

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing this collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Department of Defense, Washington Headquarters Services, Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. **PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.**

1. REPORT DATE (DD-MM-YYYY) 23-10-2007		2. REPORT TYPE FINAL REPORT		3. DATES COVERED (From - To) July 2006 to October 2007	
4. TITLE AND SUBTITLE A Case Study of the Implementation of Radio Frequency Identification Asset Visibility Tracking at Walter Reed Army Medical Center				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S) Morrison, James, A., MAJ, MS				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Walter Reed Army Medical Center 6900 Georgia Avenue, N.W. Washington, D.C. 20307-5001				8. PERFORMING ORGANIZATION REPORT	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) US Army Medical Department Center and School BLDG 2841 MCCS-HFB (Army-Baylor Program in Health and Business Administration) 3151 Scott Road, Suite 1411 Fort Sam Houston, TX 78234-6135				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S) 9-07	
12. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited					
13. SUPPLEMENTARY NOTES: None					
14. ABSTRACT This case study analyzes the decision to implement radio frequency identification (RFID) asset tracking at Walter Reed Army Medical Center (WRAMC). The study examines the existing RFID asset tracking systems at Womack Army Medical Center (WAMC) and the Lahey Clinic in Massachusetts to determine RFID's impact on property maintenance, management, and accountability. The study identifies best business practices learned from the implementation of RFID at these institutions. Additionally, the study examines methods of determining return on investment (ROI) for a RFID system. This study concludes that RFID has shown some success at reducing the effects of missing equipment within the examined facilities. Through the analytic technique of pattern matching, the study identifies four issues as being critical to a successful RFID implementation strategy. Finally, this study determines that there is no common business method or corporate standard of determining ROI for RFID.					
15. SUBJECT TERMS Case Study, Radio Frequency Identification Asset Tracking					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 49	19a. NAME OF RESPONSIBLE PERSON Education Technician
a. REPORT U	b. ABSTRACT U	c. THIS PAGE U			19b. TELEPHONE NUMBER (include area code) (210) 221-6443

Running head: IMPLEMENTATION OF RADIO FREQUENCY IDENTIFICATION

A Case Study of the Implementation of Radio Frequency Identification Asset Visibility Tracking

at Walter Reed Army Medical Center

MAJ James A. Morrison, MS, USA

Army-Baylor University Graduate Program in Health and Business Administration

Walter Reed Army Medical Center, Washington, D.C.

23 October 2007

20080304273

A Graduate Management Project Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Health Administration

Acknowledgements

I would like to take this opportunity to thank the many individuals whose help and assistance made this report possible. First, I would like to extend my sincere appreciation to LTC Robert Griffith, my faculty reader at the Army-Baylor University Graduate Program in Health and Business Administration for his guidance and mentorship over the past two years. His interest in my success and dedication to the program were instrumental and invaluable in the preparation of this report. Next, I would like to thank MAJ Mark Dick, Chief of Material, at Walter Reed Army Medical Center (WRAMC). His idea served as the impetus for this study and without his technical knowledge and guidance, this report would not exist. Also, let me acknowledge the contributions of COL McCreary-Watson, Assistant Chief of Staff for Logistics and Acquisition, North Atlantic Regional Medical Command (NARMC) and Mr. Alphonso Boards, NARMC Medical Maintenance Manager. The access to data and knowledge provided by this staff was invaluable to understanding the issues involved in this document. Next, I would like to thank the clinical, administrative, and logistics staffs at WRAMC, Womack Army Medical Center, and Lahey Clinic for their openness and willingness to answer my questions. Most importantly, I would like to thank my wife, Melissa and our two daughters Autumn, and Emma whose love, support, and understanding over the past two years allowed me to complete this challenging and rewarding program.

Abstract

This case study analyzes the decision to implement radio frequency identification (RFID) asset tracking at Walter Reed Army Medical Center (WRAMC). The study examines the existing RFID asset tracking systems at Womack Army Medical Center (WAMC) and the Lahey Clinic in Massachusetts to determine RFID's impact on property maintenance, management, and accountability. The study identifies best business practices learned from the implementation of RFID at these institutions. Additionally, the study examines methods of determining return on investment (ROI) for a RFID system. This study concludes that RFID has shown some success at reducing the effects of missing equipment within the examined facilities. Through the analytic technique of pattern matching, the study identifies four issues as being critical to a successful RFID implementation strategy. Finally, this study determines that there is no common business method or corporate standard of determining ROI for RFID.

Table of Contents

Acknowledgements.....	ii
Abstract.....	iii
List of Tables.....	v
Introduction.....	1
Overview.....	1
Conditions that Prompted the Study.....	5
Statement of Problem.....	11
Literature Review.....	12
Purpose.....	20
Methods and Procedures.....	20
Case Study Design.....	20
Data Collection Procedures.....	21
Data Analysis Plan.....	23
Outline for the Case Study Report.....	24
Findings.....	24
Data Collection.....	24
RFID's Impact on UL, FLIs, and Scheduled Medical Maintenance.....	25
Lessons Learned from Implementing RFID Asset Tracking.....	31
Return on Investment.....	35
Conclusion and Recommendations.....	37
Conclusion.....	37
Recommendations.....	38
References.....	40

List of Tables

Table 1. WAMC CY 2002 – 2005 Financial Liability Investigations.....	28
Table 2. WAMC FY 2007 Financial Liability Investigations.....	29
Table 3. WAMC % FY 01 Scheduled Service Performance.....	30
Table 4. WAMC % FY 06 Scheduled Service Performance.....	30
Table 5. Critical Implementation Strategies of RFID for Asset Tracking.....	32

A Case Study of the Implementation of Radio Frequency Identification Asset Visibility Tracking
at Walter Reed Army Medical Center

Introduction

Overview

Facility.

Walter Reed Army Medical Center (WRAMC) is a 261-bed tertiary care hospital located in Washington, D.C. It is the largest healthcare facility in the Army and the largest medical center in the Department of Defense's (DOD) military healthcare system. The mission of WRAMC is to provide warrior care. This is done through the hospital's 60 clinics that offer a comprehensive range of primary, specialty, sub-specialty, and complex medical care to its beneficiaries. Those beneficiaries include active duty service members, their families, and military retirees. Because of WRAMC's unique location within the nation's capital, it offers support to Members of Congress, Presidents, Vice Presidents, the Public Health Service, and to foreign dignitaries designated by the State Department (Walter Reed Army Medical Center [WRAMC] Online, 2006).

In addition to providing health care coverage to the metropolitan Washington D.C. area, WRAMC serves as a major referral center for the northeastern United States and Europe, including patients from the Global War on Terrorism serving in the Southwest Asian Theater of Operations. As of April 2007, WRAMC has treated 6,236 patients that have become injured or ill while at war (Walter Reed Battle Casualty Update, 2007). These patients arrive at the hospital through a global armed forces aero medical evacuation network.

The vision of WRAMC is to foster a culture of excellence in quality care, research, training, readiness, safety, service, partnership, and Tri-service collaboration founded on the

example of Major Walter Reed. MAJ Reed was an Army physician who was a pioneer in medical research. Medical research, patient care, medical education and training, and combat medical readiness are the four areas of medicine that the approximately 600 full-time physicians use to accomplish the mission of WRAMC. Walter Reed Army Medical Center is fully accredited by the Joint Commission on Accreditation of Healthcare Organizations (Joint Commission) (WRAMC, 2006a).

Providing medical care at WRAMC is not accomplished without an extensive network of administrative directorates, departments, and support services working in concert with the clinical providers. One such administrative area is the Directorate of Logistics (DOL). The vision of DOL is to lead the DoD as the premier logistics organization for materiel management, clinical engineering, property management, facility management, and environmental services. In doing so, DOL provides logistics readiness for the deployment and redeployment of Army units and the United States Army Medical Command (USAMEDCOM) and serves as an education and training base for military and civilian personnel. DOL is staffed with approximately 475 employees. Primary tasks include the request, issue, storage, receipt, and pinpoint distribution of supplies and services. Inherent in these tasks are the responsibilities for property management, property accountability, and medical equipment maintenance. The services, or branches, that comprise the Clinical Engineering Division (CED) and the Material Division of the DOL perform these functions for WRAMC (MAJ M. Dick, personal communication, October 26, 2006).

Property accountability.

