



Medication System Automation:

A Business Case Template for Pharmacy
July 2011



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1. Introduction

1.1. Project Objectives

To develop a comprehensive Business Case template which can be utilized by Medbuy members when applying for capital funding approval for the acquisition of equipment/technology for the purposes of automating any or all segments of the medication management system within their institutions.

Specifically:

- To develop a comprehensive business case template
- To assure the template can be used by Medbuy members when applying for capital funding approval for the acquisition of equipment and/or technology for any or all segments of the medication management system
- To develop the template in a way that is customizable by member

1.2. Project Plan

Scope

Within Scope

- What can be achieved with automation of the medication cycle
- Philosophy of drug distribution
- High volume, high cost automated re-packaging technology
- Automated centralized unit dose cart fill technologies (Swisslog PillPick®, McKesson RxRobot®)
- Automated decentralized cabinets (including: Pyxis®, OmniRx®,)
- CIVA robotics (Baxa, RIVA)
- Cost estimates. including equipment acquisition, renovation and installation (standard pricing)
- Templates with several sections, depending on where the client starts from in a step-wise fashion
- Costs will be standard costs that can be modified by client
- Final report with templates and recommendations

Out of Scope

- Pharmacy information system justification
- Detailed site-specific costs and implementation planning
- Established low cost repackaging technologies

This initiative will primarily focus on three types of automation technologies – high volume automated repackaging technologies, centralized automated dispensing technologies, and decentralized automated dispensing cabinet (ADC) technologies. The presence of a contemporary pharmacy information management system is a prerequisite for the use of the technologies outlined. Furthermore, if hospitals either have or are planning to acquire a computerized prescriber order entry system, there are additional issues that will need to be addressed.

The implementation of automated medication management systems represents a major change for both professional and technical staff. Pharmacy leaders must take an active role in working with other professionals (e.g. nursing) and support departments (e.g. e-Health department) in order to make significant changes to the affected medication systems. Our assumption is that Pharmacy Directors, who would use the business template, would be willing to address the significant change management processes that will be required – both in the pharmacy department and across the organization. The need for project management support and the use of appropriate change management strategies will need to be addressed. However detailed implementation planning is specific to each organization and will only be addressed at a high level in this report. Costs will be estimated based on the experience of a number of facilities that have recently implemented this technology, and on guidelines provided by the suppliers of the technology. This “standard costing” will need to be adjusted depending on each facility’s current technology and hospital structure.

This is not a simple business template where labour savings are more than adequate to purchase and operate an automated system. The effective use of an automated medication system, coupled with the transfer of technical drug distribution activities to technicians, will reduce the proportion of pharmacists’ time that is spent performing dispensing operations, allowing pharmacists to focus their efforts on high-value clinical interventions that have been shown to improve the quality, and reduce the cost, of patient care. This better use of resources, coupled with technicians’ compensation being significantly less than pharmacists, will provide much of the financial and practice-related justifications for implementation of the technology. In addition, medication system automation can be justified based upon patient safety, better patient outcomes and reduced cost through a reduction in errors. Having said this, the realization of these benefits is difficult in terms of measurement, cause and effect, and financial gain. We will address these potential cost reduction opportunities, supported by the literature and the experience of pharmacy leaders who have already implemented similar technology.

There are a number of additional benefits in medication system automation that are not as directly linked to financial savings but which will have an effect on the organization. Pharmacy staff who are supported by modern technology are likely to experience higher job satisfaction, which should lead to an improved work environment and a reduction in staff turnover. In addition, a reduction in medication errors will avoid the extended lengths of stay and associated costs that have been documented in a number of studies, as well as protect the reputation of the organization. These “savings” are not likely to be easily extracted to help fund the acquisition of technology, but they are nonetheless “real” and should be included as part of the justification for acquiring automation technologies. References will be made to these “additional savings” in this document.

1.3. Project Milestones

The organization of the project will include:

- A clear understanding of Medbuy members' requirements
- Literature review
- An analysis of successful business cases for automation in selected hospitals
- An outline the technology required to support and interface with an automated medication system
- A costing methodology including equipment, implementation and ongoing expenses
- An identification of savings with varying benefits realizations
- A description of other, less financially tangible benefits (high-level only)
- A business case/ template for medication automation
- A scalable template to allow members of varying sized to estimate costs and benefits
- A presentation template

1.4. Project Structure

The structure of the project will include:

- Executive Sponsor – Richard Jones
- Steering Committee – Chaired by Richard Jones
- Advisory Committee – Selected from the Pharmacy Committee
- Project Manager – Ron McKerrow / Kevin Hall
- Working Committee – Richard Jones, Ron McKerrow, Kevin Hall

2. Medication System Automation

2.1. Medication systems in healthcare institutions

Before beginning a discussion concerning the case for automation, it is important to establish what particular technologies will be addressed in this document. There are many forms of automation that are being used in healthcare facilities. The automation technologies that hospital pharmacists are usually responsible for implementing and managing are those that are used to support hospital drug distribution systems; specifically technologies that improve the efficiency and safety of medication repackaging, labeling and distribution to the point of care.

Although each facility must do some tailoring of their system to meet their unique needs, the institutional drug distribution systems that are in existence throughout North America can generally be categorized into a limited number of types, based on their underlying design principles. The Hospital Pharmacy in Canada (HPC) Survey and Report¹ has developed a set of definitions to describe the various categories of drug distribution systems. The descriptions that follow are largely drawn from those definitions.

Total wardstock system - In this type of drug distribution system, most medications are stocked on the patient care unit in bulk containers. Individual doses of medication are removed from those

bulk containers and often administered to patients without a pharmacist having first reviewed and approved the medication order written for a specific patient.

Traditional drug distribution system – In this system, most medications are labeled and dispensed in multidose, patient-specific vials or similar medication containers, after a pharmacist has reviewed and approved the medication and dosage ordered for that patient.

Unit dose system – In this system, most medications are packaged and supplied to the patient care unit in a single dose, ready-to-administer form. Usually, no more than a 24 hour supply of patient-specific medication is delivered to the patient care unit at any one time. With a few exceptions, such as when the pharmacy is closed, a pharmacist has reviewed and approved the medication and dosage ordered for that patient. A unit dose system can be centralized or decentralized.

- **A centralized system** requires patient specific medications to be dispensed from the central pharmacy to the patient care unit for a specified time frame (e.g. 24 hours).
- **A decentralized system** includes medication distributed from a satellite pharmacy or medication distributed from an automated dispensing cabinet located on the patient care unit.

Controlled / carded dose system – In this system, most medications are packaged in blister cards, usually containing a month's supply of medication. A pharmacist usually reviews and approves the medication order before a patient-specific label is applied to the card and the card is delivered to the patient care unit. This type of drug distribution system is most suited to long term care facilities where changes to medication orders occur less commonly than in acute care facilities.

Medications that will be administered by parenteral injection (intravenous, intramuscular, subcutaneous, intrathecal, or epidural routes of administration) represent a subset of the drug distribution systems described above. In other words they can be managed as part of a wardstock system, a traditional drug distribution system, or a unit dose system. When they are handled as part of a wardstock or traditional system, caregivers on the patient care units (usually nurses or physicians) are responsible for preparing the medication. When they are handled as part of a unit dose system, the pharmacy department prepares each individual dose in a ready-to-administer form. In the latter case, there is generally an organizational unit within the Pharmacy department that is responsible for the preparation and quality assurance of compounded sterile products. This service is often referred to as the Centralized Intravenous Admixture (CIVA) Service. However, since compounded sterile products are also given by routes other than the intravenous route, the term **Parenteral Admixture Service** is a more accurate term.

A considerable body of evidence was generated in the 1960s and 1970s that clearly established unit dose and parenteral admixture systems as the safest types of drug distribution systems. Based on the evidence that had been generated in the late 1960's and early 1970's, the American Society of Hospital Pharmacists developed a statement that endorsed the unit dose system as the preferred drug distribution system as a result of the following advantages²:

- A reduction in the incidence of medication errors
- A decrease in the total cost of medication-related activities
- More efficient use of pharmacy and nursing personnel
- Greater control over pharmacy work patterns and scheduling
- Improved drug control and improved ability to monitor drug use
- Reduction of inventory held on patient care units
- Time savings associated with processing and crediting returns
- More accurate charging of medication costs

With respect to parenterally-administered products, the quality of parenteral admixtures (products that are sterile and contain the right amount of medication) is superior when medications are prepared by well-trained, specialized pharmacy staff, working in a facility that is designed to minimize the risk of microbial contamination.

As a result of the evidence supporting the superior safety profile of unit dose and parenteral admixture services, most healthcare facilities in the United States had adopted these systems by the mid to late 1980s. The adoption rate was much slower in Canada, but the HPC Report¹ has shown a progressive increase in the use of these systems since the early 1990s. In the 2009/10 HPC Report it was reported that 77% of all beds in the hospitals that participated in the survey were serviced by a unit dose system. On the parenteral admixture side, 64% of facilities reported that they provide an admixture service for 90% or more of their beds, and a further 28% reported that they provide an admixture service, but to less than 90% of their beds.

Although unit dose systems are now widely accepted as the drug distribution system of choice in the institutional, acute care setting, these systems also have their drawbacks, which included:

- The manual process of filling unit dose carts is labor-intensive
- The repetitive nature of the work can lead to errors
- The repetitive nature of the work can lead to job dissatisfaction
- There are often excessively long delays in getting first doses to nurses/patients
- Long turn-around times when there are changes to medication orders
- Significant amounts of nursing time are spent dealing with new orders, changes to existing orders, and missing doses.
- Missing orders and medications
- Nurses usually have to count every narcotic dose, every shift
- Relatively easy to circumvent inventory control systems (drug diversion)
- Significant issues with new orders and order changes when the pharmacy is closed

Automation technologies were identified as an option for addressing many of these issues:

- Automated repackaging technologies were identified as a means of addressing the repetitive nature of manually repackaging unit dose medications, leading to a reduction in packaging/labeling errors and an increase in job satisfaction

- Robotic picking and cart-filling technologies were identified as a means of addressing the repetitive nature of filling unit dose carts, leading to a reduction in cart-filling errors and an increase in job satisfaction
- Automated dispensing cabinets were identified as a means of:
 - Reducing the repetitive nature of manual unit dose drug systems
 - Reducing the delays in initiating new medication therapy and making changes to existing medication regimens
 - Addressing the issue of missing doses
 - Reducing the time that nursing staff spend managing new medication therapy, managing changes to drug therapy, and dealing with missing doses
 - Providing better control of inventory
 - Decreasing the opportunity for drug diversion, and providing a tool for investigating drug diversion when it does occur
 - Providing access to medications for new and modified orders when the pharmacy is closed

2.2. Automation of Drug Distribution Systems

*"The counting and pouring often alleged to be the pharmacist's chief occupation will in time be done by technicians **and eventually by automation**. The pharmacists of tomorrow will function by reason of what he knows, increasing the efficiency and safety of drug therapy and working as a specialist in his own right. "*

Linwood F. Tice Dean, Philadelphia College of Pharmacy, 1966

2.2.1. Widely adopted, low cost automation technologies

The earliest automation technologies performed highly standardized tasks, such as repackaging bulk stocks of drugs into unit dose packages that each contained the same drug, and that were all labeled identically with the name, strength, expiry date and lot number of the drug. On the parenteral admixture side, the early automation technologies generally involved pumps that could be used to fill syringes or assist with the preparation of large volume admixtures, such as total parenteral nutrition solutions. These technologies are well established and their cost, in the thousands or tens of thousands of dollars, is low enough that they are usually purchased through departmental funds or through the facility's normal capital budget dollars. These technologies will not be addressed further in this document.

2.2.2. Established, high cost automation technologies

1. Canister-type, high volume unit dose repackaging technologies

In these technologies, medications are stored in calibrated canisters that are designed specifically for each medication. A tablet or capsule is ejected from a particular canister into a strip-packing device where it is packaged, sealed and labeled. These second generation, high volume, automated repackaging technologies can be used to repackage medications into a unit dose format where, like the earlier technologies described in the previous section, all doses are labeled identically with the name, strength, expiry date and lot number of the drug. Many larger acute care hospitals use this type of technology in that way to support their unit dose systems. In the 2009/10 HPC *Report*, canister type repackaging, which was not patient-specific (i.e. did not include the patient's name on the label), was reported by 39.6% (63/159) of respondents.

These technologies can also be interfaced to the Pharmacy Information System to perform more complex packaging and labeling tasks, such as patient-specific repackaging and labeling of unit dose medications. Depending on the specific technology and the design of the facility's unit dose system, additional information can be printed on the label, such as the patient's name and the scheduled time of administration for the medication. A further evolution of those repackaging technologies enabled all of the doses of medication for a specific patient, at a specific administration time (e.g. 0800 hours), to be repackaged in a single pouch. The latter type of pouch repackaging by time of administration is particularly useful in long-term care facilities. In the 2009/10 HPC *Report* canister type repackaging, which included the patient's name on the label, was reported by 35.8% (57/159) of respondents.

Early studies with this type of technology reported that it had an accuracy rate of 99.98%, compared to 92.62% for systems which utilized technicians to manually fill unit dose carts³. Given the very large number of doses that are involved in unit dose cart-fill operations, this difference in cart-fill error rates is very significant. In addition, other studies have shown a significant reduction in the technician time required to fill unit dose carts, when the process is supported by automated repackaging technologies⁴.

Examples of this type of technology include FastPak EXP[®] by AmerisourceBergen and PACMED[®] by McKesson.

A relatively recent addition to this type of automation is the *MedCarousel*[®] system, developed by McKesson that streamlines the restocking of unit-based automated dispensing cabinets. It can also be linked to the wholesaler through a software system (*FulfillRx*[®]) that automatically orders stock replacement from the wholesaler. Replacement stock is then delivered to the facility by the wholesaler (McKesson), in *MedCarousel*[®] totes that facilitate the restocking process.

2. Robotic cart-fill technologies

These automation technologies utilize an interface to the Pharmacy Information System to drive a robotic arm or carousel system that picks the correct drug from racks holding prepackaged unit dose medications. The prepackaged drugs can include tablets, capsules, syringes, pre-packaged liquids, vials, amps and patches. Bar-coding systems are used to verify the items that are picked from the shelving racks by the robotic arm. Some manufacturers of robotic cart-fill technologies also have a repackaging module that can be purchased as part of an integrated repackaging and picking system. These are bar-code driven picking systems that have been reported to reduce medication errors and increase efficiency of the cart-fill process. One study reported that they achieved a complete return on investment through the reduction in medication errors and increased efficiency⁵. Disadvantages of early versions of this type of robotic system were that all medications had to be prepared in a certain type of package with the medication name and bar code on the package. Since few medications came in this format, keeping the robotic device stocked was time consuming. In addition, when a robotic system of this nature fails there needs to be an ability to revert to a manual cart-fill unit dose system, or to purchase additional robotic units to insure that there is sufficient remaining capacity when one unit fails.

Some of the current robotic systems that are available have incorporated an automated repackaging unit into the system, which repackages medications into labeled, bar-coded unit dose packages that are compatible with the robotic packaging unit, thus overcoming the packaging workload that was associated with separately repackaging and stocking the device.

Examples of robotic cart-fill technology include *Robot-Rx*[®] by McKesson or Swisslog PillPick[®]

In the *2009/10 HPC Report*, 8.8% (14/159) of respondents reported that they used robotic cart-fill technology in their drug distribution system. In the *2008 American Society of Health-System Pharmacy (ASHP) Survey*⁶, it was reported that 10.2% of the respondents in the U.S. indicated that they used this type of robotic technology to support their unit dose systems. The usage of this technology had been reported by 4.5% of respondents in the 1999 ASHP survey, and by 7.8% of respondents in the 2002 ASHP survey. Usage of this technology had roughly doubled over a 10 year period, but the overall penetration of this technology, at 10.2 % of all US hospitals, remains quite low.

3. Automated dispensing cabinets (ADCs)

Automated Dispensing Cabinets (ADCs) are mechanical systems, located in patient care areas, which store medications, control their release to authorized personnel, and capture all transaction information. These devices can be set up in such a way that an interface to the Pharmacy Information System is used to maintain a complete and accurate profile of the patient's medication orders. With this type of "profiled" setup, controls can be put in place that restrict access to only those medications that have been ordered for the patient,

and only at the time of scheduled administration. Alternatively the cabinets can be used in a non-profiled setup mode, which provides less control over access to medications.

The reported advantages of this type of system are:

- The system eliminates the need to manually fill unit dose carts
- Bar-coding can be used to verify the correct placement of stock in the cabinets
- The carts can be configured to achieve the desired degree of control over medications (stock locations can be set up so that only one medication can be accessed in a given stock location or, in the case of other less critical medications, more than one medication may be accessed at a single stock location in the cabinet)
- Medications are immediately available to nursing staff once the order has been entered into the system
- Designated nursing staff can be given override authority so that medications can be accessed when a pharmacist is not available to review and enter the order
- The system captures comprehensive data related to the staff member who accessed medications, the time the medication was accessed, stock returns, etc.

Studies have shown that by placing ADCs on patient care units, medications were 2.3 times more likely to be administered on schedule⁷, capture of medication utilization (charges) increased from 63% to 97%⁸, the clinical time of the pharmacist increased from 36.5% to 49.1% on one unit and from 27.9% to 35.1% on another unit (REF) and the medication error rate decreased from 16.9% to 10.4% when wrong time administration error rates were included⁹. However, ADCs have been reported to introduce other sources of error. To avoid these occurrences, both ASHP¹⁰ and ISMP¹¹ have developed guidelines for the safe and effective use of ADCs.

Examples of this type of technology include Pyxis® by Carefusion and OmniRx® Medication Dispensing Cabinets by Omnicell. In the 2009/10 HPC Report, decentralized ADCs were reported to be in use by 53% (84/159) of respondents. This was a substantial change from the 36% (59/162) who reported the use of automated dispensing cabinets in 2007/2008. Eighty-one of the 84 respondents who reported the use of decentralized automated unit dose systems also provided information on the location where the cabinets were used (e.g. general inpatient units, operating room, etc.) Among these respondents:

- 95% (79/83) reported that they use the technology in the emergency department,
- 3% (59/81) use it in critical care units,
- 58% (47/81) use it in general inpatient units,
- 55% (42/81) use it in the recovery room
- 52% (42/81) use it in the operating room,

Overall, in the facilities that participated in the 2009/10 survey, 18% of all beds were serviced by decentralized automated dispensing cabinets. This is a 50% increase over the 12% figure reported in the 2007/08 survey.

In the U.S., the 2008 ASHP Survey⁶ reported that 83% of all hospitals reported that they were using ADCs. In hospitals with more than 300 beds, the use of ADCs was reported by 98% of all respondents. In small hospitals with less than 50 beds, the use of ADC's was reported by a smaller percentage of respondents (64%), but that still represents a significant penetration of this type of technology, even in very small facilities. It is also informative to note the rate at which the use of this technology had increased in U.S. hospitals; from 49% of responding facilities in the 1999 ASHP survey, to 58% in the 2002 survey, 72% in the 2005 survey, and 83% in the 2008 survey.

Respondents to the 2008 ASHP survey were also asked if they were using a "centralized" or a "decentralized" model of drug distribution system. A centralized model was defined as *"systems that include traditional manual unit dose and stationary robotic systems that automate drug dispensing using bar-code technology"*, while a decentralized model was defined as *"systems that include satellite pharmacies and automated dispensing cabinets."* Two-thirds (67.2%) of respondents indicated that they were using a centralized model versus one-third (32.8%) who reported that they were using a decentralized model. When asked what model they expected to be using in the future, less than half (45.8%) reported that they expected to be using a centralized model, versus 54.2% who expected to be using a decentralized model. These results seem to suggest that the current trend in U.S. hospitals is a movement away from a centralized philosophy of drug distribution and towards a decentralized model.

It is of interest to note that although 67.2% of respondents in the 2008 ASHP survey indicated that they were currently using a "centralized" model of drug distribution, there was only a small difference in the number of ADCs being used by facilities that reported using a centralized unit dose model (18.6 ±0.9 ADC stations), versus those who reported that they were using a decentralized unit dose model (24.1±1.4 ADC stations). In addition, over half of all respondents (53.8%) reported that they use ADCs for first-dose delivery, and almost half (49.2%) reported using ADCs for maintenance-dose delivery. These results suggest that ADCs are being used extensively in U.S. hospital, regardless of whether or not they reported having a "centralized" or "decentralized" model of drug distribution system.

