NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

INTEGRATION OF PERSONAL DIGITAL ASSISTANT (PDA) DEVICES INTO THE MILITARY HEALTHCARE CLINIC ENVIRONMENT

by

Jason Keltner
and
Paul Miller

September 2001

Thesis Advisor:	Carl Jones
Associate Advisor:	Donald Brutzman

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The business drivers within managed care are mandating that physicians have point-of-care access to medical reference data, patient specific data, formularies, treatment protocols, and billing/coding information. One emerging technology that has the potential to provide this access with little economic investment is the mobile Personal Digital Assistant. The authors address a variety of wireless technologies and security concerns regarding real-time access to patient data. The family practice staff at the Naval Hospital Lemoore explored and contrasted the capabilities of commercially available PDAs, wireless interfaces, and medical software applications to ascertain their value within the Military Health System. A production-ready interface between the Composite Health Care System and the Nutrition Management Information Server demonstrates the potential for eliminating the difficulties associated with documenting patient encounters and capturing charges. Survey tools generate a requirements standard for deployment of this technology within the Military Health System on an enterprise-wide scale with a hybrid approach to packaging based on functionality. The authors recommend the Military Health System embrace this technology as a means to realize its vision of best value health services.

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INTEGRATION OF PERSONAL DIGITAL ASSISTANT (PDA) DEVICES INTO THE MILITARY HEALTHCARE CLINIC ENVIRONMENT

Jason R. Keltner
Lieutenant, United States Naval Reserve
B.S., University of La Verne, 1989
M.B.A., University of LaVerne, 1991

Paul C. Miller
Lieutenant, United States Navy
B.A., Rutgers University, 1989
M.H.A., St. Joseph's University, 1992

Submitted in partial fulfillment of the
requirements for the degree of

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NAVAL POSTGRADUATE SCHOOL
September 2001

Authors: ______________________
Jason R. Keltner

____
Paul C. Miller

Approved by: ______________________
Carl Jones, Thesis Advisor

____
Don Brutzman, Associate Advisor

____
Dan Boger, Chair
Information Systems Academic Group

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ABSTRACT

The business drivers within managed care are mandating that physicians have point-of-care access to medical reference data, patient specific data, formularies, treatment protocols, and billing/coding information. One emerging technology that has the potential to provide this access with little economic investment is the mobile Personal Digital Assistant. The authors address a variety of wireless technologies and security concerns regarding real-time access to patient data. The family practice staff at the Naval Hospital Lemoore explored and contrasted the capabilities of commercially available PDAs, wireless interfaces, and medical software applications to ascertain their value within the Military Health System. A production-ready interface between the Composite Health Care System and the Nutrition Management Information Server demonstrates the potential for eliminating the difficulties associated with documenting patient encounters and capturing charges. Survey tools generate a requirements standard for deployment of this technology within the Military Health System on an enterprise-wide scale with a hybrid approach to packaging based on functionality. The authors recommend the Military Health System embrace this technology as a means to realize its vision of best value health services.

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I. INTRODUCTION

A. PURPOSE

This thesis focuses on evaluating personal digital assistants, wireless technologies, medical software applications and generates a requirement to enable the deployment of a comprehensive system that will provide accurate access to diagnostic and billing information. This technology will streamline processes and integrate data collection and information retrieval, thus reducing time spent on administrative tasks and increasing the time providers spend with their patients, which will enhance quality of care and patient satisfaction levels and may lead to safer outcomes. In addition, more complete and accurate patient encounter documentation can dramatically reduce third party revenue losses and greatly reduce billing/coding time.

The following table presents recommended reading indicated by highlighted areas based on functionality.

	Providers, Nurses, Clinicians	COs/XOs, Directors	Network Administrators, Security & Privacy Officers	Comptroller Billing Claims	CIOs, TMA, Program Offices
Chapter I	Section B only				
Chapter II					
Chapter III	Sections C,D,E				
Chapter IV					
Chapter V		Table 5.5 only			
Chapter VI					
Chapter VII	Section B only	Section B only		Section B only	
Chapter VIII					
Appendix A					
Appendix B					
Appendix C					
Appendix D					

Table 1.1. Suggested Reading by Occupation.

B. MOTIVATION

1. Administrative Burdens and Lost Revenue

Managed care changed physician incentives to control healthcare costs. Managed care has also dramatically increased the administrative burden placed on physicians. Patient expectations have risen and regulatory compliance has become more intricate. Physicians must now follow a series of insurer and health plan medical guidelines as well as prescribe only those medications that appear on an approved formulary. Physicians lack the requisite administrative tools, time, and expertise to manage these intricacies and clashes with management abound over inaccurate and incomplete patient data necessary for reimbursement. Inaccurate and incomplete patient encounter documentation results in dramatic decreases in revenue collection. A WR Hambrech & Co (WRH & Co) report which analyzed data from the Healthcare Financing Administration (HCFA) and healthcare industry studies indicates that $25 billion is lost in denied or reduced fee-for-service claims, annually. A Synergy Medical Informatics Study according to WRH & Co deduced that, "Lost billings average approximately $60,000 per year for each of the roughly 450,000 physicians in active clinical practice in the United States." (Fisher, 2000) These numbers are staggering and yet fail to account for delays in reimbursement due to coding errors and patient encounters that are poorly documented or not documented at all.

2. Medical Errors

The National Academy of Sciences' Institute of Medicine Division's report titled, T*o Err is Human*, stated that the cost of injuries resulting from medical errors exceeds $17 billion and accounts for 44,000 deaths, annually. (Hamblen, 2000) The report further indicated that 7,000 plus deaths in 1993 were the direct result of medication errors. These errors are a consequence of using the incorrect drug name, inaccurate dose calculations, and indistinct dosage directions. (Chesanow, 2000) Another study indicated that over 9 million prescriptions are rechecked due to illegible handwriting or to clarify a discrepancy over insurance/ formulary approval. (Freudenheim, 2001)

C. RESEARCH QUESTIONS

The primary research question addressed in this thesis is: Will deploying PDAs allow providers to use previously not easily attainable information when needed during doctor-patient interactions?

Ancillary research questions include the following:

- Can administrators and providers see a reduction in administrative tasks, cost savings, and increased third-party revenue?
- Is there a requirement to integrate PDA technology with Department of Defense (DoD) Medical legacy systems?
- Can quality of care and patient satisfaction increase by using PDA technology?
- Can providers capitalize on PDA technology and utilize its' full potential?
- Can wireless real-time access to patient data reduce medical errors?

D. SCOPE OF THESIS

This thesis:

- Provides a broad perspective on the uses of PDA technology as a business tool, both clinical and administrative.
- Generates a requirements standard through the use of survey tools.
- Demonstrates the benefits of deploying PDAs on an enterprise-wide scale with a uniform software and training package.
- Explores the benefits of wireless connectivity of the PDA in the clinical environment.
- Examines issues of connectivity, security, ease of use, network compatibility, reliability and user ease of administration/time reduction.
- Identifies appropriate key intangible factors.

E. METHODOLOGY

The methodology used for this research consists of the following steps:

- Conducting a literature search of books, journal/magazine articles, CD-ROM systems, and other library information resources for the years 1985 - 2001 using key word queries.
- Conducting a thorough review of current Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) standards and the Health Insurance Portability and accountability Act of 1996 (HIPAA).
- Exploring and contrasting the capabilities of various state-of-the-art 2001 PDAs.

- Determining how each system provides management and providers with the tools and information to make sound, informed, and timely decisions.
- Interviewing other healthcare organizations and medical technology companies that may add value to this thesis.
- Discussing the requisite changes in management/provider philosophy that must accompany deployment of this technology.
- Developing and testing solutions in a laboratory environment - implementing and analyzing those solutions in the field.
- Developing a user requirement survey and promulgating that survey throughout DoD Medicine as well as compiling the results for requirements generation.
- Assessing user and satisfaction levels using questionnaires, interviews, and observations.
- Installing wireless interfaces on devices and within Naval Hospital Lemoore.

F. ORGANIZATION OF STUDY

Chapter II offers the reader a brief introduction to background works in hand-held computers, including applications in the public and private sectors.

Chapter III details commercially available hardware (personal digital assistants and wireless interfaces) and medical software applications that were evaluated by Naval Hospital Lemoore's family practice clinic.

Chapter IV examines the difficulties associated with documenting patient encounters and capturing charges and proposes a solution using PDA technology. Furthermore, this chapter details two case studies which illustrate how these difficulties were successfully eliminated and explores the feasibility and value of using an HL/7 interface to provide patient information to a calendar on a PDA.

Chapter V explains the development and issuance of the user requirement survey disseminated in this study, and subsequent analysis and presentation of survey findings. It also examines the results of a second post-testing phase-out survey developed for the participants assisting with hardware and software assessment at Naval Hospital Lemoore.

Chapter VI examines the wireless networking technologies currently available for use with Personal Digital Assistants. These technologies include Frequency-Hopping and Direct-Sequencing Spread Spectrum, Coded Orthogonal Frequency Domain Multiplexing, Infrared and Bluetooth.

Chapter VII identifies the federal legislation that will drive security measures for electronic data, both at rest and in transit, within the healthcare industry. It explores solutions for safeguarding that data, using certification, integrity and authentication as guidelines. Encryption solutions are presented, and weaknesses are identified.

Chapter VIII provides conclusions arrived at during this study and applies them toward the military healthcare environment. Recommendations for future research are also presented in this chapter.

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II. BACKGROUND AND RELATED WORK

A. INTRODUCTION

In this chapter the authors explore physician acceptance of mobile devices as computer technology transitions from administrative offices to physician desktops and patient examination rooms. Also explored are the early generations of lightweight and portable devices, which are replacing these large desktop computers. Examined are related studies of work in both the private and public sectors.

In the early 1990's, the computer and communication industries realized tremendous growth in the mobile device sector. Mobile devices now abound. They interrupt the President of the United States during press conferences. They are an annoyance in restaurants when someone at the next table feels they are too important to turn off their cell phone for one hour. With global positioning satellites, they provide guidance on roadways and on golf course fairways and through wireless capabilities allow stock market transactions from a lounge chair on the beach. On the other hand, the integration of PDAs in healthcare although still in its infancy is lacking in-depth research, which examines clinical practice management efficiencies and improvements in quality of care. However, several articles do discuss briefly the processes of implementation and physician interaction with the devices.

B. PHYSICIAN ACCEPTANCE

1. Migration

Traditionally, computers in healthcare simply provided aid in the performance of administrative tasks such as scheduling and billing. Computer technology has since migrated from back offices and reception desks to physician desktops and patient examination rooms as a need arose for that technology to integrate with hospital information systems, access automated patient records, interface with pharmacy systems, and even to provide patient summaries for on-call physicians. Despite stereotypes that physicians are technophobes and resist change, physicians are embracing this new technology. The business drivers within managed care are mandating that physicians have point-of-care (P-O-C) access to medical reference data, patient specific data, formularies, treatment protocols, and billing/coding information. Concurrently, the technological revolution is allowing for large desktop computers and monitors, dumb terminals, a pocket full of 3 x 5 cards containing medical reference data, and stickies with hurriedly written patient encounter notes to be altogether replaced by lightweight and portable systems with powerful features.

2. The Technology

The early 1990's saw a new generation of hand-held computers. These hand-helds weighed a pound or less, were half the cost of desktop PCs, possessed the memory necessary to store adequate amounts of medical reference and patient specific data, and did not require the long boot up period of desktop PCs.

The authors of this study found the majority of family practice physicians embraced this technology virtually from its inception. It may be the breadth of diagnoses encountered, rural practice locations, and/or greater involvement in administrative and financial tasks that made these early PDAs an invaluable tool to them.

One such device, the Apple Newton Message Pad 120 released in 1995 contained a 20 mHz processor, large screen with a resolution of 320 x 240 pixels, built in speaker, 20 - 50 hour battery life, optional fax/ modem, handwriting recognition, infra red capability, weighed 1 pound, and measured 8 x 4 x 1.2 inches. However, it was not without limitations. Its handwriting recognition software was inconsistent and required a lengthy period to adapt to the users handwriting. It had no illumination (screen not backlit) making it difficult to view text in poorly lit areas and its 2 MB memory precluded the loading of multiple large applications. Another much smaller device, the Franklin Digital Book System contained a 16 mHz processor, a screen with a resolution of 160 x 40 pixels, 200 hour battery life, a key board, weighed 4 ounces, and measured 5 x 3.5 x 0.5 inches. With no operating system, it was primarily a reference tool capable of holding two 20 MB digital books. (Ebell, 1995) With the next generation of PDAs and medical applications available in the market place, the PDA has evolved into a decision support tool that is saving lives. (Ram, 1994) Physicians in the private sector are using PDAs for practice management, patient tracking, dosage and pregnancy calculations, treatment protocols, pharmaceutical data and prescription ordering, patient education, coding, documenting patient encounters, and stress relief (playing games).

C. RELATED WORK

1. Private Sector

This section lists related studies of work in the private sector including Kaiser Permanente, Wake Forest University School of Medicine, the University of California and Thomas Jefferson University.

a. Kaiser Permanente

At Kaiser Permanente's offices in Woodbridge VA, physicians are using palm pilots and an application named *ePhysician* to wirelessly locate an automated patient record, screen for drug allergies/ contraindications, verify insurance coverage, and transmit prescriptions to the pharmacy. *ePhysician* reduces callbacks from pharmacies and eliminates the need to decipher scribbles on a prescription pad. (Joyce, 2000)

b. Wake Forest University School of Medicine

At Wake Forest University School of Medicine in Winston-Salem NC, all third year medical students receive a *palm pilot*. "The program has enabled students to monitor patient diseases and other ailments from the outset and observe their progression with amazing accuracy." (Bass, 2000)

c. University of California, Davis

The Director of Psychiatric Informatics and Assistant Clinical Professor at the University of California, Davis, John Lou, M.D. stated that all of his medical students carry palm devices loaded with various approved medical applications. He views PDAs as indispensable teaching devices and as tools which aid physician clinical decision-making. (Lou, 2001)

d. Thomas Jefferson University

Richard H. Epstein, M.D., Associate Professor, Department of Anesthesiology at Thomas Jefferson University, Philadelphia, PA states that medical schools across the country are realizing the importance of training medical students in what he termed medical informatics. With biomedical devices such as fetal monitors and medical resonance imagers (MRI) storing or transmitting patient data, it is now necessary for a physician to be computer literate in order to leverage that information to enhance the quality of healthcare. (Epstein, 2001)

2. Public Sector

As the authors sought information on this subject only occasional pockets of PDA technology use were found within the Department of the Navy (DoN) and only draft policies regarding their use. The Navy is beginning to bring this technology to ships and hospitals with pilot programs focusing on wireless e-mail and administrative efficiencies.

a. The Space and Naval Warfare Systems Command (SPAWAR)

SPAWAR systems center in Chesapeake VA is conducting a proof of concept study utilizing an Environmental Health Module of the Shipboard Automated Medical System (SAMS) which has been modified to run on the palm operating system. A corpsman (preventive medicine technician) using a stylus can record heat stress survey data, pest control inspections, and potable water test results and then transmit that data to the SAMS database. This proof of concept holds tremendous potential for increasing administrative efficiencies by reducing data errors and redundancy, paper record keeping, and streamlining supply management. (SPAWAR, 2000)

b. The Uniformed Services University

The Uniformed Services University, Department of Biomedical Informatics, Bethesda, Maryland provides PDAs for its healthcare students as a means to communicate with students at clinical sites, enter clinical encounter data, look up medical reference material, make calculations, and access calendar information. (USUHS, 2001)

D. SUMMARY

The business drivers within managed care are mandating that physicians have point-of-care access to medical reference data, patient specific data, formularies, treatment protocols, and billing/coding information. Physicians in the private sector are using PDAs for practice management, patient tracking, dosage and pregnancy calculations, treatment protocols, pharmaceutical data and prescription ordering, patient education, coding, documenting patient encounters, and stress relief (playing games). Private sector uses that were examined included; Kaiser Permanente, Wake Forest University School of Medicine, University of California, and Thomas Jefferson University. Public Sector uses, although limited and lacking coordination, included SPAWAR, and The Uniformed Services University.

III. OPERATIONAL FAMILIARIZATION

A. INTRODUCTION

In this chapter the authors explore the technology employed at a Department of Navy (DoN) Medical Treatment Facility (MTF) test site to set a foundation for subsequent chapter discussions and generation of requirements for similar integration with DoD Medical information architectures. Detailed are two categories of hardware installed for the purposes of this study at Naval Hospital Lemoore, PDAs and wireless interfaces. Medical software applications deployed on the PDAs were selected based on physician reviews and include at least one application from each of the following categories; the Drug Databases, Medical Information Databases, Patient Billing and Coding, Medical Calculators, and Patient Information Databases. This chapter offers a sample of how a physician might use a PDA during a patient encounter.

With today's technological and business practice revolutions, private sector healthcare organizations are on the verge of significant improvements in the delivery of care. Mobile inventory management, medication administration management, and a host of tools, which reduce administrative functions and medical errors, are being integrated into current hospital information architectures. These organizations are dramatically enhancing business efficiencies and their bottom lines as well as making tremendous strides in improving the quality of care delivered to patients. The public sector is now under more and more scrutiny to employ these same business and clinical efficiencies. (Fisher, 2000, Levine, 2000, and Freudenheim, 2001)

The purchase prices quoted in this chapter are direct quotes from vendor web sites are subject to change and do not reflect possible government discounts. If interested in purchasing any of these products please contact the vendor's government representative.

B. PARTICIPATING MEDICAL TREATMENT FACILITY (MTF) AND PERSONNEL

Naval Hospital Lemoore (NHL) located within the Naval Air Station (NAS) Lemoore, CA is a DoN MTF with an Administrative Support Unit in Monterey, CA and a Branch Medical Clinic in Fallon, Nevada. NHL provides healthcare services to more than

25,000 active duty service members (5,000 located on NAS), family members, and retirees. NHL's statistics are illustrated in Table 3.1.

Naval Hospital Lemoore Statistics	
Staffing	
Medical Corps officers	20
Nurse Corps officers	30
Medical Service Corps officers	15
Enlisted personnel	150
Civilian staff	150
Contract physicians and nurses	25
Beds	
Inpatient Beds	16 (1 positive pressure isolation, 1 negative pressure isolation, 8 medical surgical beds, and 6 labor, delivery, recovery and post-partum)
Patient Visits/Admissions	
Outpatient visits	Average 11,000 per year, 916 per month
Inpatient admissions	Average 780 per year, 65 per month

Table 3.1. Naval Hospital Lemoore Statistics (From NHL, 2001).

NHL was chosen as a test site for this study based on several factors most notably its receptive Family Practice physicians and its strategic goal for technology integration. Their technology goal states, "Seek, investigate and integrate present and future technologies designed to enhance high quality clinical outcomes, decrease healthcare delivery costs, and improve management processes and organizational performance." (NHL, 2000)

The team of family practice clinic evaluators who tested and reviewed the hardware and medical application software is shown in Table 3.2.

Hardware and Software Evaluators
Blackwood, Carol L., is a Family Practice Physician and a Lieutenant Commander in the United States Naval Reserve (USNR) Medical Corps. She is a prior Naval Intelligence Officer, attended the University of Vermont College of Medicine, and completed her Family Practice Residency at Naval Hospital, Camp Pendleton.
Brown, Chawn T., is a Registered Nurse and Lieutenant in the United States Navy (USN) Nurse Corps with clinical experience in Internal Medicine, Post-Anesthesia, and Family Practice. He attended Florida A&M University where he received a B. S. in Nursing.
Burgess, Lloyd G., is a Family Practice Physician and a Lieutenant Commander in the USN Medical Corps. He attended Finch University of Health Sciences/Chicago Medical School, completed his Family Practice Internship at Methodist Medical Center in Illinois, and completed his Family Practice Residency at Naval Hospital, Camp Pendleton. He is a member of the American Academy of Family Physicians and the Christian Medical and Dental Association.
Howard, Christina L., is a Nurse Practitioner and Commander in the USN Nurse Corps with over 23 years of nursing experience. She attended Pacific Lutheran University where she received a M. S. in Nursing. She is a member of the American Nurses Association, American Academy of Nurse Practitioners, the Uniformed Nurse Practitioners Association and Sigma Theta Tau National Nursing Honor Society.
Lee, Benjamin K., is the Head of Naval Hospital Lemoore's Family Practice Clinic and a Lieutenant Commander in the USN Medical Corps. He attended Albany Medical College in New York and completed his Family Practice Residency at Naval Hospital, Camp Pendleton. He is a member of the American Academy of Family Physicians.
Madewell, Lawrence J., is a Family Practice Physician and a Lieutenant in the USN Medical Corps. He attended medical school at the University of Cincinnati and completed his residency at Valley Medical Center, Renton, WA. He is a member of the American Academy of Family Physicians and the Uniformed Services Academy of Family Physicians.
Malik, Mohammad A., is a Family Practice Physician and a Lieutenant in the USN Medical Corps. He attended medical school at Finch University of Health Sciences/Chicago Medical School and completed his residency at University of Illinois' St. Francis Hospital of Evanston. He is a member of the American Academy of Family Physicians. He was also a beta tester of the Windows CE based Iscript handheld system.
Miller, Patricia J., is a Registered Nurse and an Ensign in the USN Nurse Corps with one-year clinical experience in ambulatory care. She received her B. S. in Nursing from Fresno State University in California and is a member of Sigma Theta Tau National Nursing Honor Society.
Partridge, David R., is a Registered Nurse and a Lieutenant in the USN Nurse Corps. He received his B. S. in Nursing from Idaho State University and has clinical experience in Neonatal Intensive Care, Antenatal and Post-Partum.

Table 3.2. Family Practice Clinic Evaluators.

C. HARDWARE

The hardware used for the study comes in two major categories, Personal Digital Assistants (PDAs) and wireless interfaces. The hardware includes the Palm Vx, symbol SPT 1700, Handspring Visor Platinum, Compaq Ipaq 3630, PDAs and CreditCard Wireless Ethernet adapter, SpringPort wireless Ethernet Module, Wireless Ethernet Access Point, Symbol Spectrum24 Access Point AP-3020. The PDAs under study are:

1. PDAs

a. Palm Vx

Palm Incorporated first introduced the Pilot 1000 and Pilot 5000 organizers in March 1996. In December 1997, Palm began licensing the Palm OS platform. Leveraging its "first mover" advantage, Palm's operating system quickly dominated the marketplace. Palm introduced the lightweight and compact Palm Vx in October 1999. Currently there are over 10,000 third-party software applications for Palm OS based handhelds. Table 3.3 provides hardware specifications on the Palm Vx at the time of this study. (Palm, 2001)

Figure 3.1. Palm Vx (From Palm, 2001).

b. Symbol SPT 1700

Symbol Technologies Incorporated along with its strategic partner Sybase iAnywhere provide technological solutions to healthcare organizations, which afford more mobile healthcare. Symbol was founded in 1975 and introduced the SPT 1700 and wireless LAN product line in 2000. The Symbol SPT 1700 family features include scanning, wireless connectivity, and ruggedness. Table 3.3 provides hardware specifications on the Symbol SPT 1700 at the time of this study. (Symbol, 2001)

Figure 3.2. Symbol SPT 1700 Series (From Symbol, 2001).

c. Handspring Visor Platinum

Jeff Hawkins and Donna Dubinsky co-founded Handspring. Impressively, Hawkins is credited with inventing the Palm Pilot and he was the founder of Palm Computing, which he has since sold. Table 3.3 provides hardware specifications on the Handspring Visor Platinum at the time of this study. (Handspring, 2001) Table 3.3 provides hardware specifications on the Palm Vx at the time of this study. NOTE: Adding the wireless module on two test units did require the removal of the 16 MB memory modules, a design difficulty.

Figure 3.3. Handspring Visor Platinum (From Handspring, 2001).

d. Compaq Ipaq 3630

Compaq Computer Corporation was founded in 1982. In November 1996, Compaq introduced the handheld personal computer (PC), the PC companion and in April 2000 introduced the iPAQ Pocket PC. Table 3.3 provides hardware specifications on the Compaq Ipaq 3630 at the time of this study. (Compaq, 2001) Note: The optional expansion packs added to bulkiness and to date there are fewer applications written for Pocket PC OS.

Figure 3.4. Compaq iPAQ Pocket PC 3630 (From Compaq, 2001).

2. Wireless Interfaces

a. CreditCard Wireless Ethernet Adapter

This IEEE 802.11b compliant adapter provides secure real-time access to your Local Area Network (LAN) wirelessly through a Wireless Local Area Network (WLAN). It eliminates the need for additional hard wiring and is scalable. The cost is just over $100.00. Xircom offers a discounted set with 2 adapters and its wireless Ethernet access point for $599.99 (Xircom, 2001)

b. SpringPort Wireless Ethernet Module

This module made by Xircom allows wireless access to IEEE 802.11b (WLAN) through the Handspring Visor Series of PDAs. It eliminates the need to Hot sync in the cradle on a desktop, supports peer-to-peer links between devices, and provides 40 or 128 bit encryption. It costs $299 and does add size and weight to the handheld. The Visor Platinum requires a charger for the module, as it is not supplied power from the Platinum's AAA batteries. The charger is included with the module. To surf the web one must purchase Handspring's web browser software called Blazer at a nominal cost. Note: Network configuration was relatively simple despite a known error in the instructions. (Xircom, 2001)

	Vendor Defined Hardware Characteristics			
	Palm Vx	Compaq Ipaq 3630	Handspring Visor Platinum	Symbol SPT 1700
Memory RAM ROM	 8 MB N/A	 32 MB 16 MB	 8 MB	 8 MB 2 MB
Operating System	Palm v3.5	Pocket PC	Palm v3.5.2	Palm v3.5
Processor	16 MHz	206 MHz	33 MHz	16 MHz
Display	B/W	Color	B/W	B/W
Resolution	160 x 160	240 x 320	160 x 160	160 x 160
Expansion Card Slot	N/A	Yes	Yes	N/A
Battery	Rechargeable	Rechargeable	AAA	Rechargeable
Battery Life	30 days	14 hours	2 months	N/A (Energy Mgt. System)
Wireless Communications	N/A	802.11b	802.11b	802.11 or 802.11b
Speaker/Microphone	N/A	Yes	Yes (Expansion Module)	N/A
Weight	4.0 oz	6.3 oz (not including modules)	5.4 oz (not including modules)	11.8 oz
Size	4.5" x 3.1" x .4	5.11" x 3.28" x .62 (not including modules)	4.8" x 3" x .7" (not including modules)	7" x 3.6" x 1
Barcode scan engine	N/A	N/A	N/A	Yes
Ruggedized	N/A	N/A	N/A	Yes
Environmental Sealing	N/A	N/A	N/A	Yes
Cost (no discounts applied)	$299	$599 (with expansion pack, no modules)	$249 (not including modules)	$1,765 (with wireless ethernet adapter)

Table 3.3. Vendor Defined Characteristics.

c. Wireless Ethernet Access Point

This access point can accommodate 802.11b compliant adapters; it is small and lightweight. It supports 40-bit encryption. It features; a data rate of either 11 Mbps, 5.5, 2, 1, Direct Sequence Spread Spectrum (DSSS), frequency band at 2400 - 2483.5 MHz, 3 channels (simultaneous), Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA), 11 Operating Channels (in United States). The wireless Ethernet access point has a published range of 300 ft in an unobstructed environment at 11 Mbps and 100 ft in office type environments. Ranges at 1 Mbps are 1000 ft and 300 ft respectively. This access point if purchased separately costs $329.99. (Xircom, 2001)

Figure 3.5. Xircom Wireless Solution (From Xircom, 2001).

d. Symbol Spectrum24 Access Point AP-3020

AP-3021 is currently available. Spectrum24 complies with the 802.11 standard and its NetVision phone product line employs voice-over-IP technology that is ITU H.323 multimedia standard compliant. It supports Wired Equivalent Privacy (WEP) 64 bit encryption and decryption. The access point features; data rates of 2 or 1 Mbps, Frequency Hopping Spread spectrum (FHSS) transmission operating within the 2.4 - 2.5 GHz band with 79 hops in the United States, CSMA/CA, ranges of 2,000 ft in open environments at 1 Mbps and 250 ft in office type environments at 2Mbps. AP-3021 is currently available at a cost of $1,495.00 and the PC Card adapter costs $395.00. (Symbol, 2001)

Figure 3.6. Symbol Wireless Solution (From Symbol, 2001).

D. SOFTWARE

The medical software applications utilized in this study can be broken down into five distinct categories. They are:

- Drug Databases – They are electronic drug references that provide dosing, adverse reactions, drug-to-drug interactions, contraindications, packaging and pricing information.
- Medical Information Databases – They have replaced large text references containing medical diagnosis, treatment and follow-up information.
- Patient Information Databases – They provide access to patient records, demographics, reports and test results etc.
- Medical Calculators – They allow numerous formulas and clinical scores to be rapidly calculated.
- Patient Billing and Coding Databases – They provide Evaluation and Management (E&M), Current Procedures Terminology (CPT), and International Classification of Diseases (ICD-9) codes required for billing purposes.

Several Family Practice physician reviews of the numerous applications presently on the market are available on vendor web sites. Identified are one or two from each category that met our criteria. The elements comprising the criteria, placed in order of relevance, are: accuracy of medical data (patient safety), physician acceptance (ease-of-use), compatibility, price, and application size. Before deploying the PDAs with the installed medical applications, John Luo, M.D., Assistant Clinical Professor at the University of California, Davis briefly evaluated the applications and affirmed the value and clinical relevance. However, as is repeatedly pointed out in this area of application integration, they are in no way a replacement for sound medical judgment. Dr. Luo further indicated that the medical residents he instructs are provided with a similar set of applications. It was noted, however, that several medical software applications require one to register with their web site, download a trial version, e-mail PDA user ID and application serial number, and then wait 2-4 business days to receive a registration code to release the full version. The majority of vendors offer free trial versions. The applications under study are described in the following section:

1. Drug Databases

a. ePocrates qRx, Version 3.0

ePocrates provides clinicians with an alphabetical database of over 1,600 drugs. A collaborate development effort among physicians, pharmacists, and software engineers ensures drug information accuracy. One can search for adult/pediatric specific dosing, adverse reactions, drug-to-drug interactions, contraindications, pregnancy and lactation data, receive alerts of drug recalls etc. and automatic database updates. Version 4.0, currently available, adds packaging and pricing information and other features. The OS and program size are Palm only and under 900K, respectively. The price is very attractive: free. Its web site states, "Physicians using qRx have already avoided thousands of drug errors based on a recent study conducted by clinicians at Harvard Medical School." (ePocrates, 2001)

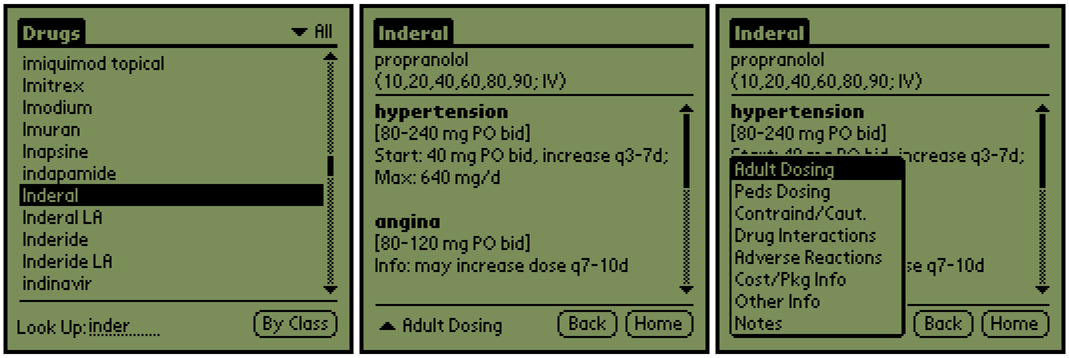

Figure 3.7. Screen Captures of ePocrates (From ePocrates, 2001).

b. NursingDrugs, 2000

NursingDrugs by Skyscape presents the most commonly prescribed medications in a user friendly and easily accessible manner. It is an electronic representation of the Lexi-Comp, Incorporated text, *Drug Information Handbook for Nursing*. During this study, NursingDrugs was replaced at Skyscape by DrugGuide (Davis Drug Guide for Nurses), version 4.0.5. This is a drug reference containing in excess of 5,000 drugs, 140 drug classifications, 700 drug combinations, and 1,000 drug monographs. It runs on either Palm OS or Pocket PC/Windows CE and its program sizes are 3.5 MB and 8.2 MB respectively. A trial version is available and the full registered version's price is $49.95. (Skyscape, 2001)

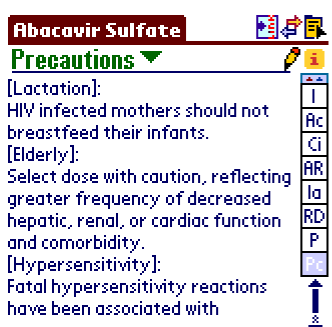

Figure 3.8. Screen Capture of DrugGuide (From Skyscape, 2001).

2. Medical Information Database

a. 5-Minute Clinical Consult 2000

This application has reduced a standard and incredibly large text reference for medical diagnosis and treatment and placed it in the palm of a single hand. It features in excess of 1,000 alphabetical topics and 593 expanded topics contributed by 300 clinicians. It provides patient diagnosis, treatment, medication, and follow-up information. The OS and program size are WinCE at 5.2MB and Palm at 1.987 to 2.8MB. The price is $64.95. (Skyscape, 2001)

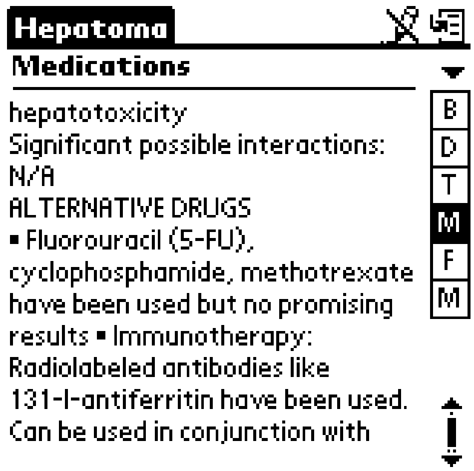

Figure 3.9. Screen Capture of 5 Minute Clinical Consult (From Skyscape, 2001).

3. Patient Billing and Coding

a. ICD-9 Notes

This application is a searchable database using key words or 3 digit codes. It contains a complete set of over 15,000 ICD-9/CM diagnosis codes and can be tailored so that the most frequently used codes are on top. The OS and program size are Palm OS and under 321K, respectively. The price is $20.00. However, its web site is rudimentary with all correspondence restricted to e-mail. (med-notes, 2001)

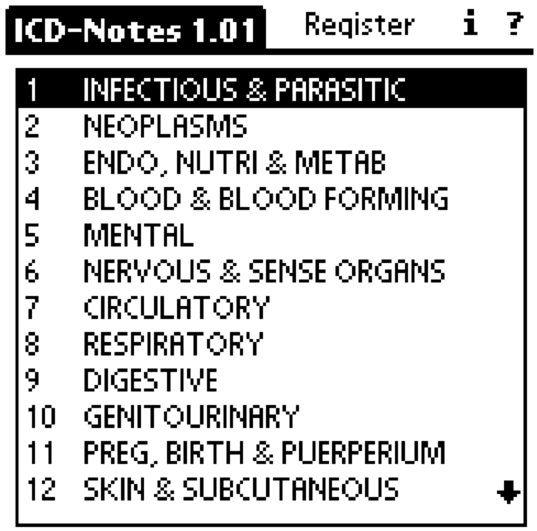

Figure 3.10. Screen Capture of ICD-9 Notes (From med-notes, 2001).

b. TOPS EM Coder

e-MDs' TOPS EM Coder handheld application was released in October, 2000. It calculates the correct E&M codes and identifies missing documentation required to reach the appropriate E&M level. E-MD provides practice management (clinical and financial) tools for physicians and its E&M Coder can significantly reduce the $60,000 average per physician of lost billings annually in the United States. (Fisher, 2000)

Tops EM Coder runs on both the Palm OS and Win CE and is approximately 1.9 MB. The price is $49.95. (e-MDs, 2001)

4. Medical Calculator

a. MedCalc

With 66 formulas and clinical scores the majority of which have accompanying references and clinical-use hints all listed in alphabetical order, MedCalc is a favorite among physicians. The most frequently used formulas can be placed in a separate category and patient calculation results can be stored in a database file on your PDA.

Some calculations that might be performed are Apgar score, Bayes Theorem, Oxygen Index, Pregnancy due date, and Vascular Resistances. The OS and program size are Palm and under 193K , respectively. The price is free. (MedCalc, 2001)

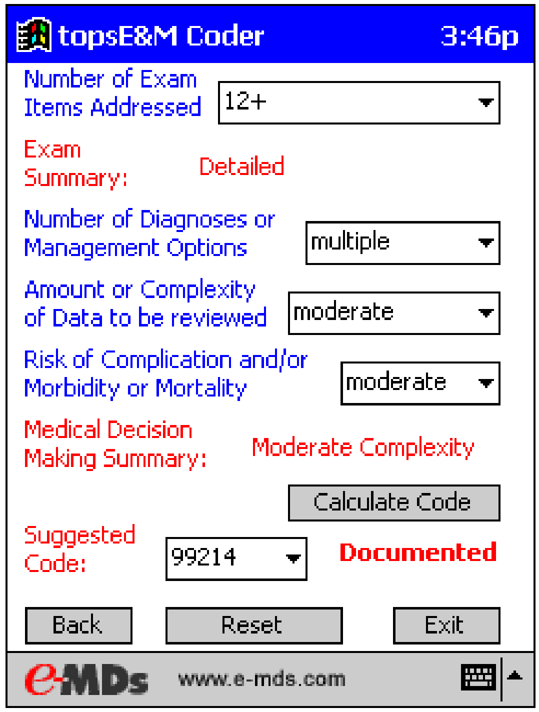

Figure 3.11. Screen Capture of Tops E&M Coder (From e-MDs, 2001).