All property procured by the Army, including medical equipment, must be accounted for in accordance with established policies, regulations, and procedures. Army Regulation 710-2

(AR 710-2) defines property accountability as the “obligation to keep records of property, documents, or funds such as identification data, gains, losses, dues-in, dues-out, and balances on hand or in use” (2005, p. 7). The accountability of property extends over the life cycle of the equipment from the time of acquisition to disposal of the material. The primary record utilized for property accountability is the property book. Data obtained from the Property Management Branch at WRAMC indicate that as of November 2006 the value of the Walter Reed property book was in excess of \$136 million (Defense Medical Logistics Standard Support [DMLSS], 2006).

The Property Book Officer is the individual responsible for maintaining the property book. The Property Book Officer delegates responsibility for the proper use, maintenance, and safekeeping of items listed on the Property Book to individual members of the command at WRAMC. These individuals may be either members of the military or civilian government employees. Based upon their position within the command and relationship to the item of equipment, they incur one of the five types of responsibility outlined in AR-735-5 (2005): command responsibility, supervisory responsibility, direct responsibility, personal responsibility, and custodial responsibility. Command and supervisory responsibility are distinctive duties within a designated job or position, such as Commander, Walter Reed Health Care System. These responsibilities are a part of that position and therefore assignment of these responsibilities to other members of WRAMC is not possible. Equipment formally assigned to an individual, through written delegation or hand receipts, incurs direct responsibility. Individuals with direct responsibility have custody of the property but are not necessarily in possession of it. Personal responsibility always accompanies the physical possession of property irrespective of formal receipt for the property. The final type of responsibility, custodial responsibility, exists when an

individual is assigned as a supply sergeant, supply custodian, supply clerk, or warehouse person. Custodial responsibility is the obligation of an individual for property in storage awaiting issue or turn-in to exercise reasonable and prudent actions to properly care for, and ensure proper custody, safekeeping, and disposition of property (AR 735-5, 2005). Property management and accountability are the cornerstones to an effective Command Supply Discipline Program.

Medical maintenance.

In addition to the property management duties, WRAMC DOL supervises and performs the medical equipment maintenance functions for the hospital. These responsibilities encompass the oversight and management of all maintenance activities and include: management of medical equipment repair services, the monitoring of service programs, regulatory compliance, and documentation and reporting of maintenance data (United States Army Medical Command Regulation [MEDCOM Reg] 10-1, 2000). Equipment repair services are based on preventive maintenance checks and services (PMCS). The Army defines PMCS as the “systematic care, servicing, and inspection of medical equipment” (AR 40-61, 2005, p. 35). PMCS applies to all medical equipment used throughout WRAMC.

Along with PMCS, repair services encompass calibration and safety inspections. Certain items, such as x-ray machines, require periodic verification that they are operating in accordance with established performance requirements delineated within maintenance policy or a manufacturer’s publication. The primary method to ensure completion of these calibration and safety checks is the scheduled service. Scheduled services are maintenance inspections performed at periodic intervals based on the item’s applicable technical manual. Maintenance personnel working with the property management personnel identify and track all medical equipment requiring scheduled maintenance services. Currently there are 5,176 items of medical

equipment requiring scheduled medical maintenance at Walter Reed (DMLSS, 2006) The U.S. Army Medical Command, Walter Reed's higher headquarters, has stipulated that the corporate objective is to complete 100% of scheduled maintenance services. MEDCOM has further established a minimum acceptable performance level of 95% completion for equipment requiring calibration, preventive maintenance, or safety tests (Operations Management Bulletin No. 3-02 [OMB 3-02], 2002). Furthermore, the Joint Commission has standards pertaining to medical equipment. These standards, divided into component requirements called elements of performance, provide the guidelines for successful accreditation (Subhan, 2005). Failure to service medical equipment has serious implications for patient safety and could result in adverse findings by the Joint Commission.

Defense Medical Logistics Standard Support.

To assist healthcare personnel across the DOD with medical logistics business practices, the Assistant Secretary of Defense (Health Affairs) along with the Deputy Under Secretary of Defense (Logistics and Materiel Readiness) developed the Defense Medical Logistics Standard Support automated information system. This system standardizes medical logistics practices among the services and is in use at WRAMC by the DOL. DMLSS consists of several applications and modules. Several of these components such as the equipment and technology (E&TM) module and the facility management (FM) module directly support property management, property accountability, and biomedical maintenance (DMLSS Online, 2006).

Conditions that Prompted the Study

The loss, or inability to find, medical equipment potentially has serious implications for patient care at WRAMC. The consequences associated with missing equipment manifest in delinquent scheduled services, inefficient use of personnel, liability investigations, and increased

financial costs to the hospital. In addition, there exists the potential for adverse findings from accrediting organizations. To mitigate these problems, WRAMC decided to purchase a radio frequency identification (RFID) technology solution that assists with medical equipment property management and accountability. This system, utilizing small, lightweight tags affixed to assets moving within a series of sensors, allows personnel to locate medical equipment within a radius of two feet anywhere in the facility.

Providing scheduled maintenance services for medical equipment is a primary function of the Medical Maintenance Branch within the DOL. Scheduled maintenance minimizes equipment repair costs over the long term and ultimately provides optimal safety for the patient. Equipment requiring services ranges from large stationary objects to mobile patient movement items. These patient movement items accompany an individual throughout the hospital making accountability difficult. Some items carry the designation of life support devices. The Joint Commission defines a life support device as “devices intended to sustain life and whose failure to perform their primary function, when used according to the manufacturer’s instructions and clinical protocol, is expected to result in imminent death in the absence of immediate intervention” (“Maintaining Life Support”, 2004, p. 247). All types of items require scheduled maintenance services that include preventive maintenance, electrical safety testing, or calibration, verification, and certification (WRAMC Reg. 750-1, 2005).

The process of identifying and locating medical equipment for scheduled services begins with the property book officer and the DMLSS information system. The property book officer allocates the 5,176 items of medical equipment requiring scheduled servicing to 255 individuals within the hospital. These personnel exercise either supervisory or direct responsibility for the accountability of the property. The document delegating this responsibility is the Department of

the Army Form 2062 (DA 2062) or, as more commonly known, the hand receipt. In addition, the DMLSS Equipment and Technology Management (ET&M) module maintains the maintenance schedule for medical equipment requiring scheduled services. This schedule is entered into DMLSS ET&M upon receipt of the item at WRAMC. The manufacturer's manual or other applicable technical publication determines the maintenance schedule (AR 750-1, 2006). When services are required, DMLSS generates a list of items needing maintenance. The maintenance managers then distribute this list of equipment to the hand receipt holders who have accountability of the property. The hand receipt holder identifies the property and communicates the physical location to biomedical maintenance personnel to ensure services are completed. Items that cannot be located for servicing are identified as medical equipment not located for scheduled services or unable to locate (UL) (OMB 06-05, 2005). According to a 2006 decision brief on asset tracking within WRAMC, UL items are the primary reason the scheduled service completion rate averages only 83%. This is considerably below the 95% minimum acceptable performance level established by MEDCOM (WRAMC Asset Tracking System, 2006b).

In an attempt to locate medical equipment that is delinquent for scheduled services, WRAMC medical maintenance branch personnel conduct monthly physical searches for property. These searches are during non-scheduled work hours and encompass canvassing the facility for UL items. The CED at WRAMC estimates that approximately 125 man-hours per month are applied to locating delinquent or missing equipment (MSG D.Gould, personal communication, October 5, 2006). Considering that the primary responsibility of the hand receipt holder is property accountability, these searches not only place additional burdens on an understaffed biomedical maintenance section, but also lead to an inefficient use of personnel. Following the search, the biomedical maintenance manager communicates any UL items to the

Walter Reed property book officer. In addition, UL items designated as life support equipment are reported to the hospital safety committee (OMB 06-05, 2005).

Upon notification that an item of medical equipment is UL, the property book officer initiates a financial liability investigation (FLI) of property loss. The purpose of the FLI is to document and determine the circumstances surrounding the loss, damage to, or destruction of government property and to determine if assessment of financial liability or relief from financial liability against individuals is warranted. The Commander of the Medical Center Brigade at WRAMC appoints an investigating officer to examine the circumstances and make recommendations to the command concerning the property loss. This individual can either be a military member or government civilian employee. Additionally, the individual must be senior in rank to any individual involved with the investigation that may potentially be subject to any financial liability. The appointment as an investigating officer becomes that person's primary duty until the investigation is completed. Army regulations allow 30 calendar days to complete the investigation (*AR-735-5*, 2005). However, extenuating circumstances such as operational deployments, military reassignments, and other personnel actions often lengthen the process. Data obtained from DMLSS and the FLI register indicates that since October 2005 Walter Reed has initiated 25 investigations for missing equipment. The average time for completion is 347 days (WRAMC Financial Liability Investigations of Property Loss Register, 2006c).