The above information on the use of the three types of high-cost drug distribution technologies suggests that they have already achieved a substantial degree of adoption in both U.S. and Canadian hospitals. However, it is reasonable to ask if the adoption of these expensive technologies is being driven by evidence, or if marketing hype and our society's infatuation with new technologies are behind the apparent enthusiasm for these technologies. A later section of this report will address the evidence that exists to help answer those questions.

2.2.3. Emerging automated drug distribution technologies

Stand-alone robotic technologies for parenteral admixture preparation

A number of robotic technologies for the preparation of parenteral admixtures are now available and are generating considerable interest. However, these technologies are in a very early stage of application and their benefits versus limitations have not yet been clearly demonstrated. None of the respondents to the 2009/10 Hospital Pharmacy in Canada survey reported that they were using robotic technologies for the preparation of parenteral admixtures.

For a number of reasons, there is considerable interest in these emerging robotic technologies. Many facilities that prepare hazardous pharmaceuticals such as oncology admixtures, view these technologies as a promising way to avoid worker exposure to these agents. In addition, many healthcare facilities currently have sterile compounding facilities that fail to meet the current standards for such facilities, particularly the Chapter 797 standards that are in place in the United States. Although Canadian healthcare facilities are not subject to Chapter 797 standards, it is clear that many facilities fail to meet even the voluntary standards that have been established by the Canadian Society of Hospital Pharmacists. It is probable that Canadian healthcare facilities will have to address the identified deficiencies in the existing compounding facilities and practices that have been identified.

These emerging technologies do not yet have a sufficient track record, or a body of evaluative literature, on which their acquisition can be justified. As a result, these emerging technologies will not be addressed in this document

Examples of this technology include the Intellifill® system by FHT technologies (a division of BAXA) and RIVA ®(Robotic IV Automation) by Intelligent Hospital Systems.

In summary, the types of drug preparation and distribution technologies fall into several categories. Technologies that are well-established and relatively low in cost will not be addressed in this report. The value of these technologies is widely accepted and most facilities that could benefit from these technologies have already acquired and are using these technologies. Emerging technologies, specifically those that are intended to automate the production of parenteral admixtures, will also not be addressed further in this report. These technologies are very expensive and, although their potential application in hospitals appears promising, there is insufficient experience or evidence to arrive at any conclusion concerning the cost-benefit of these technologies.

This report will focus on the high cost automation technologies that have been adopted by enough facilities to establish their place in practice, and for which there is a reasonable amount of objective evidence on which to base an assessment of their usefulness. Specifically, this report will address the case for the use of the following technologies:

1. Canister-type, high volume unit dose repackaging technologies
2. Robotic cart-fill technologies
3. Automated dispensing cabinets

3. Recent publications/reports describing the outcomes associated with 'high-cost' pharmacy automation technologies

A review of the literature was conducted to find reports that had identified benefits that had been realized as a result of the use of the high-cost pharmacy automation technologies that were identified in the previous section. In the previous section, the evidence from early studies that looked at the impact of these technologies on medication errors, efficiency of pharmacy operations, nursing impacts etc. was presented. Given that these technologies have undergone substantial revisions and upgrades in an effort to improve their functionality, it was felt that a review should be undertaken to look for more recent publications and reports dealing with the implementation and use of these technologies. We limited our literature search to reports that have been published since the year 2000. The literature review looked for articles that had been published in the pharmacy/medical literature, as well as other reports that were found through an Internet search. Many of the reports found through the Internet literature search consist of brief case reports that were found on the websites of the companies that sell those technologies. In some cases, those reports appear to have been conducted by a third party, while others report data that appears to have been collected and analyzed by the hospital itself and/or the vendor of the technology. In the brief summaries that follow, we have identified the source of the article, as best we are able to do so. Each summary also provides a brief description of the hospital, as well as the reported benefits that were realized through the implementation of a particular technology, or combination of technologies, at that particular facility.

3.1. Mercy Medical Center, Canton, Ohio¹²

Type of Report: Case report on the McKesson website

Description of the facility: 476 bed, acute care facility

Description of drug distribution system prior to implementation: 48-hour manual cart fill

Issues that drove the change:

- manual cart-fill process was very labour-intensive
- long turn-around times for new medications
- nurses had to deal with missing medications and orders
- poor inventory control

Type of technology addressed in the reported:

- PACMED high volume packager
- AcuDose-Rx medication dispensing cabinets
- Robot Rx

Year the report was published: 2006

Benefits reported:

Productivity/efficiency outcomes reported

- 75% reduction in time required for daily cart-fill
- 42% reduction in first-dose turn-around time
- 20% reduction in stat dose turn-around time

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy:

- Pharmacist time redirected to direct patient care activities, including the establishment of an anticoagulation clinic that generated \$138,000 in additional revenues
- Pharmacist job satisfaction rose to 95%

Staff practice outcomes reported – nursing:

- eliminated the need for narcotic counts at the end of each shift
- missing medications decreased by 40%
- an additional 1 hour per shift became available for direct patient care activities

Safety enhancements reported:

- Stated, but no figures presented

Inventory/drug cost outcomes reported:

- expired medications decreased by 5%
- Better overall inventory management yielded \$55,000 in annual inventory savings

3.2. Northeast Georgia Medical Center¹³

Type of Report: Case report on the McKesson website

Description of the facility: 557-bed acute care facility

Description of drug distribution system prior to implementation:

Issues that drove the change:

- long turn-around times for new medications
- nurses had to deal with missing medications
- poor inventory control

Type of technology addressed in the reported:

- PACMED high volume packager
- AcuDose-Rx medication dispensing cabinets
- Robot Rx
- MedCarousel

Year the report was published: 2010

Benefits reported:

Productivity/efficiency outcomes reported

- Freed up 4.8 FTE technician positions

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy:

- 4.8 FTE technicians redeployed to medication reconciliation in the ER, targeted at heart failure management improvements (HF-1), and to “nurse concierge” roles on the patient care units
- HF-1 medication reconciliation scores rose to 92.1% in the first quarter of 2009, reached 95% accuracy by the end of 2009 and reached 100% accuracy by early in 2010
- HF-1 medication reconciliation scores rose by 22.3%

Staff practice outcomes reported – nursing:

- Overall satisfaction with pharmacy services increased 50%

Safety enhancements reported:

- Stated, but no figures provided

Inventory/drug cost outcomes reported:

3.3. Phoebe Putney Memorial Hospital, Georgia¹⁴ (Ref)

Type of Report: Case report on the McKesson website

Description of the facility: 450-bed, regional medical center

Description of drug distribution system prior to implementation: 48-hour manual cart fill

Issues that drove the change:

- high staff turnover rate; 68% annual turnover for pharmacy technicians
- staff under extreme pressure to keep up with workload demands
- long delays in getting first doses from the pharmacy to nursing units

Type of technology addressed in the reported:

- Robot Rx
- MedCarousel

Year the report was published: 2005

Benefits reported:

Productivity/efficiency outcomes reported

- increased productivity reported, but no figures provided
- decreased time spent in crediting returns reported, but no figures provided

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy:

- technician turnover rate decreased from 68% to 11%

Staff practice outcomes reported – nursing:

- “great feedback” from nursing units reported, but no figures reported

Safety enhancements reported:

- 80% reduction in medication picking errors
- virtual elimination of all types of medication selection errors reported, except for “wrong quantity” errors, which were a function of manual counting

Inventory/drug cost outcomes reported:

- Better inventory control reported but no figures provided

3.4. Comanche County Memorial Hospital, Lawton, Oklahoma¹⁵

Type of Report: Case report, posted on the McKesson website, which was conducted by a third party organization (Shack and Tulloch) that was commissioned to provide an independent economic evaluation

Description of the facility: 283-bed acute care facility

Description of drug distribution system prior to implementation: Unit-based automated medication cabinets. Technicians picked medications for restocking cabinets and pharmacists checked 100% of those prior to cabinet restock. Nurses manually picked and checked medications prior to patient administration

Issues that drove the change:

- vast majority of pharmacist time was spent on medication distribution and order entry tasks, severely limiting the time available for clinical activities
- nurses were forced to balance time constraint associated with accessing medications from cabinets positioned long distances from patient rooms
- no real-time monitoring of medication usage and inventory levels
- poor tracking of medication expiry dates

Type of technology addressed in the reported:

- Horizon Meds Manager pharmacy information system
- Horizon NedComm medication order transmission system
- PAKPlus service to package medications into bar-coded, unit dose form
- Robot Rx with MedCarousel
- AcuDose-Rx medication dispensing cabinets
- NarcStation Vaults and software system
- Horizon Admin-Rx bar-code medication administration system

Year the report was published: 2008

Benefits reported:

Productivity/efficiency outcomes reported

- eight year net project value exceeding \$1.7 million with a return on investment of 42% (considered to be "outstanding" by the third party organization that conducted the study)
- cut pharmacist checking labor by 90%
- reduced technician picking labor by 33% and reduced technician training time by 33%
- cut missing doses by 92% and cut medication cabinet stockouts by 75%
- saved \$26,000 per year by buying certain medications in bulk
- reduced by 54% the annual cost of medication write-offs due to expired medications

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy:

- pharmacists reported improved job enrichment, contributing to reduced turnover
- projected an eight-fold increase in time spent by pharmacists on clinical intervention activities, resulting in an annual 10% reduction in ADRs and related costs

Staff practice outcomes reported – nursing:

- stated that nurses were able

Safety enhancements reported:

- risk of medication errors and associated litigation costs was stated, but no figures were provided

Inventory/drug cost outcomes reported:

- saved \$26,000 per year by buying certain medications in bulk
- reduced by 54% the annual cost of medication write-offs due to expired medications

3.5. University of Wisconsin Hospital and Clinics, Madison, Wisconsin¹⁶

Type of Report: Peer-reviewed article published in the American Journal of Health-System Pharmacy

Description of the facility: 471 bed, tertiary care facility

Description of drug distribution system prior to implementation: 24-hour cart-fill system that utilized a robotic system, supplemented by technicians who manually retrieve medications to complete the cart-fill. Pharmacists working on patient care units were responsible for checking all first-doses filled from the central pharmacy, and for placing the medications in the proper patient-specific medication drawer. ADCs were used to provide access to “as needed” medications, controlled substances and some routine first doses. .

Issues that drove the change:

- Decision made to fully automate the dispensing phase, thus eliminating as many manual processes as possible.

Type of technology addressed in the reported:

- MedCarousel integrated into the dispensing phase of the of the medication-use process
- MedCarousel linked to ADCs to increase the efficiency of cabinet restocking
- MedCarousel communicates with the Pharmacy information system to allow first-dose and cart-fill dispensing requests to be received and processed by pharmacy technicians
- MedCarousel software prioritizes workflow by separating stat orders from normal requests and communicates that information to pharmacy technicians
- Robot Rx

Year the report was published: 2010

Benefits reported:

Productivity/efficiency outcomes reported

- Technician time savings totalled 2.6 FTEs

Labour reductions implemented:

- 2.0 FTE pharmacy technician positions were eliminated; while technicians were still able to take on additional responsibilities

Staff practice outcomes reported – pharmacy:

- Pharmacist time redirected to direct patient care activities, including the establishment of an anticoagulation clinic that generated \$138,000 in additional revenues
- Pharmacist job satisfaction rose to 95%

Staff practice outcomes reported – nursing:

- eliminated the need for narcotic counts at the end of each shift

- missing medications decreased by 40%
- an additional 1 hour per shift became available for direct patient care activities

Safety enhancements reported:

- annualized dispensing errors decreased by 47%

Inventory/drug cost outcomes reported:

- on hand inventory reduced by about 8% and inventory turnover was increased by 15%

3.6. Wesley Medical Center, Wichita, Kansas¹⁷

Type of Report: Case report, posted on the McKesson website, conducted by a third party organization (Shack and Tulloch) that was commissioned to provide an independent economic evaluation

Description of the facility: 760 bed, tertiary care teaching facility

Description of drug distribution system prior to implementation: Automated dispensing cabinets (Pyxis®), that appear to have been manually refilled based on Pyxis® inventory data.

Issues that drove the change:

- desire to enhance pharmacy productivity while also taking steps to implement a bar-code based electronic medication administration record (eMAR)

Type of technology addressed in the reported:

- MedCarousel integrated into the dispensing phase of the of the medication-use process
- MedCarousel linked to ADCs to increase the efficiency of cabinet restocking
- MedCarousel communicates with the Pharmacy information system to allow first-dose and cart-fill dispensing requests to be received and processed by pharmacy technicians
- MedCarousel software prioritizes workflow by separating stat orders from normal requests and communicates that information to pharmacy technicians
- Fulfill Rx is used to calculate daily stock replacement orders and transmit them to the wholesaler (McKesson) MedCarousel specific totes are delivered to the facility to facilitate restocking.

Year the report was published: 2004

Benefits reported:

Productivity/efficiency outcomes reported

- labor required to create the daily order was reduced by 75%
- labor required to receive the daily order was reduced by 50%
- labor required to complete inventory valuation was reduced by 53%

- labor for cabinet restocking was reduced by 8%
- time required to train new technicians was reduced by 85%, from 3 months to 2 weeks
- total labor savings estimated at \$54,000 per year
- “outstanding” return on investment of 211% with a net present value of \$514,00

Labour reductions implemented: none reported

Staff practice outcomes reported – pharmacy: none reported

Staff practice outcomes reported – nursing:

- requests for expedited medications reduced by 75%, improving pharmacy/nursing relationship

Safety enhancements reported:

- picking errors reduced by 96%, to near zero

Inventory/drug cost outcomes reported:

- inventory turns projected to increase by 14%
- 10% reduction in inventory write-offs

3.7. Hospital of Saint Raphael, New Haven, Connecticut¹⁸

Type of Report: Case report, posted on the Pyxis®/Cardinal Health website

Description of the facility: 511-bed acute care facility

Description of drug distribution system prior to implementation: Manual cart-fill, unit dose system

Issues that drove the change:

- Increased regulatory scrutiny regarding medication security throughout the hospital
- Inefficient pharmacy and nursing processes
- Desire to control costs
- Desire to improve patient safety

Type of technology addressed in the reported: Profile-based Pyxis® MedStation and CPOE

Year the report was published: 2008

Benefits reported:

Productivity/efficiency outcomes reported:

- Time to first dose reduced from approximately 6 hours to 25 minutes;
- Reduced nursing overtime costs by 15 minutes per day per shift

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy:

- Redeployed 4.5 FTE technicians
- Redeployed a pharmacist to the ICU to participate in medical team rounds
- Implemented a program for converting IV antibiotics to oral therapy that “realized significant cost savings”
- Opened an anticoagulation management program, that generated \$65,000 in annual revenue
- Proactive drug diversion prevention

Staff practice outcomes reported – nursing:

- More nursing time became available for patient care, as opposed to non-value added activities

Safety enhancements reported: None reported

Inventory/drug cost outcomes reported:

- Increased inventory turns from 9 to 12

3.8. Saudi Aramco Medical Services Organization, Dhahran, Saudi Arabia¹⁹

Type of Report: Published Article (Dib, J.G. et al “Effects of an Automated Drug Dispensing System on Medication Adverse Event Occurrences and Cost Containment at SAMSO”; Hospital Pharmacy 2006; 41 (12): 1180-1184

Description of the facility: 390-bed tertiary care facility

Description of drug distribution system prior to implementation: Manual cart-fill, unit dose system, with an open-floor-stock system

Issues that drove the change: Decision made to evaluate the impact that an automated drug dispensing system would have on medication adverse events and cost containment

Type of technology addressed in the reported: Automated dispensing and supply cabinets (specific type not specified, but appears to be Pyxis®, or a Pyxis®-like system) implemented in five nursing units (cardiac care, medical intensive care unit, surgical and medical intensive care step-down units, and a hemodialysis unit).

Year the report was published: 2006

Benefits reported:

Productivity/efficiency outcomes reported: None reported

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy: Pharmacists “enabled to provide better patient care”

Staff practice outcomes reported – nursing: Nurses “enabled to provide better patient care”

Safety enhancements reported: Medication Adverse Events reduced by 27% from pre-implementation, 3 month study period, compared to a post-implementation, 3 month study period. Overall number of MAEs was too small for statistical significance to be determined.

Inventory/drug cost outcomes reported: Medication units dispensed in a 1 month post-implementation study period were 43% lower than the 1 month, pre-implementation study period. This was associated with a 42% reduction in drug costs between the pre-implementation and post-implementation study. In the 5 units studied, the projected annual medication cost savings were \$193,000 US.

3.9. Huntsville Hospital, Huntsville, Alabama, USA²⁰

Type of Report: Case report, found on the Cardinal Health website.

Description of the facility: 881-bed acute care hospital

Description of drug distribution system: Pyxis® MedStation technology

Issues that drove the change: The Joint Commission on Accreditation of Healthcare Organizations (JCAHO) requires that hospitals have a comprehensive adverse drug event (ADE) reporting system in place. The manual system in place at the Huntsville Hospital was felt to be significantly under-reporting ADEs. The facility decided to use the ADR reporting feature that is built into the Pyxis® MedStation system.

Type of technology addressed in the reported: Pyxis® MedStation’s ADR reporting functionality. When an antidote was removed from the Pyxis® cabinet, the system asked if the antidote was for an ADR. If the nurse clicked “yes”, a report was generated and sent to the pharmacy. The facility’s list of tracer drugs covered 80% of the drugs commonly used as antidotes.

Year the report was published: 2006

Benefits reported:

Safety enhancements reported:

ADR reports increased each year after the system was implemented increasing by

- 50% in the 2001-2002 period
- 88% in the 2002-2003 period

- 61% in the 2003-2004 period
- 40% in the 2004-2005 period

Inventory/drug cost outcomes reported: None reported

3.10. Guelph General Hospital, Guelph, Ontario, Canada²¹ (Ref)

Type of Report: Case report, published in Canadian Healthcare Technology April 2008. An independent third party consultant was hired to take measurements over a 3 month period prior to implementation and a 3 month period after the implementation had occurred.

Description of the facility: 165-bed acute care hospital

Description of drug distribution system prior to implementation: Traditional, Mosaic drug distribution system

Issues that drove the change: Decision made to evaluate the impact that an automated drug dispensing system would have on medication errors and efficiency of the drug distribution system

Type of technology addressed in the reported: OmniRx® automated drug dispensing technology, supported by a MACMED (McKesson) unit dose repackaging system

Year the report was published: 2008

Benefits reported:

Productivity/efficiency outcomes reported:

- Reduction in the number of missing medications from 22 per day prior to implementation to 2.5 per day post-implementation
- Reduction in the number of out-of-stock medications from 22 per day prior to implementation to 3.25 per day after implementation
- Reduction in the average time between the writing of the order and the medication being available for administration from 4.5 hours to 42 minutes
- Calls to the Pharmacy reduced from an average of 71 per day pre-implementation to 16.5 per day post implementation
- Time savings for nursing “are huge”.

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy: None reported

Staff practice outcomes reported – nursing: None reported

Safety enhancements reported: A decrease in medication incidents (including near-misses) from 90 to 66 between the 3 month pre-implementation period and the 3 month post-implementation period

Inventory/drug cost outcomes reported: None reported

3.11. A Group of Seven Hospitals, location not specified²²

Two of the authors are identified as Cardinal Health employees, while the third author is a faculty member at the Ecole de Technologie Superieure in Montreal

Type of Report: Paper from the Cardinal website, describing outcomes associated with different medication management systems in 7 hospitals.

Description of the facility: Seven acute care hospitals with average daily census of 616, 212, 300, 344, 225, 100 and 425.