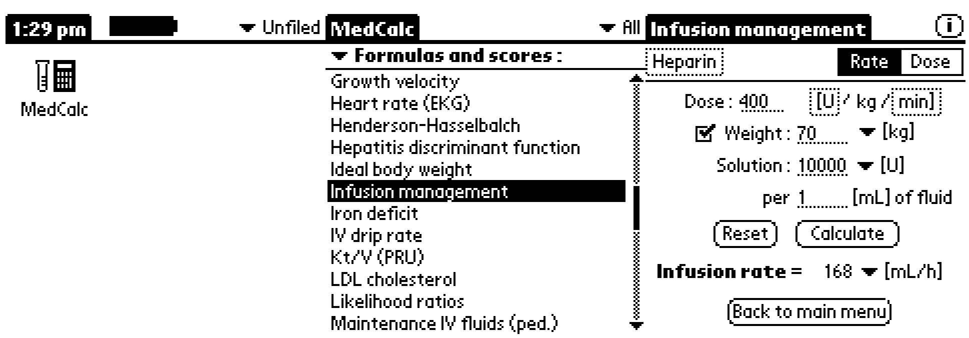

Figure 3.12. Screen Captures of MedCalc on Monochrome Palm OS Device (From MedCalc, 2001).

b. Archimedes

70 Formulas covering a broad range of medical specialties are listed alphabetically, historically, and by category for user convenience. It has a built in calculator and a help button that provides detailed information on each formula.

The OS and program size are WinCE and 550k, respectively. The price is free. (Skyscape, 2001)

5. Patient Information Database

a. Patient Tracker 4.1

Patient Tracker is a patient management database that provides access to patient records, demographics, reports and test results. It can automatically generate progress notes to include lab results, vital signs, radiology reports, and prior patient notes. It also has the capability to print notes, checkout lists, and patient logs. Version 5.1 adds password protection to ensure patient privacy. The OS and program size for is WinCE and 348K and for Palm is under 150K. The price is free. (Handheldmed, 2001)

E. SAMPLE CLINICAL USE OF PDA SOLUTION

A skeptical manager or physician might ask, "How will using a PDA during a patient encounter be beneficial?" The answer is surprisingly simple. Utilizing any one of the PDAs and a medical software application from each of the following five categories; drug databases, medical information databases, patient information databases, medical calculators, and patient billing and coding described in detail in this study, a physician in the palm of his/her hand could perform any number of the tasks in Table 3.4. These business and clinical efficiencies can be integrated into virtually any physician office, clinic, hospital, or other healthcare organizations' information system architecture with relative ease and at minimal cost.

PDA USE DURING A PATIENT ENCOUNTER	
1.	View daily patient schedules on a standard date book or calendar
2.	Customize an address/phone book or file to facilitate patient referrals, consults, and reference local pharmacy information
3.	Search a drug database for adult/pediatric specific dosing, adverse reactions, drug interactions, contraindications, as well as medication costs, manufacturer, and packaging details resulting in the elimination of prescription errors
4.	Reference standard medical diagnosis and treatment texts to locate uncommon, rare, or forgotten patient diagnosis, treatment, medication, and follow-up information
5.	Access patient records, demographics, reports, test results and even generate progress notes through a patient management database
6.	Perform numerous calculations by simply tapping on a formula or clinical score, store patient results, and review accompanying reference or help sections for clinical-use information;
7.	At the point-of-care, accurately identify patient billing and coding information optimizing revenue collection.
8.	From daily downloads, review medical journals, be alerted of drug recalls, and even read the newspaper.

Table 3.4. PDAs in Practice.

F. SUMMARY

In this chapter the authors detailed why NHL was selected as a DoN MTF test site at which to employ the latest technology for the purpose of assessing its potential within DoD of realizing the same efficiencies experienced in numerous private sector healthcare organizations as well as generate a requirement for integration within MTF information architectures. This chapter also explored two categories of hardware installed for the purposes of this study at NHL, PDAs and wireless interfaces. The PDAs under study are: Palm Vx, Symbol SPT 1700, Handspring Visor Platinum, and the Compaq Ipaq 3630. The wireless interfaces include: Xircom's CreditCard wireless Ethernet Adapter, SpringPort Wireless Ethernet Module and wireless Ethernet Access Point, and Symbol Technologies Spectrum24 Access Point AP-3020.

The medical software applications utilized in this study by category detailed in this chapter are: the Drug Databases, ePocrates qRx, version 3.0, and Nursing Drugs; a Medical Information Database, 5-Minute Clinical Consult; Patient Billing and Coding, ICD-9 Notes and TOPS EM Coder; and Medical Calculators, MedCalc and Archimedes; Patient Information Database, Patient Tracker 4.1. The software was selected based on family practice physician reviews and adherence to the following criteria: accuracy of medical data (patient safety), physician acceptance (ease-of-use), compatibility, price, and application size. This chapter also offered a sample of how a physician might use a PDA during a patient encounter.

IV. BUSINESS OPPORTUNITY

A. INTRODUCTION

This chapter presents the Military Health System's (MHS) vision and optimization team mission. In support of that mission and vision, this chapter explores the benefits of using PDAs and wireless technologies, to support rapid and accurate access to diagnostic and billing information using case study success stories. Illustrated are the lack of consistent high data quality and difficulties of provider interaction with military healthcare information systems. In addition, this chapter shall illustrate that the capturing of missed patient encounters enhances revenue generation in particular lost third party revenue and reduces medical records and collection personnel labor requirements. This chapter will demonstrate that rapid access to patient data on a PDA is possible within the DoD Military Health System, in particular a DoN MTF.

B. THE VISION OF THE MILITARY HEALTH SYSTEM

"The MHS is responsive and accountable to DoD, line leadership, and our beneficiaries by providing best value health services using best clinical and business practices." (Military Health System Optimization, 2001) To meet that vision MHS has chartered the Military Health System Optimization Team.

1. The Military Health System Optimization Team Mission

"The MHS' success depends on innovations and enterprise-wide reengineering. The Military Health System Optimization Team is chartered by and reports to MHS leadership to conduct research, coordinate working groups, integrate initiatives, and recommend strategies and operational plans to achieve the MHS vision." (Military Health System Optimization, 2001)

2. MHS and Managed Care

Managed care systems are ones that have transitioned from the traditional delivery model of fee-for-service where patients pay for every service or procedure to one of capitation. Capitation calls for the payment of a predetermined annual premium with small co-payments. All healthcare services have to be provided to the total beneficiary population using that finite pool of resources. This philosophy is exactly what is driving MHS's vision of best value health services. TRICARE's Management Activity

(TMA) Executive Director, James Sears in a press release states, "The conversion of the Military Health System to a managed care environment has created the need to adopt new and innovative business practices that are data driven." (News Release, 1999) Also mentioned in the release is the need for accurate data collection to ensure regulatory compliance and receive Medicare reimbursement.

C. MILITARY ENTERPRISE HEALTHCARE INFORMATION SYSTEMS

The TMA data quality team established to enhance TRICARE patient services will first examine the following systems:

1. KG-ADS

This system interfaces with CHCS and provides a pick list of diagnosis and procedure codes. CHCS, through the interface known as the Standard Ambulatory Data Record (SADR) Log, completes the ambulatory patient record in the ADS server. The ADS server processes the patient encounter data and generates the Standard Ambulatory Data Record (SADR). The SADR is transmitted to a central Department of Defense data repository. ADS has the capability to locate Composite Health Care System (CHCS) appointments without a corresponding ADS record.

2. Composite Health Care System (CHCS)

This system provides ADS with patient appointment data and demographics, laboratory and clinical test results, and reference data required for batch file updates and data synchronization. Evaluation and Management (E&M), Current Procedures Terminology (CPT), and International Classification of Diseases (ICD-9) codes are applied to patient records using KG-ADS. Current Clinical Information Technology Program Office (CITPO) offerings do not provide smart encoding of outpatient records. Instead, KG-ADS was developed to provide a method to look-up codes.

D. WHY EXAMINE THESE SYSTEMS FIRST?

1. Charge Capture Difficulties

At the commencement of this study, Naval Hospital Lemoore experienced in excess of 2,000 KG-ADS missed patient encounters per month. Patient encounter data is entered into ADS via steps 1 through 4 in Table 4.1 to recapture these encounters include steps 5 through 10.

In the month of May, after heightened scrutiny the delta between the CHCS visit workload of 11,084 and the KG-ADS visit workload of 10,686 was 398 indicating a reduction in patient encounter losses of over five fold. NHL TPC personnel estimate that this number will be further reduced to 200 within two months. Once identified these encounters can still be coded, closed, reported on SADR report, and subsequently billed. However, there is no automated means of verifying the completeness of KG-ADS patient encounter. Again, this presents a significant obstacle since a patient could have multiple diagnoses and procedures performed and documented in the medical record but only the primary diagnosis code entered in KG-ADS. A Quality Performance Review on all records is the only way to ascertain any discrepancies and medical records and TPC personnel must then perform the aforementioned tasks.

It is quite evident that this process is time consuming, redundant, and has a negative impact on billing and collection efforts. Improper accounting for procedures adversely affects NHL's budget and when direct care records are incorrect or missing JCAHO accreditation is jeopardized.

2. Why are Patient Encounters Partially Completed or Missed?

The difficulty begins when the Provider interacts with the system. Physicians describe this data entry process as antiquated, requiring excessive screen scrolls, and time consuming. Time they add, appropriately, that can be better spent on patient care. The steps necessary for a Provider to complete a patient's KG-ADS file are illustrated in Table 4.2. These steps, depending on patient complexity can require 10 to 16+ screen scrolls and take up to 5 minutes for physicians. The time to input data can be reduced by ensuring pick list accuracy, reducing word searches, and increasing physician proficiency with the system. At NHL, Nurses and Hospital Corpsman input this data more frequently and can perform the tasks more rapidly requiring approximately 2 minutes to complete a patient's KG-ADS record.

	Outpatient Charge Captures
	Data Entry
1.	CHCS provides a daily download to ADS for the next day's outpatient appointments. This takes place the night before the patient encounters scheduled for the day, and occurs dynamically if walk-ins or new appointments occur same-day.
2.	Patient encounter codes are entered into KG-ADS.
3.	That data is transmitted to the ADS server and updates the ambulatory patient records through ADSI.
4.	ADS records are then matched to CHCS appointment file. At this point third party collections (TPC) personnel can identify kept appointments without an ADS record.
	Recapture Efforts
5.	TPC personnel request third-party extract file. The rule of thumb for TPC personnel is to not take ADS as the only document to bill from.
6.	When in doubt about an entry made in KG-ADS, TPC personnel copy the CHCS/KG-ADS entry and e-mail it to the Physician for clarification.
7.	Medical records then locates the SF 600 for review; 91% of the time according to Medical records staff at NHL
8.	After the SF-600 is located and the Physician response received, complete and accurate patient coding data necessary for reimbursement is now entered into KG-ADS usually by a nurse or Hospital Corpsman.
9.	Since the codes have now changed, TPC personnel must re-run the third party extract file before it can be loaded into the Third Party Outpatient Collection System (TPOCS), which recoups the cost of providing care to beneficiaries with third party insurance.
10.	Claims at this point can still be rejected due to inaccurate codes.

Table 4.1. Patient Encounter Data.

	Steps To Complete A Patient's KG-ADS File
1.	Sign onto CHCS
2.	Select KG Ambulatory Data Systems Option
3.	Select an action such as Physician Management Menu (default)
4.	Select ADS Data Entry Menu Option
5.	Select Location of the Clinic (default)
6.	Sele ct Provider Name (default)
7.	Enter Start and End Dates (default)
8.	Select Patient Name
9.	Select Evaluation and Management Code(s) from a pick list of 75-90 codes or conduct a single or partial word search. NOTE: Providers describe this functionality as wholly insufficient. Correctly designed pick lists will reduce the number of codes to choose from significantly.
10.	Select Diagnosis Code from a pick list or word search
11.	Rank Diagnoses in order of significance
12.	Enter a Procedure Code from a pick list or word search
13.	Match the procedure to a Diagnosis
14.	If a procedure was not performed, the Provider selects the File Option and completes the record.
15.	Update the Patient's Master Problem List with new diagnoses (Optional)
16.	Input notes/comments to be reviewed by other Providers

Table 4.2. Provider Interaction (From Ferguson, 2001).

E. CANDIDATE SOLUTIONS

Looking to industry benchmarks, technological advances, and traditional business competencies in coding and reimbursement, data integration, and cost management, potential solutions emerge. These solutions utilize PDA technology and must be accompanied by changes in management and provider philosophies as well as sound policies and processes. When this study is concluded, the hardware and software examined will already be dated. The pace at which medically related hardware and software applications are being developed is as much overwhelming as it is awe-inspiring. The W R Hambrect & Company Industry Report predicts that twenty percent of physicians will use a PDA in clinical practice by the year 2004. (Fisher, 2000)

Management must realize that harnessing this technology for physicians requires redesigning the way in which they work and a strong commitment to its use. For business competency enhancements to begin with the physician, management must provide them with the requisite tools and training. The ability to replace scribbled patient notes and reduces the amount of lost patient encounter data is just now being visualized by physicians as a clinical tool and not another reason to change the way they do things. Chapter III of this study provided descriptions of patient management software and patient encounter billing and coding software that can accomplish just that.

1. Success Story: Capturing Charges and Increased Bottom Line

The following synopsis of a case study at the Department of Surgery at Brigham and Women's Hospital details the benefits these new programs have on capturing charges and increasing bottom lines. This study focused on reducing; the number of lost charges, write-offs due to delayed billing, processing costs for denied claims, and write-offs due to a lack of authorization for service. Its goal was "clean claim" submission. "Clean claims are those that are not rejected as unprocessable due to inaccurate or missing information." (pdaMD, 2001) As alluded to earlier, this goal must begin with the provider and more specifically at the point-of-care. The Department of Surgery prior to the installation of Mdeverywhere's EveryCharge system experienced lost charges at a rate of 9.5 percent of total outpatient visits. The study reports that this equates to $27,440 in lost revenue. Months after installation of the system, lost charges were reduced from 99 over four months to only ten over three months. The study indicated that with continued physician education regarding the systems capabilities that that number could be reduced to zero. Claim write-offs resulting from exceeding insurance company deadlines for submission are all too common in healthcare. The study correctly points out that a majority of the delays occur while collections personnel are attempting to locate supplementary patient encounter data. The Department of Surgery wrote off 29 patient encounters at a cost of $4,548: a direct result of these types of delays. Following the EveryCharge installation, days-to-post claims were decreased from an average of 24.5 to a remarkable 7.9. EveryCharge also reduced the number of claims written off resulting from no prior authorization for service being obtained or obtained incorrectly saving $2,834, annually.

To address the reduction of administrative costs, EveryCharge's customizable rule engine verifies charge accuracy at the point-of-care long before bill submission. It eliminates the need to reprocess a claim saving an estimated $25 per claim. (pdaMD, 2001)

2. Another Success Story: Increased Charge Capture Rates

Studies conducted at the HealthFirst Medical Group in Portland Oregon goals were twofold. First, utilizing the Hewlett Packard's 620LX Handheld PC with the Windows CE 2.1 OS, to track physician schedules, procedures, and consultations. Second, to use this handheld device to capture and transmit patient billing data in a manner that will reduce billing delays and improve the cost-effectiveness of the process. The results indicated no significant reduction in days-to-post patient encounter charges. Hospital charge capture rates increased dramatically but still showed a three percent lost charge rate. Again, physician training and software enhancements are required to realize further improvements. The number of consultative charges increased by 157% and the charge amounts for hospital charges increased by 111%. It is however, worth noting that the study indicated that surgical group practice did experience a growth rate of 27% during the time of the study. (Blackman, 1999)

F. NAVAL HOSPITAL LEMOORE PROOF OF CONCEPT

This proof of concept will demonstrate that rapid access to patient specific data by a provider on a PDA is plausible within the DoD Military Health System, in particular a DoN MTF.

1. A Test of HL/7 Message Data

Broadening the scope of this thesis project, Electronic Data Systems (EDS) demonstrated at NHL that an HL/7 interface already exists between CHCS and the Nutrition Management Information System (NMIS) and that this interface could be adapted to provide patient information to Microsoft Outlook at which point a provider could download the data to a calendar on a PDA. The HL/7 interface demonstration provided patient schedule data and a years worth of pharmacy and laboratory data for outpatient appointments at NHL. NHL's Family Practice physicians were receptive to the concept of having patient laboratory and pharmacy data in their PDA calendars days in advance allowing time for review and conducting research on any questions they might have regarding the patients' history. EDS, the authors of this thesis, and the physicians hypothesized that rapid access to this data would enhance business efficiencies and the quality of patient care. Providing a production-ready interface of this type at other Naval Hospitals requires the completion of the following steps:

- Installation of a Microsoft Outlook software interface, which leverages NMIS's capability to receive, parse, and store HL/7 message data sent from CHCS.
- Acquire and install an NT Server at NHL to host the software interface, receive HL/7 messages from CHCS, and establish a connection with local mail servers.
- Modify the CHCS production routine, currently available only for Nutrition Management clinics, for the appropriate outpatient clinics. (White, 2001)

The physicians hope to no longer be delayed by lengthy dumb terminal or desktops PC boot ups or numerous screen interactions to locate patient data. They as with other aspects of this study are enthusiastic about assessing the value of utilizing PDAs to interface with CHCS.

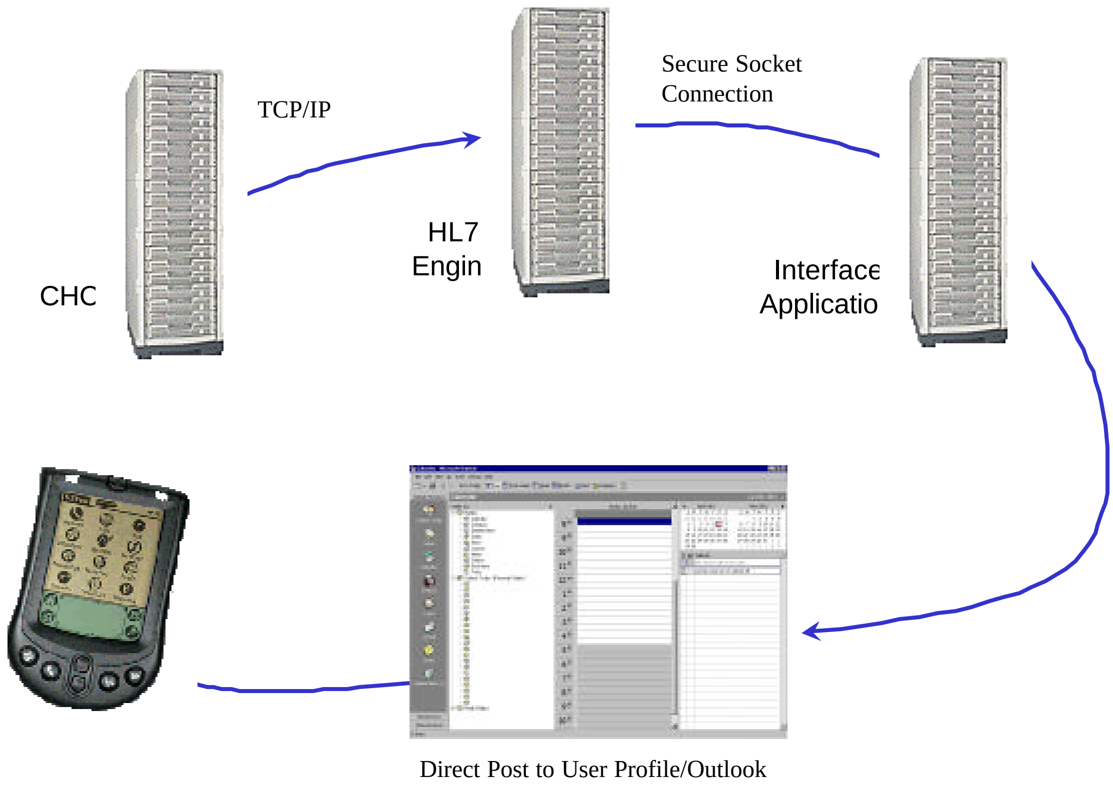

Figure 4.1. HL/7 Interface (From EDS, 2001).

Unfortunately, only steps one and two were accomplished as budget restrictions and lengthy approval procedures impeded the accomplishment of step c. noted above. These budget restrictions and approval procedures include the following:

- The CHCS HL/7 message routine was hard coded with NMIS Medical Expense and Reporting System (MEPRS) codes. These codes afford consistent reporting of personnel workload, obligation and expense data by MTF. Redeveloping the routine to accept a dynamic MEPRS designation and test the routine in both a model office and production environment was too costly for this study.
- Interface definitions undergo a rigorous design and approval review to ensure that clinical information systems will continue to operate properly. Time was not available to subject the interface to the review process.

Finally, MHS, TMA, management, and physicians must see the clinical and business efficiencies associated of having this patient data available on a PDA vice a workstation in each examination room.

2. EDS Business Case

In a draft white paper, EDS has proposed a hybrid solution of desktop workstations and PDAs as the user interface platform for CHCS II. CHCSII will provide similar outpatient clinical encounter support to that of CHCS's inpatient clinical encounter support as well as expand capabilities to include dental patient encounter data. The three drivers of this business case are reduced life cycle costs, enhanced productivity, and deployment with the latest technology. The current CHCS II deployment plan calls for desktop PCs in every examination/treatment room, nursing station, and physician office. EDS's hybrid approach would significantly reduce the $140 plus million-dollar price tag for LAN upgrades and CHCS II desktop workstations as well as allow multiple access methods. It details three different user scenarios for interfacing with CHCS II. First, a corpsman may require a fully capable desktop PC to perform administrative tasks such as insurance verification and patient scheduling. Second, a nurse might opt for a laptop PC. The nurse could access patient specific data through a WLAN connection. The nurse would have the capability to generate patient notes etc. without the limitations of pick lists and review nursing drug information. Third, a physician may choose a nimble and compact PDA to access patient data. The physician could document the patient encounter, review reference material, and send patient orders seamlessly. This paper outlines business process efficiencies such as increased productivity (more time spent with patients) that have bee addressed in the previous chapters of this study. Through the reduction of lifecycle costs, move/add/change activity, and the replacement of expensive CHCS II workstations/desktop PCs with laptops and PDAs, EDS is estimating a total savings through fiscal year 2004 in excess of $53 million-dollars. (EDS, 2001)

G. SUMMARY

Using case study success stories conducted at the Department of Surgery at Brigham and Women's Hospital and at the HealthFirst Medical Group, this chapter demonstrated that the use of PDAs and wireless technologies does streamline processes and integrate data collection and information retrieval. Illustrated was the fact that patient management and patient encounter billing and coding software can provide significant benefit towards capturing charges and increasing bottom lines. The authors of this study deduced that since the charge capture difficulties experienced at NHL are not dissimilar to other healthcare organizations. NHL should then realize the same enhancements and subsequent increase in its bottom line if it implements a system that allows for point-of-care charge capture and review. A test of an existing HL/7 interface between CHCS and NMIS provided patient information to Microsoft Outlook on a PDA and desktop. This chapter supports MHS's mission and vision as well as demonstrated that deployment of accurate and complete charge capture systems is possible.

V. REQUIREMENTS GENERATION AND ANALYSIS

A. INTRODUCTION

In this chapter the authors explain the development and issuance of the User Requirement Survey, and subsequent analysis and presentation of the survey findings. The processes and techniques used to analyze the survey data submitted by users are identified. Next, User Requirement Survey respondent demographics are presented. This is followed by the online User Requirement Survey results. Detailed analyses of results are provided in *Appendices A* through *C*. Finally, the Post-Testing Phase Out Survey results from the case group at Naval Hospital Lemoore are presented.

B. USER REQUIREMENT SURVEY DEVELOPMENT

Several methods of data collection were used in this study. Primary data was collected using personal interviews, observation, and surveys. Secondary data collection was largely comprised of literature research. The intent of this study is that the resultant analysis of requirements will be communicated to the Information Management, Technology, and Reengineering Directorate of the TRICARE Management Activity for their use in generating DoD-level user requirements. Early coordination with this team, as well as others listed in *Chapter VIII: Conclusions and Recommendations*, should greatly assist the Department of Defense with developing agency-wide requirements for the use of PDAs in the military healthcare environment.

After development of the online survey, contact was next made with either Executive Officers, Chief Staff Officers, Chief Information Officers, or Command Webmasters (or their equivalents) from major facilities, including those listed below, and asked that the survey be promulgated throughout their facility to be completed on a voluntary basis:

- National Naval Medical Center, Bethesda
- Naval Medical Center, San Diego
- Naval Medical Center, Portsmouth
- Tripler Army Medical Center, Honolulu
- Madigan Army Medical Center, Tacoma
- Wilford Hall Medical Center, Lackland

- Wright-Patterson Medical Center, Dayton

Some facilities provided full participation; some passed the request to selected areas within their cognizance; still others declined to participate. The online survey remained open for several weeks. A total number of 277 personnel responded to the survey. A complete version of the online survey with accompanying response totals by position can be found in *Appendix A*. Examples of the visual and statistical representations for survey responses will be found in the following section. *Appendix B* provides the detailed statistical analyses for all survey responses.

A second Post-Testing Phase Out Survey was developed for the participants assisting with hardware and software assessment at the Naval Hospital Lemoore. That survey population consisted of eight respondents: one Director of Clinical Services, five Family Practice providers, and two Family Practice nursing specialists. Results of that survey can be found in *Section E* of this chapter. All hardware and software applications in *Section E* have been discussed in detail in *Chapter III: Operational Familiarization.*

C. PROCESSES AND TECHNIQUES

The final iteration of the User Requirement Survey consisted of 36 questions, plus demographic data and a comments section. The initial survey was developed locally at the Naval Postgraduate School, with its question content drawn upon from:

- Literature research
- Individual interviews
- Personal experience

The survey was created using an interactive format and placed on a server at the Naval Hospital Lemoore. It was initially tested using only participants from that Naval Hospital. A Delphi-group round table among Family Practice physicians from the facility was conducted in order to elicit personal comments, reaction, and advice with respect to survey. All feedback from the round table session was incorporated into the final version, which we then placed on a website hosted at the Naval Postgraduate School.

1. Data Pre-Processing

Data pre-processing consisted of two tasks. The initial survey was hosted on a website at NH Lemoore and issued to users from that facility alone. Based upon their feedback in the Delphi roundtable sessions, the survey was modified to reflect several new questions. The original survey data was assimilated into the final data set. This will account for several questions not having the quantity of responses match the total number of respondents.

The second task involved reviewing every response. Some respondents felt that they were not qualified to mark certain questions. This led to a processing error, because by survey design at least one response was always selected, and no option was given for *Not Applicable*. Where respondents identified such situations in their comments section, those data elements were removed from the results. Additionally, the survey was screened for duplicate entries, of which several were found. In most cases, the *Comments* section of the data reflected a statement similar to *"You may have just received an input from me, but I wanted to add another comment…"* Data from those duplicate submissions were cleared.

2. Data Conversion

Data conversion consisted of coding raw responses into usable data. Coding is defined here as the assignment of a numerical value to a non-numeric function. For example, the majority of the question had as their response choices *High, Medium, and Low*. In order to determine statistical values such as mean and variance, those values were given weights of 9, 5, and 1, respectively.

3. Data Storage

Data storage, while conducting the survey, consisted of maintaining a "live" electronic copy of the Access database hosted on a NPS server. Additionally, daily backups of the database were made in order to preserve the most current data in case of catastrophic loss. Data storage, while in processing (analysis), was performed using a combination of the electronic storage method (database), additional electronic storage methods (spreadsheets), and traditional paper copy methods.

4. Processing

The processing phase of this section contains two primary themes: summarization and analysis. The summarization of data is presented visually using tables and charts. The summarization also extends into descriptive statistical presentation. Analysis of data begins with the descriptive statistics (those that define the observed data of the sample population) and continues with the inferential analysis (those which can be used to make predictions about the entire population).

a. Visual Representation

The visual representation method used here is provided as the initial means for interpretation of survey data. Tables will be used to provide numeric counts, either for raw data or for data segregated by categories. *Appendix A* provides the reader with a complete inventory of visually represented data by question and user position.

Position	High	Med	Low	
CO/XO	3	3		
Director (DCS, DFA, DNS)	16	4		
Provider	119	36	10	
Nursing Specialist	13	6		
Comptroller/Billing/Claims	1	2	1	
MIS Head/CIO	7	2		
Patient Administration	13	6	1	
Provider Support (Clinician)	18	9	7	
Total:	190	68	19	277

Table 5.1. Example of Raw Data Count.

b. Statistical Representation

In order to better represent patterns to the reader, several statistical methodologies were used. The methods used include those representing descriptive statistics, inferential statistics, and hypothesis testing. While some descriptive statistics given in the appendices are not used in hypothesis testing in this study, they are compiled for the reader for their own use. The software programs used to compile statistics for this study are *Microsoft Excel 2000* and *Prentice Hall's PHStat 97 for Excel.* Examples are given below

(1) Descriptive (Weighted Mean). Descriptive statistics are those methods used to describe values of a *sample* population. Examples would be the mode (most common response) median (that response which has an equal number of responses above and below in value), and the mean (numeric average of all responses).

For numerical representation of High-Medium-Low responses, weights of 9-5-1 were assigned, respectively.

Q1	Responses	Weight	Weighted value	Weighted average
High	204	9	1836	
Medium	60	5	300	
Low	18	1	18	
Total	282		2154	7.61

Table 5.2. Example of Weighted Mean Table.

(2) Descriptive (Likert Scale). The Likert scale can be displayed visually. For example, the blue arrow represents a high value and the gold arrow represents a low value.

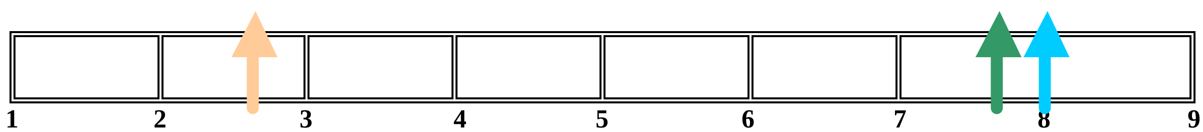

Figure 5.1. Example of Likert Scale Representation.

(3) Descriptive (General).

Descriptive Statistics	
Mean	8.292419
Standard Error	0.096322
Median	9
Mode	9
Standard Deviation	1.603115
Sample Variance	2.569979
Kurtosis	3.134851
Skewness	-2.03753
Range	8
Minimum	1
Maximum	9
Sum	2297
Count	277
Confidence Level(95.0%)	0.189619

Table 5.3. Example of Descriptive Statistics.

(4) Inferential and Hypothesis Testing. This testing will define a null hypothesis (H_o) and an alternative hypothesis (H_a). It is assumed that if responses were representative of a random distribution, there would be an equal number of responses per category. For example, if 90 people responded to a question having two answers, yes and no, it would be expected that 45 people would answer yes and 45 people would answer no. A Chi-Square distribution was used to test the value of the sample population. The null hypothesis for responses to the survey is H_o : There is no statistical significance for a user preference shown among response categories. If the Chi-Square test shows that the H_o should be rejected, the alternative hypothesis: H_a must be accepted: There is statistical significance for a user preference shown among the response categories.

Chi-Square Test					
Observed Frequencies:		Column variable			
	Row variable	1-3 scrolls	4-6 scrolls	7+ scrolls	Total
	Actual Count	230	45	2	277
	Total	230	45	2	277
Expected Frequencies:		Column variable			
	Row variable	1-3 scrolls	4-6 scrolls	7+ scrolls	Total
	Expected Count	92.33	92.33	92.33	276.99
	Total	92.33	92.33	92.33	276.99

Level of Significance	0.05	
Number of Rows	1	
Number of Columns	3	
Degrees of Freedom	2	
Critical Value	5.991476	
Chi-Square Test Statistic	#NUM!	At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.
p-Value	9.26E-70	
H_O: There is no preference shown		
H_A: There is a preference shown		
Reject the null hypothesis		

Table 5.4. Example of Chi-Square Test.

From the previous example, the following conclusions were made:

- Reject the null hypothesis
- Accept, at the .05 level of significance, that there is statistical significance indicating a user preference in the response category.

D. ONLINE USER REQUIREMENT SURVEY DEMOGRAPHICS

The following demographic information is provided.

- **Total respondents:** 277
- **Respondents by service:**

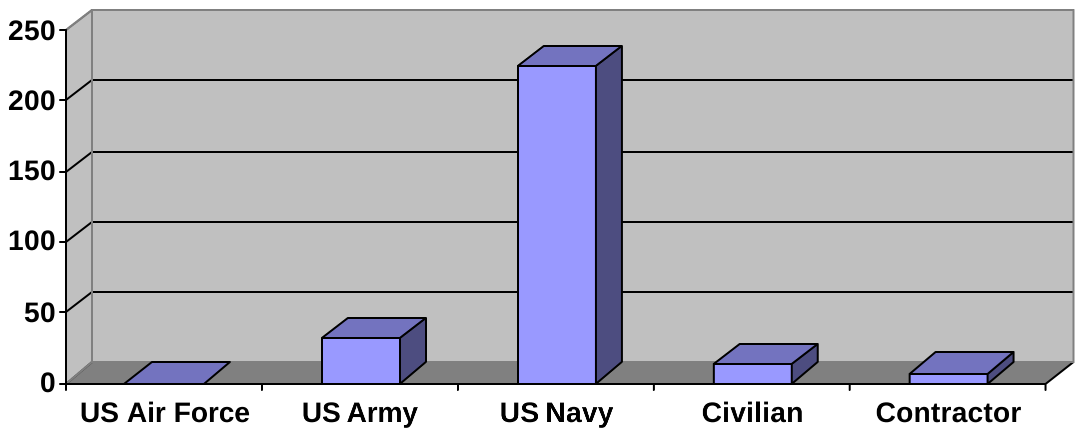

Figure 5.2. Respondents by Service.

- **Respondents by position:**

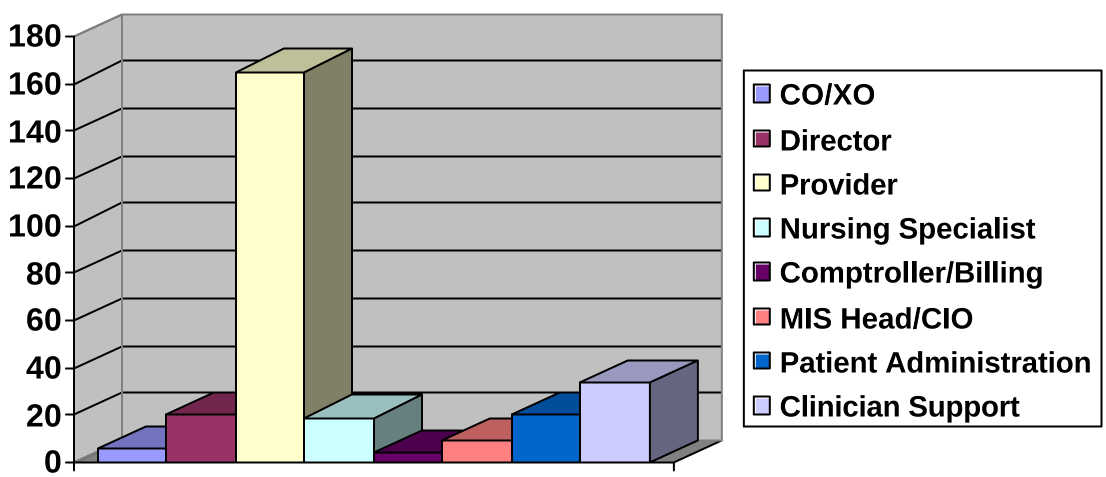

Figure 5.3. Respondents by Position.

E. ONLINE USER REQUIREMENT SURVEY RESULTS

As discussed, the survey results are provided in several formats. *Appendix A* lists the survey questions and responses by position. *Appendix B* lists the survey responses with statistical analysis. *Appendix C* lists the survey raw data responses by user ID. Note that user IDs are not numbered sequentially from 1 to 277. Several ID numbers were used in the development of the survey, while numbers missing from the body are those that were processed as duplicate entries. The following table also provides detailed survey information in the form of user-ranked priorities for requirements. The methodology used to determine rank ordering was weighted mean of responses (refer to *Appendix B* for details). This table should provide significant input in the determination of user requirements with respect to PDAs in the military healthcare clinic environment.

