

**MARKETING PLAN FOR THE PROMOTION AND IMPLEMENTATION
OF AUTOMATED DISPENSING MACHINES AT VARIOUS HOSPITALS
WITHIN VANCOUVER COASTAL HEALTH AUTHORITY AND
PROVIDENCE HEALTH CARE**

by

Aileen Ngai Lam To
B.Sc. Biochemistry, Simon Fraser University, 2001

and

Mabel Yan
B.Sc. Pharmacy, University of British Columbia, 1996

PROJECT SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF BUSINESS ADMINISTRATION

In the
Faculty
of
Business Administration

Management of Technology Program

© Aileen Ngai Lam To and Mabel Yan 2006

SIMON FRASER UNIVERSITY



Spring 2006

All rights reserved. This work may not be reproduced in whole or in part,
by photocopy or other means, without permission of the authors.

APPROVAL

Name: **Aileen Ngai Lam To**

Name: **Mabel Yan**

Degree: **Master of Business Administration**

Title of Project: **Marketing Plan for the Promotion and
Implementation of Automated Dispensing Machines
at Various Hospitals within Vancouver Coastal
Health Authority and Providence Health Care**

Supervisory Committee:

Dr. Colleen Collins-Dodd
Senior Supervisor
Associate Professor
Faculty of Business Administration

Dr. Ian P. McCarthy
Second Reader
Associate Professor of Marketing
Faculty of Business Administration

Date Approved:

April 3, 2006



**SIMON FRASER
UNIVERSITY** library

DECLARATION OF PARTIAL COPYRIGHT LICENCE

The author, whose copyright is declared on the title page of this work, has granted to Simon Fraser University the right to lend this thesis, project or extended essay to users of the Simon Fraser University Library, and to make partial or single copies only for such users or in response to a request from the library of any other university, or other educational institution, on its own behalf or for one of its users.

The author has further granted permission to Simon Fraser University to keep or make a digital copy for use in its circulating collection, and, without changing the content, to translate the thesis/project or extended essays, if technically possible, to any medium or format for the purpose of preservation of the digital work.

The author has further agreed that permission for multiple copying of this work for scholarly purposes may be granted by either the author or the Dean of Graduate Studies.

It is understood that copying or publication of this work for financial gain shall not be allowed without the author's written permission.

Permission for public performance, or limited permission for private scholarly use, of any multimedia materials forming part of this work, may have been granted by the author. This information may be found on the separately catalogued multimedia material and in the signed Partial Copyright Licence.

The original Partial Copyright Licence attesting to these terms, and signed by this author, may be found in the original bound copy of this work, retained in the Simon Fraser University Archive.

Simon Fraser University Library
Burnaby, BC, Canada



STATEMENT OF ETHICS APPROVAL

The author, whose name appears on the title page of this work, has obtained, for the research described in this work, either:

- (a) Human research ethics approval from the Simon Fraser University Office of Research Ethics,

or

- (b) Advance approval of the animal care protocol from the University Animal Care Committee of Simon Fraser University;

or has conducted the research

- (c) as a co-investigator, in a research project approved in advance,

or

- (d) as a member of a course approved in advance for minimal risk human research, by the Office of Research Ethics.

A copy of the approval letter has been filed at the Theses Office of the University Library at the time of submission of this thesis or project.

The original application for approval and letter of approval are filed with the relevant offices. Inquiries may be directed to those authorities.

Simon Fraser University Library
Burnaby, BC, Canada

ABSTRACT

Patient safety is now a primary concern in most hospitals, some of these concerns include medication errors, which can cause serious harm to patients and can be avoided with the right practices. Hospitals are responding by implementing process changes. Among the successes are changes in the medication dispensing and administration processes.

Vancouver Coastal Health Authority and Providence Health Care are in the process of implementing the Omnicell® Automated Dispensing Machines in their hospitals. Their objective is to implement these machines in most nursing units in an effort to reduce medication errors and increase patient safety.

This marketing plan presents strategies to promote the proper use of the Omnicell® Automated Dispensing Machines to help enhance medication safety. In addition, we provide recommendations for the implementation of the Automated Dispensing Machines to help address some of the users' concerns and create initial buy-in.

Keywords: Vancouver Coastal Health Authority, Marketing Strategy, Omnicell® Automated Dispensing Machines, Reduction in Medication Errors

EXECUTIVE SUMMARY

Over the past decade, hospitals have become increasingly concerned with patient safety. According to information provided by the US Institute of Medicine, approximately 44,000 to 98,000 Americans die in hospitals each year due to adverse events many of which could have been prevented. (Kohn, Corrigan, and Donaldson, 2003) Preventable medication errors account for a large part of these adverse events and are continuing to draw public attention.

An increasing number of hospitals are responding by implementing technologies such as Automated Dispensing Machines (ADMs), Bar-Code Point-of-Care devices (BPOC), and Computerized Provider Order Entry Systems (CPOE). Such technologies can help reduce errors in medication dispensing and administration. At the same time, these technologies can provide nurses with up-to-date patient's medication records and more accurate ways to document and track the medication administration process. Vancouver Coastal Health Authority and Providence Health Care have various strategies in place to help reduce medication errors, and are currently in the process of implementing the Omnicell® Automated Dispensing Machines. This marketing plan provides data and analysis derived from in-depth interviews with nurses, pharmacy staff, doctors, (in particular anaesthetists) and organizational managers who are directly involved in the implementation processes. We focus on the practical implications of deploying the Omnicell® Automated Dispensing Machines to help transform hospitals into safer, more efficient, and more effective institutions.

Previous research has shown that Automated Dispensing Machines can help prevent potential medication dispensing errors by providing a more controlled method for nurses to access medications. This analysis helps identify some of the common issues that current users of

the Automated Dispensing Machines are concerned with and provides recommendations and strategies to help create buy-in from the users in the hopes of reducing medication errors. Our findings demonstrate that users of these Automated Dispensing Machines are not fully aware of the consequences of medication errors and how the machines can help increase patient safety. Users are generally more concerned with the impact that the ADMs will have on their workflow. Therefore, in order to create buy-in, users need to be informed about the occurrences and consequences of medication errors. A successful implementation plan for the Omnicell® Automated Dispensing Machines will include strategies that will address the end-users' concerns and help them adapt the machines to their current workflow processes. The benefits and limitations of implementing the Omnicell® ADMs based on the interviews and surveys are listed in Appendices 1-4.

Recommendations:

Prior to implementation:

- Users should be fully informed about the Omnicell® Automated Dispensing Machines. This will not only help familiarize the users to the technology, but also help create buy-in.
- Audits should be conducted on the current medication administration process to identify the numbers and types of medication errors that are occurring.
- A “Failure Mode and Effects Analysis” should be conducted to better anticipate risks involved, in an effort to help educate the users about these risks.

During and Post Implementation

- Sufficient hands-on training should be provided.
- 24 hours technical support should be provided for at least 2 weeks after “go-live” (initial implementation).
- An Omnicell® Systems Administrator who can provide training and technical support should be made available at every hospital site, at least during the initial implementation and adoption of the ADMs.
- In-service support, which involves the Omnicell® Systems Administrator going on-site to each hospital unit to follow-up with issues, concerns, and additional training, should be available bi-weekly or monthly, at least for a duration of time after the initial implementation.
- A Post-implementation Evaluation/Follow-up should be performed to:
 - Encourage feedback from front-line staff
 - Encourage feedback from nurse educators, clinicians, and managers
 - Encourage feedback from pharmacy
 - Address and help find solutions for the concerns of the front line staff

DEDICATION

I would like to dedicate this to my parents who has always had faith in my abilities and has always taught me to be my very best.

To my sister, Ackie, for putting up with me in the past years, especially in the last few years in helping me cope with work and school at the same time.

To my fiancée, Garry, for his unfailing patience, encouragements, and support throughout this project and the whole MBA program.

At last I would like to thank my good friend and partner, Mabel, without whom this project would not have been possible.

Aileen

I would like to thank my rock, RW, for putting up with the constant crying and continual encouragement and emotional support.

And to all others who had a hand in making this paper a reality.

I ditto Aileen's last comment. Her constant support and encouragement was greatly appreciated and was what made this project possible.

Mabel

ACKNOWLEDGEMENTS

We would like to acknowledge and thank those people who contributed to this marketing plan:

Colleen Collins-Dodd for her guidance, advice, encouragements and various reviews of our project.

Ian McCarthy for his help as the second reviewer of our project and in working with our strict timelines.

Robin Ensom for providing the opportunity for this project and his endless support and valuable insights.

Helen Lee for her time, patience and support.

Tessa Valg for being incredibly helpful with setting up and attending all the interviews with the nursing staff.

Anne McDonald for providing her helpful insights and helping us organize and attend the interviews with the nurses.

Su Schuck for putting up with our endless emails and we do mean endless...

The Nurses and Nurse Educators at UBC and VGH for providing us with what precious little time they already had.

Fruzsina Pataky, Camille Ciarniello, Suzanne Tytler, Luciana Frighetto and Tonya Ng for taking the time to meet with us.

Erick Wong for being our word doc. expert and for being our 0th reader.

And at last we would like to "Thank" all of our friends who has been tremendous support for both of us throughout the past few years.

TABLE OF CONTENTS

Approval.....	ii
Abstract.....	iii
Executive Summary	iv
Dedication.....	vii
Acknowledgements.....	viii
Table of Contents	ix
List of Figures.....	xii
Glossary	xiii
1 Introduction and background	1
1.1 Objective and Scope of Analysis	2
1.2 Problems with Medication Errors	2
1.3 Solutions for Medication Errors.....	3
1.4 Implementation of Automated Dispensing Machines	4
2 Automated dispensing machines (ADM).....	6
2.1 What ADM is and how it works	6
2.2 Potential Benefits	8
2.2.1 Non-profiled Automated Dispensing Machines	8
2.2.2 Profiled Automated Dispensing Machines.....	10
2.3 Potential Drawbacks.....	11
2.3.1 Non-Profiled Automated Dispensing Machines vs. Manual vs. Profiled	11
2.3.2 Profiled Automated Dispensing Machines.....	13
3 Vancouver Coastal Health Authority and Providence Health Care.....	14
3.1 Current Practices	14
3.1.1 The Current Medication Distribution System	14
3.1.2 The Current Manual Medication Distribution Process	14
3.1.3 The Non-Profiled Process	16
3.2 Potential Problems	17
3.2.1 Problems with the manual process	17
3.2.2 Problems with the non-profiled process	18
3.3 The Environment	19
3.3.1 The OR and PAR Units	19
3.3.2 The Emergency Room	19
3.3.3 Other Hospital Medical Units	19
3.4 Customers	20
3.4.1 The OR and PAR Units	20
3.4.2 The Emergency Room	20
3.4.3 Other Hospital Units	20
3.4.4 Hospital Administrators.....	20

3.4.5 The Pharmacy	21
3.5 The Implementation Plan	21
3.5.1 Non-Profiled ADMs	21
3.5.2 Profiled ADMs	22
4 Framework for Analysis: Rogers' Adoption Factors.....	24
4.1 Adoption Process	24
4.1.1 Rogers' Model of Adoption	24
5 Research and Analysis	27
5.1 Rogers' Adoption Model for the implementation of ADM	27
5.1.1 Interviews.....	27
5.1.2 Results	27
5.1.3 Analysis of Adoption Factors.....	45
5.2 Issues/Concerns	51
5.2.1 Non-Profiled Machines.....	51
5.2.2 Profiled Automated Dispensing Machines.....	56
6 Strategy and Recommendations	58
6.1 Strategy.....	58
6.1.1 Overall Strategy.....	58
6.1.2 Strategies for the Implementation of Non-profiled ADMs	60
6.1.3 Strategy for Transition from Non-profiled to Profiled ADMs	63
6.2 Recommendations	65
6.2.1 Pre-implementation	65
6.2.2 Post-implementation	67
7 Conclusion.....	73
Appendices	74
Appendix 1: Benefits of the Non-profiled ADMs	74
Appendix 2: Benefits of the Profiled ADMs.....	76
Appendix 3: Limitations for the Non-profiled ADMs	77
Appendix 4: Limitations of the Profiled ADMs	78
Appendix 5: Rogers Adoption Model.....	79
Appendix 6: Questionnaire 1	81
Appendix 7: Questionnaire 2.....	82
Appendix 7: Questionnaire 2.....	83
Appendix 8: Issues/Concerns – Non-Profiled ADMs.....	85
Appendix 9: Issues/Concerns Profiled ADMs.....	86
Appendix 10: Raw Data from Questionnaire 1	87
Appendix 11: Raw Data from Questionnaire 1	91
Appendix 12: Raw Data from Questionnaire 2	94
Appendix 13: Raw Data from Questionnaire 2	96
Appendix 14: Average Ratings	99
Appendix 15: Correlations	100
Appendix 16: Frequencies of some of the subjective responses from users	101
Appendix 17: Minutes from the meeting with Regional Manager for Decision Support, and Risk Manager Coordinator for Patient Safety.....	102
Appendix 18: Minutes from meeting with the Pharmacy Operations Director.....	105
Appendix 19: Minutes from 2 nd meeting with Regional Manager for Decision Support.....	109

Appendix 20:	Minutes from the meeting with Clinical Nurse Educator at Providence Health Care	111
Appendix 21:	Minutes from the meeting with Medication Safety Coordinator at Providence Health Care	113
Appendix 22:	Revised Questionnaire	115
Appendix 23:	Example of a Failure Mode and Effects Analysis	117
Reference List.....		118

LIST OF FIGURES

Figure 1:	Number of times nurses need on one shift.....	28
Figure 2:	Percentage of time nurses spent on medication related tasks.....	29
Figure 3:	Knowledge about ADMs	30
Figure 4:	Comfort level with technology.....	32
Figure 5:	Level of willingness to try the ADMs	33
Figure 6:	Satisfaction Level with the ADMS.....	34
Figure 7:	Effectiveness of the training and support.....	35
Figure 8:	Ease of use of the ADMs	36
Figure 9:	Average ratings for pre-implementation questions	37
Figure 10:	Average ratings for post-implementation questions	38
Figure 11:	Users' average ratings Pre/Post Implementation.....	39
Figure 12:	Common Concerns in the implementation of ADMs	40
Figure 13:	Common Advantages Observed in the implementation of ADMs.....	41
Figure 14:	Things that helped users feel more comfortable with the implementation of the ADMs.....	42

GLOSSARY

Terms	Definitions
OR	Operating Room
PAR	Post Operative Recovery Where patients recover from their anesthetics after surgery.
ER	Emergency Room
ADM	Automated dispensing machine for automated management and dispensing of medication.
Non-profiled ADM	The computer system used with the ADM that allows medication access in a non-patient-specific way. Nurses may have access to all medications stored in the machine, instead of strictly medications prescribed to a particular patient. This system is linked with the hospital pharmacy system for optimal inventory management.
Profiled ADM	The computer system used with the ADM that limits medication access to patient-specific prescriptions only. This system operates along with the hospital's pharmacy system for patient-specific medication information.
Ward stock Cabinets	Cabinets in each hospital unit which contain bulk supply of the common medications used in that unit. Nurses have unlimited and uncontrolled access to these medications at all times.
Personal Medications	Medications specific to individual patients that are usually not available in the ward stock cabinets and must be prepared by the pharmacy.
Med Carts	Medication carts that contain both ward stock and personal medications. Medications in these carts are separated for individual patients and are ready for nurses to administer to each patient.

Terms	Definitions
Unit dose	Medication dispensed in a package that is a single dose and ready to administer to patients. It can be used for medications administered by any route. Oral, parenteral, and respiratory routes are especially common.
STAT Medications	Urgent medications that are needed within 15 minutes of ordering.
ASAP Medications	Medications that are needed within 1 hour of ordering.
Routine Medications	Medications that are taken on a regular basis by patients and are needed within 4 hours of ordering.
MAR	Medication Administration Record The report that serves as record of the drugs administered to a patient by a nurse or other healthcare professionals. The nurse or healthcare professional signs off on the record at the time that the drug is administered.
In-service support	On-site services provided by an Omnicell® Systems Administrator after the initial implementation of the ADMs.
Omnicell® Systems Administrator	A pharmacy technician who has been trained by the vendor to provide in-service support for the users. This technician is in close contact with the vendor regarding technical support, repairs, maintenances that the ADMs may need.
VCHA	Vancouver Coastal Health Authority
PHC	Providence Health Care
CPOE	Computerized Provider Order Entry Electronic system where physicians can enter their medication orders into an electronic device and the device automatically sends the order to the hospital's information systems where they can be processed by other departments.
BPOC	Bar-Code Point-of-Care Devices Electronic devices that are used as a last checkpoint to ensure that the correct medication is being administered to the right patient.

Terms	Definitions
VGH	<p>Vancouver General Hospital</p> <p>Part of the VCHA group, site at which the ADMs are being implemented. Some units within this hospital have the ADMs, but others are waiting for its implementation. 60% of the interviews for this analysis were from users or potential users of the ADMs at this hospital.</p>
UBCH	<p>University of British Columbia Hospital</p> <p>Part of the VCHA group, site at which most units have already been using the ADMs for several years. Most users at this hospital had previous experience using the Pyxis[®] automated dispensing machines, and have now switched to the Omnicell[®]. 40% of the interviews for this analysis were from users of the ADMs at this hospital.</p>
Omnicell[®]	<p>The brand of automated dispensing machines, which VCHA and PHC have chosen to implement in their hospitals. Omnicell[®] will be providing the automated dispensing machines and providing support for the Omnicell[®] system.</p>
Medication Error	<p>A preventable mistake in prescribing or delivering medications to a patient; that is, any improper uses of medicine that causes harm to a patient.</p>

1 INTRODUCTION AND BACKGROUND

VCHA and PHC delivers health care services to over 1 million people (25% of BC's population) in communities ranging from Richmond through Vancouver, the North Shore, Sunshine Coast and Sea to Sky area, Powell River, Bella Bella and Bella Coola. VCHA and PHC manages a full range of health services and programs, from acute care hospitals to community-based residential, home health, mental health and public health services.

VCHA and PHC form the largest health authority in BC. Their hospitals and care units work closely together to share their experiences and expertise to maintain a standard of excellence in health care. Together they strive to improve patients' access to hospital and surgical services, increase patient flow through hospital services, and implement best medical and ethical practices within their facilities. VCHA and PHC's overall goal is improved health for the patients they serve, to be better able to meet patients' needs; and improve the overall medication system to reduce medication errors.

Improving patient safety in their hospitals is on the forefront of VCHA and PHC's interests. This interest has led VCHA and PHC to re-examine approaches to safety and allocate resources toward this vital goal. There are various methods and technologies that can be powerful tools in ensuring patient safety by reducing errors in the medication administration process, including Automated Dispensing Machines, Barcode Labelling and Bar-Code Point-of-Care Devices. VCHA and PHC have made and are ready to continue to make a substantial commitment to integrating these technologies, especially the ADMs, throughout their facilities. The implementation of the ADMs should present enormous opportunities to reduce dispensing errors, increase efficiency, and enhance patient safety.

1.1 Objective and Scope of Analysis

The objective of this analysis is to prepare a marketing/communications plan to promote the use of the Omnicell® Automated Dispensing Machines as part of a medication safety strategy in hospitals within VCHA and PHC. The marketing plan will help address and resolve some of the issues that are currently preventing the implementation of these machines and also highlight some of the benefits of implementation of these machines using the profiled format. The marketing plan will also include recommendations for developing strategies to promote and provide effective training for end users (nurses and doctors), and also include strategies that will be helpful in the implementation of the ADMs.

1.2 Problems with Medication Errors

Medication errors have received a great deal of attention in recent years. For patients medication errors can result in inconvenience, pain, suffering or even death. In addition there can be a huge financial burden associated with these errors. In 1999, the National Academy of Sciences' Institute of Medicine (IOM) focused national attention on the issue of errors within the health care system of the United States. According to this report, medication errors were estimated at \$17 -\$29 billion. In 1993, it was estimated that medication errors accounted for about 7000 deaths in the United States. (Kohn, Corrigan, and Donaldson, 2003).

Increased attention is being placed on preventing and reducing errors. Early efforts to improve medication safety within hospitals focused on easy to correct problems. For example, easily misidentified products with similar labels, such as potassium chloride and Lasix, were removed from patient care areas and prepared in the pharmacy to prevent mix-ups and potential harm. However, these efforts were not enough and stronger mandates are required to increase patient safety.

To circumvent medication errors, we need to better understand the medication process. There are four interdependent steps involved in the delivery of medication: prescription, transcription, dispensing, and administration. Since the medication system is complex and involves numerous personnel, the probability for the occurrences of errors would be high (39% of errors occur during the prescription phase, 12% occur during transcription, 11% occur during dispensing and 38% occur during administration). More importantly, it has been revealed that 48% percent of prescription errors are intercepted before they reach the patient, but only 2% of drug administration errors are intercepted (Vaida and Cohen, 2005, p.151). This is expected since drug administration is the last step in the medication process. Therefore it is critical to implement strategies that will help prevent medication administration errors.

