Utilization of Pharmacy Automation For the Reduction of Adverse Drug Events In the Veterans' Administration Medical Center Setting

Abstract

The occurrence of adverse drug events in the United States Healthcare System is a great burden upon the nation's resources. The number of adverse events has increased at such a rate that it now represents one of the greatest drains upon the efforts of the nation's healthcare providers to ensure optimum pharmacotherapeutic outcomes for patients. In recent years, a great endeavor has been initiated to try to find the causes, demographics, and possible solutions to help stop the vast proliferation of adverse drug events. The United States Veterans' Administration is a forerunner in examining new and revolutionary solutions to alleviate the burden presented by the occurrence of adverse drug events in the nation's healthcare system. The fact that all Veterans' Administration Medical Centers are teaching hospitals, have an aging population that requires multiple drug regimens, and have the direct backing of the United States Government makes them a perfect testing ground for new medication management systems and dispensing technology. One such alternative technology that shows great promise for stopping the occurrence of adverse drug events is the use of ***Automated Pharmacy Services*** within all Veterans' Administration Medical Centers in the United States.

Introduction

It has become the norm that hundreds of new, ever-potent, and pharmacologically diverse medicines are released into the mainstream pharmaceutical market every year. With the release of these drugs, great strides have been accomplished in treating previously inoperable disorders and improving the prognosis of patients everywhere. An ever-growing problem associated with these drugs, however, is the escalating occurrence of adverse drug events associated with their administration. The growing trend in preventable adverse drug events shows a drastic increase in number over a relatively short period of time. In 1994 alone, *702,000* adverse drug events in the United States resulted in emergency room visits or hospital admissions. Similarly, in the same year, *1,547,000* patients experienced an adverse drug event while being treated in an American hospital. By combining these numbers, the total number of adverse drug events estimated in the United States in 1994 would have been *2,216,000*.[1]

Great efforts have been exhausted trying to find the nature, causes, and most importantly solutions to help halt the vast proliferation of adverse drug events associated with the administration of drugs. Although there are no clear or complete solutions to this problem, recent advances in technology and drug distribution management show great promise in eliminating drug errors and eventually adverse drug events.

This study will aid the reader by documenting the demographics of adverse drug events, which relate directly to their occurrence. Furthermore, this study will explore recommendations given by pharmaceutical associations, private organizations, and government agencies that will help prevent adverse drug events. Lastly, this study will explore and review technologies such as bar code medication administration and pharmacy distribution automation as alternative ways to help reduce adverse drug events.

Demographics, Nature, and Causes of Adverse Drug Events

For the purposes of this study, adverse drug events will be classified as, "any noxious, unintended, and undesired effect of a drug, which occurs at doses used in humans for prophylaxis, diagnosis, or therapy.

This definition excludes therapeutic failures and intentional misuse of a drug in abuse or poisoning. This definition does include errors in administration".[1]

Adverse drug events are an important indicator of the quality of health care providers, institutions, and systems.[2] Historically, increased numbers of adverse drug events in healthcare institutions has been viewed as inversely proportional to the quality of care that an institution is able to provide. For several decades, the occurrence of adverse drug events has been blamed exclusively on human error and other processes controlled solely by human workers. Now, however, it is more apparent that several other factors determine the frequency of adverse drug events in any given institution. Some factors predisposing institutions to high numbers of adverse drug events include: human error, overwhelming inpatient workload, system failures, lack of adequate clinical pharmacy programs, lack of modern order entry and managing systems such as electronic order entry or bar code medication administration, and inefficient, unreliable, or error prone medication dispensing systems.[3]

Statistics Related To The Occurrence of Adverse Drug Events

With adverse drug events reaching epidemic numbers in recent years, members of higher education, pharmaceutical organizations, and the government have devoted large sums of money and effort to examining the problem and searching for possible solutions.

