BUSINESS CASE FOR A REGIONAL PRODUCTION CENTRE FOR VANCOUVER COASTAL HEALTH AUTHORITY AND PROVIDENCE HEALTH CARE PHARMACY DIVISIONS

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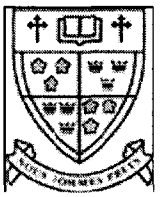

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ABSTRACT

Having recently merged and reorganized Vancouver Coastal Health's Pharmacy division is evaluating methods for increasing patient safety and cost effectiveness. By conducting stakeholder interviews and research this project has established and weighed the costs and benefits of centralizing pharmacy production within a new pharmacy distribution centre or within existing facilities. Several other health authorities have built or are considering similar projects and their experience is integrated into this evaluation. Our research shows that in the short term the region's capabilities and obligations necessitate using existing facilities but that planning should commence immediately to provide for construction of a new distribution centre by 2009.

Keywords: Vancouver Coastal Health Authority; business operations; health care management; cost effectiveness; drug distribution

EXECUTIVE SUMMARY

The recently formed Pharmacy division at Vancouver Coastal Health (VCH) is currently engaged in a number of projects to standardize and modernize pharmacy services across the region. One such proposal involves building a central pharmacy distribution centre that would provide unit-dose packaging services, a central IV admixture program, preparation of Total Parenteral Nutrition bags and consolidated inventory and purchasing. Unit-dose packaging allows for recycling of unused medications and, particularly when provided in a patient specific manner, greatly decreases the number of medication errors. Centralized IV admixtures will allow for better production standards and for efficiencies gained by batching. As with unit-dose the IV admixture program when provided in a patient specific manner is also associated with increased patient safety. Finally, consolidating inventory and purchasing will allow the region to decrease overall inventory and increase the number of inventory turns as well as decreasing administrative costs associated with purchasing and accounts payable. The option of consolidating production and inventory within existing facilities is also considered.

The Calgary Health Authority (CHA) is currently using a central pharmacy distribution centre and the Fraser Health Authority (FHA) is coming online with a new facility at the time of this report. Each of the options listed above is considered using information gained from fifteen interviews with management from VCH, CHA, and FHA

as well as tours of two major hospital pharmacies and the newly built distribution centre in the FHA.

VCH currently is approximately 75% unit dosed (see appendix 2). Using data from a recent study on Canadian adverse drug events (Baker et al, 2004) we have estimated that 1412 medication errors daily can be attributed to oral doses alone. Using data from the same study these errors can be attributed to an estimated 1.9 million additional patient days in hospital and 3402 patient deaths per year. Switching the region to a 100% unit-dose distribution system would result in a three-fold reduction in medication errors, patient days, and deaths.

In addition to increases in patient safety, a pharmacy distribution centre can result in significant financial savings. The FHA estimated a total annual savings of $995,854 attributed to decreased drug waste, staff reclassification and reduction, reduced inventory costs, and in house production of previously pre-packaged products. VCH was not able to provide accurate measures of inventory cost and turns, drug waste, or staff costs so it was not possible to quantify the total financial savings to the region though the current situation at VCH is very similar to that of the FHA at the time their estimates were done.

We evaluated two options for VCH, centralizing within existing facilities, and building a pharmacy distribution centre. From the perspective of an issue analysis, stakeholder analysis, and site analysis centralizing production to a pharmacy distribution centre is preferable to centralizing within existing facilities. In both the CHA and FHA models, pharmacy distribution was consolidated with materials management (non-pharmaceutical supplies) distribution in order to share costly infrastructure. In VCH this

option will not be possible until their materials management lease obligation in New Westminster is fulfilled in four years.

Considering the lack of internal capabilities (e.g. measurement and information systems) and existing lease obligations we have recommended that VCH consolidate production within their existing facilities in the short term. We do, however, recommend that VCH pursue the pharmacy distribution centre in conjunction with a materials management distribution centre as soon as possible considering that planning and implementation at FHA took approximately four years.

Either option, but especially the pharmacy distribution centre, offers the opportunity for VCH to greatly increase the value of pharmacy practice within the region. Increased patient safety and efficiency and decreased cost will help pharmacy to meet the challenging environment in which it is currently situated.

I would like to dedicate this to my parents for their continuous support, love, and encouragement throughout my entire life.

To my boyfriend, Mike, for his unfailing confidence in my abilities, encouragement, love, and support throughout this project and the MBA program.

To my sisters, Tara and Christina, for their love and emotional support.

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I dedicate this report to all those who have suffered as a result of an imperfect healthcare system - that their loss may not pass unnoticed or unheeded.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

GLOSSARY

Terms	Definitions
ADEs	An adverse drug event is any incident in which a medication at any dose or a special nutritional product may have resulted in an adverse outcome in a patient.
ADMs	Automated dispensing machines for automated management and dispensing of medication
CIVA	Centralized intravenous admixture
Error of commission	This is an error that occurs as a result of an action. For example, when a medication is administered at the wrong time, in the wrong dose, or using the wrong route.
Error of omission	This is an error that occurs as a result of an action not taken. For example, when a nurse omits a dose of medication.
FH	Fraser Health
IV admixtures	Compounded sterile preparations that are administered through an IV
Health Service Delivery Area	VCH has divided the authority into 4 health service delivery areas based on geography: Coastal, Providence, Richmond Health Services & Vancouver Community, and Vancouver Acute
LGH	Lions Gate Hospital
MAR	Medication Administration Record A record of the medications administered to a patient by a nurse or other healthcare professional.

Med Carts	Medication carts that contain both personal and ward stock medications. The medications in these carts are separated for individual patients and are ready for nurses to administer.
Medication Error	Any type of medicine related mistake made by a health care professional that may severely impact a patient, causing serious injury.
Pac Med®	An automated unit dose, high speed, multiple canister, tablet and capsule bar-coding, packaging, and dispensing device. A product of McKesson Automation.
PHC	Providence Health Care
TPN	Total parenteral nutrition is the practice of feeding someone intravenously. The sterile bag of nutrient solution contains water, glucose, salts, amino acids, vitamins and sometimes fats.
UD or Unit-dose	Medication packaged individually as a single dose. Each package contains a single tablet or capsule and is labelled with the drug name, strength, lot number and expiry date.
UBCH	University of British Columbia Hospital
VCH	Vancouver Coastal Health
VGH	Vancouver General Hospital
Ward stock	Cabinets that are on each hospital unit that contains medications that would be required on immediate or life-threatening conditions and medications that are used in routine patient care without a high potential for toxicity.

1 Introduction

1.1 Background

Over the past few years there has been increasing attention to the issues of safety and efficiency in the health care system. The service and practice of hospital pharmacy is no exception. The hospital pharmacy is an area of complex organization, coordination, and prospective hospital efficiency enhancements. As a result, Vancouver Coastal Health's Pharmacy division has identified pharmacy services as an area to provide enhanced patient safety, process efficiency, greater capacity, and potential long-term cost savings.

Vancouver Coastal Health (VCH) is the largest health authority in BC and serves 25% of BC's population in communities from Richmond through Vancouver, the North Shore, Sunshine Coast, Sea-to-Sky area and Powell River (for a map of communities served see figure 4). VCH operates over 9,000 acute, rehabilitation and residential beds in 14 acute care facilities and two diagnostic treatment centres. Providence Health Care (PHC), the largest Catholic health care organization in Canada, was formed in 1997 through the consolidation of CHARA Health Care Society, Holy Family Hospital and St. Paul's Hospital. PHC operates over 714 acute and rehabilitation in-patient bed and 697 residential beds.

The partnership formed by VCH and PHC creates the largest health authority in BC. This newly formed partnership aims to improve people's health, seek out opportunities for regional efficiency and to improve quality and standardization. In the past few years, Providence has worked closely with Vancouver Coastal Health on regional improvement initiatives and better hospital coordination including such areas as emergency department care, comprehensive critical care, medicine, surgery, palliative care, maternity services, mental health and addictions, and hospital-to-community services care.

Another potential improvement initiative and a current area of interest involve centralizing some of the pharmacy operations into a new facility. The quality and safety of drug distribution can be enhanced by centralizing and standardizing certain functions. This interest has led VCH and PHC to consider allocating resources to explore and develop opportunities for centralization of drug distribution in preparation for implementation.

The facility will be designed to consolidate medication preparation for VCH and PHC and will provide the opportunity to utilize automated technology (e.g. unit-dose machines) to package drugs in a more efficient and standardized manner. Oral medications will be packaged individually as unit doses and IV mini-bags will be mixed and labelled in a sterile environment known as a clean room. The proposed facility will allow those hospital pharmacies to increase their use of unit doses, to free up space for patient services (especially at urban hospitals such as VGH where space is at a premium), realize economies of scale, take advantage of a current distribution channel (e.g. non-

pharmaceutical supplies distribution centre in New Westminster), and, most importantly, increase patient safety.

1.2 Objective and Scope of Analysis

This project seeks to answer a basic question – whether or not a centralized unit-dose distribution system will be of greater benefit to VCH than the current fragmented system. From a business perspective the issue comes down to cost – whether the cost of hospital space, medication errors, inventory, waste, or labour. From a healthcare perspective, however, centralized pharmacy distribution involves outcomes that may not be easily monetized as they relate to the most precious resource of all, life. Within our analysis of the two health regions and other pharmacy distribution models across Canada, then, we seek to explore the various opinions of management, pharmacists, technicians, service people, and most importantly the patients who ultimately will be affected by the proposed distribution centre. Most of the background information for this project comes from fifteen personal interviews conducted with various members of the VCH management team as well as management in the Fraser Health Authority, Calgary Health Authority, and Interior Health Authority where varying degrees of centralized pharmacy services have been attempted. As well, pharmacy facilities at VGH and St. Paul's Hospital and Fraser's Pharmacy Drug Distribution Centre (PDDC) were toured.

