Proceedings of the 2010 Industrial Engineering Research Conference
A. Johnson and J. Miller, eds.

1a0The Health Care Economics of Automating Health Care Systems

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Abstract

In today's environment, health care has become a key issue. Initiatives such as BCMA, RFID, CPOE, and EHR that require expensive automation implementations are being scrutinized. This research transcript describes a process for: 1) evaluating health care economic societal impact, 2) evaluating the implementation costs for automation such as barcodes and RFID into the pharmaceutical supply chain, 3) evaluating the risk factors associated with integration of multiple healthcare automation initiatives. The research results to date describe lot control of track-able capsules from manufacturer, to dosage level administration in hospitals, and ingestion confirmation for at-home patients.

Keywords

BCMA, RFID, Medical Loss Ratio, Dosage level tracking, Health care, Automated identification technologies

1.0 Introduction

After the Institute of Medicine (IOM) report titled "To err is human: Building a safer health system" in 2000, stating that 44,000 to 98,000 people die every year in the United States [1] the perspective of individuals has changed the way they look at health care systems in practice. The methodology adopted by health care organizations in administering right drug to right patient at the right time has been the interest of researchers and there have been many methods and technologies developed like Computerized Physician Order Entry (CPOE), Bar-Code Medication Administration (BCMA) and the latest among these technologies is the used of Radio Frequency Identification (RFID) technology.

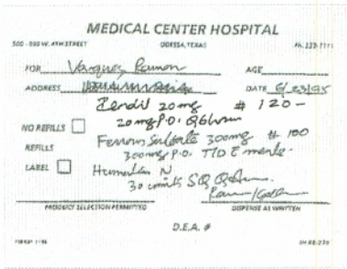
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Figure 1: Hand written prescription by a Cardiologist [2].

Consider a case in a hospital setting that lead to the death of the patient. "On June 23rd, 1995; Ramon Vasquez received the prescription shown in above figure from his cardiologist. He began taking the medication given to him by the pharmacist on a Saturday morning. By Sunday night, the medication had affected his heart so much that he had a heart attack. He died several days later. What is the name of the first drug prescribed? Is it Plendil? or Isordil? The pharmacist who filled this prescription read it as *Plendil*. The cardiologist who wrote the Rx states that he wrote *Isordil*. The jury found that the cardiologist was negligent for writing the prescription illegibly and awarded damages of $450,000.00" [2].

The cause of this error may be one or many among negligence (as found by jury), stress, perception of pharmacist, poorly designed systems. The above explained example is one among the many instances happen every year because of the unintentional injury. According to the Drug Abuse Warning Network (DAWN) estimates there were 1.7 million cases in emergency department (ED) that could be associated with drug misuse and abuse in the U.S. for the year 2006. Recently there have been several instances where adult doses of heparin have caused infant deaths. Eliminating this type of preventable medical errors using the modern methodology and technologies and the impact these technologies have on the society is the primary focus of this research. The other outcome of this research study would be to study the improvement in health care quality and patient safety. Health care can utilize the methods and best practices from other industries that have utilized this methodology as a means to attain significant reduction in overdose and abuse. The novelty and significance of this work is that it attempts to design, develop, and evaluate alternate technologies that can have an economic and societal impact in near future.

1.1 Automated Identification Technologies (AIT) in Health care systems

Automated Identification Technologies (AIT) have become common place in access control and security applications, in industries requiring the tracking of products through the supply chain or manufacturing process, and in industries requiring the identification of products at the point of sale or point of service [3]. AIT's such as RFID and barcode reading are perhaps the best technologies that can be recruited to address the problems of medication errors.

A study performed in Taiwan describes how RFID can be utilized as a health care information system in which RFID can be used for patient identification, avoidance of wrong usage of drugs, the warehousing of medical objects, and the prevention of counterfeit drugs [4]. Among other types of advantages that may be impacted by RFID include identification of medication errors that were found to be highly significant and have a high frequency of occurrence [5]. Barcode scanning is the machine-readable identification system that has been widely accepted in the operations of industrial manufacturing, shipping, and inventory control [6].