Rank-Ordered User Preferences (Weighted-mean method)		
Rank value		**Question**
8.55	Q23	The value of a portable (pocket sized) PDA is
8.29	Q28	The number of acceptable screen interactions (scrolls) until desired information is located is (1-3 scrolls)
8.22	Q3	The value of using PDAs in an environment where a wireless connection to a LAN provides continuous, real-time data is
8.22	Q12	The value of using PDAs to reduce medical errors (drug interaction warnings, dosage calculators, etc) is
8.15	Q27	The minimum PDA delay in screen response time that is acceptable is (1-5 seconds)
7.99	Q26	The value of standardized medical/business applications on the PDA is
7.92	Q25	The value of accessing patient information at the point of patient care with a PDA is
7.58	Q13	The value of using PDAs for personal and patient scheduling is
7.58	Q24	The value of medical records integration/access with a PDA is
7.56	Q19	With respect to PDAs, limited application storage (internal RAM) concerns are
7.56	Q7	The value of using PDAs to look up ICD-9/CPT /PDR is
7.48	Q10	The value of using PDAs to search professional literature (e.g., AMA abstracts, Epocrates, et al) is
7.47	Q1	The value of using Personal Digital Assistant technology (Palm Pilot, Pocket PC, et al) to input data to/extract data from the Composite Health Care System and/or the Ambulatory Data System is
7.45	Q8	The value of using PDAs to reduce/or eliminate KG-ADS terminal use time is
7.34	Q6	The value of using PDAs for Radiological Order Entry is
7.27	Q5	The value of using PDAs for Laboratory Order Entry is
7.27	Q4	The value of using PDAs for Pharmaceutical Order Entry is
7.27	Q16	With respect to PDAs, patient privacy (HIPAA) concerns are
7.24	Q18	With respect to PDAs, the ability to personalize content are
7.11	Q15	With respect to PDAs, network security concerns are
7.01	Q17	With respect to PDAs, ease of use concerns are
6.83	Q11	The value of using PDAs for e-mail connectivity is:
6.70	Q2	The value of using PDAs where you must return the device to a cradle or use infrared sync station to update either the PDA or CHCS/ADS is
6.67	Q35	The value of integrating barcode scanning capability (match medications with patient, associate material costs with episodes of care/inventory control) on the PDA is
6.48	Q33	The value of integrating voice transcription services on the PDA is
6.46	Q21	With respect to PDAs, additional functionality (use as a voice recorder, beeper, etc.) is
6.42	Q9	The value of using PDAs to provide billing info directly to billing dept is
6.36	Q22	The value of point-of-service patient registration/admission with the PDA is
6.17	Q34	The value of providing an audio alert for high-priority e-mail on the PDA is
5.53	Q36	The value of utilizing medical imaging (low-level diagnostic display capability) on the PDA is
5.48	Q14	With respect to PDAs, cost concerns are
4.88	Q20	With respect to PDAs, a color display is important

Table 5.5. Rank-Ordered User Preferences for Requirements.

F. POST-TESTING PHASE-OUT SURVEY

Recall that the operational phase of this research was to gain provider perspective with respect to hardware and software applications. This was accomplished via a partnership with the Naval Hospital Lemoore, whereby the Family Practice Department agreed to assist in evaluating product characteristics to determine desired functionality with respect to requirements evaluation. The participants were given three matrices, with selections for High, Medium, or Low value. Again, for numerical purposes the values, 9, 5, and 1 respectively were assigned to derive a weighted-mean value. The respondent demographics and survey responses are provided in the remainder of this section.

1. Demographics

Rank	Quantity
O1-O3	5
O4 or above	3

Table 5.6. Out Survey Respondents by Rank.

Position	Quantity
Director	1
Family Practice Physician	5
Family Practice Nurse	2

Table 5.7. Out Survey Respondents by Position.

2. Software Evaluation

	Medical Applications						
	Coding	Patient Tracking	Drug Databases		Diagnosis &Treatment	Medical Calculators	
	ICD-9 Notes	Patient Tracker 4.1	EPocrates	Nursing Drugs	Five minute Clinical Consult	MedCalc	Archimedes
Ease of use	7.25	6.33	7.50	7.00	9.00	8.33	5.00
Readability of graphics/text	9.00	7.66	8.00	7.00	7.66	7.66	5.00
Program navigation/ responsiveness	7.25	7.66	7.50	7.00	9.00	8.33	6.33
Accuracy of medical data	9.00	7.00	8.00	7.00	9.00	8.33	6.33
Program reliability (buggy software)	7.25	7.66	8.00	7.00	9.00	9.00	6.33
Medical value	6.00	6.00	9.00	7.00	9.00	9.00	7.66
Help/Service/Support	5.00	7.00	7.14	7.00	9.00	6.30	6.33
Program customizability	3.00	7.00	5.00	7.00	5.00	5.00	7.00
Total	53.75	56.31	60.14	56	66.66	61.95	49.98
Weighted mean	6.72	7.04	7.52	7	8.33	7.74	6.25

Table 5.8. Evaluation of Medical Applications.

In Figure 5.4, the medical applications are displayed in a visual format for ease of understanding.

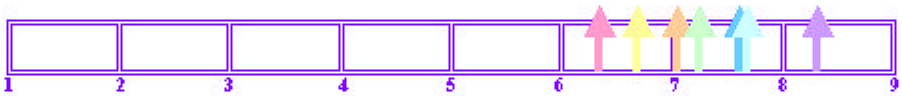

Figure 5.4. Likert Scale Plot of Medical Applications.

3. Hardware Evaluation

	PDA Platforms			
	Palm Vx	**Handspring Visor**	**Compaq iPAQ Pocket PC**	**Symbol SPT 1700**
Desktop Software	8.20	9.00	9.00	7.66
Operating System	8.20	9.00	9.00	9.00
Memory	4.20	7.00	9.00	5.00
Display	6.60	8.00	9.00	7.66
Battery Life	7.40	4.00	7.00	6.33
Portability Size/weight	7.40	6.00	5.00	3.66
Expandability	3.40	7.00	9.00	5.00
Connectivity	5.00	5.00	9.00	6.33
Ruggedness/ Survivability	5.00	5.00	5.00	9.00
Ergonomic design	6.60	6.00	5.00	5.00
Total	**62**	**66**	**76**	**64.64**
Weighted mean	**6.2**	**6.6**	**7.6**	**6.46**

Table 5.9. Evaluation of Hardware Platforms.

In Figure 5.5, the hardware platforms are displayed in a visual format for ease of understanding.

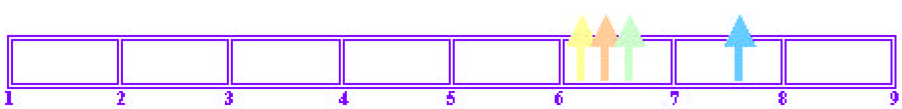

Figure 5.5. Likert Scale Plot of Hardware Platforms.

G. SUMMARY

This chapter explained the methodologies used to collect, analyze, and display data for generation of PDA requirements in the military healthcare clinic environment. Surveys were developed and posted; data, both demographic and survey specific, was then collated and analyzed using both graphical imaging and statistical analyses.

Detailed responses were given in Tables 6.5, 6.8, 6.9 and *Appendices A* through *C*. Recommendations based on the analyses are given in *Chapter VIII: Conclusions and Recommendations*.

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VI. WIRELESS NETWORKING TECHNOLOGIES

A. INTRODUCTION

In this chapter the authors provide a brief PDA technology background followed by an overview of wireless technologies. Those technologies include detailed Bluetooth, Infrared, Frequency-Hopping Spread Spectrum (FHSS) and Direct-Sequence Spread Spectrum (DSSS). An empirical presentation of an FHSS and a DSSS wireless solution is provided. Finally, a glimpse into future wireless applications, including Coded Orthogonal Frequency Division Multiplexing (COFDM), is provided. A visual overview of this chapter is presented in the following table.

Wireless Technologies	
Section B	Technology Background
Section C	Bluetooth
Section C.1	Parameters
Section C.2	Usage Models
Section C.3	Medical Advancements
Section D	Infrared
Section D.1	Parameters
Section D.2	Support
Section E	Spread Spectrum Technologies
Section E.1	Frequency-Hopping Spread Spectrum
Section E.2	Direct-Sequencing Spread Spectrum
Section F	An Empirical Comparison of Products
Section G	Future Applications

Table 6.1. Chapter VI Overview.

B. TECHNOLOGY BACKGROUND

The proliferation of Personal Digital Assistants (PDAs), and the widespread progress in mobile/wireless technologies, has made available for several years the opportunity for improving business practices across industries. As discussed earlier, one sector of the market that has taken particular advantage is healthcare. Major healthcare facilities/groups ideally centralize personal patient healthcare and billing data into one, or possibly two, interconnected information systems (hereafter described as enterprise systems).

Commercial-off-the-shelf (COTS) software applications exist which integrate seamlessly with these enterprise systems and allow for functionality such as physician order entry (e.g., ordering laboratory or radiological studies, or entering a personal prescription into the system). As shown in Chapters I, II and III these applications can also provide for patient scheduling, mobile access to patient data, and medical guidance on critical paths to patient care. These tools can reduce medical/prescription errors, make accurate connections between treatment plans and patient billing, properly assign medical material costs, and make adjustments to material inventories, thus triggering automatic reordering processes. These improvements to patient care have a synergistic effect when operated in a real-time wireless environment. While the commercial healthcare sector has been investigating potential benefits and developing solutions for several years, the military has yet to formally assess requirements in this area at either the Department of Defense (DoD) or component level.

Several wireless technologies available today standout when discussing use over a Local Area Network (LAN). These include Bluetooth, Infrared, and RF wireless LAN (both 802.11 and 802.11b). While this study emphasized the use of the latter, the former bear at least cursory discussion here as their use in medical facilities becomes more common. Private sector success stories utilizing mobile platforms with wireless connections abound. The Chicago-based Midwest Heart Specialist cardiology group, for example, has been using the Proxim RangeLAN solution for several years (Levine, 2000). The practice has installed five wireless access points in four offices. Each of the three single-story offices has one access point, while the two-story facility has one on each floor. The group uses 60 handheld Sharp wireless devices to seamlessly transmit medical data between the units and their wired networks

C. BLUETOOTH

In 1994, Ericsson Mobile Communications began a study that was to explore the feasibility of a short-range, low-powered, low-cost solution that would allow cellular telephones to connect with their peripherals. The result was Bluetooth, an RF wireless technology developed for local area voice and data communication by a Special Interest Group (SIG) consortium of leading technology companies. The group now numbers in excess of 1300 members, and includes industry leaders such as IBM, Intel, Microsoft, Lucent, Motorola, Nokia, Toshiba, Ericsson and 3Com.

1. Parameters

The system operates in the 2.4 GHz ISM (Industrial, Scientific, Medical) band, providing license-free operation in the United States, Europe, and Japan. The hardware is based on a 9mm x 9mm RF microchip that provides up to a 10-meter range. The range can be extended to up to 100 meters with amplifiers. The technology also includes an open standard adaptive protocol that controls connections, sessions, and security. Bluetooth technology is fast becoming synonymous with the phrase Wireless Personal Area Network (WPAN), or the IEEE 802.15 standard. Bluetooth-enabled devices can form piconetworks by linking with up to seven other Bluetooth enabled devices that are within range.

The Bluetooth Specification is a de facto standard containing the information required to ensure that diverse devices supporting the Bluetooth wireless technology can communicate with each other worldwide. The document is divided into two parts:

- Volume 1 (Core)
- Volume 2 (Profiles)

The Core section specifies components such as the radio, baseband, link manager, service discovery protocol, transport layer, and interoperability with different communication protocols. The Profiles volume specifies the protocols and procedures required for different types of Bluetooth applications. Bluetooth will support three synchronous 64 kbps voice connections and a 721 kbps bi-directional or a 56 kbps one-way multimedia connection.

2. Usage Models

The Bluetooth Special Interest Group has identified potential usage models. Some of the more applicable models are listed in the following table.

Bluetooth Usage Models	
1.	A phone functions as a portable phone (fixed line charge) while at home. When on move, it functions as a mobile phone (cellular charge). When the phone comes w range of another mobile phone with built-in Bluetooth wireless technology it funct as a walkie-talkie (no telephony charge).
2.	Real-time internet access is provided on a mobile computer regardless of loca using Bluetooth connections through a mobile phone (cellular) or through a prox wired access point (e.g. PSTN, ISDN, LAN, xDSL).
3.	In meetings and conferences, selected documents can be instantly transferred participants, and exchange of electronic business cards occurs automatically.
4.	Wireless headset connection to a mobile phone, mobile computer or any w connection keeps hands free for more important tasks when at the office or in a car.
5.	Automatic synchronization of a desktop, mobile computer, notebook (PC-PDA and HPC) and mobile phone is achieved. For instance, as soon as a personal offic entered the address list and calendar on a notebook will automatically be update agree with the one on a desktop, or vice versa.

Table 6.2. Examples of Bluetooth Usage Models.

3. Medical Advancements

A specific advancement of Bluetooth technology in the medical arena is the development of the "Smart Shirt" (Wolf, 2000). Originally funded by the Defense Advanced Research Projects Agency, the intent was to provide a monitoring unit with transmitted vital biologic statistics of the soldier in the field. In that way, triage-like determinations could be made that could help shape any rescue attempts. The Georgia Institute of Technology's School Textile and Fiber Engineering developed the fabric used in the tee shirt, which is woven with conductive fibers.

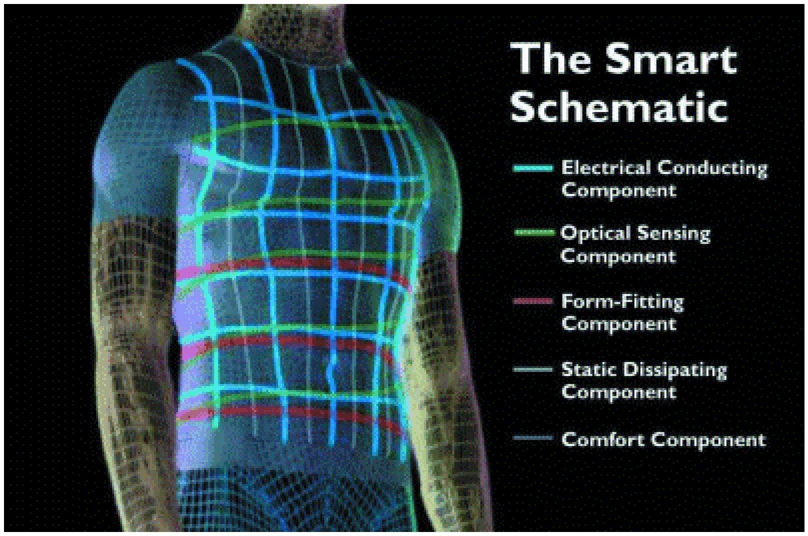

Figure 6.1. The Smart Shirt Fabric Model (From Wolf, 2000).

Micro-sensors transmit the medical data using Bluetooth technology to 802.11-based transceivers carried by the individual. Those signals are then transmitted to the appropriate monitoring units. The shirts are now being used in some neo-natal intensive care units to provide vital signs monitoring of premature infants.

Figure 6.2. A Smart Shirt Monitoring a Premature Infant's Vital Signs (From Wolf, 2000).

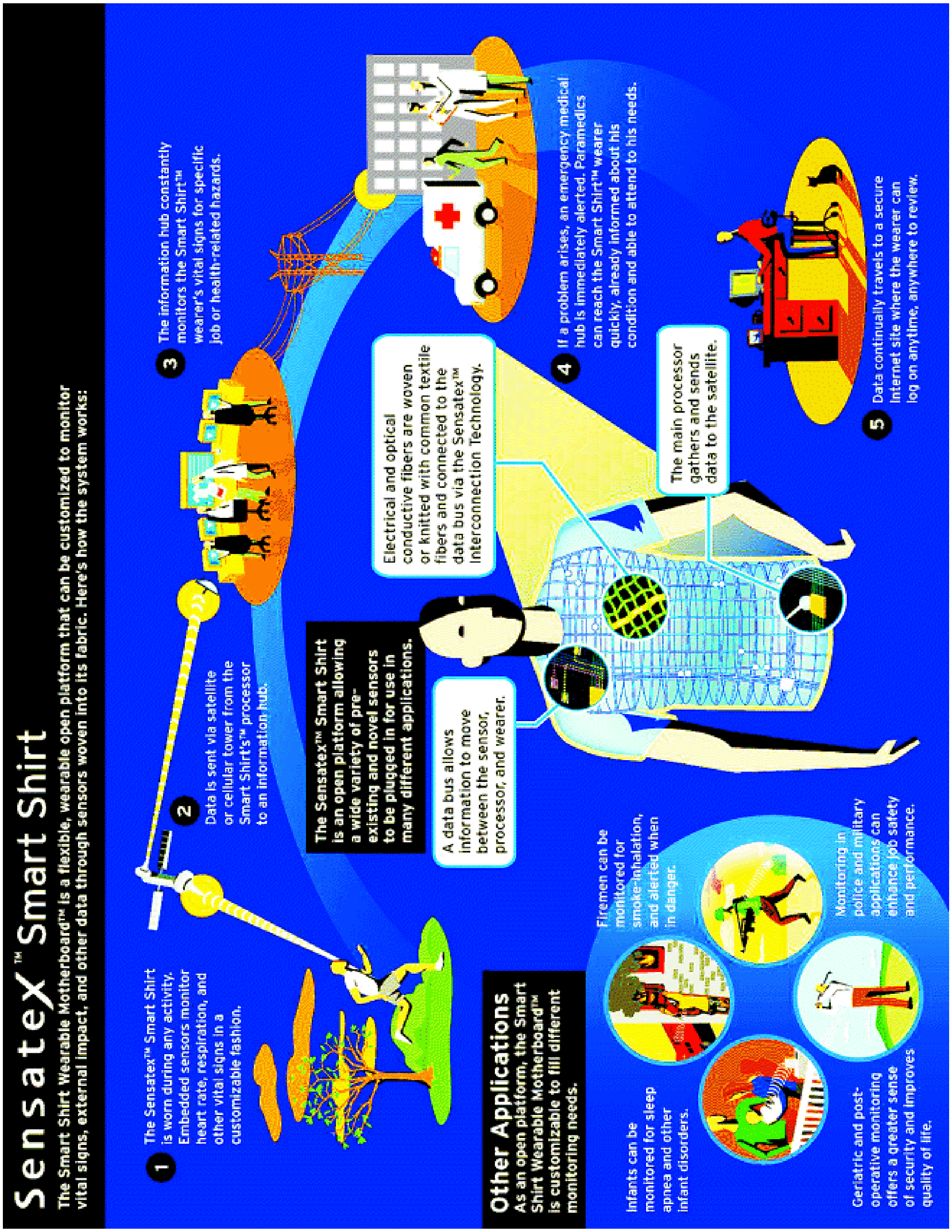

Figure 6.3. Overview of Smart Shirt Technology (From Wolf, 2000).

The commercial deployment of Bluetooth-enabled devices is only now beginning. The potential exists for healthcare providers to reduce the current time spent on logging in to multiple devices and synchronizing the data between them, thus freeing them from routine administrative tasks to perform clinical functions. It will take a few years to determine its impact and acceptance in the healthcare industry as a wireless technology.

D. INFRARED

Infrared (IR) communications is based on technology that is similar to the remote control devices such as TV and entertainment remote controls used in most homes today. IR offers a convenient, inexpensive and reliable way to connect computer and peripheral devices without the use of cables. In 1993, the Infrared Data Association (IrDA, 2001), a non-profit organization, was founded in Walnut Creek, CA to promote global IR Standards. Today, IrDA connectivity is routinely incorporated into portable devices to bring us the most cost-effective and easy-to-use support available for wireless technologies. There are few US, European or other international regulatory constraints. Manufacturers can ship IrDA-enabled products globally without any constraints, and international travelers can use IrDA functional devices wherever they are. Environmental interference problems are minimal with this technology, however unobstructed line-of-sight transmission is a requirement (DeJesus, 1998). This is not the same as direct line-of-sight. Distant connectivity has been established with IrDA systems using holographic diffraction gratings (mirrors) as a method of bypassing physical obstructions such as hallway corners. This is usually only useful in an internal environment, as inclement weather can inhibit infrared transmissions of this nature.

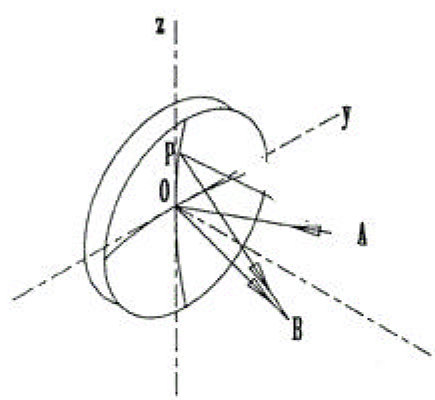

Figure 6.4. A Concave Holographic Diffraction Grating (From, Agilent, 2001).

1. Parameters

IrDA has a developed set of standards for interoperable IR data communications. In 1993, IrDA determined the basis for the Serial Infrared (SIR) Data Link Standards (Millar, 1998). In June 1994, IrDA published the standards that include (SIR) Link specification, Link Access Protocol (LAP) specification, and Link Management Protocol (LMP) specification. They released extensions to SIR standard including 4Mb/S in October 1995. The IrDA Standard Specification has been expanded to include high-speed extensions from 1.152 Mb/S, 4.0 Mb/S and 16 Mb/S. This extension requires an add-in card to retrofit legacy PC's with high speed IR, and a synchronous communications controller or equivalent. The standard is now divided into two major categories: data and control (IrDA Standards 2001). IrDA data defines the standard for two-way data interchange using the infrared medium for transmission between data ports. IrDA Control (IrDA-C, formerly known as IrBUS) defines the standard that allows peripherals to interact with intelligent host devices. These include keyboards, mice, joysticks, and pointing devices. IrDA-C is a PC-peripheral style bus protocol, and does not interfere with the application developer (Microsoft, 2001). The protocol is low speed, low latency, long distance (6 meters), wide angle, and multiple-device enabled. Multiple devices are enabled through a dithering scheme that is a form of Packet Reservation Multiple Access (PRMA) technology.

2. Support

In 1995, several market leaders announced/released products with IR features based on IrDA standards. These products included adapters, printers, PC's, PDA's, notebook computers, LAN access devices, and software applications. In November 1995, Microsoft Corporation first announced it had added support for IrDA connectivity to the Microsoft Windows 95 operating system, enabling low-cost wireless connectivity between Windows 95 based PC's and peripheral devices (Microsoft, 2001). That support has continued through to their latest operating systems iteration, Windows 2000 and Windows XP. Windows 2000 is the first NT-based operating system to incorporate IrDA protocols, providing support for IrNET and IrDial. Windows XP further integrates the technology by providing support for those plus IrCOMM.

E. SPREAD SPECTRUM (SS) TECHNOLOGIES

Spread Spectrum (SS) technology, also referred to as Code-Division Multiple Access (CDMA), takes a conventional narrow-band signal and transmits it across a broader frequency spectrum in one of several ways. A SS signal bandwidth is much greater than the message bandwidth, with the information bandwidth being 20 to 254 times larger for commercial systems, and up to 1000 times as large for some military applications. SS technology is achieved in a variety of methods. Common to both of the following technologies, an Access Point or wireless LAN transceiver functions in effect as a bridge, connecting 802.3 Ethernet to 802.11(b). The typical range of an Access Point varies from 20 to 500 meters, dependent upon such factors as transmitted power, antenna configuration, and structural interference. Actress Hedy Lamarr and composer George Antheil devised and patented the technology in 1942 (Macdonald, 1992).

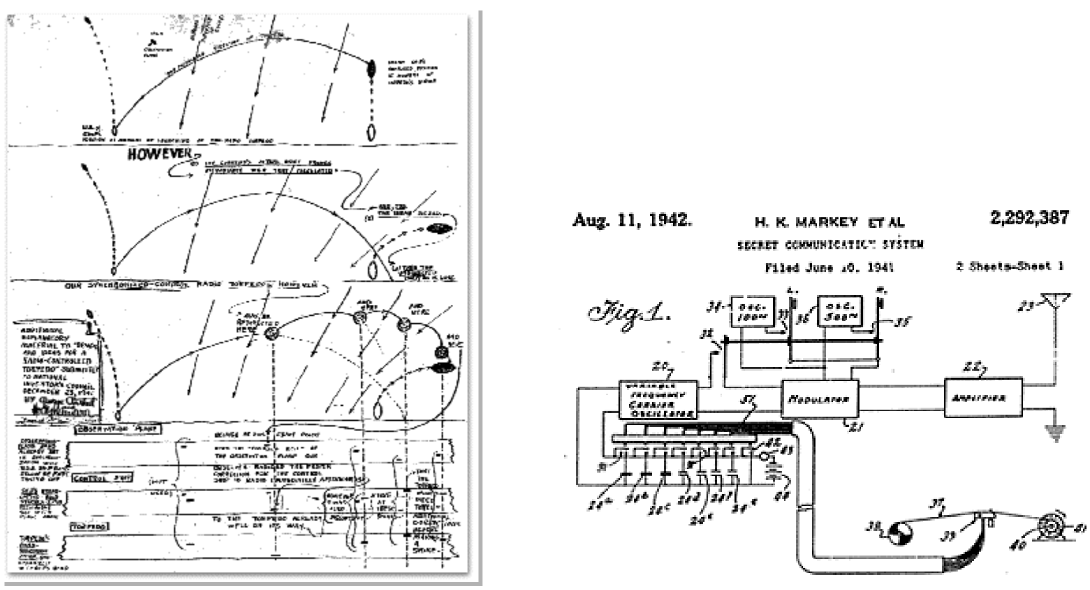

Figure 6.5. Sketches Submitted by Hedy Lamarr and George Antheil Supporting their Frequency Hopping Technology Patent in 1942 (From Hoglund, 2001).

Their vision was that the U.S. Navy in World War II would be able to control our torpedoes using a radio frequency, and that by "hopping" the frequency, transmission would be provided against unwanted interception. It was not used by the US military, however, until 1962, during the Cuban missile crises. This was three years after the patent had expired.

1. Frequency-Hopping Spread Spectrum (FHSS)

FHSS "hops" the narrow-band transmission signal across the broad transmission band as a function of time. Standard narrow-band radio transmissions are susceptible to interference from adjacent frequencies. With an FHSS solution, that type of spatial interference is effectively negated because the frequency of the carrier is constantly shifting. Additionally, since the Spread Spectrum signals are spread so widely across a broad transmit band, the necessary transmit power level is less than required for standard narrow-band transmissions. Recalling the mathematical postulation of C. E. Shannon (Fitzummons, 1997):

Shannon's Law:

$$C = W\log(1+S/N)$$

where C is Channel capacity, W is Bandwidth, and S/N is the ratio of signal power to noise power. By increasing bandwidth, system signal power requirements are reduced. The graph below demonstrates another representation of the same principle.

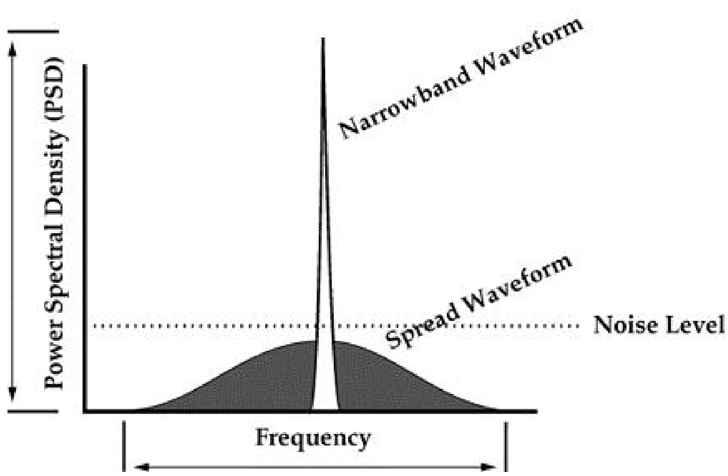

Figure 6.6. Comparison of Spread Spectrum and Narrow Band Waveforms (From Fitzummons, 1997).

For FHSS, the transmitter and receiver share a code that determines where (at what frequency) the carrier will be at any given time. The code synchronizes both devices so that they hop in unison. The technology utilizes 66 different hopping patterns, and the frequency-hopping rate is very high, with the signal remaining on a specific frequency for less than 10 milliseconds. These are all critical for anti-jamming/Lowest Possibility of Detection (LPD) characteristics desired in both military and sensitive private-sector systems.

FHSS is governed by the IEEE 802.11 industry standard. The standard defines three physical layer methods, FHSS and DSSS using RF, and the third using infrared technology. The two RF layers operate in the 2.4 GHz spectrum. Per the standard, over-the-air data rates fall into either 1Mbs or 2Mbs categories. Both use Gaussian Frequency Shift Keying (GFSK). Two-level GFSK yields 1Mbs rates, while four-level GFSK provides the 2Mbs rate (Caruthers 1995). The hopping rules defined are very specific. 79 channels are used world wide, except in Japan where 23 frequencies are the standard (Canterbury, 1998). Hops must achieve at least six channels of separation from the previous channel, and an FHSS transmitter must tune to within 60Khz of $f_{transmit}$ in less than 224 microseconds. FHSS signals appear random, but are predefined and monitored by both the transmitter and receiver.

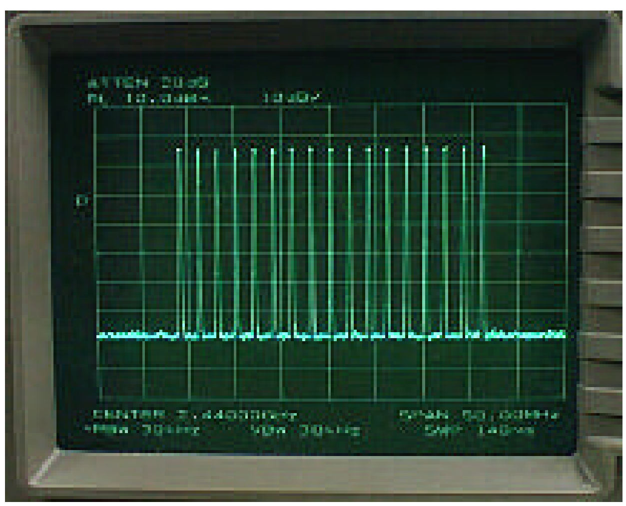

Figure 6.7. FHSS Waveform on Spectrum Analyzer (From Fitzummons, 1997).

As stated above, dwell time for a single transmitted frequency is in the area of 10 milliseconds. Typical hop rates are around 75 hops every half-minute, or approximately every 400 milliseconds. FHSS wireless uses Carrier Sense Multiple Access/Collision

Avoidance (CSMA/CA) with random back off, a variation of CSMA/Collision Detection. The three authorized bands begin at 902MHz, 2.4GHz, and 5.7525Ghz respectively (Proxim, 2001), and no governed site license is required for operation. The technology calls for a four-way handshake as illustrated (Rose-Hulman, 2001).

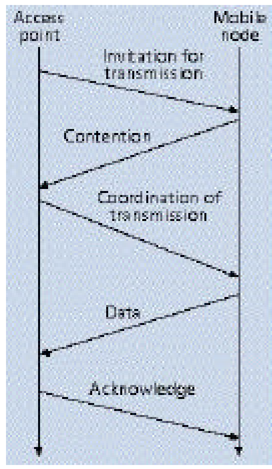

Figure 6.8. FHSS Wireless Handshake (From Rose-Hulman, 2001).

2. Direct-Sequencing Spread Spectrum (DSSS)

DSSS expands the narrow signal across the broad portion of the transmission band. DSSS is achieved by multiplying a data signal with a pseudo noise (PN-coded) signal. The PN-code is an extremely high frequency binary signal (large bandwidth). Thus, the convolution of the two frequencies spreads the signal spectrum of the data signal to the wider PN-coded bandwidth, i.e., the data is "spread" around the center frequency (Fitzummons, 1997). Since the noise-like signals are difficult to detect, this technology is also a favorite for military application because of that low probability of detection.

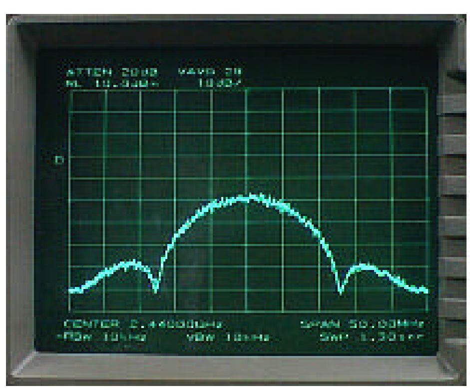

Figure 6.9. DSSS Waveform on Spectrum Analyzer (From Fitzummons, 1997).

As with FHSS technology, the DSSS receiving device is familiar with the transmitting device's encoding pattern and decodes accordingly. Whereas FHSS uses 79 channels, DHSS uses eleven channels, each 22MHz wide. Of the eleven prescribed channels, however, only three can simultaneously operate in the 2.4GHz band (at the maximum standard 11MB data transfer rate) without overlapping. The IEEE 802.11b standard governs DSSS technology, and calls for fall-back sequencing of data rates as follows: 11MB, 5.5MB, 2MB, to 1MB.

A summary of spread spectrum technologies shows that each has relative strengths and weaknesses. Frequency Hopping (802.11) can handle more users per access point, has very strong interference-immunity characteristics, and is a more mature (reliable) technology. Direct Sequence (802.11b) is faster--it can handle up to 11MB data transfer rates--but is limited in scalability. It is best suited for low device density, high data rate requirement systems. An innovative modulation technique called Coded Orthogonal Frequency Division Multiplexing (COFDM) will allow bit-rate technology to exceed 54Mb/sec (Anderson, 2001). This technique transmits data in an immensely parallel fashion. It also compensates for problems of delay spread experienced in the 2.4Ghz band. Delay spread is the unwanted characteristic of a signal arriving at a certain point at different times due to bouncing off obstacles in the transmission path.

IEEE Standard	Modulation type	Data Bandwidth	Spectrum
802.11	FH, DS, Infrared	2Mb, 1Mb	2.4 GHz
802.11b	DS only	11Mb (back off to 5.5, 2, and 1 Mb)	2.4 GHz
802.11a	COFDM	54Mb	5.6 GHz

Table 6.3. Spread-Spectrum Characteristics.

F. AN EMPIRICAL COMPARISON OF PRODUCTS

The two wireless solutions used to help provide the authors with experiential data were the integrated Symbol 802.11 solution and the Xircom 802.11b solution. The

Xircom solution was used to connect both our IBM ThinkPad laptop and the Compaq iPaq H3600 Pocket PC to the network. Characteristics such as battery life and data throughput of the devices were previously discussed in Chapter III.

Both solutions were fairly easy to configure. Physical HotSync of the Symbol devices was achieved rather quickly. Wireless configuration of the HotSync function for the devices did, however, require us to contact the Symbol support division. After a short familiarization, they were up and running. Area of coverage was greatest for the Symbol access points (see Figures 6.10 through 6.12), however both fell short of advertised ranges. This was due in part to structural limitations between devices and access points. The radii were measured to the point where connectivity was lost. Because of the Symbol's greater area of coverage, those access points were able to be physically located in existing communications closets located at opposite ends of the treatment facility. The hospital first floor dimensions are 353 feet long by 213 feet wide. The Symbol Spectrum 24 also offered 40-bit and 128-bit encryption packages.

Due to the smaller area of coverage of the Xircom access point, that device was located centrally within the Family Practice clinic. Configuration of the Xircom PC Card for the iPaq Pocket PC required an additional driver download, which was accomplished with routine ease. The Xircom solution provided greater administrative functionality, including a comprehensive set of diagnostic tools. This solution also had the ability select 40-bit and 128-bit encryption packages. The lack of incorporated encryption features in most current wireless solutions is an issue that needs to be addressed in industries requiring confidentiality of data (Stammer, 2001). Encryption of data in the healthcare environment will be discussed in greater detail in Chapter VII: Security.

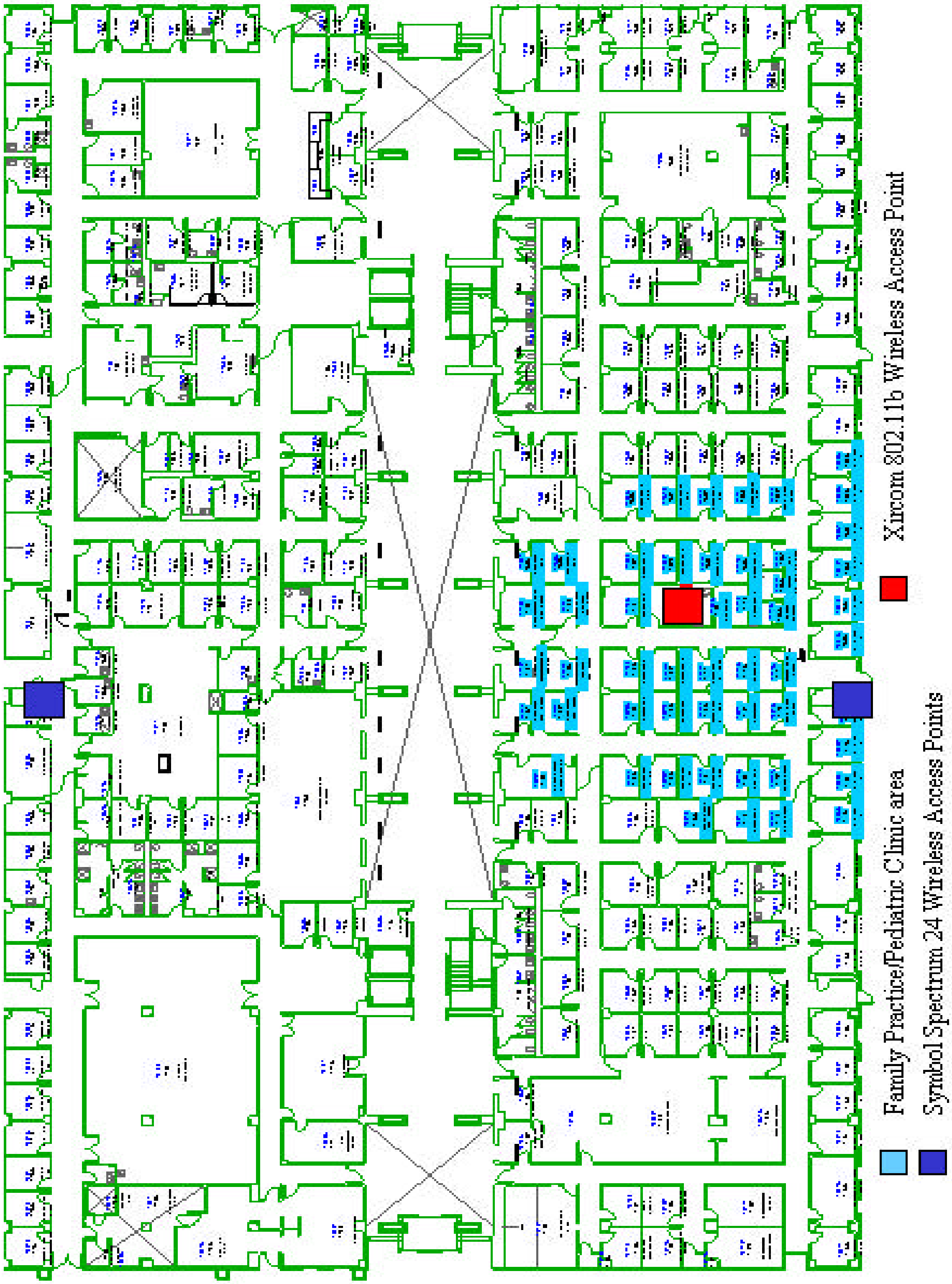

Figure 6.10. Access Point Locations.