This project takes the form of an early stage business case that will lay the groundwork for future analysis. Bearing in mind the current and estimated future needs of the health region the business case will determine whether a new facility must be built or whether an efficient unit dose distribution system can be established using the existing

facilities and infrastructure. The internal capabilities of the VCH shared pharmacy services department will determine the extent to which the organization can respond to pressures from the external environment. This project is not intended to provide a detailed financial analysis, however, as the region has not yet established standardized measurement systems this type of analysis will be pursued at a later stage. Currently the only operational central pharmacy distribution centre in Canada is located in the Calgary Health Authority and a second facility has recently been built in the Fraser Health Authority. Insights from their experience are drawn upon heavily in this report.

Upgrading or building a new distribution centre also offers the opportunity for process reengineering. Throughout our analysis of the health region we therefore must ask how we can make the system better than it is today. We are cautious though in working within the constraints of the public healthcare system. Still, some insights are sought into the types of structures, technologies, and systems that might facilitate future improvements to the regions even if they are not currently feasible. Any such improvements, however, require a deep understanding of the current pharmacy system. The tools used in this analysis are intended to elucidate a complicated system for the writers and readers and hopefully also will prove useful for management in conducting further planning.

Increases to patient safety have been identified by the project sponsor as paramount in this business case. Estimates of the increases in safety due to unit dosing and admixtures are available but measures of safety should be considered within the business case to justify the proposed investment as well as future investments. Other non-

financial benefits to the system or future opportunities might also result from the proposed distribution centre and these are gleaned from interviews with the various parties involved and the other health authorities who have considered or attempted such programs.

We have also assumed that the VCH region is large enough to generally behave in much the same way as the health systems that have been studied to establish error rates. In fact, we believe that small rural hospitals likely have unique sources of error. For the sake of this analysis, however, we have used the same data for larger sites (because there are very few beds in the rural hospitals this assumption will not have a significant effect on the overall analysis.

With respect to the proposed distribution centre we are assuming that resources can be made available to go ahead with future planning and implementation and that a suitable site can be found. Vancouver is perhaps a more challenging and expensive city in which to locate a distribution warehouse but these challenges do not seem insurmountable.

Finally, the nature of this project requires that the majority of our information be derived from direct sources rather than from research. We assume, given the lack of scholarly, sources that interviews are the best way to discern the potential costs and benefits of the proposed distribution centre. Furthermore we assume that our interviewed sources are relatively un-bias and that by using a number of such interviews we will in effect correct for such bias.

1.3 Project Structure

The next chapter of this project deals with the current state of VCH's pharmacy services. The role of pharmacy and the process from prescription to administration is described. The complicated external environment surrounding healthcare and pharmacy is considered from political, economic, social, technological, environmental, and legal perspectives in chapter 3. Chapter 4 describes the three pharmacy production activities that the pharmacy department performs that will be the focus of this case. Chapter 5 analyses the costs and benefits of the current system, a centralized distribution system using existing resources (options 2a and 2b), and a custom built central distribution centre (option 3). These three options are qualitatively analyzed from the perspective of various stakeholders and each site within the health region. A risk assessment is also presented in chapter 4 with various containment strategies. Chapter 6 offers short, medium, and long term recommendations to VCH and presents a timeline of the proposed actions. Chapter 7 summarizes the findings of this report and Chapter 8 offers reflections on the overall learning process.

2 Current State

2.1 Introduction

The purpose of this chapter is to provide a brief look at the internal operations of hospital pharmacy. The drug distribution process is considered and mapped out visually for the reader in order to provide a bird's eye view of some of the issues considered in the business case. Finally, internal drivers and enablers of change are described in order to provide greater context for VCH Pharmacy Division's strategic position.

2.2 Role of Pharmacist

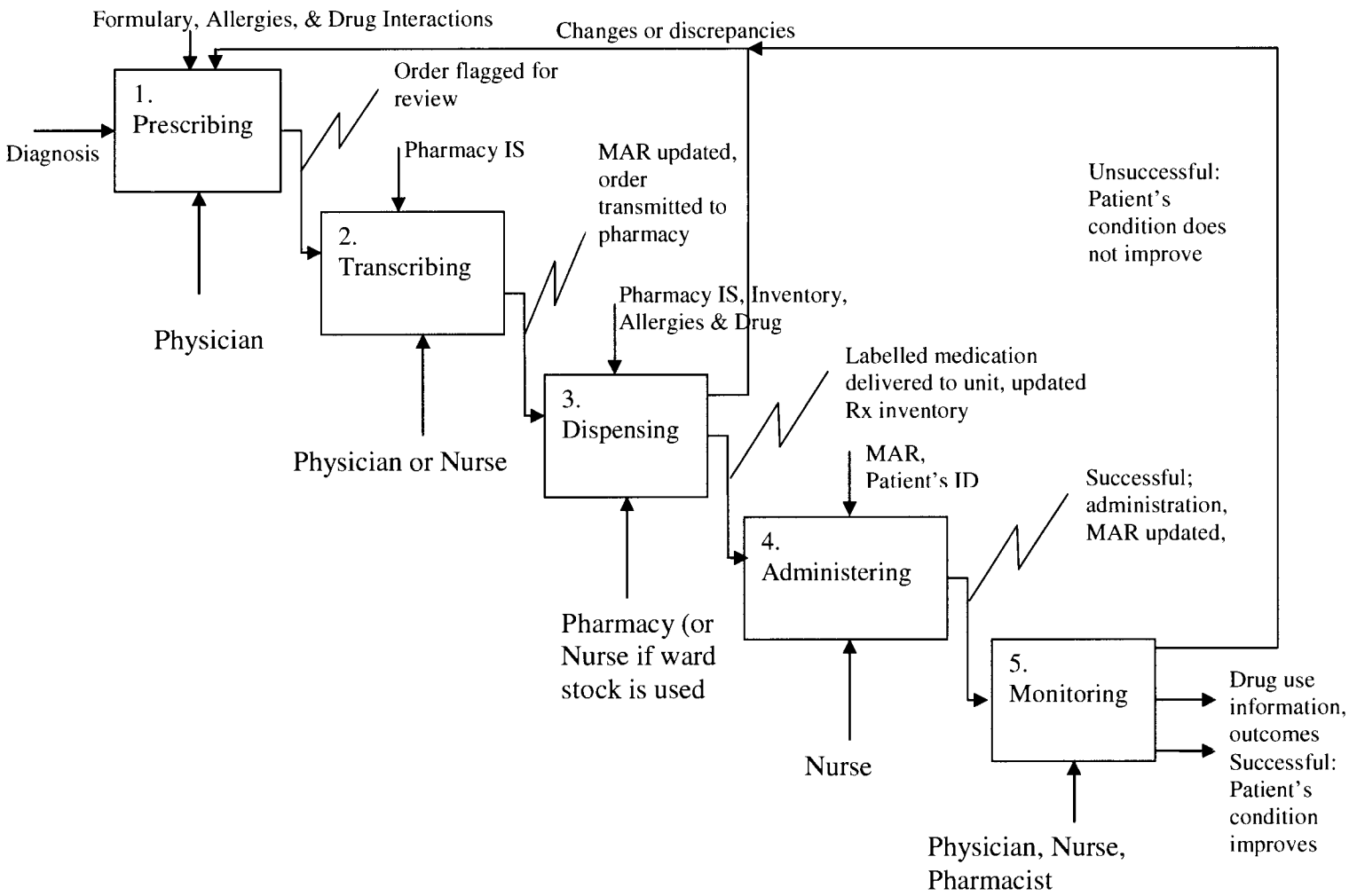
One of the primary functions of the Pharmacy Division of VCH is to provide patient centered pharmaceutical care and as a result clinical pharmacists are involved in providing drug therapy for the purpose of achieving positive outcomes for a patient's well being. They are responsible for providing drug information and advice in regards to drug therapies, transcribing, verifying and dispensing medications and are therefore responsible for the safe and effective use of medications. They are a critical source of medical knowledge and can also participate in optimising and monitoring drug therapies in collaboration with physicians.

2.2.1 The Medication-Use Process

The Medication-Use process is a model that describes the typical steps related to drug therapy. The process begins when a patient, recognizing that they have some health-related problems, enters the healthcare system. A process map of the current medication

use process of the hospital pharmacy was developed using the IDEF0 (Integrated Definition for Function Modeling) modeling methodology (Figure 1) IDEF0 is a graphical representation of a process that exhibits the activities and their interdependence. The model reveals the interactions between activities in terms of inputs and outputs while showing the controls placed on each activity and the types of resources assigned to each activity.

Figure 1: IDEF0 Model of the Medication-Use Process



Each of these 5 steps of the Medication-Use Process involves a number of activities. The following is a brief description of these activities.

Prescribing requires the physician to examine the patient and evaluate their condition. The physician must then establish the need for medicine and select the right medication. In choosing a medication, the physician must consider any interactions with medications that the patient is currently taking and any allergies that they are aware of. The physician can then prescribe a medication.

The second step in the medication-use process involves transcribing or documenting the prescription order. The order is then transmitted to the pharmacy.

The third step in the process involves dispensing the medication order. The prescription order is first reviewed and the transcription is confirmed. If at this point there are any concerns or discrepancies, the prescribing physician is contacted. The medication is then filled, packaged, labelled and checked for accuracy. The prescription is then distributed to the appropriate nursing ward.