Description of drug distribution system prior to implementation: Study was conducted on existing drug distribution systems:

Facility 1: ADCs, CPOE, eMar, and centralized robot

Facility 2: ADCs, eMAR, bar-code medication administration (BCMA), centralized robot

Facility 3: ADCs, eMAR, BCMA, centralized robot

Facility 4: ADCs, eMAR, Carousels, ADC wholesaler restocking system

Facility 5: ADCs, ADC wholesaler restocking system

Facility 6: ADCs, eMAR, BCMA, bar-code ADC replenishment system

Facility 7: ADCs, CPOE, bar-code ADC replenishment system

Issues that drove the change: Desire to analyze the outcomes associated with different medication management systems in 7 hospitals

Type of technology addressed in the reported: Automated dispensing and supply cabinets in combination with a variety of other medication management technologies

Year the report was published: 2008

Benefits reported:

- The total time initiate drug therapy declined as the % of medications dispensed through ADCs increased
- The two hospitals with the lowest % of doses handled through ADCs (4% and 23%) reported greater than one missing dose per patient per day, while the 2 hospitals with the highest % of medications managed through ADCs (80% and 95%) reported negligible missing doses per patient per day

Productivity/efficiency outcomes reported:

- Calculated that a 300 bed hospital handling only 4% of doses through ADC technology would require staffing of 3.32 FTE pharmacists and 20.23 FTE technicians. In comparison, the same hospital providing 95% of its doses through ADC technology would require staffing of 1.25 FTE pharmacists and 6.21 FTE pharmacy technicians to accomplish similar outputs.

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy: Not reported

Staff practice outcomes reported – nursing: Nursing “non-value added steps” were substantially lower in hospitals with most of their medication doses handled through ADCs, as compared to hospitals with a low percentage of medication doses handled through ADC pathways.

Safety enhancements reported: Medication Adverse Events reduced by 27% from pre-implementation, 3 month study period, compared to a post-implementation, 3 month study period. Overall number of MAEs was too small for statistical significance to be determined.

Inventory/drug cost outcomes reported: Not reported

3.12. Hammersmith Hospital, London, England²³

Type of Report: Published research paper *Franklin, BD et al “The impact of a closed-loop electronic prescribing and administration system on prescribing errors, administration errors and staff time: A before and after study” Qual Saf Health Care 2007 16:279-284.*

Description of the facility: Conducted in a 28 bed general surgery ward of a London teaching hospital

Description of drug distribution system prior to implementation: The ward received a pharmacy service that was typical of that seen in most UK hospitals. Medication orders were written on paper charts and medication was stored in two drug trolleys and in stock cupboards. A pharmacist visited the ward each weekday and paid a short visit to the ward on Saturdays. One nurse carried out most medication-related tasks on each half of the ward.

Issues that drove the change: Objectives were to assess the effect of a closed-loop electronic prescribing and administration system on the prevalence, types, and clinical significance of prescribing errors and medication administration errors as well as the impact of the system on staff time.

Type of technology addressed in the reported: Implementation of the following technologies:

- CPOE, with 2 prescribing terminals on the ward and one in the pharmacy department
- Two handheld computer tablets which could be taken from patient to patient and used to view, prescribe and discontinue medication orders

- A nurse (most commonly), a pharmacist or a physician scheduled the doses to specific drug round times on an electronic MAR
- Majority of medications were stored in large automated cabinets on the ward. The automated cabinets contained computer-controlled drawers and a touch-sensitive screen. The computer screen indicated the patients for whom doses were due in the next 2 hours. To prepare for a drug round, the nurse selected each patient and was then presented with a list of the medications due. On selecting each medication, the relevant drawer in the cabinet opened so that the nurse could take the number of dosages ordered and place those in an electronic trolley. To restock the automated cabinets, a technician printed a list of the medications that fell below the specified reorder level. Barcodes on each drug product were used to confirm the identity of the medication loaded into each drawer. There were 2 electronic trolleys, one for each half of the ward. When medication was being transferred from the automated dispensing cabinets to the trolleys, only one drawer in the trolley opened at a time, and the patient's name was indicated on the drawer's liquid crystal display. When all medication for a given patient was placed in the drawer, the system instructed the nurse to close that drawer before medication for the next patient could be prepared.
- The electronic trolley was taken from patient to patient. After scanning a patient's wristband barcode, that patient's drawer would open. The nurse confirmed administration using the trolley's touch-sensitive screen. Medication administration data was uploaded to the patient's eMAR when the trolley was docked with the automated dispensing cabinet.

Year the report was published: 2007

Benefits reported:

Productivity/efficiency outcomes reported:

- Physician order processing time increased from 15 seconds to 39 seconds per order
- Nursing time per drug administration round decreased from 50 minutes to 40 minutes
- Overall nursing time spent on medication tasks increased from 21.1% of their work shift time to 28.7%
- Pharmacist time spent on the ward increased from 68 to 98 minutes each workday

Labour reductions implemented: None reported

Staff practice outcomes reported – pharmacy: More pharmacist time spent on the ward

Staff practice outcomes reported – nursing: None reported

Safety enhancements reported:

- Prescribing errors were reduced from 3.8% of orders written prior to the implementation of the new system to 2.0% of orders written post-implementation
- Medication adverse events were reduced from 7.0% pre-intervention to 4.3% post-implementation

- Patient identity was not checked in 82.6% of doses administered pre-intervention, versus 18.9% post implementation

Inventory/drug cost outcomes reported: Not reported

Summary

The information contained in the papers and case reports described above identified a number of positive outcomes that could potentially be realized as a result of the implementation of a variety of different pharmacy automation scenarios. These positive outcomes can generally be described as:

- Overall improvements in the efficiency of the drug distribution system
- Improved drug inventory management
- Improvements in the utilization of nursing and pharmacy staff (practice model improvements)
- Patient safety improvements

However, the reported results are based on many different models of automation, making it a complicated task to assess the available data and arrive at conclusions concerning the benefit and cost-justification for these technologies. In Canada, there is an organization that has been established to perform those kinds of complicated analyses of both drugs and technology. The Canadian Agency for Drugs and Technology in Health (CADTH) undertook an analysis of "Technologies to Reduce Errors in Dispensing and Administration of Medication in Hospitals: Clinical and Economic outcomes²⁴ " and published the results of their analysis in August 2009. CADTH undertook a comprehensive systematic review of the published literature and also offered all of the major technology suppliers with the opportunity to provide input and to review a preliminary draft of the report. The Executive Summary of the CADTH analysis reported the following findings related to the clinical and economic outcomes of these technologies, as well as the budget impact of implementing these technologies:

4. Clinical Effectiveness (Error Reduction)

Pharmacy-based automated dispensing systems:

"The equipment that was used in two studies on pharmacy-based automatic dispensing devices is no longer available for purchase. These studies showed a decrease in dispensing errors. Five studies were conducted on devices available in Europe. The applicability of these results to Canadian hospital pharmacies is questionable."

Based on the results of three studies, carousel systems (series of revolving shelves set on rails) reduced filling or dispensing errors."

Automated, decentralized dispensing technologies:

“Three of four studies on profiled, ward-based automatic dispensing devices were conducted using an older model of device. These studies showed a decrease in dispensing or medication error. One study showed an increase in medication errors in a cardiac intensive care unit.

These findings are limited because of several factors. The definitions that were used to describe the outcomes were inconsistent among studies. The errors were counted using different methods. Compelling evidence was lacking. Observational study designs were used in all the studies. Most were uncontrolled before and after studies in which the participants were not blinded to the purpose of the study. Not all studies reported the use or results of statistical tests of significance. Factors other than automation may have led to changes in work practices. All of these factors could have affected the error rates, and the risk reduction may have been overestimated.”

5. Economic Analysis

5.1. Economic Review:

“A systematic review of available economic studies on the automation of medication dispensing and administration in hospitals was conducted.

There is evidence that nursing time is saved with the use of automatic dispensing devices. Less storage space may be needed with the use of pharmacy-based dispensing devices. The financial analyses indicated that overall, there would be savings to hospitals. In studies from the United States, savings accrue to hospitals because the use of automated systems allows for more complete billings. These savings do not apply to Canada

Most studies had limitations. There was an absence of statistical tests of significance in the studies that were not conducted by modelling. Some of the studies on workload showed mixed results. Many costs were excluded from some of the studies. None of the studies looked at the clinical significance of medication errors or the downstream costs.”

Economic Evaluation:

An economic model was designed to explain the difference in costs when a manual drug distribution system (with medication cassettes) is compared with ward-based automated dispensing devices (with or without patient medication profiles).

When the analysis was conducted for unprofiled devices, there were savings of approximately \$34,000 per patient care unit annually. Each intensive care unit had additional costs of \$17,000, annually.

After discounting and adjusting for inflation, there were net savings of \$152,000 per patient care unit over a five-year period. Each intensive care unit costs an additional \$75,000.

Overall, a 400-bed hospital would achieve five-year savings of \$2.7 million with the use of unprofiled equipment. The savings would be \$2.2 million if profiled units were acquired.

Sensitivity analyses showed that these results were robust for an unprofiled system. In several sensitivity analyses, a profiled automated system was more costly than a manual system.

5.2. Budget Impact

"The equipment costs for each patient care unit or intensive care unit are \$123,000 for an un-profiled automatic dispensing device and \$138,000 for a profiled device. The planning costs are \$73,800 and \$82,800. The up-front costs are \$196,800 and \$220,800 per patient or intensive care unit for un-profiled and profiled automatic dispensing devices, respectively.

For a 400-bed hospital with approximately nineteen 20-bed patient care units and two eight-bed intensive care units, there would be up-front capital costs, as follows:

- *For an un-profiled system, the cost of capital equipment would be \$2.5 million, and planning costs would be \$1.5 million, for a total of approximately \$4 million.*
- *For a profiled system, the cost of capital equipment would be \$2.9 million, and planning costs would be \$1.7 million, for a total initial outlay of \$4.6 million.*

There is some outstanding uncertainty regarding budget impact as these results are sensitive to underlying assumptions regarding equipment costs. Actual budget impact may change if more precise data are obtained."

The CADTH report concluded by stating that **"the implementation of a ward-based automatic dispensing device can reduce costs while reducing medication errors."** It was noted that these conclusions are only valid for medical-surgical patient care units. The increased costs associated with ADC implementation in intensive care units is a function of the small number of patients that are serviced by the ADC technology in ICUs.

6. Pharmacy Practice Models of the Future – The Role of Technicians and Technology

The future role of the pharmacist has been the subject of a great deal of debate over the past 40 to 50 years, both within the profession and beyond.

In 1971, after 3 years of research and debate, the Commission on Pharmaceutical Services in Canada published its final report²⁵. In that report the Commission stated that:

"Over the long term, the big question for pharmacy is whether the profession will be able to develop a role in which its specialized knowledge can be brought to bear where it is most needed - at the point where decisions about drug usage are made."

The Commission made a wide range of recommendations for refocusing the role of the pharmacist to one that would closely describe what we now refer to as "medication therapy management." Many others called

for changes that would move pharmacy in a similar direction. In one of their recommendations the Commission commented that”

“In the face of rising demands and skyrocketing costs, all the occupations and institutions in the field of health care are being challenged to develop more effective and economical forms for the delivery of their services. Planning is taking place for integrated health care systems in which responsibilities will be reallocated among the health professions and their associated para-professions.....It has even been suggested that the ultimate goal should be to give the pharmacist the responsibility for prescribing medication and monitoring the patient's response to his therapy regimen.”

Don Francke, who was then the editor of the journal “Drug Intelligence and Clinical Pharmacy” also commented on the need to make better use of pharmacy human resources.

“It has been said that we do not suffer from a shortage of resources. We need appropriate utilization of talent, better management and better administration of the resources now available... It is time that we stop performing the counting, pouring, packaging and labeling routines and delegate these functions to appropriately educated, trained and qualified technicians.”

Dean Tice of the Philadelphia College of Pharmacy was probably the most prescient when he recognized back in 1966 that the transition of technical tasks from pharmacists to technicians would eventually be followed by a transition of many of those tasks to automation technologies.

“The counting and pouring often alleged to be the pharmacist's chief occupation will in time be done by technicians and eventually by automation. The pharmacist of tomorrow will function by reason of what he knows, increasing the efficiency and safety of drug therapy and working as a specialist in his own right. It is in this direction that pharmaceutical education must evolve without delay.”

We can then fast forward to the late 1990s and 2000s when a serious shortage of pharmacists developed throughout North America and many other parts of the world. In response to the pharmacy manpower issues in Canada, federal funding was provided for a \$1.5 million study of human resource issues in the profession of pharmacy. That study, entitled “**Moving Forward: Pharmacy Human Resources for the Future**” was a 3 year study that tabled its final report and recommendations in September 2008²⁶. The report began with a repeat of the call for pharmacy practice change that has been echoing through the profession and beyond for the past 50 years.

“The human resources challenges facing pharmacy today call for solutions that go beyond addressing basic issues of supply and demand. Instead, these challenges must be addressed within the context of a larger strategic vision and action plan for the pharmacy workforce. This vision must allow for the creation of an environment that enables pharmacists and pharmacy technicians to practise to the full extent of their knowledge and competence in expanded and innovative roles.... In the future, pharmacists will spend more of their time providing pharmaceutical care to their patients, as regulated pharmacy technicians assume greater responsibility for the technical aspects of drug distribution.”

The report included 36 recommendations, many of which dealt with the evolving role of pharmacists, pharmacy technicians and technology. Recommendation 6 and the commentary that accompanied it, specifically addressed the role of technology.

Recommendation 6: SUPPORT the adoption of technologies that enhance the efficiency and safety of drug distribution.

Adopting appropriate drug distribution technologies in pharmacy practice sites will support both pharmacists and pharmacy technicians in their future health care roles.

Drug distribution technologies designed to streamline and safeguard the dispensing process include robotics applications, automated dispensing systems and unit-dose packaging equipment. Although evidence shows that effective drug distribution technologies can reduce the rate of occurrence of medication errors, such technologies have not been widely adopted. For example, in one survey of pharmacists, only half of respondents working in hospital settings and fewer than 12% of those working in community settings reported using automated dispensing technologies. From a human resources perspective, the introduction of new technologies that enhance drug distribution will change the day-to-day tasks of the pharmacy staff. These changes will in turn affect the pattern of work carried out by pharmacists, pharmacy technicians and other health care providers in the practice setting. The impacts these technologies will have on the pharmacy workforce will have to be carefully considered and managed.

Recommendation 7 also dealt with technology, envisioning an integrated technology-enabled pharmacy practice model.

Recommendation 7: SUPPORT the adoption and implementation of e-health technologies that enhance the ability of pharmacists to provide outcomes-focused, interdisciplinary care.

“Electronic health information, and the systems by which it is transmitted, are intended to allow timely access to that information by the most appropriate health care provider. The pharmacist’s ability to manage a patient’s drug therapy (which can include prescribed and self-care medications), is enhanced by access to that patients’ health information. Complete patient drug profiles, records of prescriptions filled, diagnoses, laboratory data, and self-reported usage of non-prescription medications and supplements are examples of potential electronically-accessible health information that pharmacists should consider if they are to effectively exercise their professional judgment in optimizing the drug therapy outcomes of their patients.

Drug distribution automation technologies have the potential to provide valuable information to the e-Health system by providing a complete and accurate record of drug use by the patient, particularly when point-of-care bar code systems are used to document the actual administration of a medication.

In 2009 a number of papers were published that addressed the practice model changes that were finally becoming a reality in the profession of pharmacy. Abramowitz addressed ten concepts that he felt would represent the foundation of future practice models. Those concepts included²⁷:

- “A trained, certified, and potentially licensed technician work force will be responsible for additional and more complex roles in the medication-use process.”

- “Medication preparation and distribution will become more centralized and automated in our hospitals and in the community.”
- “The vast majority of all pharmacist time will be spent providing direct patient care in all practice settings.”

Also in 2009, the ASHP Section of Pharmacy Informatics and Technology published “Technology-enabled practice: A vision statement”²⁸. In that report it was noted that the current practice model in most acute care settings was “an obsolete practice model”. The report described an alternative technology-enabled practice model that would permit the migration of pharmacists away from the current emphasis on drug distribution to one that would be focused on medication therapy management/pharmaceutical care. Specifically the alternative model proposed by this group would include the following technology supports:

- An electronic health record
- A prescriber order-entry system
- Clinical decision support systems
- A preparation and distribution automation infrastructure that uses automatic identification and other technologies to verify that medications selected or prepared in response to specific orders were appropriately selected, packaged, stocked and administered, through the use of:
 - robotic technology that automates the preparation of medication doses
 - unit-based cabinets and other just-in-time distribution equipment
 - automatic identification technologies to positively identify and validate drugs during the restocking of unit-based technologies
 - automatic identification technologies to track medication withdrawal and administration

In the fall of 2010, as a result of the perceived need to define what the pharmacy practice model of the future should look like, the American Society of Health-System pharmacists convened a summit of pharmacy practice leaders to address the issue. The Pharmacy Practice Model Initiative (PPMI) took place in November, 2010. A number of background documents were prepared in advance of the meeting, including one that addressed *“Opportunities and challenges related to technology in supporting optimal pharmacy practice models in hospitals and health-systems.”* In that background paper a number of recommended health technology approaches were recommended. These included:

1. Recognize that health technology will have a major impact on pharmacy practice
2. Current and emerging technologies will change the roles of pharmacists and pharmacy technicians.
3. Don't wait for perfect solutions to become available.
4. Seek health technology solutions that yield incremental gains, and are aligned with a future vision
5. Articulate an ideal vision for a health-technology-enabled medication use process
6. Work collaboratively with others to achieve higher levels of connectivity and integration
7. Pursue a medication distribution system that is overseen by a pharmacist, but operated by appropriately trained technicians
8. Pursue a medication system where drug selection, preparation and distribution are highly automated

At the end of 2010, the profession of pharmacy has arrived at a point where the use of automation and other health technology applications are an essential component of the pharmacy practice model of the future.

7. Business Case and Business Planning

Introduction

A Business Case captures the reasoning for initiating a project. These decision documents are generally presented in a well-structured written format. The logic of the business case is that, whenever resources or effort are consumed, they should be in support of a specific business need.

Information included in a formal business case includes the background of the project, the expected business benefits, the options considered (with reasons for rejecting or carrying forward each option), the expected cost of the project, a gap analysis, and the expected risks. Consideration should also be given to the option of doing nothing including the costs and risks of inactivity. From this information, the justification for the project is derived.

7.1. Formal Business Case

Formal business cases are evaluated to ensure:

- The investment has value and supports the strategic plan(s)
- The project will be properly managed
- The health organization has the capability to deliver the benefits
- The health organization has dedicated resources who are working on the highest value opportunities
- Projects with inter-dependencies are undertaken in the appropriate sequence

The business case process should be designed to be:

- Adaptable - tailored to the size and risk of the proposal
- Consistent - the same basic business issues are addressed by every project
- Business oriented - concerned with the business capabilities and impact, rather than having a technical focus
- Comprehensive - includes all factors relevant to a complete evaluation
- Understandable - the contents are clearly relevant, logical and, although demanding, are simple to complete and evaluate
- Measurable - all key aspects can be quantified so their achievement can be tracked and measured
- Transparent - key elements can be justified directly
- Accountable - accountabilities and commitments for the delivery of benefits and management of costs are clear.

The purpose of the business case is to:

- Introduce a way of thinking that causes people with the authority to recommend projects to firstly consider their value, risk and relative priority
- Require those proposing a project to justify its value to the health organization
- Enable executives to determine if the project proposed is of value to the business and achievable compared to the relative merits of alternative proposals.
- Enable executives to objectively measure the subsequent achievement of the business case's benefits.

7.2. Generating a Business Case and Business Plan

A business case must be tailored to an individual organization and project. Generation of the business case should not be mechanical and must demonstrate that issues have been thought through, the full benefits will be realized on time, any technical aspects have been thoroughly evaluated, costs have been evaluated, and that processes are in place to track and measure the achievement of the stated objectives.

A business case should contain the following information:

- Project name/reference
- Background/current state
- Context - Business objectives/opportunities
- Business strategic alignment (priority)
- Value Proposition - Desired business outcomes, outcomes roadmap, business benefits (by outcome), quantified benefits value, costs, return on investment financial scenarios, risks/costs of not proceeding
- Project risks (to project, benefits and business)
- Focus - problem/solution scope, assumptions/constraints, options identified/evaluated, size, scale and complexity assessment
- Deliverables - outcomes, deliverables and benefits expected,
- Organizational areas impacted (internally and externally)
- Key stakeholders
- Dependencies
- Workload - approach, phase/stage definitions, change activities, technical delivery activities,
- Required resources - project leadership team, project governance team, team resources/funding
- Commitments - project controls, reporting processes, deliverables schedule, financial budget/schedule

A Business Plan is a formal statement of a set of business goals, the reasons why they are believed attainable, and the plan for reaching those goals. It may also contain background information about the organization or team attempting to reach those goals.