There are two types of costs associated with missing medical equipment. The first is the replacement cost for the item. As of November 2006, the total replacement value for all FLIs associated with missing equipment was \$1.386 million (DMLSS, 2006). This amount does not include short notice purchases of duplicate items whose immediate use is required within the hospital. The second type of cost is lost productivity. Lost productivity results when an

individual is not performing their primary duties, such as searching for missing equipment or performing FLIs.

Additionally, the inability to find medical equipment can potentially result in adverse findings from accrediting organizations. The Joint Commission primarily accredits Walter Reed. The Joint Commission consists of surveyors that are sent to health care organizations to evaluate their practices and facilities. Beginning in January 2006, all Joint Commission surveys are unscheduled and unannounced. If the organization is found in compliance with all Joint Commission standards, it is considered to be accredited. The Joint Commission outlines its standards in chapters consisting of component requirements called elements of performance. According to clinical engineering experts, "elements of performance are specific performance expectations and/or structures or processes that the hospital must have to provide safe high-quality care, treatment, and services" (Subhan, 2005, p.187). The environment of care chapter contains the elements of performance pertaining to medical equipment. This chapter identifies 16 separate elements of performance specifically relevant to property management, property accountability, and medical maintenance. The omission or disregard of one of these items can feasibly result in an adverse non-compliance finding by a Joint Commission survey team (Subhan, 2005).

To reduce the effects of missing items of medical equipment, the Command of Walter Reed in 2006 decided to purchase a radio frequency identification (RFID) asset tracking system. These automation systems utilize radio frequency energy to read information contained on tags affixed to either objects or even people. Typically, a RFID system consists of three components: tags, readers, and a software application. The tags are attached to medical equipment and contain information about that item such as make, model, and serial number. The readers

interrogate the tag and read the information it contains. Because radio frequency energy can pass through solid objects, RFID does not require a direct, unobstructed transmission path between a tag and a reader. Readers can be located throughout the hospital making it possible to locate an item within feet of its actual location in near real time. Information is then transferred to a data management software application for any of a variety of uses including tracking and tracing (“Radio Frequency Identification, Its Potential in Healthcare”, 2005). According to the WRAMC Asset Tracking Device Proof of Concept Business Case Analysis, the projected cost to the facility for implementation was \$940,000 (WRAMC Proof of Concept Business Case Analysis, 2006d).

Any large fiscal expense at WRAMC must take into consideration the recommendations of the 2005 DOD Base Realignment and Closure Committee (BRAC). This committee is part of an ongoing process to reorganize the nation’s military base infrastructure to more efficiently and effectively support the forces, increase operational readiness, and facilitate developing business practices (2005 Base Closure and Realignment Report, 2006a). In an effort to consolidate medical capabilities within the NCA, the committee recommended to the President the realignment of WRAMC. The BRAC defines realignment as “any action that both reduces and relocates functions and civilian personnel positions” (2005 BRAC Definitions Online, 2006b). The actions proposed by the BRAC include the relocating and merging of all sub-specialty and complex care to the National Naval Medical Center in Bethesda, Maryland. This newly merged facility will establish the Walter Reed National Military Medical Center (WRNMMC). Furthermore, all of WRAMC’s primary and specialty care services will relocate to a newly constructed community hospital at Fort Belvoir, Virginia. These actions will close the main hospital and campus of WRAMC by September 2011 and prevent any infrastructure

improvements (2005 Base Closure and Realignment Report, 2006a). The President subsequently approved the recommendations of the BRAC on 15 September 2006 (President's Transmittal Letter to Congress, 2006c).

Statement of Problem

WRAMC personnel are unable to locate items of equipment for property accountability and scheduled maintenance procedures. This has resulted in increased costs to the facility in terms of replacement costs and the inefficient use of the work force. Furthermore, missing medical equipment can potentially affect the accreditation of the hospital. The Joint Commission has outlined stringent requirements associated with property accountability and scheduled medical maintenance. Any deviation away from these standards could result in an adverse finding.

In an effort to reduce the effects associated with missing medical equipment, WRAMC has decided to purchase a RFID asset tracking solution. WRAMC projects several operational benefits from the implementation of this system and its ability to locate medical equipment. Those benefits include: improved accountability of assets, a reduction in purchase costs, improved efficiency and utilization through enhanced property allocation, a reduction in risk and exposure to patients through better management of asset maintenance, and a reduction in time spent looking for assets. Secondary benefits include a reduction in the number of FLIs, and increased productivity for the work force. Hand receipt holders and medical maintenance personnel will be able to identify and locate all items requiring scheduled maintenance services. This includes mobile patient use medical items that have historically been extremely difficult to track and account for. A resulting increase in the scheduled maintenance completion rate will allow WRAMC to attain established corporate and accrediting bodies standards. However, this

near term solution is expensive and the hospital is facing realignment and closure under recommendations of the 2005 DOD BRAC process.

The question this study will address is: How can WRAMC maximize return on investment of a RFID asset tracking system knowing that the facility will close and integrate to the new WRNMMC in 2011? The RFID solution is under time constraints to show return on investment prior to the realignment of WRAMC in 2011 and any large capital expenditure decision must consider the future medical force restructuring in the National Capital Area (NCA).

Literature Review

Radio frequency identification technology has existed for over 50 years. Nagy et al. describe RFID as “an automatic recognition system that uses radio waves to identify and track objects” (2006, p. 61). The British Air Force first used RFID in early identification friend or foe (IFF) systems during World War II to identify friendly aircraft returning from missions (Fanberg, 2004). In the 1960s, commercial applications, such as electronic article surveillance systems were developed to deter theft (Radio Frequency Identification: Its Potential in Healthcare, 2006). During the 1970s and 1980s, commercial farmers, ranchers, and scientists began using RFID technology for animal tracking. The tagging of livestock, pets, laboratory animals, and endangered species for identification purposes inspired Michael Biegel to pursue a design aimed at greatly reducing the size of RFID devices allowing them to be implanted into animals (Troyk, 1999). Biegel’s 1979 patent is considered by many to be the landmark RFID application ultimately leading to today’s implantable microchip called VeriChip (Garfinkel & Rosenberg, 2005).

Retail and public interest in RFID has increased as the technology improves and prices fall. The adoption of RFID in healthcare has been sluggish and currently lags behind manufacturing and retail companies that are creating new uses for RFID and transforming business practices within their industries. The E-Z Pass system in the Northeast improves highway travel on toll roads by allowing customers to speed through tolls and pay with a RFID tag attached to their windshields. Automobile keys are now designed to prevent a car from starting unless the appropriate embedded RFID chip is sensed near the steering column. Security passes that use RFID are authenticating employees' access rights while amusement parks, ski areas, and concerts are tagging their tickets with RFID chips to allow venue entry. Libraries are implementing RFID systems to trace books, reduce inventory times, and prevent theft. A revolution is taking place in supply chain management where RFID is producing efficiencies, enhancing accuracy, and generating a positive return on investment (Federal Trade Commission Report, 2005).

Many large organizations are giving their support for the application of RFID technology. Wal-Mart, the world's largest retailer, mandated that its top 100 suppliers begin using RFID by 2005 (Mullen, 2004). Target and other major retailers are following Wal-Mart's lead and adopting RFID. The Healthcare and Distribution and Management Association (HDMA) Board set a goal for pharmaceutical packagers and manufacturers to implement RFID technology at the selling unit level by 2007 (Mallozzi, 2003). In November of 2004, the U.S. Food and Drug Administration (FDA) published a Compliance Policy Guide (CPG) providing guidance to companies for RFID feasibility studies and pilot programs for drugs. As explained by the acting FDA Commissioner, Lester M. Crawford (Young, 2004, p. 2612), the goal of the CPG is to "enable industry to gain experience in using RFID technology to ensure the long-term safety and

integrity of the U.S. drug supply.” The CPG goes on to reference an earlier report stating that the FDA expects RFID technology to be in widespread commercial use by 2007.