The fourth step in the process is administration of the prescription to the patient. These activities are typically done by the nursing staff and require the nurse to first review the prescription order and verify the correct patient, time and dose. The nurse will then confirm the directions and review any warnings, allergies and interactions. The nurse will then evaluate the patient and administer the medicine.

The final step in the process involves monitoring the patient. In this step the patient is monitored to assess the patient's response to the medicine and to report and document the results of this assessment.

The medication use process is highly complex. It also faces a number of challenges including more complex drug therapies, increasing drug prices, an aging population, more direct-to-consumer marketing, and more over-the-counter products (i.e. supplements and herbal products). Therefore, if improvements are going to be implemented in this process, it is important to understand the activities involved in each stage and the flow of activities within this system.

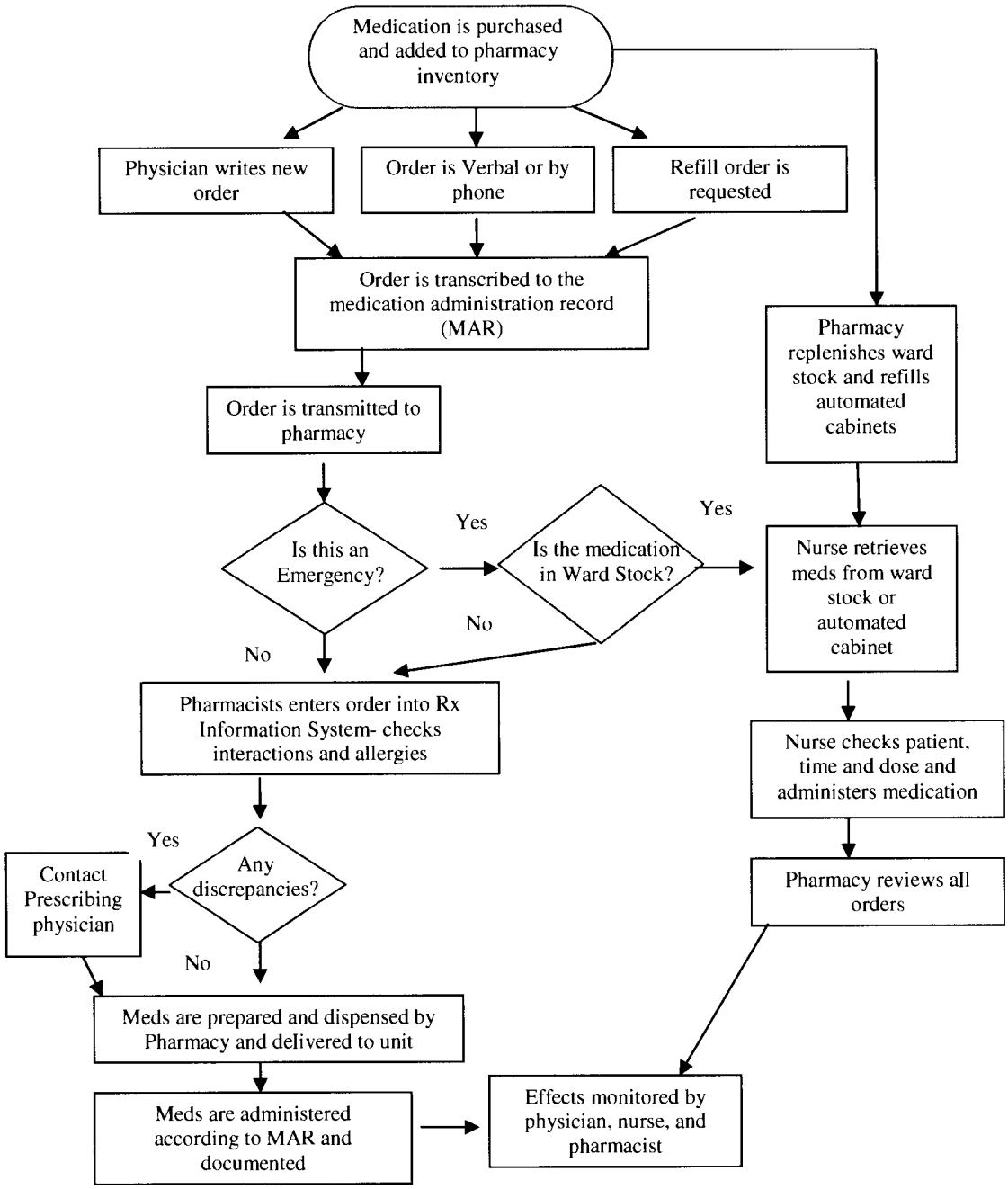


Figure 2: Medication-Use Flow Diagram

The medication-use flow diagram depicts the general flow of activities for medication distribution. The process begins with the purchasing and receiving of medications. Purchasers at each facility order medications through either the vendor or

the wholesaler and the medications are then delivered directly to each site in the form that is provided by the manufacturer (i.e. bulk or unit-dose blister packed). This decentralized system of purchasing creates a large number of purchase orders, increases workload for accounts payable and therefore has a very high level of administration costs.

Physicians then place prescription orders. These could be new written orders, verbal, by phone or prescription renewals. The preferred process is a hand written or electronically entered order. According to Helen Lee, Regional Manager Decision Support, VCH has considered a computerized physician order entry (CPOE) system for years. However, this project is not being pursued at this time due to a lack of sufficient funding (H, Lee, personal interview, June 23, 2006).

The next step requires the order to be transcribed onto the medication administration record (MAR) and then transmitted to the pharmacy. The pharmacy then enters the order into their pharmacy information system and checks for interactions and allergies. Currently, there is not a standardized information system used for the pharmacy division and according to Helen Lee there is no plan to standardize these systems at this time. It is simply too expensive and would have to be driven by needs greater than those of the pharmacy division (K. MacDonald, personal interview, June 14, 2006). Providence uses GE centricity / Rx DFC and will be upgrading to centricity pharmacy version. Vancouver General Hospital uses IDX and Coastal uses Star Navigator.

In the case of an emergency, patients may not be able to wait for the time it would take the pharmacy to review an order. In these cases, nurses will use the ward stock or request an emergency dose of medication from the automated dispensing machines. The

medication is then administered according to the directions on the MAR. The pharmacist will then review all of these emergency doses and try to reconcile any discrepancies.

If it is not an emergency, then the order is reviewed by the pharmacist, entered into the pharmacy information system, and checked against any known interactions and allergies. If the pharmacist feels that there are any concerns or discrepancies, then the prescribing physician is contacted and these issues are reconciled. The prescription order is then prepared and dispensed to the patient's unit. If the hospital is using a traditional distribution system, then the medication is dispensed in a vial for a 5-7 day supply. In contrast, a hospital that uses a unit-dose system dispenses medications every 24 hours or less.

The medication is then administered by the ward nurse and is recorded on the MAR. When the traditional distribution model is used, the nurse must take the medication out of the vial, put it into a medication cup and take it to the patient unlabelled and unpackaged. This system is more susceptible to error and waste (see appendix 1). The final step of the medication-use process involves the entire healthcare team (nurse, pharmacist, physician, and dietician) and requires the patient to be monitored for any positive or negative reactions to the medication.

2.2.2 Current Services

The role of the hospital dispensary in most of the VCH facilities will have similar activities. Theses activities include the review and transcription of new prescription orders into the patients' medication profile, dispensing initial and stat medication orders, refilling ongoing medication orders, compounding IV admixtures and TPN bags,

medication purchasing and inventory control. However, not all of these services necessarily need to be done onsite and could therefore be consolidated and centralized in order to take advantage of economies of scale. These production services include activities such as refills, unit-dose packaging, compounding batch IV admixtures, preparing TPN bags, purchasing and inventory. Some of these production services, batch IV admixtures (at St. Paul's), patient specific 35-day cards (at UBCH) and TPN production (at Vancouver General Hospital) are currently centralized in order to take advantage of economies of scale, cost savings, and safety. However, the current centralized services serve only a limited number of sites.

2.3 Drivers for Change

2.3.1 Decreasing Adverse Drug Events

Improving medication safety and reducing adverse drug events is one of the most important drivers for change. These errors are expensive and can cost people their lives. They result in greater costs to the hospital due to longer length stays, malpractice insurance, litigation, and reputation. These errors occur because the process is complex; there is poor communication and minimal automation. However, medication incidents are the most preventable cause of patient injury. Studies that have examined the effects of medication incidents have been conducted predominantly in the United States. One study conducted at two prestigious teaching hospitals in the United States found that approximately 2% of all hospital admissions experience a preventable adverse drug event (ADE). These ADEs result in increased lengths of stay averaging an additional 4.6 days at an average cost of $4700 per admission (Bates et al, 1997). Even though there is little information on the cost of impact of medication incidents in other health care facilities,

one study in the United States found that for every dollar spent on medications in nursing facilities, $1.33 was spent for the treatment of drug related problems (Bates, 1997). Recent studies (Bates et al, 1995 and Lazarou et al, 1998) found that of all ADEs, 1% were fatal and non-preventable, 12% life-threatening, 30% serious, and 57% significant. Overall, 28% of all ADEs were believed to be preventable.