If anything can be derived from the scientific literature available today concerning adverse drug events, it is that their number, frequency, and severity is growing exponentially. For example, while researching adverse drug events in a larger tertiary teaching hospital, Timothy S. Lesar found that between 1987 and 1995 adverse events related to medication prescribing rose from ***522*** to ***2,115***. In the same study, Lesar concluded that overall clinically significant error rates for the hospital were, ***2.87*** errors per 1,000 medication errors, ***6.52*** errors per 1,000 patient days, and ***5.29*** errors per 100 admissions.[4] In a similar study performed by Leape, et al., retrospective review of 30,195 randomly selected hospital records demonstrated that the occurrence of adverse drug events represented ***19%*** of all medication administrations.[5]

Prince et al., found that ***2.9%*** (293 out of 10,184) of all patients visiting the emergency department of a 517-bed tertiary care institution were victims of drug-induced illnesses or adverse drug events.[6] Adverse Drug Events are a real and very dangerous problem and no break in their steady climb is visible in the near future.

Costs Associated With Adverse Drug Events

The annual costs associated with adverse drug events in the United States are staggering. These costs represent expenditures for prevention of adverse drug events, costs of post-event treatment of patients, and all-to-often the costs associated with litigation after the injury of a patient.

In 1994, drug-related morbidity and mortality constituted a cost of ***$76.6 billion*** (C.I. $30.1 to $136.8 billion) to the United States healthcare system.[7] A summary of costs directly associated with drug-related morbidity and mortality is given below:

Table 1:

Costs Associated With Drug-Morbidity and Mortality

	# of Events	Cost
Physician Visits:	115,654,949	$7,459,744,000
Additions Prescriptions:	76,347,604	$1,933,121,000
Emergency Department Visits:	17,053,602	$5,320,723,000
Hospital Admissions:	8,761,861	$47,445,477,000
LTC Admissions:	3,149,675	$14,398,644,000
Deaths:	198,815	***
Totals:	***	**$76,557,711,000**

[1]

In a related study, Bates et al., derived findings which stated that ***3.7%*** of patients hospitalized in New York in the Harvard Medical Practice Study experienced an adverse events while in the hospital. Of these events, drugs (at 0.7%) constituted the greatest cause of observable adverse events. In the same hospital study, the overall adverse drug event rate was found to be ***6.5*** per 100 admissions of which ***28%*** were judged to be preventable.[8]

During the study, 4,108 admissions to a tertiary hospital were reviewed. One group, termed "cases", included patients who had experienced an adverse drug event while in the hospital. A second group, termed "controls" included patients from the same floors as the "cases" group and who had similar afflictions, but who had not experienced an adverse drug event. Patients who experienced an adverse drug event while in the hospital stayed an average of ***8.5*** days longer than those patients in the control group. Furthermore, patients who experienced an adverse drug event paid an average of ***$23,357*** more than other patients in the control group of the study. When extrapolated to the rest of the country, it was found that costs of adverse drug events related to medication administration for similarly-sized hospitals was ***$5.6 million*** per year. For preventable adverse drug events, the corresponding cost was ***$2.8 million*** per year.

As a result of his study, Bates found that on average, an adverse drug event was associated with ***$2,595*** of additional cost to the hospital and the patient. This figure can be doubled when considering preventable adverse drug events.[8] This is compared to previously released information that documented an increase in overall cost of therapy of only ***$1,939***.

Table 2:

Resource Utilization and Costs Associated With Adverse Drug Events and Hospitalization

	Cases (n=190)	Controls (n=190)	Entire Cohort (n=4108)
Length of Stay:	20.4	18.2	11.9
Total Hospital Charges:	$51,640	$46,467	$28,283
Total Costs To Patients:	$27,173	$24,974	$12,452

[8]

The greatest cost realized by the American healthcare system as a result of adverse drug events is the loss of human life. In 1994, adverse drug events were believed to have taken 106,000 American lives.[1] This would translate into 4.6% (106,000 of 2,286,000) of all deaths during 1994 being caused by adverse drug events. Mathematically, this would make adverse drug events the ***4th*** leading cause of death in America.