1.3 Solutions for Medication Errors

A number of different automated systems have proven to be successful at increasing medication safety; such systems include CPOE, Safety Huddles, ADMs and BPOC.

CPOE allows physicians and other healthcare providers to enter orders for medications, laboratory tests, and other procedures electronically reducing the risks inherent in illegible handwriting, and providing physicians with information about possible drug interactions, drug allergies and best courses of treatment. These electronic prescriptions are transmitted to the pharmacy almost immediately and helps decrease the turnaround time for delivery of medications, thereby providing nurses quicker access to medications.

Safety Huddles are meetings with nursing staff to raise awareness and identify concerns witnessed by the front-line workers. These briefings are held with the intention to discuss and address issues and problems; nurses are encouraged to share their experiences or incidents that might have caused patient harm, and to suggest ways to help prevent these problems in the future.

The key points generated from these huddles are printed into newsletters and distributed to other nursing units and management.

The ADMs are automated cabinet systems for secure storage and rapid dispensing of medication. An ADM accurately monitors and tracks all medications that are being dispensed by patient, time, type and user. It has the ability to immediately alert nurses about patient allergies and drug interactions and with its “profiling” ability, assures that the right medications are being administered to the right patient.

Bar-Code Point-of-Care devices (BPOC devices) are hand-held devices or computers that are available at patient’s bedside. These devices allow nurses to scan the bar code of a medication and the patient to ensure that the correct medication is being administered to the correct patient at the correct time. In order words, these devices help nurses ensure that they are following the nurse’s 5 rights/checks (right patient, right drug, right time, right dose, and right route of administration). BVD provides the last line of safety check and an electronic documentation process for the point of administering medications to patients.

1.4 Implementation of Automated Dispensing Machines

Our focus will be on the implementation and adoption of the Automated Dispensing Machine, in particular the Omnicell® Medication System. ADMs appeared on the scene in the 1980s, in the hopes of reducing medication errors, increasing efficiency for the pharmacy and nursing staff, providing readily available medication, accurately tracking patient medication usages and improving pharmacy inventory control. ADMs allow medications to be stored on nursing units and allow users to have convenient access to medications. ADMs are appropriate for dispensing medications that are prescribed to only one particular patient at a time, improving availability, increasing the efficiency of drug dispensing, and increasing time for other patient care activities.

The Omnicell® Medication System helps:

- Reduce medication errors and improves patient safety by providing a guided light system that directs the users to the correct medications;
- Provide automated single-dose dispensing, which ensures accurate dispensing and restocking while decreasing the opportunity for inventory discrepancies
- Displays “patient medication profiles”, patient-specific information at the cabinets, which can alert nurses to patient-specific issues, such as drug-drug interactions, drug-disease interactions, and drug allergies, which will enhance patient and medication safety in the hospitals.

2 AUTOMATED DISPENSING MACHINES (ADM)

2.1 What ADM is and how it works

The automated dispensing machines came to market in the 1980s, in an effort to reduce rates of medication errors, increase efficiency of hospital staff, and provide a more effective way to inventory and charge inpatients for their medication expenses.

Automated dispensing machines storage cabinets are drug storage devices or cabinets that electronically dispense medications in a controlled fashion and tracks medication use. VCHA and PHC are in the process of implementing the Omnicell® ADMs with the non-profiled system. The non-profiled system provides users with uncontrolled access to medication; nurses get access to the ADMs using their login ID and password. They then select the patient for which they would like to withdraw medications. Once the patient is selected, the nurse chooses the needed medication from the long list of medications available in the ADM. With the profiled system users are only allowed to access medications that are in the patient's profile. The profiled system will only give users access to medications that have been entered and verified by pharmacy.

Here is a step-by-step layout of how the automated dispensing machines works:

- 1) Users use their login and pass code to access the ADMs
- 2) Once they are granted access into the machine, the user can select from a patient list.

With the non-profiled system, once the user selects the patient, they are prompted with a list of all medications available in the machine. However, with the profiled system, after the user selects the patient, they will only have access to the

medications that are listed under the patient's profile. With the profiled system users have limited access to medications in the machine.

- 3) Once the medication is selected (this is the same for profiled or non-profiled system), the ADM will automatically dispense the medication or unlock the drawer, and the 'guiding light' system guides the user to the correct bin containing the medication.
- 4) This information is then documented into the pharmacy information system, tracking the user, time, and patient, enabling pharmacy to have more accurate records and efficient inventory control.

There are several different companies that produce these automated dispensing machines and each operates with a slightly different system, which is usually dependent on the hospital's needs. At VCHA and PHC, Omnicell[®], will be the primary vendor supplying the automated dispensing machines to each nursing unit.

In an ideal environment, automated dispensing machines are not used as a stand-alone system. They are usually used in conjunction with other automated or electronic systems that can further assist in reducing the rates of medication errors. These other systems may include CPOE and BPOC devices.

CPOE will help to streamline and structure the prescribing process. Since the prescriptions are immediately sent to the pharmacy after the physicians selects and authorizes the order it significantly improves turnaround time from when the medication is ordered to when the medication is accessed/received and administered. In addition, by having prescriptions electronically written, transcription errors are reduced. CPOE can also help with checking for drug- allergies and drug-drug interactions, to ensure that the medication is appropriate for the patient.

BPOC devices can help by ensuring that the right medication, right dose, and the right route of administration are used for a particular patient. A BPOC device requires that the nurse scans his/her nametag, patient's identification bracelet, and the medication, the electronic system automatically checks and verifies the scans, warnings and alerts will indicate that there was a mismatch for the patient with the medication. BPOC helps to reduce errors, such as administering the wrong drug, or wrong dose, or wrong medication for a particular patient at the time of administration.

Medication Systems for the future would have physicians write orders on a computerized system; the order is sent electronically to pharmacy for review; orders are entered and verified; nurses get access to ADMs and retrieve the medication; and BPOC devices are used to ensure the right medication is given to the right patient at the right time, at the point of administration. This will help to significantly reduce dispensing and administration errors.

2.2 Potential Benefits

2.2.1 Non-profiled Automated Dispensing Machines

- ❑ “Guiding light” technology or automatic dispensing helps guide nurses to removing the “correct” medication(s) for the patient

Once the nurse chooses the medication from the ward stock list, depending on the machine, either the drawer will open and the bin holding the medication will light up or the machine will automatically dispense the medication. These added safety features assist the nurses in retrieving the correct medications from the ADMs creating an additional safety check against retrieval errors (provided that the correct medication was placed in the correct bin and the nurse had selected the right medication). The automated

drug storage bins are also designed specifically for storing individual medications, thereby reducing mix-up errors and creating a safer environment for patients.

❑ Maximize security of controlled and narcotic medications

Narcotic and controlled medications will be accessible to all users at all times in a controlled manner. With the ADMs, nurses will no longer have to share and search around for one set of narcotic keys when they need access to these medications. The nursing units will have to worry less about losing narcotic keys or patients stealing or taking these controlled medications.

❑ Narcotic counts are performed once per week rather than per shift.

When nurses remove narcotics or controlled medication from the bins, they are required to count back and confirm the quantity of the medication remaining in the bin. In addition, the ADM's internal tracking system helps to keep an accurate narcotic count. With these two added features in place, narcotic counts are no longer required after every shift, instead narcotic counts are only required once a week. This frees up a significant portion of the nurses' time that can be used for other duties, such as patient care.

❑ Enables pharmacy to keep a more accurate and efficient inventory

The ADMs' tracking system and sensing bins enables pharmacy to keep an accurate perpetual inventory count ensuring that the ADMs never run out of medications.

❑ Unit-dose medication dispensing, preventing medications and dosage mix-ups.

Unit-dose medications are dispensed in a package that is ready to administer to patients. This will not only help nurses with dosing calculations; it also helps to reduce waste of medications. In addition, it helps to enhance patient safety as it reduces medication

administration errors by providing the medication name and expiry date on the label of each package.

- ❑ Secured user access, protecting against unauthorized access to medications and tracking medication use. Without a login code and password, unauthorized users are unable to gain access to medications.

2.2.2 Profiled Automated Dispensing Machines

All of the previously stated benefits for the non-profiled system can also apply to the profiled system with the following additional benefits.

- ❑ Nurses will only be choosing from a list of medications that was actually prescribed to that particular patient.

This added safety feature ensures that nurses can only choose and access medications that are specifically prescribe to the patient. This prevents selection errors from being made, which may still occur in the non-profiled setting. Nurses will no longer have to spend time trying to find the right medication and dosage for patients.

- ❑ The patient medication profiling provides nurses with readily accessible, up-to-date patient medication information.

Nurses are able to pull up the list of medications currently prescribed to a patient, the time of the last administered dose and by whom the medication was administered. This enhances medication safety by ensuring that medication administrations are not missed or duplicated and discontinued medications are not administered to patients.

- ❑ Provides pharmacy oversight to address possible allergies or interactions.

The profiled system allows pharmacy to control nurses' access to the medications in cases where there might be possible drug allergies or interactions. With the non-profiled system nurses have access to all medications before pharmacy has checked them, but with the profiled system pharmacy can ensure that they have verified the medication orders before the nurses gain access to them. For example, consider the scenario that a nurse is going into the profiled ADM to access a particular medication for a patient and the medication is not yet on the patient's profile. The nurse will then call pharmacy to ask why the medication is not available. Pharmacy can explain that there might be a possible drug allergy and they are waiting for the doctor's confirmation, and the nurse will know and understand that they should not administer that medication to the patient until it has been confirmed. But in the non-profiled system the pharmacy might not be able to alert the nurse in time before he/she administers the medication to the patient.

2.3 Potential Drawbacks

2.3.1 Non-Profiled Automated Dispensing Machines vs. Manual vs. Profiled

- ❑ Selection errors may be more likely to occur when compared the profiled system.

In a non-profiled situation, nurses choose the patient's medication from a long list of ward stock medications. Not only is the list long but also there are also many medications that have similar names and dosages. These two factors may increase the chance of selecting the wrong medication when compared to the profiled system, where nurses are only given a list of the patient's actual medications to select from.

- ❑ Human errors may prevent these systems from functioning as designed.

Errors may occur during the course of refilling the bins or during the packaging of medications and as a result, nurses may retrieve and administer the wrong medication without even being aware.

❑ Human Intervention

An example was witnessed during one of our interviews. A nurse is in the process of signing out a medication for a patient. While she was in the process of retrieving the medication from the ADM, another nurse interrupts and informs her that the patient no longer requires the medication. Without thinking the nurse places the medication back into the drawer and leaves to attend to her patient. The ADM documents that the medication has been retrieved and counts it out of inventory. A short while later another nurse requires the same medication. But when she tries to access the drawer the ADM informs her that there is no medication available and denies her access to that drawer, even though there is clearly one unit of medication available in the drawer. In this case, the nurse's misuse of the ADM resulted in the ADM denying access to the medication that was available and needed by the patient.

- ❑ Breakdowns/downtimes may impede or prevent access to ADMs, thereby delaying patients from receiving medications prescribed at the right times.

Breakdowns/downtimes, such as door jams, can not only prevent access to medications but also affect the workflow for nurses; they can delay patients from receiving their needed or scheduled medications, and they can affect the pharmacy and nurses' workflow leading to increased work load, decrease patient care and an increase in medication errors.

- ❑ Delayed access to medications when needed quickly.

The requirement of a login code and password may increase the time required to obtain medications, which may be detrimental in emergency/life-or-death situations.

2.3.2 Profiled Automated Dispensing Machines

All of the above-mentioned potential drawbacks for the non-profiled ADMs may also apply to the profiled ADMs.

❑ Pharmacy Turnaround

The turnaround time is the time from when the medication is ordered to when nurses have access to medications. Nurses are unable to access medications that are not listed under a patient's profile. They have to wait until the pharmacy enters and verifies the order before they are able to retrieve and administer the medication. This may result in nurses developing workarounds to mitigate this hindrance. However, some of these workarounds, such as the nurses administering medications to patients before pharmacy verifies the order, are already being used with the manual system.

3 VANCOUVER COASTAL HEALTH AUTHORITY AND PROVIDENCE HEALTH CARE

3.1 Current Practices

3.1.1 The Current Medication Distribution System

Currently, most hospitals within VCHA and PHC use a manual medication distribution system. In an effort to reduce medication errors, some of these hospitals have begun implementing Omnicell® ADMs. .

The implementation of these machines has been successful to some extent. However, hospital units that currently have the Omnicell® ADMs are not using the machines to their full potential. Instead the machines are being used with a non-profiled format. With the non-profiled format users have access to all medications stored in the ADMs and patients lack their own unique medication profile. As a result, the ADMs are used as glorified storage cabinets that allow access to all medications stored in the machine.

In order to use the Omnicell® ADMs to their full potential, they should be used in a profiled format. The profiled system will only allow users access to medications listed under the patient's profile. One advantage of using the profiled system is that it reduces the chance of nurses selecting the wrong medication. As a result, nurses not only spend less time and effort searching for the right medication but they are also less likely to make a selection error.

3.1.2 The Current Manual Medication Distribution Process

Here is a step-by-step layout of how the manual process works:

- 1) The process begins with a doctor seeing a patient.

- 2) If necessary the doctor will then prescribe medication(s) to the patient or revise a previously prescribed medication order.
- 3) If there is an order for medication(s) then the doctor flags the patient's chart indicating there is an order.
- 4) The nurse then records the order for that particular patient on the Medical Administrative Record (MAR).
- 5) The medication order is then transmitted to the pharmacy (via fax or in person).
- 6) If medication(s) are available in ward stock nurses can retrieve the medication(s) and administer it to the patient, by-passing the pharmacy checks to ensure the order is safe and appropriate for the patient. If the medication is not available in ward stock, nurses have to wait for pharmacy to process and deliver the order.
- 7) The pharmacist at the dispensary checks all of the medication orders for drug allergies, drug-drug interactions, drug-disease interactions, dosages, and appropriate indications.
- 8) Once the medication order has been checked and approved, the pharmacy technician prepares the medication order.
- 9) Once the medication is prepared and the appropriate label attached, a certified pharmacy technician or pharmacist checks the final product.
- 10) The medication orders are then distributed to the nursing wards.
- 11) Before administration the nurse ensures that the 5 Rights of Patient Care are being met.
- 12) At the completion of the medication administration process the nurse records exactly what has been administered to the patient on the MAR.

3.1.3 The Non-Profiled Process

The non-profiled process is very similar to the manual process. The automated dispensing machines operate much like an electronic storage for ward stock medications. These electronic computerized cabinets guide nurses to the selected medication but cannot ensure that the right medication is administered to the right patient. However a benefit of the non-profiled automated dispensing machine is that it keeps a perpetual record of the drug inventory. This allows pharmacy to keep a more accurate inventory count, ensuring that the ADMs never run out of medication.

Here is a step-by-step layout of how the medication system works with the implementation of the non-profiled ADMs. The first five steps of the medication distribution process are the same as the manual process, followed by:

- 1) All of the medications that were available as ward stock in the manual system are now available in the ADMs. Nurses can select the medication and the machine automatically directs the nurses to the correct bin where the medication is stored.
- 2) Once the medication is retrieved from the ADM, the nurse can administer the medication to the patient immediately (precluding any checks put in place to enhance patient safety and drug appropriateness). However, the majority of the medications stored in the ADMs are packaged in unit doses with the medication name and expiry date stamped on the package. This allows nurses to double check to ensure that the medication is in fact the medication requested.
- 3) If the medication is unavailable in the ADM, nurses will have to wait for pharmacy to process the order and deliver the medication(s) to the nursing ward.

Note: Nurses continue to rely on the MAR and patient chart to determine what medications to administer and when. The process of recording and checking remain the same as the manual process.

3.2 Potential Problems

As with any system, the systems described above are not fool-proof and consist of many areas where human error can be introduced. As a result, potential medication errors may occur. As part of VCHA and PHC's initiative towards reduction of medication errors, in particular administration errors, automated dispensing machines are being implemented.

3.2.1 Problems with the manual process

Below are some of the problems that might be encountered with the manual process.

- Transcription errors: when the nurse or pharmacist transcribes the doctor's prescription order.
- Recording error: the nurse might forget to record the medication order in the MAR
- Retrieval error: the nurse might retrieve the wrong medication from the ward stock cabinets.
- Entering error: the pharmacy technician might enter an incorrect order into the pharmacy administration system.
- Checking/Verifying error: i) the pharmacist might miss drug-drug interactions, drug-disease interactions, appropriate dosages, and suitability of medication for

the diagnosis. ii) The checking pharmacy technician/pharmacist might miss a dispensing/preparation error on the final check.

- Packaging error: the pharmacy technician might place the wrong medication or an incorrect dose into the medication package.
- Administration error: the nurse might administer the wrong medication to the patient.

3.2.2 Problems with the non-profiled process

- Administration errors: Since nurses have access to medications at all times they may skip the checking/verifying step by the pharmacy and retrieve medications from the machines as soon as an order has been placed.
- Uncontrolled access: Nurses have the ability to retrieve medication in larger quantities than indicated, once they gain access to the medication.
- Selection errors: Nurses have a long list of medications with similar names and some with the same names but different strengths to choose from. They could select the wrong medication or the wrong strength for a patient.
- Retrieval error: Not all medication drawers within the machine are locked. Nurses may be able to access other drawers while having selected access to another medication.

Stocking errors: Pharmacy technicians might incorrectly stock the machines and as a result the wrong medications may be placed into the wrong drawers.

3.3 The Environment

Hospital units within VCHA and PHC have their own unique characteristics and environments. In the sections below we will attempt to describe some of the major differences among these units.

3.3.1 The OR and PAR Units

The OR and PAR units have a high patient turnover rate. Patients usually reside in these units during their surgeries, and after their surgeries. . The duration of stay is usually short. For example, a single OR bed may be occupied by 2-5 different patients on an average day. The medications used by nurses and anaesthetists are most often narcotics or controlled medications to which access must be restricted.

3.3.2 The Emergency Room

The emergency room is also presented with a high volume of patients. Patients that come through the emergency room can range from having very minor injuries to very critical life-threatening illnesses. Treatments for these patients can be critical and usually cannot be delayed. As a result, nurses in these units need quick access to medications. In addition, the variety of injuries/illnesses that presents itself in the emergency room requires that the unit's ward stock store a large variety of medications, including narcotic and controlled medications. Potential theft is a major concern as patients can readily gain access medications from the ward stock cabinets.

3.3.3 Other Hospital Medical Units

Each hospital unit may vary depending on the needs of the area and of the patients. Some medical units may vary in size of operation, number of medication administrations per day and length of stay. We are cognizant that each unit will have its similarities and differences and will be taken into consideration as the ADMs are implemented at each hospital site. .

3.4 Customers

3.4.1 The OR and PAR Units

The end users of the Omnicell® ADMs in the OR and PAR will be generally be nurses and anaesthetists. The anaesthetists will need to access medications from the ADMs in preparation for their patients' surgeries. In absence of the ADMs, the anaesthetists are generally used to having nurses retrieve their medications from the pharmacy. The nurses in these units will need to access the ADMs for any additional medications the patients may need during and after the surgery.

3.4.2 The Emergency Room

Nurses in the emergency rooms face a substantial amount of pressure when treating their patients. Their patients tend to vary from non-threatening injuries to sever illnesses. ER nurses often need to access medications on the fly. By placing medications in the ADMs, nurses can access medications from one central location. In addition, they no longer have to search for the narcotic key to gain access to narcotics or controlled medications. .

3.4.3 Other Hospital Units

Nurses in other hospital units are used to either having access to most medications in their ward stock cabinets or medication carts. By placing medications in the ADMs, nurses can access medications at all times (even when the pharmacy is closed) in one central location.

3.4.4 Hospital Administrators

The hospital administrators will decide on the implementation process of the non-profiled and profiled ADMs. Depending on the resources available, the non-profiled machines may be implemented first before the profiled machines.

3.4.5 The Pharmacy

The pharmacy at each of the hospital sites will be the primary driver of this project. They will be the ones who will manage and monitor the operation of the ADMs. They will also be responsible for overseeing the inventory, stocking and servicing of the machines, and for providing technical support when needed.

3.5 The Implementation Plan

The implementation plan of the Omnicell® ADMs is divided into a two-step implementation process. The first step is to implement the Omnicell® ADMs with the non-profiled format. The second step is to introduce the profiled format to units that are using the non-profiled ADMs. The overall goal of the implementation process is to eventually have all of the hospital units use the Omnicell® ADMs with the profiled format. The reasons for the two-step implementation process are: 1) to initially familiarize users with the ADMs; 2) to provide the hospital's IT department time to develop and test out the interface for the profiled system; and 3) budgetary constraints. We will now briefly describe the segments within the non-profiled system and profiled system.