Before attempting to improve medication safety and ultimately patient safety, it is important to understand where errors occur in the delivery of medications. Bates et al performed a systems analysis over a six month period in 2 tertiary care hospitals in which 334 errors were measured causing 264 adverse drug events (ADEs). The research found 39% of errors resulted from physician ordering, 12% involved transcription and verification, 11% were attributed to pharmacy dispensing, and 38% were from nurse administration (Figure 3). Therefore, 49% of errors in this study were in the dispensing and administration stages. However, after further research, the investigators found that adverse drug events were more likely in the administration stage (34%) than in the dispensing stage (4%) (Bates et al, 1995).

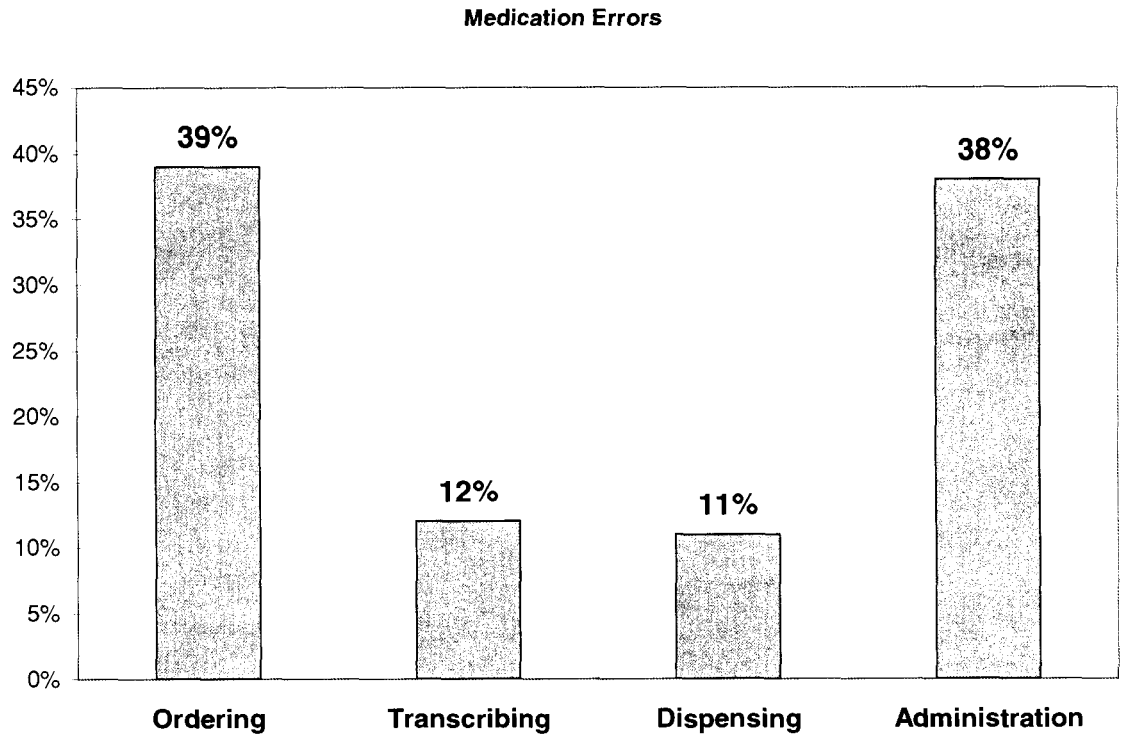


Figure 3: Where Do Medication Errors Occur?

2.3.2 Lack of Standardization

A key driver behind this need for change is the lack of standardization of systems and processes for medication distribution. The regionalization of VCH and PHC's pharmacy divisions resulted in a lack of standardization between facilities. There is a clear need for safer medication distribution and administration (see section 2.2.1 and appendix 2), better control of medications and services (L, Frighetto, personal interview, June 6, 2006, B. Jewesson, personal interview, June 7, 2006), more efficient use of the current automation such as the Pac Med packagers (L, Frighetto, personal interview, June 6, 2006), improvements to the work environment and job satisfaction of pharmacy personnel (S. Shalansky, personal interview, May 31, 2006).

2.3.3 Reform and Reorganization

There is a great need for reform and reorganization in the pharmacy department in order to improve drug management and control, patient safety, system inefficiencies, workplace satisfaction, and to reduce errors, patients' length of stay and costs (S. Shalansky, personal interview, May 31, 2006, L, Frighetto, personal interview, June 6, 2006 and B. Jewesson, personal interview, June 7, 2006, and see appendix 2). VCH is looking for opportunities to re-deploy scarce pharmacists' time to increase clinical consultations and provide enhanced assistance to other health care professionals in order to improve patient care and outcomes.

Reorganization and restructuring of the pharmacy division to separate the cognitive pharmacy practice from the preparation of products for administration will enable the redeployment of pharmacists to occur. This will help to transform the pharmacist's role from one that is product based to one that is knowledge based. Pharmacists would therefore be able to focus their time and resources on improving their knowledge and skill development in therapeutics. While the production facility will staff pharmacy technicians that can specialize in production and focus on quality, speed, cost, flexibility, and dependability.

2.4 Enablers for Change

2.4.1 Efficient use of Resources

Since the optimization and efficient use of resources is a prime objective of VCH (Vancouver Coastal Health, 2005), the possibility to co-locate with Materials Management and share resources such as transportation, infrastructure, housekeeping,

security, IT support, cart washing, waste disposal, parking, and administration costs is a great opportunity.

2.4.2 Pharmacist Shortage

In Canada there is currently a pharmacist shortage and there is a growing clinical and distributive demand on pharmacy staff. Expanding the responsibilities and capabilities of pharmacy technicians will enable the pharmacy department to increase its distributive workload while controlling its costs.

2.5 Conclusion

One of the overall goals of the VCH pharmacy division is to improve the health outcomes of the people they serve. However, they are faced with the challenges of a complex and complicated drug distribution system that is prone to errors, the evolving roles of pharmacists and technicians, the introduction of new technology and information systems, and a lack of standardization of systems and processes. Obstacles in addressing these challenges include financial constraints and a national pharmacist shortage. Due to the complexity of this system, the Pharmacy Division and its managers must plan and implement any changes with the greatest of care and consider how these changes might affect other parts of the system and interconnected systems.

3 External Analysis

3.1 Introduction

The following analysis presents a brief look into the macro environment in which Vancouver Coastal Healthcare's Pharmacy division is situated. The environmental influences are categorized as political, economic, social, technological, environmental, and legal following the strategic framework set out by Johnson and Scholes (2002). This analysis is by no means exhaustive as healthcare is such a complex and widely talked about issue that it would take many volumes to describe all of the external factors important to it.

3.2 Political Influences

Political influences exist in the forefront for healthcare at a national, provincial, and regional level. Indeed, healthcare has remained a hot button political issue since doctors first went on strike in Saskatchewan following Premier Tommy Douglas' introduction of the country's first public healthcare system in 1947. Since then the amount of discussion has ballooned such that in 2002 no fewer than three major national reports, the Mazankowski Report, the Senate (Kirby) Report, and the Romanow Report were released. All of these reports focus on several key issues including: the need to create a financially sustainable health system, reduced wait times, establishment of an electronic health record, and development of national pharmacare assistance. After the much publicized first ministers conference in 2004 these issues were addressed by a 10

Year Plan to Strengthen Health Care which includes a National Pharmaceutical Strategy (NPS). The NPS includes nine recommendations among which are the development of a national formulary, provision of catastrophic drug coverage, a common drug review (a pricing and equilibrating mechanism), and a national pharmacare program (Wayne, 2006).

Provincially, documents such as the 2002 report "The Picture of Health" outline the future vision of healthcare in BC along much the same lines as those laid out federally. The regionalization that created VCH is part of a broader provincial strategy that includes using resources better to increase access; increasing quality of life for seniors, the chronically ill, and the disabled; focusing on prevention; addressing human resource shortages and issues; and creating a financially sustainable system that is accountable to the public (BC Health Planning, December 2002) . BC has had a pharmacare program since 1974 and as of 1993 the program covered some 899,669 patients for a total cost of $659 million (BC Pharmacare Ministry of Health, 2003). The province also has an eHealth strategy that will help work towards establishment of an electronic health record. The first phase of the eHealth strategy, released in 2005, calls for immediate action towards providing access to critical patient information such as prescription records (British Columbia eHealth Steering Committee, November 2005).

Another significant political trend whose impact is as yet unclear is the move towards more private health delivery. Currently, many health services are contracted out to private firms by government, but until now a two tiered health system has been largely precluded by the Canada Health Act. The Supreme Court of Canada, in a landmark

decision, recently ruled that Quebec could not prevent individuals from seeking private health insurance for operations available from the public health system. This decision and other actions in the provinces, most notably, Alberta Premier Ralph Klein's "Third Way" has cleared the way for dual public/private delivery of some services. BC's premier Gordon Campbell has voiced a more cautious but supportive argument in favour of privatization (Kuyumcu, 2005).

3.3 Economic Influences

In 2003 Canada spent $121 billion on healthcare, or approximately 10% of GDP, a number which has increased steadily since 1975 when costs were only 7% of GDP (CBC News Online, September 2004). Furthermore, Canada's healthcare insurance system is not sustainable and our spending is increasingly born by future generations and by the provinces (Kirby, LeBreton & Keon, 2002). Healthcare costs in BC are currently rising at the rate of 8% per year and already represent 41% of the provinces' discretionary spending (Canada politics: Provinces push for healthcare reform, May 2006). Drugs represent one of the largest components of healthcare spending, greater than the cost of physicians, despite the fact that many drug prices are kept down by the Patented Medicine Prices Review Board of Canada. In fact, the very practice of regulating drug prices has been drawn into question in a recent Fraser Institute report that suggests that the practice of granting virtual monopolies to many generic manufacturers reduces competition and costs Canadians approximately $2 billion annually (Skinner, 2005). Drug costs are currently rising at an average rate of 16.5% per year (Laudrum, 2005) and will continue to rise as more treatments become available for common diseases like diabetes and arthritis. Significant pressure therefore exists for hospital pharmacies to

contain costs and to meet increased capacity. Unfortunately, though, nearly 80% of healthcare costs occur at the point of care (Chambers, 2003) leaving precious little in the way of capital funding for projects such as a pharmacy distribution centre.