As of November 2004, four major pharmaceutical makers began participation in pilot projects to test RFID. Pfizer announced plans to place RFID tags all bottles of Viagra sold in the United States by the end of 2005 (Young, 2004). The FDA and HDMA recommendations will greatly influence the pharmaceutical industry and accelerate the adoption of RFID as a valuable tool in theft and counterfeit prevention, drug tracking, and emergency recalls. The FDA reported 1,230 drug recalls during a span of six years, or an approximate average of four recalls per week (Krohn, 2004). Fanberg explains, “RFID is beginning to revolutionize retailing, and healthcare will not be far behind. It may even result in new and innovative healthcare services and displace any number of current healthcare technology providers” (2004, p. 44).

In an effort to improve its supply system, the Defense Logistics Agency Executive Board issued a mandate that the DOD would require suppliers to utilize RFID technology by January 2005 (U.S. Department of Defense, 2004). Furthermore, the Department of Homeland Security (DHS) along with individual airports and airlines is using RFID to track travelers’ baggage for security purposes and to find lost luggage (Federal Trade Commission Report, 2005). Hickey and Ward predict the overall global market for RFID is expected to grow at an annual rate of 45% to \$4.6 billion in 2007 (Wicks, Visich, & Suhong, 2006, p. 3).

Despite a slow adoption of radio frequency identification by healthcare organizations, it now “has the potential to revolutionize business processes across a wide range of industries including...health care” (The Journal of Commerce, 2004). RFID applications are already making improvements in problem areas such as asset tracking, surgery site identification, patient tracking, infant and child security, drug counterfeiting, medication errors, and supply chain

management. Bon Secours Health System in Richmond, VA, installed a RFID system to monitor and track 12,000 pieces of equipment (Krohn, 2004). Within a year, Bon Secours documented benefits estimated at \$200,000 above the cost of implementation, including theft prevention, utilization efficiencies, and staff productivity gains. An analysis estimated that each nurse could recover 20 minutes of equipment hunting during a typical eight-hour shift (Becker, 2004). Beth Israel Deaconess Medical Center also implemented an asset tracking system in their Emergency Department and obtained data to show nurses can spend up to 30 percent of their time searching for equipment (Neil, 2005).

RFID can also help prevent perioperative errors. Regarding patient safety in operating rooms, the FDA approved a RFID product to help prevent wrong-site surgeries called the SurgiChip (Neil, 2005). This device is currently in pilot studies. A RFID chip with pertinent patient and surgery information is printed on a label that is placed on the surgical site. The caregivers must first scan and read the information on the RFID chip before conducting the surgical procedure. Additionally, leaving foreign bodies inside of patients is another patient safety issue that can be overcome with RFID technology. Surgical instruments can be tagged and accounted for by readers placed on surgical trays. Sponges and other disposable surgical items that account for the majority of surgical errors can also be tagged to prevent adverse outcomes (Nagy et al., 2006).

Medication errors are another serious problem in the healthcare industry. The Institute of Medicine (IOM) produced a report estimating that 7,000 deaths are related to medication errors each year (Perrin & Simpson, 2004). In response to the IOM report, the Agency for Healthcare Research and Quality (AHRQ) commented that “providers need to focus on making systems improvements and not simply blame caregivers for medical errors” (Perrin & Simpson, 2004, p.

34). Automatic identification (Auto-ID) systems including bar coding and RFID are currently assisting nurses in matching ordered medications with the correct patient and have been shown to radically reduce medication administration errors. The FDA and the Joint Commission have strongly recommended that organizations adopt Auto-ID/Bar Code Enabled Medication Administration (ABMA) solutions at the bedside by January of 2007 (Becker, 2004). Because many hospitals have not implemented bar coding solutions, there is a possibility that they will bypass the older, limited bar coding technology, and adopt RFID solutions.

The military health system has also adopted RFID technology. In an effort to enhance patient safety the U.S. Navy Pensacola Fleet Hospital, operating in Iraq, implemented a RFID patient tracking and identification system. Hospital staff can locate and obtain status updates on their patients through RFID enabled wristbands. Chief Petty Officer Michael Stiney, U.S. Navy, stated, "The ability to keep important information with each patient, and to track his or her whereabouts automatically have helped medical professionals at this facility better manage patient care" (Reiner & Sullivan, 2005, p. 76). Additionally, Womack Army Medical Center (WAMC) at Fort Bragg, North Carolina now uses a RFID asset tracking system to improve locating items for scheduled medical maintenance. According to LTC Dan Chapa, Director of Logistics at WAMC, the "biomedical maintenance efficiency jumped to 98-99 percent in performance of scheduled services, because you can find the products" (Versus Technology, Inc., 2006). Other military treatment facilities such as the NNMC, Lansdstuhl Regional Medical Center, Madigan Army Medical Center, Eisenhower Army Medical Center, Keesler Medical Center, Naval Medical Center San Diego, and Wright Patterson Medical Center have either deployed or are considering a pilot deployment of RFID asset tracking systems in their facility (DMLSS Program Office, 2007).

Several civilian hospitals are using a RFID solution to solve a myriad of problems. One such hospital is the Lahey Clinic outside of Boston, Massachusetts. The Lahey Clinic is an 83-year-old integrated multi-specialty group practice providing primary and tertiary care. The clinic operates two campuses that share its 327 licensed beds. Both facilities operate 24-hour emergency departments and one campus serves as a Level II trauma center. Additionally, Lahey Clinic serves as an academic medical center and is a teaching hospital for Tufts University School of Medicine. Furthermore, several of Lahey's 450 physicians hold teaching assignments at Harvard Medical School and Boston University School of Medicine.

The Lahey Clinic has several years of experience with RFID beginning in 1999. Early efforts met with shortcomings due to the evolving technology and staff reservations. However, in 2001, Lahey began an evaluation of RFID applications including biometric applications such as iris scanning, personal identification, and the use of RFID for asset management. This led to discussions with General Electric for a corporate commitment to assist with the development of RFID throughout the clinic. By 2005, this partnership led to a joint development agreement for RFID with an initial focus on asset management.

Lahey identified several emerging and ongoing needs with which the RFID solution could assist. First was the management and multi-site coverage of a growing number of costly mobile and portable equipment items in addition to compliance with the preventive maintenance schedule. Lahey was encountering problems with inventory due to movement between the Lahey North clinic and the Lahey Main clinic. This led to increased rentals, loss, and over purchase of moveable medical equipment. The second identified need was to contain capital and operating costs, especially with equipment rentals, inventory levels, and pilferage. This manifested in equipment hoarding and had an effect on quality of care delivery. The third

emerging need was to standardize and simplify the approach to physical security. Since Lahey Clinic operated on multiple campuses, access control was difficult and required the use of multiple systems. Some complex systems, such as iris scanning, had a higher probability for failure and the staff was becoming dissatisfied due to the use of multiple security tools. The final emerging need addressed by the partnership involved the proliferation and management of wireless technology within the facilities. Lahey had a history of experimenting with wireless technology and the introduction of another system raised questions regarding the disruption of the network through downtime introduced by adding a RFID system. Additional concerns arose surrounding Health Insurance Portability and Accountability Act (HIPAA) compliance as information technology presence expanded within the clinics.

Initial return on investment analysis indicates a cost savings of approximately \$379,000 with the majority of savings coming from reducing lost equipment and improving equipment utilization. Other intangible benefits for Lahey have come from improved Joint Commission compliance, staff timesavings, and patient satisfaction. Using only a conservative 10% increase in utilization of tagged equipment, Lahey estimated a rapid return on investment based on cost avoidance mainly through improved search efficiencies and equipment management. Additionally, loss prevention alone provides an immediate cost benefit in equipment and personnel efficiencies. Within 90 days of post RFID implementation, the scheduled maintenance compliance rate increased from 94.5% to 97.5%. This increase was attributable to a reduction in UL medical equipment.

Lahey identified two key lessons learned from the implementation of the RFID technology solution for asset tracking. One, management buy-in and support are critical for a successful implementation. Lahey accomplished this by using department champions and go-to

experts who educated individual on RFID and its potential benefits. The second lesson was that a commitment to staff education is imperative to realize the full benefits of a RFID system. Not only was educating the users on how the system operates important, the real key was having users gain an understanding of how RFID enhances or changes underlying business processes (Barczak & Doran, 2007).

While the potential positive applications of RFID are almost limitless, they come with numerous problems. These problems include the current high cost of implementing RFID systems, environmental impact, a lack of tag supply, user acceptance, and lack of standards, database security, and privacy. Senator Patrick J. Leahy stated, "RFID has tremendous potential for improving productivity and security, but it will also become one of the touchstone privacy issues of our times" (Krim, 2004, p. E.01). Although RFID costs are declining because of higher utilization, more opportunities for surveillance and privacy invasion exist.