A typical structure for a business plan includes:

- Cover page and table of contents
- Executive summary
- Business description
- Business environment analysis
- Industry background
- Competitor analysis
- Market analysis
- Marketing plan
- Operations plan
- Management summary
- Financial plan
- Attachments and milestones

In health care applications the structure is generally modified to include:

- Cover page and table of contents
- Executive summary
- Strategy/operating objectives for health care in the Province
- Strategy/operating objectives for the healthcare organization
- Medication delivery system background
- Proposed business description with alignment to strategy/objectives
- Market analysis
- Operations plan
- Management summary
- Financial plan
- Attachments and milestones

8. Business Template

Introduction

The purpose of this business template is to provide a guide and appropriate reference material to support pharmacy leaders in developing a business plan for medication system automation using established high-cost automation. The expectation is that this business plan will be submitted to executives within a specific facility, usually as part of a capital and/or operating budget process, to support a funding request.

Before beginning to use this business template to develop a proposal for submission to executives within the organization, it is important that certain prerequisites are in place within the organization, including:

- A pharmacy information system that can be interfaced with the planned automation technology and that will be able to exchange all the required data for the effective operation of the automation technology
- Repackaging technology that can support the automation technology and, where applicable, can be interfaced with the automation technology

- A well-established culture of safety
- An organizational IT infrastructure that has sufficient capacity and speed to support the information/automation technologies that are being pursued

A standard business plan cannot be developed which would be suitable for every medication automation proposal, as the specifics regarding each organization and the current state of medication system automation will be different. These unique characteristics and their impact on the proposal need to be addressed in a site-specific plan. This template should significantly reduce the time required to develop a business plan as a literature search, benefits, cost estimates and specific strategies that have been successful in other Canadian pharmacy situations are provided.

The specific strategy used should also be tailored to the environment that exists at the provincial and organizational level. An effective pharmacy automation strategy must support the organizational vision and mission and the priorities that exist at the provincial level. Likely strategies may include improved patient safety, cost savings, and effective use of resources. Prior to selecting a specific strategy it will be important to understand the priorities and annual objectives of your organization, the Ministry of Health in your specific province and any federal government health priorities.

The proposal should have a strong alignment with the priorities that have been established by your particular organization. These will likely include:

Patient safety:

- 'First do no harm'
- Included in most federal, provincial and health organization's long-term and short-term strategies
- The medication system in most organizations is one of the most significant sources of serious error causing patient harm
- Automation is one of the most effective strategies in reducing medication error
- Can leverage current investments
- Can build on increasing safety over time – building-block argument
- Patient adverse events increase operational costs and reduce patient throughput
- Systems to reduce error result in increased job satisfaction
- Automation helps in the tracking of safety problems
- Automation enables tracking of 'fixes' to assure error reduction strategies are effective
- Automation and forcing functions help enforce safety policies and procedures

Effective use of Resources:

- Medication system automation can result in a reduction in labour costs, through the reduction of FTE's and by changing the skill mix requirements within the department
- Alternately: Saved pharmacist time can be reallocated to high-value "medication management" activities
- More appropriate use of the skills and time of pharmacists, technicians, and nurses
- Increased job satisfaction for nursing and pharmacy staff
- Organizational engagement (magnet hospitals)

Financial

- Capital or operating strategy
- Investment decision – leverage current investments
- Effective way to reduce error and can be tracked
- Measurable
- Better use of professional staff resources
- Reduced medication wastage

With those considerations in mind, the development of the business plan can be addressed in a stepwise manner.

8.1. Title

The Title of the plan is an important consideration in order to attract the attention of decision makers. It should outline the rationale for supporting the project. Examples:

- Improved Medication Management using Medication System Automation
- Improved Safety and Economic Outcomes through the Use of Medication System Automation
- Reducing Medication Error through Medication System Automation
- Patient Safety Improvements through
- Protecting Patients from Medication Error: Medication System Automation

8.2. Executive Summary

An Executive Summary is one page that outlines what is recommended, why do it, how to do it, costs, savings and risk assessment.

8.3. Strategic Vision

The strategic vision should begin with broad strategies for the Provincial healthcare system and the Organization. The vision for pharmacy services should support the overall goals and objectives of the provincial/hospital through the provision of clinical, distribution, education and research services.

Following the vision of the Pharmacy within the health organizational structure, the overall vision of the drug distribution system should be presented. Issues to include are high-level and may include:

- Drug distribution is an organizational system which involves many health professionals including physicians, nurses, pharmacists and pharmacy technicians. The system should be easy to use, easy to train and make the best use of staff time.
- Patient safety is critical and medication use is a significant contributor to serious adverse events. This includes procuring medications, storage conditions, medication selection, preparation, ordering, dispensing, administration and charting. Pharmacy services impact the safety cycle in a number of areas including clinical programs and

distribution systems. This means the right medication, in the right dose, to the right patient via the right route at the right time.

- In order to create and implement effective systems, staff with the right skills and training need to be involved at the right times. Drug distribution activities in the pharmacy can be done largely by technical staff, thereby freeing up pharmacist time for additional clinical responsibilities.

8.4. Drug Distribution Systems

This section should provide sufficient information that executives have a high-level understanding of what systems are available and the relative advantages and disadvantages of each. Sections 2.1 and 2.2 should be reviewed and used to describe systems that could be used in your facility.

8.5. Drug Distribution: Current State

This section should describe in some detail the current system(s) used in your facility. This should include:

- Pharmacy information systems
- Pharmacy packaging systems
- Distribution of oral solids/liquids
- Parenteral admixture programs
- Narcotic control
- Ward stock availability

This section, in addition to describing the current systems, should provide some confidence that the pharmacy is ready to make a significant change. In addition it should indicate that the IT system that the pharmacy uses can be interfaced with the chosen technology as required, leveraging the hospital's investment in information systems. Any equipment that is currently available and will be used in the recommended system should be noted (e.g. repackaging equipment).

8.6. Rationale for Change

The rationale for change should be clearly stated with appropriate references. Some key references are included in this report. However, personal conversations with pharmacy leaders that have implemented automated systems successfully can also be included.

The rationale for change may vary depending on an Organizations vision and objectives but likely will include the following:

8.6.1. Patient Safety

Hospitals are dangerous places for patients to be, as many studies and reports have documented. The Institute of Medicine report of 2000, entitled "To Err is Human: Building a Safer Health System" ³⁰, examined the available evidence and concluded that medication errors were the largest single category of medical errors in the hospital setting, and were responsible for more than 7000 deaths each year in the united States. Overall,

the estimates of deaths from the legitimate use of medications in the US range from 7000 to 140,000³¹.

In Canada, the results of the Baker-Norton study³² found an overall incidence rate of adverse events (AEs) of 7.5%. Errors related to drugs or fluid management, at 23.6% of all AEs, were second only to surgery-related AEs. The study results suggested that of the almost 2.5 million annual hospital admissions in Canada that were similar to the type studied, about 185 000 were associated with an AE and close to 70,000 of these were potentially preventable. By extrapolation, the study suggested that in the year 2000, between 141,250 and 232,250 of 2.5 million admissions to acute care hospitals in Canada were associated with an AE and that 9250 to 23,750 deaths from AEs could have been prevented.

Medication errors also cause many non-fatal injuries that leave patients with permanent disability or other persistent consequences. In addition to human suffering, medication errors also have other consequences. Studies in the US have suggested that the cost, in the mid-1990s, of treating an adverse drug event ranged from \$3244 to \$ 5857^{33,34}. Almost twenty years later, those costs have undoubtedly risen considerably. Much of the added cost arises from the prolongation of hospitalization that often results from a medication error. In the Canadian context, prolongation of hospitalization means that acute care beds are being used to manage the consequences of medication errors, rather than being available for patients waiting in the ER or waiting for access to the hospital for a surgical procedure. Failure to address preventable AEs affects not only the quality and cost of care, but also the accessibility of care.

The "To Err is Human" report³⁰ called on hospitals to improve medication safety by implementing proven medication safety practices that reduce reliance on memory, standardize terminology, use constraints and forcing functions and minimize data hand-offs. The report identified a number of technologies that had been shown to reduce medication errors. The medication cycle involves four major components – prescribing, transcribing, dispensing and administration - and studies have shown that medication errors can occur in each of these areas. Errors are more likely to have originated in the prescribing phase (49%) and the administration phase (26%) than in the dispensing phase (14%) and the transcribing phase (11%).

In 2001 the Institute of Medicine published a follow-up to the "To Err is Human" report in which it advocated that a number of health information and automation technologies (HIATs) be implemented to improve patient safety³⁵. The adoption of electronic health records (EHRs), integrated with computerized prescriber order entry systems, automated drug distribution systems and point-of-care medication verification systems (e.g. bar-code systems) was advocated as way to address deficiencies in each phase of the medication cycle. It is envisioned that these systems will ultimately share real-time patient information and provide clinical decision support at the point of care.

The use of medication-management technologies, within the framework of an integrated EHR, is inevitable. As discussed in an earlier section of this document, the adoption of automation for managing the repackaging, storage and controlled release of medications

has already occurred in most US hospitals, and the adoption rate in Canadian hospitals has accelerated rapidly in the last few years. However, the adoption of medication management technologies would ideally be part of an overall organizational plan and vision for technology. Health care organizations that have pursued such an approach, with a vision for a system that achieves improved connectivity and clinical decision support, have reported greater improvements in quality and safety^{36,37,38}.

8.6.2. Waste: Resources and Drugs

Early studies of unit dose systems demonstrated that drug costs were reduced substantially when compared to traditional drug distribution systems. The US General Accounting Office conducted a study entitled "Unit dose life cycle cost analysis and Application to a Recently Constructed Health Facility", in which it was reported that pilferage and wastage in traditional drug distribution systems accounted for 35-50% of all drug costs, compared to 4-12% in unit dose systems³⁹. Later studies showed that decentralized drug distribution systems were associated with better drug use control and lower drug costs than centralized cart-exchange unit dose systems^{40,41}. Most of the more recent reports in Section 3 of this report, that describe the results of implementing automated drug distribution technologies, reported drug cost savings ranging as high as \$200,000 per year. In a mid-size hospital with \$5 million in drug expenditures, a conservative estimate of 2% to 4% savings, achieved through improved inventory management, reduced wastage, and reduced pilferage, would translate to savings of \$100,000 to \$200,000 annually.

Theft of narcotic and controlled drugs is a common, well-recognized problem in the hospital setting. The theft of these drugs represents a direct financial cost to an organization. In addition there are other very significant costs associated with this form of drug diversion. Chemically dependent staff members represent a risk both to themselves and to the patients that they care for. In addition, there are substantial human resource and legal costs associated with staff members who are found to have a substance abuse problem and who have been diverting drugs. When hospitals implement certain types of automation technology, particularly automated dispensing cabinets, the enhanced controls and audit tools frequently detect incidents of drug diversion that have often gone unnoticed for long periods of time.

The extent of pilferage of other types of drugs is something that many hospitals fail to acknowledge or address. The early studies of unit dose systems demonstrated that pilferage of drugs from uncontrolled ward stock inventory can be very substantial. Recent newspaper articles have highlighted the fact that drug theft remains a significant problem in hospitals and other institutional care settings.⁴² Many of the drugs that have come to the market in the last decade are very expensive, and failure to maintain tight controls over these expensive drugs offers a great temptation for staff members who are either personally prescribed those medications, or who have family members who are taking those drugs.

8.6.3. Personnel Staffing / staff mix

Pharmacists have generally commanded higher salaries than those paid to most other allied health professionals with similar levels of university education, such as nutritionists, physiotherapists and occupational therapists. Although the wage gap between pharmacists and nurses has decreased in recent years, pharmacists still tend to be paid more than nurses with a similar level of university education. There are probably a number of reasons why pharmacists have been well-paid health professionals, not the least of which may be the fact that there has been a very large private sector demand for pharmacists as the retail pharmacy sector has undergone dramatic growth over the past several decades. In addition, the role of drug therapy in the care of patients has risen to the point where it is the dominant form of treatment that patients receive, when compared to surgery, radiation and other forms of treatment. It would be reasonable to assume that pharmacists have been in demand because of their ability to improve the positive outcomes of drug therapy and to minimize the negative outcomes. However, the reality in many practice settings has been that pharmacists remain heavily committed to the technical aspects of drug dispensing. The pharmacist shortages of the late 1990s and 2000s led to a careful assessment of the factors that were contributing to the shortage. One of the key health human resource questions that was explored by the *Moving Forward* initiative and similar studies was "do we have the right health professional, in the right place, at the right time, doing the right things?"²⁶ When that question was explored in pharmacy practice, the answer supported what many commentators had been saying for decades - many pharmacists spend significant amounts of their time carrying out technical, drug-distribution activities that could be performed as effectively and as safely by pharmacy technicians and/or pharmacy automation technologies.

The acknowledgement of this reality leads to a limited number of strategies that can be justified. One option would be to simply alter the staff mix ratio so that the proportion of pharmacy technicians is increased and the proportion of pharmacists is reduced. Pharmacists would focus their efforts on activities that technicians are not qualified to perform, and which existing pharmacy technologies cannot perform. This change in staff mix could substantially reduce the overall pharmacy wage costs. However, many experts argue that there is a different strategy that would yield a far better outcome. Although drug therapy has resulted in many positive outcomes, there is also a high cost burden associated with medication *mismanagement*. The frequency of preventable medication misadventures and the costs associated with those incidents has been documented in a number of studies that were referred to earlier in this document^{33,34}. There is a strong financial and patient care justification for redirecting pharmacists' time from technical activities to high-value medication-management activities. Rather than pursuing a simplistic staff ratio adjustment, a strong argument can be made for reinvesting saved pharmacist time and restructuring pharmacy services in a way that will achieve higher quality drug therapy outcomes through the cost-effective use of pharmacy technology, pharmacy technicians and pharmacists.

8.6.4. Ease of use

One of the strengths of unit dose systems is that they limit the variety and quantities of drugs that are available on the nursing units. By doing so, the possibility of the patient receiving the wrong medication or the wrong dose of a medication is reduced. The ideal situation is one where nursing staff only have access to the right drug in the right dose at the right time. In a traditional cart-fill unit dose system, during the cart-fill process in the Pharmacy, the correct medication and correct dosage for each administration time is placed in the patient's drug bin, usually in a slot designated for a specific administration time.

This strength of unit dose systems can also be one of its major shortcomings. When new orders are written, or changes are made to existing orders, nursing staff usually do not have immediate access to the new medication or strength. The pharmacy department has procedures in place for filling and delivering the needed medication to the patient care unit, but the delay before the new medication is available on the nursing unit is often quite long. Nursing staff can spend considerable amounts of time managing the "first-dose" process, which frequently involves a number of interactions with pharmacy staff. For pharmacy staff, managing interim doses until the next cart-fill occurs can be a very time-consuming and inefficient process. Finally, from a patient care perspective, there is often a significant delay in the patient receiving the first dose of the new medication/new strength of medication. While the delay may not be critical for many drugs, for certain drugs such as antimicrobials, the delay can adversely affect patient outcomes.

For nursing staff, having access to wardstock of commonly administered medications may seem to be the solution to this problem. However Pharmacy staff will resist that, since the availability of significant amounts of wardstock will essentially negate many of the advantages of a unit dose system. Nursing staff may well end up finding creative solutions to this problem, such as "borrowing" drugs from other patient's bins.

Some automated technologies, particularly automated dispensing cabinets address this issue reasonably well. The cabinets contain a stock of many medications, but the release of those medications to nursing staff is controlled, based on the patient's medication orders. When new orders are written and entered into the patient's medication profile, nursing staff have immediate access to medications that are stocked in the cabinet. This substantially reduces the time to administration of first-doses. In situations where pharmacists are not available to review and enter orders (nights, weekends, etc.), designated nursing staff (unit managers, charge nurses, etc.) can be given the ability to access medications that are not yet entered in the patient's medication profile. The software will track these "overrides" so that pharmacy staff can review those situations and insure that this "override" authority is not being used inappropriately. In this case the automation improves efficiency and improves nursing satisfaction with the drug distribution system.

Looking forward to a future where health information technologies are fully integrated, hospitals will have a closed loop system which tracks and charts medications from the time they are ordered until their administration to the patient.

8.6.5. Staff satisfaction

The available literature, which was reviewed in earlier sections of this document, support the view that nursing and pharmacy staff are more satisfied with certain types of automated drug distribution systems because they address some of the deficiencies associated with cart-fill unit dose systems, while simplifying medication-related responsibilities.

8.7. Automation Models

The three types of automation technologies that are the primary focus of this document (automated repackaging technologies, robotic cart-fill technologies, and automated dispensing cabinets) can be employed alone, or in combination, in a number of different models.

Automated repackaging technologies have been used by many hospitals to increase the efficiency of traditional cart-fill unit dose systems. The same types of automated repackaging technologies can be used to prepare the unit dose packaged drugs that are stocked in automated dispensing cabinets (ADCs). In fact, an interface can be created between the automated repackaging equipment in the pharmacy, and the ADCs based on patient care units so that replacement stock is automatically repackaged when the remaining inventory in a cabinet falls below a pre-defined minimum stock level.

Some robotic cart-fill technologies have their own built-in repackaging component (e.g. Swisslog). Other robotic technologies do not have a built-in repackaging capability, in which case one of the automated repackaging technologies (e.g. FastPak EXP® by AmerisourceBergen. , PACMED® by McKesson)) may be needed to support the robotic cart-fill technology.

Models that use robotic cart-fill technologies as part of a largely centralized drug distribution model may also opt to use some ADCs to help address the shortcomings associated with cart-fill systems. For example, ADCs may be placed in a number of locations within the hospital in order to provide nursing staff with access to medications more quickly when new or changed orders are written. This helps to address the delays and inefficiencies that are associated with obtaining "first" or "interim" doses, particularly when the pharmacy is closed. ADCs may also be used in areas like the operating rooms and ERs that are not normally serviced as part of a cart-fill unit dose system. When ADC technology is used to support a robotic cart-fill system, it essentially serves as a form of "controlled" wardstock system where records are kept of the staff who accessed drugs from the ADC. This enables follow-up with the staff involved, if any issues arise with respect to the medications that were removed from the ADC. , Similarly, some hospitals use ADCs to control access to narcotic and controlled drugs in areas like the ORs.

The process:

Although a variety of planning approaches are possible, and each facility will have to decide upon an approach that is tailored to their own environment, the following approach has been successfully in other Canadian healthcare organizations.

Phase 1:

For most pharmacy managers, the planning process could be initiated with the preparation of a short briefing note for discussion with his or her superior on the senior management team. The one or two page briefing note should briefly summarize the trends in adoption of pharmacy automation systems, such as those that have been reported in the ASHP and Hospital Pharmacy in Canada surveys. The briefing note should also include an overview of the factors that are driving the adoption of pharmacy automation. These include the issues identified earlier in this report, such as the shortcomings in traditional drug distribution systems, inefficiencies that result from traditional manual drug distribution systems, patient safety issues, human resource utilization issues, and the movement toward integrated health information and automation technologies (HIAT). The goal at this early stage should be to gain support for the establishment of a multidisciplinary group that would explore the potential benefits that the organization might realize through the use of pharmacy automation technologies. It should be emphasized in the briefing note that there is recent evidence, such as the CADTH report, which indicates that automation technologies do reduce costs, with the potential for a positive return on investment in as little as 5 years. The case should also be made that ultimately all hospitals will have to invest in contemporary pharmacy information and automation systems before the organization can pursue the implementation of integrated health information systems such as the electronic health record (EHR), CPOE, or point-of-care, bar-code verification systems.

Phase 2:

With the approval of the senior manager to whom pharmacy reports and, if required, the senior management group as a whole, the multidisciplinary group should be created and charged with carrying out a high-level overview of the role that pharmacy automation systems could play in the organization's medication management system, and ultimately in the hospital's HIAT infrastructure.

The makeup of the group that is tasked with examining these technologies, and reporting back to senior management, will be an important determinant of the success of the next phase. Efforts should be made to have at least the following members on the multidisciplinary committee:

- A senior management representative, preferably the individual to whom the pharmacy department reports
- The director of pharmacy, or an alternate pharmacy manager, who has thoroughly acquainted themselves with how the various pharmacy automation technologies could be used to improve your organization's medication management systems
- A senior nursing manager, preferably one who has worked with pharmacy on other initiatives and who has demonstrated an appreciation of the role that information systems and automation technologies might play in addressing shortcomings in the hospital's existing drug distribution systems
- A representative from e-Health/IT, preferably one who has demonstrated an appreciation of the critical role that pharmacy information systems and medication management systems will play in the HIAT infrastructure that will be required to optimize other parts of the hospital's integrated health information system, such as CPOE and the EHR.