Figure 2: BCMA in patient and drug identification.

The use of bar-code medication administration (BCMA) systems to improve patient safety has been recommended by many organizations, including the Institute of Medicine, the National Patient Safety Foundation, the American Society of Health-System Pharmacists, and the National Alliance for Health Information Technology [7]. The methodology of integrating barcodes into the system has been widely called Bar-code Point of Care (BPOC).

Published studies have also reported the use of Computerized Physician Order Entry (CPOE) [8]. CPOE is the process of entering instructions regarding prescriptions into the system through a computer screen at the point of care by the physician. CPOE has significant benefits in error reduction and guideline adherence, but its implementation has often been complicated by creating a gap in an established workflow process [8]. This CPOE technology implementation includes a large up-front investment with more remote, albeit substantial returns [9]. The complexity in implementation can be reduced by close integration with multiple systems in the laboratory and pharmacy systems. Failure to give close attention to the impact of large-scale efforts on organizational culture and dynamics may result in total implementation failure [10]. The figure 3 below shows a model health care organization that utilizes RFID in all aspects of operations. RFID is the latest addition to the AIT in health care. Details about implementation of RFID are explained in section 3 of this article.

2. Evaluation of Health Care Economic Societal Impact

The process of evaluating the economic societal impact of using the above described technologies like BCMA, CPOE, and RFID uses a variable "medical loss ratio". This article would the use the methodology described by Dr.

James C. Robinson from his research article on the medical loss ratio for measuring the performances of health plans. Medical loss ratio as explained in the literature is the percentage of revenue or the amount from the insurance plans that is used to pay for health care of the customers.

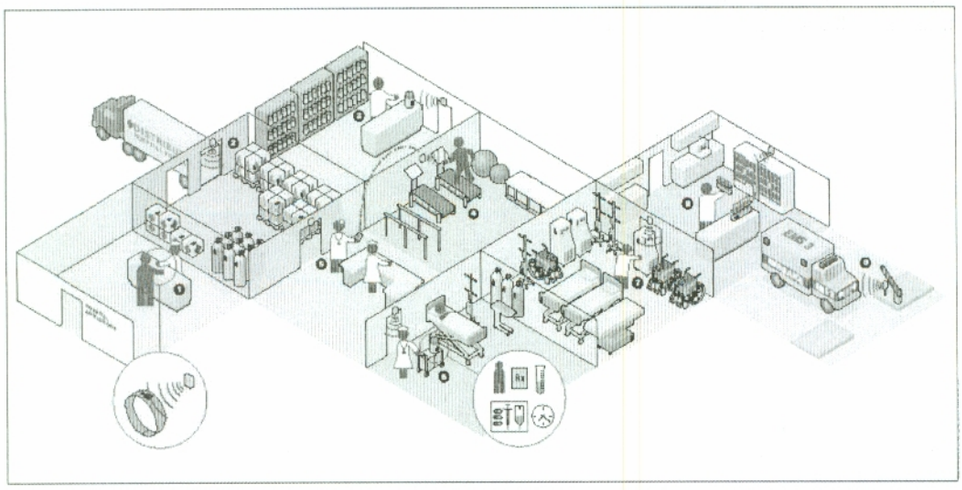

Figure 3: Schematic process flow in an automated hospital [10]

A medical loss ratio of 85 percent indicates that the insurer is using the remaining 15 cents of each premium dollar to pay expenses that do not directly benefit policyholders, such as salaries, administrative costs, advertising, agent commissions and profits. This research transcript plans to use health life benefit ratio's to justify the need for the use for AIT's in health care organizations. It is a simple calculation adopted from insurance industry to evaluate the impact on society by automating hospital operations with technologies like BCMA, RFID in comparison to organizations without automation and also between automated identification technologies. Much of the interest in and demand for medical loss ratio has come from the customers seeking measures of health care value, efficiency, and quality. The medical loss ratio among the other data elements stands out in its simplicity and its link to plan efficiency and the service quality for the health care organizations.