An example of the potential security problems with RFID surfaced when a team of students from Johns Hopkins University was successful in evading encrypted RFID devices and gaining access to the stored data (Smith, 2005). These students were able to read all the data from an Exxon SpeedPass and then reproduce the radio signal to pay for gasoline using the SpeedPass owner's credit account linked through a database. The security of databases and the information contained within is of great concern in the current environment of identity theft and protected health information.

In summary, RFID is an old technology currently receiving significant interest due to its robust application capabilities. With technology improvements and declining prices, RFID has exploded onto the healthcare scene in a myriad of new uses. John Wade, Chief Information Officer at Saint Luke's Health System, says, "We're on the cusp of an era with this technology.

There is no limit to where this can go to benefit patients” (Becker, 2004, p. 39). It is likely that RFID will be strategically used to enhance a healthcare facility’s image with the goal of attracting and retaining paying patients (Fanberg, 2004). Privacy and data security are primary concerns with the expanded use of RFID devices to identify people and link them to sensitive information.

Purpose

The purpose of this case study is threefold. First, determine if the implementation of RFID asset visibility tracking at similar medical institutions has had any impact on the reduction of UL items, a reduction in the number of FLIs, or an improvement in the scheduled medical maintenance completion rate. Second, this study will identify best business practices learned from the implementation of RFID asset visibility tracking at Womack Army Medical Center (WAMC) and other large civilian medical treatment facilities. All facilities that are studied will be of similar size and scope and examining data from them can yield reasonable inferences for WRAMC. Finally, this case study will propose a method of determining ROI for the RFID solution. The units of analysis for this case study will be the medical maintenance and property accountability branches of the concerned medical treatment facilities. The objective of this study is to justify the capital expense and to improve the implementation of RFID asset tracking in a facility that is to realign and close under the 2005 DOD BRAC recommendations.

Methods and Procedures

Case Study Design

The case study will be a multiple-case design using both quantitative and qualitative data. The rationale for this design is that both WAMC and Lahey Clinic in Massachusetts are representative and typical facilities and that any lessons learned are assumed to be informative

about the experiences of the average institution. Furthermore, lessons learned from WAMC and Lahey can hold reasonable inferences for WRAMC.

Data Collection Procedures

Data sources.

Data will come from WRAMC, WAMC, and the Lahey Clinic for this study and will include documentation, archival records, interviews, and direct observations. Types of documentation include: memoranda, policies, regulations, proposals, briefings, reports, and other internal records for the examined facilities. Archival records consists of current performance indicators for medical equipment not located for scheduled services, financial liability investigations, scheduled maintenance services completion rate, and labor and replacement costs associated with missing items of medical equipment. This information will primarily come from DMLSS, which serves as the corporate database for hospitals in the military healthcare system.

The study will conduct interviews with key individuals in a number of different work areas within WAMC and WRAMC to collect the required data. The work areas chosen are the Directorate of Logistics, the Clinical Engineering Division, and the Property Accountability Branch. Personnel will be selected for interviews based on their knowledge of RFID implementation and the associated business processes. Interviews will be both open-ended and focused in design. Focused questions are:

1. What method do you use to determine ROI for your RFID asset tracking system?
2. What was the impetus for implementing a RFID solution?
3. What are the lessons learned from the implementation of RFID asset tracking in your facility?

4. Are there any underlying business processes that had to be changed as the result of the RFID implementation? If so, what are they and were there any associated costs?

5. Are you considering any other possible applications for the RFID technology? If so, what are they?

6. Have you seen a reduction in delinquent scheduled services because of the implementation of RFID?

7. Have you seen a reduction in the number of FLIs because of the implementation of RFID?

8. Have you seen a reduction in labor or equipment replacement costs because of the implementation of RFID?

9. Are there any intangible benefits or consequences of the RFID solution?

Finally, the case study will incorporate direct observations through site visits. Site visits will be to WAMC, the only military medical center that is in post-implementation of a RFID asset tracking solution, and WRAMC. The field observations at the facility will include the property management and medical maintenance processes.

Ethical considerations of data collection.

This study observes the ethical rights of all study participants. Any personnel interviewed receive a description of the purpose of the study and are given the choice not to answer questions. Confidential data or data deemed derogatory to the commands or facilities examined is reviewed prior to release of the study. Data drawn from corporate databases are collected by the appropriate system technicians and formatted accordingly.

Principles of data collection.

All data collection adheres to the three data collection principles outlined in Robert Yin's *Case Study Research: Design and Methods* (2003). Those principles are the use of multiple sources of evidence, creating a case study database, and maintaining a chain of evidence. The use of multiple sources of evidence (data) allows for the development of converging lines of inquiry through a process of triangulation. Specifically, this study uses the triangulation of data sources or data triangulation. The aim of collecting information from multiple sources is corroborating those critical steps that WRAMC needs to undertake to maximize the implementation of the RFID system. Furthermore, data triangulation addresses construct validity because the multiple sources of evidence provide multiple measures of the successful implementation of RFID systems. The case study database consists of all evidence used in the preparation of the case and the case study report. This includes any notes, documents, or other materials used in the preparation of the case study. Finally, the chain of evidence will increase the reliability of the information contained in the case study. There will be sufficient citation throughout the case study to allow the reader to track the conclusions back to the generating evidence. Additionally, the circumstances under which the information was collected will be consistent with the procedures and sources of evidence outlined within the proposal.

Appropriate annotations will be made of the conditions under which the evidence is collected.

Data Analysis Plan

The general strategy for this case study is to develop a case description using the specific analytic technique of pattern matching. This technique takes the pattern developed by the analysis of lessons learned from the successful implementation of RFID at Lahey Clinic and WAMC and uses this information as a predictor of successful techniques for the implementation

of RFID at WRAMC. If the information from Lahey and WAMC coincide, it will strengthen the internal validity of the case study and information will be a useful predictor for WRAMC.

Outline for the Case Study Report

The structure of the case study report will be a linear-analytic design. The sequence will begin with the issue under study and a review of the relevant literature. It will then proceed to cover the methods used, the finding from the data collected and analyzed, and the conclusions and recommendations from the findings. The intended audiences for the case study report are administrators within the DoD military health system seeking to implement a RFID tracking system for asset visibility.

Findings

Data Collection

Data sources used in this study consisted of documentation, archival records, and interviews. Documentation included memorandums, policy letters, funding proposals, information and decision briefings, and reports from the DOD, DA, USAMEDCOM, WRAMC, WAMC, and the Lahey Clinic. All documentation was easily obtained from the agencies public Web sites or through the organizational intranet, shared public knowledge folders, or proponent offices.

Archival records for the military facilities came from DMLSS and the office of the NARMC Assistant Chief of Staff for Logistics and Acquisition. These records consisted of past and current performance metrics for medical equipment not located for scheduled services, financial liability investigations, scheduled maintenance services completion rates, and replacement costs associated with missing items of medical equipment. Initially, this data proved difficult to obtain because of the potential that these metrics could be viewed as

derogatory to the commands or facilities. This proved especially true in light of the public attention in early 2007 paid to the status of health care for returning service members from the Global War on Terrorism in the military health system. Data was readily provided upon thorough explanation of its use from DMLSS pre-formatted reports and data queries. Archival records for the Lahey Clinic came from the organization's clinical engineering division and central supply department.

Five individuals from WAMC and Lahey Clinic were interviewed for this case analysis. Three were from WAMC and two from Lahey. All five were males and one was a military member. The military member was a United States Army Medical Service Corps officer in the grade of Colonel with over 20 years experience in medical logistics. The senior civilian was a Senior Vice President from Lahey Clinic. The individuals were emailed a list of interview questions and all five responded within 14 days without follow-up reminders. All responses from the participants were printed, totaling over 13 pages of responses. After reviewing each response, I highlighted key terms and issues that were important to each respondent. Then I initiated a process of matching responses to reduce the number of key terms and issues from an initial count of 17 to a number less than ten. Then I recounted each key term and issue to determine a simple count of the number of responses to determine which issues were of most importance to the respondents.

RFID's Impact on UL, FLIs, and Scheduled Medical Maintenance

Overall.

Data obtained from Lahey Clinic and WAMC indicate mixed results of RFID's impact on reducing the number of UL items, reducing FLIs, and increasing scheduled medical maintenance performance. Data indicated that Lahey Clinic experienced a substantial reduction in lost

equipment and equipment replacement costs in addition to a dramatic increase in compliance with scheduled services after adoption of a RFID asset tracking system. Data from WAMC showed no clear relationship between the implementation of RFID and any of the three target areas. However, interviews with a senior administrator at Lahey Clinic and the Chief of Logistics at WAMC did identify two intangible benefits of RFID that created efficiencies in coping with the issues of UL, FLIs, and scheduled medical maintenance.