3.5.1 Non-Profiled ADMs

3.5.1.1 OR and PAR with the non-profiled system

The duration of stay in the OR and ER tend to be short. Anaesthetists usually prepare for all of their surgeries at the beginning of their shift by retrieving all required medications for their patients. . The ADMs can help facilitate the medication retrieval process since all medications required are stored in one central location. In addition, the ADMs are easy for nurses or anaesthetists to access during or after surgery.

3.5.1.2 ER with the non-profiled system

The implementation of the ADMs in the emergency rooms will be a fairly easy process. Most medications are already stored in a central location. What may be difficult is deciding which medications should be stored in each ADM and in what quantities. This is a result of the amount of patients passing through ER with different injuries and illnesses. The ADMs will provide nurses with easy access to medications without having to sort through ward stock medications or searching for the narcotic keys. In addition, the ER will only be using the non-profiled format because of the need to access medications immediately.

3.5.1.3 All Hospital units with the non-profiled system

Almost all hospital units within VCHA and PHC will start with the implementation of the non-profiled Omnicell® ADMs. These machines will replace the ward stock cabinets and narcotic cupboards, providing easier, safer, and more secured access to medications.

The introduction of the non-profiled system will help familiarize users with the machines and help initiate the adoption and buy-in process.

3.5.2 Profiled ADMs

3.5.2.1 Hospital units with the profiled system

The implementations of the Omnicell® ADMs have taken place in majority of the nursing units at UBCH and VGH. Most of the nursing units have familiarized themselves with the Omnicell® ADMs and are adjusting and adapting it to their workflow processes. Most of these nursing units are ready to take the next step, the profiled ADM system. UBCH already has the profiling interface in place however the software application still needs to be tested before implementation.

The profiled system will ensure that nurses only have access to medications that have been prescribed to the patient - i.e. listed under the patient's profile - thereby reducing the chance of selection error. With the profiled system nurses will only be able to access one patient's medication profile at a time. They will no longer have uncontrolled access to medications that have not been prescribed. In order for the Omnicell® to acknowledge that a particular medication should be in a patient's profile, the medication order has to be processed, approved, and entered by pharmacy. But instead of preparing the order and sending it up to the nursing unit, the medication order is made available in the system so that nurses are able to access and retrieve the medication at the appropriate time for administration.

4 FRAMEWORK FOR ANALYSIS: ROGERS' ADOPTION FACTORS

4.1 Adoption Process

4.1.1 Rogers' Model of Adoption

Rogers' adoption of innovation theory provides a framework to identify human responses to innovation/change. The model's five categories exemplify varying degrees of acceptance or rejection behaviours in the adoption process. Refer to the appendices for the responses we gathered from nurses during our interview process regarding the current implementation of the Automated Dispensing Machines. Below is a brief explanation of Roger's model.

1. Relative Advantage

Relative advantage is the degree to which ADMs are perceived as being better than the current process of medication administration. It does not matter so much that the machines have a great deal of objective advantage. What does matter is whether the users perceive the machines as advantageous. The greater the perceived relative advantage of the machine, the more rapid its rate of adoption will be.

Key points:

- How is the technology relative to the status quo
- Advantages as perceived by the user
- Benefits valued by the user
- Relative costs (e.g. learning costs, switching costs) of adoption
- Ease of use
- Immediacy of benefits

2. Compatibility

Compatibility is the degree to which the ADMs are perceived as being consistent with the existing values, past experiences, and the needs of current and potential users. An idea that is incompatible with the values and norms of the current working system will not be adopted as rapidly as a technology that is compatible. The adoption of an incompatible technology often requires the adoption of a new value system, which is usually a relatively slow process.

Key points:

- Need to learn new behaviours
- Need to adapt technology to the current work processes
- Is the technology compatible with current work processes?

3. Complexity

Complexity is the degree to which the ADMs are perceived as difficult to understand and use. Most users readily understand new technologies, while others are more reluctant, which slows down the rate of adoption. New ideas that are simple to understand are adopted more rapidly than technologies that require the user to develop new skills and understandings.

Key points:

- Features of technology are easily communicable to nurses
- Depends on the user's knowledge and comfort level with technology
- Amount of training required to learn technology
- Is the technology user-friendly?

4. Triability

Triability is the degree to which the technology may be experimented with on a limited basis. New products or ideas that can be tried on a small scale and gradually expended will be adopted more quickly than technologies that are not divisible. A technology that is trialable allows the user to learn by doing and represents less uncertainty to the individual who is considering it for adoption.

Key points:

- Ability to try out the machines
- Ability to adopt the machines a bit at a time

5. Observability

Observability is the degree to which the results of the technology are visible to others. The easier it is for users to see the results of the technology, the more likely they are to adopt it. Such visibility stimulates discussion of a new idea among users, which generates interest and attention towards the product/technology and helps ease the adoption process.

Key points:

- Noticeable to users
- Demonstrable to users
- Communicable to users
- Observable by users

5 RESEARCH AND ANALYSIS

5.1 Rogers' Adoption Model for the implementation of ADM

5.1.1 Interviews

We conducted interviews with 30 individuals, including nurse educators, front-line nurses and pharmacy administrators, within the UBCH and the VGH to obtain insights into the ADM adoption process. We realized that the data that we would be collecting from our interviews with nurse educators/clinicians, front-line nurses, and pharmacy administrators would be mainly subjective. Therefore we designed the questionnaires to include more quantitative questions that would provide us with more objective data.

In order to get a better understanding of the adoption process of the ADMs at these hospitals, we developed questionnaires to help us with the information gathering process. Refer to Appendices 6 and 7 for an outline of the questionnaires 1 and 2. After using Questionnaire 1 with approximately 10 interviewees, we found that some of our questions were causing ambiguity and did not generate the in-depth answers that we were looking for. We considered removal of the questions, but in the end decided to add more questions in regards to the information we were looking for to get a more in-depth view of the issue. As a result, we devised questionnaire 2, which helped us cover more grounds and get more information.

5.1.2 Results

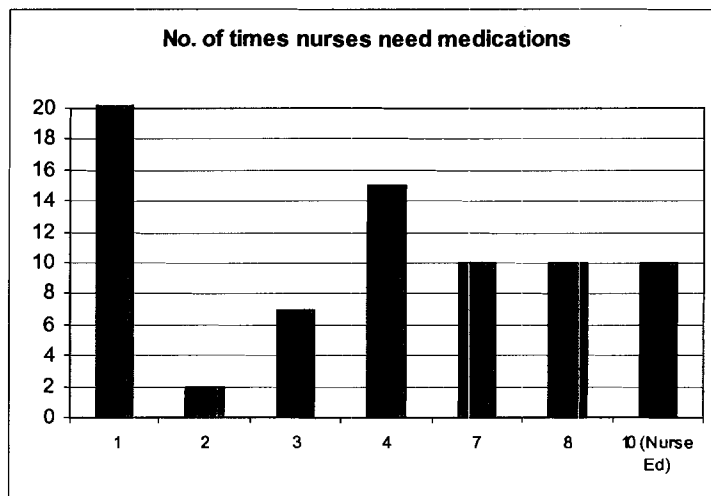
5.1.2.1 Results from the Questionnaires

The results from the questionnaires are presented in Appendices 10-13. Below are some of the findings that arose from some of the questions on the questionnaires.

Questionnaire 1: What is the number of times on average in a shift do nurses have to retrieve medications from the ward stock?

This question was asked to give us a better indication of the number of times nurses retrieve medications from the ADMs on average within a shift. Although the nurses were able to provide us with an approximate number, many of them felt that it was difficult to estimate since this number depended on the nurse-to-patient ratio, which varies throughout the day, the type of patients they were treating, the types of medications that they needed, and the shift they were working.

Figure 1: Number of times nurses need on one shift

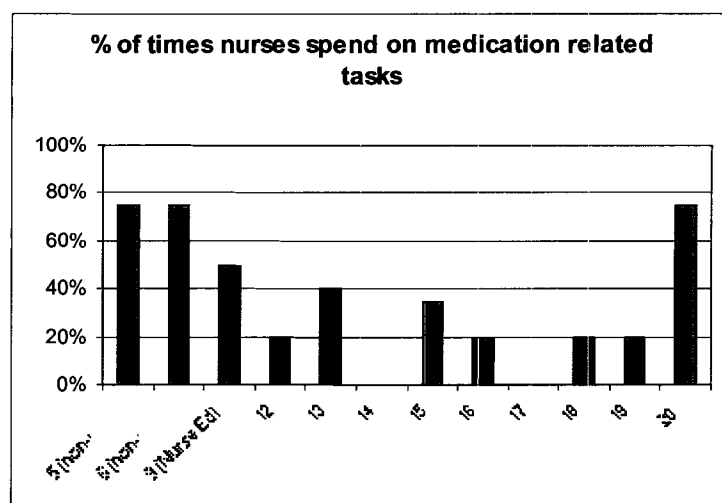


Questionnaire 1: What is the average percentage of time spent on medication related tasks per shift?

This question asked nurses on average how much time they spend on medication-related tasks. Medication related tasks include ordering medications, record keeping, retrieving, and administering medications. This question was meant to provide us with a better idea of how big an effect the implementation of ADMs would have on the nurses' work load.

When we posed this question to the nurses, most responses were: “a lot”. Most of the nurses felt that they spent a substantial amount of their time on medication related tasks. Most of the nurses were only able to roughly estimate a percentage; however, these rough figures did reveal to us, as shown in Figure 2, that on average the nurses spent ~43% on medication-related tasks. The users of the ADMs felt that they spent ~33% of their time on medication-related tasks, and the non-users felt that they spent ~75% of their time. We are not sure why there is such a large difference between the two groups. It could be a result of the ADMs increasing workflow efficiency and thereby reducing the amount of time nurses spent on medication related tasks. The large difference could also be due to the fact that only a few non-users were interviewed and the units that they worked in could just be one of the care units that require more medication-related tasks. A larger sample size will be able to help justify these results; therefore, further research and analysis will have to be performed to verify these findings.

Figure 2: Percentage of time nurses spent on medication related tasks

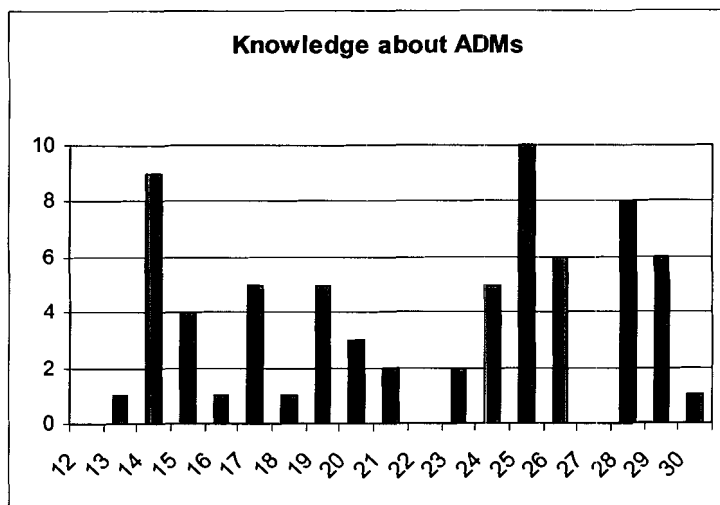


Questionnaire 1: What was your knowledge level about the ADMs before their implementation?

From this question we wanted to determine what the nurses knew about the ADMs before the machines were first introduced at their hospital. We wanted to know whether they had any knowledge or preconceived notions about the ADMs prior to the implementation. We also wanted to find out if management had provided any information to them prior to implementation.

The nurses rated their knowledge level about ADMs on a scale of 1 to 10, with 1 being no knowledge at all and 10 being a high degree of knowledge. The average knowledge level was 3; the average for users was 3; the average for nurse educators was 1 and the average for non-users was 3. See Appendix 14 for more details about the averages. Figure 3 provides a graphical representation of the results. Some of the users might have had a higher knowledge level about ADMs because they had experience working with them in another nursing unit or at another hospital.

Figure 3: Knowledge about ADMs

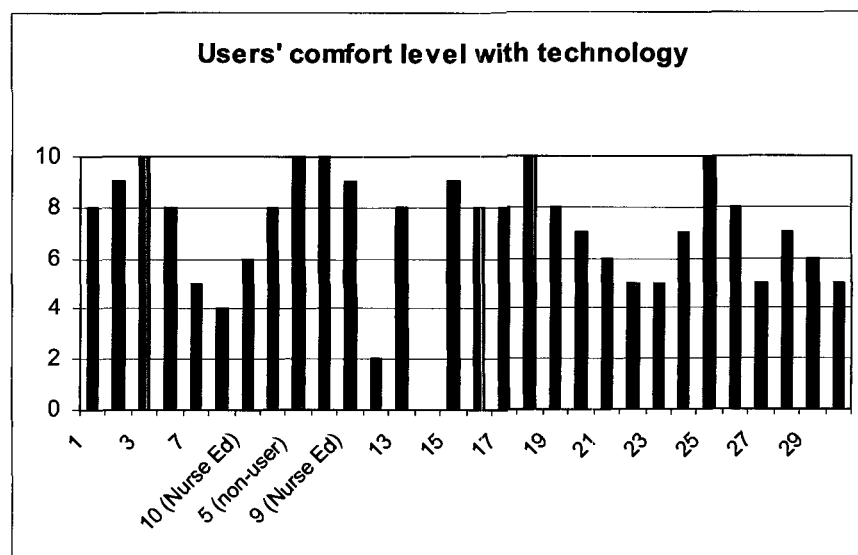


Questionnaire 1: What is your comfort level with technology?

This question asked the nurses how comfortable they were with using new technology or technology in general. The comfort level was rated on a scale of 1-10, 1 being not comfortable at all and 10 being very comfortable.

We understood that the responses from this question would be very subjective since it depended on how the interviewees perceived themselves. In addition we anticipated that the ratings would fluctuate depending on the age of the interviewees and the nursing unit they worked in (depending on the number and type of patients in the units and the length of stay of the patients). For example, some units use a lot of high-tech. equipment, therefore nurses in those units will be more exposed to technology and as a result feel more comfortable with them. We realized that the younger nurses would tend to be more comfortable with technology, while the older nurses would usually be more apprehensive. We found that most of the nurses were fairly comfortable with technology. As we can see in Figure 4 and 9, and also Appendix 14, the average comfort level with technology was 7. We also found that the averages for the users and the non-users were very similar, the average for users was 7 and the average for non-users was 8. This similarity is expected because the use of one piece of technology doesn't change a general attitude, but this is a good basis for other analyses, since this proves that differences in other aspects of the technology will not be due to the underlying differences in comfort with technology.

Figure 4: Comfort level with technology

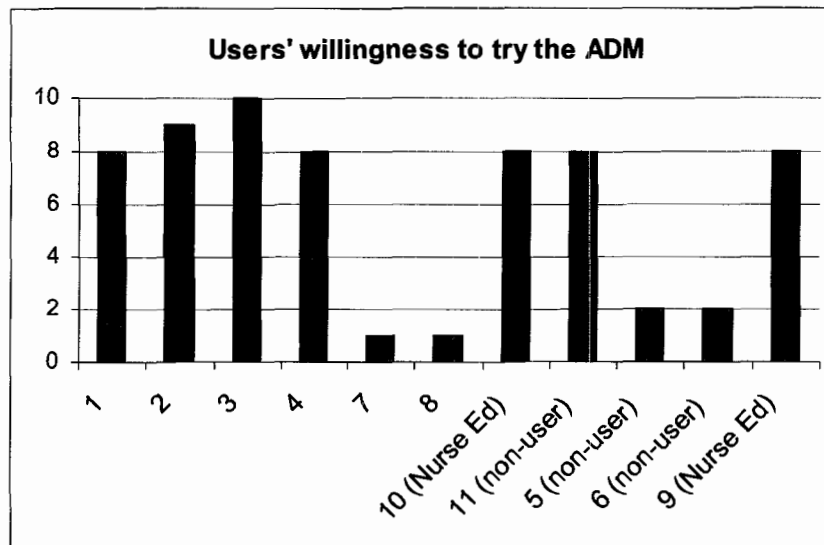


Questionnaire 1: What was your level of willingness to try the ADMs?

This question asked the nurses how willing they were to try the ADMs. Their willingness was again rated on a scale of 1-10, with 1 being not willing at all and 10 being very willing. As seen from Appendix 14 and Figure 9, the average level of willingness to try was 6, but we found that the averages varied among the user groups. The nurse educators had an average of 8. The users, with the exception of two, all rated their willingness to try the machines relatively high, with an average of 6 for the group and an average of 8 without the two exceptions. The two exceptions may be due to the fact that these two users with low ratings were older nurses that were more set in their ways of practising or that they were more skeptical from past experiences with technology. The users may have biased their ratings after reflecting on their current practises with the ADMs and past practises without the ADMs. In other words, the users who had positive experience with the ADMs may have rated their willingness higher than those who had negative experiences. Again further research and analysis is needed before we can ascertain the reasons.

Two of the three non-users rated low on the level of willingness to try. This may be due to the fact that these two non-users have limited knowledge about the ADMs and have only been exposed to the negative attributes of the machines (via word of mouth). See Figure 5 below.

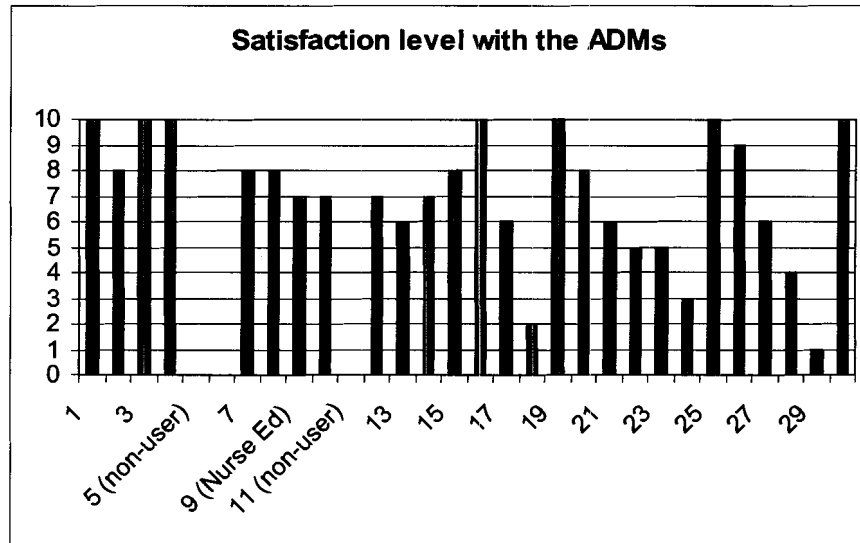
Figure 5: Level of willingness to try the ADMs



Questionnaire 1: Overall how satisfied were you with the ADMs?

This question asks the nurses how satisfied they were with the implementation and functions of the ADMs. The satisfaction level again was rated on a scale of 1-10, 1 being not satisfied and 10 being extremely satisfied. Most of the nurses who used the machines were quite satisfied and 10 being extremely satisfied. The average satisfaction level was 7 and 7/27 were extremely satisfied, from Appendix 14 and Figure 10. However there were 4 respondents who were on the “unsatisfied” end of the scale. During our interviews we noticed that most users were happy to have the ADMs and liked using them, however there were just a few that did not like the machines at all and seems to not like any type of change, these users could be the “unsatisfied” users represented here. See Figure 6 below.

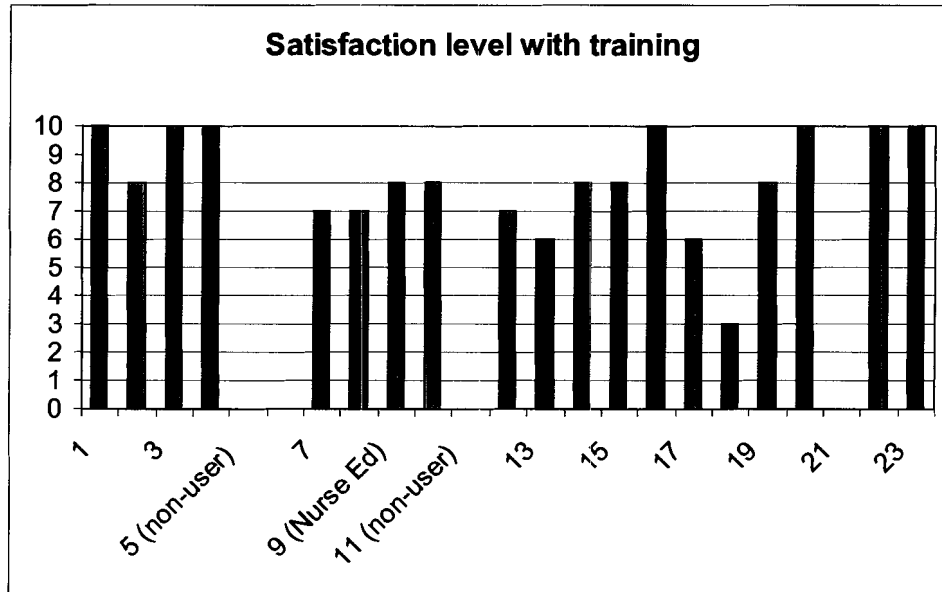
Figure 6: Satisfaction Level with the ADMS



Questionnaire 1: How effective was the training and support?