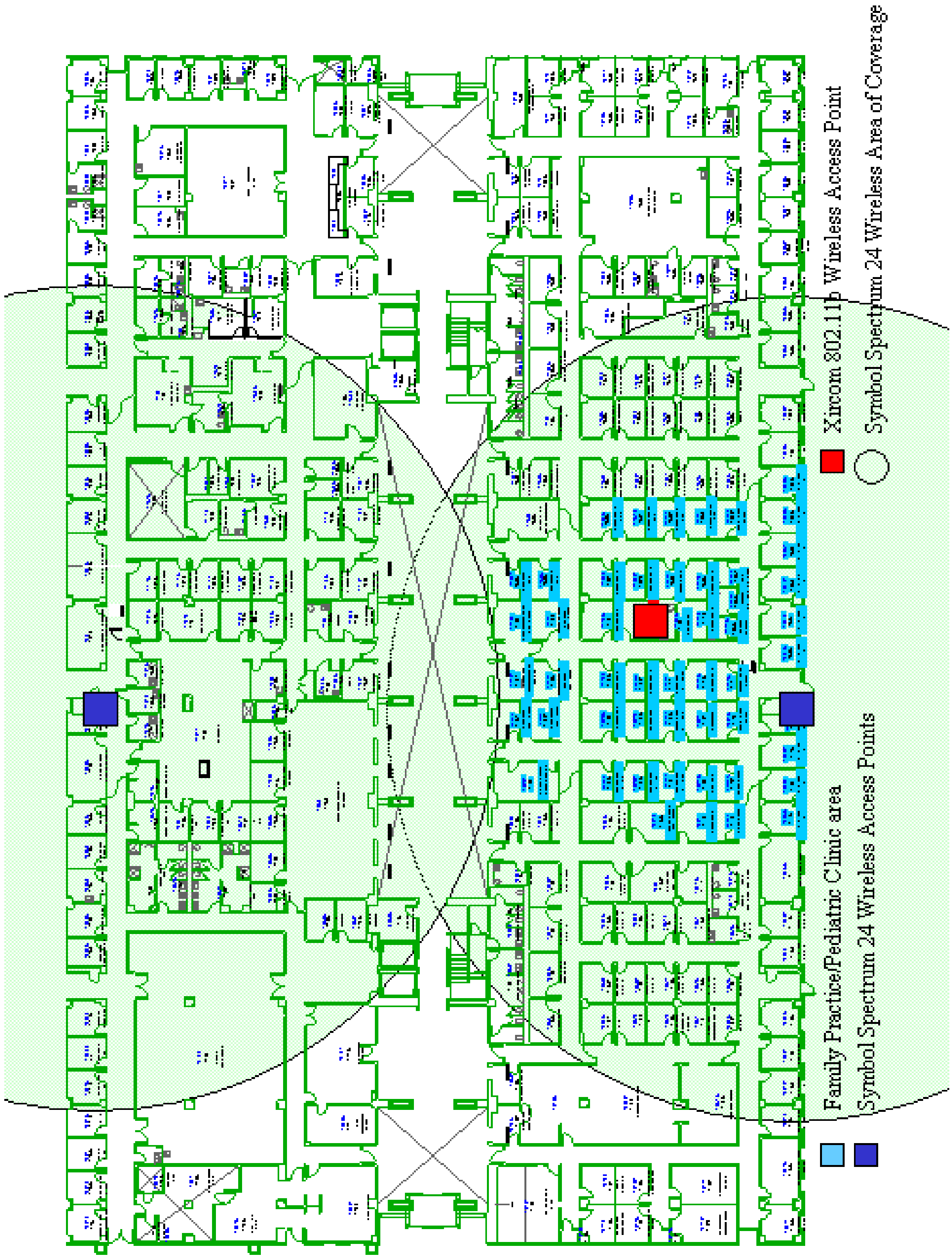

Figure 6.11. Symbol Access Point Area of Coverage.

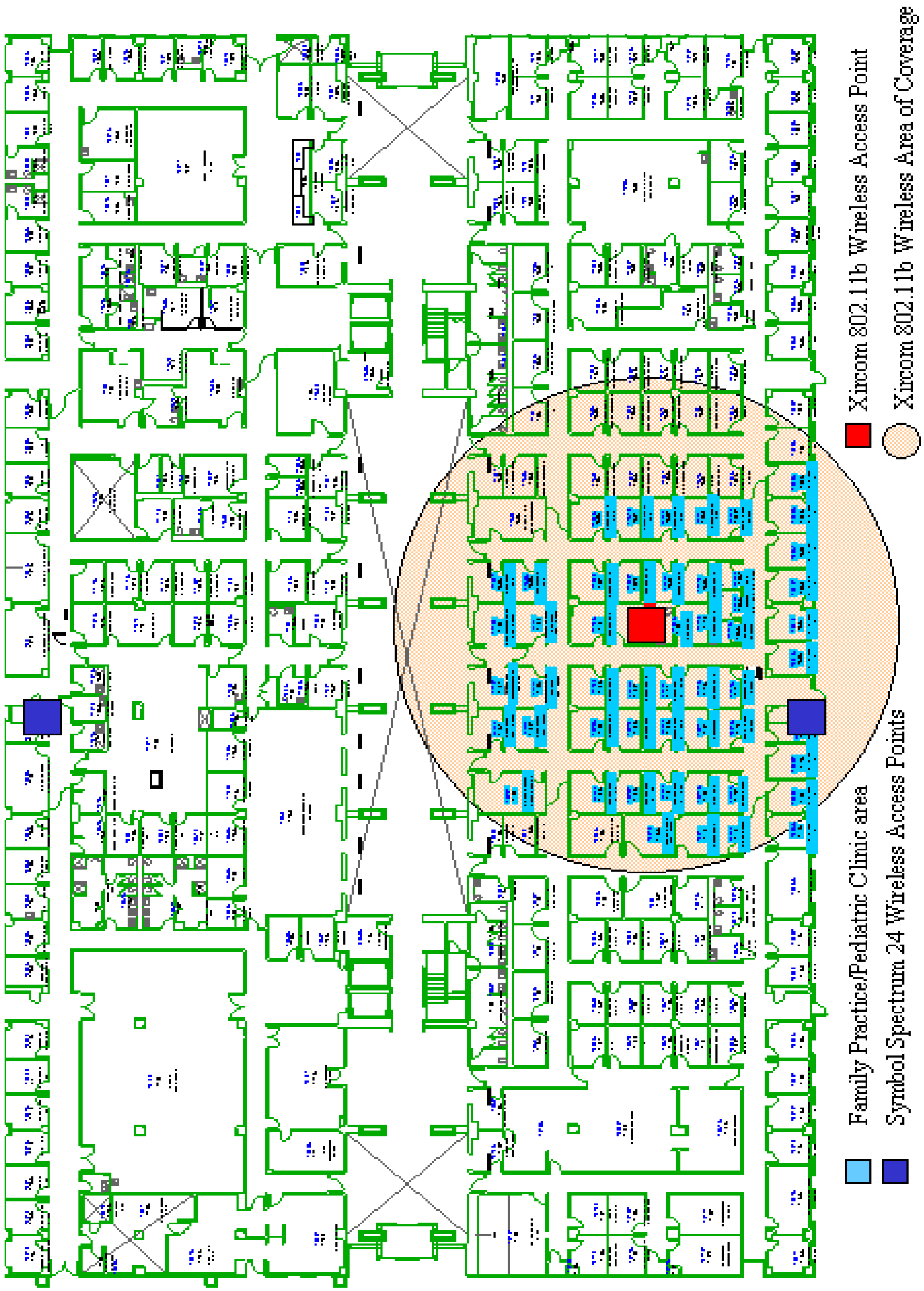

Figure 6.12. Xircom Access Point Area of Coverage.

While configuration of the access points and wireless nodes were accomplished with relative ease, it is noted that management of network configuration and connectivity for these assets should lie with authorized system administrators. Physical and network security issues surrounding these devices and their applications are discussed in detail in the following chapter.

G. FUTURE APPLICATIONS

IEEE finalized the 802.11 standard in June 1997. By fall of 1999, they had published two supplements to the standard: 802.11a and 802.11b (Geier, 2000). While the private sector has made 802.11b products readily available, development of solutions supporting 802.11a have been longer in coming. Some benefits of 802.11a, which uses Coded Orthogonal Frequency Division Multiplexing (COFDM) are its high data rates--up to 54Mb/sec in 20 MHz channels--and its 5.6 GHz operating fequency range (Anderson, 2001). Operating in this range will allow interference-free coexistence with the Bluetooth standard, which operates in the 2.4 MHz range.

As healthcare facilities migrate toward a more integrated wireless environment, many direct and indirect benefits can be expected. Patient administration functions become automated as changes in a patient's status automatically trigger a physical transfer (McCormick, 1999). Voice over IP phones, based on H.323 standards, will allow providers to stay in constant personal communication with staff members—a capability currently prohibited by bans on cellular use within specifically impacted areas of healthcare facilities. Caregivers provide triple verification when scanning medication barcodes, patient barcodes, and provider barcodes, ensuring the distributed pharmaceuticals are authorized and delivered to the correct patient in the correct dosage. The system has already automatically checked for medical contraindications such as adverse drug interactions and proper dosage by weight/age allocation. By providing real time evaluations and documentation, the wireless LAN can improve a facilities audit results on Joint Commission on Accreditation of Healthcare Organizations (JCAHO) studies, and its legal position in the event of adverse litigation.

Healthcare Informatics magazine, in both their February 2000 and 2001 issues, listed wireless capabilities as one of the nine hottest technology trends, along with Supply Chain Management and Interactive and E-business technologies (DeJesus, 2000 and

Stammer, 2001). They state the solution is in response to the demand for support applications that users want. Their caveat is that IT managers need to provide justification for the cost of the new technology. The authors, while not endorsing the following source, provide it to the reader as a justification reference. A recent study conducted by the Wireless Local Area Network Alliance (WLANA) showed the average time for full payback of initial wireless costs was less than nine months, and that 97 percent of customers who elected to install wireless LANs had met or exceeded expectations of competitive advantage (WLANA, 2001).

H. SUMMARY

In this chapter current and future wireless technologies and their application in the medical environment were explored by the authors. Among current technologies, Bluetooth, Infrared, 802.11, and 802.11b all have contributing value. The piconetworks enabled by Bluetooth technology will play an expanding role as multiple personal wireless devices become transparently connected. Infrared offers an affordable wireless solution with an established and widely supported technology. Frequency-Hopping and Direct-Sequencing Spread Spectrum solution currently provide solution offering data transmission rates of 1 to 11 MB/sec. However, due to congested bandwidth and potential growing interference with biomedical equipment, advancements in 802.11a operating in the 5.6GHz spectrum will provide the greatest increased opportunities for wireless connectivity. It operates in a frequency band separate from Bluetooth, and will allow data transfer rates of 54MB/sec, supporting emerging medical interactive Voice Video and Data (VVD) technologies.

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VII. SECURITY

A. INTRODUCTION

One of the most serious concerns of Information Technology executives is the security of their networks and the data that lies within. In this chapter the authors provide an overview of the federal legislative requirements and their implication for healthcare facilities as it applies to Personal Digital Assistants and wireless technologies. Also addressed in detail are security aspects of wireless transmissions, protection of patient data while in electronic format (at rest on the PDA), virus concerns, and measures of authentication and non-repudiation of transmitted messages.

B. HEALTH INSURANCE PORTABILITY AND ACCOUNTABILITY (HIPAA) ACT OF 1996

A recent survey, conducted at the annual Healthcare Information Management Systems Society (HIMSS) conference and exhibition in February 2001, listed upgrading security to meet Health Insurance Portability and Accountability Act (HIPAA) requirements as the top priority for 61 percent of the nearly 500 healthcare IT respondents. This concern displaced the previous year's lead issue: deployment of Internet technology dropped 17 percent to a 2001 second-place priority. In 1996, then-President Clinton signed into legislation HIPAA, establishing the patient's right to privacy, setting minimum security standards, and defining implementation timelines and enforcement penalties. The HIPAA Act of 1996, in addition to ensuring portability of insurance when workers transfer to a new place of employment, also defines legislation which protects patient health information by setting and enforcing security standards. While this section focuses on the accountability aspects of HIPAA, we do not discount the importance of insurance portability issues. For a good overview of portability issues, the reader is directed to the following sources.

- Health Care Financing Administration (HCFA*) HIPAA Welcome Page* http://www.hcfa.gov/medicaid/hipaa/
- US Department of Health and Human Services (DHHS) *Administrative Simplification* http://aspe.hhs.gov.admnsimp/

The U.S. Department of Health and Human Services has cognizance over the security requirements defined by HIPAA.

1. Rules Processing

The U. S. Department of Health and Human Services follows a formal process for developing those standards (Branco, 2000). DHSS first develops recommendations and publishes those proposed rules in the Federal Register. The Notice of Proposed Rule Making remains on the register for a 60-day Comment Period, at which time comments are analyzed for incorporation into the rules. The Final Rule is then developed and published on the register, at which time healthcare entities are required to begin compliance. In most cases, compliance for each individual rule must be achieved within two years. Smaller health plans may have up to 36 months to comply. Compliance timelines are presented later in this section.

2. Applicability and Penalties

The Act directly applies to healthcare providers who transmit any health information in electronic format, public and private health plans (e.g. Blue Cross, Kaiser, Medicare, Medicaid), and clearinghouses (those services which provide storage and transmittal of patient data. The definition of health information is laid out in section 1171 of the Act. Roughly presented here, it is any information, in any form or medium, created or received by the healthcare entity (provider, hospital, plan, university, insurer, etc.), that relates to the past, present, or future physical health, mental health, condition, provision of health, or payment for the provision of health. The civil penalties for violating this Act include $100 per episode, and up to $25,000 per calendar year for multiple violations of a single provision. The criminal penalties place a greater onus on the provider to protect patient information: up to $50,000 and/or imprisonment for one year. If conducted under false pretenses, the penalty escalates up to $100,000 and/or a five-year imprisonment. Finally, if the unauthorized disclosure of patient information is used for personal gain, commercial advantage, or malicious harm, the penalty is up to $250,000 and/or 10 years in prison. It is evident that in addition to improving business efficiencies with respect to electronic data and conducting healthcare delivery in a manner that agrees with our beneficiaries, providers now have other incentives to ensure HIPAA compliance.

3. HIPAA in Detail

The Act repeatedly states that the patient's right to privacy should be *reasonable*. While this is not a definitive explanation, and the use of specific technology is not mandated within the security rules, a reasonable level of effort must be made to ensure privacy. Also be aware that state privacy laws, when more restrictive than the federal HIPAA legislation, have priority. Disclosure of patient information must be kept to a minimum, and can only occur with consent, authorization, or when compelled by legal requirement. Patients can request disclosure restrictions, information amendments, access to their information, and provider information practices. Keeping all of this in mind, providers *cannot* lock down information so tightly that it impedes the delivery of healthcare. Some level of risk must be assumed in order to ensure continued provisioning. That said, providers also have the responsibility of due diligence when it comes to protecting patient information. They must effect reasonable measures of control to ensure confidentiality. Risk analysis, needs assessment, and policy development need to be addressed individually by entities to determine local business requirements for HIPAA compliance. It is critical that documentation be maintained to indicate why decisions where made in the areas indicated. Ideally, this will help to ensure proper level of effort. The measures listed in the following table apply not just to PDAs, but also to information/information systems in general.

Information System Security Measures	
Administrative	Roles and Responsibilities
	Policies and Procedures
	Training and Awareness
	Security Planning
Physical	Access Control (locked doors, escorts)
	Computer Workstations
	Media Controls
Technical Services and Mechanisms (Data in transit or at rest)	Integrity Controls
	Message authentication
	Access controls/encryption
	Alarms
	Audit trails
	Entity authentication/non-repudiation
	Event reporting

Table 7.1. Summary of Measures for Information System Security Plans. (From Walsh 2001).

HIPAA regulations will force healthcare entities to implement heightened security measures. Until the first several iterations of compliance are achieved, the Act will reduce the rate at which healthcare IT innovation has pervaded in recent years. Most organizations have two years to comply from the date the signing of specific Act areas.

HIPAA Timeline	
Transactions and Code Set:	October 16, 2002
Privacy:	April 14, 2003
Security Requirements:	To be determined
Unique Identifiers:	To be determined
Enforcement Procedures:	To be determined

Table 7.2. U. S. Department of Health and Human Services HIPAA Compliance Timeline (From DHHS, 2001).

Transactions mandate entities to streamline the processing of health care claims, reduce the volume of paperwork and provide better service for providers, insurers and patients. The new standards establish standard data content and format for submitting electronic claims and other administrative health care transactions (HHS, 2001). The *Privacy Rule* is that portion of the act that gives patients more control, establishes boundaries for use and release of health data, and mandates healthcare providers establish appropriate safeguards to protect patient privacy. *Security* will address improper access or alteration of data, while *Identifiers* will direct standardized unique identifiers be assigned to employers, providers and health plans. These three identifiers are being addressed separately.

4. Compliance

Preliminary results of the HIMSS Leadership Survey conducted in February shows the following industry compliance rates.

HIPAA Compliance Rates	
54%	Installed security technologies
53%	Assesses organizational compliance
47%	Documented security policies
34%	Hired Security/Privacy Officers
32%	Implemented security procedures
16%	Hired consultant to assess readiness
14%	Have not begun

Table 7.3. Industry Wide Compliance Rates as of February 2001 (From Dash, 2001).

These figures indicate that in an industry responsible for protecting patient privacy, and as network specialist responsible for affecting that level of protection with respect to electronic data, we have fallen well short of the ideal. Last year a 25-year-old Dutch hacker identified as Kane infiltrated the University of Washington Medical Center's computer system (Chin, 2001). The hacker gained access to an administrative database that contained the records of over 5,000 cardiology and rehabilitation patients. The information obtained included patient names, addresses, social security numbers, and the medical procedures that they had undergone. Admittedly, security of the system was weak. The following sections address security focus areas.

C. INFORMATION ASSURANCE

The desired outcome of HIPAA is to ensure availability, confidentiality, and integrity of patient data at all times. Additionally, it is necessary to ensure policies and methods authentication, certification, and reconstitution of all electronic data are in place and being utilized.

- Confidentiality refers to protecting patient data from unauthorized access.
- Integrity of patient data refers to the assurance that data has not been altered.
- Authentication validates the source location of data.
- Availability refers to the capacity of a system to provide the required data at the required time.
- Certification, sometimes referred to as non-repudiation, confirms the data sender.
- Reconstitution provides for the swift recover of data

The following tables will assist the reader in defining their own position with respect to HIPAA and administrative procedures and physical safeguards to guard data confidentiality, integrity, and availability. Using technology to help comply with these desired outcomes is the focus of the remaining sections of this chapter.

Administrative Procedures to Guard Data Integrity, Confidentiality and Availability	
HIPAA Requirement	Implementation
Certification	
Chain of trust partner agreement	
Contingency plan *(all listed implementation features must be implemented).*	• Applications and data criticality analysis. • Data backup plan. • Disaster recovery plan. • Emergency mode operation plan. • Testing and revision.
Formal mechanism for processing records.	
Information Access Control (*all listed implementation features must be implemented).*	• Access authorization • Access establishment. • Access modification.
Internal audit	
Personnel security *(all listed implementation features must be implemented).*	• Assure supervision of maintenance. • Maintenance of record of access authorizations. • Operating, and in some cases, maintenance personnel have proper access authorization. • Personnel clearance procedure. • Personnel security policy/procedure. • System users, including maintenance personnel, trained in security.
Security configuration mgmt. *(all listed implementation features must be implemented).*	• Documentation. • Hardware/software installation & maintenance review and testing for security features. • Inventory. • Security Testing. • Virus checking.

Table 7.4a. HIPAA Security Matrix-Administrative Safeguards from Proposed Rule Published August 1998 (From Bogen, 2001).

Administrative Procedures to Guard Data Integrity, Confidentiality and Availability (continued)	
Security incident procedures *(all listed implementation features must be implemented).*	• Report procedures. • Response procedures.
Security management process *(all listed implementation features must be implemented).*	• Risk analysis. • Risk management. • Sanction policy. • Security policy.
Termination procedures *(all listed implementation features must be implemented).*	• Combination locks changed. • Removal from access lists. • Removal of user account(s). • Turn in keys, token or cards that allow access.
Training *(all listed implementation features must be implemented).*	• Awareness training for all personnel (including mgmt). • Periodic security reminders. • User education concerning virus protection. • User education in importance of monitoring logs in success/failure, and how to report discrepancies. • User education in password management.

Table 7.4b. HIPAA Security Matrix-Administrative Safeguards from Proposed Rule Published August 1998 (From Bogen, 2001).

Physical Safeguards to Guard Data Integrity, Confidentiality and Availability	
HIPAA Requirement	**Implementation**
Assigned security responsibility	
Media controls *(all listed implementation features must be implemented).*	• Access control. • Accountability (tracking mechanism). • Data backup. • Data storage. • Disposal.
Physical access controls /limited *access (all listed implementation features must be implemented).*	• Disaster recovery. • Emergency mode operation. • Equipment control (into and out of site). • Facility security plan. • Procedures for verifying access authorizations prior to physical access. • Maintenance records. • Need-to-know procedures for personnel access. • Sign-in for visitors and escort, if appropriate. • Testing and revision.
Policy/guideline on work station use	
Secure work station location	
Security awareness training	

Table 7.5. HIPAA Security Matrix-Physical Safeguards from Proposed Rule Published August 1998 (From Bogen, 2001).

Technical Security Services to Guard Data Integrity, Confidentiality and Availability	
HIPAA Requirement	**Implementation**
Access control *(The following implementation feature must be implemented: Procedure for emergency access. In addition, at least one of the following three implementation features must be implemented: Context-based access, Role-based access, User-based access. The use of Encryption is optional).*	• Context-based access. • Encryption. • Procedure for emergency access. • Role-based access. • User-based access.
Audit controls	
Authorization control (*At least one of the listed implementation features must be implemented).*	• Role-based access. • User-based access.
Data Authentication	
Entity authentication *(The following implementation features must be implemented: Automatic logoff, Unique user identification. In addition, at least one of the other listed implementation features must be implemented).*	• Automatic logoff. • Biometric. • Password. • PIN. • Telephone callback. • Token. • Unique user identification.

Table 7.6. HIPAA Security Matrix-Technical Security Services from Proposed Rule Published August 1998 (From Bogen, 2001).

Technical Security Mechanisms to Guard against Unauthorized Access to Data Transmitted over a Network	
HIPAA Requirement	**Implementation**
Communications/network controls *(The following implementation features must be implemented: Integrity controls, Message authentication. If communications or networking is employed, one of the following implementation features must be implemented: Access controls, Encryption. In addition, if using a network, the following four implementation features must be implemented: Alarm, Audit trail, Entity authentication, Event reporting).*	• Access controls. • Alarm. • Audit trail. • Encryption. • Entity authentication. • Event reporting. • Integrity controls. • Message authentication.

Table 7.7. HIPAA Security Matrix-Technical Security Mechanisms from Proposed Rule Published August 1998 (From Bogen, 2001).

D. ENCRYPTION

The security risks experienced by both wired and wireless networks are similar (Weatherspoon, 2001). Both need to protect against threats to physical security (external sabotage or distributed denial of service (DDOS) attacks; unauthorized access from eavesdropping; and internal attacks from authorized users. This section will discuss the need for encryption of patient data under two conditions: during transmission and while at rest. As discussed in Chapter IV, wireless LAN transmissions conform to specific standards: IEEE 802.11 for FHSS and DSSS, IrDA for infrared, and IEEE 802.15 (Wireless Personal Area Network) for Bluetooth. Very few wireless LANs installed as of 2000 featured encrypted transmissions (Mitchell, 2000). Signals near wireless access points can be captured and observed, as indicated by the photo below. In an unencrypted environment, that means the signal is indicative of live network traffic. The display indicates two 11MB Direct Sequence transmissions. The one on the left is from an access point that is experiencing heavy, continuous network traffic, and thus has a more defined signal.

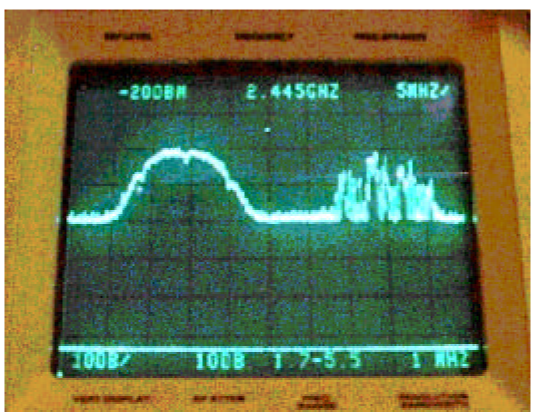

Figure 7.1. Spectrum Analyzer Display of Captured 2.4 GHz Wireless Transmission (From Mitchell, 2000).

Spread-Spectrum (SS) modulation characteristics alone provide only a modicum of security with respect to transmission. In order to intercept actual data during transmissions, one of two compromising situations must have occurred. Some piece of hardware, e.g. a network interface card, must have been stolen, or the software defined network identifier must have been disclosed. That Extended Service Set ID (ESSID) definition is part of an administrator's initial wireless network configuration that identifies a workgroup subnet. The ESSID is very susceptible to unofficial disclosure. An unauthorized connection only requires an intruder to have brief access to a wireless node (laptop, PDA) in order to determine the ESSID and encode his or her own compatible wireless device.

E. WIRED EQUIVALENCY PRIVACY (WEP)

The most readily available method to further protect data during transmission is the Wired Equivalency Privacy (WEP) protocol, which provides link-level protection. The WEP protocol address the confidentiality issues prescribed by HIPAA, that is it protects patient data from eavesdropping during wireless transmissions. The WEP algorithm was selected as an encryption solution for the 802.11b protocol because it met the following criteria (Weatherspoon, 2001):

- Reasonably strong
- Self-synchronizing
- Computationally efficient
- Exportable to other countries
- Optional

1. WEP Encryption Process

With WEP encryption, the 40-bit key is concatenated with a 24-bit initializing vector (IV), resulting in an overall key size of 64 bits. This concatenated key is then fed into a pseudorandom number generator (PRNG), which yields an RC4 pseudorandom sequence based on the input key. A CRC-32 integrity algorithm is used to compute an integrity check value (ICV) of the plaintext message, thus providing protection from unauthorized modification of the message. The pseudorandom key sequence is then used to encrypt the message (plaintext + ICV). The same-shared key is used to encrypt, decrypt, and authenticate the sender. The 40-bit encryption standard was developed to comply with limiting export requirements then in place. Most vendors also now offer 128-bit solutions. 128-bit encryption for 802.11 systems is realized in the same manner. A 104-bit key is concatenated with a 24-bit IV to produce an overall key size of 128 bits. Where 40-bit encryption is somewhat susceptible to a determined hacker using brute force attacks, the larger key size effectively eliminates this sort of unwanted intrusion.

As detailed in the next section, however, it will become clear that even 128-bit WEP is not secure against a determined attacker.

2. WEP Vulnerabilities

The goals of encryption are to provide message data with confidentiality, integrity and authenticity. In the past nine months, several independent sources have proven that WEP encryption is not secure, and that none of the goals are actually met with WEP. The weakness has been identified not in the RC4 encrypted component of the algorithm (either 40 bit or 104 bit), but in the 24-bit IV component (Walker, 2000). Since the size of the IV is so small, and the protocol calls for the 2^{24} possibilities to be exhausted before reuse happens, reuse of an IV can occur in less than five hours—much less if a station or group of stations is extremely active (Borizov, 2001). By using only passive attacks an eavesdropper can monitor wireless transmissions until an IV collision occurs. The Berkley group comprised of Borizov, Goldberg, and Wagner discusses in their paper how an attacker can construct correctly encrypted messages and insert them into a network, modify packet headers to redirect messages to an unauthorized IP, and forward unencrypted messages through open ports in a firewall (e.g. port 80). They also surmise that the small space of possible IVs can allow a hacker to build a table over comprised of all possible IVs and corresponding RC4 encrypted key streams. That table would require less than 15 GB of space, and would allow a hacker to decrypt every message broadcast wirelessly over your network. This sort of parking lot attack can occur without an intruder ever entering a facility's physical premises. Given a wireless component in one's network, the presence of a firewall in a military treatment facility may increase the vulnerability to this type of attack because of the false sense of security derived by network administrators (Arbaugh, 2001).

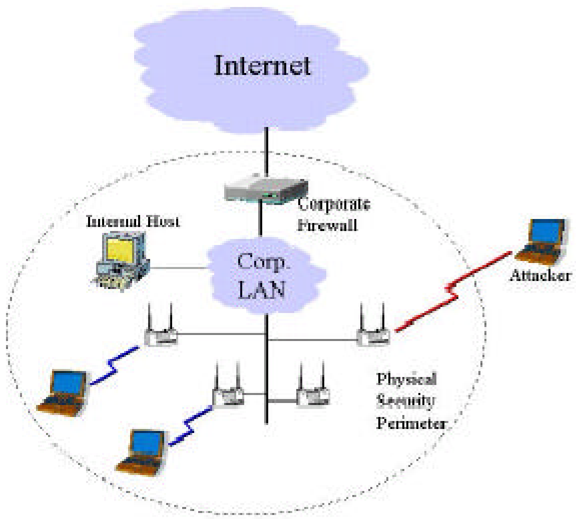

Figure 7.2. Illustration of Parking Lot Attack (From Arbaugh, 2001).

F. PRETTY GOOD PRIVACY (PGP)

PGP is a public-key cryptography program. Its uses include personal file encryption to message encryption. Before defining public key cryptography, it will help to explain the disadvantages of systems like the Data Encryption Standard (DES), which uses symmetric cryptography.

1. Symmetric Cryptography

DES utilizes a very robust encryption algorithm, providing great security for electronic data. Its weakness lies in key management. Symmetric cryptography uses a single key to both encrypt and decrypt a file or message. As long as there a relatively few number of users involved this solution works quite well. As you will see, once the number of users grows even a little, the system becomes very difficult to manage.

The formula for determining the number of keys per node is given as

$$\frac{n(n-1)}{2}$$

Thus, if the number of nodes in the system is three, the number of necessary keys is

$$\frac{3(3-1)}{2}=3$$

If the number of user nodes grows to 20, we find that required keys to manage are

$$\frac{20(20-1)}{2} = 190$$

The safeguards necessary to transport and securely manage that large number of keys would soon be overwhelming to any of our treatment facilities, let alone looking at it from an enterprise perspective.

2. Public Key Cryptography

Public key technology uses only two complementary keys: a public key and a private key for each user. Public keys are made available to those wishing to encrypt a message to the public key owner. For example, if Mike wanted to send Beth an encrypted message, he would request from Beth her public key and use that to encrypt the data. Beth is the only person who can decrypt the message using her private (secret) key. The number of keys required for this system is given as

$$2n$$

For three users, the number of keys required totals six. For the 20 users given in the example above, the number of keys required is only 40 (vice the 190 shown). Understand that key management is still required. If Bob was able to replace Beth's public key with his own, he would then be able to intercept and decrypt and messages intended for her.

G. COMMERCIAL ENCRYPTION SOLUTIONS

While currently no transmission encryption protocols are commercially available for the 802.11 solutions, efforts are underway to correct the deficiencies exhibited in the previous section. This may manifest itself either as a modification to or replacement of the WEP encryption method. While waiting for that solution protecting patient data while at rest still needs to be addressed. Providers are still capable storing patient data on their PDAs either via manually entry or physically syncing their device to their host computer/network. Palm OS and Pocket PC devices both come with password protection as part of their standard application suite. These password programs provide only a cursory level of protection for the data contained on your PDA. In fact, the biggest security threat to the personal digital assistant is loss (Crouch, 2001). Until hardware vendors begin packaging stronger security software, it is essential that some third-party password and encryption applications be included as part of a standard software suite. Discussion of the following products/product types is used for illustrative purposes only, and does not necessarily indicate endorsement of the writers.

Some downloadable applications may serve to provide all the protection a network administrator needs to ensure that PDAs are given the level of effort indicated by their facility's policy in order to comply with the previously mentioned HIPAA requirements. Due to the larger memory and processing capabilities of Pocket PC devices over Palm OS devices, security software for the former tends to be more robust.

1. PDABomb

A Palm-based application that provides both enhanced password functionality and encryption. It has a selectable "bomb" which activates after a pre-assigned number of unsuccessful login attempts are recorded. The bomb, when activated, erases all data on the PDA. This application also disables data transfer mechanisms such as HotSync and IrDA ports unless the proper password is entered. The application does not store the actual password on the device, only an encrypted form. PDABomb also initializes first after a device reset, ensuring its functionality. Additionally, it functions to keep data encrypted when Handspring Springboard memory modules are removed.

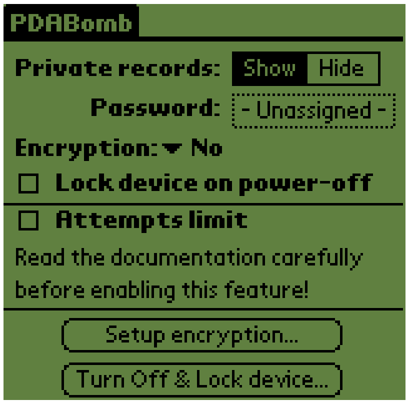

Figure 7.3. PDABomb Configuration Screen Capture (From PDABomb, 2001).

2. OnlyMe

From Tranzoa, is a Palm-based application that provides additional password protection functionality. With up to seven button or stroke combinations, it avails the user to nearly 350,000 password possibilities. After five incorrect password attempts, the device locks for 7 minutes. Five more incorrect attempts yield a 14-minute lockout. Further sets of five incorrect entries will lock the device out for 28-minute increments. If a user forgets their password, they will need to perform a cold reset, and restore any data from backup. An initial power up screen can be customized to provide displayed contact information.

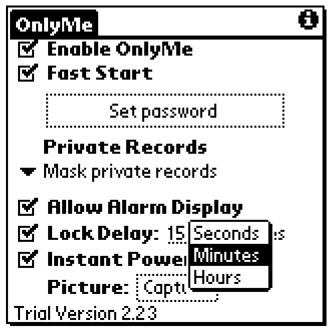

Figure 7.4. Initial Configuration Screen Capture (From OnlyMe, 2001).

3. Sentry 20/20

This is a Pocket PC solution offering encryption that has a minimum 128-bit key. The application creates an encrypted virtual volume, and all folders, files, and applications placed on that volume are transparently encrypted/decrypted every time a read or write operation is performed. The solution utilizes the CAST-128 encryption algorithm, and can maintain the key in one of two ways. If strong password policy is enforced, the key can be maintained on the Pocket PC device itself. If weak (or no) passwords are used, it is recommended that the key be stored on removable media, e.g., compact flash cards. As with other third-party applications, if the password is forgotten or the key is lost, a hard reset must be performed and data must restored from backup.

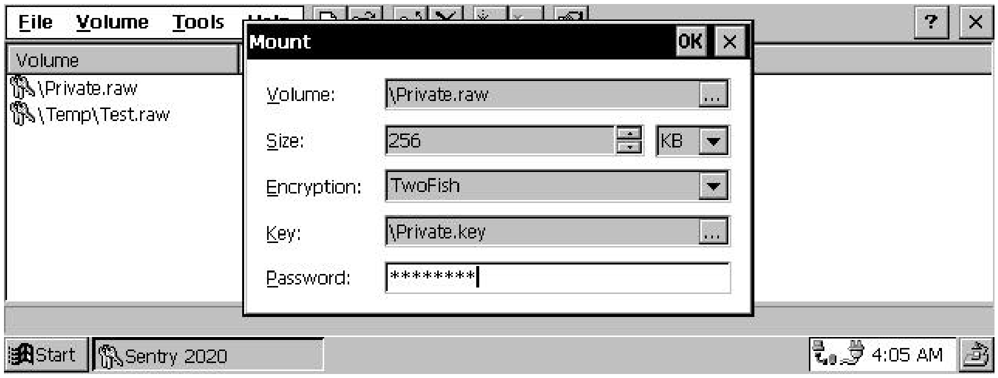

Figure 7.5. Sentry 20/20 CE 1.8 Screen Capture (From Sentry 20/20, 2001).