- A representative from medicine, preferably one who has demonstrated an interest in drug distribution systems, patient safety and medication management issues. Medical staff members are usually the most difficult representatives to find for committees like this, unless it connects with other initiatives that they are involved with. If there is a member of the medical staff who is already involved in planning for the implementation of CPOE or an EHR system, they would likely be a good choice to invite to participate in this initiative.

The individuals who serve on this group should be individuals with a “big-picture” view of the health care system. They should be individuals who appreciate that the drug distribution system is not a “pharmacy system”, but rather a “hospital medication management system” that has an important impact on other health disciplines (nursing, medicine), on hospital administration (patient safety, financial management) and, most importantly, on patients (safety, efficacy). Furthermore they should be individuals who understand that “medication management technologies” will provide critical information to each patient’s future EHR. A contemporary pharmacy information system, combined with pharmacy automation technologies, will provide an important part of the foundation that is required to realize the full benefits of CPOE and the EHR. Admittedly, this argument may be more convincing with ADC technology than it is with robotic cart-fill technology, given that ADC technology can be used to generate medication administration records that are as reliable as those generated manually by nursing staff. However, each of the pharmacy automation technologies generate valuable medication use information that the organization can benefit from.

Phase 3:

To help bring the group to a common understanding of the role that pharmacy automation might play in your hospital, some organizations have found that a strategic planning model can be very helpful. That approach begins with the creation of a future vision of *what* the organization’s drug distribution/medication management systems should look like. Will the current system serve the organization well in 5 or 10 years? A tool that could help answer that question is a SWOT analysis (Strengths/Weaknesses/Opportunities/Threats). Each member of the committee should be asked to identify the strengths and weaknesses of the current system, particularly but not exclusively, from the perspective of the constituency that they represent on the committee. What are the threats if the medication management system remains in its current state? What are the opportunities associated with pursuing changes to the medication management systems? Does the hospital have plans for an integrated HIAT infrastructure? Would the existing medication management systems serve as a strong foundation for other initiatives that the hospital may be considering, such as CPOE, a point-of-care barcode verification system, or an EHR system?

After the organization decides *what* it wants its pharmacy/medication management systems to look like in the future (the vision), it then has to focus on *how* it will achieve that vision. The *mission* represents an overview of *how* the vision will be realized. For example, if the vision for the organization’s future pharmacy/medication management systems is different than what currently exists, how will the change be achieved? Would the changes be facilitated through the use of technology such as pharmacy automation? If pharmacy automation was to be pursued, would the intent be to focus on stand-alone pharmacy automation that is intended to improve the efficiency and quality of certain pharmacy operations, like the repackaging of medications into a unit dose format or the filling of unit dose carts? Alternatively, is the hospital pursuing a broader health

technology strategy that would require that pharmacy systems be interoperable with other existing or planned health technologies, such as an electronic chart, a prescriber order entry system or bedside bar-code verification system? Are there needs at the nursing unit level that should be addressed? Are there needs in other departments that also need to be addressed? Could medication system automation address those needs (e.g. ADC technology)?

After these questions have been answered it should be clear if the group believes that pharmacy/medication management technologies are viewed as playing a role in achieving the organization's future vision for its drug distribution/medication management systems. It is probable that there will be some level of agreement that pharmacy automation technologies could play a helpful role. However, before the committee agrees to incorporate pharmacy automation into the mission statement the question of "at what cost?" will almost certainly need to be addressed.

Phase 4:

At this point, the committee will likely want a ballpark estimate of the costs of the available technology.

i. Automated repackaging technology:

A single high volume repackaging machine can manage the packaging needs of a 400-500 bed, acute care facility. Automated repackaging technologies of that nature, such as the FastPak EXP® by AmerisourceBergen or PACMED® by McKesson technologies, can be expected to cost approximately \$250,000 to purchase. In addition there are ongoing costs for maintenance that are approximately 10% of the purchase cost per year. Finally, there will be operating costs required for the unit dose packaging supplies, which the manufacturer of the particular technology chosen will be able to provide.

ii. Robotic cart-fill technology:

Robotic cart-fill technology, such as that offered by McKesson or Swisslog, can be expected to cost between \$1- 2 million per unit, depending on the type of unit purchased and the number of units purchased. In addition there will be significant renovation costs within the pharmacy department. Renovation costs are difficult to estimate as there is significant variation between hospitals with respect to their existing pharmacy space and space configuration. Plant Services Departments can usually provide an estimate from rough drawings. There will also be packaging supply costs for this technology at an approximate cost of \$0.061 per repackaged dose (all packaging supplies including print ink stock)

iii. Automated Dispensing Cabinet Technology:

The cost of this type of technology depends to a large degree on the equipment configuration that is chosen. In an effort to reduce the implementation costs, some facilities have tried to get by with an equipment configuration that later proved to have been inadequate. That approach will almost always lead to substantial dissatisfaction on the part of nursing staff who use the system. Experience suggests that organizations should aim to have 95% of all routinely used medications stocked in the cabinets located on each unit. For

most medical/ surgical units there should be two mirrored ADC stations from which medications can be withdrawn. This prevents nursing staff from having to line up at a single station at busy medication pass times. It also provides a back-up if one of the stations stops working, or if stock of a particular item runs out in one of the stations. In addition, most medications should be stocked in a manner that only allows one drug to be accessed from a given stock location in the cabinet. This helps prevent medication errors from occurring when nursing staff have to select the correct medication from more than one open stock location. In other words, most drugs should be contained in more expensive mini-drawers or cubie drawers, where nursing staff can only access a single medication when the drawer opens, rather than the medication being stored in less-expensive carousel drawers where nurses have to select the correct medication from a number of open, available stock locations.

Based on the approach described above, the table below provides information on the actual 2007 lease or purchase costs for 6 acute care hospitals. Four of those hospitals are community acute care hospitals, while the remaining two are tertiary care teaching hospitals.

Automated dispensing cabinets Purchase, lease, and maintenance costs, for 6 acute care facilities *					
Hospital 1	Purchase Cost per bed (one-time cost)	Leasing cost per bed per year	Leasing cost per patient day	Annual maintenance cost per patient day (for both purchase and lease)	Lease and maintenance cost per patient day
1	\$ 5995	\$ 1432	\$ 3.91	\$ 0.48	\$ 4.39
2	\$ 3397	\$ 811	\$ 2.74	\$ 0.33	\$ 3.07
3	\$ 6216	\$ 1443	\$ 4.07	\$ 0.50	\$ 4.57
4	\$ 5906	\$ 2224	\$ 4.37	\$ 0.57	\$ 4.94
5	\$ 6373	\$ 1484	\$ 4.47	\$ 0.57	\$ 5.04
6	\$ 5652	\$ 1355	\$ 3.97	\$ 0.52	\$ 4.49
Average	\$ 5590	\$1458	\$ 3.92	\$ 0.50	\$ 4.41

*2007 costs (Canadian CPI: 2007 - 2.4%, 2008 - 1.2%, 2009 - 1.3%, 2010 - 2.4%)

These costs provide a good indication of the costs that can be anticipated if ADC technology is either purchased or leased. It should be noted that the costs are in 2007 dollars and minor adjustments to these amounts should be made to adjust for inflation since 2007.

There are two options for acquiring ADC technology – lease versus buy. Given the difficulty in acquiring large amounts of capital to replace aging equipment every 5 to 7 years, serious consideration should be given to the option of leasing ADC technology. This approach essentially recognizes that medication management systems are an operating expense, whether they are manually delivered or delivered via some form of automation. This insures that the hospital is always using the most current version of the operating software, and that equipment upgrades will become available in a timely manner. When looked at from a cost per patient bed per day, the leasing and maintenance costs are under \$5.00 per patient day. This cost can be put in perspective by comparing it to other expenses that can be calculated on a cost per patient day basis. Average drug costs are approximately \$30 per patient day in the medical/ surgical acute care setting. Average pharmacy staffing costs per patient day are in the range of \$30 to \$35 per

patient day and average nurse staffing costs per patient day are well in excess of \$130 per patient day. Overall, the leasing costs of ADC technology are quite small in relation to other costs of care in the hospital setting

If the hospital's or funding agency's policies will not permit a lease option, the purchase option presented above suggests that ADC technology for a 25 bed medical surgical unit would cost about \$140,000 (in 2007 dollars), for a robust ADC configuration.

How do these costs compare to those reported by CADTH in 2009? The cost information presented by CADTH was as follows:

*"The equipment costs for each patient care unit or intensive care unit are \$123,000 for an unprofiled automatic dispensing device and **\$138,000 for a profiled device.**"*

The purchase cost estimates from the group of 6 hospitals in the table above are very similar to those that CADTH had calculated.

Renovation costs will be the same for either the lease or purchase option. . Renovation costs for 3 of the four community acute care hospitals in the group of 6 hospitals described in the table above averaged approximately \$12,000 to \$13,000 per patient care unit (in 2007 dollars). The other 3 hospitals already had ADCs prior to their replacement in 2007, and no further renovation costs had to be incurred by those facilities in 2007..

These are not the only costs that will need to be addressed. CADTH estimated that planning costs for a profiled system would be in the range of \$82,800 per unit. Those planning costs would include the renovations costs of \$12,000 to \$13,000 described above, as well as the costs for e-Health, project management, and pharmacy support for the implementation of this technology.

In addition to pharmacy planning (with related costs) each patient care area will require renovation. It is not possible to estimate the construction costs for every facility however rough estimates are:

- Interfacing only - \$25,000
- With a sink - \$60,000
- And walls - \$100,000

These costs can be very significant and require a more detailed plan and estimate, however care should be taken to assure that areas are well planned and sufficient funds are available to assure that the space is efficient.

Phase 5:

In the strategic planning phase, decisions are first made about the future vision for the hospital's medication management systems. Then the strategies/tools needed to achieve that vision, which will likely include pharmacy automation, are identified. Based on the strategies selected (i.e. type of automation that would be needed to achieve the vision) rough cost estimates can be developed, using the information above. At this point the information can be reviewed by the committee and a

decision made as to whether or not the committee is prepared to recommend that the organization pursue the acquisition of pharmacy automation technology. If the committee decides to make that recommendation, a formal briefing note would be prepared, outlining both the benefits and costs of acquiring the desired automation technology. This briefing note would require senior management approval before the next phase of planning could proceed.

8.8. Project Implementation

Once senior management has approved the briefing note and authorizes the funding required to proceed with the implementation of pharmacy automation, an appropriate implementation strategy needs to be developed and operationalized.

8.8.1. High-volume automated repackaging technology:

If the hospital has made a decision to implement high-volume automated repackaging technology, most of the change management will be internal to the pharmacy department. Equipment installation and setup will need to be overseen by a pharmacy manager who will work closely with the vendor. Pharmacy staff, primarily technicians, will need to be trained in the operation of the new equipment. Policies and procedures for the new workflow need to be developed, Contingency plans for situations where the equipment fails will have to be developed and tested. The department should be prepared to operate for several days in a contingency mode if the technology fails. The equipment vendor should be involved in the development of the contingency plans. As part of the contract development with the vendor, there should be clear agreements related to service timeliness and escalation procedures in the event that the technology fails.

External to the pharmacy department, communication will need to occur with nursing staff and others who directly work with unit dose packaged drugs, concerning the changes in the appearance of the packaging and labeling of unit dose medication that will occur as a result of the new technology. If the repackaging technology will be interfaced with the pharmacy information system, so that patient-specific packaging and labeling occurs, there will be a need for substantial support from e-Health and the vendor during the implementation phase.

8.8.2. Robotic unit dose cart-fill technology:

Similarly, if a decision was made to implement robotic cart-fill technology, the majority of the change management will be occurring within the pharmacy department. There will again be changes to the appearance of the packaging and labeling of unit dose medications that needs to be communicated to nursing staff, but otherwise there will generally be minimal change in how the system works from a nursing perspective. Unit dose carts will still be filled and delivered to the nursing units and the processes on the nursing units will undergo little, if any, change. However, within the pharmacy department, there will be major changes in how the work is carried out. Pharmacy technicians will have new work procedures that are focused on maintaining the stock levels of the drugs that are picked and placed in the unit dose cart bins by the robot. One of the most important planning activities for robotic cart-fill technologies is the development of contingency plans

for a backup system if/when the technology fails. Policies and procedures for reverting, on short notice, to a manual system for filling unit dose carts needs to be in place. Pharmacy staff that would need to implement the contingency plans need to review the policies and procedures on a regular basis to insure that the plan can be seamlessly implemented when the technology fails, which will inevitably happen.

To effectively implement this technology a Project Management methodology should be used. This will include a Project manager, implementation team and “leads” for the various working groups.

8.8.3. Automated Dispensing Cabinet Technology

Unlike the previous two forms of pharmacy automation, the implementation of ADC technology will have a major impact on a wide range of disciplines within the hospital. There will be major changes in the way that nursing staff carry out their medication-related activities. The e-Health/IT department will have a major role to play in the setup and ongoing maintenance of the IT infrastructure that will support the technology. Staff who work in the Admission/Transfer/Discharge (ATD) process may need to revise their processes, since the technology relies on accurate and current information concerning the name and location of all staff. Physical plant staff will be involved in the planning and execution of the renovations that will be required on nursing units. If the technology will be deployed in areas such as the OR, for management of narcotic and controlled drugs, physicians will also require training on the use of the technology.

Given the complexity of managing all the components of a project of this nature, and the critical interdependencies that exist between the various components of ADC implementation, it is strongly recommended that a formal project management approach be used to manage ADC implementation. An individual with formal project management training, and previous experience with a project of this magnitude, should be engaged as soon as possible after the project funding has been approved. The funding for this position would be part of the planning and implementation costs (\$82,800 per patient care unit) that CADTH identified in their assessment of this technology. The role of this individual is to coordinate the various implementation activities that are underway, using the tools and methods of program management. These tools include:

- GANTT charts to organize the timing of the various sub-projects, to insure that the needed resources are available when needed for each subproject, and to insure that the interdependencies of the various subprojects are being managed, etc.
- RACI charts that identify the changes, and the timing of those changes, that are expected to occur in the Responsibilities, Accountabilities, Communication roles and Information requirements of all the major players that will be involved in the overall project
- Status tracking system that identifies the current status of all subprojects. A green, yellow or red status is applied to various sub-projects as an early warning system for any issues or problems that may arise, allowing early intervention and correction before they have a significant negative impact on the overall project

A coordinating committee should be established to oversee and manage the overall project. The committee should include:

- a representative from the hospital's senior management group, preferably the individual to whom the Director of Pharmacy reports
- the Director of Pharmacy or the Pharmacy manager who has been assigned to lead the pharmacy component of the project
- the Project Manager
- the Leads of the various working groups (described below)

Working groups should be established to deal with the various components of the implementation. The number and nature of the groups will vary, depending on the hospital, but would generally include:

- **ADC Configuration/Setup Working Group.** This working group should minimally be made up of representatives from pharmacy and nursing, with a mandate to establish the equipment requirements for each patient care unit and determine the setup of the equipment (drawer configurations and stock locations). Some of the responsibilities of this group will include:
 - running reports for each patient care unit to establish the types and volumes of drugs used on each patient care unit over a 2 to 4 week period
 - assessing the level of control desired for each item that will be stocked in the ADC and assigning individual medications to the appropriate type of drawer configuration (e.g. mini-drawers, cubies, carousel drawers, etc.)
 - determining the overall ADC equipment configuration required on each patient care unit (i.e. the number of main and auxiliary units), with the aim of having 95% of all routinely used medications available in the ADCs on each patient care unit
- **ADC IT Working Group.** This group should minimally be made up of representatives from e-Health/IT and pharmacy, with the mandate of insuring that all IT issues associated with the ADC implementation project, (e.g. interfaces, network connections and other relevant IT issues) are addressed. Some of the responsibilities of this group will include:
 - insuring that the existing pharmacy information system is running on a current version of software, and that the system possesses all of the functionality that will be required to effectively support the ADC technology
 - insuring that product identifiers used by the pharmacy information system are identical to those to be used in the ADC technology
 - insuring that data entry into the hospital's admission/transfer/ discharge (ATD) system will occur in a timely manner and that all required information from the ATD system will be communicated in a timely manner to both the pharmacy information system and the ADC technology

- insure that all new interfaces that are required (e.g. ATD to Pharmacy, ATD to ADC technology, ADC to automated repackaging technology, etc.) are developed and implemented at the appropriate time points in the implementation schedule
- if barcode identification technology will be used in loading the ADC technology, insuring that an appropriate bar code system is used and that all products are assigned a unique barcode identifier
- **Human Resources Working Group.** This group should minimally be made up of representatives from pharmacy, nursing and human resources (HR), with the mandate of addressing all HR issues that arise from the implementation of the ADC technology. Some of the responsibilities of this working group will include:
 - identifying any and all changes in the roles and responsibilities of the different categories of staff that will be impacted by the implementation of ADC technology (e.g. pharmacists, pharmacy technicians, nurses, ATD staff, etc.)
 - Identifying any changes in staff mix that may be desirable in order to optimize the efficient utilization of staff resources
 - Identifying any potential union issues that might arise as a result of changes in the roles that various staff will be performing and developing strategies for addressing those issues
 - Identify any training issues that will be required to prepare staff for any changes in their roles that will be expected to occur
- **Education Working Group** This group should minimally be made up of representatives from pharmacy and nursing, with the mandate to develop and deliver the training required for staff who will be impacted by the implementation of ADC technology. Some of the responsibilities of this working group will include:
 - the development of training programs for pharmacists, pharmacy technicians, nurses and other staff whose roles and responsibilities will change as a result of the implementation of ADC technology
 - the establishment of training “laboratories” where staff can be trained to use the ADC technology
 - the development of a training schedule that will insure that all affected staff will have been trained on the use of the ADC technology from the perspective of their individual roles (the training of nursing staff on how to access medications in the cabinets, the training of pharmacy technicians on how to prepare medications and load them into ADC cabinets, etc)
 - the assessment of all staff who will be using the new technology to insure that they possess the competency level required to safely utilize the new technology

- **Finance Working Group** This group should minimally be made up of representatives from senior management, finance, pharmacy, and nursing, with a mandate to monitor the financial status of the project. Some of the responsibilities of this group would include:
 - monitoring variances between the budget and actual expenses incurred for all components of this initiative.
 - reviewing and approving requests for contingency funding to address unbudgeted requirements that have arisen as the project progresses
 - Note: In a project of this magnitude, it would be unlikely if unexpected issues did not arise during the implementation process, and some of those issues will require expenditures to be made that were not specifically identified in the original budget. For this reason a contingency fund of 10% to 15% should be built into the project budget.
 - Insuring that implementation occurs within the financial framework that was approved for the ADC implementation project

The ADC Coordinating Committee, with the support of the Project Manager, should serve as the leadership group for driving the ADC implementation project.