Medical loss ratio for implementing automation technologies and the non-automation scenario will be analyzed and a comparison of medical loss ratio between the individual automation technologies described in section 1 would be done and the best technology would be recommended for health care organizations and health care departments. The tabular calculations would be similar to the ones explained by Dr. James C. Robinson in his article [12]. The table below shows the sample medical loss ratio calculation table for two insurance plans. Similar calculations would be performed for selected AIT's as shown in table 2. These calculations would be based on fixed and variable costs of implementation and the benefits would be evaluated that the hospitals would have by the implementation of various Automated Technologies.

Table 1: Medical, Administrative, profit ratios from selected technologies [12]

	Status*	Medical Loss ratio	Administrative Loss Ratio	Profit Ratio
Blue Cross of California	NP	93.5	4.2	2.4
California Care	FP	73	16.3	10.6

Table 2: Model Calculation table for AIT

	Status*	Medical Loss ratio	Administrative Loss Ratio	Profit Ratio
RFID				
BCMA				
CPOE				

Status*= Non Profit/For Profit Organization

The impact of the improvements would be visible in the areas of patient safety, asset tracking, operation costs, and inventory control. Medical loss ratio calculations would assist policy makers to justify the need for implementation of these AIT's in pharmaceutical industry and hospitals.

3. Evaluating the Implementation of Costs for Automation

The basics of economic evaluation involve identifying measuring, valuing, and comparing the costs and benefits of alternatives are being considered [13]. The real cost of any health care intervention is the loss of health outcomes from other programs that have been forfeited by putting the resources in question into the first program [14].

Automation of the health care organizations by BCMA and RFID would greatly reduce the possible medical errors, improve the hospitals operational ability, and greatly improve drug tracking to assist pharmaceutical industry. This section would discuss the advantages of using these AIT's and provide the explanation to justify the adoption and implementation of these technologies in pharmaceutical industry and hospitals by comparing the supply chain operations of other industries and the results achieved by implementation.

Let us study the results when RFID technology was installed in a hospital. "The regular installation cost of RFID system is a one-time $35,000 expense. This includes a computerized storage cabinet and additional $ 15,000 for the software systems integration required to be integrated for the hospital's electronic medical record and radiology information systems. The annual maintenance and software cost accounts for approximately to $10,000 and savings of $ 31,370. The calculations based on net present value (NPV), the payback period in years and economic models were analyzed in this case study. The discount rates for the analysis were 5%, 10%, and 15% and a life expectancy of 10 years was assumed for the installed RFID technology in the hospital. The inventory savings resulting from the installation of RFID system in the organization had a positive NPV over a broad range of discount rates. From the traditional financial theory, if the NPV of a project is positive, it would be wise to invest in it rather than doing nothing. Projects that have positive NPV then add value to the organization. An effective 41% IRR from this analysis ensures that this percentage would get a NPV greater than zero by installing the RFID system. Also, there are many other quantitative and qualitative savings that can be achieved by installing the RFID system like improved patient care and patient safety, overall personnel efficiency, and an improved methodology for billing/ reimbursement department" [15].

The main focus of the section would be discussion of the results published in the case study report of a multi-national organization with large variety of consumer goods. The case study was "Analysis of Automatic Identification Technology-enabled Business Process Benefits" [16]. The study used two scenarios to evaluate the impact of implementation of barcode and RFID. Barcode and RFID are in compliance with ePedigree and can be easily embedded into the existing supply chain system. The tasks in the supply chain in packaging were items packaged into cases, cases to pallets, pallets moved, packaged, made into lots, and loaded into truck for delivery. The tasks in warehouse/distribution were delivery is unloaded, stored, order received for delivery, order checked, product moved and loaded into the truck.

These two scenarios were evaluated with RFID and barcode embedded at prefixed sections individually. This evaluation was done to calculate fixed costs of the implementation, elimination of unnecessary tasks as a result of automation, average time saved and labor savings. An in-depth analysis of the data from the two cases yielded that required process time was reduced by 8% in the case of barcode and was 26% for RFID. There was 67% reduction in overages, shortages, and damages (OSD) in both the cases of barcode and RFID.

