational change. How would you describe your organization's change process (situation) with respect to these factors?
- **Pace**
- **Scope**
- **Depth**
- **Publicity**
- **Supporting structures**
- **Who has been driving the change process (level in the organization)**

How is implementation proceeding in your organization?

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5. THEORY: Organizational Learning

- Do handhelds foster organizational learning? Changes in clinical practice?

- How has use expanded/spread over time? Is there a plan to expand use?

- Do some users create their own applications?

- Can you provide an example of how institutional operations have changed since the introduction of handhelds in clinical practice?

F. Clinical Quality and Outcomes

- **How did you anticipate that the use of handhelds would change patient care/clinical quality?**

- How can you see quality of clinical care being affected by the use of handheld computer?

- Have you studied outcomes due to handhelds? Can you hypothesize about changes in outcomes and care processes?

- How have you perceived the reactions of patients/parents to the use of handhelds by clinicians?

- How is the use of handhelds perceived by others in the organization (e.g., of physicians by nurses)

- Can you describe instances where new uses of handhelds have emerged in response to opportunities for process improvements or improvements in patient care?

G. Information Systems and Technology

- **How have you attempted to integrate the use of handheld devices in your organization?**

- Is there a plan to integrate handhelds with existing or new information systems capabilities?

- Is the introduction of handhelds similar to any other technology introduction process you have experienced? How so?

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- Is there a link to organizational IS (e.g., results reporting, patient financial or clinical data, etc.)

- Is there printer access for handheld users? Infrared printers? (Where? Is it used?)

- Who is involved in technology adoption decisions? Who is accountable for changes in information technology?

- Is use of handhelds wireless? Is wireless expected or a goal in the future?

- How do you handle handheld security? (Handhelds are lost, misplaced, taken home, left in pockets and on car seats, etc. Wireless transmissions can be intercepted. HIPAA concerns.) How are security issues resolved (especially around use of handhelds outside the facility)?

H. Organizational Support

- **How have resources been allocated for the use of handhelds? (Resources? Money? Time? IT staff? Other staff?)**

- **What managerial concerns do you have regarding the use of handhelds?**

- Have there been any efforts to standardize applications across the organization?

INTERVIEW CLOSURE AND FOLLOW-UP

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Appendix B: Focus Group Questions

Introduction

What we are interested in is obtaining perspectives about physicians needs, attitudes, behaviors, and expectations about using PDAs in clinical practice. So, as physicians, we turn to you to get the answers to these questions…

To begin, we'd like you to spent a couple minutes writing down your thoughts about this topic. Here are papers and pens, so if you would, please jot down a few ideas you have about your use of PDAs in clinical practice.

Now, to get going, let's have everyone introduce themselves and describe how you do or do not use PDAs in your clinical practice.

(1. How do you use PDAs in your clinical practice, or do you not use them?)

2. Why do you use PDAs?
  - Did someone show you?
  - Were you required?
  - Was/is there a specific benefit?

    If you don't use, why not?
  - Took it out of box and it didn't work
  - Takes too much time
  - Other

3. Now that you have the PDAs, do you do things differently?
  - On rounds or preparing for rounds?
  - When you talk with patients or their families?
  - When you talk with nurses, other clinicians?
  - When you make consults?
  - When you write notes?
  - When you change shifts?

4. What are benefits you have found using PDAs?
  - What features or aspects of PDAs are most useful to you?

5. Have you encountered any specific barriers or challenges using PDAs (in clinical practice)?
  - Do you have any fears/concerns so far, based on your own experiences of those of others?

6. Is there anything you need from your organization with respect to support, resources, etc. to make using PDAs easier?

7. What did you expect with this technology?
   - Have there been any surprises?
   - What did you expect that didn't happen/you didn't get?
   - What did you get/what happened that you did not expect?
   - (In clinical care)

8. What does this replace for you? What is completely new?

9. Are the PDAs changing how you feel about and/or use other technologies?

   - Do you have more confidence with other technologies you use or might use in the future?

Wrap Up:

Make sure everyone has the opportunity to make a final statement, answering the question…

10. What would you like to be able to do with the PDAs?

In Conclusion…

11. Do you have other comments or concerns about the use of PDAs in clinical care? (anything else you want to say/comment on?)