8.9. General Recommendations

Adapted from the ASHP Pharmacy Practice Model Summit and other published papers dealing with HIAT implementation

1. Articulate an ideal vision and strategy for a health information and automation technologies - enabled, medication-use process
2. Recognize that health information and automation technologies (HIAT) will have a major impact on all health professions, including pharmacy
3. Resist waiting for the perfect solutions to become available before pursuing any HIAT applications
4. Continue to seek HIT solutions that yield incremental gains and assure that those gains are aligned with institutional goals and ideal HIAT strategic objectives
5. Accept that current and emerging technologies could supplant roles traditionally performed by pharmacists, while creating greater opportunities for pharmacists to assume greater responsibility for medication therapy management
6. Work collaboratively with other health professions and IT personnel to achieve a higher level of medication-system connectivity and integration
7. Insure that an appropriate multidisciplinary group is identified or established to provide oversight for the automation of medication management systems

8. Insure that the respective responsibilities of the vendor and the facility are clearly laid out and agreed upon , for each of the following activities:
 - education
 - installation
 - validation
 - operations
 - maintenance
 - troubleshooting

Recommendations for Automated Drug Cabinet (ADC) technology

1. Insure that electronic interfaces, or manual alternatives, are created between the ADCs and other systems that are used to:
 - maintain current admission, transfer, and discharge information
 - maintain current medication profiles (e.g. pharmacy information system or an EMR system)
 - repackage medications (e.g. automated repackaging technologies such as FastPak EXP® or PACMED® Automed)
 - maintain pharmacy inventory records
 - order medications
 - document medication administration (e.g. an EMR system, bar-code enabled point of care systems)
 - manage financial information
 - generate accurate, accessible and timely information related to medication usage at the level of:
 - the individual patient
 - the patient care unit
 - the overall facility
2. Insure that sufficient equipment will be acquired to insure the effective and efficient operation of the automated medication system
3. Insure that adequate space for the ADCs will be available on the patient care units and the space will:
 - a. be located in an area that allows easy access by pharmacy and nursing staff
 - b. be located in an area that minimizes distractions and disruptions for nursing and pharmacy staff who are using the technology
 - c. have adequate environmental control to protect the integrity of medications stored in ADCs
 - d. facilitate routine cleaning and infection control procedures
 - e. have adequate lighting for reading and documentation
 - f. facilitate the protection of confidential health information
 - g. provide power outlets that provide backup power during power outages
 - h. provide access to data connections
 - i. if necessary, appropriate renovations will be carried out in affected patient care areas to insure that the space needs described above are met

4. Insure that all required medications can be made available, either through the automation technology or through safe and effective alternative arrangements
5. Insure that the desired features of a unit dose system are maintained, thereby insuring, to the greatest extent possible.
6. Insure that medications are packaged in, and administered from, unit of use packaging
7. Insure that medications are available for administration only at the intended time of administration
8. Insure that an up-to-date, electronic medication profile is available to pharmacy, nursing, medicine and other authorized users, at the point of care
9. Insure that access to certain medications can be limited, based on law or organizational policies
10. Insure that differences between the existing, planned, and recommended workflow practices are addressed
11. Insure that appropriate security controls are in place.
12. Insure that performance standards are established for accuracy and timeliness
13. Insure that all affected staff including, but not limited to, pharmacists, pharmacy technicians and nurses are made aware of how the automation technology will impact upon their daily activities.
14. Insure that orientation and education of affected staff is provided at appropriate time points in the implementation process
15. Insure that a written plan, which identifies potential sources of errors that have been reported in association with ADC technology and describes how those risks will be addressed, is created and maintained
16. Insure that access rights, that control who can access medications contained within the ADC technology, are established and maintained
17. Insure that procedures for safely transporting medications from the pharmacy to the ADC cabinets are established
18. Insure that procedures are established to insure that machine-readable codes (e.g. bar codes) are used to insure placement of the correct medication in the appropriate storage compartment of the ADC technology
19. Insure that procedures for insuring that medications are transported from ADCs to the correct patient are established

20. Insure that procedures are established for insuring the security of all stored medications
21. Insure that additional security requirements for narcotic and controlled drugs are established to minimize opportunities for drug diversion
22. Insure that procedures are established to enable early detection of drug diversion
23. Insure that procedures are established for routine auditing of all transactions that are tracked by the ADC technology
24. Insure that procedures are established for minimizing the risk of cross-contamination
25. Insure that procedures are established for monitoring expiry dates and insuring that medications are removed from ADC s prior to their expiry date
26. Insure that procedures are established for reporting and correcting ADC malfunctions
27. Insure that procedures are established for reviewing override data and insuring that the ADC safety and security features are not being unnecessarily compromised

8.10. Financials

A summary of the costs associated with the project should include:

- Cost of the technology
 - Financing recommendation
 - Lease
 - Buy
- Operating cost (maintenance, supplies, etc.)
- Renovation cost including cabling (Pharmacy, patient care areas, etc.)
- Interface costs with additional maintenance costs
- Project costs:
 - Executive Sponsor
 - Multi-disciplinary Oversight Committee
 - Pharmacy Leadership
 - Implementation Team
 - Project Manager (\$150,000+)
 - Project Charter
 - Team Charter
 - Impact and Readiness Assessment
 - Transition Plan to operations
 - Risk Tracking
 - Project status reporting
 - Change management
 - Project Team
 - Training costs

- Policy & Procedure changes
- Safety Planning
- Equipment and space planning
- Implementation
- Validation & Quality assurance

An example of a financial document supporting a project is included in Appendix 1

9. Appendices

9.1. Appendix 1: Cost Analysis

Summary

One-Time Costs:

Facilities	0
Equipment (over \$5000)	0
Project Costs	0
TOTAL ONE-TIME COSTS	0

Operating Costs	Year 1	Year 2	Year 3	Year 4	Year 5	5-Year
	2006/07	2007/08	2008/09	2009/10	2010/11	Total

STAFFING REQUIREMENTS (INCLUDING RELIEF):

Director		\$-	\$-	\$-	\$-	
Manager/Specialist (Specify)	\$-	\$-	\$-	\$-	\$-	-
Clerical	\$-	\$-	\$-	\$-	\$-	-
Other (Specify)	\$-	\$-	\$-	\$-	\$-	-
SUB-TOTAL		\$-	\$-	\$-	\$-	
Benefits @ 20%	\$-	\$-	\$-	\$-	\$-	-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-

NON-LABOUR COSTS:

Administrative Expenses	-	-	-	-	-	\$-
Travel and Accommodation	-	-	-	-	-	-
Supplies	-	-	-	-	-	-
Equipment Maintenance	-	-	-	-	-	-
Consulting fees	-	-	-	-	-	-
Other (Specify)	-	-	-	-	-	-
Depreciation (Check with Finance)	-	-	-	-	-	-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-

DIAGNOSTIC & CLINICAL SUPPORT SERVICE

IMPACTS:

Pathology	-	-	-	-	-	-	\$-
Radiology	-	-	-	-	-	-	-
Pharmacy	-	-	-	-	-	-	-
Other (specify)	-	-	-	-	-	-	-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-	\$-

SUPPORT SERVICE IMPACTS:

Patient Food	-	-	-	-	-	-	\$-
Sterile Processing	-	-	-	-	-	-	-
Laundry/Linen	-	-	-	-	-	-	-
Transcription Services	-	-	-	-	-	-	-
Housekeeping	-	-	-	-	-	-	-
Security (program specific)	-	-	-	-	-	-	-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-	\$-

PHYSICIAN COSTS:

Physician Costs (specify)	-	-	-	-	-	-	\$-
Physician Costs (specify)	-	-	-	-	-	-	-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-	\$-

TOTAL COSTS:

Total Direct Operating Costs	\$-	\$-	\$-	\$-	\$-	\$-	\$-
Facility Overhead @ 10%	-	-	-	-	-	-	-
TOTAL COSTS	\$-	\$-	\$-	\$-	\$-	\$-	\$-

TOTAL COST SAVINGS:

Total Estimated Cost Savings	-	-	-	-	-	-	\$-
TOTAL COST SAVINGS	\$-	\$-	\$-	\$-	\$-	\$-	\$-

REVENUES:

Physician funding (Specify source)	-	-	-	-	-	-	\$-
Patient revenues	-	-	-	-	-	-	-
Other (Specify)	-	-	-	-	-	-	-
TOTAL REVENUES	\$-	\$-	\$-	\$-	\$-	\$-	\$-

One-Time Costs

Facilities		Qty	Unit Price	Year	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
A. Leasehold Improvements									
1					\$-	\$-	\$-	\$-	\$-
2					\$-	\$-	\$-	\$-	\$-
3					\$-	\$-	\$-	\$-	\$-
4					\$-	\$-	\$-	\$-	\$-
5					\$-	\$-	\$-	\$-	\$-
	Total Leasehold Improvements				<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

B. Assets under Construction

1					\$-	\$-	\$-	\$-	\$-
2					\$-	\$-	\$-	\$-	\$-
3					\$-	\$-	\$-	\$-	\$-
4					\$-	\$-	\$-	\$-	\$-
5					\$-	\$-	\$-	\$-	\$-
	Total Assets under Construction				<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Equipment

				Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X	
A. Machinery & Equipment									
1				\$-	\$-	\$-	\$-	\$-	
2				\$-	\$-	\$-	\$-	\$-	
3				\$-	\$-	\$-	\$-	\$-	
4				\$-	\$-	\$-	\$-	\$-	
5				\$-	\$-	\$-	\$-	\$-	
	Total Machinery & Equipment				<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	

B. Furniture & Other Equipment

1				\$-	\$-	\$-	\$-	\$-
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2		\$-	\$-	\$-	\$-	\$-
3		\$-	\$-	\$-	\$-	\$-
4		\$-	\$-	\$-	\$-	\$-
5		\$-	\$-	\$-	\$-	\$-
	Total Furniture & Other Equipment	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

C. Computer Equipment

1		\$-	\$-	\$-	\$-	\$-
2		\$-	\$-	\$-	\$-	\$-
3		\$-	\$-	\$-	\$-	\$-
4		\$-	\$-	\$-	\$-	\$-
5		\$-	\$-	\$-	\$-	\$-
	Total Computer Equipment	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

D. Computer Software

1		\$-	\$-	\$-	\$-	\$-
2		\$-	\$-	\$-	\$-	\$-
3		\$-	\$-	\$-	\$-	\$-
4		\$-	\$-	\$-	\$-	\$-
5		\$-	\$-	\$-	\$-	\$-
	Total Computer Software	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Project Costs		Year 1	Year 2	Year 3	Year 4	Year 5
		200X/0X	200X/0X	200X/0X	200X/0X	200X/0X

1	Consulting	\$-	\$-	\$-	\$-	\$-
2	Training	\$-	\$-	\$-	\$-	\$-
3		\$-	\$-	\$-	\$-	\$-
4		\$-	\$-	\$-	\$-	\$-
5		\$-	\$-	\$-	\$-	\$-
	Total Project Costs	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Other Start-up Costs		Year 1	Year 2	Year 3	Year 4	Year 5
		200X/0X	200X/0X	200X/0X	200X/0X	200X/0X

1	see note	\$-	\$-	\$-	\$-	\$-
2		\$-	\$-	\$-	\$-	\$-
3		\$-	\$-	\$-	\$-	\$-
4		\$-	\$-	\$-	\$-	\$-
5		\$-	\$-	\$-	\$-	\$-
Total Project Costs		<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Non-Labour Costs

I. Administrative Expenses	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
Postage, Courier					
Miscellaneous Expense					
Office Supplies					
Training & Continuing Ed.					
Local travel and parking					
Meeting Costs					
Total Administrative Services	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

II. Travel and Accommodation	# People	Days	Hotel Rate	Per Diem	Flight Rate	Total 200X/0X	Est'd 200X/0X	Est'd 200X/0X
Trip 1						\$-		
Trip 2						\$-		
Trip 3						\$-		
Trip 4						\$-		
Trip 5						\$-		
Total Travel Costs					Total	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

III. Supplies	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
item 1	\$-	\$-	\$-	\$-	\$-
item 2					
item 3					

item 4

item 5

Total Supplies	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
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IV. Equipment Maintenance	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
computer software license fees	\$-	\$-	\$-	\$-	\$-
equipment maintenance					

Total Equipment Maintenance Costs	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
--	------------	------------	------------	------------	------------

V. Consulting Fees	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
consulting fee 1	\$-	\$-	\$-	\$-	\$-
consulting fee 1					
consulting fee 1					
consulting fee 1					
consulting fee 1					

Total Consulting Fees	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
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VI. Other	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
Other	\$-	\$-	\$-	\$-	\$-
Other					
Other					
Other					
Other					

Other Costs	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
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VII. Depreciation	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
--------------------------	---------------------------	---------------------------	---------------------------	---------------------------	---------------------------

Depreciation	\$-	\$-	\$-	\$-	\$-
Depreciation					
Depreciation					
Depreciation					
Depreciation					
Depreciation	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Staffing Costs

Please complete Section I. Section II will automatically calculate.

Assumptions:

Benefits = 20%

Annual salary increase = 3%

Section I - Program Staff Requirements (Salaried Staff)

Position / Person	Salary	% Paid OT	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
Director							
Name / Role 1 - <i>example</i>	\$100,000	10.0%	0.5				
Name / Role 2							
Name / Role 3							
Manager/Specialist							
Name / Role 4							
Name / Role 5							
Name / Role 6							
Clerical							
Name / Role 7							
Name / Role 8							
Other (Specify)							
Name / Role 9							
Name / Role 10			-	-	-	-	-

Total FTEs	<u>0.50</u>	-	-	-	-
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Section II - Program Staff Salaries						Total
--	--	--	--	--	--	--------------

Director						
Name / Role 1 - example	\$55,000.00	\$-	\$-	\$-	\$-	\$55,000.00
Name / Role 2	\$-	\$-	\$-	\$-	\$-	\$-
Name / Role 3	\$-	\$-	\$-	\$-	\$-	\$-
Manager/Specialist						
Name / Role 4	\$-	\$-	\$-	\$-	\$-	\$-
Name / Role 5	\$-	\$-	\$-	\$-	\$-	\$-
Name / Role 6	\$-	\$-	\$-	\$-	\$-	\$-
Clerical						
Name / Role 7	\$-	\$-	\$-	\$-	\$-	\$-
Name / Role 8	\$-	\$-	\$-	\$-	\$-	\$-
Other (Specify)						
Name / Role 9	\$-	\$-	\$-	\$-	\$-	\$-
Name / Role 10	\$-	\$-	\$-	\$-	\$-	\$-

Support Services Impact

Please complete Sections I & II if there are increased costs to support service areas associated with the proposed initiative.

Section I - Diagnostic & Clinical Support Service Impact

Department	Year 1 200X/ 0X	Year 2 200X/ 0X	Year 3 200X/ 0X	Year 4 200X/ 0X	Year 5 200X/ 0X	Total
Pathology						\$-
Radiology						-
Pharmacy						-
Other (Specify)						-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-

Section II - Support Service Impact

Department	Year 1 200X/ 0X	Year 2 200X/ 0X	Year 3 200X/ 0X	Year 4 200X/ 0X	Year 5 200X/ 0X	Total
Patient Food						\$-
Sterile Processing						-
Laundry/Linen						-
Revenue Detail						
Physician funding	Year 1 200X/ 0X	Year 2 200X/ 0X	Year 3 200X/ 0X	Year 4 200X/ 0X	Year 5 200X/ 0X	-
MOHS AFP						

MSC Sessionals											
UBC											
Total Physician Funding		<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>					
Patient Revenue	Year 1	Year 2	Year 3	Year 4	Year 5						
	200X/	200X/	200X/	200X/	200X/						
	0X	0X	0X	0X	0X						
Total Patient Revenue		<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>					
Grant Revenue	Year 1	Year 2	Year 3	Year 4	Year 5						
	200X/	200X/	200X/	200X/	200X/						
	0X	0X	0X	0X	0X						
	\$-	\$-	\$-	\$-	\$-						
Total Grant Revenue		<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>					
Resources Reallocated	Year 1	Year 2	Year 3	Year 4	Year 5						
	200X/	200X/	200X/	200X/	200X/						
	0X	0X	0X	0X	0X						
	\$-	\$-	\$-	\$-	\$-						
Total Resources Reallocated		<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>					

Other Revenue	Year 1 200X/ 0X	Year 2 200X/ 0X	Year 3 200X/ 0X	Year 4 200X/ 0X	Year 5 200X/ 0X						
Confirmed MOHS Required from PHSA Recoveries	\$-	\$-	\$-	\$-	\$-						
Total Other Revenue	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>						
Transcription Services											-
Housekeeping											-
Security (program specific)											-
TOTAL	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-	\$-

Physician Costs

Please complete this section if there are any incremental physician costs or revenue related to physician services (from MSP).

Physician Costs	Year 1 200X/ 0X	Year 2 200X/ 0X	Year 3 200X/ 0X	Year 4 200X/ 0X	Year 5 200X/ 0X	Total
Physician Costs (Specify)						-
Physician Costs (Specify)						-
TOTAL	-	-	-	-	-	-

Cost Savings

Please complete this section if any cost savings will be incurred as a result of the proposed initiative.

Cost Savings						
Source	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X	Total
Cost Savings (Specify)						-
Cost Savings (Specify)						-
TOTAL	-	-	-	-	-	-

Revenue Detail

Physician funding	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
MOHS AFP					
MSC					
Sessionals					
UBC					
Total Physician Funding	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

Patient Revenue	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
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Total Patient Revenue	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
-----------------------	------------	------------	------------	------------	------------

Grant Revenue	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
	\$-	\$-	\$-	\$-	\$-

Total Grant Revenue	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
---------------------	------------	------------	------------	------------	------------

Resources Reallocated	Year 1 200X/0X	Year 2 200X/0X	Year 3 200X/0X	Year 4 200X/0X	Year 5 200X/0X
	\$-	\$-	\$-	\$-	\$-

Total Resources Reallocated	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>
-----------------------------	------------	------------	------------	------------	------------

Other	Year 1	Year 2	Year 3	Year 4	Year 5
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Revenue	200X/0X	200X/0X	200X/0X	200X/0X	200X/0X
	\$-	\$-	\$-	\$-	\$-
Confirmed MOHS Required from PHSA Recoveries					
Total Other Revenue	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>	<u>\$-</u>

9.2. Appendix 2: Policy

IH Master Nursing Policy & Procedure Guidelines

For Pyxis MedStation 3000 IH MASTER Policy & Procedure Guidelines for Pyxis MedStation 3000 Version 0.8

1. Authorized Privileges for Access to MedStation
 - 1.1. User Additions, Deletions, and Changes
 - 1.2. Personnel who have access to Pyxis
 - 1.3. Temporary Pyxis Access
 - 1.4. User ID
 - 1.5. BioID
 - 1.6. Passwords
 - 1.7. Active User Forgets Password – Some site specific procedures
 - 1.7.1. During Pharmacy Operating Hours
 - 1.7.2. Outside Pharmacy Operating Hours – Site Specific
 - 1.8. Creating a New User
 - 1.9. Creating a Temporary User – Pharmacy After Hours: (Site Specific)
 - 1.10. Activating Current Pyxis User on Another MedStation – Site Specific
 - 1.11. Creating a New Anesthetist – Site Specific
 - 1.12. Adding an Anesthetist on a Temporary Basis
 - 1.13. Anesthetist Name Setup As Single Option
2. Pyxis Medication SETUP
 - 2.1. Configuration of MedStations
 - 2.2. Medications handled through Pyxis

- 2.3. Medications not kept in Pyxis
- 2.4. Orders for Medications that are not stored in Pyxis
- 2.5. Pharmacy non-operational hours
- 2.6. Restocking of Trays and Crash Carts by Nursing Staff from Pyxis (Site Specific)
- 2.7. Override Medications and Profiled MedStations
- 2.8. Borrowing of Medications From Another Unit
- 2.9. Multi Dose Meds
- 2.10. MedStation Restocking
- 2.11. Expired Meds
- 2.12. Maintenance and Troubleshooting
 - 2.12.1. Accessing Printer Paper
 - 2.12.2. MedStation Maintenance
- 3. Medication Removal, Return and Waste
 - 3.1. Medication REMOVAL – Unit Specific Policy
 - 3.1.1. Profiled MedStations (Unit Specific Policy)
 - 3.1.2. Fridge Items
 - 3.1.3. Expired Items
 - 3.2. Medication RETURNS
 - 3.3. Narcotic/Controlled Substance WASTE – Site Specific
 - 3.4. Unidentified Patients
 - 3.5. Adding a New Patient When not Displayed on Screen
 - 3.6. Wrong Med Removed
 - 3.7. Drawer Closed Before Med Withdrawn

- 3.8. Drawer Closed Before Multi-Dose Med Placed Back in MedStation
- 4. Narcotic and Controlled Substances
 - 4.1. Narcotic/Controlled Substance Inventory
- 5. OR Narcotic/Controlled Substance Controls
- 6. Generated Reports
 - 6.1. Reports generated by Pharmacy and sent to the Nurse Shift Supervisor or suitable designate for review weekly
 - 6.2. Narcotic/Controlled Reports:
 - 6.3. Narcotic/Controlled Discrepancy Reports:
 - 6.4. User Modification Information
- 7. DOWNTIME PROCEDURES FOR MEDSTATION
 - 7.1. Access to MedStation Keys
 - 7.2. Narcotics and Controlled Substances
 - 7.3. Pyxis questions or MedStation problems
 - 7.4. BioID Hardware Failure – Site Specific
 - 7.5. MedStation Emergency Access – Site Specific

Appendix A: Access to Console, MedStation and Med Privileges

Appendix B - Pyxis User Access Form (Additions / Changes)

Appendix C – Override Medications

Page 3 of 20 12/14/2007 IH MASTER Policy & Procedure Guidelines for Pyxis

MedStation 3000 Version 0.8

Policy

Interior Health Staff and Physicians who use the Pyxis MedStations will adhere to procedures that are defined through a multi-disciplinary process. Procedures are designed to provide safe and accurate provision of medication, secure storage, accurate accountability for controlled substances and other drugs, and in compliance with Canadian and provincial regulations.