3.4 Social Influences

Demographic changes to the Greater Vancouver Regional District pose many challenges and few benefits to healthcare delivery. Despite the fact that BC's population is widely touted as one of the healthiest in North America and the world, a 1996 GVRD census showed that the proportion of seniors (those over 60 years of age) is forecasted to double between 1996 and 2021 (GVRD Strategic Planning Department, October 1997). Seniors are also living longer thanks to a generally increasing life expectancy, but small increases in life expectancy are often the result of costly medical intervention. Furthermore, the population in general is increasing rapidly with the GVRD leading the country as the fastest growing municipality in Canada from 1986 to 1996 (GVRD Strategic Planning Department, April 1997). The booming construction industry suggests that such growth shows no sign of abatement. At the same time, however, consumers are becoming increasingly aware of health choices and as alternative therapies gain prominence some pressure on the healthcare system may be alleviated.

Labour shortages also affect hospital pharmacies and the healthcare system in general. Pharmacists are in short supply and the hospital pharmacy will be affected by doctor and nursing shortages as pressure is felt throughout the continuum of care. A recent report from the Canadian Institute for Health Information revealed that one in three nurses is over 50 years of age which presents a potential for massive future

shortages (Vu, 2005). BC has recently addressed the issue of shortages by targeting foreign professionals and easing immigration requirements. Still, greater attention must be paid to ensure that vacant positions are filled and overall growth strategies should be mindful of current and anticipated future shortages.

3.5 Technological Influences

Besides political pressure to create an electronic health record there are a vast number of new and changing technologies which burden administrators with the issue of choice. Still, some argue that hospitals have been too slow to adopt information technology and that the incentive structure to reward such innovators is non-existent (Chambers, 2003). Among the currently available technologies for hospital pharmacies are robotics, automatic dispensing machines, automatic unit dose machines, RFID systems for establishing drug pedigrees, bar-code machines, and a variety of IT systems. Given that there is very little in the way of pharmacy technology research funding it is perhaps not surprising that hospital pharmacies rely on already proven models and that change is slow to occur.

Changes in the way that drugs are developed and prescribed are also likely to exert a strong influence in the pharmacy setting. Classic drug discovery has typically focused on the screening of small chemical entities that can be produced in stable pill forms. Since the early 1990's, however, a host of new large protein based therapies have become available. It is estimated that these biopharmaceuticals now represent 7% of the total drug market and will grow to 25% by 2010 (Ng, 2004). Unfortunately, biopharmaceuticals also tend to be more expensive and have significantly reduced shelf

lives. Pharmacogenetics and Pharmacogenomics are also likely to add to the complexity of drug development and prescriptions. Although the approach is slightly different each one has the capacity to divide diseases based on genetic polymorphisms (different versions of genes) into different subtypes. Drug responsiveness often varies significantly according to these subtypes and not surprisingly regulators have begun to ask for pharmacogenetic/genomic data where it is available. The FDA for, example, issued a guidance document requesting voluntary submission of pharmacogenomic data where it is available (Guidance for industry pharmacogenomic data submission, March 2005). The impact of this development is twofold: first it has the potential to drastically reduce disease populations and thus increase the number of unique treatments, and second it will necessitate genetic testing for patients in order to determine the appropriate course of therapy. From a pharmacy perspective advances in genetics and drug development will mean more products, higher cost, shorter shelf life, and the need to closely coordinate activities with genetic testing facilities.

3.6 Environmental Influences

If not properly disposed of (e.g. in biohazard containers) waste medication poses a serious environmental threat. Specific types of medications, such as chemotherapy, are also a concern and are governed by strict environmental guidelines regulating how they are handled and disposed of. Other than medication, however, which is a relatively small by-product there are few environmental concerns around hospital pharmacy by-products. Environmental influences, specifically water and air quality in the Greater Vancouver Regional District, are also important as they are key determinants of public health. Concentrations of thirteen key pollutants are regularly measured and were below national

desirable limits for 2004 (GVRD Policy and Planning Department, October 2005). ICBC's AirCare program and the general lack of heavy industry in the Fraser Valley likely play an important role in ensuring continued favourable air quality which in turn decreases respiratory and other illness. The most recent report on water quality was not quite so rosy. Bacteria, turbidity, and pollutants were well within Canadian limits though there was an incident (testing but not infection) of fecal E. Coli in one municipality and limited incidents in increased turbidity (Greater Vancouver water district, 2005). Upgrades to the city's three major watersheds, however, are underway in 2006 and should help provide safe drinking water well into the future.

3.7 Legal Influences

Various legal constraints exist within the healthcare setting. Those most relevant to pharmacy relate to Health Canada regulations, the College of Pharmacists, and the union to which pharmacists and technicians belong. Health Canada and the College of Pharmacists dictate the ways in which drug products are produced and handled, and so for example, prohibit the re-use of returned open stock medication. Narcotics must be kept in a vault and controlled to prohibit free dispensing. Regulations dictate that injectable substances are produced in a clean room environment – a regulation to which the Vancouver Coastal Health Authority is not currently in compliance with. Union rules present a variety of constraints but will be critically important as the region transfers employees and changes their classifications in an attempt to centralize services.

3.8 Conclusion

Healthcare is a universal right in Canada and is therefore universally talked about. Politicians make and break careers over issues in health care and ballooning budgets suggest significant continued interest. New technologies offer the chance to revitalize an ailing industry that is often criticized as causing more harm than good. Healthcare managers must be cognisant of all the environmental factors that come to bear on the industry but especially those relating to cost, quality, and efficiency of care.

4 SWOT Analysis

Prior to consideration of any business case options, an in-depth understanding of the organization is required. This was accomplished through the use of a SWOT analysis and benchmarking with other similar operations. The information and analysis covers all areas of the current operations and organization that must be considered when making operational recommendations. The information was gathered through a combination of secondary and primary research (i.e. personal interviews).

SWOT is an acronym for strengths, weaknesses, opportunities, and threats. A SWOT analysis is a tool used to identify key issues from the business environment and the strategic capabilities of organization. This tool is typically employed during the early stages of a project in order to help evaluate environmental factors and internal situations facing the project. The strengths and weaknesses are internal to the organization while the opportunities and threats originate outside of the organization. The opportunities are the external conditions that are helpful in the achievement of the objective and the threats are the external conditions that are harmful or may hinder the achievement of the objective.

Table 1: The following matrix presents a concise summary of the SWOT analysis that was performed. In the following 4 sections, each of these points will be described in greater detail.

Table 1: SWOT Matrix

Strengths	Weaknesses
- Well staffed - High skill & knowledge level - Visible and experienced leadership - Central production experiencce (CIVA, AUD, & TPN) - Two existing PacMeds - Automated Dispensing Machine roll out - Regional matrix structure (by HSDA & service) - Purchasing power through buying group - Communications with Materials Management	- High staff turnover - Increasing workloads - Inefficient production / Limited automation - Space constraints - High administrative costs - Inexperience with new organizational structures - Budget constraints (particularly capital budgets) - Little standardization of policies/practices/processes - Outdated pharmacy practice at some sites - Discrepant pharmacy information systems - Little sophisticated security (drugs vulnerable to theft) - High medication waste - Inadequate measurement systems - No growth forecasting model - Change fatigue - Low capacity for innovation - Unclear mission/vision/values - Large geographic area
Opportunities	**Threats**
- Expiring materials management lease in 2009 - Legacy Project to construct new major hospital - Modern automation technology available - Increased acceptance of technicians and other low wage employees in pharmacy production - Experience with centralization in other regions - National/Provincial health awareness/prevention - Political drivers support centralization	- Increasing population - Increasing senior population - Pharmacist/doctor/nurse shortages - Labour unions - Increasing drug costs (average 16.5% per year) - Increasing drug numbers / therapy complexity - Rising fuel prices (transportation expenses) - Privatization may threaten public funding - High and rising land costs in Lower Mainland - Increased complexity of drugs with biotechnology and pharmacogenomics/genetics

4.1 Strengths

Resources

Relative to other health authorities in British Columbia, VCH is relatively well staffed and has highly skilled professional and knowledgeable staff.

Administration

Vancouver Coastal Health also has sufficient and supportive administrative staff.

Experience

Some experience with shared production services already exists at the major teaching hospitals (e.g. TPN, IV admixtures and unit-dose packaging). This will facilitate the transition towards a fully centralized pharmacy distribution centre. Vancouver Acute has a developed shared services 35-day unit-dose card service at UBCH as well as a well established CIVA program that currently provides centralized services at St. Paul's Hospital

Capital

Two Pac Med machines were purchased for St. Paul's and these will likely be able to handle the solid oral dose packaging requirements for the entire region. The machines have the capability to be integrated into the pharmacy information systems so that when a patient's order is entered at any hospital, the machine will automatically prepare, package, and label the medication in preparation for distribution.

Infrastructure

The recently formed Pharmacy Shared Services department facilitates regional coordination. Structurally, the team is somewhat of a matrix divided by health region but with regional portfolios that span all the health regions. This structure also facilitates region wide coordination.