The only other causes of death that superceded adverse drug events in 1994 were heart disease, cancer, and stroke.[1]

Table 3:

Causes of Death In America For 1994

Ranking:	Disease State:	# of Deaths:
1st	Heart Disease	**743,460**
2nd	Cancer	**529,904**
3rd	Stroke	**150,108**
****4th***	Adverse Drug Events	**137,000**

*Adverse drug events would constitute the fourth leading cause of death in the United States if the upper limit (137,000 deaths) of the tabulated critical interval derived by Lazarou et. al. were used. If the lower limit (76,000 deaths) were used, adverse drug events would constitute the sixth cause of death after pulmonary disease (101,077 deaths) and accidents (90,523 deaths)in the United States.[1]

Recommendations To Reduce The Number of Adverse Drug Events and Improve Patient Care

As the occurrence of adverse drug events quickly began to spiral out of control, it became apparent that wide-reaching changes to the accepted medication administration and distribution processes were needed. In 1994, the American Society of Hospital Pharmacists (now American Society of Health-System Pharmacists) supported a joint coalition with the American Medical Association and the American Nurses Association to study the occurrence and possible preventability of adverse drug events.[9] After much review, the coalition derived seven main actions that hospitals could enlist to help reduce the number of adverse drugs events. The seven possible actions that hospitals could enlist to reduce adverse drug events are summarized below:

1. ***Hospitals should establish processes in which prescribers enter medication orders directly into computer systems.***

2. ***Hospitals should evaluate the use of machine-readable coding (e.g., bar coding) in their medication-use processes.***

3. ***Hospitals should develop better systems for monitoring and reporting adverse drug events.***

4. ***Hospitals should use unit-dose medication distribution and pharmacy-based intravenous medication admixture systems.***

5. ***Hospitals should assign pharmacists to work in patient care areas in direct collaboration with prescribers and those administering medications.***

6. ***Hospitals should approach medication errors as system failures and seek system solutions to preventing them.***

7. ***Hospitals should ensure that medication orders are routinely reviewed by a pharmacist before first doses and should ensure that prescribers, pharmacists, nurses, and other workers seek resolution whenever there is any question of safety with respect to medication use.***[9]

All seven of these recommendations have the design and ability to greatly reduce the number of medication errors and adverse drug events in the United States. In order to realize the benefits of the above recommendations, essential system changes must be made. One such change that shows great promise for the United States Veterans' Administration to help in the reduction of adverse drug events is the implementation and use of Inpatient-Base Automated Pharmacy Systems.

Automation Pharmacy Distribution

Automation pharmacy distribution is an extremely dynamic field. Just ten years ago, there were only five American firms that offered pharmacy automation products and / or services. Today, that number has grown to more than thirty providers and continues to rise every year (please see table D below). Similarily, the number of acute care hospitals utilizing some form of pharmacy automation has grown from zero to more than 3,000.[10]

Table 4:

Pharmacy Automation Providers In The United States

Company Name	Location	Company Name	Location
ADDS	Bellerica, MA	KVM Technologies	Houston, TX
ApotheTech	Colombus, OH	LifeServ Technologies	Clearwater, FL
Autros	Toronto, CAN	Lionville Systems	Wxton, PA
AutoMed Technologies	Buffalo Grove, IL	McKesson APS	Pineville, LA
Baxter Healthcare	Round Lake, IL	McKesson Automated Healthcare	San Francisco, CA
Bridge Medical	Solana Beach, CA	Medical Packaging Systems	Ringoes, NJ
Diebold	Canton, OH	Medical Technology Systems	Clearwater, FL
Health Care Systems	Birmingham, AL	NextRx	Bothell, WA
Health Systems Services	Houston, TX	Omnicell Technologies	Palo Alto, CA
Innovation Technologies	Johnson City, NY	Pyxis Corporation	San Diego, CA
Integrated Dispensing Systems	N/A	Script Pro	Shawnee Mission, KS

This drastic increase in the number of pharmacy automation providers and pharmacy automation users is evidence that a new and beneficial technology has been created and should be taken advantage of.