4. PocketLock

This is another Pocket PC based encryption program that offers flexibility in choosing both the data to be encrypted and the level of encryption served. Encryption options range from 40-bit RC2 to 168-bit triple DES. ARC4 (128-bit RC4 compatible) is the default selection. The following list provides all encryption options available. Note that those listed with an asterisk (*) require the user to download and install the *Microsoft High Encryption Pak* from the PocketPC.com website.

- ARC4 (128-bit RC4 compatible)
- RC2 (40 bit)
- RC4 (40 bit)
- DES (56 Bit)
- RC2 (128 bit)*
- RC4 (128 bit)*
- 3DES TWO KEY (112 bit)*
- 3DES (168 bit)*

PocketLock also offers an encryption solution for desktop devices. It should be noted that some files, once encrypted on either the PDA or desktop, will not be able to be read on a device other than the one which handles original encryption.

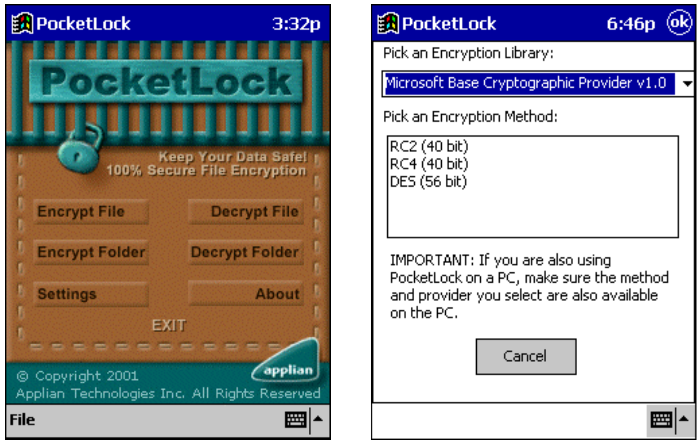

Figure 7.6. PocketLock's Software Encryption Solution Screen Captures (From PocketLock, 2001).

5. MovianCrypt

Movian is the Palm-based encryption solution offered by Certicom. The application addresses the issues of password vulnerabilities and unsecured data at rest by extending the basic functionality of the Palm OS device. The cipher used is the 128-bit Advanced Encryption Standard (AES). Encryption/decryption occurs below the Palm application layer, so that its operation is transparent to the user. The product also touts a simple graphical user interface (GUI) and installation process. It also prevents against unauthorized access to the device and data via known Palm security holes such as the HotSync function and IrDA beaming by requiring password authentication prior to operation. MovianCrypt provides an option for predetermining the time before automatic lockout occurs at power down. Finally, it safeguards the password against unwanted access on the device or HotSync partner by only maintaining a hash of the password and encryption key on the PDA.

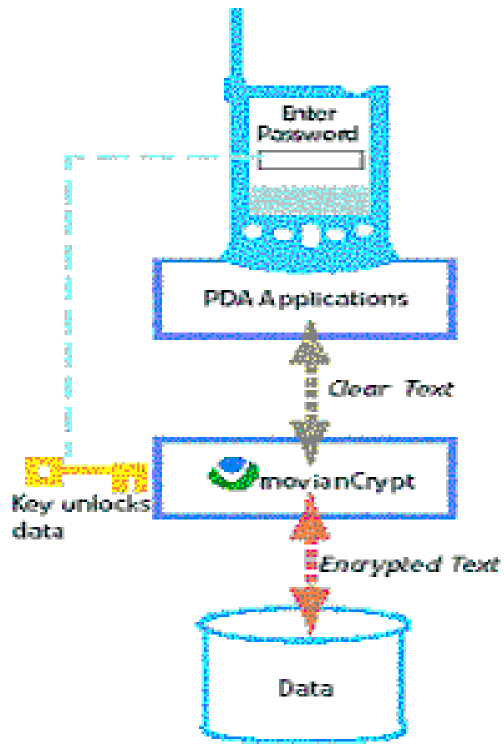

Figure 7.7. MovianCrypt Data Encryption Process (From MovianCrypt, 2001).

Other security measures will play a more integral role as they develop into economically feasible solutions. Bluetooth technology will soon provide a reasonable access solution for those who wish to use Bluetooth-enabled physical "keys" in conjunction with manual passwords. Advancements are being made in the area of public key infrastructure (PKI) development with respect to mobile technologies. Biometrics will soon be affordable options for network administrators. While retinal-scanning technology is a viable, albeit expensive, option for desktop or network access, solutions are currently being offered for fingerprint recognition access to mobile devices. Expect costs of these technologies to continue to drop, and consider the facility's needs vice wants when determining appropriate security solutions.

H. VIRUS CONCERNS

While the number of virus attacks directed at mobile devices has remained fairly small, both Symantec and McAfee, leaders in the development and maintenance of antivirus software, expect sharp increases as the PDA industry growth makes them an attractive target for hackers (Crouch, 2001). While in excess of one million PDA devices were sold last year, estimates place the number of handhelds in the market place by 2003 at nearly 20 million. As with the advent of any new communications technology, the chance for hackers to develop malicious code for portable devices is not just an opportunity, it is a challenge. Concomitantly, the challenge as technology advisors within organizations is to ensure the continuous education of staff on proper security measures with which to combat those undesirable elements. With respect to malevolent code in the wireless environment, the threat to PDAs comes in two forms (Trend Micro, 2001).

Application-based threats occur when malicious code attaches itself to new or existing wireless software. The threat comes when an application is either downloaded onto your device, or executed once it is already installed. Receiving applications from unknown sources, i.e. "shareware", increase this potential. In August 2000 the Trojan horse "Liberty Crack" made it's streaking presence known. The free download purported to convert a shareware-based game into a registered version. Unbeknownst to the PDA user, once the application was executed it proceeded to delete all other executable programs on their device. While the example used here shows transference to devices via shareware games, it illustrates two key points. First, malicious code can be developed and transmitted through similar legitimate means—the technology is the same. Second, to ascertain if the devices that customers are using do not contain these shareware programs, try performing a random inspection. The development of a sound policy and the staff education will be key in protecting your network. Guidance on that policy development can be found in references listed in the following section and in Chapter VII.

Content-based threats make malicious use of the content or message itself. Presently, the most susceptible application on your PDA (as well as your PC) is e-mail. The first content-based threat to wireless devices appeared just one year ago. The malicious Visual Basic Script "Timofonica" replicated by sending e-mail messages over wireless networks to all addressees of their Microsoft Outlook Address Book. Another attack occurred around the same time in Japan. In that case, their emergency 110 system (similar to our 911 system) was accessed without the reader's knowledge when the user clicked on a hyperlink in their e-mail message. This demonstrates the ability of wireless devices to have a serious detrimental impact on key services or networks. The fear of many is that the development of hybrid viruses, those which combine the characteristics of both content-based and application-based threats, would enable spreading of malicious code at such a prolific rate as to devastate those key infrastructures.

Several vendors have begun to offer antivirus protection for Personal Digital Assistants.

PDA Antivirus Solutions	
Symantec	Current solution is Antivirus 2001 for Palm OS. Every time your PC connects to the internet, Symantec LiveUpdate will update the program definition files. These will be updated on your Palm device during the subsequent HotSync.
McAfee	Supports Pocket PC, Windows CE and Symbian's EPOC, as well as the Palm Operation Systems with their VirusScan wireless solution. The application protects against virus receive during physical, wireless, or infrared synchronization/transmission, and also addresses dormant viruses that attack the OS directly.
Trend Micro	PC-Cillin for Wireless provides two means of detection. Real-time scanning will intercept a virus as its carrier attempts transmission into your device via physical, wireless, or infrared connection. Alternatively, the user can initiate a manual scan of the entire PDA environment at any time. This product has solutions for the Palm, Pocket PC and EPOC systems.

Table 7.8. Examples of Commercial PDA Antivirus Applications.

I. DEPARTMENT OF THE NAVY (DON) POLICIES

Use of Personal Electronic Devices (PED), especially in a wireless environment, is becoming very widespread. Under the Job Performance Aids (JPAs) for Newly Commission Officers Program, the CNO has authorized the purchase and distribution of PDAs for all new officer accessions. Guidance on the use of PDAs can be found throughout the Department of the Navy. While some sources are more restrictive than others, all seem to have some basic underlying themes. They are presented here in no specific order of priority. Comments in this section refer to the use of PDAs in an unclassified data environment. For suggestions on policy development for PDA use in a classified environment, refer to CINCPACFLT Naval Administrative message 111813Z JUN 01.

- Software downloads should have as their source government or commercially developed applications, or those developed from trusted sources.

- Only upload or download applications when physically synced with a host PC. Wireless or infrared downloads, or those executed directly across the network, should be avoided.
- Due to the wireless susceptibilities discussed earlier in this chapter, synchronization and data transmission should occur either physically or via infrared until such a time as wireless transmission weaknesses are sufficiently protected against.
- Do not use your PDA to store passwords, combinations, or PINs
- PDAs should be protected with antivirus applications. If the nature of the data stored on the device is sensitive or HIPAA-related, additional measures of protection (password/encryption) should be taken.
- If personal PDAs are to be authorized for use on government networks or in government facilities, they should conform to local policy. Additionally, personal devices, if used outside the government facility, should ensure the same measure of protection as established at work.
- PDA users in a facility should be educated as to local policy, and information assurance representatives should be required to document that education be having the user sign a PDA Use Agreement.

At the time of this writing, the Naval Medical Information Management Center (NMIMC), Bethesda, MD has developed a draft policy on the use of Personal Digital Assistants in the form of a BUMED instruction. That instruction, listed in this document as *Appendix F*, contains references directly affecting the policy development. The following resources are also provided.

Information Assurance Resources	
Carnegie Mellon Software Engineering Institute	http://www.cert.org
Chief of Naval Operations (CNO N6)	http://cno-n6.hq.navy.mil
Critical Infrastructure Assurance Office	http://www.ciao.gov
Defense Technical Information Center	http://www.dtic.mil
Fleet Information Warfare Center	http://www.fiwc.navy.mil
Information Technology and Operations Center	http://www.itoc.usma.edu
Infosec and Infowar Portal	http://www.infowar.com
Naval Medical Information Management Center	http://navmedinfo.med.navy.mil
Space and Naval Warfare Systems Command	https://infosec.navy.mil

Table 7.9. Commercial and Governmental Computer Security Resources.

J. SUMMARY

Prior to HIPAA, security was one of the key elements of our jobs. With a HIPAA-induced emphasis, network and data security have become *the* key elements. The act, while defining requirements and penalties, does not specify which technologies will fulfill the requirements. With the known insecurities in both spread spectrum transmissions and the Wired Equivalency Privacy encryption protocol, the authors feel that neither of these provides an adequate measure of security against a determined infiltrator.

These two technologies only apply toward the RF wireless transmission of patient data (excluding infrared). Our statement reflecting inadequacy with respect to HIPAA requirements carries only until an acceptable WEP fix or replacement protocol is delivered to the industry.

Until then, data at rest protection measures need to be pursued. These include the measures currently taken to protect our networks, but now must also be extended to the use of PDAs. *Appendix D,* the BUMED Draft instruction providing PDA guidance, is a good place to start. A hybrid solution of sufficiently strong access passwords plus sensitive data file and folder encryption is a necessity. A review of the tables in this chapter reflecting implementation guidance to fulfill HIPAA requirements should round out a facility's PDA policy and program development.

VIII. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

In this chapter the authors summarize the previous body of work, and provide conclusions and recommendations based on the research conducted and presented here. Areas addressed include proven private sector benefits and Military Healthcare System applicability. Also presented are synopsized findings of our user-requirement data search, and the technically focused wireless encryption and transmission segments. This is followed by concerns of protecting the electronic data while at rest on the PDA. Finally, recommendations for future research, both in collaborating with governmental agencies and potential focus areas, are presented.

B. CONCLUSIONS

1. Private Sector Successes

Physicians in the private sector are using PDAs to enhance clinical and business efficiencies as well as improving the quality of care delivered. Specific uses include; practice management, tracking patients, medication dosage and clinical score calculations, reviewing treatment protocols and pharmaceutical data, prescription ordering, insurance verification, patient education, coding, and patient encounter documentation. The PDA has evolved into an invaluable decision support tool that saves lives, reduces costly medical and prescription errors, and increases revenue collection.

2. Potential Military Healthcare System Applicability

This research has demonstrated that inexpensive portable digital assistant technology can be successfully integrated into the Military Healthcare System to effect point-of-care access to medical reference data, patient specific data, formularies, treatment protocols, and billing/coding information. Illustrated was the lack of consistent high data quality and provider interaction difficulties with military healthcare information systems. This results in improper accounting of medical diagnoses and procedures as well as sub-optimal third-party collection efforts, which jeopardizes JCAHO, HIPAA compliance and Medicare subvention, and adversely affects the bottom line. The Military Healthcare System can realize the same business and clinical enhancements experienced by private sector healthcare organizations.

3. Requirements Analysis

This study involved detailed analyses of data collected via surveys, literature research and personal interviews. Two major categories of information have been developed using the analysis tools: Rank-ordered user requirements based upon survey responses, and evaluation of hardware devices and software applications. These data sets should be given attention by activities responsible for requirements generation. When identifying initial requirements for unit capabilities, attention should be paid to Table 5.5, where staff members have identified the value of their needs. When addressing software solutions, this study has shown it is necessary to ensure applications are included that support each of the five major categories: Diagnosis & Treatment, Medical Calculators, Drug Databases, Patient Tracking, and Coding. With respect to hardware devices, the iPAQ Pocket PC system was the unit that displayed a break away from the group. Several personal interviews with providers have shed light on an aspect of hardware not tested during this study, the use of tablets. Devices such as the Vadem Clio and Sharp TriPad have display areas in the range of 9 to 10 inches, and while not as portable as Palm or Pocket PC devices, would provide software engineers interface display options not available to PDAs. Section C of this chapter holds recommendations.

4. Wireless

The two most popular current wireless technologies, 802.11 and 802.11b, are adequate for wireless operations in many industries. However, due to our responsibility to protect patient data, HIPAA requirements, the possibility of interception of wireless transmissions, and the weaknesses of the Wired Equivalent Privacy protocol, pursuit of these technologies at this time is not recommended. This is not to say that no wireless solution should be pursued quite the contrary, in fact. Wireless connectivity, or real-time access to the enterprise system utilizing PDAs to push and pull patient information, is one of the top requirements surveyed.

5. Security

HIPAA will be the primary driver for securing electronic data in the healthcare field for the next several years. Chapter VII discussed the legislative impact, and provided guidance on establishing organizational plans to help military treatment facilities comply. Chapter VII also addressed the recently identified weaknesses of the

Wired Equivalency Privacy encryption protocol. Activities currently operating Spread Spectrum technologies using this industry-based encryption solutions are at risk of unauthorized network intrusion. Vulnerabilities also exist for privacy act-related data at rest on PDAs if steps have not been taken to increase security measures with respect to device access and file encryption.

C. RECOMMENDATIONS

1. Private Sector Partnering

To allow for continued research in this area, Cooperative Research and Development Agreements (CRADAs) should be established between government agencies and academic institutions with leading private sector healthcare institutions, academic institutions, and commercial companies.

2. Potential Military Healthcare System Applicability

Clearly, the Military Health System needs to embrace this technology as a means to realize its vision of best value health services. The Military Health System must eliminate its traditional reliance on stovepipe and legacy healthcare information systems. The MHS, unlike commercial healthcare organizations, is not driven by its bottom line and therefore lacks the incentive to implement technologies that increase revenue. The MHS is driven by a need to deliver care that supports military personnel readiness within certain budget constraints. Unfortunately, these budget restrictions impede the rapid adoption of the latest technologies. The MHS must realize that the utility of a PDA is one of improving the quality of care delivered, supporting readiness, and increasing revenue collection and overcome the aforementioned impediments.

3. Requirements Analysis

The authors recommendation for device selection is a hybrid approach based upon functional use. A provider needing to access a great number of CHCS-like pages might be served equally as well by a tablet as an iPAQ. The nursing staff and clinical support would have greatest use of a PDA, while if the device was shared by clinical staff members rather than personally assigned, a ruggedized version such as the Symbol solution would be the most appropriate. It is suggested Tricare Management Activity (TMA) not only address the user requirements specified in Chapter V, but define a multiple-platform solution in their request for proposal. In this way users could, much like the seat-management options offered by Navy and Marine Corps Internet (NMCI), select a hardware solution that is most suited for the function being performed.

4. Wireless

Alternative to pursuit of FHSS or DSSS solutions, concurrent pursuit of wireless solutions that utilizes 802.11a is recommended. Recall from Chapter VI that Coded Orthogonal Frequency Domain Multiplexing (COFDM) operates in the 5.6 GHz spectrum, avoiding interference with many 2.4 GHz technologies, including Bluetooth. It also offers much greater data transfer rates—up to 54 MB/sec. While fairly new to the mainstream wireless arena, availability of solutions using this standard is expected to grow dramatically over the next 12-18 months.

In addition, continue pursuing technologies that utilize Bluetooth integration of devices. Featured uses such as certification and user log-on are already commonplace enabled using this standard. Additionally, continue pursuing technologies, which utilize Infrared interfaces. Although infrared benefits are limited in functionality, especially with respect to real-time or on-demand synchronization (recall an infrared port must be readily available), the standard still offers several advantages including low infrastructure cost and existing market saturation in devices. Selection of infrared solutions should be made locally based on need.

5. Security

The first step to ensuring sensitive patient data in electronic format is protected is a strong liaison between an organization's Chief Information Officer and Privacy Officer. Development of policy and educational plans, followed by the actual education of the staff are paramount. HIPAA compliance deadlines for Transactions and Code Sets begin in October 2002.

With respect to the weaknesses born out in the Wired Equivalent Privacy (WEP) encryption protocol for wireless transmissions, the industry “fix”, when available, must be utilized. This will likely be either an actual fix to the inherent weakness, or a newly adapted protocol. Regardless, the encryption protocol eventually used should be compatible with 802.11a wireless standards, the recommended wireless solution for mobile enterprise connectivity of PDAs, tablets and laptops.

It is also necessary to ensure policy exists and is being adhered to that govern the use of PDA access. Third-party enhanced password protection for PDA access and data encryption for any privacy-related data stored on PDAs should be a requirement in any treatment facility.

6. Future Research

It is recommended that any future research in this area by those in government outside of the Naval Postgraduate School begin with establishing a close working relationship with several organizations. These activities include, but are not limited to, the first three listed in the following Table 8.1. Naval Postgraduate School students and staff interested in research grants should contact Ms. Danielle Kuska listed below. The benefits to leveraging existing efforts which are seeking to integrate similar technologies cannot be overstated. Additionally, recommended focus areas for future related research are provided in Table 8.2.

PDA Research Points of Contact	
TRICARE Management Activity (TMA) - Information Management	
Major Anthony Inae anthony.inae@tma.osd.mil (703) 681-5611	Skyline 5, Suite 810 5111 Leesburg Pike Falls Church, VA 22041
Tri-Service Infrastructure Management Program Office (TIMPO)	
CDR Lyn Hurd lyn.hurd@tma.osd.mil (703) 399-2200	Skyline 5, Suite 810 5111 Leesburg Pike Falls Church, VA 22041 Attn: TIMPO
Telemedicine and Advanced Technology Research Center (TATRC)	
Dr. Rufus Sessions sessions@tatrc.org (301) 619-4011	
Space and Naval Warfare Systems Command (SPAWAR) – Research Grants	
Ms. Danielle Kuska (Local POC) dkuska@nps.navy.mil (831) 656-2099	1 University Circle, Code 91 Monterey, CA 93943-5207

Table 8.1. Contact List for Future Research Initiatives.

Related Future Research Areas
Use of PDAs for administration of medication dispensing
Use of PDAs for disease management
Use of PDAs for medical inventory management
User interface application development for integration with the enterprise system
Use of 802.11a connecting technologies for mobile platforms
Use of Bluetooth connecting technologies for development of medical piconetworks
Use of ruggedized PDAs for shipboard, submarine, and field applications
Navy medicine concerns regarding wireless transmission interference with other medical telemetry devices
PDA support for DoD Common Access Cards for Wireless LAN access
PDA Thin Client Applications

Table 8.2. Recommended Focus Areas for Future PDA-Related Healthcare Research.

D. SUMMARY

This chapter provided a synopsis of conclusions based upon work conducted throughout the thesis period. Significant areas covered included: private sector applications, potential business applicability within the Department of Defense Military Health System, research analysis of user requirements, technology-focused areas of wireless data encryption and transmission, and legislative drivers in the form of HIPAA. Recommendations covering those specific topics were also presented. Finally, recommendations were given for future research addressing PDA integration, both with respect to existing agency sources of information, and to specific focus areas of potential benefit to DoD healthcare.

APPENDIX A. TABULAR REPRESENTATION OF USER REQUIREMENT SURVEY DATA BY POSITION

This appendix provides a comprehensive tabulation of all online survey responses. The data is given in the same order as the questions were presented in the survey, and user responses have been compiled by the respondent's position within their organization.

Q1. The value of using Personal Digital Assistant technology (Palm Pilot, Pocket PC, et al) to input data to/extract data from the Composite Health Care System and/or the Ambulatory Data System:

Position	High	Med	Low	
CO/XO	3	3		
Director (DCS, DFA, DNS)	16	4		
Provider	119	36	10	
Nursing Specialist	13	6		
Comptroller/Billing/Claims	1	2	1	
MIS Head/CIO	7	2		
Patient Administration	13	6	1	
Provider Support (Clinician)	18	9	7	
Total:	190	68	19	277

Q2. The value of using PDAs where you must return the device to a cradle or use infrared sync station to update either the PDA or CHCS/ADS is

Position	High	Med	Low	
CO/XO	4	1	1	
Director (DCS, DFA, DNS)	15	5		
Provider	87	65	13	
Nursing Specialist	8	6	5	
Comptroller/Billing/Claims	2	2		
MIS Head/CIO	2	4	3	
Patient Administration	12	7	1	
Provider Support (Clinician)	18	9	7	
Total:	148	99	30	277

Q3. The value of using PDAs in an environment where a wireless connection to a LAN provides continuous, real-time data is

Position	High	Med	Low	
CO/XO	6			
Director (DCS, DFA, DNS)	17	3		
Provider	144	16	5	
Nursing Specialist	15	3	1	
Comptroller/Billing/Claims	4			
MIS Head/CIO	9			
Patient Administration	18	1	1	
Provider Support (Clinician)	23	5	6	
Total:	236	28	13	277

Q4. The value of using PDAs for Pharmaceutical Order Entry is

Position	High	Med	Low	
CO/XO	5		1	
Director (DCS, DFA, DNS)	16	4		
Provider	121	25	19	
Nursing Specialist	12	3	4	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	7	2		
Patient Administration	14	4	2	
Provider Support (Clinician)	17	6	11	
Total:	195	44	38	277

Q5. The value of using PDAs for Laboratory Order Entry is

Position	High	Med	Low	
CO/XO	4	1	1	
Director (DCS, DFA, DNS)	17	3		
Provider	119	27	19	
Nursing Specialist	12	5	2	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	6	3		
Patient Administration	14	2	4	
Provider Support (Clinician)	18	7	9	
Total:	193	48	36	277

Q6. The value of using PDAs for Radiological Order Entry is

Position	High	Med	Low	
CO/XO	3	2	1	
Director (DCS, DFA, DNS)	17	3		
Provider	123	22	20	
Nursing Specialist	12	5	2	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	6	2	1	
Patient Administration	15	2	3	
Provider Support (Clinician)	20	5	9	
Total:	199	41	37	277

Q7. The value of using PDAs to look up ICD-9/CPT /PDR is

Position	High	Med	Low	
CO/XO	6			
Director (DCS, DFA, DNS)	18	2		
Provider	122	24	19	
Nursing Specialist	14	3	2	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	6	2	1	
Patient Administration	16	3	1	
Provider Support (Clinician)	21	8	5	
Total:	206	42	29	277

Q8. The value of using PDAs to reduce/or eliminate KG-ADS terminal use time is

Position	High	Med	Low	
CO/XO	3	3		
Director (DCS, DFA, DNS)	17	1	2	
Provider	121	25	19	
Nursing Specialist	14	3	2	
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	6	2	1	
Patient Administration	16	3	1	
Provider Support (Clinician)	24	1	9	
Total:	204	39	34	277

Q9. The value of using PDAs to provide billing info directly to billing dept is

Position	High	Med	Low	
CO/XO	5		1	
Director (DCS, DFA, DNS)	15	4	1	
Provider	86	35	44	
Nursing Specialist	11	5	3	
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	6	1	2	
Patient Administration	15	2	3	
Provider Support (Clinician)	19	7	8	
Total:	160	55	62	277

Q10. The value of using PDAs to search professional literature (e.g., AMA abstracts, Epocrates, et al) is

Position	High	Med	Low	
CO/XO	4		2	
Director (DCS, DFA, DNS)	16	4		
Provider	124	27	14	
Nursing Specialist	14	3	2	
Comptroller/Billing/Claims	1	1	2	
MIS Head/CIO	6	1	2	
Patient Administration	17	1	2	
Provider Support (Clinician)	20	8	6	
Total:	202	45	30	277

Q11. The value of using PDAs for e-mail connectivity is:

Position	High	Med	Low	
CO/XO	2	2	2	
Director (DCS, DFA, DNS)	16	3	1	
Provider	97	40	28	
Nursing Specialist	12	5	2	
Comptroller/Billing/Claims	2		2	
MIS Head/CIO	4	2	3	
Patient Administration	16	1	3	
Provider Support (Clinician)	22	9	3	
Total:	171	62	44	277

Q12. The value of using PDAs to reduce medical errors (drug interaction warnings, dosage calculators, etc) is

Position	High	Med	Low	
CO/XO	5	1		
Director (DCS, DFA, DNS)	19	1		
Provider	142	13	10	
Nursing Specialist	18	1		
Comptroller/Billing/Claims	4			
MIS Head/CIO	7	2	2	
Patient Administration	18			
Provider Support (Clinician)	25	6	3	
Total:	238	24	15	277

Q13. The value of using PDAs for personal and patient scheduling is

Position	High	Med	Low	
CO/XO	4	2		
Director (DCS, DFA, DNS)	17	3		
Provider	121	31	13	
Nursing Specialist	13	3	3	
Comptroller/Billing/Claims	2	1	1	
MIS Head/CIO	7	1	1	
Patient Administration	17	1	2	
Provider Support (Clinician)	22	8	4	
Total:	203	50	24	277

Q14. With respect to PDAs, cost concerns are

Position	High	Med	Low	
CO/XO	2	2	2	
Director (DCS, DFA, DNS)	4	12	4	
Provider	55	68	42	
Nursing Specialist	10	6	3	
Comptroller/Billing/Claims	2	1	1	
MIS Head/CIO	3	4	2	
Patient Administration	11	6	3	
Provider Support (Clinician)	12	13	9	
Total:	99	112	66	277

Q15. With respect to PDAs, network security concerns are

Position	High	Med	Low	
CO/XO	3	2	1	
Director (DCS, DFA, DNS)	15	4	1	
Provider	96	47	22	
Nursing Specialist	12	7		
Comptroller/Billing/Claims	4			
MIS Head/CIO	7	2		
Patient Administration	16	2	2	
Provider Support (Clinician)	25	3	6	
Total:	178	67	32	277

Q16. With respect to PDAs, patient privacy (HIPAA) concerns are

Position	High	Med	Low	
CO/XO	2	2	2	
Director (DCS, DFA, DNS)	15	4	1	
Provider	109	29	27	
Nursing Specialist	15	4		
Comptroller/Billing/Claims	4			
MIS Head/CIO	7	2		
Patient Administration	15	3	2	
Provider Support (Clinician)	27	2	5	
Total:	194	46	37	277

Q17. With respect to PDAs, ease of use concerns are

Position	High	Med	Low	
CO/XO	2	3	1	
Director (DCS, DFA, DNS)	11	5	4	
Provider	110	34	21	
Nursing Specialist	11	5	3	
Comptroller/Billing/Claims	4			
MIS Head/CIO	6	2	1	
Patient Administration	15	2	3	
Provider Support (Clinician)	20	7	7	
Total:	179	58	40	277

Q18. With respect to PDAs, the ability to personalize content are

Position	High	Med	Low	
CO/XO	3	1	2	
Director (DCS, DFA, DNS)	10	10		
Provider	121	32	12	
Nursing Specialist	12	5	2	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	5	1	3	
Patient Administration	12	4	4	
Provider Support (Clinician)	20	10	4	
Total:	186	63	28	277

Q19. With respect to PDAs, limited application storage (internal RAM) concerns are

Position	High	Med	Low	
CO/XO	2	2	2	
Director (DCS, DFA, DNS)	15	4	1	
Provider	121	39	5	
Nursing Specialist	14	4	1	
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	4	5		
Patient Administration	16	2	2	
Provider Support (Clinician)	19	9	6	
Total:	194	66	17	277

Q20. With respect to PDAs, a color display is important

Position	High	Med	Low	
CO/XO		1	5	
Director (DCS, DFA, DNS)	6	9	5	
Provider	55	53	57	
Nursing Specialist	5	5	9	
Comptroller/Billing/Claims	2	2		
MIS Head/CIO	3	2	4	
Patient Administration	10	4	6	
Provider Support (Clinician)	11	9	14	
Total:	92	85	100	277

Q21. With respect to PDAs, additional functionality (use as a voice recorder, beeper, etc.) is

Position	High	Med	Low	
CO/XO		3	3	
Director (DCS, DFA, DNS)	13	4	3	
Provider	89	54	22	
Nursing Specialist	7	7	5	
Comptroller/Billing/Claims	2		2	
MIS Head/CIO	4	4	1	
Patient Administration	15	2	3	
Provider Support (Clinician)	17	10	7	
Total:	147	84	46	277

Q22. The value of point-of-service patient registration/admission with the PDA is

Position	High	Med	Low	
CO/XO	3	1	2	
Director (DCS, DFA, DNS)	13	7		
Provider	89	38	38	
Nursing Specialist	13	3	3	
Comptroller/Billing/Claims	2	1	1	
MIS Head/CIO	5	1	3	
Patient Administration	14		6	
Provider Support (Clinician)	18	6	10	
Total:	157	57	63	277

Q23. The value of a portable (pocket sized) PDA is

Position	High	Med	Low	
CO/XO	5	1		
Director (DCS, DFA, DNS)	20			
Provider	157	7	1	
Nursing Specialist	15	4		
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	8	1		
Patient Administration	17	2	1	
Provider Support (Clinician)	26	5	3	
Total:	251	21	5	277

Q24. The value of medical records integration/access with a PDA is

Position	High	Med	Low	
CO/XO	3	3		
Director (DCS, DFA, DNS)	16	3	1	
Provider	125	32	8	
Nursing Specialist	14	4	1	
Comptroller/Billing/Claims	2		2	
MIS Head/CIO	5	4		
Patient Administration	15	2	3	
Provider Support (Clinician)	22	4	8	
Total:	202	52	23	277

Q25. The value of accessing patient information at the point of patient care with a PDA is

Position	High	Med	Low	
CO/XO	5	1		
Director (DCS, DFA, DNS)	19	1		
Provider	139	18	8	
Nursing Specialist	16	1	2	
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	6	3		
Patient Administration	16	1	3	
Provider Support (Clinician)	21	4	9	
Total:	225	29	23	277

Q26. The value of standardized medical/business applications on the PDA is

Position	High	Med	Low	
CO/XO	6			
Director (DCS, DFA, DNS)	18	2		
Provider	129	26	10	
Nursing Specialist	18	1		
Comptroller/Billing/Claims	3		1	
MIS Head/CIO	6	3		
Patient Administration	18		2	
Provider Support (Clinician)	26	4	4	
Total:	224	36	17	277

Q27. The minimum PDA delay in screen response time that is acceptable is

Position	1-5 seconds	6-10 seconds	10+ seconds	
CO/XO	4	2		
Director (DCS, DFA, DNS)	19	1		
Provider	136	29		
Nursing Specialist	11	6	2	
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	8	1		
Patient Administration	14	5	1	
Provider Support (Clinician)	27	6	1	
Total:	222	51	4	277

Q28. The number of acceptable screen interactions (scrolls) until desired information is located is

Position	1-3 scrolls	4-6 scrolls	7+ scrolls	
CO/XO	4	2		
Director (DCS, DFA, DNS)	16	4		
Provider	138	27		
Nursing Specialist	18	1		
Comptroller/Billing/Claims	3	1		
MIS Head/CIO	8	1		
Patient Administration	16	3	1	
Provider Support (Clinician)	27	6	1	
Total:	230	45	2	277

Q29. The minimum acceptable battery life between charges is

Position	0-4 hours (duration of rounds)	5-8 hours (one shift)	9-12 hours	12+ hours	
CO/XO		3	2	1	
Director (DCS, DFA, DNS)	3	2	10	5	
Provider	35	44	34	52	
Nursing Specialist	3	8	5	3	
Comptroller/Billing/Claims	2	2			
MIS Head/CIO	4	3	1	1	
Patient Administration	6	3	8	3	
Provider Support (Clinician)	6	14	8	6	
Total:	59	79	68	71	277

Q30. Currently, are you confident that CHCS II and KG-ADS patient specific data is accurate

Position	Yes	No	
CO/XO	2	4	
Director (DCS, DFA, DNS)	8	12	
Provider	105	59	
Nursing Specialist	16	3	
Comptroller/Billing/Claims	3	1	
MIS Head/CIO	3	6	
Patient Administration	15	5	
Provider Support (Clinician)	24	10	
Total:	176	100	276

Q31. Are you frustrated with CHCS II and KG-ADS integration/operability

Position	Yes	No	
CO/XO	3	3	
Director (DCS, DFA, DNS)	16	4	
Provider	139	25	
Nursing Specialist	15	4	
Comptroller/Billing/Claims	2	2	
MIS Head/CIO	6	3	
Patient Administration	14	6	
Provider Support (Clinician)	20	14	
Total:	215	61	276

Q32. How long does it require to locate/input desired information (ICD-9/CPT codes) into CHCS II and KG-ADS

Position	1-5 seconds	6-10 seconds	11-15 seconds	16-20 seconds	20+ seconds	
CO/XO	1	2	1	0	2	
Director (DCS, DFA, DNS)	8	3	1	2	6	
Provider	49	19	18	16	62	
Nursing Specialist	1	2	4	5	5	
Comptroller/Billing/Claims	4	0	0	0	0	
MIS Head/CIO	2	1	3	1	2	
Patient Administration	8	4	3	3	2	
Provider Support (Clinician)	15	3	4	1	11	
Total:	88	34	34	28	90	274

** Q33-Q35 have significantly fewer responses. These questions were added based upon Delphi roundtable sessions with providers at Naval Hospital Lemoore after they had taken the survey, and thus do not reflect their answers.*

Q33. The value of integrating voice transcription services on the PDA is

Position	High	Med	Low	
CO/XO	3	1	2	
Director (DCS, DFA, DNS)	16	2	1	
Provider	93	24	34	
Nursing Specialist	9	3	5	
Comptroller/Billing/Claims	2		1	
MIS Head/CIO	4	3	2	
Patient Administration	8	2	3	
Provider Support (Clinician)	15	10	9	
Total:	150	45	57	252

Q34. The value of providing an audio alert for high-priority e-mail on the PDA is

Position	High	Med	Low	
CO/XO	3	2	1	
Director (DCS, DFA, DNS)	15	3	1	
Provider	75	36	40	
Nursing Specialist	9	7	1	
Comptroller/Billing/Claims	2		1	
MIS Head/CIO	4	5		
Patient Administration	8	3	2	
Provider Support (Clinician)	13	12	9	
Total:	129	68	55	252

Q35. The value of integrating barcode scanning capability (match medications with patient, associate material costs with episodes of care/inventory control) on the PDA is

Position	High	Med	Low	
CO/XO	5	1		
Director (DCS, DFA, DNS)	13	4	2	
Provider	88	28	35	
Nursing Specialist	14	3		
Comptroller/Billing/Claims	2		1	
MIS Head/CIO	3	4	2	
Patient Administration	8	3	2	
Provider Support (Clinician)	21	6	7	
Total:	154	49	49	252

Q36. The value of utilizing medical imaging (low-level diagnostic display capability) on the PDA is

Position	High	Med	Low	
CO/XO	2		4	
Director (DCS, DFA, DNS)	8	6	6	
Provider	78	35	52	
Nursing Specialist	10	5	4	
Comptroller/Billing/Claims	2		2	
MIS Head/CIO	2	2	5	
Patient Administration	12	3	5	
Provider Support (Clinician)	15	5	14	
Total:	129	56	92	277

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APPENDIX B. STATISTICAL ANALYSIS IN SUPPORT OF REQUIREMENTS GENERATION

This appendix provides the statistical analyses that were performed on the on-line User Requirement Survey data. The primary methodology used is the Chi-Square test. Chi-Square hypothesis testing provides the premise that in a random distribution, the expected number of responses would be divided equally among the response choices (null hypothesis). If the test concludes that the null hypothesis should be rejected, the assumption is made that there is significance to a user's response or responses. The software used to analyze this data set is Microsoft Excel 2000 and Prentice Hall's PHStat 97 for Excel.

**NOTE: Throughout this appendix, as the p-value approaches zero in the Chi-Square test, the Chi-Square test statistic may appear as *#NUM!* due to a Microsoft Excel bug. This phenomena in no way interferes with the test result to accept or reject the null hypothesis.

Additionally, weighted mean data is provided where appropriate, with a visual Liker scale representation. Descriptive statistics, while not used specifically in this study, are provided for any future analysis.