This question asked the nurses to rate the effectiveness of the training with the ADMS. The users of the ADMS and the nurse educators were asked if the pre-implementation training they received was adequate. The users and nurse educators rated the adequacy of the training on a scale of 1-10, 1 being useless and 10 being very useful. Most of the users were very happy with the training and support they got pre-implementation and the first few weeks after 'go-live' (initial implementation). From Appendix 14 and Figure 10, the average rating for the training and support was at least 8 for all three groups, the users, non-users, and nurse educators. Nurse 18, had one of the lowest satisfaction scores and also had the lowest training effectiveness score. Further analysis of the relationships between satisfaction with ADMS and training follows in section **5.1.2.4 Correlations**.

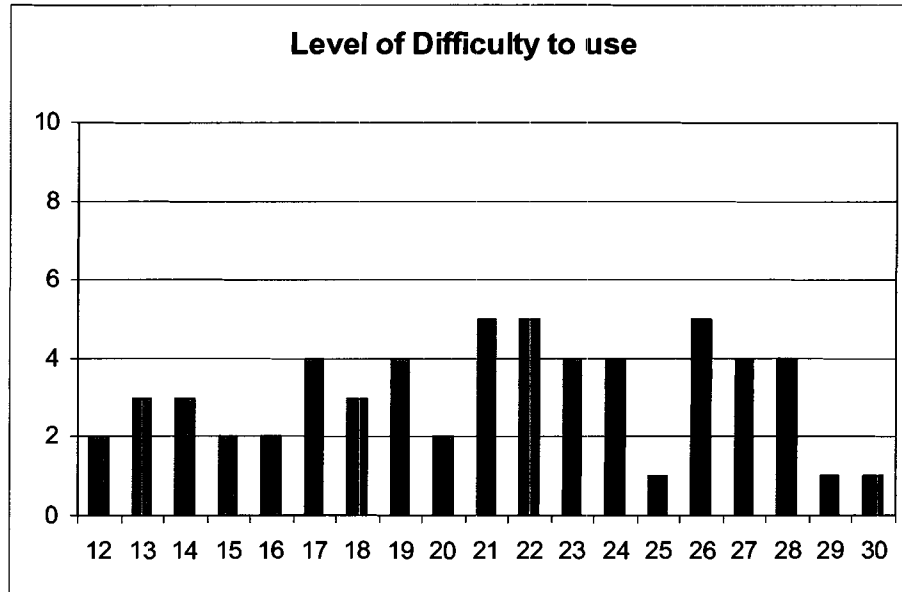
Figure 7: Effectiveness of the training and support



Questionnaire 2: How difficult was the ADMs to use?

This question asks the nurses how difficult did they find the ADMs were to use. It asks them to rate the ease of use of the ADMs on a scale of 1-10, 1 being very easy and 10 being very difficult. The results of this question were collected from questionnaire 2 and the ratings were collected from the uses of the ADMs. Most of the users felt that the ADMs were relatively easy to use, the average ratings for ease of use were 3 and none of the users gave a rating of more than 5. See Appendix 14 and Figure 11.

Figure 8: Ease of use of the ADMs



5.1.2.2 Average results

The results and graphs below present some of the average outcomes that were generated from the data collected with the two questionnaires and some of the common themes that we found from the data that was collected.

Figure 9, shows a graphical representation of the average knowledge of about the ADMs, average level of comfort with technology, and average level of willingness to try the ADMs. This graph shows the difference between the different user groups. Refer to Appendix 14 for more details.

Figure 9: Average ratings for pre-implementation questions

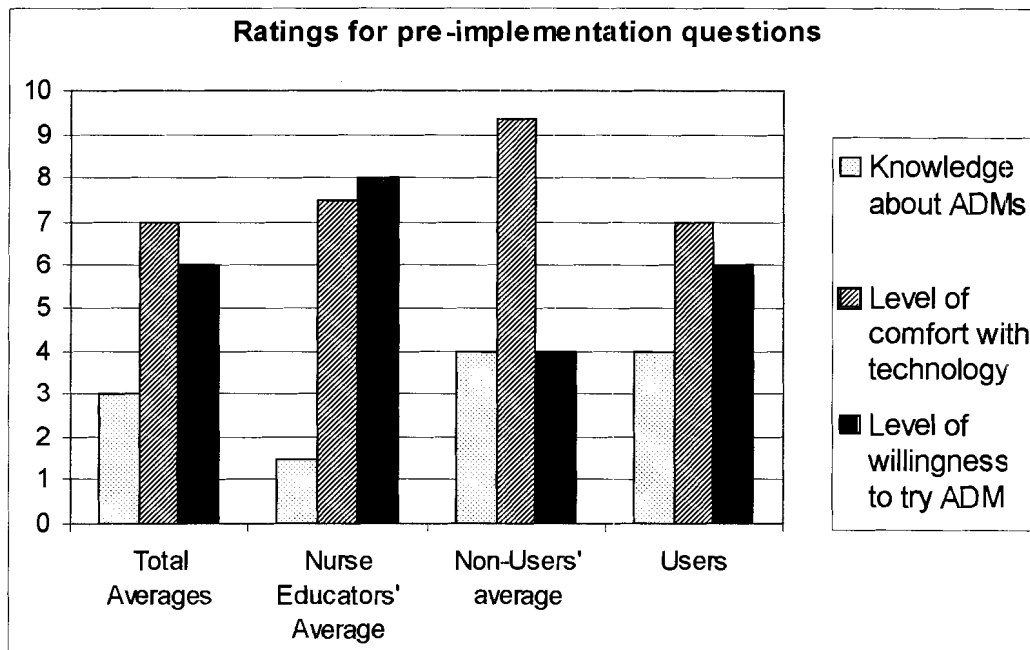


Figure 10, shows a graphical representation of the average satisfaction level with the ADMs and the average satisfaction level with the training and support among the different groups. The average knowledge about the ADMs for the non-users is higher than the users, this is expected since the non-users are currently witnessing the implementation and learning more about the machines from the current users.

Figure 10: Average ratings for post-implementation questions

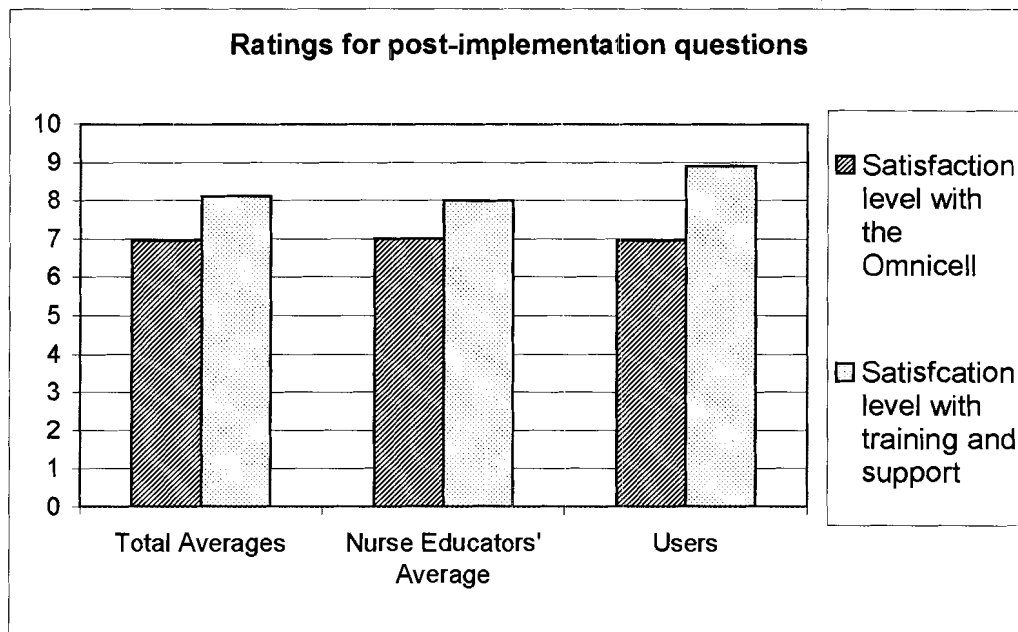
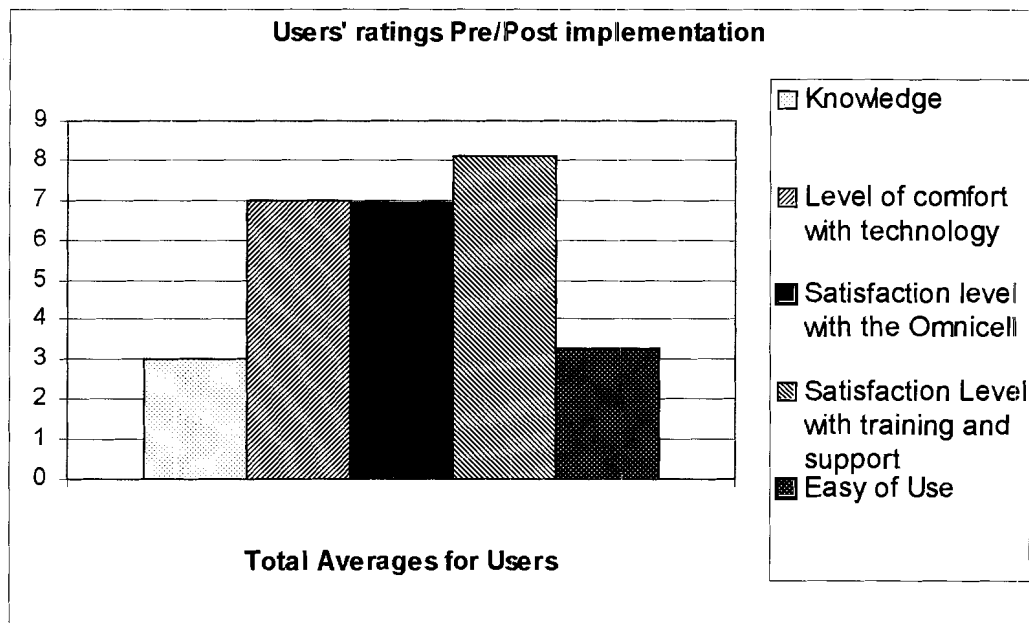


Figure 11, is a graphical representation of the average ratings for the questions that were asked on knowledge level of the ADMS, comfort level with technology, satisfaction level with the ADMs, satisfaction level with training and support and ease of use in questionnaires 1 and 2. We also notice a low rating value for the ease of use, which implies that the machines are fairly easy to use for all users.

Figure 11: Users' average ratings Pre/Post Implementation



5.1.2.3 Frequencies

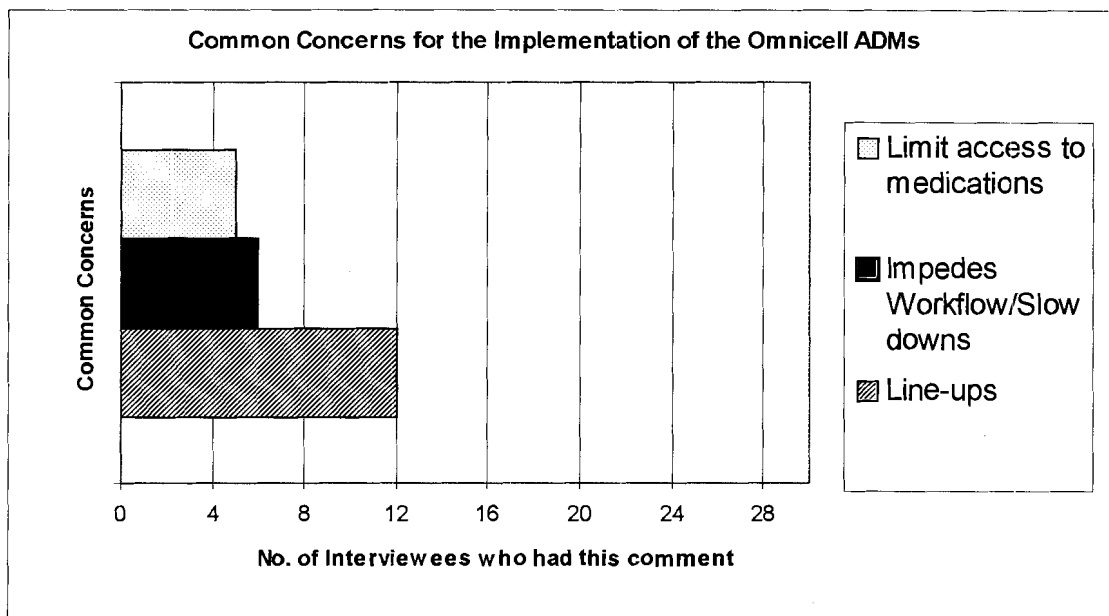
Concerns with ADMS

From the data collected in our interviews, we discovered three dominant concerns: 1) limited access to medications, 2) impede or slow down workflow, and 3) line-ups. In particular, line-ups were the foremost on the nurses' minds. Line-ups became a problem during set medication administration times. Nurses would have to wait in line in order to retrieve medications for their patients from the ADMs. Not only was this an issue for users but it was also an issue for the non-users. This was due to several reasons: 1) testimonials from other nurses, 2)

anticipation of extra steps needed to access medications, and 3) comfort with their current work processes.

When asked about how they dealt with the line-ups, the users' responses ranged from performing other tasks to just waiting in line. Some of the users found that they had already gotten used to the wait time and were already finding other things to do or finding ways to work around. Some of the users commented that there was wait time, but it was very minimal and you could always come back.

Figure 12: Common Concerns in the implementation of ADMs

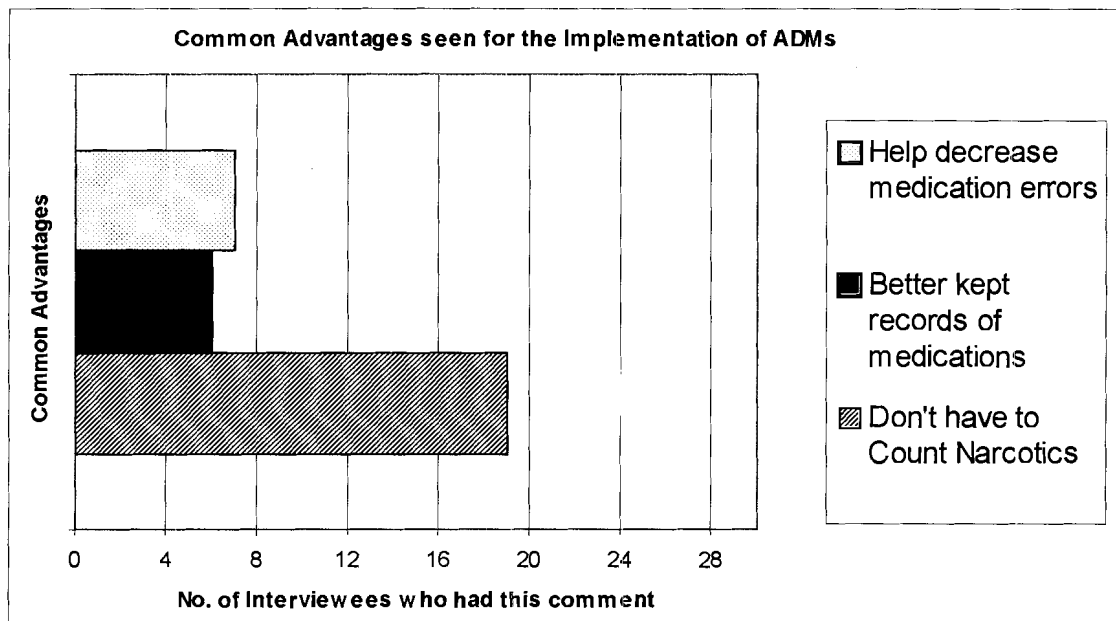


Advantages of ADM's

The most common advantage that both the users and non-users voiced was in regards to narcotic counts. Narcotic counts were no longer required after every shift but only once per week since the machines electronically documents the narcotic usages. Most of the nurses were very happy and felt that it took a lot off their workload to be able to count once a week instead of every shift. Other advantages that nurses commented about the ADMs were that it reduces

medication errors, but most of these nurses also noted that they felt there were very few medication errors happening in their units. Therefore, comments about a reduction in medication errors makes us wonder whether these nurses are actually noticing a reduction in medication errors or is it just an advantage that they heard about and assumed it was happening. The rates of medication errors has proven to be difficult to measure in the past and so the impact on medication errors that the ADMs have, would be subtle and also difficult to measure.

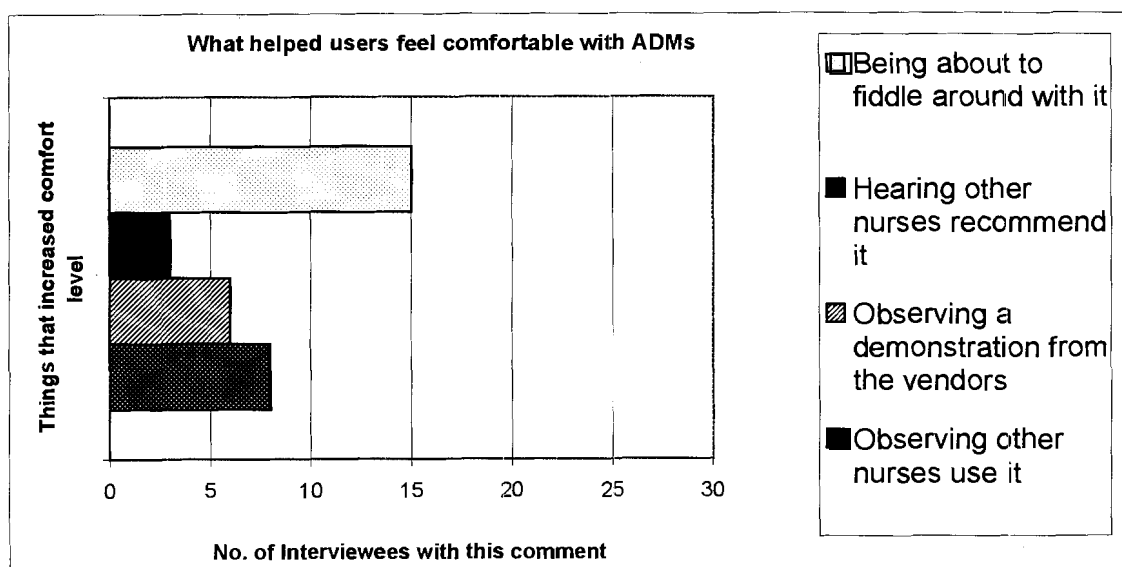
Figure 13: Common Advantages Observed in the implementation of ADMs



Training and adoption

Figure 14 shows us that users preferred more hands-on training and trying it out, than just hearing about the advantages. Most of the users felt that they were sceptical at first, but after they had a chance to use it, they actually liked it. Most of the users felt that it was a process change that they needed to get used to, once they got used to it, it was easy and they liked using it. They were all especially happy about easier medication record keeping and less narcotic counts.

Figure 14: Things that helped users feel more comfortable with the implementation of the ADMs



5.1.2.4 Correlations

Below are some of the correlations that we found among the different items we had the nurses respond to. Refer to Appendix 15 for full details of the correlations between the different items.

Correlation between level of comfort with technology and level of willingness to try ADMs

As you can see from Figure 9, there appears to be somewhat of a correlation between “level of comfort with technology” and “level of willingness to try ADMs.” From Figure 9 and Appendix 11, we can see that the “level of comfort with technology” is high usually when the “level of willingness to try ADMs” is also high for users and nurse educators. It appears that users who felt comfortable with technology are more willing to try the ADMs, than those who felt apprehension and fear with technology, the correlation coefficient between these two attributes was 0.38.

However, again from Figure 9, there appears to be a weak relationship between “level of comfort with technology” and “level of willingness to try ADMs” for the non-users. Out of the

three non-users, one non-user scored high on both the comfort level with technology and willingness to try the ADMs. He embraced the use of the ADMs and foresaw the potential benefits the machines would bring – i.e. reduction in medication errors. Whereas in the case of the other two non-users, although they perceived their comfort level with technology was high, they were not positive about the ADMs. These two non-users only saw the negative aspects of the ADMs and anticipated that the machines would be time-consuming and impede their workflow process.