Lahey Clinic.

In 2005, Lahey Clinic, in a joint development with General Electric, implemented a RFID asset tracking solution to cope with the management and inventory control of a multi-site medical facility. Problems centered on compliance with preventive maintenance schedules and cost containment. Data from Lahey show that in 2005, the first year of RFID implementation, there was a 70% reduction in lost equipment with a resulting cost savings of \$75,610. In 2006, there was a 90% reduction in lost equipment. According to Jeff Doran, Senior Vice President at Lahey Clinic, cost savings resulted from reduced rentals and a decrease in the leasing or purchasing of replacement equipment. RFID brought the capability of real-time visibility of equipment and gave insights into utilization patterns that helped management make better purchasing decisions. Furthermore, the RFID system obviated the need for the clinical staff to hoard equipment because of the continuous visibility of equipment throughout the enterprise. No longer was there a need for the staff to maintain excess equipment in anticipation of a future use. This improvement in equipment utilization resulted in another estimated cost savings of \$270,000. When summed the cost savings from reducing lost equipment and the better utilization of existing equipment was \$345,610 for the two years post-implementation of RFID asset tracking.

Since Lahey Clinic is a civilian institution, it has no requirement to conduct a FLI to determine the circumstances and assign liability surrounding the loss of property. However, Mr. Doran alluded to a similar type of investigation process conducted by the clinic's Central Supply department whenever the loss of equipment was identified. Like military facilities, these searches require individuals from Central Supply to conduct searches in an attempt to locate the missing item or items. Since the implementation of RFID, cost savings from reducing lost productivity associated with physical searches have totaled \$2,601.

Mr. Doran further discussed RFID's impact on compliance with scheduled maintenance services for medical equipment. Lahey Clinic recognizes and adheres to the elements of performance pertaining to medical equipment outlined by the Joint Commission in its environment of care chapter. This area has seen the most dramatic improvements as a result of the implementation of RFID. Within 90 days of RFID implementation in 2005, compliance with scheduled medical maintenance improved 3% from 94.5% to 97.5%. This was a direct result of RFID's real-time visibility of equipment, allowing preventive maintenance employees to quickly locate equipment and perform maintenance services.

WAMC.

Unlike Lahey Clinic, data from WAMC does not clearly show a quantitative benefit from the implementation of RFID for asset visibility and tracking. WAMC installed its asset tracking and locating system during the construction of a new hospital building in 1999. The tags and readers were activated in 2003 for locating medical equipment and mobile patient movement items. Implementation of RFID tracking occurred using a four-phase implementation plan. Phase 1 consisted of tagging and tracking maintenance specific items that fall under Joint Commission requirements. This included all items requiring scheduled medical maintenance.

Phase 2 was the tagging and tracking of all high-dollar inventory items. Phase 3 involved the tagging and tracking of any item designated necessary by the command. The final phase involves patient and employee tracking and only has been implemented on a limited basis.

Data in Table 1, obtained from DMLSS on WAMC FLIs indicated that in calendar year (CY) 2002, prior to RFID activation for asset tracking, the hospital had 483 separate FLIs totaling \$125,969.09 for missing equipment. During CY 2003, following implementation of RFID, there was a 55% reduction in the number of FLIs. In CY 2004, FLIs further declined another 20% to 174. However, beginning in CY 2005 the numbers of FLIs has begun to increase.

Table 1

WAMC CY 2002 – 2005 Financial Liability Investigations

<u>CY</u>	<u>Count of document numbers</u>	<u>Sum of acquisition price</u>
2002	483	\$125,969.09
2003	218	\$346,051.44
2004	174	\$105,832.06
2005	268	\$641,381.55
Total	1143	\$1,219,234.14

Furthermore, data in Table 2 from DMLSS shows that during the first three quarters of fiscal year (FY) 2007 (October 2006 – June 2007) WAMC has initiated over 300 FLIs for lost equipment.

Table 2

WAMC FY 2007 Financial Liability Investigations

<u>QTR</u>	<u>Count of document numbers</u>	<u>Sum of acquisition price</u>
1st	81	\$277,409.76
2nd	108	\$316,462.60
3rd	126	\$432,967.87
Total	315	\$1,026,840.23

These results are not congruent with Lahey Clinic's sustained reduction in lost equipment following implementation of RFID asset visibility tracking. According to WAMC logistics personnel, several reasons could account for the recent increase in FLIs. Most likely, these are items that have circumvented the normal procurement process and, as part of that process, failed to have a RFID tag affixed. Another possible explanation is a failure of RFID hardware. Since active tags are battery powered, a possibility exists that a piece of equipment whose RFID tag is low on power would fail to be interrogated by a RFID reader. A third possible explanation is that the missing equipment does not meet the criteria for RFID tagging outlined in WAMC's four-phase implementation plan. According to an interview with Mr. Dale Nuxoll, Logistics Analyst Supervisor for WAMC, the hospital has had zero loss of tagged assets since implementing the program. The items that were tagged were recovered.

WAMC's compliance with MEDCOM standards for completion of scheduled maintenance has been exemplary. Data in Table 3 taken from the MEDCOM Maintenance Manger's corporate database indicate that in FY 2001 scheduled maintenance service performance was above corporate standards for preventive maintenance, safety tests, and

calibrations. In FY 2001, WAMC averaged compliances of 98.3% for preventive maintenance, 99.0% for safety tests, and 97.6% for calibrations.

Table 3

WAMC % FY 2001 Scheduled Service Performance

Service type	Quarter			
	1st	2nd	3rd	4th
Preventive maintenance	98.5	98.1	99.4	97.1
Safety tests	99.0	98.7	99.6	98.6
Calibration	96.6	97.6	99.0	97.1

Although still within MEDCOM standards, data in Table 4 for FY 2006 shows performance of scheduled maintenance services in each of the three categories has decreased post-implementation of RFID. Averages for the four quarters of FY 2006 for preventive maintenance, safety tests, and calibration were 97.2%, 98.1%, and 96.5% respectively.

Table 4

WAMC % FY 2006 Scheduled Service Performance

Service type	Quarter			
	1st	2nd	3rd	4th
Preventive maintenance	98.0	96.8	98.4	95.7
Safety tests	98.3	97.6	98.7	97.8
Calibration	96.8	96.2	98.4	94.7

Interviews with senior logistics personnel at WAMC and the North Atlantic Regional Medical Command (NARMC) suggest that RFID's impact on scheduled medical maintenance completion

comes from the ability to quickly locate items thereby saving multiple man-hours of lost productivity searching for UL equipment.

Intangible Benefits. Although no specific metrics exist, there are some noted intangible benefits of RFID on reducing ULs and FLIs in addition to improving performance of scheduled maintenance services. Most prominent are the staff efficiencies created by reducing the amount of search time for equipment. These efficiencies are difficult to quantify and track but can be significant when referring to multiple man-hours on a department basis in large facilities such as Lahey and WAMC. According to Mr. Doran of Lahey Clinic, any reduction in the amount of search time creates efficiencies with associated cost savings. A WAMC logistics manager notes that there is no direct way to assess a dollar amount, but concludes it is a significant savings.

Another intangible benefit is RFID's impact on staff and patient safety. Periodically, quality assurance, safety, or recall notices are issued on items of medical equipment. RFID's ability to precisely locate tagged items provides a method to immediately locate the equipment and remove it from patient use. COL Chapa, Director of Logistics at WAMC, recalls an instance where a particular pump was recalled due to a bad gasket. Using the RFID system, medical maintenance personnel were able to go straight to the rooms where the equipment was located and within an hour had all of the equipment centralized for repair and away from patients. Not only did this RFID capability improve patient safety, but also it was essential to risk management and compliance with Joint Commission elements of performance.

Lessons Learned from Implementing RFID Asset Tracking

Focused interviews with senior administrators and logistics personnel at both Lahey Clinic and WAMC yielded significant lessons learned from the implementation of RFID systems for asset tracking at their respective institutions. These lessons learned focused on critical

implementation strategies for successful adoption of a RFID asset tracking system. Table 5 lists the six most important implementation strategies as described by the survey respondents along with the number of respondents who indicated that strategy as a key lesson learned from the implementation of RFID for asset tracking. Any implementation practice or strategy mentioned by more than one interview participant as being critical is listed. Results from all interviews were compared against each other to discern any identifiable patterns. For the purposes of discussion, this study will focus only on those strategies corroborated by at least four of the interview participants (80 percent). These strategies are the following: management support and buy-in; established RFID implementation objectives; staff education and training; and business process redesign.