1. Authorized Privileges for Access to MedStation

Access to Pyxis MedStations is strictly controlled through pre-defined authorization parameters and user security. All MedStation access is logged through internal audit trails. The Pyxis User ID and BioID/password is considered to be an "electronic signature" for medication transactions. If at anytime a user believes the security of his/her password has been breached, the user must change their password immediately. Each user is responsible for all transactions made under his/her account.

1.1. User Additions, Deletions, and Changes

Nursing Shift Supervisor or suitable designate, medical administration and pharmacy will be responsible for user additions, deletions and changes. Pharmacy will process user access requests. Pharmacy is notified of additions, deletions and changes via the Interior Health Human Resources E-form staffing form (on-staff, off-staff and change form) found on the InsideNet or by the Medical Administration office. Adequate notice via this process is required to ensure Pyxis user access is setup by Pharmacy for staff working on the unit. Users are granted access to each Pyxis MedStation where they work. Security and access privileges are defined in Appendix A.

1.2. Personnel who have access to Pyxis:

- Pharmacy Technicians, Pharmacists
- Registered Nurses, LPNs, Nursing Students, Nursing LPN Students
- OR/ER Physicians, Physician Residents
- Respiratory Technicians
- EMT/Paramedic

1.3. Temporary Pyxis Access

Designated nursing personnel will be able to create temporary users or activate users at the MedStation as necessary during pharmacy off-hours. Temporary user privileges use a template with preconfigured settings which are set up at the Console. This means that any temporary user will have RN privileges regardless of their position.

1.4. User ID

The Pyxis user ID is the IH Network login ID as assigned by the IHA IMIT Department, e.g. hanr5.

1.5. BioID

BioID will be used for user access in combination with the user ID to meet current and future regulatory requirements for two levels of security and positive identification of the user. Fingerprint images cannot be reconstructed from the stored binary template. If a user experiences problems with using the BioID, she/he is required to present to Pharmacy for resolution.

1.6. Passwords

- The password must be a minimum of 5 numbers or letters or a combination of both up to a maximum of 8.
- Users will have their passwords **expire every six months** per existing IMIT standards. The system will automatically take the user into the Change Password function.
- Users must never share their password with another individual.

1.7. Active User Forgets Password – Some site specific procedures

1.7.1. During Pharmacy Operating Hours

- Go to Pharmacy with your ID badge and ask for the Pharmacy Pyxis Super User.
- The password will be reset by Pharmacy. The password will expire immediately when the user logs onto the station. The user will then enter a new password.

1.7.2. Outside Pharmacy Operating Hours – Site Specific

- The user will report to the, Nursing Shift Supervisor or suitable designate with their ID badge.
- The Nursing Shift Supervisor will setup the user with a temporary user ID that will remain active for _____hours at the MedStation.

1.8. Creating a New User

1. The nursing shift supervisor or suitable designate will fill out the Human Resources E-form Staffing form (on, off, change).
2. This E-form will issue a notification to Pharmacy to add, change or delete the Pyxis user ID.
3. If an E-form has been completed but Pyxis user ID has not been setup in advance of when it is required, the Nursing Shift Supervisor or suitable designate will fill out a Pyxis User Access form for Pharmacy. See Appendix B for blank forms.

1.9. Creating a Temporary User – Pharmacy After Hours: (Site Specific)

A nurse can be added onto the MedStation if he/she does not already have privileges on Pyxis. Designated personnel will have the ability to add a temporary Pyxis user onto the MedStation. Temporary access will be granted for _____ hours on the MedStation.

1.10. Activating Current Pyxis User on Another MedStation – Site Specific

Every nurse will have access to only his or her assigned unit's MedStation. A nurse who may float to a Pyxis Station from another unit can be "Activated" on that Pyxis Station. Designated Managers will have the ability to activate another Pyxis user. An activated RN will use his/her own ID and password and is active for ____ hours on that Station. Permanent access on multiple MedStations must be processed by Pharmacy.

1.11. Creating a New Anesthetist – Site Specific

Develop site specific procedure for user set up that fits with the Medical Admin Office (part of the on-staff setup)

1.12. Adding an Anesthetist on a Temporary Basis

Nursing may access medications for a new physician on a temporary basis until access can be granted by Pharmacy during operating hours. Nursing will create a "patient" under the physician's name in which the medications may be removed under.

1.13. Anesthetist Name Setup As Single Option

Procedures for Anesthetist Name Setup as Single Option allows the physician to reduce the user list to just one name eliminating the need to search through the user list. This is a one-time setup.

2. Pyxis Medication SETUP

Consistent setup and configuration of Pyxis MedStations and Medications have been defined. Guidelines for obtaining medications for patients and performing all related activities are outlined below. There are two types of Pyxis MedStations: profiled and non-profiled. Profiled MedStations are located on inpatient nursing units.

2.1. Configuration of MedStations

- Medications will be configured in the MedStation so that no "look alike" and "sound alike" medications will be in the same drawer.
- All drawers and pockets will be numbered according to configuration of medication setup. A detailed inventory list of medication and pocket number will be located on top of, or near the MedStation.

2.2. Medications handled through Pyxis

- Ward stock medications
- Narcotics and Controlled Substances
- General Medications
- Multi-dose Meds
- Fridge Meds
- Non-standard narcotics/controlled substances. These will be loaded into Pyxis when required to fill a patient order.

2.3. Medications not kept in Pyxis

Approximately 5% of medications will be managed outside of the Pyxis MedStations. Pharmacy will supply these meds through a routine supply schedule.

- Patient's own meds
- Some bulk liquids
- Oral chemo therapy
- Non-formulary meds

2.4. Orders for Medications that are not stored in Pyxis

- Non-Profiled MedStations: contact Pharmacy for the medication required per existing procedures.
- Profiled MedStations: When Pharmacy processes the order they will be alerted that the Medication is not in the Pyxis MedStation. The medication will be supplied by Pharmacy through a routine schedule.

2.5. Pharmacy non-operational hours

- Medications not in Pyxis will be obtained from the Pharmacy night cupboard.
- Critical Override, which allows nursing access to all meds in that MedStation, will be enabled by Pharmacy for all profiled MedStations at the close of business.
- Critical Override for profiled MedStations will be disabled when Pharmacy reopens for business in the morning.

2.6. Restocking of Trays and Crash Carts by Nursing Staff from Pyxis (Site Specific)

Crash Cart medication may be replenished from Pyxis and will be determined on a site by site basis. Nursing staff will restock trays from Pyxis by removing meds using the Patient name that coded and required the crash cart meds. Outdates on crash carts will be supplied and replaced directly from Pharmacy.

2.7. Override Medications and Profiled MedStations

Override medication privileges grant access to medications that have not been verified and processed by Pharmacy. Override medications have been limited to medications required in urgent situations where delays could seriously affect outcome, and medications required for comfort.

Override medications have been identified for each override group: basic, respiratory, critical care, paralyzing agents and comfort meds. A list of override medications will be defined for and be located at each MedStation. See Appendix C for a complete list of medications given override status in Pyxis.

Requests for additions to the override lists will be reviewed and approved through the Interior Health P&T Committee.

2.8. Borrowing of Medications From Another Unit

Medications will not be sent or borrowed from another unit using the Pyxis machine. Medications are only to be used on the Patient Care Unit where the Pyxis machine is located.

2.9. Multi Dose Meds

- Multi-dose injections and liquids will be defined in the Pyxis formulary dictionary. Nursing will be prompted by screen instructions.

2.10. MedStation Restocking

The supplies of medications for the MedStations are replenished at regular intervals by Pharmacy Technicians. The replenishment of the MedStation is according to set schedules as defined by medication usage. Min/Max levels have been set and will be reviewed and adjusted by Pharmacy according to usage.

- Pharmacy will refill MedStations in a Timely Manner to Ensure no “Stock Outs”
- Notify pharmacy if there are no medications in pocket when drawer opens. This should only occur if users are not accurately indicating quantities removed.

2.11. Expired Meds

Expiry dates will be handled by Pharmacy per Pharmacy Procedures.

2.12. Maintenance and Troubleshooting

Maintenance procedure and a troubleshooting guide have been developed by Pyxis to enable them to resolve most problems independently at the MedStations. Refer to the **MedStation Quick Reference Guide**.

2.12.1. Accessing Printer Paper

Pyxis MedStation Printer Paper will be available on the nursing unit. This item may be on automatic top-up in locations where top-up is available. Mat Man item number is _____

2.12.2. MedStation Maintenance

Pharmacy staff will be responsible for completing a thorough MedStation cleaning once a week. A bottle of cleaning product, safe to use on the MedStation screen will be located near the MedStation for nursing to use on an as need basis. Clean BioID lens **ONLY WITH** cellophane tape. Firmly apply to lens and peel away to remove dust, oil and debris.

Do NOT use an alcohol based solution to clean the unit.

3. Medication Removal, Return and Waste

3.1. Medication REMOVAL – Unit Specific Policy

Except in emergency situations, medications will be removed from Pyxis by the person who will be administering the medication to the patient. Only medications that are **due** to be administered will be removed, e.g. medications will not be removed for an entire shift.

3.1.1. Profiled MedStations (Unit Specific Policy)

Medications removed from Pyxis will be stored in _____ and transported to the patient location. Details of how medications will be removed (e.g. for how many patients) and transported to the patient location need to be determined for each profiled unit.

3.1.2. Fridge Items

All fridge items for the unit must be documented using the Pyxis MedStation even though the fridges will NOT be locked.

3.1.3. Expired Items

Expired items found during “removal” from the MedStation will be removed by the user and placed in the External Return Bin for pharmacy.

3.2. Medication RETURNS

All unopened medications will be returned to Pyxis. Users will be prompted, via the screen where to return the meds. Med return procedures are based on default configuration settings in the Pyxis formulary dictionary determined by Pharmacy. Designated pharmacy personnel will be responsible for emptying the internal return bin on each scheduled refill day.

3.3. Narcotic/Controlled Substance WASTE – Site Specific

ALL Narcotic/Controlled Substance wastage MUST be documented on the MedStation. A witness for Narcotic/Controlled Substance wastage is required except at sites where staffing levels do not support having a double signature.

3.4. Unidentified Patients

For unidentified patients in emergency situations, a temporary patient may be entered as “Trauma Bed 1, 2, etc.” for the patient name. **Once these patients have been identified the nurse is required to edit the Patient name with the known patient information.** Pharmacy will audit, on a regular basis, all unknown Patient information.

3.5. Adding a New Patient When not Displayed on Screen

If your patient does not appear on the Pyxis Screen, a patient can be added manually to the Pyxis MedStation. Some of the reasons your patient may not appear on screen:

- Pt arrives on the unit before Admissions has done the paperwork.
- Your patient has disappeared from the MedStation due to being transferred or discharged.

Enter the patient:

Last Name: _____

First Name: _____

Patient ID (Account Number in Meditech): _____

You must enter the Meditech Account number exactly

3.6. Wrong Med Removed

If you remove the wrong med for a patient, follow Procedure 4.2.2.3 and use the “Return” button to return the med to Pyxis (follow on-screen instructions – most meds returns go to the internal return bin). The patient is credited for the med. Then choose the “Remove Med” button to access the correct med for the patient.

3.7. Drawer Closed Before Med Withdrawn

If you inadvertently close the drawer before removing the med, repeat the REMOVE MED process making sure to select the same patient, medication, and quantity.

When the drawer opens, remove the same quantity of medications that you indicated on the previous selection. Select “Cancel Removal” and close the drawer. The count in the drawer is now correct and the patient’s medication is properly documented.

3.8. Drawer Closed Before Multi-Dose Med Placed Back in MedStation

If you inadvertently close the drawer before returning the med, repeat the REMOVE MED process making sure to select the same patient, medication, and quantity. When the drawer opens, place the med back in the pocket and select “Cancel”. Close the drawer. The count in the drawer is now correct.

4. Narcotic and Controlled Substances

All transactions for Narcotic/Controlled Substances are recorded electronically. End of shift counts for narcotic/controlled substances are therefore not required. The charge nurse will be responsible to ensure that the no Discrepancy Icon remains on the MedStation at the end of each shift. **All discrepancies must be resolved prior to shift end.**

A narcotic/controlled substance discrepancy occurs when the user inputs an amount that is different than what the Pyxis system expects. When you enter a quantity different from the expected, a transaction slip will print the discrepancy information.

- The person who discovered the discrepancy at the MedStation will be responsible for resolving the discrepancy at the MedStation
- All UNRESOLVED discrepancies must be returned to Pharmacy within 1 day. An incident report will be filled out with a copy sent to Pharmacy.
- Summary Discrepancy Reports will be generated weekly at the Pharmacy Console and all discrepancies will be forwarded to the appropriate department for review.
- Pharmacy will file resolved Discrepancy Reports with the Narcotic/Controlled Substance records.
- Individuals who are frequently involved in discrepancies will be required to do more training with the Clinical Nurse Educator.

- Inappropriate reasons for narcotic/controlled substance discrepancies will be reviewed by the Departmental Manager/Head and followed up with the individuals involved.

4.1. Narcotic/Controlled Substance Inventory

- When a discrepancy occurs, an inventory of the medication will be done to ensure the count is correct.
- The user who has created a discrepancy by entering an incorrect beginning count must do an inventory of the pocket to correct the count.

Note: On Demand Count has corrected the inventory but has created a discrepancy. Pharmacy is responsible for investigating and resolving OR discrepancies. Issues will be brought to the attention of the Chief of Anesthesia and the OR Nursing Manager.

5. OR Narcotic/Controlled Substance Controls

- The Anesthetist will remove narcotics/controlled substances for their patients from the OR MedStation.
- The Anesthetist is responsible for returning all unopened Meds to the MedStation return bin at the end of shift.
- The Anesthetist is responsible for documenting all narcotic/controlled substance usage per patient on a daily basis. Narcotic Record forms will be supplied at the MedStation. Completed forms will be returned to the MedStation at the end of each day.
- Each Anesthetist is to place all unused drugs dispensed from the MedStation into 'plastic baggie' with a MedStation transaction slip and put properly into the return bin at the end of shift. Baggies will be available at the MedStation.
- Nurses are **NOT** to remove and deliver narcotics/controlled substances to the Anesthetist unless circumstances dictate that the Anesthetist cannot leave the patient unattended.
- Nurses are **NOT** to return narcotics/controlled substances to the MedStation that have been removed by an Anesthetist.
- Pharmacy will audit, on a regular and random basis, all narcotic/controlled substance transactions in the OR MedStation.

6. Generated Reports

Pyxis generated reports provide useful information for medication utilization, access and discrepancy resolution.

6.1. Reports generated by Pharmacy and sent to the Nurse Shift Supervisor or suitable designate for review weekly

- Narcotic and Controlled Discrepancy Report
- Ward stock Discrepancy Report
- User Modification Information List
- Overrides

6.2. Narcotic/Controlled Reports:

- AUTO RUN
- This report replaces the narcotic/controlled substance administration sheets.

6.3. Narcotic/Controlled Discrepancy Reports:

- AUTO RUN
- This detailed report indicates all users, medications involved in a Narcotic or Controlled Substance Discrepancy
- The reasons for resolutions are to be reviewed by Pharmacy. Pharmacy Professional Practice Leader is to be notified of inappropriate resolutions found for follow up.
- Pharmacy discrepancies will be forwarded to the Pharmacy Technician Team Leader
- Nursing discrepancies will be forwarded to the Patient Care Manager.
- Physician discrepancies will be forwarded to the Physician Head.

6.4. User Modification Information

- To be run by Super users only
- This detailed report shows all Users that were manually entered at the MedStation.

7. Downtime Procedures for Medstation

7.1. Access to MedStation Keys

Only Pharmacy or Nurse Super Users or designated nursing shift supervisors will have access to the MedStation keys. Each hospital will develop a specific procedure and storage location for access to the MedStation keys

- **Under no circumstances shall the MedStation be moved for service or repair without Pharmacy supervision.**
- Pyxis Field Service Technicians will access the keys from the Pharmacy Super Users or designated personal if required to access MedStation for repairs. They will be supervised by Pharmacy or Nursing staff at all times the cabinets are open and in manual override.
- The MedStation may be removed from site once all meds have been removed by Pharmacy Staff

7.2. Narcotics and Controlled Substances

Narcotics and Controlled Substances will be placed in a locked cupboard and a manual narcotic/controlled substance sheet will be maintained with end of shift counts during DOWNTIME of MedStation.

- Initial inventory count of all medications in the MedStation must be supervised by Pharmacy.

7.3. Pyxis questions or MedStation problems

- Call: 1-800-727-6102, Pyxis staff are available 24 hours day / 365 days of the year

7.4. BioID Hardware Failure – Site Specific

If a banner appears at the Station which states “BioID device needs maintenance” the stations login mode must immediately be switched to ID/Password for continued access to the MedStation. This must be done at the Pharmacy console or workstation.

- i. During Pharmacy hours, call Pharmacy and ask for Pyxis SuperUser.
- ii. Outside Pharmacy hours, call Pharmacy Pyxis designate.

7.5. MedStation Emergency Access – Site Specific

Most problems with the Pyxis MedStations can be resolved by reading the screen at the station, or by calling the Pyxis Help Line at 1-800-727-6102. If something more serious happens, such as the event of a power failure, an internal battery backup at the Pyxis cabinet provides about **one minute** of power to automatically initiate a safe shutdown of the cabinet. You may then need to gain *emergency access to the meds*:

During Pharmacy Hours:

1. If problems occur follow any messages that are on the Pyxis screen to resolve the problem.
2. If this does not resolve the problem, call Pharmacy.

After Regular Pharmacy Hours: - Site Specific

1. If problems occur or you cannot get medications, follow any messages that are on the Pyxis screen to resolve the problem.
 2. If this does not resolve the problem, call the ***Pyxis Help Line at 1-800-727-6102***. They will want to know the MedStation type and version (***MEDSTATION 3000 Vx.x***), and product **and Customer Number**. These numbers are located on a card on top of the MedStation.
 3. If the Pyxis Help Line cannot help you resolve the problem, they will call a Pyxis field service tech to respond to the call.
 4. If medications are required before a Pyxis field service tech arrives on site the nurse can obtain the Pyxis keys needed to open the station. Keys are stored
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5. If **ACCESS TO THE STATION IS NEEDED, TURN OFF THE MACHINE** before opening. Turn off the power to the station by switching the power switch (located on the right rear of the main cabinet – the one with the computer screen on it) to the OFF position.
 6. Using the LEFT KEY and RIGHT KEY, open the back of MedStation. **DO NOT UNPLUG THE MACHINE**. Once the back is open there is a ground wire that is hooked to the door and the machine itself. Leave this hook attached.
NOTE: At any Pyxis station there will be a Main Cabinet (with the computer screen) and there may also be an Auxiliary Cabinet and a Tower. **DO NOT REMOVE CABLES THAT ATTACH THESE TO THE MAIN CABINET.**

7. Only open drawers as required or only the drawer that needs to be fixed due to jamming. The MedStation inventory list is located on top of the station.
8. To OPEN drawers, go to the back of the station: There is a red release lever on the right side of each drawer. Each one of the three types has a slightly different red release lever and method of pushing the drawer out. From the back, you may not be able to tell what kind of drawer you are opening – **look for the red levers.**
 - Matrix drawer – press the red release lever to the RIGHT and the drawer will pop open.
 - Pocket drawer – press the red release lever to the RIGHT. Push the pocket from the front and it will pop open.
 - Carousels – press the red release lever to the RIGHT and the drawer will pop open. To open completely, press the red release lever to the RIGHT again, allowing the drawer to open completely.
 - Cubie drawer – press the red button found to the left of the red levers (the power must still be on for this button to work). If no power medications will need to be accessed via Pharmacy during operating hours or via the night cupboard afterhours.
9. To OPEN THE TOWER: Unlock the access panel on the front of the Tower using the left and right keys. Push the black button on the left side of the tower up and the doors will pop open.
10. Nurses will remove medications as required from the MedStation, but narcotics/controlled substances must be relocated to a locked drawer if the station is not operational for an extended period of time. Manual narcotic/controlled sheets will be maintained until relocated back to MedStation. Notify Pharmacy via on-call or emergency Pharmacy contact procedures when this situation occurs.
11. To CLOSE DRAWERS:
 - Matrix and Carousel: close drawer and it will latch
 - Pocket drawer:
 - Press the red release lever to the LEFT (lock position)
 - Close pocket in front by pushing in.
12. Place 'Back Panel' back on MedStation once completed and turn station back on. Follow directions on screen and **"Recover Drawer"** if required on screen.