Correlation between satisfaction level with training and satisfaction level with ADMs

One of the strongest correlations in our results is the correlation between the “satisfaction level with training” and “support and the satisfaction level of the ADMs” (correlation = 0.64). The “satisfaction level with training” and “support and the satisfaction level of the ADMs” were high for all of the user groups. From our interviews, training and was an important aspect in creating buy-in from the users. The more training the users received, the more comfortable and self-assured they felt with using the ADMs, thereby generating a more positive experience with the machines. As mentioned before, most users felt that the 1-hour training sessions were adequate but more hands on training were preferred. Users that were apprehensive about using the machines had a positive response once they tried using the machine. In addition, technical support was also crucial in creating buy-in. Users were reassured with the notion that technical support was a phone call away. They appeared to benefit from the in-service support provided by the Omnicell® Systems Administrator. The continual knowledge management and training mitigated any uncertainties users may have had with the machines.

Adequate training can create a positive experience with the use of the ADMs thereby increasing the satisfaction level with the ADMs. Training not only educates the users on the use of the ADMs but also on the benefits of the machines. We found that many users perceived the

ADMs as electronic storage units that helped to better organize the ward stock medications but acted as an impediment in quick access to medications. Training and floor level problem solving would be an opportunity to negate these mistaken notions. In addition, training will not only provide the users' with the necessary skills and knowledge but also the confidence and capability to operate the machines.

Correlation between willingness to try and satisfaction with ADM

There appears to be a very strong correlation between the "willingness to try the ADMs" and "satisfaction with ADMs" (correlation = 0.72). This could be due to the fact that users who are more willing to try the ADMs are also more open minded and more keen to learn the features, benefits and use of the ADMs. As a result they developed a better understanding and became more confident in the use of the ADMs. They were more likely to properly use the ADMs, more likely to experience the positive benefits of the ADMs and overall more satisfied with the ADMs.

Correlation between comfort level with technology and satisfaction with ADM

We found from our interviews that there was a positive correlation between "comfort level with technology" and "satisfaction with ADM"(correlation = 0.22). The users that were more comfortable with technology were more willing to try the ADMs and more satisfied with the ADMs. This may be due to the users' ability to embrace the use of ADMs and understand both the benefits and concerns of the ADMs. By keeping an open mind towards the ADMs, the users were better able to learn to use ADMs and adopt them effectively into their work processes.

Correlation between willingness to try and satisfaction with training

There is also a positive correlation between the nurses' "willingness to try the machines" and their "satisfaction with training" (correlation= .30). This maybe due to the fact that these nurses had already accepted the idea of the ADMs but were also more willing to learn how to use

the machines. As a result they may be more likely to pay attention during training and learn more skills and knowledge from these sessions.

5.1.3 Analysis of Adoption Factors

5.1.3.1 Relative Advantage

From our interviews and research, it was revealed that the relative advantages of the automated dispensing machines were different among the different user groups: hospital administrators, pharmacists, and nurses.

Hospital Administrators

From our meetings and various interviews with hospital administrators, a common theme was established: the ADMs were being implemented in the hopes of reducing medication errors. They believed that the ADMs assisted the nurses in choosing the right medications for the right patient, thereby enhancing patient safety. As we have mentioned earlier, approximately 40% of medication errors occur during administration and only approximately 2% of these errors are discovered and prevented prior to administration. This is where the ADMs will play a role. The ADMs will help ensure the 5 Rights of Patient Care by directing the nurses to retrieve the right medication for the right patient.

Pharmacy

In our meetings with the pharmacy representatives, they expressed that the relative advantage of ADM's for the pharmacy department is the increased efficiency in regulating the inventory both in the pharmacy and the nursing units. In addition, it will provide a more effective delivery and restocking of medications. As a result, this ensures that nursing units don't run out of medications or store and use expired medications, it also helps shorten the pharmacy turnaround

times (from ordering to processing to delivering), and encourages a better working relationship between pharmacy and the nursing staff.

Nurses

From our interviews, we discovered that the relative advantages for the nurses were quite different from those of the hospital administrators and pharmacy. The nurses viewed the ADMs as more of a medication storage cabinet rather than a machine that helped enhance the reduction of medication errors. We found that from the question regarding their view of the rate of medication errors in their unit, the majority of the front line nurses were unaware of making any medication errors. "Mistakes never happen...we always double check..." Of the 27 front-line nurses interviewed, most of them didn't believe that medication errors were an issue in their unit. Instead they believed that the ADMs were installed for better storage of medication helping to reduce clutter in the ward stock cabinets.

Majority of the nurses felt that the ADMs impeded their workflow because it not only acted as a barrier to their medications but it also resulted in them having to perform more steps to access the medications.

However, some of the nurses did express advantages with the ADMs. The biggest advantage that all the nurses expressed was the documentation and tracking of narcotics. Because the ADMs performed the documentation for them, they no longer needed to fill out paperwork when retrieving narcotics. Not only did this facilitate easier access but it also saved time. In addition to the documentation, the ADMs required the nurses to perform a count back each time they accessed a narcotic medication. This ensures that the narcotic counts are accurate at all times and narcotic counts were no longer required after each shift. Another big advantage of the ADMs for the nurses is that they didn't have to go around searching for the narcotic keys. Most nursing wards had 1 set of narcotic keys to access the narcotic cabinet. Nurses sometimes spend a lot of

time tracking down the narcotic keys. This not only impedes the workflow process but also causes undue stress on the patients. With the ADM in place, nurses can use their own access codes to access narcotics from the machine anytime. During our interviews, an ER manger commented that the ADMs would be advantageous not only for the reasons above but also because it would prevent potential theft of controlled or narcotic medications. Although not mentioned by the front line nurses, 3 of the nurse educators did mention that the ADMs are better able to regulate inventory and ensure the routine restocking of medications.

The nurses also experienced some relative disadvantages with the implementation of the ADMs. For example, line-ups may initially be an issue. To deal with line-ups nurses may decide to take more medications out of the ADMs than they have requested, so that they have extra medications available for later use. Or nurses may decide to take out all of the medications needed for their patients at one time, to avoid having to go back to the ADM or having to wait in line again. As a result, longer line-ups or mix-up of medications between patients may occur.

When the Omnicell® system becomes profiled, another advantage for the nurses would be the turnaround time for medication orders from the pharmacy would be reduced. Instead of waiting for the pharmacy to process, prepare, verify and deliver medications to the units, nurses will only have to wait for the pharmacy to process and verify the medication orders, before being able to access the medications from the machines. This helps to eliminate the waiting time for medications, especially when the pharmacy is closed.

As we can see from this discussion nurses saw advantages quite differently from administrators and pharmacy. This is not a problem as long as the various objectives are achieved and the technology is adopted. One problem with technology adoption in organizations is that when end-users fail to see the benefits to them, they either ignore the available technology or develop workaround strategies to avoid using it. In this case, although the relative advantages

perceived are different for each group, they are compelling enough for each group to facilitate adoption. However, as we discussed earlier in this section, nurses may develop workarounds to avoid the problems of line-ups and can increase medication errors.

5.1.3.2 Compatibility

The implementation of the Omnicell® automated dispensing machines will need to be compatible with the hospital's administration system with patient and medication records, especially when the system becomes profiled. The Omnicell® system should have patients' up-to-date medication information. This means that the information technology department in the hospital will have to work with the vendor, Omnicell®, to integrate the two systems together, so that users will be able to access the hospital's system from the Omnicell®.

We found in our meetings with the nurses that the ADMs would require nurses to learn new skills and adapt to new work processes. We found that the younger and/or more technology savvy nurses were more willing to embrace the ADMs. They found the machines easy to learn and adopt into their current work processes. The older nurses, on the other hand, were more used to the "old ways" of practicing. They wanted easy and immediate access to medications and viewed the machines as a barrier to accessing the medications and impeded their workflow.

In our interviews with 2 non-users, we found that although they scored themselves high with the question about comfort level with technology, they appeared to be uncomfortable with the notion of using the technology. They anticipated that it would be time consuming, require extra steps, and impede in their workflow. Although they understood the purpose of the ADMs, they were not keen on idea of adopting these machines into their workflow.

Line-ups seem to be one of the major concerns that kept coming up in our questionnaires. Nurses are used to going to the ward stock cabinets and retrieving their medication. And because the cabinet is accessible by more than one nurse, line-ups were never an issue. In the case of the

ADMs, only one nurse can access the machine at a time. This becomes an issue during regularly scheduled medication administration times. In addition, waiting for the machines may be more of a problem in some units than others, since some units administer medications to their patients at certain set intervals and other units administer medications only when needed. For example, in units like the ER, medications are administered to patients on an as needed basis, so most nurses are retrieving medications at different times, thereby avoiding the line-up problem altogether. Hence compatibility with current work processes is something of an issue. Resolution to these problems requires changes to work processes likely determined at the unit level itself.

Line-ups may also become an issue depending on how comfortable the nurses are with the ADMs. Nurses who are unfamiliar and unable to use the machines will take longer to retrieve their medications. This may pose a problem if many nurses are waiting to access medications at the same time. In addition, the line-up problems will also be more prominent in units where there are student or training nurses since these nurses will be less familiar with the technology. .

5.1.3.3 Complexity

The Omnicell® system will not be a very complex system for hospital administration and the Omnicell® vendor will help support the implementation of their system with the hospital's IT department. Pharmacy and pharmacy technicians will have to act as technical support for the users (nurses) and learn how to stock and solve the day-to-day mechanical problems with the machines. Pharmacy technicians will be responsible for stocking and restocking the correct medications into the machines when needed. They will also need training on how to fix machine jams and other malfunctions for the users. Hence for the pharmacy and pharmacy technicians the complexity could be considered high.

For the nursing staff, the ADMs are not very difficult to learn and use. Each screen provides easy to follow instructions that guide the user to the next step. There are also flip charts attached to the machines that users can easily access and follow when they need help. A majority of nurses that we interviewed found the machines relatively easy to use. This was especially the case when they are retrieving medications from the machine. They became more proficient as they continued to use the machines. However, it did pose a problem when the nurses were required to correct discrepancies and return medications. Part of the reason was because these functions were hardly used and therefore the action was not reinforced as much. This suggests that experience helps reduce complexity.

In our questionnaires, we also found that the 1-hour training sessions were adequate for the nurses however we believe more hands on training would be preferable. We believe that the hands on training will help to reinforce what the nurses learned and enable them to feel more comfortable about using the machines. As the nurses learn by using (especially the more seldom used functions), they may have more questions and other concerns that will need to be addressed. This is where on-site support in the early stages of implementation and follow-up discussion would be useful and help adopt this new technology.

5.1.3.4 Triability

In many of our interviews we found that the nurses were given an opportunity to try out the ADMs. They were given the chance to try and test the machines before their initial training. This helped the nurses become more comfortable with the machines. In addition it allowed the nurses to adopt the machines a bit at a time, which we found more effective in enabling the adoption process. Instead of overwhelming the nurses with a steep learning curve they were able to take smaller steps in the learning process.

5.1.3.5 Observability

We found that there were benefits to the machine that the nurses regarded as important. One important benefit that most nurses brought up was the reduction of the narcotic count from the end of each shift to once a week. Because most nurses found that the narcotic counts were a chore, most nurse educators promoted this feature to create buy-in. This feature was so easily communicable, demonstrable and observable to the nurses that it quickly became one of the noticeable benefits of the machines.

5.2 Issues/Concerns

In an effort to better promote and implement the Automated Dispensing Machines in various other VCHA and PHD hospital sites we performed an Issues/Concerns Analysis in the hopes of helping them identify areas or opportunities for improvement. The goal is to identify possible issues/concerns that nurses may have with the ADMs and assign appropriate actions to help reduce or prevent their occurrence. See Appendix 8 and Appendix 9 for the summarized charts.

5.2.1 Non-Profiled Machines

Issues/Concerns Line-ups was one of the most common concerns that came up during the interview.

Failure Causes Line-ups tended to be more of an issue initially when the machines were first implemented.

Older nurses, nurses who feared or hated the idea of using the machines, or nurses who lacked technology savvy tended to struggle with the use of the machines and took longer when retrieving medications.

Student nurses, who were unfamiliar with the use of the ADMs, also seemed to be a source of the line-ups.

Nurses who tended to access the machines less frequently were less familiar with the machines and as result also caused line-ups to occur.

Failure Effects

Nurses were more likely to retrieve more than the quantity specified.

Nurses would take out all the medications they needed under one patient's profile instead of signing in to each patient and retrieving only the prescribed medications for each.

Actions to Prevent or

Reduce Occurrence

of Failure

Educate and inform nurses that initially there will be line-ups but as they get used to ADMs line-ups will dissipate. The line-up problem will be specific to each unit and solutions for this will have to be worked out on a case-by-case basis.

Educate the nurses on the benefits; by retrieving medication under each individual patient when the system is profiled will not only resolve the line-up problems but it will also ensure accurate documentation of the medications administered to each patient. Audit errors in medication.

Provide in-service support to continually train and assist users with the machines.

<i>Issues/Concerns</i>	Casual nurses/student nurses
<i>Failure Causes</i>	These nurses may either have no experience with the technology or may not have regular interaction with the machines
<i>Failure Effects</i>	<p>Nurses may be unable to access medications from the machine causing them to pick up bad habits, such as signing out all medications under one patient or removing a larger quantity of medication than requested. This may result in an inaccurate inventory or medications running out.</p> <p>Patients may end up receiving medications that are not prescribed to them.</p>
<i>Actions to Prevent or Reduce Occurrence of Failure</i>	<p>Ensure proper training is provided to all nurses.</p> <p>Ensure a nurse educator is on hand to help train and guide the use of the ADMS.</p> <p>Ensure at the initial implementation that an ADM System Administrator is available in case any problems, issues, or questions should come up.</p>

<i>Issues/Concerns</i>	Removing medications from ADMs without following proper sign-out procedures.
<i>Failure Causes</i>	<p>Nurses want to avoid line-ups, especially during set medication administration times</p> <p>Nurses want to increase their work efficiency and avoid having to continually go back to the ADMs to access medications</p> <p>Nurses are having problems adopting the ADMs into their workflow and are finding that the machines impede their workflow.</p>
<i>Failure Effects</i>	<p>Results in an inaccurate inventory, which may result in nursing units running out of medications.</p> <p>Can result in patients not receiving the medication that they need, especially if the pharmacy is closed.</p>
<i>Actions to Prevent or Reduce Occurrence of Failure</i>	<p>Educate and inform nurses about the consequences that may occur when removing a larger quantity of medication than requested.</p> <p>Educate nurses that line-ups might be an issue at the beginning as everyone adjusts and familiarize him or herself with using the ADMs.</p> <p>Educate nurses to retrieve medications for just one or just a few patients at a time. This will enable the line-ups to move quicker and also ensure</p>

that the right medications are being administered to the right patient, since the nurses will only be handling one or two patient's medications at one time.

<i>Issues/Concerns</i>	ADMs are a barrier to medication access.
<i>Failure Causes</i>	Nurses view the ADMs as a physical barrier to medication access. Nurses feel that ADMs brings about extra steps in medication access.
<i>Failure Effects</i>	Results in nurses creating “workarounds” to avoid using the machines The workarounds ultimately defeats the purpose of implementing the ADMs, which is reduction in medication errors.
<i>Actions to Prevent or Reduce Occurrence of Failure</i>	Educate nurses about the consequence of the workarounds. Educate nurses that ADMs help to reduce medication errors. Audits can be conducted before and after the implementation of the ADMs to prove to nurses that medication errors have reduced.

5.2.2 Profiled Automated Dispensing Machines

Most of the issue/concerns that were introduced with the non-profiled system may also apply to the profiled system, with the addition of the following.

<i>Issues/Concerns</i>	Emergency/STAT orders will become an issue in a profiled environment.
-------------------------------	---

<i>Failure Causes</i>	Nurses are unable to access medications that are not listed under the patient's profile.
------------------------------	--

<i>Failure Effects</i>	Patients will have to wait for medication that is needed immediately.
-------------------------------	---

<i>Actions to Prevent or Reduce Occurrence of Failure</i>	
--	--

	Each nursing unit will be provided a list of override medications that they will be to access under critical or emergency situations.
--	---

<i>Issues/Concerns</i>	Pharmacy's turnaround time from when the medication is ordered to when the medication is provided access or delivered
-------------------------------	---

<i>Failure Causes</i>	Nurses are unable to access medications for patients until pharmacy enters and verifies the order into the patient's profile.
------------------------------	---

<i>Failure Effects</i>	Patient does not receive medication in a timely matter.
-------------------------------	---

<i>Actions to Prevent or Reduce Occurrence of Failure</i>	
--	--

	Increase communication between nurses and pharmacy and implement procedures that will ensure orders are delivered in a timely fashion.
--	--

<i>Issues/Concerns</i>	Converting Non-profiled ADMs to Profiled ADMs.
<i>Failure Causes</i>	<p>Nurses may feel that the profiled system is more time consuming because the nurses are used to the non-profiled system.</p> <p>Nurses are only able to access medications that are listed under a patient's profile.</p>
<i>Failure Effects</i>	Nurses may feel a lack of control from the non-profiled system and become reliant on the override function to access medication.
<i>Actions to Prevent or Reduce Occurrence of Failure</i>	<p>To show and educate nurses that profiled system will save time because the nurses will only be picking medications listed under each patients' profile rather than having to pick medications from a master list</p> <p>Build in a function that requires nurses to enter a reason for the override.</p>

6 STRATEGY AND RECOMMENDATIONS

6.1 Strategy

6.1.1 Overall Strategy

The marketing strategy will be a communication strategy that will positively influence the users' perceptions of the Automated Dispensing Machine, while at the same time address concerns that the users may have. The communication strategy will play an important role in the successful launch and implementation of the ADMs. It will be the critical element that is responsible for communicating the goals of the implementation process to the users and helping nurses adopt the new technology.

The communication strategy will be comprised of two parts: pre-announcement strategy and promotion strategy. There are several reasons for choosing this type of communication strategy. First, a lack of product knowledge creates a need for customers to be educated before the technology is introduced to the hospital. Pre-announcement will pre-empt resistance, be used as a tool to familiarize the users with the new technology, and help to shape their expectations. In addition, it will prevent significant impediment to the adoption process and encourage proper use of the technology. Second, the promotion strategy plays an essential role in the buy-in process. Good communication between the user and the implementers can help ease users' anxiety and concerns about the new technology for the users.

The pre-announcement strategy is a formal announcement made to the users before actually introducing the machines into the hospital. According to Lee and O'Connor (2003), when users perceive a new product requiring substantial learning, pre-announcement with

education oriented messages is associated with higher new product adoption. Pre-announcing will help the hospital develop an initial level of opinion leader support and favourable word of mouth needed to accelerate the acceptance of the new product (Lee and O'Connor, 2003, p.8). In addition, it can also help reduce risks perceived in the product. From the nurses' perspective, the new technology may be associated with fear of unfamiliar product/technology functions, substantial change of workflow processes, and high switching costs, which cause apprehensions and anxieties for the users. Pre-announcement will be beneficial in this case since the technology will require learning and usage pattern adaptation on the nurses' part. Pre-announcement can also help educate nurses about the technology and its functionality creating a sense of familiarity and allowing them to change over with minimal disruption to workflow. In addition, pre-announcement can be used as a tool to educate nurses in regards to medication errors, such as types of errors and rates of errors.

The promotion strategy is used to convey the product appeal. Promotion will help demonstrate the product's attributes and features to the nurses in an objective manner. It will also show the improvements and user benefits the technology could bring to their day-to-day duties. In other words, the objective is to persuade the nurses that this technology will provide significant concrete benefits to them, so that they will be eager to abandon their old ways of doing things. Super-users can be used to help facilitate the process of adoption, as pragmatists tend to better identify themselves with other pragmatists. We are cognizant that when faced with new technology the nurses will simultaneously encounter both positive and negative experiences. The promotion strategy will enable us to play on the positive benefits of the technology and address the negative issues that may impede adoption.

6.1.2 Strategies for the Implementation of Non-profiled ADMs

Through our interviews we found that the nurses were continually expressing several common issues. To ensure the success of this project, we believe these issues need to be addressed before the implementation of the non-profiled Automated Dispensing Machines into other hospitals.

6.1.2.1 Line-ups at the ADMs

One strategy to mitigate this problem would be to educate the nurses that line-ups will initially be a problem as they adjust to the use of the ADMs. However, with continued use, they will become more proficient with the ADMs and the duration of the wait time will be significantly reduced. In addition, the line-ups at the ADMs can be worked out over time as nurses adjust their schedules and workflow to accommodate each other. Nurses could also be informed that the issue with line-ups has occurred with previous implementations and may be an issue during the initial implementation process. However, based on past implementation experiences, the line-ups tend to become a non-issue as nurses adjust or adept the ADMs into their work processes. The key is to inform the nurses that line-ups tend to occur more often during set medication administration times and that they will not be as much of a problem during other times. In addition, it is important to convey to the nurses that this issue may never dissipate entirely but they can work together to come up with strategies to improve the situation. For example, nurses or medical units as a whole can work together to develop and implement a new schedule for medication administration. This new schedule may address the issue by staggering medication administration times, thereby alleviating line-ups directly, and leading to shorter wait times for nurses.