The publication that is considered the "textbook" on automation in pharmacy is the White Paper On Automation In Pharmacy, published by the Pharmacy In Automation Initiative.[11] The publication is an extremely informative source concerning the implementation of pharmacy automation. The purpose of the Pharmacy In Automation Initiative is to, "address issues affecting pharmacy and automated equipment in all practice sites, particularly issues concerning patient safety, control and appropriateness of access to medications, and possible legislative and regulatory barriers to automation in pharmacy".[11] From their work, the Pharmacy In Automation Initiative hoped to ease and accelerate the transition of the pharmacist from the traditional dispensing role to that of a patient-focused (clinical) service provider.[11]

Advantages of Automated Pharmacy Distribution

Pharmacy automation truly enables a vast re-engineering of the entire practice of pharmacy and allows the individual pharmacist to escape the confines of pharmacy distribution and embrace the practice of true pharmaceutical care. Currently, there are over ***190,000*** licensed pharmacists in the United States. A full two-thirds of these people practice in community pharmacies. By removing the burden of pharmacy distribution, pharmacists in the community settings would have direct contact with patients and an easier means of carrying out pharmaceutical care.

The writers of the White Paper On Automation In Pharmacy are quick to point out that several basic changes concerning the profession of pharmacy must take place in order for pharmacists to accept their role as pharmaceutical care experts. The most difficult change that pharmacists will incur is to change the profession's focus from that of output (filling prescriptions) to the outcome of drug therapy. For pharmacists to easily transition into this role as drug therapy specialists, new skills must be learned. Similarily, if the clinical pharmacists is to fully take advantage of and utilize automated pharmacy services, new technical skills must be mastered. New skills related to pharmacy automation are as follows:

1. How to operate automated pharmacy systems in order to produce the outcome desired.

2. How to recognize when a system failure occurs or is imminent.

3. How to compensate to protect patient safety when a system failure does occur.

4. How to get failures corrected expeditiously.

Pharmacy automation possesses several characteristics which makes it more suitable to efficiently dispensing medications than traditional human-run manual systems. Pharmacy automation is beneficial in the fact that it can out-perform humans in tasks that require tedious repetition, tiresome movement, intense concentration, immense memory retention, and meticulous record keeping. Furthermore, automated pharmacy systems are superior to manual pharmacy systems because they are able to reduce medication errors, improve documentation, improve and increase authorized access to medications and information, and enhance security within the pharmacy. One recently realized advantage of automated pharmacy systems is that institutions who have utilized automated pharmacy technology have seen fewer turnovers of pharmacists over a number of years. These phenomenon has been attributed to the fact that automated pharmacy systems free pharmacists from tedious dispensing functions and allows them to pursue the clinical aspects of their jobs (i.e., pharmaceutical care). When pharmacists are more involved in direct patient care, the outcome is quite simply increased productivity, increased accuracy, better drug-use control, and a vast improvement in patient care.

As eluded to in the above paragraphs, when pharmacists are allowed to participate directly in patient care, patient outcome is improved, length of stay is decreased, and the cost of medical care is reduced. Although it is difficult to quantify in financial terms, pharmacists do have a positive outcome on patient care. Continuously, it has been shown that when pharmacists are not burdened with distribution and are allowed to concentrate on patient care, the result is an overwhelmingly positive patient outcome. Automated pharmacy systems allow this to happen. For example, in a study performed by Schneider et. al. it was determined that ***$3.9 billion*** was spent in 1983 in the United States to manage the preventable gastrointestinal adverse effect of nonsteroidal anti-inflammatory drugs (NSAIDS).[12] These costs could have been easily avoided if drug information experts such as clinical pharmacists were more closely involved with the individual patient's pharmaceutical care. Lesar et. al., has shown that improving the availability of pharmacists and overall pharmacy services in a hospital directly correlates with reduced length of stay and decreased incidence of mortality.[4]