The Regional Director of Pharmacy, Robin Ensom, provides a clearly visible leadership position that will help to enable regional process and systems changes.

The health care facilities in this authority are grouped into 4 health service delivery areas that are geographically clustered close to one another enabling easier distribution. Most of the beds serviced are in a small geographic area (greater Vancouver area)

Automated dispensing machines (ADMs) are already in use at several sites and are scheduled for roll-out at other sites (H, Lee, personal interview, June see H. Lee, personal interview, June 23rd, 2006). This will help to tighten inventory controls (ward stock is not currently counted in inventory but will be once the ADMs are linked into the inventory systems)

A regional pharmacy team meets and communicates regularly. This enables collaboration and communication among Operational Directors of the 4 HSDAs

A newly formed Pharmaceutical and Therapeutic (P&T) committee has been formed with a goal of increasing the alignment between sites. They have also been given approval to manage the regional formulary.

General

Materials Management has been engaged in planning with pharmacy for future consolidation. This will facilitate a quick project implementation and hopefully ensure that both divisions' needs are met.

Vancouver Coastal Health participates in a BC/Ontario group purchasing organization alliance (BCHS/HealthPro) in order to contain drug acquisition costs

4.2 Weaknesses

Resources

There is continuing challenges in staffing and retention. According to one of the Operational Directors, the high turnover rate places a great strain on the Human Resources department (B. Jewesson, personal interview, June 7, 2006).

The workloads for pharmacy staff are increasing as the demands for the pharmacist's clinical services are increasing.

Many facilities still rely on manual packaging and value-added processes that are inefficient and labour intensive.

The position for the Operations Director of Vancouver Acute has recently left and this position along with a few other essential positions needs to be filled before any proactive initiatives can take place.

Administration

A decentralized purchasing system creates a large number of purchase orders, accounts payable, and consequently high administrative costs

Experience

The regional leadership team is still in its infancy and is working its way towards the performing stage of group development.

The regional team is formed by individuals with different experience levels and various backgrounds.

The new partnership between VCH and PHC is just over a year old.

The Pharmacy Division is still working on team building, identifying its own vision and unique organizational culture.

Capital

Due to financial constraints and population growth, the current hospital pharmacies are cramped for space and many have less than ideal floor plans and work flows.

Budget constraints limit the number of new initiatives and projects undertaken by the regional pharmacy division. Therefore, only the effective use of resources to improve efficiencies will be carried out.

Infrastructure

The transportation routes within this health authority are not the most ideal. The challenges for transportation routes include insufficient highways, a large number of bridges and bottlenecks, including ferry traffic, especially for some of the more rural

sites. In addition to the lack of defined transportation routes, this health authority is spread across a large geographic area covering over 54,000 km^2

Most of the CIVA facilities are out-of-date, less than ideal and do not meet the new USP 797 standards and requirements. The U.S. Pharmacopoeia has set forth standards and requirements for the compounding of sterile preparations (U.S. Pharmacopoeia, 2006).

A lack of high level security and surveillance make the pharmacy vulnerable to theft.

The current pharmacy information systems (IS) across the region are not standardized and some will likely need to be updated. The pharmacy systems at some sites, particularly at VGH are linked into hospital administration systems which are not likely to be changed in the near future and do not handle the pharmacy side as well as some of the dedicated pharmacy systems.

Legacy pharmacy systems may need to be replaced if new systems are implemented and interfaces need to be created

Processes

There is limited standardization of processes and procedures across the authority due to the recent partnering of the VCH and PHC and the diverse nature of the facilities that operate within the diverse communities of this authority.

The current medication distribution system is a mix of traditional, medication cards, and unit-doses. Some hospitals such as St. Paul's are almost completely unit-dose while other hospitals are still completely reliant on ward stock and the traditional drug distribution system.

The current CIVA program is ineffective and inconsistent due to the lack of batch processing, standardization and sub-par facilities.

Medication wastage due to the inability to re-use medications that have been dispensed to the nursing wards but not fully consumed due to the lack of use of the unit-dosed system. Unused medications that are not individually packaged and labelled must be disposed of according to the College of Pharmacists. In addition, wastage does not appear to be accurately measured

Measurement systems are either lacking or not well understood. Of the Operations Directors interviewed none was able to give a clear answer about medication use, inventory costs, or waste (S. Shalansky, personal interview, May 31, 2006, L, Frighetto, personal interview, June 6, 2006; B. Jewesson, personal interview, June 7, 2006 and K. MacDonald, personal interview, June 14, 2006). Furthermore, system wide measures are complicated by differing information systems and measurement practices.

There does not appear to be any consistent model used for growth forecasting. Drug costs increase annually but planning for cost and volume increases does not seem to be a central issue.

Capacity for Change

The organization seems to have a low capacity for innovation. There are no specific incentives to reward staff for creating improvements. One interviewed long time staff member had several ideas for improvements but had either never been asked or was not given resources to further the pursuit.

Organizational culture seems to be mainly a professional one; however, a clearly communicated vision does not seem to have been promulgated.

Change fatigue is a serious problem for this large, highly complex and ever-changing organization. Many are struggling to keep up the multitude of concurrent changes

4.3 Opportunities

There is an opportunity to enhance the scope of pharmacy technicians in production work in order to further support pharmacists and the increasing demand on their services.

Compliance with the Ministry of Health, Report on Drug Procurement, recommendation that all British Columbia Health Authorities centralize drug inventory functions (Ministry of Health, 2002)

Materials Management (the non-pharmaceutical hospital supplies) are currently using a distribution centre in New Westminster with a lease that runs out in four years time. The facility was only intended for temporary use and therefore Materials Management will need to relocate before the lease ends. This creates the opportunity to collocate and build a new facility in conjunction with the pharmacy division. This will

enable the two divisions to share resources such as transportation, building, overhead and administration costs.

The Providence Legacy Project is currently planning a new major hospital to replace St. Paul's, Mt. St. Joseph's and Holy Family Hospital. The current suggested site on Terminal Avenue in Vancouver is central to most of the region and might provide the opportunity to collocate a pharmacy distribution centre alongside the hospital.

Many new technologies are now available to support regional production. These include automated unit dose machines, automated dispensing machines, robotics for sorting and picking and bar coding for tracking inventory.

As mentioned several other regions have varying degrees of experience with centralization. The Calgary Health Authority has had a distribution centre active for over a year and the Fraser Health Authority is in the process of phasing in production at their new facility. The wealth of knowledge available from these two regions and others who have considered or attempted centralized pharmacy services represent an opportunity for VCH to learn from their experience and possibly 'leapfrog' into using next generation technology.

Health promotion and disease prevention has become a major trend within many levels of government and was part of the overall strategy for forming health regions. In as much as these measures help to reduce hospitalization they represent an opportunity for pharmacy to help alleviate future demand.

4.4 Threats

A rapidly increasing local population due mainly to an aging population places greater pressure on the current healthcare facilities and resources

Steadily increasing property values in the Greater Vancouver Area as well as ballooning construction costs make expansion and leasing increasingly more expensive

Aggressive recruiting agencies pose a great threat to the retention of pharmacy staff.

Changes to Provincial legislation could require process and/or systems changes that were unforeseen.

Contract negotiations with labour unions could pose a threat to current resources.

Standardization and centralization will require resources for creating pharmacy management system interfaces which may be difficult and time consuming given some of the legacy systems currently in use.

Rapidly increasing drug costs (approximately 16% per year – see external analysis) will increase the already large medication budget.

There is an increasing number of available therapies and increasingly complicated therapy regimes (e.g. multi drug treatment for hypertension).

Public entities such as public healthcare are highly scrutinized by the media and the public.

The introduction of private health clinics and medical services may threaten public healthcare funding

Transportation costs will increase as a result of the additional distribution costs that will be associated with expanding the current centralized services to more sites. There is also a risk that transportation costs will increase as a result of increasing fuel prices

5 Production Activities

The Vancouver Coastal Health Authority and Providence Health Care formed a partnership to create one of the largest health care regions in British Columbia in order to increase the efficiency of the health care system. With their new continuum of care strategy, these facilities will share knowledge, work more closely together and perform according to the regional clinical standards (Vancouver Coastal Health, 2005). This health region is divided into 4 health service delivery areas (HSDA) known as:

Coastal / Garibaldi

Providence Health Care

Richmond Health Services and Vancouver Community

Vancouver Acute

VCH operates 14 acute care facilities and two diagnostic and treatment centres, 8,500 acute, rehabilitation and residential beds, and covers a geographic area of 54,165km^2 serving a total population of 1,003,150 people which is 25% of B.C.'s population (Vancouver Coastal Health, 2006). Figure 4 shows a map of the VCH region (in yellow) that is the focus of this case.

Figure 4: Map of Vancouver Coastal Health (Yellow Area)

In 2005, Vancouver Coastal Health released a document titled *Strategic Priorities* which outlined the health authority's strategic direction that will support its vision "to support healthy lives in healthy communities with our partners through care, education, and research." Their goal is "to improve access to healthcare services and to improve health outcomes for the people" they serve (Vancouver Coastal Health, 2005). This document outlined seven key focus areas that they believe will make the system more efficient and more sustainable. Four of the seven focus areas relevant to this business

case include: emphasizing patient safety, improving service levels, efficiently using resources, and workforce planning and employee development (Vancouver Coastal Health, 2005).

With the objective of improving patient safety, enhancing healthcare delivery, increasing the utilization of pharmacists' clinical services, decreasing medication errors and reducing costs, VCH Pharmacy Division is focusing on the following three pharmacy production activities.