6.1.2.2 Casual/Student Nurses

The issue with casual/student nurses is that they tend to cause slowdowns at the machines due to unfamiliarity and infrequent use of the machines. This can be resolved by conducting additional training sessions to ensure these groups are properly trained.

To solve the problems with new users and slower learners and avoid hold-ups at the ADMs, on-site support by the Omnicell® Systems Administrator can facilitate the training and learning processes. These on-site services can address issues and problems that the nurses are experiencing. In addition, it may be helpful during the pre-implementation and implementation processes that trial machines be available so that the nurses can practice during their breaks or downtimes. This will ensure that nurses not only get help from an expert user but also reinforce their learning process.

6.1.2.3 Improper use of the ADMs

Proper training and education will help avoid improper use of the ADMs. Users need to understand what consequences may result should the machines be used improperly. Proper usage can ensure that the machines function efficiently and effectively. However, in situations where non-compliance becomes an issue, reports can be generated to identify users that are non-compliant. Hopefully by monitoring and following up with users that are non-compliant, it will encourage nurses to use the ADMs correctly.

For example, if a nurse decides to take out more medication than they requested from the machine, the system will not be able to adjust the quantity properly and as a result the machine will run out of medications before the pharmacy system realizes that the machine needs to be refilled. This can have detrimental consequences, as the next nurse who needs the medication will not be able to retrieve it because the machine has run out. It is obvious from this example that small misuses can have a ripple effect and cause bigger problems down the road. Another

example would be when a nurse decides to take out all of the medications needed by his/her patients for that day, instead of retrieving medications for each individual patient at the times they are needed. As a result, the nurse spends a longer period of time at the machine creating a line-up, and the documentation process is also skewed by this action.

6.1.2.4 ADMs as a barrier to medication access

Nurses are used to having their ward stock medications in an unlocked medication cabinet where they can just grab their medications and go. However with the implementation of the ADMs, nurses will have to first punch in their access code, identify the patient, and then identify the medication before they can actually access the medication. Some of the nurses view these extra steps as a barrier to retrieving medications. In order to resolve this mentality, nurses need to be educated about the benefits of the system and how it will facilitate their processes. It should be pointed out to them that it would probably take the same amount of time for them to find their medications in the ward stock cabinet and prepare them, as it would take them to access the medications from the ADMs. In addition, the advantage of the machine is that it will help guide them to the proper location of the medication, ensuring that they retrieve the right medication for the right patient. It may also be beneficial to educate the nurses on medication errors and how the ADMs will help in reducing medication errors.

Training and information sessions can be used to show nurses that the machines are not going to be a barrier to their work flow, it will actually help and speed up their work processes once they get past the initial learning curve. In addition, it will help reduce medication errors. Peer –training and discussion sessions can also be useful. Super-users who have already adopted the ADMs can identify any benefits or issues that they have encountered with the ADMs and how they went about dealing with them.

6.1.2.5 'Down-time' and breakdowns of the ADMs

Pharmacy has been given the responsibility of maintaining the ADMs. There needs to be a back-up plan in the event that the machines break down. In addition, support should be provided to the nursing units at all times so that nurses are never left without access to medications. It would be beneficial for the nurses to have an Omnicell® Systems Administrator on site to help with training, and in-service support.

Back-up plans and medication kits should also be prepared in case the machine malfunctions, the pharmacy is closed, and the Omnicell® Systems Administrator is not available. This will ensure that patients are never left without medications, especially at non-peak times.

6.1.3 Strategy for Transition from Non-profiled to Profiled ADMs

The issues stated above may continue to be issues that nurses will face with changing from the non-profiled to the profiled system. However, we do anticipate from our interviews that a few additional issues may also arise in the profiled environment.

6.1.3.1 Converting from Non-profiled to Profiled

The conversion from a non-profiled system to a profiled system will require adjustments to the nurses' and the pharmacy's work processes. Nurses will not be able to access medications unless they are listed in the patient's profile on the Omnicell® (after pharmacy has entered and approved the order in the system). Nurses may resent that they cannot access medications for their patients when they need them and become reliant on the override feature to retrieve needed medications.

Nurses need to be educated that the main benefit of a profiled system is getting the right medication to the right patient. They need to be educated that medication administration errors do

occur, and that very few errors are caught, and they themselves are the last check before the medication is given to the patient. They need to be made aware that in the profiled system, medications can only be retrieved if they have been assigned to the patient and appear in the patient's profile. This ensures that the patient receives the right medication, the right dose, at the right time, with the right route of administration.

In order to deter the overuse of the override function, a reason must be provided each time this function is used. The tracking system allows the nurse managers or clinicians to follow up with the user or determine the reasons for the override.

6.1.3.2 ASAP/STAT medication turnaround time

In critical situations, it will be vital for nurses to be able to access ASAP/STAT medications as soon as possible. The pharmacy will have to make changes to their current work process to ensure that the ASAP/STAT medications that are available in the ADMs gets priority processing, this will allow nursing to have access to the medications as soon as possible to avoid any frustrations or delays. The pharmacy and the nursing units should also work on ways to better communicate problems with accessing and getting medications. Nurses should be instructed to double check with pharmacy if possible before they proceed with the override function.

However, if for some reason pharmacy is unable to process and check the order and the patient is in serious need for the medication, nurses are given the ability to override the system for certain medications, provided they give a legitimate reason for the override. Nurses should be using the override function, as their last resort for getting medications from the ADMs when patients are in immediate need for the medications. Nurses should not rely on the override function to get medications whenever they want them, and a legitimate reason should be provided each time the

override function is used. The system will also be able to provide reports on the frequencies of the overrides to monitor whether other procedures need to be put in place.

6.2 Recommendations

6.2.1 Pre-implementation

More educational approaches should be taken in the implementation of the ADMs. Users should be provided with information sessions to familiarize them on the use of the machines and also to encourage buy-in. We found from our interviews that education was the key to creating buy-in from the users. The more the users understood the needs for the ADMs, the more willing they were to invest their time in learning to properly use the machines. It was revealed during our interviews that the majority of the nurses regarded the ADMs as an electronic storage device for medication storage. It never occurred to these nurses that the machines would also aid in reducing medication errors.

In addition, the nurses need to be educated on and made aware that medication errors do exist and some of the common errors that happen. We believe that issues such as the rate of medication administration errors, ways of preventing these errors, and ultimately how the ADMs will help prevent and reduce errors and as result enhance patient safety should be addressed prior to, during, and post-implementation of the ADMs. Therefore we recommend:

1) Information Sessions

We suggest that VCHA and PHC institute a series of Omnicell® information sessions. They should be transparent in their approach to providing information, showing that the implementation of the ADMs is designed to facilitate the nurses' workflow processes and enhance patient safety. Here management can take the opportunity to inform the nurses about the ADMs to alleviate fears concerning the unfamiliar product, how it may affect

workflow processes, and the switching costs, such as the learning that will be required and the challenge of adapting the current workflow to include the ADMs. It will also be an opportunity to educate nurses on the technology – i.e. the functionality of the technology, familiarity with the technology and adaptation of the technology with minimal disruption to workflow – and on the realities of medication errors. In addition, it will also provide nurses the opportunity to ask questions and bring up issues/concerns that they anticipate. By addressing the questions and concerns, management can help prevent resistance to adoption and proper use of the technology.

2) Training Sessions

We advise that VCHA and PHC provide hands-on training sessions to provide nurses with the necessary skills to operate the ADMs. The learning curve may vary among the nurses depending on their comfort level with technology, their openness to new technology, and their ability to learn and adapt technology. Management must be cognizant of the negative effects that new technology may have (e.g. high switching costs, risks perceived by the users, and increased investment of time to learn new behaviours), and the uncertainty that users may experience.

Nurse educators should be included in the training process to provide “like me” referents to front-line nurses to encourage adoption. In addition the nurse educators are better able to understand the trials and tribulations that the nurses will experience with the ADMs. The training sessions should provide nurses with the opportunity to experience first hand the benefits of the ADMs and how the ADMs will assist them in providing better patient care. By providing hands-on experience with the machines nurses will be able to see the value of the machines and gain some confidence and proficiency in using the machines. It

will also allow the nurses to experiment with the machines, thereby alleviating resistance and fear, and enriching the learning process. In addition, hands-on training helps the nurses reinforce what they have learned from previous information sessions to promote confidence and use of the technology.

- An audit should be conducted on the medication process to identify the numbers and types of medication errors that occur.

Our findings demonstrate that front-line nurses are unaware that medication errors are a big problem. The audit it will help identify the types of errors and the rates that they occur and help to educate nurses about the problem.

- Failure Mode and Effects Analysis

We highly recommend a failure mode and effects analysis to help understand what the risks are post-implementation and educate the nurses about these risks. This would be best achieved through generating a multidisciplinary group that not only includes management but also front-line users from different nursing units. See Appendix 23 for an example of a failure mode and effects analysis table.

6.2.2 Post-implementation

- Perform a post-implementation follow-up.

Post-implementation Follow-up

The idea of evaluation/follow-up is to determine how satisfied the nurses were with the pre-implementation process and address any issues or concerns that may have come up during or after the implementation process. Management can achieve this by:

- *Encouraging feedback from front-line nurses*

Users are more likely to buy into a product if they are given a chance to provide their input. This was evident from the responses we received with our first two questionnaires. Therefore we recommend that management continue to gather input from nurses. We have formulated a revised questionnaire, which can be used to get more feedback from the current users and non-users of the ADMs. This revised questionnaire (see Appendix 22) can be used to gather the necessary information to help 1) identify and promote the benefits as perceived by the nurses and 2) identify and address the concerns that may come up pre-implementation and post-implementation of the ADMs. . This feedback can also identify referent nurses (i.e. “Users like me”) that other nursing staff can look to as referents and “consultants” to answer questions. Ideally if nurses see other nurses like them adopting and embracing the ADM’s they may be influenced that it will work for them too. Referents that are more “like me” are among the most powerful influencers.

- *Encouraging feedback from nurse educators, clinicians, and managers*

Although they may not be day-to-day users, nurse educators, clinicians, and managers do receive feedback from their staff and are made aware of issues or concerns that may come up with the ADMs. In addition, they are in a better position to be objective and put forth solutions to deal with the problems. Nurse educators and managers can also, for example help with deciding which medications to stock and list as override medications, because they work in the unit and are aware of the issues specific to the unit. Providing nurse educators and managers with medication usage reports from

the Omnicell® will help them understand what is going on and what is needed in their units.

- *Encouraging feedback from pharmacy*

The pharmacy department will also be affected by the implementation of the ADMs, especially when the machines are converted from non-profile to profile. By taking a more proactive approach and anticipating issues that may come up in the pharmacy, management can ensure a smoother implementation process.

These actions will send users the message that the implementers care about users' input and how these machines will impact their workflow processes, further helping the buy-in process. It will also allow management to address or resolve any unanticipated issues that may come up during the implementation process.

- Follow up strategy for non-compliant nurses – strategy for identifying non-compliant staff and how they should be handled. It is important to demonstrate that VCHA and PCH are committed to the adoption and implementation of the ADMs. Otherwise non-compliance can spread causing workarounds to dominate or staff to revert to earlier processes.
- On-going knowledge management is provided post-implementation of the ADMs.

We highly recommend on-going knowledge management. On-going knowledge management will not only continue to alleviate resistance and fear, but also help create buy-in and encourage the nurses to use the machines properly. In addition, it will enable on-going development, address immediate needs of the nurses, provide the necessary

tools to operate the ADMs, facilitate a learning environment, and create an atmosphere of openness and trust to promote better performance.

- Dedicated technical support should be provided for at least 2 weeks after “go-live”(initial implementation).

Dedicated support should be available during the “go-live” period to ensure proper use of the machines, address any issues that may come up, and provide guidance and support when needed. A learning curve is to be expected but this may vary among nursing units. By providing the nurses with technical support, it will encourage the nurses to use the machines more regularly, which will reinforce their learning process and enable them to be become more proficient.

- An Omnicell® Systems Administrator is made available at every site.

The Omnicell® Systems Administrator will provide technical and in-service support, which includes training, on-going knowledge management, and follow-up evaluations. He or she will act as a source of information for nurses, pharmacy, and hospital administrators.

- In-service support

We highly recommend in-service support be provided to every hospital site. In-service support should be made available on a weekly or bi-weekly basis initially for the first 3 to 6 months after implementation, to ensure that issues and concerns are dealt with and further training is available if needed. We found that the current in-service support provided at the VGH and UB CH has been very beneficial to the users. This extra service helps to address any issues/concerns that come up which may not have been anticipated.

It also helps to provide additional training, address any immediate concerns for the front-line nurses, and provide a method for the nurses to communicate their feedback.

We also recommend that the Omnicell® Systems Administrator include additional services, such as:

- Refresher training

Refresher training should be made available to the various nursing units to address any training or operating concerns. Units that use the ADM on a regular/consistent basis may not need any refresher training, while nursing units that use the ADM or certain functions infrequently may need refreshers to assist them in using the machines properly.

- Fine tuning or customizing the ADMs

Fine-tuning can include services such as customization and providing usage reports to nurse educators and nurse managers.

Customization can be beneficial to nursing units that frequently remove groups of medications on a recurring basis. For example, anaesthetists in the OR frequently remove a certain set of medications for patients in preparation for surgery. The Omnicell® ADM has an option which allows the administrator to set-up pre-set medication kits for the users. The pre-set kits can include any of the common medications that the users might be using for certain routine procedures. Instead of going through the list and selecting each of the medications, the user can select a kit, which gives them access to all of the medications in the kit. The medications for the kits can also be

placed close to each other for easier access. These pre-set kits can facilitate the retrieval process creating buy-in and proper use of the ADMs.

Usage reports can assist the nursing units in fine-tuning their inventory to ensure that the minimum and maximum reorder points are adequate so that the nursing units never run out of any one medication. The reports give nursing educators/clinicians the ability to analyse recurring issues/problems so that actions can be taken to address them.

7 CONCLUSION

We don't believe that this technology will adopt itself. Instead, a successful implementation will need to have users' involvement, which can be achieved by addressing users' concerns, developing easy-to-use interface tools, and refining of usage processes. The implementation process should involve adequate training and provide a supportive environment for the nurses, especially those who may lack the necessary skills or mindset to adopt the ADMs.

It is our belief that ADMs can assist in reducing medication administration errors while improving the availability of patient medication information and nurses' working environments. Hospitals that embrace these technologies and commit the necessary resources for a successful deployment will benefit from a reduction in medication errors. We believe that VCHA and PHC will have great success with the implementation of the Omnicell® ADMs as they continue with their current strategies and processes, and at the same time follow the above-recommended strategies towards the implementation and adoption of these machines.

APPENDICES

Appendix 1: Benefits of the Non-profiled ADMs

Benefits		
Non-Profiled Automated Dispensing Machines		
Feature	Impact	Benefit
"Guiding Light" technology on the drawers	Once the nurse has selected the medication he/she wants the drawer containing that particular medication will unlocked and light up, directing the nurse to the appropriate drawer	Nurses will be retrieving the correct medication for their patients providing that they selected the right medication and that the correct medication was stored in the drawers.
Maximize security for controlled medications and narcotics	Controlled medications and narcotics are placed in locked drawers inside the ADMs, providing extra security. Nurses that have access to the ADMs will have access to these controlled medications at all times.	Nurses will no longer have to share a set of keys to the locked cupboards containing the controlled medications. They don't have to worry about losing or searching for keys when they need access to the cupboards.
Perform narcotic counts once a week rather than per shift	When nurses access the narcotic drawers in the ADMs, the ADM requires that the nurses count the amount of narcotics that are currently there and also enter the amount that is left after they have taken what they need. If there is a discrepancy then the ADM can generate a report of the last user that used that drawer and the discrepancy can be traced back to the users and corrected.	Nurses don't have to do their narcotic counts at the end of each shift. Because they are counting each time, they can fix the problems while they still remember. The machine can generate and track that has used the drawers and can help fix some of the discrepancies.
Helps pharmacy and administration keep a more accurate inventory record	Pharmacy can generate reports from the ADMs regarding usage and inventory of each of the machines in each unit. These reports will also indicate which medications will need to be restocked at each machine and which of the medications have expired in the machine.	Pharmacy can evaluate the reports and use them to help make decisions regarding the inventory levels of the medications. The reports will help pharmacy ensure that the ADMs never run out of medications and any expired medications are removed from the ADMs.

Feature	Impact	Benefit
Each medication is placed into a specific drawer	Instead of having bottles of medications in a medication cupboard, each medication will be packaged in unit-dose packages and placed into a specified drawer just containing that medication.	This will help avoid errors in grabbing the wrong medication and avoiding mixing-up medications.
The drawers in the ADMs are designed to store medications in unit-dose packages	Most of the medications will be packaged in individual unit dose packages, with their name and expiration date printed on the package so that nurses can check right before administration. Ex: 1 tablet/package. Nurses won't have to put the medications into small paper cups to take to patient's bedside.	Unit-dose packages help keep a more accurate inventory, and helps with calculating and reporting usage. This also allows nurses to double check that they are administering the correct medication to the patient at patient's bedside. Instead of putting the medications in to paper cups and taking a risk that they might mix up paper cups for different patients. Nurses can look to see exactly what they are giving to the patient
Secured user access to medications	The medications are placed into a locked cabinet and only authorized personnel will have access to it. Medications will no longer be placed in unlocked medication cupboards	Prevents patients or any unauthorized users to access medications. The ADMs will track its users and their usages to prevent any miscounts and improper uses.

Appendix 2: Benefits of the Profiled ADMs

Benefits

Profiled Automated Dispensing Machines

The features listed above in for the Non-profiled Automated Dispensing Machines will also apply to the Profiled ADMs with the following additions

Feature	Impact	Benefit
Access only to one particular patient's actual medication profile at one time	When nurses use the ADMs and select a particular patient, they will only have access to this patient's medication profile. Therefore, only medications that have been prescribed to this patient and have been approved by the pharmacy will show-up on this list of medications. Nurses no longer have access to all the medications in the machine when they bring up a patient's profile.	This helps make sure that the nurses are choosing the right medication and dosages for a particular patient. It also gives nurses a shorter list to choose from when they are selecting the medications. It also prevents nurses from selecting the wrong dosage or strength for medications that come in different strength and dosages.
Nurses have access to the medications in their wards and don't have to wait for pharmacy to bring them up.	As soon as pharmacy enters and approves the medication orders from the units, the nurses will be able to access the medications in the ADMs.	Nurses won't have to wait for pharmacy's next delivery or for pharmacy to send up the medications, they will have access to it in the ADMs and can retrieve from there and administer it to the patients.
Provides nurses with up-to-date medication information for patients	As soon as pharmacy enters and approves the medication orders from the units, the ADMs will be up-to-date with this information	Nurses will have up-to-date information about the patient's medication changes. For example, change in dose or discontinuation of certain medications, etc...