Likewise, in a recent study performed by George Haig and Lori Kiser, it was determined that utilization of pharmacists on medical teams within hospital acute care wards was directly related to reduced pharmacy

costs and charges, hospital charges, and patient length of stay.[13] The savings in pharmacy costs, pharmacy charges, hospital costs, and patient length of stay are diagramed in **Table 5** below:

Table 5:

Savings Realized When Pharmacists Are Included In Patient Care Teams

	Control Team (A)	Pharmacist Team (B)	p-Value
Pharmacy Costs:	$278	$173	*0.0124*
Pharmacy Charges:	$1,020	$652	*0.0008*
Hospital Charges:	$8,187	$6,122	*0.0013*
Length of Stay:	7.2 days	5.9 days	*0.0036*

[13]

Recently, the most convincing evidence promoting the removal of pharmacists from dispensing functions and inclusion into clinical medical teams was published in the July 21, 1999 edition of the Journal of the American Medical Association. The study, "Pharmacist Participation On Physician Rounds And Adverse Drug Events In The Intensive Care Unit" was performed by Leape et. al. in a large urban teaching hospital. The study was designed to measure the effect of pharmacist participation on medical rounds in Intensive Care Units of teaching hospitals and to quantify whether pharmacist participation could lower the rate of preventable adverse drug events caused by physician ordering errors.[14]

The results of the study were overwhelmingly favorable. When pharmacists were allowed to participate in the ICU rounds, the rate of preventable ordering adverse drug events decreased ***66%*** (from ***10.4*** adverse drug events per 1000 patient days to ***3.5*** adverse drug events per 1000 patient days).[14] The rate of adverse drug events actually increased in the control group from ***10.9*** adverse drug events per 1000 patient days to ***12.4*** adverse drug events per 1000 patient days.[14] Of the 366 recommendations made by team pharmacists for changing drug orders, 362 were accepted by physicians. The ***98.91%*** acceptance rate of prescribing recommendations shows that the pharmacists on the hospital ICU teams were giving necessary information and were being taken seriously by their physician counterparts.

The pharmacists on the ICU round were able to prevent ***58*** adverse drug events on one single unit during the duration of the study. By preventing the ***58*** adverse drug events on this single unit, it was estimated that the pharmacists had saved the hospital ***$270,000.00***.[14] The findings of the Leape et. al. study are detailed in Tables 6 and 7 below.

Table 6:

Number of Preventable Adverse Drug Events Avoided When Pharmacists Are Included On ICU Medical Teams

	Study Group	Control Group
Rate of Preventable Ordering Adverse Drug Events Per 1000 Patient Days:	***3.5***	***10.4***
Percentage Drop In Adverse Drug Events:	***66%***	

[14]

Table 7:

Cost Avoidance Realized When Pharmacists Are Included On ICU Medical Teams

	Study Group	Control Group
Adverse Drug Events Prevented:	58	N/A
1995 Cost Per Adverse Drug Event:	$4,685.00	N/A
Total Cost Avoidance:	***$271,730.00***	N/A

[14]

A similar study examining the effectiveness of pharmacists in the hospital setting was performed by Bjornson et al. to look at the cost : benefit ratio of including pharmacists on medical care teams. This study compared data collected for 3,638 patients at Walter Reed Army Medical Center-Washington, D.C. When pharmacists were included on medical care teams, it was shown that ***$377.00*** per patient admission was saved, annual return on investment for all staff pharmacists was ***$150,951.00***, and length of stay was significantly reduced (***p=0.032***).[15] The findings of the Bjornson et. al. study are detailed in Table 8 below.