5.1 Focus Area #1: Unit-Dose Packaging Activities

5.1.1 Current Drug Distribution Systems

Currently, the medication distribution systems used within VCH varies between ward stock, a traditional distribution system and the preferred unit-dose distribution system. Automated unit-doses are medications packaged individually as a single dose and are dispensed for a 24 hour period. Each package contains a single tablet or capsule and is labelled with the drug name, strength, lot number and expiry date. Unit-dosing involves the re-packaging of tablets and capsules into individually packaged and labelled, ready-to-administer unit doses. The unit-dose drug distribution system was developed to support nurses in medication administration and to decrease medication waste and is recognized as the safest medication distribution system available (Canadian Society of Hospital Pharmacists, 2004). See Appendix 1 for a comparison between traditional and unit-dose drug distribution systems.

5.1.2 Unit-dose Distribution System

The unit dose system was developed in the 1960s in order to support medication administration and to reduce the waste of increasingly expensive medications. Most studies show a positive impact on the reduction of medication errors of omission and commission with unit-dose dispensing (Hynniman, 1970, Schnell, 1976, and Taxis 1998). Due to the evidence of its significant advantages over the past 25 years, the Canadian Society of Hospital Pharmacists endorses the unit dose drug distribution system in which medications are dispensed in a ready-to-administer form for a 24 hour period. The advantages of this system over other systems include:

Fewer medication errors

Reduced wastage

Improved drug monitoring

More control of medication use

Administration is less time consuming for nursing personnel

More efficient use of pharmacy and nursing personnel

VCH currently uses a mixture of different distribution systems in its facilities but would like to establish the unit-dose distribution system throughout the health authority. This would create a common standard across the authority and improve the safety to its patients by helping to ensure that the right drug in the right dose gets to the right patient at the right time. The larger facilities such as VGH, St. Paul's, and UBC are already

heavily using this system. However, for most of the smaller sites, the unit-dose system requires automation (i.e. Cadet packager) that they do not have and/or is too labour intensive and not feasible as an onsite service. Currently, this system of unit-dose distribution is achieved through the use of small stand alone Cadet Packagers at various sites and two Pac Med packagers located at St. Paul's (the second of which has just arrived and is not yet operational). The Pac Med packager is a larger more sophisticated automated unit-dose packager that can be interfaced with the pharmacy information system. The Pac Med packager has allowed centralization of the unit-dose service and provides automated unit-doses to some select sites within VCH. However, it is not being used at full capacity since it is only operational for approximately 8 hours per day. Therefore, further centralization of the current automation (specifically the 2 Pac Med packagers) and extending the current workload of the Pac Med packager would allow VCH to realize even greater efficiencies in staffing, automation and supplies as well as supporting the standardization and utilization of the unit-dose system as the primary drug distribution system.

The unit-dose system is a value-added service that the pharmacy staff can provide most efficiently with sophisticated automation. Therefore, the centralization of drug inventories, also discussed in focus area #3, will support the optimization of the current packaging automation in order to successfully support the implementation of the unit-dose distribution system throughout the health authority.

5.1.3 Automated Dispensing Machines

The phased role-out of the Automated Dispensing Machines (ADMs) is being pursued independently over the next 2 to 3 years. ADMs will be placed on each of the nursing wards for the automated management and dispensing of medications in a unit-dose form. Therefore, unit-dose packaging activities will support the implementation and role-out of these devices and reduce the time nurses spend preparing medications, improve control of medication use, and facilitate better outcome monitoring. The ADMs will become interfaced with the pharmacy information systems and will be filled by pharmacy technicians with unit-dose medications.

5.2 Focus Area #2: IV Admixture Services

5.2.1 Role of CIVA

The role of a Centralized IV Admixture (CIVA) program is a safe, efficient and cost effective way of providing IV admixtures to patients. CIVA products are individually packaged IV bags produced in a clean room as sterile as an operating room and are labelled with the appropriate patient information when sent to the acute care sites. These products include antibiotics and other medications as well as Total Parenteral Nutrition (TPN).

5.2.2 Current Services

A CIVA program is provided to all of the 14 acute care sites within VCH. However, the scope of the CIVA programs at each site differs. All sites are equipped to provide intermittent infusions such as IV antibiotics. Pharmacy personnel at most sites prepare narcotic infusions, epidural infusions, and a varied selection of direct

intravenous, subcutaneous and intramuscular doses. However, each site uses different formulations. Therefore, each CIVA program is unique in terms of its products.

5.2.3 CIVA Centralization

At present, VCH has consolidated the preparation of some select centralized IV admixture services to a couple of sites. For instance, all TPN is produced at Vancouver General Hospital and serves the 5 sites that utilize TPN products. The daily production varies daily with an average between 30-35 bags per day but has historically reached almost 50 per day during the extremely busy period such as the end of December. Batches of some large volume infusions including both antibiotics and other medications are also produced centrally by St. Paul's Hospital and are distributed to various sites. However, due to space and resource limitations such as transportation, expansion of the currently provided services and the range of products provided are limited.

5.3 Focus Area #3: Decentralized Drug Purchasing and Inventory

Vancouver Coastal Health participates as a member of BCHS/Health Pro, a group purchasing organization alliance that helps to remove unnecessary costs form the supply chain. As a result, VCHA is able to contain drug acquisition costs and realize volume purchase savings.

Currently, medication purchasing is a decentralized function in which each hospital pharmacy orders drugs directly from the vendors or wholesalers. Medications are then delivered directly to the onsite pharmacy and inventory levels are updated at each site and since each Health Service Delivery Area has its own unique information system, inventory is controlled and managed differently for each system. As a result, there are a

number of problems with the current decentralized, site-specific purchasing and inventory systems.

5.3.1 Costs Associated with a Decentralized system

Hospitals with inconsistent and informal inventory controls are more likely to have lower inventory turnovers and consequently have higher costs due to higher inventory levels, poor inventory management, control and visibility, increased wastage, and drug returns. By our estimates, VCH has less than ideal inventory turnover and therefore a costly investment in drug inventory.

There are some system inefficiencies that are inherent in the current decentralized drug purchasing and inventory services that could improve significantly through consolidation and centralization. Evidence of these benefits were realized in Victoria, where in past 10 years these services have been centralized and consequently have led to great cost savings due to fewer purchase orders issued, fewer drug items purchased and therefore more efficient workload for both Pharmacy Purchasers and Accounts Payable. These same benefits are also expected for the Fraser Health Region and there new Pharmacy Drug Distribution Centre (PDDC).

5.3.2 Centralization of Purchasing and Inventory

Once purchasing and inventory are centralized, this will also help to support other initiatives such as moving towards an automated unit-dose (AUD) system throughout the region. VCH has just received its second Pac Med machine which will provide medications in labelled and ready to administer unit-dose packaging. Centralizing drug inventories along with the Pac Med machines will increase efficiencies and support the

initiative to increase the use of the AUD system. In addition, centralizing purchasing and inventory with other currently provided centralized services such the IV admixture (CIVA) program and Total Parenteral Nutrition (TPN) will again be more efficient and cost-effective than housing them separately.

5.4 Conclusion

The partnership between VCH and PHC and the establishment of the Shared Pharmacy Services Division as single department creates the opportunity to achieve economies of scale and efficiency in processes that are performed by the pharmacies throughout the health authority. Consolidation and further centralization of these services will enable greater standardization of processes, cost savings, superior quality, as well as improved medication and patient safety.

6 Option Analysis

6.1 Introduction

The following analysis weighs the costs and benefits of centralizing pharmacy production within existing facilities (options 2a and 2b) and within a newly constructed pharmacy distribution centre (option 3). The current or baseline situation is described and used as a benchmark for evaluation. Later in the chapter the various options are considered from the perspective of the various sites and stakeholders and a risk analysis is done. Polar diagrams are used to describe the quality of service from an internal customer perspective.

6.2 Baseline

Currently VCH/PHC Pharmacy Services has resources spread across 14 acute care sites (2259 beds) as well as 15 owned extended care sites (2106 beds) in four health service delivery areas (HSDA's). IV admixture prep has been somewhat centralized at St. Paul's Hospital by batching commonly used preparations such as IV antibiotics. However, St. Paul's CIVA (Centralized IV Admixture) program is constrained by the limited capacity of their existing fume hoods and production area. Furthermore, the production methods used at St. Paul's and other sites (with the exception of LGH) fall short of safety regulations for sterile injectables (which necessitate pressurized clean rooms). Total Parenteral Nutrition for all sites is done at VGH. The region is on average 75% unit dosed (see appendix 2); however, only in the Providence HSDA has unit dosing

(and multi-dosing) been centralized using a single automated PacMed machine. A second more modern PacMed machine has recently been installed and additional space acquired in the hopes of expanding production to include sites outside of the Providence HSDA. At other sites unit dosing is done by small slow packaging machines that require staff supervision. Extended care sites use 35 day single medication blister cards which are particularly labour intensive both in production and administration. UBCH currently prepares these blister cards for the Vancouver Acute HSDA and as mentioned these are automated by PacMed within Providence. Strangely the number of reported full time equivalents (FTE's) in Vancouver Acute for unit dosing and multi-dosing is less than the number of FTE's used at Providence (2.5 vs. 4.2) to manage the PacMed machines which produce unit and multi dose packs for an equivalent sized HSDA (L. Frighetto, personal interview, June 6, 2006 and B. Jewesson, personal interview, June 7, 2006). It seems likely, however, that measurements may be to blame for this anomaly.