Appendix 3: Limitations for the Non-profiled ADMs

Concerns		
Non-Profiled Automated Dispensing Machines		
Feature	Impact	Risks
Long list of ward stock medication to choose from	Nurses are more likely to make a medication selection error	Patient receives wrong medication
Human error - i.e. medications can be put in wrong bin, medications can accidentally fall into another bin	Nurses assume that the ADMs are filled properly and dispenses correct medication; therefore they may become confident in the reliability of machine; as a result they do not double check medication to ensure that it is indeed the medication requested	Patient receives wrong medication
Nurses may remove a larger/smaller quantity of medication than requested	Inventory of medication is no longer accurate and ADM may run out of medication (s)	Patient does not receive medication Patient is delayed in receiving medication Patient may receive wrong medication
Nurses remove medications ahead of time to circumvent having to access ADMs for the same medication and/or for each patient Nurses remove medications ahead of time to circumvent having to wait in line to use the machines	Documentation of medication administration is no longer accurate	Patient does not receive medication Patient is delayed in receiving medication Patient may receive wrong medication Patient may receive extra dose of medication
Breakdowns may impede access to medications	Nurses can not retrieve medications for patients, this may especially be a problem if pharmacy is closed	Patient does not receive medication Patient is delayed in receiving medication
Nurses may have access to other medications in same drawer	Nurses will retrieve medication without documentation Inventory is no longer accurate and ADMs run out of medication(s)	Patient profile is not updated Patient may receive another dose of medication

Appendix 4: Limitations of the Profiled ADMs

Concerns		
Profiled Automated Dispensing Machines		
The features listed above in for the Non-profiled Automated Dispensing Machines will also apply to the Profiled ADMs with the following additions		
Feature	Impact	Risks
Pharmacy Turnaround time - the turnaround time is from the time the medication is ordered to the time the medication is entered patient's profile and access to medication is provided	Patient is delayed in receiving medication Patient is subjected to unnecessary suffering	Nurse developing workarounds to access medication - I.e. overusing the override feature, taking larger amounts of medication than requested
Nurses unable to access medication for patient until it has been entered into patient profile	Patient is delayed in receiving medication Patient is subjected to unnecessary suffering	Nurse developing workarounds to access medication - I.e. overusing the override feature, taking larger amounts of medication than requested

Appendix 5: Rogers Adoption Model

	Segment #1: Implementing non-profile ADMs			Segment #2: Switching current ADMs from non- profiling to profiling
	Sub-segment A: OR and PAR	Sub-segment B: ER	Sub-segment D: other units	
Relative Advantages	<ul style="list-style-type: none"> - Faster and easier access to anesthetics and other medications need during an operation - No longer need to wait for pharmacy's turnaround - No longer have to go searching for the 1 set of narcotic keys 	<ul style="list-style-type: none"> - Faster and easier access to the narcotic medications - No longer have to go searching for the 1 set of narcotic keys - Prevents potential theft 	<ul style="list-style-type: none"> - Faster and easier access to medications from one central location - Nurses no longer have to search for narcotic key - 24/7 Access to medications 	<ul style="list-style-type: none"> - You can only choose medications under the patient's list - Achieve clinical safety checks for medication dispensing and administration process - Have a quicker turnaround time from written order to patient medication administration
Compatibility	<ul style="list-style-type: none"> - Need to learn how to use machine - Anesthetists will have to access medications themselves, rather than having the nurses prepare it for them 	<ul style="list-style-type: none"> - Need to learn how to use machine - Nurses are still accessing medication from 1 central area, therefore not impacting workflow 	<ul style="list-style-type: none"> - Need to learn how to use machine - Instead of going to cabinets for ward stock medications, nurses will be going to the machines to retrieve medications 	<ul style="list-style-type: none"> - Need to adjust workflow processes as majority of medications will be stored and accessed from the ADMs - Need to be cognizant that medications are not accessible until entered in patient's profile by pharmacy - Need to ensure that orders are sent to pharmacy as soon as possible so that patients are receiving medication in a timely fashion

Complexity	<ul style="list-style-type: none"> - Depends on the user' knowledge and experience with technology - Anticipate a medium to high learning curve depending on age, technological capability and open mindedness of the nurses - Touch screen and user friendly system that guides users through each step 	<ul style="list-style-type: none"> - Depends on the user' knowledge and experience with technology - Anticipate a lower learning curve as the nurses are younger and more technology savvy - Touch screen and user friendly system that guides users through each step - Minimal training required - Ease of use 	<ul style="list-style-type: none"> - Depends on the user' knowledge and experience with technology - Anticipate a medium to high learning curve depending on age, technological capability and open mindedness of the nurses - Touch screen and user friendly system that guides users through each step - Minimal training required - Ease of use 	<ul style="list-style-type: none"> - Depends on the user' usage with the technology - Minimal adjustment required as access becomes more restricted - Touch screen and user friendly system that guides users through each step - Minimal training required - Ease of use
Triability	<ul style="list-style-type: none"> - By initially implementing the non-profiled system the nurses and anesthetists are able to familiarize themselves with the machines, adopting the machine a bit at a time 	<ul style="list-style-type: none"> - By initially implementing the non-profiled system the nurses are able to familiarize themselves with the machines, adopting the machine a bit at a time 	<ul style="list-style-type: none"> - By initially implementing the non-profiled system the nurses are able to familiarize themselves with the machines, adopting the machine a bit at a time 	<ul style="list-style-type: none"> - Because of the initial implementation of the non-profiled system, the nurses should be familiarized with the machines and switching to profiled system should require minimal training
Observability	<ul style="list-style-type: none"> - Nurses no longer have to do daily narcotic counts - No longer any need for narcotic key - Anesthetists can have medication "kits" set up to simplify their process 	<ul style="list-style-type: none"> - Easy access to narcotics with minimal impact to workflow - No longer any need for narcotic key - No longer have to do daily narcotic counts - Decrease potential theft of narcotics by patients 	<ul style="list-style-type: none"> - Nurses no longer have to do daily narcotic counts - Nurses don't have to search and ask for keys to the medication cabinets 	<ul style="list-style-type: none"> - Nurses don't have to search through a large list of medications to find the correct medication - Helps to reduce errors in choosing the wrong medication - Nurses will have fewer choices to choose from and be able to choose the right one more accurately

Appendix 6: Questionnaire 1

Questionnaire 1

From a scale from 1 to 10, how much change are you exposed to, with 1 being never and 10 being constantly

Low				Medium					High
1	2	3	4	5	6	7	8	9	10

Number of times on average in a shift do nurses have to retrieve medications from ward stock

Nurse to patient ratio

1:2	1:4	1:6	1:10
-----	-----	-----	------

What % of time is spent on medication related tasks?

What was your knowledge level about ADMs prior to implementation?

Low					Medium					High
1	2	3	4	5	6	7	8	9	10	

From a scale of 1 to 10, what is your comfort level with technology?

Low					Medium					High
1	2	3	4	5	6	7	8	9	10	

What do you think the rates of medication errors are within your unit?

What do you think the rates of medication errors are within the hospital?

What type of medication errors are you aware of that have been made?

What were your first impressions when you were first introduced to the idea of ADMs?

Expectations with ADMs

Concerns with ADMs

How useful is this machine for your everyday work?

Not useful					Medium					Very useful
1	2	3	4	5	6	7	8	9	10	

Do you think ADMs help reduce medication errors?

Would you recommend the use of ADMs to other hospitals?

How difficult did you find the ADMs to use?

Very Easy				Easy		Difficult		Very Difficult	
1	2	3	4	5	6	7	8	9	10

Overall, how satisfied are you with ADMs?

Not satisfied at all					Satisfied					Very Satisfied
1	2	3	4	5	6	7	8	9	10	

Profiling

From a scale of 1 to 10, how useful do you think profiling will be in helping you with your day to day work, where 1 is not useful at all and 10 is very useful?

Not useful					Medium					Very useful
1	2	3	4	5	6	7	8	9	10	

Expectations of Non-Profiling to Profiling

Concerns of Non-Profiling to Profiling

Do you think profiling will enhance the reduction of medication errors?

Overall how satisfied do you expect to with "profiled" ADMs?

Not satisfied at all					Satisfied					Very Satisfied
1	2	3	4	5	6	7	8	9	10	

Appendix 7: Questionnaire 2

Questionnaire 2

From a scale from 1 to 10, how much change are you exposed to, with 1 being never and 10 being constantly

Low				Medium				High	
1	2	3	4	5	6	7	8	9	10

Number of times on average in a shift do nurses have to retrieve medications from ward stock

Nurse to patient ratio

1:2	1:4	1:6	1:10
-----	-----	-----	------

What % of time is spent on medication related tasks?

What was your knowledge level about ADMs prior to implementation?

Low				Medium				High	
1	2	3	4	5	6	7	8	9	10

From a scale of 1 to 10, what is your comfort level with technology?

Low				Medium				High	
1	2	3	4	5	6	7	8	9	10

What do you think the rates of medication errors are within your unit?

What do you think the rates of medication errors are within the hospital?

What type of medication errors are you aware of that have been made?

What were your first impressions when you were first introduced to the idea of ADMs?

Expectations with ADMs

Concerns with ADMs

How useful is this machine for your everyday work?

Not useful				Medium				Very useful	
1	2	3	4	5	6	7	8	9	10

How effective was training and support?

Not useful				Medium				Very useful	
1	2	3	4	5	6	7	8	9	10

**Do you think ADMs help reduce medication errors?
Would you recommend the use of ADMs to other hospitals?**

How difficult did you find the ADMs to use?

Very Easy		Easy		Difficult		Very Difficult			
1	2	3	4	5	6	7	8	9	10

Did you feel more comfortable using the ADMs after?

- a. Observing other nurses using it?
- b. Observing a demonstration from the vendors?
- c. Hearing other nurses recommend it?
- d. Being about to fiddle around with it?

Overall, how satisfied are you with ADMs?

Not satisfied at all		Satisfied		Very Satisfied					
1	2	3	4	5	6	7	8	9	10

Profiling

From a scale of 1 to 10, how useful do you think profiling will be in helping you with your day to day work, where 1 is not useful at all and 10 is very useful?

Not useful		Medium		Very useful					
1	2	3	4	5	6	7	8	9	10

Expectations of Non-Profiling to Profiling

Concerns of Non-Profiling to Profiling

Do you think profiling will enhance the reduction of medication errors?

Overall how satisfied do you expect to with "profiled" ADMs?

Not satisfied at all		Satisfied		Very Satisfied					
1	2	3	4	5	6	7	8	9	10

Appendix 8: Issues/Concerns – Non-Profiled ADMs

Issues/Concerns - Non-Profiled Automated Dispensing Machines

Issues/Concerns	Failure Effects	Failure Causes	Actions to Prevent or Reduce Occurrence of Failure
Line ups	Set medication administration times Older nurses/less technology savvy nurses struggled with use of machines nurses who feared or hated the idea of using the machines Nurses who feared or hated the idea of using the machines- nurses who accessed the machines less frequently Nurses who accessed the machines less frequently	Nurses were more likely to retrieve more than the quantity specified Nurses will try to obtain medication for more than 1 patient to avoid line ups	Encourage nurses to retrieve medications for 1 patient, administer medications and then repeat process enabling line ups to move quicker Provide in-services to provide continual training and updates on the use of the ADMs Educate/inform nurses that initially there will be line ups but as they get use to ADMs line ups will dissipate
Casual/Student Nurses	No experience with technology May not be interacting with ADMs on regular basis	Nurses bypass proper procedures to access medication Patient may receive medication not prescribed to him	Ensure Nurse Educator is on the shift to help train and guide the use of ADMs Ensure at the initial implementation that an ADM System Administrator is on hand in case any problems, issues, or questions should come up Ensure proper training is provided for nurses
Removing medications from ADMs without following proper signing out procedures	Nurses want to avoid line-ups Nurses want to avoid continually going back to ADMs Nurses are finding that the ADMs impede on their workflow	Results in inaccurate inventory May result in running out of medication(s) Can be detrimental if pharmacy is closed and not available to restock medications needed	Educate nurses to the consequences of removing more than the quantity requested Encourage nurses to retrieve medications for 1 patient, administer medications and then repeat process enabling line ups to move quicker Educate, train, or demonstrate the use of the machines
ADMs are a barrier to medication access	Nurses views as barrier to medication Nurses view as “extra” step in accessing medication	Results in nurses finding ways to workaround machine – e.g. removing medications under 1 patient, removing more the amount requested, hoarding medication Defeats the ultimate purpose (reduction in medication errors) of having the machine	Educate nurses to the benefits of the machine – i.e. helps to reduce medication errors Educate nurses as to the consequences of the workarounds
“Down-times or breakdowns”	Nurses are unable to access medications for patients	Patient does not receive needed medication	Proper procedures are provided in cases of down-time or breakdowns Nurses are provided access to other ADMs in other nursing units Provide an Omnicell System Administrator at each hospital site

Appendix 9: Issues/Concerns Profiled ADMs

Issues/Concerns - Profiled Automated Dispensing Machines

Issues/Concerns	Failure Effects	Failure Causes	Actions to Prevent or Reduce Occurrence of Failure
Emergency/STAT Orders	Nurses unable to access medications not assigned to patient	Patient required to wait for medication that is needed immediately	Every unit should be provided a list of override medications Nurses will be able to use the override function to access the medications deemed emergency/stat Nurses are provided access to other ADMs in other nursing units
Pharmacy Turnaround	Unable to access medication for patient without pharmacy entering order into profile	Patient may not receive medications within timely fashion	Increase communication between nurses and pharmacy and implement procedures that will ensure orders are delivered in a timely fashion
Non-Profile to Profiled	Nurses can only access medications that are listed in the patient's profile Nurses may feel it takes longer to access medication	Nurses may feel that no longer have control May become reliant on the override feature	Educate nurses the profiled system will reduce medication errors Educate nurses that the profiled system will save time and increase efficiency Add function that requires nurses to enter reason for using override
Line ups	Set medication administration times Older nurses/less technology savvy nurses struggled with use of machines nurses who feared or hated the idea of using the machines Nurses who feared or hated the idea of using the machines- nurses who accessed the machines less frequently Nurses who accessed the machines less frequently	Nurses were more likely to retrieve more than the quantity specified Nurses will try to obtain medication for more than 1 patient to avoid line ups	Encourage nurses to retrieve medications for 1 patient, administer medications and then repeat process enabling line ups to move quicker Provide in-services to provide continual training and updates on the use of the ADMs Educate/inform nurses that initially there will be line ups but as they get use to ADMs line ups will dissipate
Casual/Student Nurses	No experience with technology May not be interacting with ADMs on regular basis	Nurses bypass proper procedures to access medication Patient may receive medication not prescribed to him	Ensure Nurse Educator is on the shift to help train and guide the use of ADMs Ensure at the initial implementation that an ADM System Administrator is on hand in case any problems, issues, or questions should come up Ensure proper training is provided for nurses
Removing medications from ADMs without following proper signing out procedures	Nurses want to avoid line-ups Nurses want to avoid continually going back to ADMs Nurses are finding that the ADMs impede on their workflow	Results in inaccurate inventory May result in running out of medication(s) Can be detrimental if pharmacy is closed and not available to restock medications needed	Educate nurses to the consequences of removing more than the quantity requested Encourage nurses to retrieve medications for 1 patient, administer medications and then repeat process enabling line ups to move quicker Educate, train, or demonstrate the use of the machines
ADM's are a barrier to medication access	Nurses views as barrier to medication Nurses view as "extra" step in accessing medication	Results in nurses finding ways to workaround machine – e.g. removing medications under 1 patient, removing more the amount requested, hoarding medication Defeats the ultimate purpose (reduction in medication errors) of having the machine	Educate nurses to the benefits of the machine – i.e. helps to reduce medication errors Educate nurses as to the consequences of the workarounds
"Down-times or breakdowns"	Nurses are unable to access medications for patients	Patient does not receive needed medication	Proper procedures are provided in cases of down-time or breakdowns Nurses are provided access to other ADMs in other nursing units Provide an Omnicell System Administrator at each hospital site

Appendix 10: Raw Data from Questionnaire 1

Questionnaire #	Interview #	Nurse/patient ratio	# Of times nurses have to get medications related within a shift	% Of time spent on medication related tasks	Knowledge about ADMs	Level of willingness to try ADM	Estimate of ADM errors in your unit	Expectations with ADMs	Concerns with ADMs
1: A	1	1:5	24	50%	0	8	Very low	- Don't have to count narcotics - medications will be in an organized place	- There might be line-ups
	2	1:7	2	60-70%	0	9	Low	- Don't have to count narcotics - don't have to look for keys to medication cabinets - less risks with expired medications	- Line-ups - casual nurses might not have access codes
	3	1:9	7	25-30%	0	10	Low	- Make their work easier	- Line-ups - heard good things but didn't know if the machine will deliver
	4	1:4	15	40%	0	8	Low	- Don't have to count narcotics	- Line-ups

Interview #	Nurse/patient ratio	# Of times nurses have to get medications within a shift	% Of time spent on medication related tasks	Knowledge about ADMs	Level of comfort with technology	Level of willingness to try ADM	Estimate rate of Medication errors in your unit	Expectations with ADMs	Concerns with ADMs
5 (non-user)	1:4	25 - 30	75%	2	10	2	Very low	<ul style="list-style-type: none"> - Automatic restocking maybe helpful - may help to enhance patient safety 	<ul style="list-style-type: none"> - Extra time and steps are required to access medications - will not facilitate the workflow process - trade off from documenting in the narcotic book and accessing narcotics from ADM
6 (non-user)	1:4	25 - 30	75%	2	10	2	Very low	<ul style="list-style-type: none"> - Automatic restocking maybe helpful - may help to enhance patient safety 	<ul style="list-style-type: none"> - Extra time and steps are required to access medications - will not facilitate the workflow process - trade off from documenting in the narcotic book and accessing narcotics from ADM

Interview #	Nurse/patient ratio	# Of times nurses have to get medications within a shift	% Of time spent on medication related tasks	Knowledge about ADMs	Level of comfort with technology	Level of willingness to try ADM	Estimate of Medication errors in your unit	Expectations with ADMs	Concerns with ADMs
7	1:4	10	10 - 15%	0	5	1	Very low	- Hassle to access medications, especially everyday meds, such as stool softeners, vitamins and pain killers - Narcotics are easier to track	- Impedes workflow acted as a barrier to medications
8	1:4	10	10 - 15%	0	4	1	Very low	- Hassle to access medications, especially everyday meds, such as stool softeners, vitamins and pain killers - Narcotics are easier to track	- Impedes workflow acted as a barrier to medications
9 (Nurse Ed)	1:4	10	50%	2	9	8	40%	- More tracking on medications - less time spent preparing meds	- Nurses will react negatively initially - something else to get use to

Interview #	Nurse/patient ratio	# Of times nurses have to get medications within a shift	% Of time spent on medication related tasks	Knowledge about ADMs	Level of comfort with technology	Level of willingness to try ADM	Estimate of ADM errors in your unit	Expectations with ADMs	Concerns with ADMs
10 (Nurse Ed)	1:4	10	30 - 40%	0	6	8	30%	<ul style="list-style-type: none"> - Helps nurses find the right medications - ease of use 	<ul style="list-style-type: none"> - Line-ups, especially at scheduled medication administration times - time consuming - nurses may feel pressure to speed up and as a result increase medication errors
11 (non-user)	1:4	60	10 - 20%	8	8	8	1 - 2% (based on incident reports)	<ul style="list-style-type: none"> - Decrease medication errors - decrease risk for potential theft - improve efficiency in relation to stocking - quicker access to narcotics 	<ul style="list-style-type: none"> - Small learning curve for the nurses (estimate they will be comfortable with the ADMs in approximately 1 month)

Appendix 11: Raw Data from Questionnaire 1

Questionnaire 1: B								
Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMS	What were some of the goods things about the ADMs	Would you recommend ADMs to other hospitals	
1	10	10	10n/a	- don't know	- line-ups	- medications are easier to retrieve	Yes	
2	8	8	8n/a	Yes	- line-ups - the location of the machine is not very safe for the nurses (in a back corner) - need more support on weekends and evenings	- don't have to count narcotics	Yes	
3	10	10	10n/a	Yes	- student nurses took longer - line-ups in the morning	- it's there when you need it, don't have to wait for pharmacy	Yes	
4	10	10	10n/a	Maybe	- students are slow and have to wait longer	- don't have to double check - IVs are available at night time even when pharmacy is closed	Yes	
5 (non-user)	n/a	n/a	n/a	Maybe	n/a	n/a	n/a	

Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMS	What were some of the goods things about the ADMs	Would you recommend ADMs to other hospitals
6 (non-user)	n/a	n/a	n/a	Maybe	n/a	n/a	n/a
7	8	7	n/a	Maybe	<ul style="list-style-type: none"> - hassle to access medications - time consuming - line ups, especially during set medication administration times - student nurses took longer 	<ul style="list-style-type: none"> - don have to count narcotics after each shift 	No
8	8	7	n/a	Maybe	<ul style="list-style-type: none"> - hassle to access medications - time consuming - line ups, especially during set medication administration times - student nurses took longer 	<ul style="list-style-type: none"> - don have to count narcotics after each shift 	No
9 (Nurse Ed)	7	8	n/a	Yes	<ul style="list-style-type: none"> - line ups, especially during set medication administration times - nurses may still choose the wrong medication 	<ul style="list-style-type: none"> - guides nurses in finding right medications (only if nurses chooses right medication initially) 	Yes

Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMs	What were some of the goods things about the ADMs	Would you recommend ADMs to other hospitals
10 (Nurse Ed)	7	8	n/a	Yes	- line ups, especially during set medication administration times	- decrease medication errors - have to perform narcotic medication once per week	Yes
11 (non-user)	n/a	n/a	n/a	Yes	n/a	n/a	Yes

Appendix 12: Raw Data from Questionnaire 2

Questionnaire 2: A	Interview #	Nurse/patient ratio	# of times nurses have to get medications within a shift	% of time spent on medication related tasks	Knowledge about ADMs	Level of comfort with technology	Level of willingness to try ADM	Estimate rate of Medication errors in your unit	Expectations with ADMs	Concerns with ADMs
	12	1:5	N/A	20%		2	N/A	low	- less med. Errors	- waste time
	13	1:6	N/A	40%	1	8	N/A	N/A	- meds are stock better	
	14	1:4	8	n/a	9	n/a	n/a	low	n/a	n/a
	15	1:5	N/A	35%	4	9	n/a	5%	- good idea - more accurate counts meds will be in correct bins	- get used to where the meds are stored, and grab from the wrong place if the meds are placed somewhere else
	16	1:5	20-30	20%	1	8	n/a	low	- like it	
	17	1:5	n/a	n/a	5	8	n/a	25-30%	- decrease med errors - ability to monitor meds that patients are taking	- hassle to retrieve ward stock; things that used to be just grab and go