Table 8:

Description of Favorable Results When Pharmacists Are Included On Medical Teams In An Army Hospital

Category Reviewed	Results
Amount Saved Per Patient Admission:	**$377.00**
Return On Investment For Pharmacists:	**$150,951.00**
Length of Stay:	Significantly Reduced (**p=0.032**)

[15]

Pharmacy automation will drastically change the profession of pharmacy as we know it. Pharmacists stand at a proverbial fork in the road in relation to where their profession will grow. Mark Boesen, Pharm.D., AACP's director of government and student affairs stated, "Automation, robotics, and unit-dose packaging are cutting down the number of pharmacists needed to take drugs from big bottles and put them into little bottles. What's needed now is the pharmacist who can sit down with a patient and explain how to use the medications".[16] As seen with the last statement, the prevailing idea with many pharmaceutical policy makers is that pharmacy automation is a good change and will be a benefit to the profession as a whole. There will always be a need for distribution pharmacists, but that need will greatly diminish over the next several years. This change has already been accepted by much of the pharmaceutical industry, managed care organizations, and by several deans of Colleges of Pharmacies. David Slatkin, Ph.D. was quoted as saying, "Automation is needed because the number of prescriptions will grow. The robots are coming, we know that, but somebody's got to manage the whole system…that's what pharmacists should be doing".[16]

Review of Three Automated Pharmacy Systems

As outlined earlier, there are over thirty providers of automated pharmacy services. This section will review three automated services available to inpatient hospital pharmacies within the United States.

The first system to be reviewed is the Medstation Rx produced by Pyxis of San Diego, CA. The Medstation Rx system promises dramatically decreased inventory costs, automation or elimination of many of the steps in the medication and supply distribution process (thereby reducing labor costs), tracking of medication and supply usage, controlled access for authorized personnel only, reduced medication adventures (adverse drug events), and increased time and energy that staff can direct to patient care.[17]

The Medstation Rx is an automated, computer-controlled device that stores and directly dispenses medications in hospital nursing wards (L). The Medstation Rx was recently evaluated in a 600-bed teaching hospital. Nurses assigned to nursing units on which the Medstation Rx machines were being tested were asked evaluate the system for ease of use. The Medstation Rx was preferred by the nursing staff because it had the ability to identify the person removing medications for a particular patient, the patient for whom the dose was intended, and the time of the transaction. This improved system of medication management relieved the hospital's nurses from performing tedious medication record keeping tasks when administering medications (especially controlled medications) to their patients. When a study was performed comparing the Medstation Rx with the hospital's traditional manual medication distribution process, it was found that the automated pharmacy system was far superior. The study was divided into two equal test periods termed Phase 1 (manual medication distribution) and Phase 2 (Medstation Rx medication distribution). When the hospital was utilizing manual distribution of medications, there was a total of ***148*** medication errors out of ***873*** observed medication administrations. This translated into a medication error rate of ***16.9%***. When the Medstation Rx was utilized for medication distribution, however, there were only ***97*** medication errors out of ***929*** medication administrations. This translated into a medication error rate of ***10.4%***. The overall medication administration error rate for the hospital had fallen by ***38.50%*** by switching to the Medstation Rx automated pharmacy system.[18]

Table 9:

Outcomes Observed By Utilizing the Pyxis Medstation Rx Automated Medication Dispensing System

Variable		Manual Distribution	Medstation Rx
# of Observations:		873	929
# of Medication Errors:		148	97
Total Error Rate		**16.90%**	**10.40%**
Total % Drop In Medication Errors:	**38.50%**		

[18]

The second pharmacy automated technology that this paper will explore is the Robot-Rx system offered by McKessonHBOC Automated Healthcare. The Robot-Rx system allows hospital inpatient pharmacies to automate storage, dispensing, and restocking of medications from a centralized location. Since the McKesson family of automated systems was one of the pioneers in the pharmacy automation industry, the Robot-Rx and its fore-runners have been rigorously tested and critiqued.

The use of the Robot-Rx system in the inpatient hospital pharmacy setting has been shown to be beneficial in several areas. First, the Robot-Rx system has the potential of saving money for the hospital pharmacy by reducing costs associated with manual pharmacy tasks and by reducing inventory. In essence, the Robot-Rx creates a "just-in-time" environment with the pharmacy inventory eliminating waste and freeing up valuable floor-space for other functions. Secondly, the Robot-Rx system frees up pharmacists for clinical activities within the hospital.[19] As stated previously in this paper, utilization of pharmacists in clinical outcome programs within hospitals has been shown to reduce pharmacy and hospital costs, decrease average length of stay per patient, and show a positive return on investment for pharmacist employment and purchase of pharmacy automation machinery.