The Return On Investment (ROI) for these technologies was summarized by the key performance results in terms of costs and expected time savings. The table below shows improvements in various sections of the supply chain. An additional ROI for fixed and variable costs for each technology was also performed. There was a 10% and 95% reduction in case of packaging and 50% and 95% reduction in warehouse/ distribution section with the use of barcode and RFID respectively. All these results can be easily adapted into pharmacy industry.

Table 3: Time and Accuracy Improvements for RFID and barcode

	RFID	2-D Barcode
Order Cycle Time	0.37%	0.12%
Average Labor Time	26%	8%

Annual Order Throughput	0.15%	0.08%
Annual OSD	67%	67%

In summary, recent studies on AIT have highlighted the implementation of barcodes and RFID into the all aspects of industry. Based on the body of knowledge, there are several contrasting views on the best technology for hospitals. For the pharmaceutical industry, using barcodes to secure the drug supply chain is considered impractical and inefficient because barcodes have "limitations around item level identification and require manual intervention." However, RFID technologies do not require the same level of manual intervention and thus are feasible for the pharmaceutical industry. RFID technologies can extend beyond medication tracking to help hospitals monitor instruments and disposables using RFID tagging, automated counting and alarms. RFID tagging can assist hospitals with locating, taking inventory of and re-ordering high value assets in a timely manner, reducing staff search time and improving the timeliness of patient care.

The figure below shows the future of supply chain for a pharmaceutical industry that would result from the automation of supply chain using RFID technology. The drugs are made so that can be identified at dosage level with a small biocompatible RFID tags on the individual doses. These tags on the doses, devices can help in locating; avoid marketing of counterfeit drugs, also to the level that if the patient/nurse has wrongly reported that the particular drug has been administered to the patient which was not administered at right time or to the right patient.

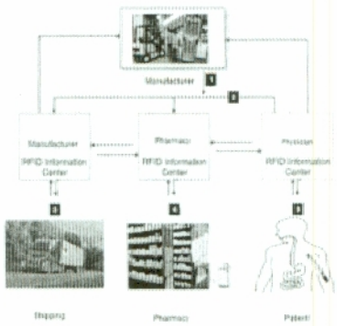

Figure 4: The future of integration of RFID technologies in pharmaceutical industry and hospitals [17].

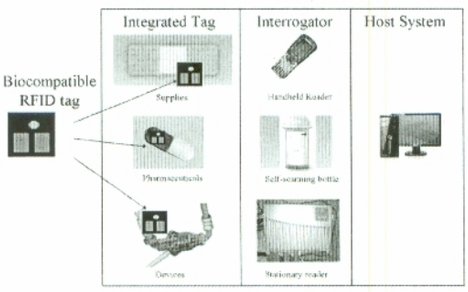

Figure 5: RFID embedded in Medical devices and on individual doses.

4. Conclusion

From the discussion and results in section 3, it is understood that adoption and implementation of AIT's in pharmacy and health care organizations would likely improve the overall performance of the health care industry in various aspects. The results from the case studies validated the implementation of AIT's with positive NPV and with an impressive payback period. One simple outcome of this would be the possible of reduction of medical errors. Apart from the benefits that other industries have achieved with the implementation of RFID, the scope for improvement

in pharmaceutical and health care organizations is enormous. The one of the important benefit among them is the possible reduction of medical errors.

Scope for Future Research

Further research would validate the results in this area of patient identification and dosage level tracking. Also calculation of medical loss ratio for AIT's (table 2) to justify the need for implementation of AIT's would assist in decision makers. Medical errors can be reduced by using a patient identification band for every patient. The band would have encrypted data about the medical history of the patient and can help in monitoring the drugs and dosages administered to the right patient at the right time. With drugs track-able to the dosage level the nurses can now monitor whether the dosage has been actually ingested with the RFID scanner to scan in the dosage in the patient stomach. The results would have a positive impact on patient safety by reducing medical errors and might aid in reduction of ever increasing medical costs.

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