Table 5

Critical Implementation Strategies of RFID for Asset Tracking

Respondent	Management support and buy-in	Established RFID implementation objectives	Staff education and training	Business process redesign	Maximize hardware coverage within facility	Correct RFID system selection
1	X	X	X	X	X	
2	X	X	X	X		
3	X	X	X		X	X
4	X	X	X	X		
5	X		X	X		X
Total	5	4	5	4	2	2

Management support and buy-in.

The first strategy is that management buy-in and support are critical for success. Every respondent stated that this was a critical strategy. According to one respondent from Lahey, “Any new information system must have the full support and commitment from the leadership.

Without this, it is doomed to fail.” Senior managers of healthcare organizations must assume the responsibility for planning and controlling the development of effective RFID tracking systems. These tasks cannot be delegated to technical personnel if the system is to be supportive of patient care and managerial decision-making. Management must insist on a careful planning process that precedes all major decisions related to the installation of RFID equipment or associated redesign of processes. Furthermore, this planning process must be linked to the strategic plan of the facility and should guide all decisions related to the RFID system. One interview participant from WAMC stated, “RFID’s ability to support a wide variety of applications made it more attractive to senior management as they examined the implementation from a strategic perspective.” Management must develop clear policies that outline the pre-conditions for RFID use to include standards and metrics that track performance.

Established RFID implementation objectives.

The second strategy is that the RFID system must have established, clear objectives. Eighty percent of those interviewed emphasized the importance of this issue. This strategy is an outgrowth of the planning phase in an information systems development process and outlines the purpose and use of the system. The RFID objectives should be as specific as possible and link to an analysis of deficiencies and gaps in current business processes. For WRAMC, potential objectives could be: (a) 100% compliance with Joint Commission standards for medical equipment, (b) Reduce administrative hours generating FLIs and searching for equipment, (c) Reduce the number of FLIs, (d) Increase asset visibility, and (e) Reduce equipment inventory loss due to UL or theft. One Lahey administrator stated that, “The implementation of RFID was tied to several management imperatives, particularly strategies that improved the management of an expanding and multi-site enterprise, containing and avoiding costs, and managing a growing

wireless environment. These, in turn, were linked to several operational objectives of which we could measure and track.”

Staff education and training.

Strategy three is that staff education is essential to successful implementation of RFID asset tracking. As with management support and buy-in, 100 percent of the interviewees commented on how critical staff education and training is to the successful implementation of a RFID tracking asset system. Alternatively, as one Lahey administrator put it, “Educate, educate, educate!!!” A well designed and managed training program can overcome user anxiety and potential resistance to change. All interview respondents also identified the need for subject matter experts, located at the clinic or service level, to serve as champions for the RFID system. Additionally, education extends beyond the implementation of the system. As RFID within the facility matures, associated business processes will change in response to newly created efficiencies. This will involve continuous user education and training, especially in WRAMC where employee turnover among the nursing staff and medical maintenance personnel is high. These two groups are the targeted operational users of the RFID technology.

Business process redesign.

The final strategy highlighted by the interviewees (80 percent) is that current business processes must change to maximize benefit of RFID. One WAMC administrator stated, “...deploying new technology without changing processes does not help.” Business process redesign is integral to performance improvement with RFID. Resulting procedural changes and methods improvement will lead to the development of standards for both procedures and performance enhancements in the areas of property management and accountability. According to one Lahey respondent, “it is critical to benchmark your data prior to implementation so you

can prove success later and justify expansion or new ideas.” These standards will improve management control and ensure accountability and compliance. Another Lahey respondent stated that, “...the possibilities associated with our RFID system are only limited by the ties to old ways of doing business. We kept trying to apply the system to old processes instead of looking at how the technology could enable or enhance new processes”.

Return on Investment

Data indicates that although Lahey Clinic and WAMC each have differing methods of determining ROI, both facilities incorporate similar metrics into their respective formulas. The ROI formulas are a mix of both hard dollar data and cost savings estimates. The hard dollar amounts comprise only a small portion of the ROI calculation for RFID. Both facilities agree that a majority of cost savings are realized from the intangible benefits of RFID such as reduced search times and improved patient safety. Furthermore, both hospitals concede that while it is difficult to determine ROI for RFID, the cost savings is substantial.

Lahey.

Lahey’s ROI formula begins with a tangible hard dollar assessment encompassing replacement costs, repeated rental purchases, current inventory levels, and upcoming purchases. Intangible benefits are then factored into the ROI equation. Intangibles include estimates for staff timesavings, improved Joint Commission compliance, staff and patient satisfaction, and RFID’s potential to expand beyond asset management. These costs and cost estimates complete the ROI calculation.

WAMC.

Similar to Lahey, WAMC calculates ROI by starting with hard dollar savings from equipment purchases and rentals. In addition to the intangible estimates stated above, WAMC

includes estimates for improved utilization of existing equipment, savings from product liability, and risk management. However, WAMC does admit there is no direct way to assess a dollar amount for these savings.

Summary.

Both ROI analyses begin with quantifiable dollar savings for equipment and assets. This incorporates the cost avoidance associated with replacements, rentals, inventory levels, and planned future purchases. This amount is based on benchmarks established prior to RFID implementation and includes equipment that historically has been difficult to track and locate. A majority of these items are the mobile patient movement items that travel throughout the hospital.

Intangible benefits of RFID comprise the second or more important portion of the ROI calculation. Both RFID formulas conservatively estimate the amount of savings from lowering rental costs, avoiding pilferage, and decreasing replacement costs. Improved utilization of existing equipment results in lower rental costs. Lahey Clinic estimates a 10% ROI from cost avoidance due to increased utilization of existing equipment. The real-time locating and improved visibility decrease the amount of theft and loss of equipment while improved property data allows management to make better fiscal decisions regarding replacements and new purchases. Although each of these intangible benefits is associated with hard dollars, it is difficult to determine the impact of RFID with regard to these savings. Other intangible benefits included in RFID calculations include improved Joint Commission compliance, staff and patient satisfaction, and the potential future use of the RFID hardware. Unlike other computer systems, the wireless hardware of RFID is not limited to asset tracking and visibility. The middleware or software application associated with asset tracking can be modified or expanded to incorporate a

number of uses for the wireless hardware. Examples can include patient tracking or employee identity verification. Additionally, military facilities enjoy cost savings from reduced administrative overhead when FLIs are avoided. Other savings include reduced inventory times, increased retrieval of equipment and cross leveling of assets. Lahey estimates that when both hard dollar and intangible costs are included the minimum ROI for RFID is 3.5 years.

Conclusion and Recommendations

Conclusion

In conclusion, RFID for asset tracking has the potential to provide at least a partial solution for improving property accountability and management within WRAMC. In the health care facilities studied, RFID is in the early adoption and deployment phase and has shown some initial success at reducing the effects associated with missing or UL equipment and scheduled maintenance performance. However, RFID did not demonstrate these results consistently across the facilities examined for this study. Data was inconclusive as to the impact of RFID on the reduction of FLIs and many of the perceived benefits of RFID are difficult to measure and capture. This can further be attributed to the inherent differences between civilian and military facilities. Each has its own procedures and policies. It is not disputed that RFID's ability to accurately track and locate property provides several benefits in organizations where it is utilized. Most notable are the efficiencies created by reducing search times for equipment, improved utilization of existing assets, and the increase in patient safety. However, a closer examination of equipment accountability and use will show that RFID technology can only provide a partial solution for addressing these problems. The use of RFID technology must be considered along with any associated business practices or standard operating procedures in developing a comprehensive solution to medical equipment management. These problems are

not unique to WRAMC and every facility must find ways to improve as this issue generates more interest by higher headquarters and the Joint Commission.

This study was successful at identifying the critical steps that WRAMC needs to undertake to maximize the benefit of the RFID system. Senior administrators and logistics personnel both at Lahey Clinic and WAMC repeatedly identified at four similar issues as being critical to a successful implementation strategy: management support and buy-in; established RFID implementation objectives; staff education and training; and business process redesign. Should WRAMC decide to proceed with the installation of the RFID system, these strategies will be essential to maximizing the return on investment before the facility closes and integrates to become the Walter Reed National Military Medical Center in 2011.