Q1. The value of using Personal Digital Assistant technology (Palm Pilot, Pocket PC, et al) to input data to/extract data from the Composite Health Care System and/or the Ambulatory Data System:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	190	68	19	277
Total	190	68	19	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	3.36E-37

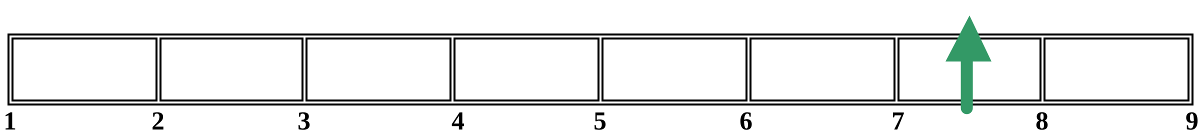
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.469314
Standard Error	0.147131
Median	9
Mode	9
Standard Deviation	2.448742
Sample Variance	5.996338
Kurtosis	0.762143
Skewness	-1.36372
Range	8
Minimum	1
Maximum	9
Sum	2069
Count	277
Confidence Level(95.0%)	0.289641

Q1	Survey Responses	Weight	Weighted value	Weighted average
High	190	9	1710	
Medium	68	5	340	
Low	19	1	19	
	277		2069	7.47



Q2. The value of using PDAs where you must return the device to a cradle or use infrared sync station to update either the PDA or CHCS/ADS is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	148	99	30	277
Total	148	99	30	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	2.95E-17

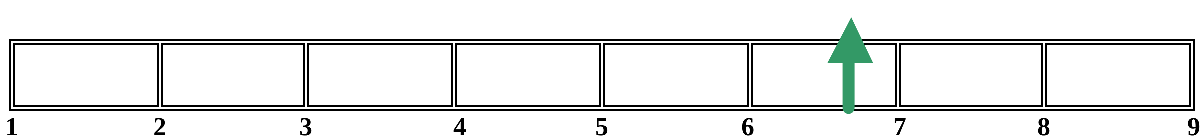
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.703971
Standard Error	0.1635
Median	9
Mode	9
Standard Deviation	2.721177
Sample Variance	7.404803
Kurtosis	-0.55421
Skewness	-0.77263
Range	8
Minimum	1
Maximum	9
Sum	1857
Count	277
Confidence Level(95.0%)	0.321865

Q2	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	148	9	1332	
Medium	99	5	495	
Low	30	1	30	
	277		1857	6.70



Q3. The value of using PDAs in an environment where a wireless connection to a LAN provides continuous, real-time data is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	236	28	13	277
Total	236	28	13	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	8.35E-74

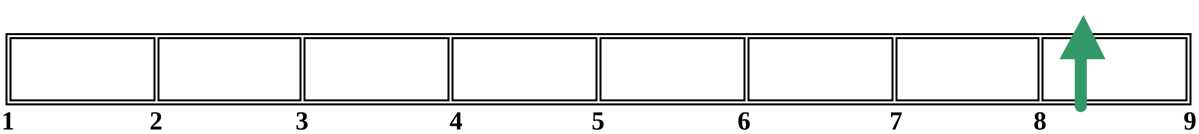
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	8.220217
Standard Error	0.120579
Median	9
Mode	9
Standard Deviation	2.006842
Sample Variance	4.027416
Kurtosis	5.739739
Skewness	-2.58116
Range	8
Minimum	1
Maximum	9
Sum	2277
Count	277
Confidence Level(95.0%)	0.237372

Q3	Survey Responses	Weight	Weighted value	Weighted average
High	236	9	2124	
Medium	28	5	140	
Low	13	1	13	
	277		2277	8.22



Q4. The value of using PDAs for Pharmaceutical Order Entry is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	195	44	38	277
Total	195	44	38	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	5.93E-38

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

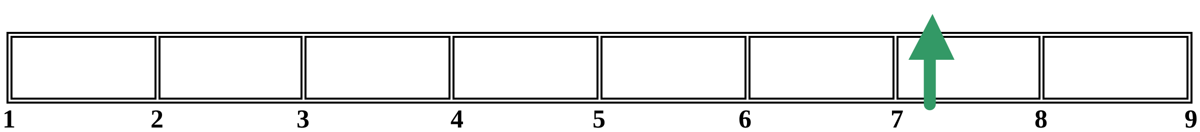
At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high

user value in this area.

Descriptive Statistics

Mean	7.267148
Standard Error	0.173608
Median	9
Mode	9
Standard Deviation	2.889405
Sample Variance	8.348663
Kurtosis	0.236584
Skewness	-1.33923
Range	8
Minimum	1
Maximum	9
Sum	2013
Count	277
Confidence Level(95.0%)	0.341763

Q4	Survey Responses	Weight	Weighted value	Weighted average
High	195	9	1755	
Medium	44	5	220	
Low	38	1	38	
	277		2013	7.27



Q5. The value of using PDAs for Laboratory Order Entry is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	193	48	36	277
Total	193	48	36	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.2E-36

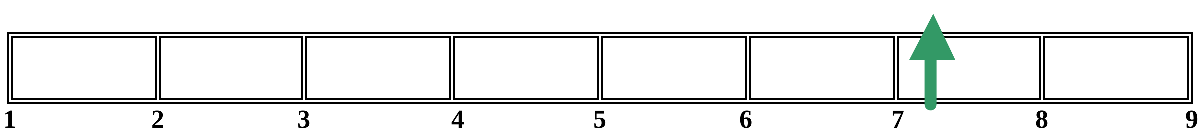
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.267148
Standard Error	0.17118
Median	9
Mode	9
Standard Deviation	2.848996
Sample Variance	8.116779
Kurtosis	0.257576
Skewness	-1.32832
Range	8
Minimum	1
Maximum	9
Sum	2013
Count	277
Confidence Level(95.0%)	0.336984

Q5	Survey Responses	Weight	Weighted value	Weighted average
High	193	9	1737	
Medium	48	5	240	
Low	36	1	36	
	277		2013	7.27



Q6. The value of using PDAs for Radiological Order Entry is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	199	41	37	277
Total	199	41	37	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

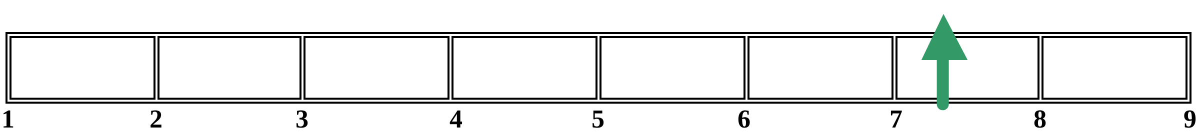
Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	6.96E-41

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics	
Mean	7.33935
Standard Error	0.171937
Median	9
Mode	9
Standard Deviation	2.861603
Sample Variance	8.188772
Kurtosis	0.418197
Skewness	-1.40788
Range	8
Minimum	1
Maximum	9
Sum	2033
Count	277
Confidence Level(95.0%)	0.338475

Q6	Survey Responses	Weight	Weighted value	Weighted average
High	199	9	1791	
Medium	41	5	205	
Low	37	1	37	
	277		2033	7.34



Q7. The value of using PDAs to look up ICD-9/CPT /PDR is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	206	42	29	277
Total	206	42	29	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.67E-46

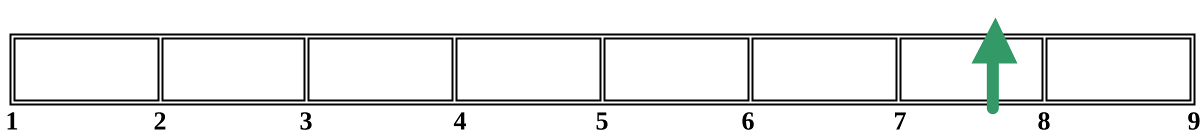
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.555957
Standard Error	0.159722
Median	9
Mode	9
Standard Deviation	2.658308
Sample Variance	7.066604
Kurtosis	1.138849
Skewness	-1.60329
Range	8
Minimum	1
Maximum	9
Sum	2093
Count	277
Confidence Level(95.0%)	0.314429

Q7	Survey Responses	Weight	Weighted value	Weighted average
High	206	9	1854	
Medium	42	5	210	
Low	29	1	29	
	277		2093	7.56



Q8. The value of using PDAs to reduce/or eliminate KG-ADS terminal use time is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	204	39	34	277
Total	204	39	34	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	9.57E-45

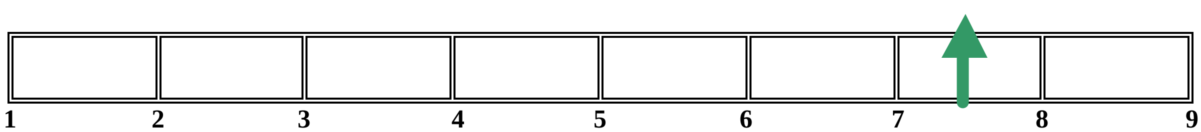
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.454874
Standard Error	0.167255
Median	9
Mode	9
Standard Deviation	2.783678
Sample Variance	7.748862
Kurtosis	0.766036
Skewness	-1.51741
Range	8
Minimum	1
Maximum	9
Sum	2065
Count	277
Confidence Level(95.0%)	0.329258

Q8	Survey Responses	Weight	Weighted value	Weighted average
High	204	9	1836	
Medium	39	5	195	
Low	34	1	34	
	277		2065	7.45



Q9. The value of using PDAs to provide billing info directly to billing department is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	160	55	62	277
Total	160	55	62	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	6.16E-17

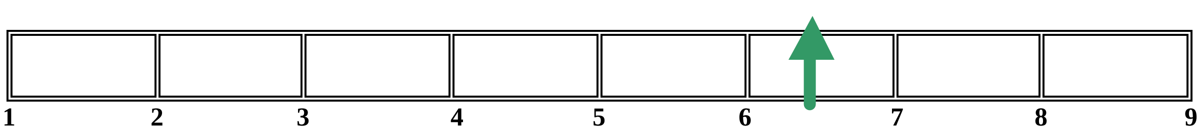
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.415162
Standard Error	0.198001
Median	9
Mode	9
Standard Deviation	3.295394
Sample Variance	10.85962
Kurtosis	-1.12776
Skewness	-0.73812
Range	8
Minimum	1
Maximum	9
Sum	1777
Count	277
Confidence Level(95.0%)	0.389784

Q9	Survey Responses	Weight	Weighted value	Weighted average
High	160	9	1440	
Medium	55	5	275	
Low	62	1	62	
	277		1777	6.42



Q10. The value of using PDAs to search professional literature (e.g., AMA abstracts, Epocrates, et al) is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	202	45	30	277
Total	202	45	30	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	2.03E-43

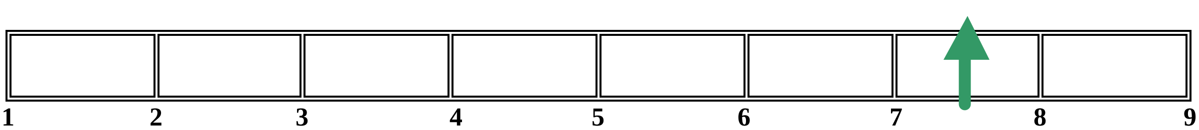
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.33935
Standard Error	0.175551
Median	9
Mode	9
Standard Deviation	2.921746
Sample Variance	8.536598
Kurtosis	0.38091
Skewness	-1.4213
Range	8
Minimum	1
Maximum	9
Sum	2033
Count	277
Confidence Level(95.0%)	0.345589

Q10	Survey Responses	Weight	Weighted value	Weighted average
High	202	9	1818	
Medium	45	5	225	
Low	30	1	30	
	277		2073	7.48



Q11. The value of using PDAs for e-mail connectivity is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	171	62	44	277
Total	171	62	44	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	6.13E-23

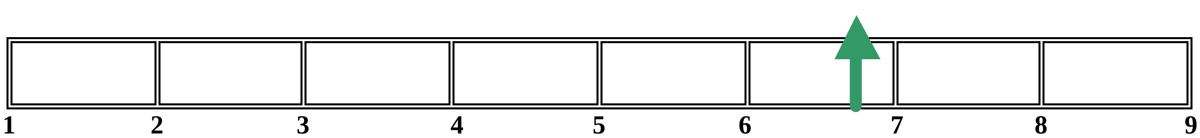
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high

user value in this area.

Descriptive Statistics	
Mean	6.833935
Standard Error	0.181134
Median	9
Mode	9
Standard Deviation	3.014675
Sample Variance	9.088265
Kurtosis	-0.54778
Skewness	-0.98319
Range	8
Minimum	1
Maximum	9
Sum	1893
Count	277
Confidence Level(95.0%)	0.35658

Q11	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	171	9	1539	
Medium	62	5	310	
Low	44	1	44	
	277		1893	6.83



Q12. The value of using PDAs to reduce medical errors (drug interaction warnings, dosage calculators, etc) is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	238	24	15	277
Total	238	24	15	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.12E-75

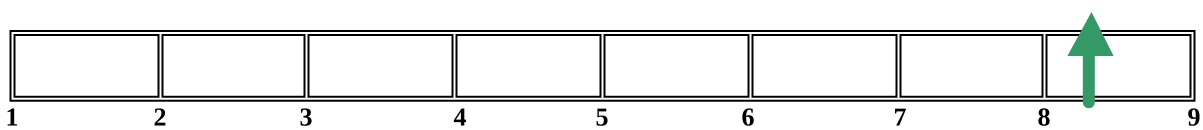
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	8.220217
Standard Error	0.124002
Median	9
Mode	9
Standard Deviation	2.063807
Sample Variance	4.2593
Kurtosis	5.832299
Skewness	-2.62996
Range	8
Minimum	1
Maximum	9
Sum	2277
Count	277
Confidence Level(95.0%)	0.24411

Q12	Survey Responses	Weight	Weighted value	Weighted average
High	238	9	2142	
Medium	24	5	120	
Low	15	1	15	
	277		2277	8.22



Q13. The value of using PDAs for personal and patient scheduling is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	203	50	24	277
Total	203	50	24	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1E-44

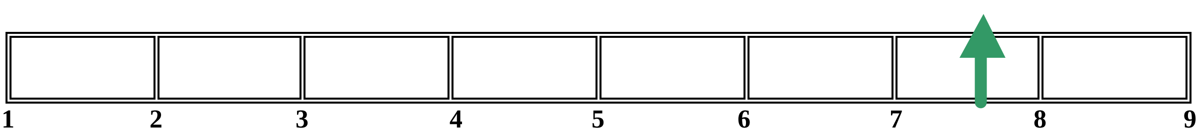
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high

user value in this area.

Descriptive Statistics	
Mean	7.584838
Standard Error	0.15264
Median	9
Mode	9
Standard Deviation	2.540438
Sample Variance	6.453827
Kurtosis	1.249257
Skewness	-1.58946
Range	8
Minimum	1
Maximum	9
Sum	2101
Count	277
Confidence Level(95.0%)	0.300487

Q13	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	203	9	1827	
Medium	50	5	250	
Low	24	1	24	
	277		2101	7.58



Q14. With respect to PDAs, cost concerns are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	99	112	66	277
Total	99	112	66	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	12.18117
p-Value	0.002264

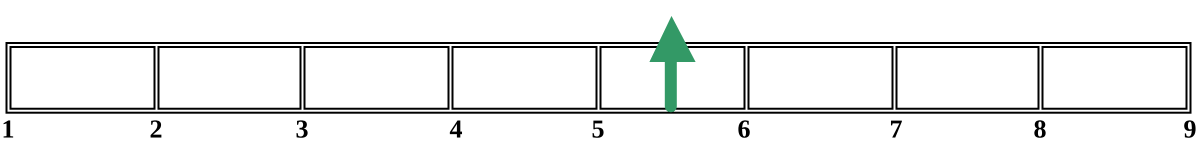
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring medium user value in this area.

Descriptive Statistics

Mean	5.476534
Standard Error	0.183599
Median	5
Mode	5
Standard Deviation	3.055701
Sample Variance	9.33731
Kurtosis	-1.25896
Skewness	-0.20494
Range	8
Minimum	1
Maximum	9
Sum	1517
Count	277
Confidence Level(95.0%)	0.361433

Q14	Survey Responses	Weight	Weighted value	Weighted average
High	99	9	891	
Medium	112	5	560	
Low	66	1	66	
	277		1517	5.48



Q15. With respect to PDAs, network security concerns are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	178	67	32	277
Total	178	67	32	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	4.68E-28

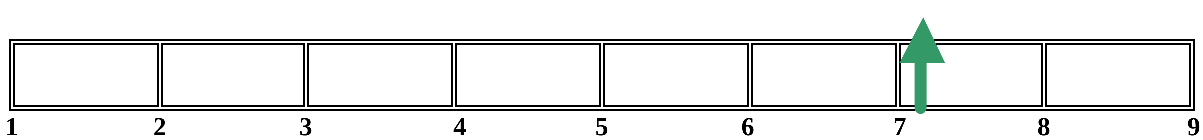
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.108303
Standard Error	0.166866
Median	9
Mode	9
Standard Deviation	2.777205
Sample Variance	7.712866
Kurtosis	-0.03572
Skewness	-1.14426
Range	8
Minimum	1
Maximum	9
Sum	1969
Count	277
Confidence Level(95.0%)	0.328492

Q15	Survey Responses	Weight	Weighted value	Weighted average
High	178	9	1602	
Medium	67	5	335	
Low	32	1	32	
	277		1969	7.11



Q16. With respect to PDAs, patient privacy (HIPAA) concerns are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	194	46	37	277
Total	194	46	37	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	2.76E-37

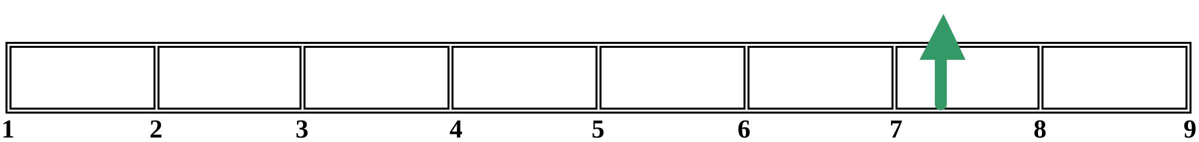
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.267148
Standard Error	0.172398
Median	9
Mode	9
Standard Deviation	2.869272
Sample Variance	8.232721
Kurtosis	0.247435
Skewness	-1.33399
Range	8
Minimum	1
Maximum	9
Sum	2013
Count	277
Confidence Level(95.0%)	0.339382

Q16	Survey Responses	Weight	Weighted value	Weighted average
High	194	9	1746	
Medium	46	5	230	
Low	37	1	37	
	277		2013	7.27



Q17. With respect to PDAs, ease of use concerns are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	179	58	40	277
Total	179	58	40	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

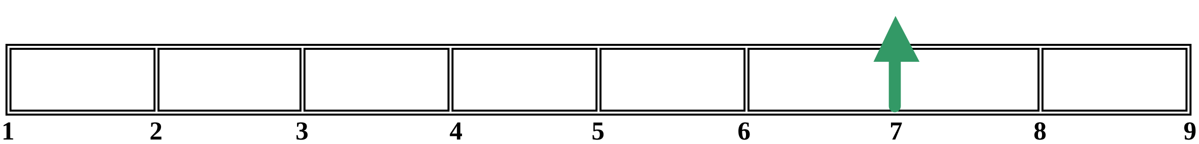
Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.32E-27

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics	
Mean	7.00722
Standard Error	0.176735
Median	9
Mode	9
Standard Deviation	2.941449
Sample Variance	8.652122
Kurtosis	-0.27012
Skewness	-1.10759
Range	8
Minimum	1
Maximum	9
Sum	1941
Count	277
Confidence Level(95.0%)	0.347919

Q17	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	179	9	1611	
Medium	58	5	290	
Low	40	1	40	
	277		1941	7.01



Q18. With respect to PDAs, the ability to personalize content are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	183	66	28	277
Total	183	66	28	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

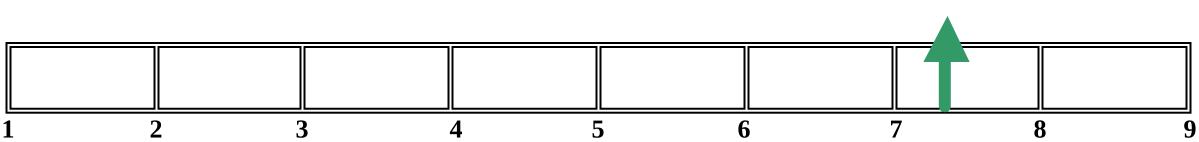
Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	2E-31

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics	
Mean	7.238267
Standard Error	0.161266
Median	9
Mode	9
Standard Deviation	2.684007
Sample Variance	7.203893
Kurtosis	0.236686
Skewness	-1.23385
Range	8
Minimum	1
Maximum	9
Sum	2005
Count	277
Confidence Level(95.0%)	0.317468

Q18	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	183	9	1647	
Medium	66	5	330	
Low	28	1	28	
	277		2005	7.24



Q19. With respect to PDAs, limited application storage (internal RAM) concerns are:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	194	66	17	277
Total	194	66	17	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	5.16E-40

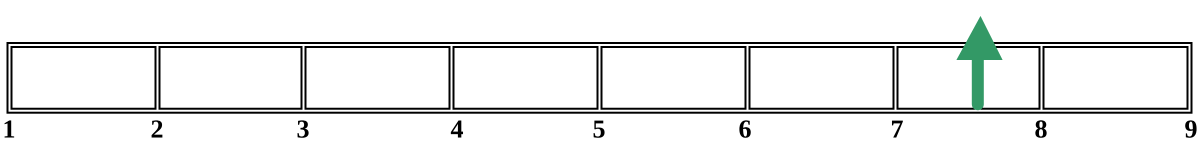
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.555957
Standard Error	0.143138
Median	9
Mode	9
Standard Deviation	2.382289
Sample Variance	5.6753
Kurtosis	0.998257
Skewness	-1.43283
Range	8
Minimum	1
Maximum	9
Sum	2093
Count	277
Confidence Level(95.0%)	0.281781

Q19	Survey Responses	Weight	Weighted value	Weighted average
High	194	9	1746	
Medium	66	5	330	
Low	17	1	17	
	277		2093	7.56



Q20. With respect to PDAs, a color display is important

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	92	85	100	277
Total	92	85	100	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	1.220261
p-Value	0.54328

H_O: There is no preference shown

H_A: There is a preference shown

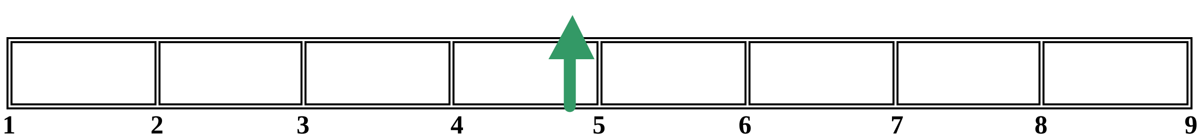
Fail to reject the null hypothesis

At the .05 level of significance the evidence does not allow us to reject the null hypothesis. Therefore, there appears to be no preference shown in this area.

Descriptive Statistics

Mean	4.884477
Standard Error	0.200334
Median	5
Mode	1
Standard Deviation	3.334223
Sample Variance	11.11704
Kurtosis	-1.55997
Skewness	0.054331
Range	8
Minimum	1
Maximum	9
Sum	1353
Count	277
Confidence Level(95.0%)	0.394377

Q20	Survey Responses	Weight	Weighted value	Weighted average
High	92	9	828	
Medium	85	5	425	
Low	100	1	100	
	277		1353	4.88



Q21. With respect to PDAs, additional functionality (use as a voice recorder, beeper, etc.) is:					
Chi-Square Test					
Observed Frequencies:			**Column variable**		
	Row variable	**High**	**Med**	**Low**	**Total**
	Actual Count	147	84	46	277
	Total	147	84	46	277
Expected Frequencies:			**Column variable**		
	Row variable	**High**	**Med**	**Low**	**Total**
	Expected Count	92.33	92.33	92.33	276.99
	Total	92.33	92.33	92.33	276.99

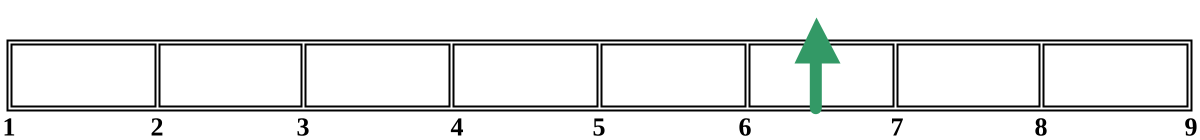
Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	5.75E-13
H_O: There is no preference shown	
H_A: There is a preference shown	
Reject the null hypothesis	

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high

user value in this area.

Descriptive Statistics	
Mean	6.458484
Standard Error	0.180788
Median	9
Mode	9
Standard Deviation	3.008907
Sample Variance	9.053524
Kurtosis	-0.89388
Skewness	-0.71388
Range	8
Minimum	1
Maximum	9
Sum	1789
Count	277
Confidence Level(95.0%)	0.355898

Q21	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	147	9	1323	
Medium	84	5	420	
Low	46	1	46	
	277		1789	6.46



Q22. The value of point-of-service patient registration/admission with the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	157	57	63	277
Total	157	57	63	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.6E-15

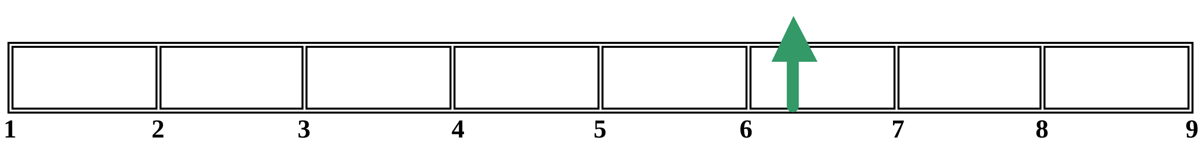
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.357401
Standard Error	0.198409
Median	9
Mode	9
Standard Deviation	3.302183
Sample Variance	10.90441
Kurtosis	-1.17227
Skewness	-0.70263
Range	8
Minimum	1
Maximum	9
Sum	1761
Count	277
Confidence Level(95.0%)	0.390587

Q22	Survey Responses	Weight	Weighted value	Weighted average
High	157	9	1413	
Medium	57	5	285	
Low	63	1	63	
	277		1761	6.36



Q23. The value of a portable (pocket sized) PDA is:

Chi-Square Test

Observed Frequencies:

		Column variable			
	Row variable	**High**	**Med**	**Low**	**Total**
	Actual Count	251	21	5	277
	Total	251	21	5	277

Expected Frequencies:

		Column variable			
	Row variable	**High**	**Med**	**Low**	**Total**
	Expected Count	92.33	92.33	92.33	276.99
	Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	7.7E-90

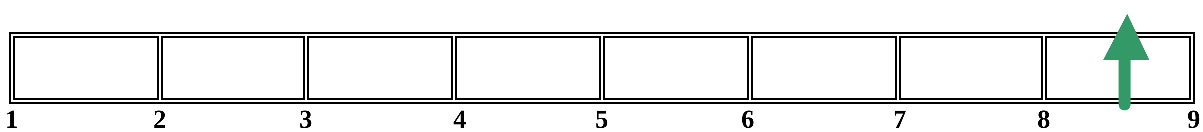
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	8.552347
Standard Error	0.088626
Median	9
Mode	9
Standard Deviation	1.475023
Sample Variance	2.175692
Kurtosis	12.31521
Skewness	-3.49433
Range	8
Minimum	1
Maximum	9
Sum	2369
Count	277
Confidence Level(95.0%)	0.174468

Q23	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	251	9	2259	
Medium	21	5	105	
Low	5	1	5	
	277		2369	8.55



Q24. The value of medical records integration/access with a PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	202	52	23	277
Total	202	52	23	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	3.83E-44

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

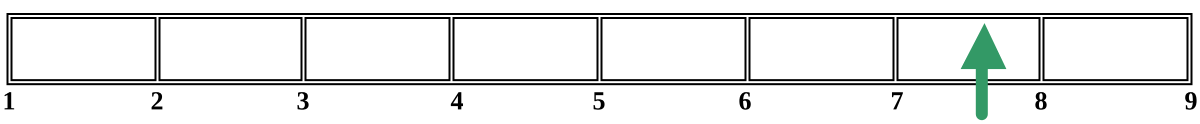
At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high

user value in this area.

Descriptive Statistics

Mean	7.584838
Standard Error	0.151263
Median	9
Mode	9
Standard Deviation	2.517516
Sample Variance	6.337885
Kurtosis	1.241911
Skewness	-1.57652
Range	8
Minimum	1
Maximum	9
Sum	2101
Count	277
Confidence Level(95.0%)	0.297776

Q24	Survey Responses	Weight	Weighted value	Weighted average
High	202	9	1818	
Medium	52	5	260	
Low	23	1	23	
	277		2101	7.58



Q25. The value of accessing patient information at the point of patient care with a PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	225	29	23	277
Total	225	29	23	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	7.36E-63

H_O: There is no preference shown

H_A: There is a preference shown

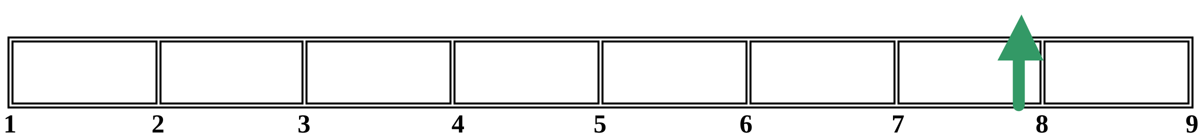
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.916968
Standard Error	0.145166
Median	9
Mode	9
Standard Deviation	2.416047
Sample Variance	5.837284
Kurtosis	2.9503
Skewness	-2.08198
Range	8
Minimum	1
Maximum	9
Sum	2193
Count	277
Confidence Level(95.0%)	0.285774

Q25	Survey Responses	Weight	Weighted value	Weighted average
High	225	9	2025	
Medium	29	5	145	
Low	23	1	23	
	277		2193	7.92



Q26. The value of standardized medical/business applications on the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	224	36	17	277
Total	224	36	17	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	2.61E-62

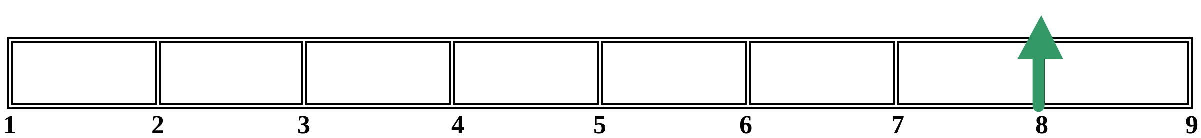
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	7.98917
Standard Error	0.134399
Median	9
Mode	9
Standard Deviation	2.236852
Sample Variance	5.003505
Kurtosis	3.426572
Skewness	-2.13066
Range	8
Minimum	1
Maximum	9
Sum	2213
Count	277
Confidence Level(95.0%)	0.264578

Q26	Survey Responses	Weight	Weighted value	Weighted average
High	224	9	2016	
Medium	36	5	180	
Low	17	1	17	
	277		2213	7.99



Q27. The minimum PDA delay in screen response time that is acceptable is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**1-5 sec**	**6-10 sec**	**10+ sec**	**Total**
Actual Count	222	51	4	277
Total	222	51	4	277

Expected Frequencies:

	Column variable			
Row variable	**1-5 sec**	**6-10 sec**	**10+ sec**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	1.22E-62

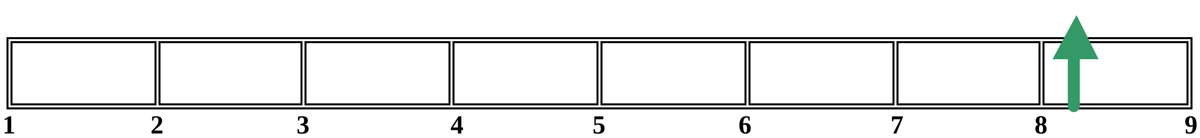
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	8.148014
Standard Error	0.106733
Median	9
Mode	9
Standard Deviation	1.776386
Sample Variance	3.155549
Kurtosis	2.756275
Skewness	-1.89762
Range	8
Minimum	1
Maximum	9
Sum	2257
Count	277
Confidence Level(95.0%)	0.210114

Q27	Survey Responses	Weight	Weighted value	Weighted average
High	222	9	1998	
Medium	51	5	255	
Low	4	1	4	
	277		2257	8.15



Q28. The number of acceptable screen interactions (scrolls) until desired information is located is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**1-3 scrolls**	**4-6 scrolls**	**7+ scrolls**	**Total**
Actual Count	230	45	2	277
Total	230	45	2	277

Expected Frequencies:

	Column variable			
Row variable	**1-3 scrolls**	**4-6 scrolls**	**7+ scrolls**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	9.26E-70

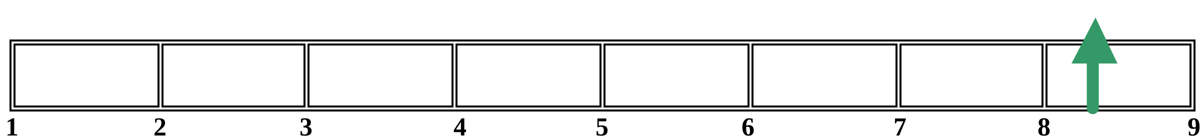
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	8.292419
Standard Error	0.096322
Median	9
Mode	9
Standard Deviation	1.603115
Sample Variance	2.569979
Kurtosis	3.134851
Skewness	-2.03753
Range	8
Minimum	1
Maximum	9
Sum	2297
Count	277
Confidence Level(95.0%)	0.189619

Q28	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	230	9	2070	
Medium	45	5	225	
Low	2	1	2	
	277		2297	8.29



Q29. The minimum acceptable battery life between charges is:						
Chi-Square Test						
Observed Frequencies:		**Column variable**				
	Row variable	0-4 hours (rounds)	5-8 hours (shift)	9-12 hours	12+ hours	**Total**
	Actual Count	59	79	68	71	277
	Total	59	79	68	71	277
Expected Frequencies:		**Column variable**				
	Row variable	0-4 hours (rounds)	5-8 hours (shift)	9-12 hours	12+ hours	**Total**
	Expected Count	69.25	69.25	69.25	69.25	277
	Total	69.25	69.25	69.25	69.25	277

Level of Significance	0.05	H_O: There is no preference shown
Number of Rows	1	H_A: There is a preference shown
Number of Columns	4	Fail to reject the null hypothesis
Degrees of Freedom	3	At the .05 level of significance the evidence
Critical Value	7.814725	does not allow us to reject the null hypothesis.
Chi-Square Test Statistic	2.956678	Therefore, there appears to be no
p-Value	0.398353	preference shown in this area.

Q30. Currently, are you confident that CHCS and KG-ADS patient specific data is accurate:				
Chi-Square Test				
Observed Frequencies:		**Column variable**		
	Row variable	**Yes**	**No**	**Total**
	Actual Count	176	100	276
	Total	176	100	276
Expected Frequencies:		**Column variable**		
	Row variable	**Yes**	**No**	**Total**
	Expected Count	138	138	276
	Total	138	138	276

Level of Significance	0.05	H_O: There is no preference shown
Number of Rows	1	H_A: There is a preference shown
Number of Columns	3	Reject the null hypothesis
Degrees of Freedom	2	At the .05 level of significance we
Critical Value	3.841455	must reject the null hypothesis.
Chi-Square Test Statistic	20.84674	Therefore, there appears to be a
p-Value	4.77E-06	preference shown favoring high
		user value in this area.

Q31. Are you frustrated with CHCS and KG-ADS integration/operability:

Chi-Square Test

Observed Frequencies:

	Column variable		
Row variable	**Yes**	**No**	**Total**
Actual Count	215	61	276
Total	215	61	276

Expected Frequencies:

	Column variable		
Row variable	**Yes**	**No**	**Total**
Expected Count	138	138	276
Total	138	138	276

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	3.841455
Chi-Square Test Statistic	#NUM!
p-Value	1.87E-20

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis
At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Q32. How long does it require to locate/ input desired information (ICD-9/ CPT codes) into CHCS II and KG-ADS:

Chi-Square Test

Observed Frequencies:

	Column variable					
Row variable	1-5 seconds	6-10 seconds	11-15 seconds	16-20 seconds	20+ seconds	**Total**
Actual Count	88	34	34	28	90	274
Total	88	34	34	28	90	274

Expected Frequencies:

	Column variable					
Row variable	1-5 seconds	6-10 seconds	11-15 seconds	16-20 seconds	20+ seconds	**Total**
Expected Count	54.8	54.8	54.8	54.8	54.8	274
Total	54.8	54.8	54.8	54.8	54.8	274

Level of Significance	0.05
Number of Rows	1
Number of Columns	5
Degrees of Freedom	4
Critical Value	9.487728
Chi-Square Test Statistic	#NUM!
p-Value	1.03E-14

H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis
At the .05 level of significance the evidence reject the null hypothesis. Therefore, there appears to be a preference at both .extremes for this area.