In July of 1999, McKessonHBOC performed a cost : benefit analysis for implementation of pharmacy automation services into the inpatient pharmacy of the Durham Veterans' Administration Medical Center in Durham, North Carolina. The study required approximately one week to complete and required the input of several employees and supervisors within the pharmacy. After an unbiased review of the findings, it was determined that the Durham VAMC would benefit from the installation of automated pharmacy services within its inpatient pharmacy facility. Total Robot-Rx investment would equal ***$1,439,714.00*** and would include all equipment necessary to make the Durham VAMC inpatient able to dispense up to ***95%*** of its medications by automated pharmacy distribution. After considering redeployment of pharmacists to clinical duties within the hospital and elimination of other costs such as inventory, total savings potential would equal ***$2,699,148.00***. This would translate into a net savings of ***$1,259,434.00*** and a return on investment of ***41.3%*** for the Durham VAMC in just 5 years time.[20]

Table 10:

Net Savings Potential and Return On Investment By Utilizing The McKesson HBOC Robot-Rx Automated Healthcare System

Total Robot-Rx Investment:	**$1,439,714**
Total Savings Potential:	**$2,699,148**
Net Savings Potential:	**$1,259,434**
Return On Investment:	**41.30%**

[20]

The last automated pharmacy system that this study shall review is the ***NextRx System*** produced by the NextRx Corporation of Bothell, Washington. The ***NextRx System*** family of products are unique in that they offer "true" unit-dose administration of medications. The ***NextRx System*** includes the "NextCentral", the "NextCart", and the "NextPatient". The "NextCentral" is a multifunctional "dock-side to bed-side" unit-dose medication distributor which promises to have a virtually perfect filling percentage. The "NextCart" is NextRx's version of the ultimate cartfill. The "NextCart" has the ability to store all medication forms including refrigerated, scheduled, controlled, PRN, and first doses directly on the patient floors for nurses to utilize on demand. Lastly, the "NextScan" allows users of the NextRx system (mainly nurses) to scan patient's wristbands and the patient's corresponding medications to ensure that all doses are being administered correctly.

The NextRx System claims the promise of being the first totally-integrated Automated Pharmacy System, automating the dispensing of unit dose medications from the original order entry to medication administration at the patient's bedside. A seamless operation for filling prescriptions is highly conducive for reducing medication errors in the long run. Furthermore, since the ***NextRx system*** was developed by physicians, pharmacists, and nurses jointly, it possesses the refinement ideas of the three major healthcare professions which would benefit most from the ***"system's"*** implementation in the hospital setting.[21]

Conclusion

In the pharmaceutical field, things change at an amazing pace. In the early 1960's, the newest technology that promised to revolutionize the practice of pharmacy was the use of unit-of-use or unit-dose packaging for the convenient dispensing of medications.[22] Now, dispensing medication is more of an art form than merely a function of a job. The pharmacist of the not-so-distant future will have to possess the knowledge of a clinical practitioner, a benevolent and kind counselor of patients, and possibly (to some extent) be a wizard of complex automated filling systems.

In the past, Automated Pharmacy Systems were out of the reach of most health care facilities due to expense and the inability of pharmacy departments and nurses or physicians to agree on what they wanted from the technology.[23] Can American healthcare professionals ignore new technologies that are available and allow the widespread problems and related dangers of adverse drug events to continue to spiral upward and out of control? The answer is (quite simply) "no".

As pharmaceutical healthcare providers, we have an inherent responsibility to continuously search out new means of improving patient therapy and outcomes. Before good pharmaceutical outcomes will ever be realized, the profession of pharmacy must cut loose the *Albatross* of adverse drug events that hangs around the neck of all American healthcare providers. Automated Pharmacy Services should be evaluated and adopted if they show a drastic reduction in the occurrence of adverse drug events. The findings of this study firmly point in the direction of implementation of Automated Pharmacy Services in the inpatient hospital pharmacy setting.

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