Finally, this study determined that there is no common business method or corporate standard of determining return on investment for RFID. Both facilities incorporated a mix of tangible dollar amounts gained from a reduction in lost equipment and coupled this with estimates of cost savings from the intangible benefits associated with RFID. This method provided only a general estimate of the impact of the investment in the technology. An accurate method of determining ROI will become more important as funds for WRAMC are scrutinized against the background of Base Realignment and Closure legislation. At a minimum, the ROI should include both tangible and intangible benefits.

Recommendations

This researcher recommends that the results of this case study be used by the WRAMC command as a basis to reexamine the decision to implement RFID at a facility scheduled to close in 2011. Instead, administrators, logistics personnel, and information technology professionals should plan for its use during the combining of WRAMC and the National Naval Medical

Center. The integration of these two great facilities provides several opportunities to maximize the monetary investment and capitalize on the benefits of RFID. First, the construction of new hospitals at both Fort Belvoir and Bethesda allow for integrating the RFID hardware as part of a comprehensive information systems plan. Second, as WRAMC closes, a large amount of medical equipment and other property will be redistributed to the new WRNMMC and Fort Belvoir. A RFID system will ease the burden of tracking and managing this property. Both commands can undertake initial implementation steps now, to make this transition of property easier. Finally, this merger could serve as a test bed for RFID applications across the military health system. This emerging technology provides limitless opportunities for use in the health care setting. Metrics developed at WRNMMC could be exported and standardized for use throughout the Defense Health System.

There is a need for further research in the area of RFID asset tracking in the health care setting. This study developed a pattern of successful implementation strategies by examining two similar medical facilities. However, this was not an exact duplication of size and scope. Future studies should focus on developing exact metrics for the measurement of the perceived intangible benefits of RFID. These benchmarks could serve to prove success and justify expansion of RFID capabilities for new ideas and uses.

References

Army Regulation 40-61 (2005): Medical logistics policies. Washington, D.C.: Headquarters, Department of the Army.

Army Regulation 735-5 (2005): Policies and procedures for property accountability. Washington, D.C.: Headquarters, Department of the Army.

Army Regulation 710-2 (2005): Supply policy below the national level. Washington, D.C.: Headquarters, Department of the Army.

Army Regulation 750-1 (2006): Army material maintenance policy. Washington, D.C.: Headquarters, Department of the Army.

Barczak, B., & Doran, J. (2007). *Managing cost and efficiency with radio frequency identification asset tracking technology*. Presented at the 2007 Annual Congress of the American College of Healthcare Executives. March 22, 2007.

Base Realignment and Closure Committee Online. (2006a). 2005 Defense base closure and realignment commission final report to the president. Retrieved October 28, 2006 from <http://www.brac.gov/finalreport.asp>

Base Realignment and Closure Committee Online. (2006b). 2005 BRAC definitions. Retrieved October 28, 2006 from http://www.defenselink.mil/brac/definitions_brac2005.html.

Base Realignment and Closure Committee Online. (2006c). Presidents transmittal letter to congress. Retrieved October 28, 2006 from <http://www.dod.mil/brac/pdf/President-Congress15Sep05.pdf>

Becker, C. (2004). A new game of leapfrog? RFID is rapidly changing the product-tracking process. Some say the technology once costs drop--could displace bar coding [Electronic Version]. *Modern Healthcare*, 34(28), 38-40.

Defense Medical Logistics Standard Support: 2006 [Data file]. Washington, D.C.: Walter Reed Army Medical Center.

Defense Medical Logistics Standard Support Online. (2006). *Defense medical logistics standard support (dmlss) system overview*. Retrieved November 10, 2006 from http://www.tricare.mil/dmlss/more_info.cfm

Defense Medical Logistics Standard Support Program Office. (2007). *Draft report*. Washington, D.C.: Asset Tracking Joint Application Development Work Group.

U.S. Department of Defense. (2004). *Radio frequency identification (RFID) policy*. Washington, D.C.: Wynne, M.

Fanberg, H. (2004). The RFID revolution. *Marketing Health Services*, 24(3), 43-44.

U.S. Federal Trade Commission. (2005). *Radio frequency identification: Applications and implications for consumers* [Electronic Version].

Garfinkel, S., & Rosenberg, B. (2005). *RFID: Applications, security, and privacy*. Addison-Wesley Professional.

The Journal of Commerce. (2004, September). VeriSign tools integrate EPC global network. 29, 1.

Krim, J. (2004, June 23). Embedding their hopes in RFID: Tagging technology promises efficiency but raises privacy. *The Washington Post*, pp. E.01.

Krohn, R. (2004). RFID: It's about more than asset tracking. *Journal of Healthcare Information Management*, 19(3), 20-23.

Maintaining life support and non-life support equipment: what do JCAHO's new requirements mean? (2004, July). *Health Devices*, 33(7), 244-250.

Mallozzi, J. (2003, December). RF sensors invade healthcare. *R&D Magazine*, 45(12), 34-35.

- Mullen, D. (2004). Benefiting from RFID. *Pharmaceutical Technology*, 28(11), 31-34.
- Nagy, P., George, I., Bernstein, W., Caban, J., Klein, R., Mezrich, R., et al. (2006). Radio frequency identification systems technology in the surgical setting. *Surgical Innovation*, 13(1), 61-67.
- Neil, R. (2005). On a roll. *Materials Management in Health Care*, 14(3), 20-23.
- Operations Management Bulletin No. 3-02 (2002): Policy for medical maintenance activities. Fort Sam Houston, TX: Headquarters, United States Army Medical Command.
- Operations Management Bulletin No. 06-05 (2005): Medical equipment not located for scheduled services. Fort Sam Houston, TX: Headquarters, United States Army Medical Command.
- Perrin, R. & Simpson, N. (2004). RFID and bar codes- Critical importance in enhancing safe patient care. *Journal of Healthcare Information Management*, 18(4), 33-39.
- Radio-frequency identification: its potential in healthcare. (2005, May). *Health Devices*, 34(5), 149-160.
- Reiner, J. & Sullivan, M. (2005, June). RFID in healthcare: A panacea for the regulations and Issues affecting the industry? [Electronic Version]. *Healthcare Purchasing News*, 74-76.
- Smith, L. (2005). RFID report. *Humanist*, 65(3), 37-39.
- Subhan, A. (2005). Regulatory compliance and quality assurance. *Journal of Clinical Engineering*, 30(4), 187-190.
- Troyk, P. R. (1999). Injectable electronic identification, monitoring, and stimulation systems. *Annual Review of Biomedical Engineering*, 01, 177-209.
- United States Army Medical Command Regulation 10-1 (2000): Organizations and functions. Fort Sam Houston, TX: Headquarters United States Army Medical Command.

- Versus Technology, Inc. (2006). *Versus information system: do you know where your resources are?* [Brochure]. Traverse City, MI: Versus Technology, Inc.
- Walter Reed Army Medical Center. (2006a). *A snapshot of business operations* [Brochure]. Washington, D.C.: Walter Reed Army Medical Center Business Operations Center.
- Walter Reed Army Medical Center. (2006b, May). *Asset tracking system*. Washington, D.C.: Turner, Ralph.
- Walter Reed Army Medical Center. (2006c, December). *Financial liability investigations of property loss register*. Washington, D.C.: Directorate of Logistics.
- Walter Reed Army Medical Center. (2006d, October). *Proof of concept business case analysis*. Washington, D.C.: WRAMC Clinical Engineering Division.
- Walter Reed Army Medical Center Online. (2006). *A day in the life of walter reed army medical center*. Retrieved November 7, 2006 from [hppt://www.wramc.amedd.army.mil](http://www.wramc.amedd.army.mil)
- Walter Reed Army Medical Center Public Affairs Office. (2007, June). Walter reed battle casualty update (Release No. 110604). Washington, D.C.: no author
- Walter Reed Army Medical Center Regulation No. 750-1 (2005): Command maintenance directive. Washington D.C.: Headquarters, Walter Reed Army Medical Center.
- Wicks, A., Visich, J., & Suhong, L. (2006) Radio frequency identification applications in hospital environments. *Hospital Topics*, 84(3), 3-8.
- Yin, R.K. (2003). *Case study research: design and methods* (3rd ed.). Thousand Oaks, CA: Sage.
- Young, D. (2004). FDA embraces RFID to protect drug supply. *American Journal of Health-System Pharmacy*, 61(24), 2612-2613.