** Q33-Q35 have significantly fewer responses. These questions were added based upon Delphi roundtable sessions with providers at Naval Hospital Lemoore after they had taken the survey, and thus do not reflect their answers.*

Q33. The value of integrating voice transcription services on the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	150	45	57	252
Total	150	45	57	252

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	84	84	84	252
Total	84	84	84	252

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	8.37E-18

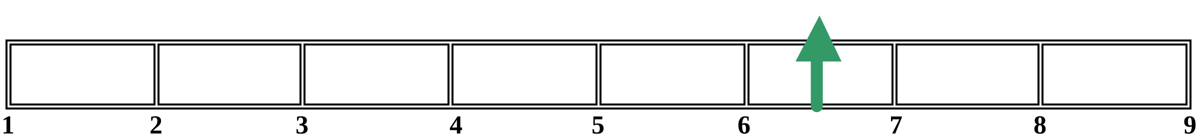
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.47619
Standard Error	0.208998
Median	9
Mode	9
Standard Deviation	3.31774
Sample Variance	11.0074
Kurtosis	-1.0977
Skewness	-0.78012
Range	8
Minimum	1
Maximum	9
Sum	1632
Count	252
Confidence Level(95.0%)	0.411613

Q33	Survey Responses	Weight	Weighted value	Weighted average
High	150	9	1350	
Medium	45	5	225	
Low	57	1	57	
	252		1632	6.48



Q34. The value of providing an audio alert for high-priority e-mail on the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	129	68	55	252
Total	129	68	55	252

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	84	84	84	252
Total	84	84	84	252

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	8.5E-09

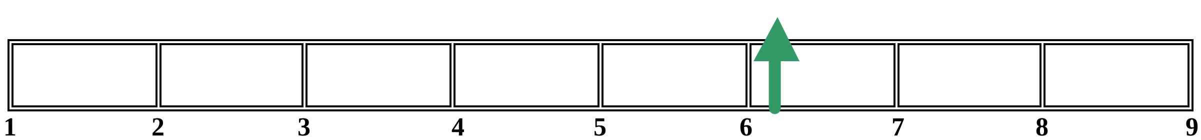
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.174603
Standard Error	0.202601
Median	9
Mode	9
Standard Deviation	3.216193
Sample Variance	10.34389
Kurtosis	-1.21388
Skewness	-0.582
Range	8
Minimum	1
Maximum	9
Sum	1556
Count	252
Confidence Level(95.0%)	0.399015

Q34	**Survey Responses**	**Weight**	**Weighted value**	**Weighted average**
High	129	9	1161	
Medium	68	5	340	
Low	55	1	55	
	252		1556	6.17



Q35. The value of integrating barcode scanning capability (match medications with patient, associate material costs with episodes of care/inventory control) on the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	154	49	49	252
Total	154	49	49	252

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	84	84	84	252
Total	84	84	84	252

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	9.99E-20

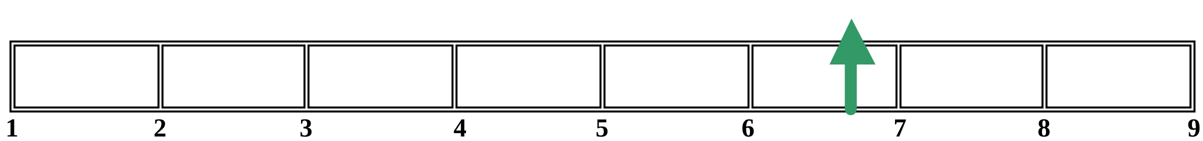
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high user value in this area.

Descriptive Statistics

Mean	6.666667
Standard Error	0.200707
Median	9
Mode	9
Standard Deviation	3.186125
Sample Variance	10.15139
Kurtosis	-0.83986
Skewness	-0.89233
Range	8
Minimum	1
Maximum	9
Sum	1680
Count	252
Confidence Level(95.0%)	0.395285

Q35	Survey Responses	Weight	Weighted value	Weighted average
High	154	9	1386	
Medium	49	5	245	
Low	49	1	49	
	252		1680	6.67



Q36. The value of utilizing medical imaging (low-level diagnostic display capability) on the PDA is:

Chi-Square Test

Observed Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Actual Count	129	56	92	277
Total	129	56	92	277

Expected Frequencies:

	Column variable			
Row variable	**High**	**Med**	**Low**	**Total**
Expected Count	92.33	92.33	92.33	276.99
Total	92.33	92.33	92.33	276.99

Level of Significance	0.05
Number of Rows	1
Number of Columns	3
Degrees of Freedom	2
Critical Value	5.991476
Chi-Square Test Statistic	#NUM!
p-Value	5.41E-07

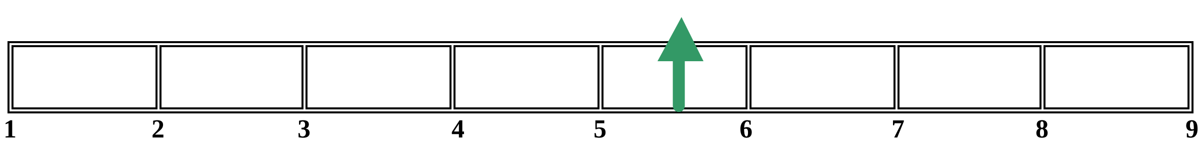
H_O: There is no preference shown
H_A: There is a preference shown
Reject the null hypothesis

At the .05 level of significance we must reject the null hypothesis. Therefore, there appears to be a preference shown favoring high and low user value in this area.

Descriptive Statistics

Mean	5.534296
Standard Error	0.212643
Median	5
Mode	9
Standard Deviation	3.53908
Sample Variance	12.52509
Kurtosis	-1.67561
Skewness	-0.26472
Range	8
Minimum	1
Maximum	9
Sum	1533
Count	277
Confidence Level(95.0%)	0.418608

Q36	Survey Responses	Weight	Weighted value	Weighted average
High	129	9	1161	
Medium	56	5	280	
Low	92	1	92	
	277		1533	5.53



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APPENDIX C. RAW DATA

SURVEY QUESTIONS 1-12

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
41	h	h	h	h	h	h	h	h	h	h	h	h
42	h	h	h	h	h	h	h	h	h	h	h	h
44	h	h	h	h	h	h	h	h	h	h	h	h
45	m	m	h	h	h	h	h	h	h	h	l	h
46	m	m	m	m	h	h	h	h	m	m	h	m
47	m	m	h	l	l	l	l	h	m	h	h	l
49	h	m	h	h	h	h	h	h	h	h	h	h
50	m	m	m	m	m	m	m	m	m	h	h	h
51	h	h	h	h	h	h	h	h	h	h	m	m
52	h	m	h	h	h	h	h	h	h	h	h	h
53	h	m	h	m	m	m	h	m	h	h	m	h
54	m	m	h	l	l	l	m	l	l	m	m	h
55	h	h	h	h	h	h	m	h	l	h	h	h
56	h	h	h	l	l	l	l	h	l	h	l	h
57	l	l	l	l	l	l	l	l	l	l	l	l
58	h	m	h	h	h	h	h	h	h	h	h	h
59	m	m	h	m	m	m	h	h	l	l	l	h
60	h	m	h	m	m	m	h	h	m	h	m	h
61	m	m	m	m	m	m	m	l	m	m	m	m
62	m	m	h	h	h	h	h	h	m	m	h	h
63	h	m	h	h	h	h	h	h	h	h	l	h
64	m	h	h	m	m	m	m	h	m	h	h	h
65	l	l	l	l	l	l	l	l	h	l	l	l
67	h	h	h	h	h	h	h	h	h	m	h	h
68	m	m	h	h	h	h	h	h	h	h	h	h
69	m	h	m	m	m	m	h	l	m	h	l	h
70	m	m	m	l	l	l	l	l	l	m	m	h
71	l	l	m	l	l	l	m	l	l	m	h	h
72	h	h	h	h	h	h	h	h	h	h	h	h
73	m	m	h	m	m	m	m	m	m	m	h	m
74	m	m	m	m	m	m	h	h	h	h	h	h
75	h	h	h	m	m	m	m	m	l	h	h	h
76	h	l	h	h	h	h	h	h	h	h	h	h
77	h	m	h	h	h	h	h	h	h	h	m	h
78	h	h	h	h	h	h	h	h	h	h	h	h
79	h	h	h	h	h	h	h	h	h	h	h	h
80	h	m	h	h	h	h	h	h	h	h	h	h
81	h	h	h	l	l	l	h	m	h	h	h	h
82	h	h	h	m	h	h	h	h	l	h	h	h
83	m	l	h	h	h	h	l	m	m	h	l	h
84	m	h	h	h	m	m	h	h	h	h	l	h
85	l	h	h	m	m	m	h	m	m	h	h	h

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
86	h	m	h	h	h	h	h	h	m	m	m	m
87	m	m	h	m	m	m	h	m	l	h	h	m
89	h	h	h	h	h	h	h	h	h	h	h	h
90	h	h	h	h	h	h	m	h	h	h	h	h
91	m	h	m	h	m	m	h	h	h	h	h	h
92	h	h	h	h	h	h	h	h	h	h	h	h
93	h	h	h	h	h	h	h	h	h	h	h	h
94	m	m	h	m	m	m	l	m	l	h	h	h
95	h	h	h	h	h	h	h	h	h	h	h	h
96	l	l	l	l	l	l	l	l	l	l	l	l
97	h	h	h	h	h	h	h	h	h	h	h	h
98	h	m	h	h	h	h	m	l	l	h	m	h
99	h	h	h	h	h	h	h	h	h	h	h	h
100	h	h	h	h	h	h	h	h	h	m	m	h
102	h	h	h	h	h	h	h	h	h	h	h	h
103	h	h	h	h	h	h	h	h	h	h	m	h
104	h	h	h	h	h	h	h	h	h	h	h	h
105	m	l	m	l	l	l	l	l	l	m	m	l
106	h	h	h	h	h	h	h	h	h	h	h	h
107	h	h	h	h	h	h	h	l	l	h	m	h
108	h	h	h	h	h	h	h	h	h	h	h	h
109	m	m	h	m	m	m	h	h	l	m	l	h
110	h	l	h	h	h	h	m	m	h	l	l	h
111	h	m	h	h	h	h	h	m	m	h	h	h
112	h	h	h	h	h	h	h	h	h	h	h	h
113	m	m	h	l	l	l	m	m	l	h	m	h
114	h	h	h	h	h	h	h	h	h	h	m	h
117	h	h	h	h	h	h	h	h	h	h	h	h
118	m	h	h	l	m	h	m	h	h	h	h	m
119	h	h	h	h	h	h	h	h	l	h	h	m
120	h	h	h	h	h	h	h	h	h	h	h	h
121	h	h	h	h	h	h	h	h	h	h	h	h
122	h	h	h	h	h	h	m	m	m	h	h	h
123	h	h	h	h	h	h	h	m	m	h	m	h
124	h	h	h	h	h	h	h	h	h	h	h	h
125	h	h	h	h	h	h	h	h	h	h	h	h
126	h	h	h	h	h	h	h	h	h	h	h	h
127	m	m	h	h	h	h	m	h	h	h	m	h
128	m	m	h	h	m	m	m	h	h	h	m	h
129	h	h	h	m	h	h	h	h	h	h	m	h
130	h	h	h	h	h	h	h	h	h	h	h	h
131	m	h	h	h	h	h	h	h	h	h	h	h
132	h	h	h	h	h	h	h	h	h	h	h	h
133	h	h	h	h	h	h	h	h	h	h	h	h
134	h	h	h	h	h	h	h	h	h	h	h	h
135	h	m	h	h	h	h	h	h	m	h	m	h
136	h	h	h	h	h	h	h	h	h	h	h	h

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
137	h	l	h	h	h	h	h	h	m	h	h	h
138	h	m	h	h	h	h	h	h	h	l	m	h
140	l	m	h	h	h	h	h	h	h	h	h	h
141	h	h	h	m	m	m	h	h	m	h	h	h
142	h	h	h	h	h	h	h	h	h	h	h	h
143	h	h	h	h	h	h	h	h	h	h	h	h
144	h	h	h	h	h	h	h	h	h	h	h	h
145	m	m	m	l	m	l	m	l	m	h	h	m
146	l	l	m	m	m	m	l	l	l	l	l	l
147	h	h	h	h	h	h	h	h	h	h	h	h
148	l	h	h	l	l	h	h	l	l	m	m	m
149	m	l	h	h	h	h	h	m	m	l	m	m
152	h	m	h	h	h	h	h	h	h	h	h	h
153	m	l	l	h	h	h	h	h	h	l	l	h
154	h	h	m	h	h	h	h	h	h	h	h	h
155	m	m	m	h	h	h	m	m	l	h	h	h
156	m	m	h	m	h	m	h	h	h	h	h	h
157	l	m	l	l	l	l	l	l	l	l	m	m
158	m	m	h	l	l	l	m	l	l	l	l	l
159	m	h	h	h	h	h	h	h	h	h	h	h
160	m	m	h	l	l	l	l	m	m	l	l	h
161	m	m	l	l	h	h	m	h	m	m	h	h
162	h	h	h	h	h	h	h	h	h	h	h	h
163	h	h	h	h	h	h	h	h	h	h	h	h
164	m	l	h	h	h	m	h	m	h	l	m	m
165	h	l	h	h	h	h	h	h	h	h	h	h
166	l	l	l	l	l	l	l	l	l	l	l	l
167	h	h	h	l	l	l	h	h	h	h	h	h
168	m	h	h	h	h	h	h	h	h	h	h	h
169	h	m	h	h	h	h	h	h	h	h	h	h
170	m	m	m	h	h	h	h	h	h	h	l	h
171	h	h	h	h	h	h	h	h	h	h	h	h
172	h	h	h	h	h	h	h	h	h	h	h	h
174	h	h	h	h	h	h	h	m	m	h	h	h
175	h	h	h	h	h	h	h	h	h	m	m	h
176	h	h	h	h	h	h	h	h	h	h	h	h
177	m	m	h	h	h	h	m	h	h	h	h	h
178	m	h	h	h	h	h	h	l	l	m	m	h
179	h	m	h	h	m	h	h	h	h	h	m	m
180	h	m	h	h	h	h	h	h	h	h	h	h
181	h	h	h	h	h	h	h	h	h	h	h	h
182	m	m	h	h	h	h	h	h	h	h	h	h
183	h	h	h	h	h	h	h	h	h	h	h	h
184	m	m	h	l	l	l	h	m	l	h	h	l
185	h	h	h	m	m	m	m	h	h	l	m	h
186	l	h	h	l	l	l	l	l	l	l	h	h
187	h	m	h	h	h	h	h	h	h	m	m	h

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
188	m	h	h	m	m	m	h	h	m	h	h	h
189	h	m	h	h	h	h	h	m	l	m	m	h
190	h	h	h	h	h	h	h	h	l	l	m	h
191	m	m	m	m	m	m	m	m	m	m	m	h
192	h	h	h	h	h	h	h	h	h	h	h	h
193	h	m	h	h	h	h	h	h	m	h	l	m
194	h	h	h	m	m	m	h	h	h	l	h	m
195	h	h	h	h	h	h	h	h	h	h	m	h
196	h	m	h	h	h	h	h	h	h	h	h	h
197	h	m	h	h	h	h	m	m	h	m	m	h
198	h	h	h	h	h	h	h	h	m	m	h	h
199	h	h	h	h	h	h	h	h	m	h	m	m
200	h	h	h	h	h	h	l	h	l	m	h	h
201	h	h	h	h	h	h	m	l	l	h	h	h
202	h	m	h	h	h	h	h	h	h	m	l	h
203	h	h	h	l	l	l	l	h	l	h	h	l
204	m	m	m	h	l	l	h	h	m	l	l	h
205	h	h	h	h	h	h	h	m	l	l	m	h
206	h	h	h	h	h	h	h	h	h	h	h	h
207	h	h	h	h	h	h	h	m	l	m	m	h
208	m	m	h	m	m	m	m	l	l	m	l	l
209	h	h	h	m	m	h	h	h	m	h	h	h
210	m	m	h	h	h	h	m	h	m	h	h	h
211	h	h	h	h	h	h	h	h	h	h	h	h
212	h	h	h	h	h	h	h	h	h	h	m	h
213	m	m	h	l	m	l	h	h	m	h	h	h
214	h	h	h	h	h	h	h	h	h	h	h	h
215	h	h	h	h	h	h	h	h	l	h	m	h
216	h	h	h	h	h	h	h	h	h	m	h	h
217	h	h	h	m	h	h	h	h	h	h	m	h
218	h	h	h	h	h	h	h	h	h	m	h	h
219	h	h	h	h	h	h	l	m	m	m	m	h
220	h	h	h	h	h	h	h	h	h	h	m	h
221	h	h	h	l	m	h	l	h	m	h	l	m
222	h	h	h	h	h	h	m	h	m	h	m	h
223	h	m	h	h	h	h	h	h	m	m	m	h
224	h	m	h	h	h	h	h	h	l	h	l	h
225	h	m	h	h	h	h	m	m	l	h	h	h
226	h	m	h	h	h	h	h	h	m	m	l	h
227	h	l	m	l	m	m	l	l	l	h	h	h
228	h	m	h	h	h	h	m	h	m	m	l	h
229	h	h	h	l	m	m	h	h	l	h	h	h
230	h	h	h	h	h	h	h	h	h	h	h	h
231	h	h	h	h	h	h	h	h	h	h	h	h
232	h	h	h	h	h	h	h	h	l	h	h	h
233	h	h	h	h	h	h	h	h	h	h	m	h
234	m	m	h	l	l	l	h	m	h	m	l	h

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
235	h	m	h	h	h	h	h	h	h	h	h	h
236	h	l	h	h	h	h	m	h	h	h	h	h
237	h	h	h	h	h	h	m	h	m	m	h	h
238	l	l	h	m	m	m	h	l	m	l	m	h
239	l	l	l	l	l	l	l	l	l	l	h	l
240	h	h	m	h	h	h	h	h	m	h	h	h
241	h	m	h	l	l	l	l	l	h	h	h	h
242	h	m	h	h	h	h	h	h	h	h	m	h
243	h	h	h	h	h	h	h	h	h	h	h	h
244	h	h	m	m	m	m	l	h	l	m	m	h
245	h	h	h	h	h	h	h	h	h	h	h	h
246	h	h	h	h	h	h	h	h	h	h	h	h
247	h	h	h	h	h	h	h	h	h	h	h	h
248	h	h	h	h	h	h	h	h	h	h	h	m
249	h	h	h	h	h	h	h	h	h	h	h	h
250	h	h	h	h	h	h	m	h	h	h	m	h
251	h	h	h	h	h	h	h	h	l	l	m	h
252	h	h	h	h	h	h	h	h	h	h	h	h
253	h	l	h	h	h	h	h	h	h	h	h	h
254	h	h	h	h	h	h	h	h	h	h	h	h
255	l	m	l	l	l	l	l	l	h	m	h	h
256	l	h	h	h	h	h	h	h	h	h	h	h
257	l	l	l	l	l	l	h	l	l	l	l	m
258	m	h	m	h	h	h	h	h	m	h	m	h
259	m	h	h	l	l	l	h	l	l	h	h	l
260	h	l	h	h	h	h	h	h	l	m	h	h
261	m	m	h	h	m	m	m	m	h	h	h	h
262	h	l	h	h	h	h	h	h	h	h	h	h
263	m	m	m	m	m	m	h	m	m	m	m	m
264	m	m	h	m	m	h	h	h	h	h	h	h
266	h	h	h	h	h	h	h	h	m	h	h	h
267	h	h	h	m	m	m	h	h	l	h	h	h
268	l	h	m	m	m	l	h	h	h	h	l	h
269	h	m	h	h	h	h	m	m	m	h	l	m
270	h	h	h	h	m	m	h	h	l	m	h	h
271	h	h	h	h	h	h	h	h	h	h	h	h
272	h	h	h	h	h	h	h	h	h	h	h	h
273	h	h	h	h	h	h	h	h	h	h	h	h
274	h	h	h	h	h	h	m	h	h	h	m	h
275	h	m	h	h	h	h	h	h	h	h	h	h
277	h	h	h	m	m	m	h	m	m	h	m	h
278	h	h	h	h	h	h	m	h	l	h	m	h
279	m	m	l	l	l	l	h	l	l	l	l	h
280	m	h	h	h	h	h	h	h	h	h	h	h
281	m	m	h	m	m	m	h	h	h	m	m	h
283	h	h	h	h	h	h	h	h	h	h	h	h
284	h	m	h	h	h	h	h	h	h	h	l	h

USERID	*Q1*	*Q2*	*Q3*	*Q4*	*Q5*	*Q6*	*Q7*	*Q8*	*Q9*	*Q10*	*Q11*	*Q12*
285	h	m	h	h	h	h	m	h	h	h	l	h
287	m	m	h	l	l	l	h	h	l	h	l	h
288	h	h	h	h	h	h	h	h	h	h	h	h
289	h	m	h	h	l	h	h	m	h	h	l	h
290	m	m	h	h	h	h	h	h	h	h	m	h
291	h	l	h	h	m	l	l	l	l	h	m	h
292	m	m	m	m	m	m	m	h	m	m	h	h
293	l	l	h	h	h	h	h	h	m	l	l	h
294	h	l	h	h	h	h	h	h	h	l	h	h
295	h	h	h	h	h	h	h	h	h	h	h	h
296	m	m	m	h	h	h	h	h	l	h	h	h
297	h	l	h	h	h	h	h	h	h	h	h	h
298	l	l	l	l	l	l	l	l	l	l	l	l
299	m	l	h	h	h	h	h	h	m	h	h	h
300	h	h	m	m	m	h	h	h	m	m	m	h
301	m	h	h	m	m	m	h	h	m	h	h	h
302	h	m	h	h	h	h	h	h	h	h	l	h
303	h	m	h	m	h	h	h	h	m	h	h	l
304	h	h	h	h	h	h	h	h	h	h	h	h
305	m	m	m	m	m	m	h	m	l	h	m	h
306	m	m	l	l	l	l	l	l	l	m	h	h
307	m	h	h	h	h	h	h	h	h	m	h	h
308	h	m	h	h	h	h	l	l	l	m	l	h
309	h	m	h	h	h	h	h	m	m	h	h	m
310	h	h	h	h	h	h	h	h	h	h	h	h
311	h	m	h	h	h	h	l	l	l	h	h	h
312	m	m	m	m	l	m	m	m	l	h	l	h
313	h	m	h	h	h	h	h	h	h	h	h	h
314	h	h	h	h	h	h	m	h	h	h	h	h
315	m	l	m	m	m	m	h	h	m	m	l	h
316	h	h	h	h	h	h	h	m	h	h	l	h
317	h	m	h	h	h	h	h	h	h	l	l	h
318	h	m	h	h	h	h	l	m	l	h	h	h
319	h	m	h	h	h	h	h	h	h	h	h	h
320	h	m	h	h	h	h	h	h	m	h	m	m
321	h	h	h	h	h	h	h	h	h	h	h	h
322	h	h	h	h	h	h	h	h	h	h	h	h
323	h	h	h	h	h	h	h	h	h	h	h	h
324	h	m	h	h	h	h	m	m	h	h	h	h
325	h	h	h	h	h	h	h	h	h	h	h	h
326	h	h	h	h	h	h	h	h	h	h	h	h
327	h	h	h	h	h	h	h	h	h	h	h	h
328	h	h	h	l	l	l	h	h	l	h	h	h
329	h	h	h	h	h	h	h	h	h	h	h	h
330	h	m	h	h	h	h	h	h	h	l	l	h
331	h	m	h	m	l	l	h	h	h	h	h	h
332	h	m	h	m	l	l	h	h	h	h	h	h

SURVEY QUESTIONS 13-24

USERID	*Q13*	*Q14*	*Q15*	*Q16*	*Q17*	*Q18*	*Q19*	*Q20*	*Q21*	*Q22*	*Q23*	*Q24*
41	h	h	h	h	h	h	h	m	h	h	h	h
42	m	m	h	h	h	m	h	h	h	h	h	h
44	h	h	h	h	h	h	h	h	h	h	h	h
45	h	h	m	l	h	h	h	l	m	h	h	m
46	h	m	h	h	h	m	m	l	h	m	h	h
47	m	l	m	h	l	h	h	h	m	l	h	m
49	h	h	h	h	h	m	h	m	h	h	h	h
50	h	m	h	h	m	h	h	m	h	h	h	l
51	h	l	m	m	h	h	m	l	m	h	h	m
52	h	h	h	h	h	m	h	l	m	m	h	h
53	h	l	l	m	m	h	l	m	m	h	h	m
54	m	l	l	l	l	m	h	h	h	l	m	l
55	m	l	m	m	l	h	m	m	h	l	h	h
56	h	l	l	h	h	h	h	m	l	l	h	l
57	l	l	l	l	l	l	l	l	l	l	l	l
58	h	m	m	h	h	h	h	h	h	h	h	h
59	l	m	h	h	l	l	m	l	m	l	h	h
60	h	m	h	m	l	h	h	l	m	h	h	h
61	m	l	l	l	l	l	l	l	l	l	l	l
62	h	m	h	m	m	l	m	l	h	l	h	h
63	h	m	h	h	h	h	m	l	l	h	h	h
64	m	h	h	h	h	h	h	h	m	m	h	m
65	h	l	h	h	l	h	h	h	h	l	l	l
67	h	m	h	h	h	h	h	h	h	h	h	h
68	m	h	h	m	m	h	m	l	l	l	h	m
69	h	l	l	h	h	m	h	l	l	m	h	h
70	h	l	l	h	h	h	h	m	m	m	h	h
71	l	l	h	h	h	m	m	m	m	l	m	m
72	h	h	h	h	h	h	h	h	h	h	h	h
73	h	l	h	h	m	h	h	h	m	m	h	m
74	h	h	h	h	h	h	h	h	h	h	h	h
75	h	l	h	h	m	m	h	m	m	m	h	m
76	m	h	h	h	h	l	m	h	h	l	h	m
77	h	l	h	h	h	h	h	l	m	l	h	h
78	h	h	h	h	h	h	h	h	h	h	h	h
79	h	h	h	h	h	h	h	h	h	h	h	h
80	h	m	m	h	m	h	m	m	h	h	h	h
81	h	h	h	h	h	l	m	m	m	h	h	h
82	h	m	m	m	m	h	m	h	h	h	h	h
83	h	l	l	l	h	l	h	m	m	l	h	h
84	m	l	l	l	m	m	l	l	l	m	h	m
85	h	m	h	h	h	h	m	m	m	m	h	h
86	m	l	m	m	h	m	l	l	m	m	h	h
87	h	l	h	l	m	m	m	l	l	l	h	h

USERID	***Q13***	***Q14***	***Q15***	***Q16***	***Q17***	***Q18***	***Q19***	***Q20***	***Q21***	***Q22***	***Q23***	***Q24***
89	h	h	h	h	h	h	h	h	h	h	h	h
90	m	m	m	m	m	m	m	l	l	h	h	h
91	m	h	l	l	m	m	h	m	h	l	h	h
92	h	m	m	l	m	m	h	m	m	m	h	h
93	h	h	h	h	h	h	h	h	h	h	h	h
94	h	l	l	l	m	m	h	m	h	h	h	h
95	h	h	h	h	h	h	h	h	h	h	h	h
96	l	l	l	l	h	h	l	l	l	l	l	l
97	h	m	m	m	m	l	l	l	m	l	h	h
98	l	m	h	h	h	m	m	l	l	l	h	h
99	h	m	m	m	l	m	h	l	l	m	h	m
100	h	h	h	h	h	m	h	m	h	h	h	h
102	h	h	h	h	h	h	h	h	h	h	h	h
103	m	h	m	m	m	m	h	m	m	m	h	h
104	h	h	h	h	h	h	h	h	h	h	h	h
105	l	m	h	h	h	m	m	m	m	l	h	m
106	h	l	h	h	h	h	h	h	h	h	h	h
107	h	l	m	l	m	h	m	l	h	m	h	h
108	h	h	h	h	h	h	h	h	h	h	h	h
109	m	l	h	h	h	h	h	m	m	l	h	h
110	h	m	m	m	m	l	m	l	m	h	h	h
111	h	h	h	h	h	h	h	m	m	h	h	h
112	h	h	h	h	h	h	h	h	h	h	h	h
113	h	l	m	h	h	h	m	l	m	l	m	l
114	h	m	m	h	h	h	h	h	m	h	h	h
117	h	m	h	h	h	h	h	l	l	h	h	m
118	h	m	h	h	h	h	h	l	h	l	h	h
119	l	h	h	h	h	h	h	h	h	l	h	h
120	h	m	h	m	l	h	m	l	h	h	h	h
121	h	h	h	h	h	h	h	h	h	h	h	h
122	h	m	h	h	h	h	h	m	h	h	h	h
123	m	h	h	h	h	h	h	m	h	m	h	h
124	h	l	h	h	m	l	l	m	h	h	h	h
125	h	h	l	l	h	h	h	l	l	l	h	h
126	h	m	h	h	m	m	h	l	h	h	h	h
127	m	m	h	h	h	h	h	m	h	h	h	h
128	m	m	m	h	m	h	h	l	l	m	h	h
129	h	l	h	h	h	h	h	l	m	l	h	h
130	h	h	h	h	h	h	h	h	m	h	h	h
131	h	m	h	h	m	h	h	m	h	h	h	h
132	h	h	h	h	h	h	h	h	h	h	h	h
133	h	h	h	h	h	h	h	h	h	h	h	h
134	h	h	h	h	h	h	h	h	h	h	h	h
135	h	m	h	h	m	h	h	m	m	h	h	h
136	h	h	h	h	h	h	h	h	h	h	h	h
137	h	m	h	h	m	h	h	m	m	h	h	h
138	h	l	h	h	h	h	h	m	h	h	h	h

USERID	***Q13***	***Q14***	***Q15***	***Q16***	***Q17***	***Q18***	***Q19***	***Q20***	***Q21***	***Q22***	***Q23***	***Q24***
140	h	l	h	h	h	h	h	h	h	h	h	h
141	h	l	m	h	h	h	h	l	l	m	h	h
142	h	h	h	h	h	h	h	h	h	h	h	h
143	h	h	h	h	h	h	h	h	h	h	h	h
144	h	l	l	l	l	h	h	l	h	h	h	h
145	h	l	l	l	h	h	h	h	h	h	h	h
146	l	m	m	m	m	m	h	l	l	l	l	m
147	h	h	h	h	h	h	h	h	h	h	h	h
148	m	l	m	l	h	h	h	h	l	m	h	l
149	h	m	m	m	m	m	h	h	m	h	m	m
152	h	m	m	h	h	m	h	l	m	h	h	h
153	l	h	h	h	h	h	h	h	h	h	h	m
154	h	m	h	h	h	h	h	m	h	h	h	h
155	h	m	m	h	h	m	m	l	m	h	m	h
156	h	h	h	h	h	h	h	m	h	m	h	h
157	l	m	h	h	m	m	l	l	m	l	h	l
158	m	h	m	l	h	h	l	l	l	l	m	m
159	h	h	h	h	h	h	h	h	h	h	h	h
160	m	l	h	h	h	h	h	m	l	l	h	l
161	h	m	h	h	h	m	m	l	h	l	h	h
162	h	h	h	h	h	h	h	h	h	h	h	h
163	h	m	h	h	h	h	h	m	h	h	h	h
164	h	m	h	h	m	h	h	l	l	h	m	m
165	h	l	h	h	h	h	h	h	h	h	h	h
166	l	l	l	l	h	h	h	h	h	l	h	h
167	h	h	h	h	h	h	h	h	h	h	h	h
168	h	m	h	h	h	h	h	h	h	h	h	h
169	h	h	h	l	m	h	h	l	m	m	h	h
170	m	h	h	h	h	h	m	l	l	m	h	h
171	h	h	h	h	h	h	h	h	h	h	h	h
172	h	m	h	h	h	m	h	m	m	m	h	h
174	h	m	h	h	h	h	h	m	h	h	h	h
175	h	m	m	h	h	h	h	l	m	h	h	h
176	h	h	h	h	h	h	h	h	h	h	h	h
177	h	h	h	h	h	m	h	m	h	h	h	h
178	h	l	m	l	h	m	h	l	h	h	h	h
179	h	l	m	m	h	h	m	m	h	m	h	h
180	m	h	h	h	h	h	h	m	m	h	h	h
181	m	h	h	h	h	h	h	m	m	h	h	m
182	h	h	h	h	h	h	h	h	h	h	h	h
183	h	h	h	h	h	h	h	h	h	h	h	h
184	h	l	h	h	l	h	h	h	h	h	m	m
185	h	h	m	m	h	h	h	l	l	h	h	h
186	l	m	h	h	m	l	m	m	h	l	m	l
187	h	m	m	m	m	h	m	m	h	h	h	h
188	h	m	h	h	h	h	h	m	h	m	h	h
189	m	m	m	m	h	h	m	m	m	m	h	h

USERID	*Q13*	*Q14*	*Q15*	*Q16*	*Q17*	*Q18*	*Q19*	*Q20*	*Q21*	*Q22*	*Q23*	*Q24*
190	m	l	m	h	h	m	h	l	m	m	m	m
191	m	h	m	m	l	m	m	l	m	m	m	h
192	h	m	m	h	m	h	h	h	h	h	h	h
193	h	m	m	m	l	l	h	l	m	m	h	m
194	h	m	m	h	l	m	m	l	m	h	h	h
195	h	m	h	h	h	h	h	l	h	h	h	h
196	h	h	h	h	h	h	h	m	h	h	h	h
197	h	m	m	h	h	l	m	h	h	m	h	h
198	h	l	m	l	l	m	h	h	h	m	h	m
199	h	m	m	m	h	h	m	m	h	h	h	h
200	h	l	h	h	m	h	h	m	h	l	h	m
201	h	m	h	h	m	m	l	m	h	h	h	h
202	h	m	h	m	l	h	m	l	h	m	h	m
203	h	m	l	m	m	l	m	h	h	h	h	m
204	l	l	l	l	m	l	m	l	m	l	h	m
205	m	l	h	m	l	h	m	l	l	l	h	h
206	h	m	m	h	h	h	m	l	m	h	h	h
207	h	m	m	h	h	m	h	m	h	h	h	h
208	l	l	h	h	m	m	h	l	h	l	h	m
209	h	h	m	m	h	h	h	h	h	h	h	h
210	h	m	m	m	h	h	h	m	h	h	h	h
211	h	h	h	h	h	h	h	h	h	h	h	h
212	h	m	m	m	l	m	h	h	h	m	h	h
213	m	h	h	h	h	h	h	m	m	m	h	h
214	h	h	h	h	h	h	h	h	h	h	h	h
215	h	l	h	h	h	h	h	l	m	h	h	h
216	h	m	m	m	l	l	h	h	h	h	h	m
217	h	l	h	h	h	l	m	l	l	h	h	h
218	h	h	h	h	h	h	h	m	h	h	h	h
219	h	m	h	m	m	h	h	l	l	m	h	m
220	h	m	h	h	h	h	h	m	h	h	h	h
221	h	m	m	l	h	h	m	m	m	l	h	h
222	m	m	h	h	m	h	h	m	m	h	h	m
223	h	l	h	h	m	h	h	h	h	h	h	h
224	h	h	l	h	h	h	h	l	m	l	h	h
225	h	m	h	h	m	h	h	l	m	h	h	h
226	h	m	h	h	l	h	h	l	l	l	h	h
227	h	h	h	h	h	h	m	m	l	m	h	h
228	m	h	m	l	m	m	m	h	l	l	h	h
229	m	m	m	m	m	m	h	l	m	h	h	h
230	h	h	h	h	h	h	h	h	h	h	h	h
231	h	h	h	h	h	h	h	h	h	h	h	h
232	h	m	m	h	m	h	m	l	h	l	h	h
233	h	m	m	h	l	h	h	l	l	h	h	h
234	l	m	m	l	m	h	m	h	h	l	h	h
235	h	m	m	m	h	h	h	h	h	h	h	h
236	m	h	h	h	h	h	h	l	h	h	h	h

USERID	***Q13***	***Q14***	***Q15***	***Q16***	***Q17***	***Q18***	***Q19***	***Q20***	***Q21***	***Q22***	***Q23***	***Q24***
237	m	l	h	h	m	m	m	l	m	h	h	m
238	h	l	m	m	l	h	m	l	l	m	h	h
239	h	h	l	l	l	h	l	l	m	m	h	l
240	h	h	h	h	h	m	m	m	h	m	h	h
241	l	h	h	h	h	h	h	l	m	l	h	h
242	h	m	l	l	l	l	m	l	l	m	h	m
243	h	h	h	h	h	h	h	h	h	h	h	h
244	h	m	h	h	h	h	h	h	l	l	h	l
245	h	l	m	m	l	h	m	m	h	h	h	h
246	h	l	h	h	h	h	h	l	l	h	h	h
247	h	l	m	m	l	h	m	m	h	h	h	h
248	h	l	m	m	m	m	m	h	m	h	h	h
249	h	h	h	h	h	h	h	h	h	h	h	h
250	h	m	h	h	l	m	m	l	h	h	h	h
251	h	m	m	l	h	h	m	l	m	l	h	h
252	h	h	h	l	m	m	m	m	m	h	h	h
253	h	l	l	l	h	h	h	h	h	h	h	h
254	h	l	h	h	h	h	h	h	h	h	h	h
255	h	m	l	h	h	m	h	m	m	m	h	m
256	h	h	h	h	h	h	h	h	h	h	h	h
257	h	m	h	h	m	h	m	l	l	l	m	l
258	h	h	h	h	h	h	h	l	m	m	h	h
259	h	m	h	h	h	h	h	m	h	m	h	m
260	h	m	h	h	m	h	m	m	m	m	m	m
261	m	l	m	m	h	m	h	l	m	m	h	l
262	h	h	h	h	h	h	h	m	l	h	h	h
263	h	h	h	h	h	m	h	l	m	h	m	h
264	h	h	h	h	h	h	h	m	h	h	m	h
266	h	h	h	h	h	m	h	h	h	h	h	h
267	m	m	l	l	l	h	m	l	h	h	h	h
268	m	l	h	h	h	h	m	l	l	l	h	m
269	m	m	l	l	m	m	h	l	l	l	h	h
270	h	m	h	m	l	h	h	m	h	m	h	h
271	h	h	h	h	h	h	h	h	h	h	h	h
272	h	h	h	h	h	h	h	h	h	h	h	h
273	h	m	h	h	h	h	h	h	h	h	h	h
274	h	m	m	m	h	h	h	l	h	h	h	l
275	h	m	l	m	l	h	m	m	m	h	h	h
277	h	l	l	l	h	h	h	h	l	l	h	m
278	h	l	h	h	h	h	m	l	m	h	h	m
279	h	m	l	l	l	m	l	l	m	l	m	l
280	m	m	h	h	h	l	m	l	m	l	h	m
281	m	m	h	h	m	m	h	m	m	m	h	m
283	h	h	h	h	h	h	h	h	h	h	h	h
284	h	h	h	h	h	h	h	l	l	l	h	l
285	h	m	m	m	h	h	h	h	h	m	h	m
287	l	h	h	h	h	h	h	l	h	h	h	h