Appendix C: Handheld Computer Selection Factors

PDA Feature	Comments
Operating System	The most important aspect of the operating system is what kinds of software have been written to run on it. Palm is the clear leader in terms of market share, hence more applications are written for Palm devices (see below). A Pocket PC interface may be more familiar for Windows PC users. However, the Palm OS is more efficient. Thus, a Pocket OC device takes more processing power to run. This means either faster processors are required, which generally cost more and use more battery power or response times are slower when you use the device.
Color	Color screens have a clearer display and enhanced readability in low light environments. The noticeable disadvantages of color are decreased battery life, and added size and weight of the device. More software is taking advantage of color displays, and the result may be more than just aesthetics, as in the case of color highlighting of medical alert information.
Battery Life	The monochrome Palm OS PDAs are the hands-down champions, with a pair of batteries lasting the better part of a month with fairly regular use. A Pocket PC device or a Palm OS device with a color screen would exhaust the batteries in a matter of days, if not hours with similar use. Most higher-end PDAs and all color devices have rechargeable batteries. This system works if the device is placed in its cradle regularly.
Memory	Pocket PC devices generally come with more memory that their Palm OS counterparts. What is much more important than the amount of memory that comes with the device is whether or not you can add more.
Size	Part of the reason for the success of the Palm PDA has been its compact size. Palm OS devices have added more functionality yet, retained their ideal form factor. Pocket PC's have tended to be larger.
Software	With over 7,500 programs available, there is very little that you cannot do on a Palm PDA. The software library for Pocket PC is slowly improving and one advantage is that, because the operating system is written by the same company that powers most desktops, synchronization between the two and some of the more popular applications (such as Microsoft Word and Excel) can be easier. The core programs (databases, document readers, drug guides, etc.) are generally available on both platforms.
Expandability	Expandibility is what will keep your device from becoming obsolete too quickly. Because expansion slots allow you to add

	things like memory and accessories, you can increase the functionality of your device over time with out having to replace it. Almost every manufacturer makes a device with an expansion slot.
Data Input	Almost all handheld computers use a stylus for data input, some PalmOS version include a thumb keyboard as well. Both Palm OS and Pocket PC devices have detachable keyboards which can be used for data entry.
Speed	One of the benefits the streamlined design of the Palm OS provides is quick response time. Because the operating system is quite simple and does not need to process colors (color models excluded of course), Palm OS devices are very fast. Pocket PC devices on the other hand tend to be a little more sluggish as the processing required to produce full-color, graphic intensive images is high.
Market share	In terms of market share, Palm OS devices are the clear leader, out selling the Pocket PC devices almost 8 to 1. Thus, software developers often write applications for the Palm OS that they do not release for Pocket PC. Also, what your colleagues are more likely to be using may influence your choice, since one of the key benefits of a PDA is being able to share information using infrared beaming.
Price	PDAs generally range anywhere in price from $100 all the way up to $1,000 with physical size, memory and color being the most influential factors in pricing. Devices based on the Palm OS tend to be at the low to mid range of this spectrum with Pocket PC devices at the middle to higher end.
Functionality	Out of the box you will find that Pocket PC devices have the broadest functionality. For example, voice recording capability, MP3 players and video players are pretty standard on most Pocket PC units. For the most part, extra attachments are quite common for Palm OS devices and allow you to add exactly the features you find most desirable.

Source: www.mdPDA.com

Appendix D: Recommended Web Sites

This list is not exhaustive (an impossible task) but is complete in the sense of providing introductory and advanced information and resources for PDAs in medicine/clinical settings.

Representative Medical PDA Sites	
Medical Sites	
CollectiveMed.com	http://www.collectivemed.com/pdasource.shtml
ectopicbrain	http://pbrain.hypermart.net/
Med Student Cafe PDA Center	http://www.medstudentcafe.com/pdacenter.htm
MedCalc	http://medcalc.med-ia.net/
PDA Cortex	http://www.rnpalm.com/index.htm
pdaMD.com	http://www.pdamd.com/vertical/home.xml
pdaRounds.com	Http://www.pdarounds.com
PocketScript	http://www.zixcorp.com/caredel/
University Sites	
Arizona Health Sciences Library	http://educ.ahsl.arizona.edu/pda/index.htm
Norris Medical Library, USC	http://www.usc.edu/hsc/nml/lis/tutorials/pdas.html
The Ohio State University	http://library.med.ohio-state.edu/pda/
UNC-CH School of Medicine	http://www.med.unc.edu/pda/
University of Wisconsin-Madison	http://www.hsl.wisc.edu/instruction/help_guides_tutorials/handheld_palmtop_pda/index.cfm
Washington University Medical Palm Initiative	http://medicine.wustl.edu/~wumpi/index.html
Organizational Sites	
American College of Physicians	http://www.acponline.org/pda/index.html
Canadian Medical Association	http://www.cma.ca/cma/common/displayPage.do?pageId=/staticContent/HTML/N0/l2/General/pda.htmhttp://www.nkdep.nih.gov/GFR-PDA.htm
National Heart , Lung and blood Institute	http://www.nhlbi.nih.gov/health/prof/other/index.htm
National Kidney Disease Education Program	http://www.nkdep.nih.gov/GFR-PDA.htm
Commercial Software Sites	
Doctors Gadgets	http://www.doctorsgadgets.com/
Epocrates	http://www.epocrates.com
iScribe ePrescribing	https://physician.advancepcs.com/advpcs_phyres/ePrescribing/ePrescribing.html
HanDBase	http://www.ddhsoftware.com/medical.html
handheldmed	http://www.patienttracker.com/index.htm
MDeverywhere	http://www.mdeverywhere.com/Home/index.aspx
PDA Medical Software	http://www.mdlinks.net/pda.htm
StacWorks	http://www.stacworks.com/
Stat Coder	http://www.statcoder.com/

Appendix E: Additional References

Source: http://www.uic.edu/depts/lib/lhsp/temp/bibsub.shtml

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