Interview #	Nurse/patient ratio	# of times nurses have to get medications within a shift	% of time spent on medication related tasks	Knowledge about ADMs	Level of comfort with technology	Level of willingness to try ADM	Estimate of errors in your unit	Expectations with ADMs	Concerns with ADMs
18	1:3	5-10	20%	1	10	n/a	15	- less med errors - no daily counting	- lots of nurses have to wait at the same time to get meds; slow down - takes longer to get meds in emergency - some meds have different names and if you don't know the name in the machine you can't find it
19	1:2	many times	20%	5	8	n/a	n/a	n/a	n/a
20	1:4	many times	75%	3	7	n/a	n/a	- great	n/a
21	1:5	many times	n/a	2	6	n/a	n/a	n/a	- complicated - too much waste
22	1:4	n/a	n/a	n/a	5	n/a	n/a	n/a	n/a
23	1:5	4-10	n/a	2	5	n/a	n/a	n/a	n/a
24	1:5	10	n/a	5	7	n/a	n/a	- narcotics will be safer	- line-ups
25	1:6	many times	n/a	10	10	n/a	n/a	- can't wait	n/a
26	n/a	n/a	n/a	6	8	n/a	n/a	n/a	- complicated
27	1:6	6-10	n/a	n/a	5	n/a	n/a	n/a	- not very time effective - waste lots of narcotics
28	1:5	10	n/a	8	7	n/a	n/a	n/a	n/a
29	1:10	10+	n/a	6	6	n/a	n/a	n/a	- increases nurses workload
30	1:4	many times	40%	1	5	n/a	n/a	- save time	- measurement errors - think that it might take more time

Appendix 13: Raw Data from Questionnaire 2

Questionnaire 2: B	Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMS	What were some of the goods things about the ADMs	Would you recommend ADMs to other hospitals	What is the best type of training
	12	7	7	2	Yes	n/a	n/a	Yes	- being able to fiddle around with it
	13	6	6	3	Yes	n/a	n/a	Yes	- being able to fiddle around with it
	14	7	8	3	Yes	n/a	n/a	Yes	- observing other nurses use it
	15	8	8	2	Yes	n/a	n/a	Yes	- observing a demonstration from the vendors
	16	10	10	2	Yes	n/a	n/a	Yes	- any kind of training
	17	6	6	4	Yes	n/a	n/a	Yes	- being able to fiddle around with it

Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMS	What were some of the goods things about the ADMS	Would you recommend ADMs to other hospitals	What is the best type of training
18	2	3	3	- maybe	n/a	n/a	no	- observing a demo. From the vendors - being about to fiddle around with it
19	10	8	4	- maybe	n/a	n/a	Yes	- observing other nurses using it - observing a demo from the vendors - being about to fiddle around with it
20	8	10	2	Yes	- waiting times diminishes efficiency	n/a	Yes	- any kind of training
21	6	n/a	5	n/a	n/a	n/a	n/a	- being about to fiddle around with it
22	5	10	5	n/a	n/a	n/a	n/a	- observing other nurses using it - being about to fiddle around with it

Interview #	Satisfaction level with the machine	Satisfaction level with training and support	How difficult was the ADM to use?	Do you think the ADMs helped reduce medication errors	What were some of the problems with the ADMs	What were some of the goods things about the ADMs	Would you recommend ADMs to other hospitals	What is the best type of training
23	5	10	4	n/a	n/a	n/a	n/a	- observing other nurses using it - being about to fiddle around with it
24	3	n/a	4	no	n/a	n/a	no	- being about to fiddle around with it
25	10	n/a	1	Yes	n/a	n/a	Yes	- being about to fiddle around with it
26	9	n/a	5	n/a	- if you can't find a witness for the return of the narcotics then you waste it	n/a	n/a	- observing other nurses using it
27	6	n/a	4	Maybe	n/a	n/a	maybe	- any kind of training
28	4	n/a	4	n/a	- not very time efficient	n/a	n/a	- being about to fiddle around with it
29	1	n/a	1	no	- nurses had to go to two places for the meds	n/a	no	- being about to fiddle around with it
30	10	10	1	No	- measurement errors, different dosage rates	- saves time for narcotic counts - faster way to get meds.	Yes	- being about to fiddle around with it

Appendix 14: Average Ratings

Averages for the total number of interviewees (30)				
	Total Averages (n=30)	Nurse Educators' Average (n=2)	*Non-Users' average (n=3)	**Users (n=25)
# of times nurses have to get medications within a shift	15	10	60	10
% of time spent on medication related tasks	43%	50%	75%	33%
Knowledge about ADMs	3	1	4	3
Level of comfort with technology	7	8	9	7
Level of willingness to try ADM	6	8	4	6
Satisfaction level with the machine	7.07	7	n/a	6.91
Satisfaction level with training and support	8.2	8	n/a	8.00
Easy of Use	3.11	n/a	n/a	3.29

* Non-users are nurses who haven't had the ADMs implemented into their units, and are currently still using the manual process for medication retrieval.

** Users are nurses who have the ADMs implemented in their units and they are currently using the ADMs.

Appendix 15: Correlations

Correlations		
		Correlation
Between Knowledge about ADM and level willingness to try		0.06
Between Comfort level with technology and willingness to try		0.38
Between Knowledge about ADM and satisfaction with ADM		-0.19
Between comfort level with technology and satisfaction with ADM		0.22
Between willingness to try and satisfaction with ADM		0.72
Between Knowledge about ADM and satisfaction with training		-0.20
Between comfort level with technology and satisfaction with training		-0.22
Between willingness to try and satisfaction with training		0.30
Between satisfaction with ADM and satisfaction with training		0.64
Between satisfaction with ADM and level of difficulty to use		-0.21
Between satisfaction with training and level of difficulty to use		-0.11
Between knowledge about ADM and level of difficulty to use		-0.02
Between comfort level with technology and level of difficulty to use		-0.08

Appendix 16: Frequencies of some of the subjective responses from users

Frequencies	
	No. of Interviewees (30)
Common Concerns	
Line-ups	12
Impedes Workflow/Slow downs	6
Limit access to medications	5
Common Advantage	
Don't have to Count Narcotics	20
Better kept records of medications	6
Help decrease medication errors	7
What helped users feel comfortable with ADMs	
Observing other nurses using it	8
Observing a demonstration from the vendors	6
Hearing other nurses recommend it	3
Being about to fiddle around with it	16

Appendix 17: Minutes from the meeting with Regional Manager for Decision Support, and Risk Manager Coordinator for Patient Safety

Questions

1. Have you had any experience with the drug dispensing machines or bedside verification devices?

As an onlooker

Heard about it

2. What is your perspective on the drug dispensing machines or bedside verification devices – i.e. benefits and concerns?

Feel the benefits outweigh the concerns

Benefits – narcotic count needs to be performed once per week vs. daily; ensure correct drug is being selected; ensure the right medication is selected for the right patient

3. Are you aware of any projects that might compete directly for resources with this project?

Not aware

4. What other methods or strategies is Vancouver Coastal using to help reduce medication errors?

Safety Huddles- meeting with facilitator and pharmacist to discuss potential errors and/or errors that may have taken place

Medication Reconciliation Project – drug profile for pt from administration to discharge

Regular abbreviation – go over abbreviations that are used to ensure they are not misinterpreted; potassium removed from ward stock

5. How effective have these strategies been?

Not sure – no measurement put in place

6. What is the feedback from the stakeholders regarding these strategies?

Not aware

7. Do you know someone who is directly involved with these strategies that we maybe able to talk to?

I.S.

8. We understand this project probably involves the pharmacy, nursing, and the IT departments at the hospitals, can you think of any other department that this project might directly involve?

Residents, Doctors, RT (Respiratory Therapists)

9. Besides nurses, doctors, patients, and hospital administrators, who do you think the stakeholders are for this project?

Pharmacists

10. Who else should I be talking to?

Medication Safety Group

Nurse Educators

11. Can you recommend any other resources, materials (e.g. journals, websites, textbooks) that would provide us with further assistance with this project?

www.ihi.org and www.ismp.org

Other Applicable notes:

- UBC Hospital has successfully rolled out ADMs in most its departments
- Children's is currently has the ADM in place but trying out the bedside verification devices
- Be aware that nurses identify themselves by their hospital – i.e. Providence Health Care and Vancouver Coastal Health Authority

Appendix 18: Minutes from meeting with the Pharmacy Operations Director

Questions

1. What marketing strategy was used to implement ADM/BVD at UBC hospital?

Communication plan to create buy-in from nurses

Forewarn nurses there will be change in workflow and helping them understand the change in workflow

2. How effective was it?

Not sure yet

3. Would you do anything differently?

D/C super-user training classes

Use the wait and see approach; super-user usually evolves from using the machines

Create focus groups

4. Were any nurses involved in the process?

Work groups were established

Met on regular basis

Also newsletters, demos in cafeteria, training

5. How did you create buy-in?

Work groups were established

Met on regular basis

Also newsletters, demos in cafeteria, training

6. Was there a well-respected peer that championed the project and explained to the nurses why these technologies were needed?

Nurse educators

Nurse specific Questions

1. Was there a huge learning curve for the nurses?

Growing pains from non-profiled to profiled – i.e. may encounter significant learning curve

2. How do casual nurses fit into this unique situation? Are they provided access, training to the drug dispensing machines and bedside verification devices?

No probs. Were able to capture them during the 2 weeks of go-live

If not provided ad hoc training since machines are easy to use

Nurses end up helping each other out

Flip chart provided – easy to follow

3. Are you aware of any problems that “casual nurses” have run into with the drug dispensing machines and bedside verification devices?

Slow

- 4. Are you aware of any problems or common complaints that nurse have run into with the drug dispensing machines and bedside verification devices?**

Not aware of any. Mostly positive.

- 5. What is the willingness to change?**

Positive

- 6. How has ADM and BVD change current practices, workflow?**

Not much

- 7. Has it helped to increase the amount of time for nurses to perform other tasks?**

Don't know – haven't measured

- 8. Was adequate training required before implementation?**

1 hour training sessions were sufficient

- 9. Was type of training did you feel was most needed – i.e. familiarity with computers?**

- 10. Was adequate IT support provided during and after implementation?**

Post go-live support was 24/7 for 2 weeks

After go-live Omnicell® Sys. Administrator or pharmacy provided support

- 11. What is its impact? Has there been a reduction in medication errors?**

Don't know – don't measure

Additional Notes

Benefits

- Don't have to search for narcotic key
- Don't have to perform narcotic counts after each shift

Concerns

- Line-ups
- Hoarding of meds – concern with non-profiled but not profiled

Unit dose medications

- Providence everything is unit dose
- VGH majority of medications are unit dose

Pharmacy oversees the running of the ADMs

- Run a off a report to see what drugs are needed and then machines are restocked by technicians
- A pharmacy technician would be assigned to be an Omnicell® System

Administrator

- All technical support calls will be directed to pharmacy – e.g. door jams, adding new medication to system, etc

Appendix 19: Minutes from 2nd meeting with Regional Manager for Decision Support

Current turnaround in the pharmacy with implementation with ADMs

Not profiled not a problem

Will be an issue when ADMs become profiled

Restock every morning and every afternoon (“critically low” list)

- In the afternoon report is run to ensure that ADMs are topped up and last until next morning, when pharmacy re-opens
- If really urgent than can go to ADM in another nursing unit to borrow medications since access is permitted in other units

Notes

All VGH will go-live by July 31/06 and ER hopefully in April/06

Issues

Nurses are forgetting to press “green button” after removing medication, which results in “null” transaction – i.e. nothing has been taken

Plain matrix – lacks sensing capability; nothing stopping nurses from removing medications in these matrices

Local list

- Not accurate in morning
- Does not fully list all the patients coming in for surgery
- Usual practise for anaesthetists is to remove all medications for all their patients in the morning
- Problem arises when patient is not on list – anaesthetists work around this by taking all medications under one patient
- When unused medication need to be returned to the ADMs, the anaesthetists has either forget who patient is or patient has been discharged and no longer on the local list – medications cannot be returned
- Need to educate anaesthetists to remove medications for one patient at a time

Benefits

No longer have to count narcotics after each shift, instead just once per week

Can create “kits” specifically for each anaesthetist – i.e. Dr. Smith’s kit, which will be made up of the usual medications that Dr. Smith uses during surgery

Appendix 20: Minutes from the meeting with Clinical Nurse Educator at Providence Health Care

Questions

1. Have you had any experience with the drug dispensing machines or bedside verification devices?

Have heard lots about the automated dispensing machines but have not actually seen or used one.

2. What is your perspective on the drug dispensing machines or bedside verification devices – i.e. benefits and concerns?

Concerns for ADMs – frequency of stocking, what happens if the machine runs out of that medication, what happens if the drawers get stuck, what about medications that need refrigeration.

Concerns for BVD – have to wake patients up to scan them, where will the nurses put the scanning machines, will they be too heavy

Benefits – help reduce medication errors and increase patient safety

3. What other methods or strategies is Vancouver Coastal using to help reduce medication errors?

St. Paul's just implemented a strategy for bar-coding forms so that forms and orders can be tracked electronically

4. Can you briefly describe the medication ordering, preparing, distributing, and administering process?

Can only provide information about St. Paul's system. Doctors make the orders and the nurses in the units transcribe that order and fax or phone it into pharmacy. Pharmacy enters, checks, and prepares the order. The goes through a final double-check at pharmacy before delivery. Most orders are delivered at the scheduled delivery time for each unit, once every 8 hours. If the order is for a STAT or ASAP medication, then the order is send up through the nomadic tubes.

5. Do you know someone who is directly involved with these strategies that we maybe able to talk to?

Don't have names but VGH and UBC hospital have the machines. Nurses from Calgary have had experience with the machines because they have a more electronic system.

Appendix 21: Minutes from the meeting with Medication Safety Coordinator at Providence Health Care

Questions

1. Have you had any experience with the drug dispensing machines or bedside verification devices?

No, but have heard lots about it. Have seen nurses at VGH use it like a vending machine, because right now they have access to everything.

2. What is your perspective on the drug dispensing machines or bedside verification devices – i.e. benefits and concerns?

Concerns – the implementation of it will be very complicated and cannot not be over looked, determining the type, number, and dosage of medications that will go into the machines will be a difficult task, when profiling happens the override feature will be an issue, issues will rise when there are emergencies and nurses need medications right the way, patients don't want to wait longer than they already have.

Benefits – it will be a great thing for patient safety; narcotic control will be much better, improve access and safety, and improve accuracy and speed

3. What other methods or strategies is Vancouver Coastal using to help reduce medication errors?

There are lots of other projects happening at various hospitals

4. How effective have these strategies been?

Not sure – no measurement put in place

5. Besides nurses, doctors, patients, and hospital administrators, who do you think the stakeholders are for this project?

Anaesthetists will be the users in OR, OR assistants, nurse educators, and pharmacy technicians.

Other Applicable notes:

- Get users input during implementation to create buy-in
- End-users want more input and training, listen to the users
- Nurses excited and optimistic
- Pharmacy technicians will need to be made aware of their role change, they will need training on stocking and technical support for the machines
- Needs to have back-up plans in place

Appendix 22: Revised Questionnaire

Nurse to patient ratio									
1:1 – 1:4			1:5 - 1:7		1:8 – 1:10			1:10+	
What % of time is spent on medication related tasks?									
20-30%			40-50%		55%-60%			65%+	
How frequently do you feel you make medication errors?									
1/shift		1/week		1/month		1/6months		1/year	
									never
(For the following questions, please state whether you agree or disagree with the statements)									
Your comfort level with technology is high.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
Your knowledge level about Omnicell prior to implementation was high.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
Training and support for the Omnicell was effective.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
The Omnicell was very easy to use.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
The Omnicell was very useful for your everyday work.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
You are very satisfied with the Omnicell.									
Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10
Do you think Omnicell help reduce medication errors?									
Did you feel more comfortable with the Omnicell after the training session? If yes, why?									

What type of training did you receive?

- a) 1 on 1 hands on training
- b) 1 on 1 demonstration
- c) Demonstration session with other nurses
- d) Learned from other co-workers
- e) Learned on own

Do you find that the Omnicell impede workflow? If yes, why?

To what degree do line-ups pose a problem?

Always a Problem					Sometimes a problem				Never a problem
1	2	3	4	5	6	7	8	9	10

How many times per day do you go to the ADM?

1-4	5-8	10-12	12+
-----	-----	-------	-----

How many times per day to you go to the ADM, do you feel you have to wait?

Every time	Occasionally	Never
------------	--------------	-------

How long does it usually take you to access and retrieve medications from the Omnicell?

<1 min.	2-3min.	3-5min.	<5min.
---------	---------	---------	--------

What do you usually do if the Omnicell is in-use when you go to access it?

Profiling

Profiling the Omnicell machines will be very helpful.

Disagree				Neutral				Agree	
1	2	3	4	5	6	7	8	9	10

What are your expectations for the profiled system?

What are your concerns for the profiled system?

Do you think profiling will enhance the reduction of medication errors?

Appendix 23: Example of a Failure Mode and Effects Analysis

This table gives an example of how the failure mode and effects analysis can be conducted. The Risk Value of each of the events happening will help determine their level of importance and urgency. The ratings will be subjective and can be based on a scale that is set by the committee that is performing the analysis.

Mode	Likelihood	Severity	Mitigation	Risk Value
Pharmacy staff fills the wrong medication into the Omnicell	3	6	2	36
Nurses retrieve medications from the Omnicell before pharmacy has a chance to check	7	1	8	56

REFERENCE LIST

James, G. Anderson, PhD, Stephen, J. Jay, MD, Marilyn, Anderson, BA, and Thaddeus, J. Hunt, BA. "Evaluating the Impact of Information Technology on Medication Errors: A Simulation." American Medical Informatics Association 10 (2003): 292-293. PubMed Central. Jan 2006 <<http://www.pubmedcentral.nih.gov/>>

Bates, David W. "Using information technology to reduce rates of medication errors in hospitals." British Medical Journal. 320(7237) (2000): 788-791. Jan 2006
<<http://bmj.bmjournals.com>>

Daley, Donna. "Regional hospital gets new drug-dispensing technology." Telegram & Gazette (2001): B1. ProQuest. Jan 2006
<fu.ca/pqdweb?index=0&did=71187093&SrchMode=1&sid=1&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1143748808&clientId=3667>

Haig, Kath "Journey Towards Safety – A Cultural Revolution." Medscape Money & Medicine (2003) Institute for Healthcare Improvement. Jan 2006 <www.IHI.org>

Kohn, Linda T., Corrigan, Janet, and Donaldson, Molla S. To Err Is Human: Building a Safer Health System. National Academy Press: Washington. 2003

Lassetter, Jane H, and Warnick, Myrna L. "Medical Errors, Drug-Related Problems, and Medication Errors". J Nurse Care Qual. 18 (2003): 175-181 PubMed Central. Jan 2006
< <http://www.pubmedcentral.nih.gov/>>

Lee, Yuikan, and O'Connor, Gina C. "The Impact of Communication Strategy on Launching New Products: The Moderating Role of Product Innovativeness". The Journal of Product Innovation Management 20 (2003): 4-21. ProQuest. Jan 2006
<<http://proquest.umi.com.proxy.lib.sfu.ca/pqdweb?index=0&did=286022341&SrchMode=1&sid=3&Fmt=2&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1143749654&clientId=3667>>

Murray Michael D. "Chapter 11. Automated Medication Dispensing Devices." Purdue University School of Pharmacy (2001). United States Department of Health and Human Services. Jan 2006<<https://www.ahrq.gov/clinic/ptsafety/chap11.htm>>

Oren, Eyal, Shaffer, Ellen R, and Guglielmo, B. Joseph. "Impact of Emerging Technologies on Medication Errors and Adverse Drug Events." American Journal of Health-System Pharmacy 60 (2003): 1447 –1460. Medscape from WEBMD. Jan 2006
<<http://www.medscape.com/viewpublication/74>>

Rogers, Everett M. Diffusion of Innovations. 5th ed. New York: The Free press, 2003.

Rosen, Robert K. "Medication errors: a 21st-century perspective." Baylor University Medical Center 17(4) (2004):464-467. PubMed Central. Jan 2006
<<http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1200687>>

Shana, Steven H. "Automated dispensing reaches patients at time of prescribing." Managed Healthcare Executive. Vol 11 Issue 4 (2001): 45. ProQuest. Jan 2006
<<http://proquest.umi.com.proxy.lib.sfu.ca/pqdweb?index=0&did=71778216&SrchMode=1&sid=6&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1143755755&clientId=3667#fulltext>>

Tallon, Robert W. "Automated medication dispensing systems." Nursing Management. Vol 27 Issue 8 (1996): 45-46. ProQuest. Jan 2006
<<http://proquest.umi.com.proxy.lib.sfu.ca/pqdweb?index=2&did=10008298&SrchMode=1&sid=9&Fmt=3&VInst=PROD&VType=PQD&RQT=309&VName=PQD&TS=1143755964&clientId=3667#fulltext>>

Vaida AJ, Cohen MR. "Point-of-care bar coded medication administration: experience in the United States." Farm Hosp 29 (2005): 151-152