USERID	*Q13*	*Q14*	*Q15*	*Q16*	*Q17*	*Q18*	*Q19*	*Q20*	*Q21*	*Q22*	*Q23*	*Q24*
288	h	h	h	h	h	h	h	h	h	h	h	h
289	h	m	m	l	l	l	h	m	h	h	h	h
290	h	h	h	h	m	l	h	l	l	h	h	h
291	h	m	h	h	h	h	h	m	h	l	m	m
292	m	h	h	h	h	h	h	m	h	h	h	h
293	m	m	h	h	h	l	m	l	m	m	m	h
294	m	m	m	h	m	l	l	l	h	m	h	h
295	h	h	h	h	l	h	h	m	h	h	h	h
296	h	l	l	m	h	h	h	m	m	l	h	m
297	h	m	h	h	l	h	h	h	m	h	h	h
298	l	l	h	h	h	m	l	l	l	l	m	m
299	h	m	l	h	m	l	m	l	m	h	h	h
300	m	m	h	h	m	m	m	h	m	m	h	m
301	h	l	h	h	l	h	h	h	h	h	h	h
302	l	m	m	m	l	l	h	l	l	h	h	h
303	m	m	h	h	h	l	h	h	h	h	h	h
304	h	h	h	h	h	h	h	h	h	h	h	h
305	h	m	h	h	h	h	h	m	m	m	h	m
306	h	m	m	h	h	h	h	m	h	h	h	m
307	h	m	h	h	h	h	h	h	h	h	h	h
308	l	m	h	h	h	h	h	m	m	l	h	m
309	h	m	h	h	m	m	m	l	m	h	h	h
310	h	h	h	h	h	h	h	h	h	h	h	h
311	m	h	h	h	h	h	h	m	l	l	h	l
312	l	m	m	m	m	m	l	l	h	l	h	l
313	m	m	h	h	h	m	h	m	m	m	h	h
314	h	m	h	h	h	h	h	m	m	h	h	m
315	l	h	h	h	h	m	l	m	l	l	m	m
316	m	l	m	m	l	m	h	l	m	l	h	h
317	m	m	h	h	h	h	h	l	h	m	h	h
318	m	h	h	h	h	h	h	l	m	m	h	h
319	h	h	h	h	h	h	h	m	h	h	h	h
320	l	m	m	h	h	m	m	l	m	m	h	h
321	h	m	h	h	h	h	h	l	m	h	h	h
322	h	m	h	h	h	l	h	m	h	h	h	h
323	h	h	h	h	h	h	h	h	h	h	h	h
324	h	h	h	h	h	h	h	m	h	h	h	h
325	h	h	h	h	h	h	h	h	h	h	h	h
326	h	m	h	h	h	m	h	m	m	h	h	h
327	h	h	h	h	h	h	h	l	h	h	h	h
328	m	h	h	h	h	h	h	m	h	m	h	l
329	h	h	h	h	h	h	h	h	h	h	h	h
330	l	h	h	h	h	l	m	m	l	m	m	l
331	h	l	l	l	l	m	h	h	h	l	h	h
332	h	l	l	l	l	m	h	h	h	l	h	h

SURVEY QUESTIONS 25-36

USERID	***Q25***	***Q26***	***Q27***	***Q28***	***Q29***	***Q30***	***Q31***	***Q32***	***Q33***	***Q34***	***Q35***	***Q36***
41	h	h	6	4	1	yes	no	1	h	m	h	h
42	h	h	11	4	9	no	yes	6	h	h	h	l
44	h	h	11	1	0	no	yes	6	h	h	h	h
45	h	h	11	1	9	no	yes	6	h	h	h	h
46	h	m	6	4	9	no	yes	1	h	h	h	l
47	m	h	6	1	5	yes	yes	11	m	m	m	h
49	h	h	11	1	0	no	yes	1	h	h	h	h
50	h	h	11	1	5	no	yes	20	h	h	h	m
51	m	h	6	1	9	no	yes	16	h	h	h	l
52	h	h	11	1	9	yes	yes	16	h	l	l	l
53	m	h	6	4	5	yes	yes	20	h	h	h	l
54	l	m	11	1	1	yes	yes	1	h	l	l	l
55	h	m	11	1	9	yes	yes	20	h	m	l	h
56	l	h	11	1	5	no	yes	20	l	l	m	m
57	l	l	12	7	9	no	no	11	m	m	m	l
58	h	h	11	1	0	yes	yes	1	h	h	h	h
59	h	h	11	1	5	no	yes	11	l	m	l	l
60	h	h	11	1	9	no	yes	11	l	m	l	l
61	l	l	12	7	5	no	yes	20	l	l	l	l
62	h	h	6	1	9	no	yes	20	h	h	l	l
63	h	h	11	1	0	yes	yes	20	l	m	m	l
64	m	m	11	4	5	yes	no	1	m	m	m	m
65	l	l	6	1	5	yes	yes	1	h	h	h	h
67	h	h	11	4	9	yes	yes	1	h	l	h	h
68	h	m	6	1	9	no	yes	20	m	l	l	m
69	h	h	11	1	9	yes	yes	20	h	l	l	l
70	h	m	11	1	1	yes	yes	11	h	m	m	m
71	m	h	6	1	5	yes	yes	6	l	m	h	l
72	h	h	11	4	9	yes	yes	20	h	h	h	h
73	m	m	11	1	0	yes	no	11	m	m	m	m
74	h	h	11	1	1	no	yes	16	h	h	h	h
75	m	m	11	1	0	yes	yes	1	h	h	h	h
76	m	h	11	4	5	no	no	1	m	h	l	l
77	h	h	6	1	1	no	yes	20	h	h	h	h
78	h	h	11	1	0	yes	yes	1	h	h	h	h
79	h	h	11	1	0	yes	yes	1	h	h	h	h
80	h	h	6	4	9	yes	no	16	h	h	h	h
81	h	h	11	1	5	no	no	6	h	m	h	l
82	h	h	11	4	0	yes	no	1	h	h	h	h
83	h	l	11	1	1	no	yes	6	h	l	h	l
84	m	h	11	1	9	yes	no	20	m	l	m	l
85	h	h	11	4	1	no	yes	20	h	l	m	m
86	h	h	6	1	5	no	no	1	h	m	h	l
87	h	h	11	1	1	no	no	1	m	l	l	h

USERID	***Q25***	***Q26***	***Q27***	***Q28***	***Q29***	***Q30***	***Q31***	***Q32***	***Q33***	***Q34***	***Q35***	***Q36***
89	h	h	11	1	0	yes	yes	1	h	h	h	h
90	m	h	6	1	5	no	yes	16	m	h	m	h
91	h	h	11	1	1	yes	yes	20	h	h	h	h
92	h	h	11	1	1	yes	no	1	h	h	m	m
93	h	h	11	1	5	yes	yes	20	h	h	h	h
94	h	h	11	1	1	yes	yes	1	m	m	m	l
95	h	h	11	1	0	yes	yes	1	h	h	h	h
96	l	l	11	1	1	no	no	1	l	l	l	l
97	h	h	11	1	5	no	yes	1	h	h	h	h
98	h	l	6	1	9	no	yes	20	h	l	l	l
99	h	m	11	1	9	no	yes	16	m	m	l	l
100	m	h	11	1	1	no	no	1	h	m	h	h
102	h	h	11	1	1	no	yes	6	h	h	h	h
103	h	h	11	4	5	yes	yes	20	h	h	h	h
104	h	h	11	1	0	yes	yes	20	h	h	h	h
105	l	m	6	4	1	yes	yes	6	m	m	l	l
106	h	h	11	1	1	no	yes	20	h	h	h	h
107	h	m	11	1	1	no	yes	20	h	l	h	h
108	h	h	11	1	0	yes	yes	6	l	m	m	m
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110	h	m	11	1	1	no	yes	20	h	m	m	l
111	h	h	6	4	5	yes	yes	11	h	h	h	m
112	h	h	11	1	0	yes	yes	1	h	h	h	h
113	m	h	11	1	5	yes	yes	11	l	h	h	l
114	h	h	11	4	1	yes	yes	20	h	h	h	h
117	h	h	11	1	9	yes	yes	20	l	h	m	l
118	l	m	11	1	9	no	no	1	m	h	l	m
119	h	h	11	1	5	yes	yes	1	h	h	h	h
120	h	h	11	1	1	no	yes	11	h	h	h	h
121	h	h	11	1	5	no	no	20	h	h	h	h
122	h	h	6	1	5	no	yes	11	h	h	h	h
123	h	h	11	1	0	yes	yes	6	h	h	h	h
124	h	h	11	1	1	yes	yes	20	h	h	h	h
125	h	h	11	1	5	yes	yes	11	l	h	m	h
126	h	h	6	1	9	no	no	1	h	h	h	h
127	h	h	11	1	5	yes	yes	6	h	m	h	m
128	h	h	11	1	0	no	no	1	m	m	m	l
129	h	h	11	1	1	no	yes	20	l	l	m	l
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132	h	h	11	1	0	yes	yes	1	h	h	h	h
133	h	h	11	1	0	yes	yes	1	h	h	h	h
134	h	h	11	1	0	yes	yes	1	h	h	h	h
135	h	h	11	1	9	no	yes	16	l	m	h	m
136	h	h	11	1	0	yes	yes	1	h	h	h	h
137	h	h	6	1	5	yes	yes	20	h	h	h	m
138	h	h	6	1	1	yes	yes	20	l	l	h	h

USERID	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
140	h	h	11	1	9	yes	yes	6	h	h	h	h
141	h	h	6	1	1	yes	yes	20	h	m	h	m
142	h	h	11	1	0	yes	yes	1	h	h	h	h
143	h	h	11	1	9	no	yes	1	h	h	h	h
144	h	h	11	1	1	no	yes	20	h	h	h	l
145	h	h	11	1	1	yes	yes	6	h	h	h	h
146	m	l	11	1	1	no	yes	11	l	l	l	l
147	h	h	11	1	0	yes	yes	1	h	h	h	h
148	m	m	11	1	5	yes	no	1	h	h	h	m
149	l	m	11	1	9	yes	no	16	h	h	m	l
152	h	h	11	1	5	no	yes	20	h	h	h	h
153	h	h	11	1	1	yes	yes	20	h	h	h	h
154	h	h	11	1	0	yes	yes	1	h	h	h	h
155	h	m	11	1	5	yes	yes	1	l	m	h	m
156	h	h	11	1	0	yes	yes	1	h	h	h	h
157	l	l	11	1	5	yes	no	1	l	l	l	l
158	m	m	11	1	9	yes	yes	20	l	l	l	l
159	h	h	11	4	9	yes	no	20	h	h	h	h
160	l	l	6	1	0	yes	no	1	l	l	l	l
161	h	h	6	4	5	yes	yes	11	l	m	h	l
162	h	h	11	1	0	yes	yes	1	h	h	h	h
163	h	h	11	1	5	no	yes	20	h	h	h	h
164	h	h	6	4	5	no	yes	11	l	m	h	l
165	h	h	6	1	5	yes	yes	20	h	h	h	h
166	h	h	11	1	1	no	yes	20	h	h	h	h
167	h	h	11	1	0	yes	no	6	m	m	m	m
168	h	h	11	1	1	yes	yes	1	h	h	h	h
169	h	h	6	1	1	yes	yes	16	l	l	m	h
170	h	h	11	4	5	yes	no	16	l	m	h	h
171	h	h	11	1	5	yes	yes	1	h	h	h	h
172	h	h	11	4	1	yes	no	20	h	h	h	m
174	h	h	11	1	5	yes	yes	6	l	m	l	l
175	h	h	11	1	5	yes	yes	6	l	m	h	m
176	h	h	11	1	0	yes	yes	1	h	h	h	h
177	h	h	11	1	1	yes	no	20	h	h	h	h
178	h	m	11	1	9	no	yes	11	l	m	m	m
179	h	h	6	1	9	no	no	16	h	m	m	h
180	h	h	11	1	5	yes	no	16	h	h	h	h
181	h	h	11	1	9	yes	yes	11	m	m	m	l
182	h	h	11	1	0	yes	yes	1	h	h	h	h
183	h	h	11	1	0	yes	yes	1	h	h	h	h
184	m	h	6	1	5	yes	yes	1	h	h	h	h
185	h	h	11	1	9	no	yes	6	l	l	h	l
186	l	h	11	1	1	yes	yes	1	h	l	l	l
187	h	h	11	1	9	yes	yes	6	m	m	h	h
188	h	h	6	4	5	no	yes	6	h	h	h	m
189	h	h	6	1	5	yes	yes	20	h	h	h	m

USERID	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
190	h	h	6	4	9	yes	yes	20	m	l	l	l
191	h	h	12	1	9	yes	no	20	m	l	h	h
192	h	h	11	1	5	yes	yes	11	h	h	h	h
193	h	m	11	1	1	yes	yes	20	l	l	l	l
194	h	h	11	4	1	yes	no	6	h	h	h	m
195	h	h	11	1	9	no	yes	20	h	m	h	h
196	h	h	11	1	5	yes	yes	11	m	h	h	h
197	h	h	11	1	1	no	yes	1	h	h	h	l
198	m	m	6	4	9	no	yes	20	l	m	m	l
199	h	h	11	1	5	no	yes	16	h	h	l	h
200	h	h	6	1	1	yes	yes	20	l	m	l	l
201	h	h	11	1	1	no	yes	6	h	h	h	l
202	h	h	6	4	9	yes	yes	20	l	l	h	m
203	l	m	11	1	5	no	yes	11	h	h	l	m
204	m	m	11	1	5	no	yes	16	l	l	l	l
205	h	h	6	4	1	yes	no	20	l	h	h	l
206	h	h	11	1	1	no	yes	20	m	m	m	m
207	h	h	11	1	5	yes	yes	16	h	m	l	l
208	h	l	11	1	1	no	yes	20	m	m	h	l
209	h	h	11	1	5	no	yes	20	m	h	m	m
210	h	m	11	1	0	no	no	1	m	m	h	m
211	h	h	11	1	0	yes	yes	1	h	h	h	h
212	h	m	11	1	9	yes	yes	6	h	h	h	h
213	h	h	11	1	9	yes	yes	20	h	h	h	h
214	h	h	11	1	0	yes	yes	1	h	h	h	h
215	h	h	11	1	1	yes	yes	20	m	l	m	l
216	h	h	6	4	1	yes	no	16	h	m	h	l
217	h	h	11	1	9	yes	yes	11	l	l	m	m
218	h	h	11	1	5	no	no	20	h	m	m	l
219	h	h	11	1	1	no	no	1	l	l	l	l
220	h	h	11	1	1	yes	yes	20	h	m	h	m
221	h	m	11	1	0	yes	yes	11	h	l	m	l
222	h	m	11	4	5	no	yes	20	m	l	l	m
223	h	h	11	1	9	yes	yes	1	h	h	h	h
224	h	h	11	1	1	yes	yes	11	h	l	l	h
225	h	h	11	1	1	no	yes	20	h	h	h	l
226	h	h	11	1	1	no	yes	20	m	l	h	l
227	h	h	6	1	9	no	yes	11	l	m	h	h
228	h	m	11	1	0	yes	yes	20	l	l	m	l
229	h	h	12	1	5	yes	yes	6	l	m	m	m
230	h	h	11	1	0	yes	yes	1	h	h	h	h
231	h	h	11	1	0	yes	yes	6	h	h	h	h
232	h	h	11	1	1	yes	yes	20	h	l	l	l
233	h	h	11	1	0	yes	yes	1	m	m	h	h
234	h	h	11	1	9	yes	yes	20	h	l	l	h
235	h	h	6	1	9	no	yes	20	h	m	m	l
236	h	h	11	1	9	yes	yes	20	h	m	h	h

USERID	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
237	m	l	6	4	0	no	yes	11	h	l	h	h
238	h	h	11	4	1	no	yes	20	h	l	l	l
239	l	h	11	1	9	yes	yes	1	l	l	h	l
240	h	h	11	1	5	no	yes	20	h	h	h	h
241	l	h	6	1	9	no	yes	20	l	m	h	l
242	m	l	11	4	9	yes	yes	16	l	m	h	l
243	h	h	11	1	0	yes	yes	1	h	h	h	h
244	l	h	6	4	9				l	l	l	l
245	h	h	11	1	9	no	yes	1	h	h	h	h
246	h	h	11	1	0	yes	yes	16	m	m	m	m
247	h	h	11	1	9	no	yes	1	h	h	h	h
248	h	h	11	1	5	yes	yes	20	h	h	h	h
249	h	h	11	1	0	yes	yes	1	h	h	h	h
250	h	h	6	1	9	yes	yes		l	m	h	m
251	h	h	11	1	1	no	yes	20	l	h	l	l
252	h	h	11	1	0	yes	yes	6	m	h	h	h
253	h	h	11	1	9	no	no	20	h	l	l	l
254	h	h	11	1	9	yes	yes	20	h	h	h	m
255	h	h	11	4	1	no	yes	11	l	h	h	l
256	h	h	11	1	0	yes	yes	1	h	h	h	h
257	l	h	11	1	1	no	yes	20	l	l	l	l
258	h	h	6	1	9	yes	yes	1	m	l	h	l
259	m	h	11	1	0	yes	yes	1	h	h	h	h
260	m	m	11	1	5	no	yes	20	m	h	m	m
261	l	l	11	1	1	yes	yes	20	l	l	l	l
262	h	h	11	1	9	yes	yes	6	h	h	h	l
263	m	h	11	4	5	yes	no	20	m	m	h	h
264	h	h	6	1	9	no	yes	1	h	h	h	h
266	h	h	11	1	0	yes	no	1	h	h	h	h
267	h	h	11	1	0	yes	yes	11	l	h	h	l
268	h	h	11	1	5	yes	yes	11	l	l	l	l
269	h	m	6	1	9	no	yes	20	l	l	m	l
270	h	h	11	1	1	yes	yes	20	h	h	h	h
271	h	h	11	1	0	yes	yes	1	h	h	h	h
272	h	h	11	1	0	yes	yes	1	h	h	h	h
273	h	h	11	1	0	yes	yes	20	m	h	h	h
274	h	h	11	1	1	no	yes	20	l	m	l	l
275	h	h	11	4	0	no	no	16	m	m	h	h
277	m	h	11	1	5	yes	yes	16	l	h	l	l
278	h	h	11	1	5	yes	no	1	h	h	h	l
279	l	m	11	1	1	yes	no	16	m	m	h	l
280	h	h	6	4	9	yes	no	16	m	m	m	l
281	h	h	11	4	5	no	no	16	h	m	m	m
283	h	h	11	1	0	yes	yes	1	h	h	h	h
284	l	l	11	1	1	no	yes	16	l	l	l	l
285	h	h	11	1	5	no	no	20	m	m	m	m
287	h	h	11	1	5	no	yes	20	h	h	l	l

USERID	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36
288	h	h	6	1	0	yes	yes	6	h	h	h	h
289	h	m	11	1	9	yes	yes	6	l	h	m	h
290	h	h	11	1	5	yes	yes	16	h	h	h	h
291	h	m	11	1	5	yes	no	11	m	m	m	m
292	h	h	11	1	5	yes	yes	1	h	h	h	h
293	h	h	11	1	5	yes	yes	1	m	m	m	l
294	h	h	11	1	9	yes	yes	11	h	h	h	h
295	h	h	11	1	1	yes	yes	11	h	h	h	h
296	m	m	11	4	1	no	yes	20	m	m	l	l
297	h	h	11	1	1	no	yes	20	l	h	m	m
298	l	l	11	1	1	no	yes	20	l	l	l	l
299	h	h	11	4	9	no	no	20	m	l	l	l
300	m	m	11	1	5	yes	no	20	m	m	m	m
301	h	h	6	1	5	yes	yes	1	h	m	m	h
302	h	m	11	1	5	yes	no	1	l	l	h	m
303	h	h	11	1	5	no	yes	20	h	l	m	l
304	h	h	11	1	9	yes	yes	1	h	h	m	m
305	m	h	11	4	9	yes	no	20	m	m	m	m
306	m	m	11	1	9	yes	no	1	h	l	h	h
307	h	h	11	1	5	yes	no	1	h	h	h	h
308	h	h	6	1	12	yes	no	6				m
309	h	h	1	1	9	yes	yes	11				l
310	h	h	1	1	0	yes	yes	1				h
311	l	l	1	1	5	no	yes	20				h
312	l	h	1	1	12	yes	no	6				m
313	h	h	1	1	0	no	yes	6				m
314	h	h	1	1	12	no	yes	1				m
315	h	h	1	1	5	no	yes					h
316	h	h	6	4	5	yes	no	6				m
317	h	h	1	1	12	yes	no	16				l
318	h	h	1	1	12	yes	yes	16				m
319	h	h	1	1	12	yes	yes	11				m
320	h	l	1	4	12	yes	yes	20				l
321	h	h	6	4	5	no	yes	6				m
322	h	h	1	1	9	yes	yes	16				m
323	h	h	1	1	0	yes	yes	1				h
324	h	h	1	1	9	yes	no	11				h
325	h	h	1	1	0	yes	yes	1				h
326	h	h	1	4	5	yes	no	11				h
327	h	h	1	1	0	yes	yes	1				h
328	m	h	1	1	12	yes	no	6				h
329	h	h	1	1	0	yes	yes	1				h
330	h	h	1	4	5	no	yes	1				l
331	h	h	1	1	5	yes	yes	1				h
332	h	h	1	1	5	yes	yes	1				h

APPENDIX D. BUMED DRAFT INSTRUCTION ON PERSONAL DIGITAL ASSISTANT GUIDANCE

BUMEDINST 5230.XX
BUMED-09D

BUMED INSTRUCTION 5230.XX

From: Chief, Bureau of Medicine and Surgery

Subj: USE OF PERSONAL DIGITAL ASSISTANTS (PDAS)

Ref: (a) FLTINFOWARCEN 131301Z JUL 00
(b) SECDEF memo of 14 Jul 00
(c) DON CIO memo of 8 Aug 00
(d) CNO WASHINGTON 272200Z APR 01
(e) Privacy Act of 1974
(f) Public Law 104-191; Health Insurance Portability and Accountability Act (HIPPA)

Encl: (1) Personal Digital Assistant (PDA) Use Agreement

1. Purpose. To promulgate policy on the use of PDAs and associated personal computing devices that connect to network automated information systems (AIS) in accordance with references (a) through (f).

2. Scope. This policy applies to Claimancy 18 personnel, including contractors, who operate PDAs connected to:

a. Bureau of Medicine and Surgery (BUMED) network.

b. Naval Medical Information Management Center (NMIMC) network.

c. Personal computers used within Claimancy 18.

d. Other network-connected AIS within the Claimancy.

3. Background

a. There are two basic classes of PDAs: those using the Palm Operating System (Palm Pilots, Handspring Visor, etc.); and those running Windows CE and Pocket PC (Compaq, HP Jornada, Casio, etc.). PDAs can have a wide variety of accessories, including modems, synchronization cables, wireless connections, and flash memory storage.

b. Both the Palm OS and Windows CE operating systems have software libraries with applications being developed and distributed through both the commercial and freeware/ shareware channels. As with any software developed by non-governmental/non-trusted sources, there is the possibility that some programs may contain Trojan Horse code, i.e., code hidden within an application without the user's knowledge.

c. Reference (a) discusses security considerations that should be implemented prior to the use of PDAs. Reference (b) addresses the use and protection of personal computing devices. Reference (c) addresses the need for activities to review their policies and procedures for protecting and accounting for portable computing devices, particularly those devices used to process or store classified information. Reference (d) provides guidance for use of portable electronic devices in the Navy.

d. PDAs are another storage medium like hard drives, diskettes, and paper records. When these media contain sensitive but unclassified patient-related data, they must be safeguarded against unauthorized disclosure, modification, or destruction in accordance with reference (e), the Privacy Act of 1974, which addresses the establishment of any Federal Agency national data bank that combines, merges, or links computerized information on individuals maintained in systems of record. In addition, reference (f), the HIPPA of 1996, established standards and requirements for the electronic transmission of health information.

e. Other vulnerabilities may exist when using PDAs attached to personal computers or other network connected AIS. The main risks associated with this usage are:

(1) A well-written Trojan Horse program could, among things, install a backdoor on host networks to permit hacker exploitation.

(2) A wireless palm connection can be used to transmit and receive data to and from a personal computer (PC) without the knowledge or permission of the user.

(3) Antivirus products for handheld and mobile devices are not as well developed as PC antivirus software because the use of PDAs has only recently become routine.

(4) Unlike desktop PCs, PDA operating systems do not limit malicious code from modifying system files.

(5) A PDA utilizes infrared transport technology, which allows users to transmit data to other PDA’S, thus circumventing Information Technology (IT) and physical security processes of an activity.

4. Policy

a. PDAs have the potential to provide business process improvements through the elimination of double entries of information ordinarily shared between PCs and PDAs. Designated Approval Authorities (DAAs), normally Commanding Officer of an activity, may authorize the use of PDAs and the connection of PDAs to networked PCs if technical personnel review the vulnerabilities in paragraph 3, address the vulnerabilities that can be eliminated or mitigated, and list the risks and mitigation strategies associated with the remaining vulnerabilities. The DAA may then elect to accept the vulnerabilities and authorize the use of PDAs.

b. Claimancy 18 commands will approve in writing the use of PDAs before they are connected to BUMED/NMIMC resources (computers, printers, monitors or the network).

c. Prospective PDA users will sign an agreement similar to enclosure (1).

d. It is strongly recommended that the following security measures be adopted for the use of PDAs that synchronize with computers on BUMED/NMIMC and all Claimancy 18 networks:

(1) Use only government and commercially-produced applications or applications developed by trusted sources.

(2) A PDA may not be used to enter passwords, combinations, PINs or classified information.

(3) In regards to PDA remote connectivity features:

(a) Allow no upload/download via wireless or infrared, while connected to a desktop PC, particularly a networked PC.

(b) Use infrared only for authorized Palm to Palm data transfers.

(4) PDAs can be used to carry data from a desktop workstation. This includes carrying schedules, contact information, notes, e-mail and other items from Microsoft Outlook.

(5) PDAs can be used to take notes, save information or write e-mails while away from a desktop PC, whether down the hall or out of the country.

(6) PDAs can be used to synchronize information with your desktop workstation using direct-connect cables or via an authorized infrared port..

(7) PDAs will not be used with commercial Internet Service Providers.

(8) PDAs will not be used with modems to exchange information with your desktop or other systems on the network.

(9) PDAs can connect to synchronize files between an authorized PDA and the designated PC or designated infrared port specified in enclosure (1). PDAs will not be used to synchronize files or devices across the network; All network synchronization features will be disabled before connecting to the network.

(10) PDAs may not be used to arbitrarily download and load freeware or shareware software or enhancements. Such software is from untrusted sources and may contain malicious code.

(11) PDAs will not be left unattended when attached to a computer.

(12) PDAs will be secured when not in use.

(13) Command issued PDAs will only be used for official government business.

(14) Use of personally owned PDAs is discouraged, but may be approved by the local Designated Approval Authority (DAA) on a case-by-case basis.

e. All personally owned PDAs will conform to this policy. Failure to comply with this policy will result in loss of PDA use privileges.

5. Action. Chief Information Officers (CIOs) will ensure that the provisions of this instruction, and related guidance, are adhered to. This is rapidly developing technology with great potential to improve business efficiency, but with an equally great potential to endanger the privacy of patient data. Authorization to use PDAs in Claimancy 18 activities is not a privilege to be taken lightly.

Distribution:
All Internal BUMED Codes
SNDL, C28G (BRDENCLINIC, LANT)
C28H (BRMEDCLINIC, LANT)
C31D (BRDENCLINIC, PAC)
C31J (BRMEDCLINIC, PAC)
C31K (MEDADMINU, PAC)
C34F (BRMEDCLINIC, EUR)
C34G (BRDENCLINIC, EUR)
C52 (SHORE BASED DETS, BUMED)
C58A (BRDENCLINIC, CNET)
C85A (BRMEDCLINIC, NAVDIS)
FA4 (AMBCARECEN, LANTFLT)

Distribution (continued):

FA40 (NAVHLTHCARE)
FA47 (HOSP/MEDCEN, LANT)
FA48 (DENCEN, LANT)
FB58 (HOSP/MEDCEN, LANT)
SNDL, FB59 (DENCEN, PAC)
FB60 (MEDCLINIC, PAC)
FB9 (AMBCARECEN, PACFLT)
FC16 (MEDCLINIC, EUR)
FC17 (HOSPITAL, EUR)
FC18 (DENCEN, EUR)
FF72 (MEDCLINIC, NAVAL ACADEMY)
FG15 (NAVENPVNTMEDU)
FH16 (DISVECTECOLCONCEN)
FH2 (FLEHOSPSUPPOFF)
FH20 (NAVHLTHRSCHCEN0
FH21 (NAVOPTHALSUPPTRACT)
FH22 (NAVDENTALRSCHINSTITUTE)
FH24 (NAVMEDINFOMGMTCEN)
FH26 (NAVENVIRHLTHCEN)
FH33 (NAVDRUGLAB)
FH35 (FLEHOSPOTC)
FH36 (NAVHLTHCARESUPPO)
FH38 (MILMEDSUPPOFF)
FH4 (NAVMEDLOGCOM)
FH5 (LABORATORY, MEDICAL)
FH6 (NAVMEDRSCHCEN)
FH8 (NAVMEDRSCHU)
FT108 (HOSPITAL, CNET)
FT109 (DENCEN, CNET)
FT4 (AMBCARECEN, CNET)
FW1 (NATNAVMEDCEN)
FW2 (NATNAVDENCEN)
FW4 (NAVMEDCLINIC, NDW)

PERSONAL DIGITAL ASSISTANTS (PDA) CERTIFICATION/ACCREDITATION WORKSHEET

PDA Information

1. Manufacturer:______________________ Model:______________ Serial Number:_____________________________________
2. Software Installed on PDA:____
3. Department where PDA will be located/used:____
4. Navy Property Account Number of CPU or designated server on which PDA software will be installed:_____________________

PDA Policy

1. Personal Digital Assistants:
   a. will be secured when not in use.
   b. will only be connected to the Command Information System listed above.
   c. will conform to approved DOD standards of operation for Information Systems.
   d. may be used to carry information from a desktop workstation, including schedules, contact information, notes, and e-mail items from Microsoft Outlook.
   e. may be used to take notes, save information or write e-mails while away from PDA user's desk.
   f. may be used to synchronize information with PDA user's desktop workstation using direct connect cables or via an authorized infrared port.

2. Personal Digital Assistants will NOT be:
   a. used to process or store classified information.
   b. connected to any classified Information System or network.
   c. used to connect to commercial Internet Service Providers.
   d. used with modems to exchange information with PDA user's desktop or other systems on the network.
   e. used to synchronize any equipment features or devices across any network.
   f. used to download and install freeware or shareware software enhancements to PDAs. Such software is from untrusted sources and may contain malicious code.
   g. left unattended while attached to a government Information System.

3. Please contact your Information Systems Security Manager (ISSM) if you have any questions or concerns regarding this policy.

PDA Use Agreement

1. I have read and understand the security guidelines in Personal Digital Assistant (PDA) use Policy. I further understand the necessity for safeguarding my personal data assistant and recognize the requirement for maintaining confidentiality of all data stored in it.

2. I agree to abide by the strict policy outlined above and understand that failure to comply will result in the loss of my PDA use privilege.

ISSM Information	USER Information
Date:_____________________________	**Date:**_____________________________
Name:_____________________________	**Name:**_____________________________
Title:_____________________________	**Title:**_____________________________
Signature:_________________________	**Signature:**_________________________

Remember that your Personal Digital Assistant (PDA) is for **OFFICIAL USE ONLY.** If you are using personal owned PDA that has been approved by your Command for use at work, the Command and BUMED/NMIMC are not responsible for theft, inappropriate use, and hardware or software failures of that PDA or any other incidental loss. All users of personal owned PDAs must follow all of the command's guidelines.

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   Washington, D.C.
   higdon.Freda@hq.navy.mil

4. Commanding Officer (RADM Kathleen Martin)
   National Naval Medical Center
   Bethesda, MD
   klmartin@bethesda.med.navy.mil

5. Service Line Leader, Information Technology Services (CDR Maria Horton)
   National Naval Medical Center
   Bethesda, MD
   mchorton@bethesda.med.navy.mil

6. Commanding Officer (RADM Clinton Adams)
   Naval Medical Center Portsmouth
   Portsmouth, VA
   pwpruden@mar.med.navy.mil

7. Head, Management Information Department (LT James Martin)
   Naval Medical Center Portsmouth
   Portsmouth, VA
   jlmartin@mar.med.navy.mil

8. Commanding Officer (RADM Alberto Diaz Jr.)
   Naval Medical Center San Diego
   San Diego, CA
   adiaz@nmcsd.med.navy.mil

9. Head, Information Technology Services (LT Richard White)
   Naval Medical Center San Diego
   San Diego, CA
   rdwhite@nmcsd.med.navy.mil

10. Commanding Officer (CAPT Nicholas Yamodis)
Naval Medical Information Management Center
Bethesda, MD
NDYamodis@us.med.navy.mil

11. Security Manager (ENS Steve Reinkemeyer)
Naval Medical Information Management Center
Bethesda, MD
spreinkemeyer@us.med.navy.mil

12. Fleet Liaison (Mr. Frank Bunn)
Naval Medical Information Management Center
Bethesda, MD
fjbunn@us.med.navy.mil

13. Commanding Officer (CAPT David Wade)
Naval School of Health Sciences
Bethesda, MD
Dswade@nsh10.med.navy.mil

14. Commanding Officer (Major General Nancy R. Adams)
Tripler Army Medical Center
Honolulu, HI
nancy.adams@amedd.army.mil

15. Commanding Officer (Major General Rodgers P. Lee)
Wilford Hall Medical Center
Lackland, TX
sqmdw.cce@sqmdw.whmc.af.mil

16. Commanding Officer (Brigadier General Joseph E. Kelley)
Wright-Patterson Medical Center
Dayton, OH
joseph.kelley@wpafb.af.mil

17. Commanding Officer (Col Virgil T. Deal)
Madigan Army Medical Center
Tahoma, WA
virgil.deal@nw.amedd.army.mil

18. Space and Naval Warfare Systems Center (Mr. Robert Bodden)
Medical/Dental Programs Office
San Diego, CA
samswest@scn.spawar.navy.mil

19. Space and Naval Warfare Systems Center (LT Michael Bowers)
Medical/Dental Programs Office
Chesapeake, VA
samseast@scn.spawar.navy.mil

20. Bureau of Medicine and Surgery, MED-26 (CAPT Richard Hibbs Jr.)
Code 26P, Bldg 7
Washington, DC
HibbsR@nmrc.navy.mil

21. Major Anthony Inae
Office of the Assistant Secretary of Defense (Health affairs)
Tricare Management Activity, Information Management
Falls Church, VA
anthony.inae@tma.osd.mil

22. Professor Carl R. Jones
Naval Postgraduate School
Monterey, CA
crjones@nps.navy.mil

23. Professor Donald P. Brutzman
Naval Postgraduate School
Monterey, CA
brutzman@nps.navy.mil

24. Lieutenant Commander Raymond Buettner
Naval Postgraduate School
Monterey, CA
rbutten@nps.navy.mil

25. Juliette Clark
Electronic Data Systems, Business Development, EDS Federal Government Unit
Falls Church, VA
juliette.clark@eds.com

26. David Hogland
Symbol Technologies, Inc.
Rancho Santa Margarita, CA
hoglundd@symbol.com

27. Ross Wilson
Symbol Technologies, Inc.
Temecula, CA
wilsonr@symbol.com

28. John Hurst
Handspring, Inc.
Lindon, UT
jhurst@handspring.com

29. Mike Ryan
Compaq Computer Corporation, Marketing Manager – West, CCM3-1844, 20555 SH 249
Houston, TX
mike.ryan@compaq.com

30. Edward Agis/Donna Atkins
Xircom
Thousand Oaks, CA
ed.agis@us.xircom.com
Donna.Atkins@intel.com

31. Major Jeffery Owen
Theater Medical Information Program (TMIP PMO, 311th HSW/YAMT
Brooks Air Force Base, TX
jeffry.owen@brooks.af.mil

32. CDR Julie Clark
CHCS II Program Office
Falls Church, VA
Julie.clark@ha.osd.mil

33. CDR Lyn Hurd
Tri-Service Infrastructure Management Program Office (TIMPO)
Falls Church, VA
Lyn.hurd@tma.osd.mil

34. Dr. Rufus Sessions
Telemedicine and Advanced Technology Research Center (TATRC)
Falls Church, VA
sessions@tatrc.org

35. Danielle Kuska
Space and Naval Warfare Systems Command (SPAWAR) – Research Grants
Monterey, CA
dkuska@nps.navy.mil