9.3. Appendix 3: The Business Case for Patient Safety

Matthew Anderson, Michael Baker, Robert Bell, Mary Ferguson-Paré, Lydia Lee, Emily Musing and Bryce Taylor

Abstract

Conventional wisdom dictates that hospitals are institutions in which ailing or injured people go for a temporary visit, their discharge ultimately dependent upon either a partial or complete recovery. Unfortunately, the most well-intended acts sometimes result in tragedy. Depending upon the severity of a patient's condition, sometimes a visit to the hospital is a one-way excursion. And in some cases (most would argue in too many cases), the reason a patient dies within the confines of a hospital is due to the lack of a systems approach to patient safety.

With this in mind, the leadership team at University Health Network decided to pursue a new information technology initiative to substantially reduce human and system errors and omissions as it pertains to medication management and patient safety. As the leadership team, we collectively decided that, since the technology was now available, and had been shown to be proven but underutilized within our industry, the time had come for our organization to apply it.

In particular, what caught our attention in recent years was a pair of groundbreaking studies. These studies confirmed that patient safety in a hospital setting can be sometimes seriously compromised due to medical error. In the report, *To Err Is Human: Building a Safer Health System*, published by the U.S.-based Institute of Medicine of the National Academies (IMNA) in 1999, IMNA found that nearly 100,000 patients per year were dying in U.S. hospitals due to adverse complications stemming from medical errors (Kohn and Corrigan 2000).

Closer to home, we were apprised of some equally disturbing statistics reported in "The Canadian Adverse Events Study: The Incidence of Adverse Events Among Hospitals in Canada" (Baker et al. 2004). This study was developed by the Harvard Medical Practice Study and based on a protocol similar to that used by the authors of the IMNA paper. It examined chart audits at a teaching hospital, a large community hospital and two small community hospitals. The hospitals were situated in five provinces (British Columbia, Alberta, Ontario, Quebec and Nova Scotia), and the data were amassed during the 2000 fiscal year. The findings were subsequently published in the May 2004 issue of the *Canadian Medical Association Journal*. In a nutshell, "The Canadian Adverse Events Study" determined that errors were occurring in 7.5% of annual hospital admissions. More unsettling was the fact that more than one-third of these mistakes (36.9%) were

entirely preventable and that 20.8% of these mishaps actually resulted in the death of a patient.

By extrapolating the data, an unsettling picture eventually emerged: Of the almost 2.5 million annual hospital admissions in Canada during the time of the study, roughly 185,000 were associated with an adverse event. Ultimately, these adverse events resulted in between 9,250 and 23,750 preventable deaths.

What was the leading cause of these sometimes-fatal errors?

"Based on the literature, there was strong consensus that errors around the administration of drugs were the most critical problem contributing to adverse events," says the Chief of Surgery at UHN. "This [incidence of adverse events] could result from any mix of incorrect writing of prescriptions by physicians, illegibility of the written orders, the prescribing of inappropriate meds, the incorrect interpretation/transcription of written orders by nurses, or the incorrect administration and documentation of the meds."

If anything, the studies indicated that there is an urgent need to improve patient safety in acute care hospitals. As well, the studies suggested that when it came to administration of medications in hospitals, changes were required to reduce the frequency of errors and adverse events.

In fact, part of the reason why mistakes are typically made vis-à-vis the administration of medications is due to the archaic nature of paper-based medication management in an increasingly digital world.

Thus, in 2001, we at UHN undertook one of the largest patient safety initiatives in Canada by requiring all medications to be ordered, administered and documented electronically. The system became known as the Medication Order Entry/Medication Administration Record project (MOE/MAR).

While not necessarily followed in a systematic fashion, we took the following key steps in making our decision to pursue MOE/MAR: □

- articulating the problem that the organization was trying to solve
- identifying a credible and feasible solution
- determining the true costs and risks of the project
- defining the benefits to get support for the project
- ensuring commitment to mitigate inevitable challenges

The process of transforming clinical practice for medical, nursing and pharmacy staff across three campuses of the nearly \$1 billion (annually) hospital organization was not without its challenges. First, MOE/MAR came with a lofty price tag, ultimately costing more than \$5 million. It was also a time-intensive project, requiring nearly five years in which to implement from investigation to complete implementation. This paper documents our decision-making process undertaken by the Executive Management team at UHN that ultimately led to the implementation of MOE/MAR.

Background on UHN

UHN, the eighth-largest acute care institution in Canada, encompasses three hospitals located in downtown Toronto: Toronto General Hospital, Toronto Western Hospital and Princess Margaret Hospital. It also encompasses Toronto Medical Laboratories. As well, UHN is a major teaching hospital for the University of Toronto with care delivered through seven program groupings: Advanced Medicine & Surgery, Community & Population Health, Heart & Circulation, Musculoskeletal Health & Arthritis, Neural & Sensory Science, Oncology & Blood Disorders, and Transplantation.

The oldest site in the UHN group is Toronto General Hospital, which has provided services to the community for more than 165 years. UHN has approximately 11,000 affiliated staff, more than 1,200 physicians, an operating budget of nearly \$1 billion, 30,000 annual inpatient cases and 950,000 annual outpatient visits.

Articulating the Problem the Organization Was Seeking to Solve

In 2001, UHN completed a 10-year corporate strategic plan in which "improving the patient experience" was a key organizational strategy. As a result, moves were undertaken to implement new processes and structures within UHN to support improvements in patient safety. Senior management observed a strong movement toward improving patient safety (particularly in the hospital setting) throughout the entire healthcare industry in the early 2000s.

Meanwhile, the federal government had established the Canadian Patient Safety Institute (CPSI). CPSI acts as an independent, not-for-profit corporation dedicated to achieving measurable improvement in the incidence of patients experiencing adverse events while in the care of the Canadian health system. These activities, which were all taking place two or three years ago, served to galvanize the industry - and UHN - into looking closer at patient safety in the context of quality improvement.

Further examination of the literature indicated that MOE/MAR-type systems were seen as being

highly effective in helping hospitals track and mitigate adverse drug events. An analysis by the U.S.-based Leapfrog Group in 2003, for example, indicated that the full implementation of a Computer Physician Order Entry (CPOE) system decreased serious medication errors by 55% (Birkmeyer and Dimick 2004). As well, a more recent study by Grandville et al. (2006) pointed to a significant 62% error reduction rate.

These findings led the Leapfrog Group to include CPOE in its list of the three recommended quality and safety practices that have the most potential to prevent medication errors and save lives. The studies also indicated that CPOE reduces the length of stay, reduces repeat tests and reduces turnaround times for laboratory, pharmacy and radiology requests. As an added benefit in this day of fiscal restraint, CPOE also delivers cost savings (Birkmeyer and Dimick 2004).

While this groundswell of concern for patient safety was occurring throughout the industry, UHN independently initiated several major organizational patient safety efforts. For example, UHN launched a Quality Clinical Risk Management and Incident Reporting Committee chaired by the then Chief Operating Officer of the Princess Margaret Hospital site (who would go on to become UHN's Chief Executive Officer in 2005). To support this committee, UHN leadership formed a Patient Safety Council. This council was given the mandate to address specific patient safety risks resulting in reported adverse events.

As well, a major corporate culture renewal initiative was also underway led by Nursing. This initiative included training for all nurses and others to emphasize patient-centred care in all aspects of the care process. A key component of this training focused on patient safety.

"By the time our council was formed, however, we felt we were already behind by both Canadian and North American standards," says UHN's Medicine Physician-in-Chief. "Our hospital likes to be at the leading edge, so we created a strategic plan to jump into the lead on patient safety, at least on the national level."

UHN had already implemented CPOE for labs and medical imaging since the late 1980s. However, it had not yet implemented medication order entry or electronic medication administration. As a result of this increased attention in the industry, coupled with the organization's commitment to step up its own patient safety efforts, UHN's senior management increasingly felt compelled to consider electronic medication order entry and medication administration systems.

Identifying a Credible and Feasible Solution

Although there was not much information in the literature regarding the actual implementation efforts for CPOE initiatives in other hospitals, UHN realized that implementing medication order entry and medication administration on-line would make for a highly complex project and would impact every clinical program in the organization. Successful implementation would require proper scoping up front, adequate staff training and change management throughout all stages of the project. There would also have to be a demonstration of patient safety and other benefits in order to justify the organization's efforts and investment.

The hospital's Information Management and Information Technology department, known as "SIMS" (Shared Information Management Services), had already been experimenting with clinical decision support software. SIMS was developing an understanding of how automated alerting (for drug-drug and drug-allergy incompatibilities as well as for duplicate orders or orders that might show a contrary indication based on lab results) could be introduced with medication order entry.

The scope of the MOE/MAR project was defined to include all inpatient units across all seven of the hospital's clinical programs. A physician order entry system would be required, as would a nursing medication administration on-line system and on-line pharmacy verification. And although not yet fully contemplated at this juncture, it was assumed there would be a need to redesign some of the clinical workflows supporting medication administration.

Finally, the scope of the MOE/MAR project would have to include implementation of wireless computer devices to support portability of the physician and nursing staffs.

Before the project received the green light, however, there was considerable debate among members of the executive team. The point of contention: Was the MOE/MAR project truly the best use of time and money in comparison to other much-needed and much-requested initiatives? Other initiatives that were considered included clinical documentation, clinical decision support alerting for lab and diagnostic orders and incident reporting electronic system changes.

Ultimately, it was decided that attempting to manage multiple patient safety projects would be too much of a drain on financial and people resources. As well, implementing multiple initiatives simultaneously would likely be too much change for the organization to handle. Based on the expected relative impact on patient safety, compared with these other initiatives, the choice was made to support MOE/MAR.

Table 1. Costs per project activity area	
MOE/MAR Project Activities	% of Total Project Costs
Project management resources & support	30%
External consultant support	15%
Technical design and development	25%
Point of care devices & set-up	20%
User training	0%
TOTAL	100%
Source: Shared Information Management Services	

Determining the True Costs and Risks of the Project

The expected capital costs of the MOE/MAR project to UHN were estimated at \$4 million over the duration of the implementation. This investment would cover project management, an information technology system build and testing activity, staff training, Medical, Nursing and Pharmacy Informatics support and evaluation. As well, an additional \$1 million to \$2 million in other staff resources from Medical Informatics, Nursing Informatics, Clinical Pharmacy and SIMS was required to further supplement the capital-funded project team and technical development. These costs did not include nursing or physician replacement costs while they would be receiving training to use MOE/MAR; rather, these costs were covered by the clinical program budgets.

SIMS developed a multi-year detailed project budget to examine the business case. The breakdown of the costs per project activity area as a percentage of the total project costs is shown in Table 1.

In addition, incremental, one-time resources would also be provided to Nursing Informatics to recruit seven clinical support analysts and to Pharmacy Informatics to support five full-time and three part-time staff to further support the implementation outside of their departments' operating budgets. However, these were not part of the original business case, as they were unanticipated.

We knew that there were many risks associated with a project of this magnitude. Notably, a change management and information technology implementation of this size was unprecedented at UHN. While the technology certainly was not new, few other North American hospitals had successfully implemented MOE/MAR due to the clinical workflow complexities and costs. For example, the termination of the Cedars-Sinai Medical Center CPOE initiative in the United States (Wachter 2006) created uncertainty among some of the physician leaders that the lofty goals of MOE/MAR might not be achievable.

Even so, against these risks, the team always believed MOE/MAR could be successfully implemented. And management, it should be noted, was motivated by something other than blind faith. For example, the hospital's existing electronic patient record and pharmacy system vendors had very robust solutions. As well, clinicians at the Toronto General Hospital and Toronto Western Hospital sites had been using the electronic patient record for more than two decades, with order entry available for labs and medical imaging for the past decade. In other words, these various stakeholders were used to working with electronic systems.

Moreover, we looked upon MOE/MAR as a way to introduce additional functionality (i.e., drug order entry) to an existing system's environment with which staff were already familiar. The fact that the Medicine Physician-in-Chief was willing to step forward as project sponsor gave further credibility to the organization's commitment to MOE/MAR. SIMS was known throughout the hospital for having strong IM/IT project management capabilities; SIMS was also perceived by management to have a strong ability to effectively work with a broad set of stakeholders across the organization to ensure change management. The organization's Director of Medical Informatics, Director of Nursing Informatics, Manager of Pharmacy Clinical Informatics and all of their respective teams further rounded out UHN's support for MOE/MAR.

"Just by looking at who the project leadership would encompass - Nursing, Medical, Surgery, Pharmacy, SIMS - it was clear that this was absolutely not just an IT project," says UHN's Vice-President and Chief Information Officer. "Our technical people would have to be the least visible amongst the participating groups. If this had been just an IT project, it would have gone nowhere."

Even so, the senior management team acknowledged that the organization would need to depend on SIMS to pull off a project like MOE/MAR, orchestrating activity on the ground and getting people to meet, discuss, make decisions and change the way they do things.

"Although decent compared to other hospitals, we have a relatively small budget for information systems initiatives compared to other industries - 4% versus the 10-12% often found in financial services, transportation and so on," notes UHN's Chief of Surgery. "And we knew that this would be all-consuming for our IS budget for at least two to three years. But we knew we had to get into this, so we simply bit the bullet and said this was important enough that we would commit what it took to make MOE/MAR happen at UHN."

Approval for MOE/MAR's implementation finally came during a UHN board of trustees meeting in the winter of 2003. The then chairman of UHN's board of trustees (a senior executive with a major

Canadian bank) challenged the Medicine Physician-in-Chief and the Chief Information Officer to catch up with the financial industry in terms of information management. Both hospital executives accepted the challenge, responding that UHN would indeed proceed with MOE/MAR.

Defining the Benefits to Get Support for the Project

Although it was acknowledged that the project would ultimately yield many additional short- and long-term benefits, the decision to implement MOE/MAR at UHN was driven almost singularly by our commitment to improve patient safety. With less than 2% of North American hospitals having substantial CPOE implementations (Gale 2005), hospital executives saw this groundbreaking project as an opportunity for UHN to distinguish itself. There was a general consensus that if we could succeed with the MOE/MAR project, not only would it be an important victory for us in terms of patient safety, but also it would significantly strengthen UHN's position as a leader in the adoption of the Electronic Patient Record (EPR).

As such, benefits to the organization were the key factor in the business case for MOE/MAR. "We had to assess both short- and longer-term benefits relative to the expected costs to get executive commitment to the project," noted the Executive Director Information Management of SIMS. "While there was no denying that a reduction in transcription errors and a more efficient order-to-administration turnaround time would serve as key patient safety benefits, we also knew that clinical decision support alerts could further improve the quality of patient care by identifying drug-drug, drug-lab and drug-allergy interactions at the time a drug was ordered."

Enhancing communications within clinical teams - thanks to reducing verbal and telephone orders and extending EPR usage to a broader base of UHN physicians - was also considered to be paramount. UHN's Chief Nursing Executive had wanted to address the "no verbal order" goal for a long time. The reason: Nursing realized the potential errors and patient safety risks that were inherent in verbal miscommunications. By taking laptops to the bedside and using MOE/MAR to help with patient education, nurses would be in a far better position to deliver patient-centred care. And because MOE/MAR would only allow medications to be ordered by physicians, verbal orders would no longer be accepted as part of the medication order workflow at UHN.

Although not decision-drivers for senior management, other benefits in pursuing MOE/MAR included efficiencies from updated order sets and better compliance with drug formulary. Finally, with UHN's vision statement of "achieving global impact," the opportunity to demonstrate CPOE leadership in Canada was certainly a key factor for UHN's board.

Finally, UHN extrapolated its adverse event rates and medication errors from the findings in Baker et al. (2004) in order to assess the opportunity for improvement in patient safety. While the project team would have preferred to complete a chart audit to gather actual baseline data, this approach was turned down due to the costs and time it would have taken to complete. Nevertheless, this baseline information - coupled with plans for how ongoing metrics would be reported to show improvement - compelled the senior management team to enthusiastically move forward with MOE/MAR.

Ensure Commitment to Mitigate Inevitable Challenges

As part of the decision to proceed with MOE/MAR, the senior management team had numerous discussions about the inevitable challenges this project would have as well as mitigating strategies. The primary concern was to ensure Physician, Nursing and Pharmacy engagement throughout the duration. The Medicine Physician-in-Chief committed to being executive sponsor for MOE/MAR. The Pharmacy department reported to him, which would help ensure alignment of that team with the project priorities. Further, a MOE/MAR steering team would be established that would encompass key Physician, Nursing and Pharmacy clinical leaders from across the three hospital campuses and SIMS.

Meanwhile, the steering committee would be accountable to senior management, including UHN's CEO, for directing the project and to serve as the point of escalation for any challenges that could not be addressed by the project team including clinical resistance to change.

"Perhaps most important of all, however, is that there was already a good relationship between the medical staff, Nursing, Pharmacy and our SIMS group that allowed them all to work closely as a multidisciplinary team," says UHN's Pharmacy Director.

A related challenge raised by the Pharmacy department: With new drug protocols being introduced on a daily basis, new drugs coming onto the market and changes in the way physicians, nurses and pharmacists act and work with respect to patient care, the hospital was a highly dynamic environment. With the hospital landscape in a continual state of flux, implementing new MOE/MAR functionality meant that implementing change would become a continuous process, both from a clinical and technical perspective. The departments involved would require sufficient staff to handle these changes on an ongoing basis, and the electronic systems would have to be flexible enough to incorporate those changes in real time as they occurred. In light of this concern, the senior management team approved one-time staffing increases within Pharmacy, Nursing Informatics and SIMS. This increase in funding would address the initial effort but would not commit to increasing

operating budgets until after the project was completed. By embracing such a strategy, it was hoped that the ongoing effort would be better understood.

Critical Factors in the Decision to Undertake MOE/MAR

1. The strong movement already afoot in the healthcare industry to improve patient safety in the acute care hospital setting provided considerable external impetus.
2. Existing UHN initiatives around patient safety and patient-centred care created an internal environment and momentum conducive to the advent of MOE/MAR.
3. Studies and work by various patient safety groups had already identified medication errors as the most critical problem contributing to adverse events, and CPOE as the most effective way to reduce those errors.
4. Executives saw MOE/MAR as an opportunity to distinguish UHN on the patient safety front and as a leader in the adoption of the Electronic Patient Record (EPR).
5. The Executive team was willing to embrace the MOE/MAR vision, commit hospital resources and take the necessary actions to see it through to completion.
6. UHN invested in Physician, Pharmacist and Nurse Informatics professionals to work cooperatively in guiding their respective colleagues through the clinical transformation.
7. Rigorous, proven project management skills orchestrated all the project logistics to ensure appropriate change management support across the organization.

The final major challenge identified by medical leadership was the need to ensure adequate training for the July and January intake of new residents every year. As the largest teaching hospital in Canada, UHN typically receives approximately 150-200 residents and 200-250 clinical fellows every 12 months. MOE/MAR would add significant additional training to the residents' UHN orientation requirements - especially since none of the other teaching hospitals in Toronto had MOE/MAR in place yet. Thus, ongoing resources were added to the SIMS Education budget to address the continual training requirements into the future as well as the development of multiple training modalities to accommodate flexibility in training residents.

It was expected that implementing MOE/MAR would be a Herculean effort, given the amount of time, effort and money required. But considering MOE/MAR was focused on reducing medication errors and adverse events - and thereby reducing unnecessary patient morbidity and mortality - the project was more than merely a way to increase efficiencies. Rather, in the final analysis, the choice as to whether to implement MOE/MAR was no choice at all. If UHN was serious about enhancing patient safety, MOE/MAR had to be developed and adopted.

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