6.2.1 Benefits

The benefits to the current system perhaps relate best to a much older system of individually run hospitals with smaller capacities. Overhead costs and capital investments are lower in the current system than in the other options considered; however, this is somewhat misleading since the current system does not meet production standards. Retrofitting current facilities to handle aseptic packaging is likely to be a major expense, probably more costly than building a new clean room in a central distribution centre. There are also some intrinsic benefits to decentralized production that should be considered. First, the very inventory redundancy that increases carrying costs also provides a degree of safety in the event of shortages. Second, transportation requirements

are much lower in the current system since the burden of transportation is born primarily by the suppliers delivering to each site. Third, specialization is more easily accomplished by decentralized production. So, for example, an order for a 90mg IV mixture in the current decentralized system is easily filled whereas if central production batches 100mg mixtures then physicians may be pressured to decrease customization. Finally, the lead time for products packaged by decentralized pharmacies is lower than if they were centralized; however, this is offset by the increased lead time for inventory arriving from external suppliers.

6.2.2 Costs and Drawbacks

Production in the current system is inefficient, only covers certain sites, and does not meet federal regulations. Economies of scale for some products are likely realized but only at those sites that use batched products. The technology employed throughout much of the region for repackaging is inefficient and labour intensive. Systems are not well integrated and many processes such as order entry and inventory counts are still done manually at many sites. Inventory controls, not surprisingly, are not particularly tight and turnover, particularly at the smaller sites, is generally quite slow. The potential for medication errors exists particularly for sites that don't use repackaged products but also in the major centres where space constraints and the hectic pace of the acute care dispensary interfere with production activities. An interviewed pharmacy technician, for example, pointed out that tasks such as labelling are often interrupted by phone calls disrupting the labelling work (anonymous pharmacy technician, personal interview, June 13, 2006).

6.3 Option 2a: Dual CIVA/AUD distribution node model

This option involves the preparation of unit dose, patient specific doses, and IV admixtures at both St. Paul's Hospital and VGH. St. Paul's would service the Providence and Coastal/Garibaldi sites while VGH would service Vancouver Acute and Richmond sites. Purchasing and inventory would increase at St. Paul's and VGH and decrease at the serviced sites (increased inventory turnover might alleviate some of the extra needed storage capacity). This option would require that the second PacMed machine at St. Paul's be moved and integrated into the pharmacy system at VGH. Also, some integration of other pharmacy systems would be required in order to prepare patient specific unit doses and/or multi-doses. The CIVA programs at both hospitals could be bolstered to accommodate batching for the four HSDA's. TPN could remain at VGH or be moved to another hospital to accommodate increased admixture preparation. In order for CIVA to be brought up to standards the existing facilities would need to be upgraded and additional space acquired. Distribution might be achieved using existing intra-hospital routes but these might need to be increased and/or contracted externally. The other acute care sites could function as transportation hubs routing deliveries to other sites (e.g. extended care facilities) thus minimizing the number of delivery routes from St. Paul's and VGH.

6.3.1 Benefits

Option 2a (and 2b) is essentially a central distribution model utilizing the available facilities and equipment. Because more facilities would participate in unit dose packaging, CIVA products, and patient specific packaging, we would expect an increase in patient safety. Using data from a recent study (Baker et al, 2004), for example, the

estimated current medication error rate (associated with unit-dose vs. traditional stock) might decrease nearly threefold from 1412 errors per day to 508 errors per day if the region were fully converted to unit-dose (see appendix 2). Patient specific IV products and multi-dose packaging for extended care facilities would be associated with similar gains to patient safety.

Inventory controls might also benefit from using the two major hospital inventories as central inventory. Because all ward and dispensary stock at the smaller sites would be ordered in unit-dose format from VGH or St. Paul's it would be possible, at least in theory, to achieve just in time supply to these sites. Greatly increased demand at St. Paul's and VGH would therefore lead to major increases in inventory turns and these would likely be associated with decreased carrying costs. In Calgary, for example, inventory turns increased from 10 to 15 turns per year (see appendix 1) and in the Fraser Health Authority it was estimated that a 10% reduction in inventories and increase in turns from 7 to 8 per year would result in $700,000 in savings per year (Fraser Health Authority, 2003).

Using available facilities offers the advantage of low overhead costs and minimal capital investment. Waste is estimated to decrease since non-unit dosed medications cannot be recycled. Similarly, Staff requirements might decrease because of centralized purchasing, better use of automated technology, and easier medication administration and preparation. Savings might also come about through tighter control of the drug formulary and use of low cost drug alternatives.

Several unique benefits to having two production centres exist. First, inventory duplication, though costly, offers increased safety in the event of shortages. Second, transportation to the two largest facilities would not be required resulting in cost savings as well as short lead times. Finally, disaster preparedness would be enhanced by having a degree of system redundancy.

6.3.2 Costs/Drawbacks

Centralizing production to the two busiest hospital pharmacies in the region would introduce immense strain on the system. In our tour of the pharmacies at St. Paul's and VGH it was evident that space is already at a premium. The Fraser Health Authority ruled out the possibility of centralized production using existing facilities for this very reason and VCH must further consider its production capabilities. Furthermore the additional workload and the hectic setting of a hospital dispensary might introduce new potential for errors. Night shifts might therefore be needed to smooth out production work. Unless additional space is to be acquired long term growth at St. Paul's and VGH would also be encumbered (though capacity would be added to all other sites).

Operating costs such as packaging and maintenance would likely increase though these would be offset by inventory and drug cost savings. The shipping and receiving areas at the two hospitals would be extremely strained by the additional transportation to each HSDA. This transportation would come at a significant cost since some of the internal routes are operated by courier or do not exist at all.

Compared to option 2b operating two production sites would be more costly with respect to staff training requirements, less opportunity to realize economies of scale,

higher inventory carrying costs, and less control over production. Integrating the automated PacMed machines into two hospital systems would also be difficult and costly as St. Paul's and VGH operate on different pharmacy management systems.

6.4 Option 2b: Single CIVA/AUD production centres

This option is similar to option 2a except that all CIVA preparation would be done at VGH and all solid oral repackaging done at St. Paul's allowing for greater specialization and economies of scale. We suggest St. Paul's for solid oral repackaging because it already has experience with the PacMed machines and system integration while both sites currently have a CIVA program. This option would require regular transportation between St. Paul's and VGH, but some efficiency would be gained because the truck would travel in both directions carrying product. Besides transferring CIVA and unit dose products between hospitals transportation to the other sites would function in the same manner as in option 2a.

6.4.1 Benefits

Most of the benefits of this option are the same as those of option 2a. There are, however, some unique benefits to having specialized production sites. Firstly, a greater degree of specialization at each production site might be expected, which offers the potential benefits of increased production quality. Secondly, CIVA and solid oral dose repackaging volumes would be higher at each site than in option 2a and greater economies of scale might therefore be achieved with this option. Thirdly, control over production might be easier to facilitate (labelling standards, for example, would be easier to achieve if all unit-dose packaging were done in a single site). Finally, the number of

rotations at each site would be lower which would therefore decrease the amount of staff training at each site and perhaps also the staffing requirements.

6.4.2 Costs and Drawbacks

There are also unique drawbacks to operating a single CIVA and AUD production centre. Additional transportation would be required to in order to bring unit and multi-dosed packages from St. Paul's to VGH and CIVA products from VGH to St. Paul's. Also, since inventory for production of CIVA and automated unit-doses would be maintained at single centres there would be less redundancy in the event of shortages. Such a lack in redundancy might also be a detriment in the event of a natural disaster.

6.5 Option 3: Central Pharmacy Distribution Centre

The final option we consider is construction of a new centralized pharmacy distribution centre according to the model established by the Calgary Health Authority and replicated in the Fraser Health Authority (see figure 5). Repackaging, purchasing, inventory, and IV admixture prep is centralized in this model to make use of new technologies, realize economies of scale, and increase standardization. Satellite pharmacies at each site would carry a reduced inventory (about 30% of baseline) required for stat and interim doses as well as non-formulary items. In addition, the distribution centre is collocated with non-pharmaceutical materials management distribution in order to take advantage of shared shipping/receiving, transportation, and infrastructure. In both successful implementations existing warehouse space close to the centre of each respective health authority has been purchased and upgraded. Vancouver Coastal Health's material management already operates a similar distribution centre in New

Westminster but their facility cannot be expanded and is not up to current production standards (e.g. clean room). Materials management is locked into a four year lease of this facility but discussion is already underway with pharmacy to collocate any future distribution centre.

Figure 5: Fraser Health Authority Distribution Centre

6.5.1 Benefits

In the current system some production work at smaller facilities is done by pharmacists and, at the large centres, pharmacists are used to check work done by pharmacy technicians. The system in use in Calgary, Fraser, and in many other North American hospitals is a tech check tech (technicians fill orders and technicians check orders) which results in a decrease in staffing costs. In the Fraser Health Authority, for example, it was estimated that eliminating pharmacist checking would save $13,273 annually and switching from packaging by cadet (small supervised machines) to

automated PacMed machines would save an additional $83,096 per year (in staff costs). Alternately, time spent doing production work by pharmacists could be spent with patients resulting in higher quality care.

Drug waste is not as clear cut. Fraser Health Authority estimated that drug waste would decrease from $200,000 per year to $30,000 per year because of unit dose packaging. Vancouver Coastal Health, however, does not accurately measure their drug waste and currently has a high degree of unit dosing in most of the major hospitals. Furthermore, Steve Long, Director of Pharmacy at the Calgary Health Authority pointed out that gains in efficiency in packaging have probably been offset by the lag time between the distribution centre and the facilities (e.g. an IV may expire before it can be returned and redistributed) (see appendix 1). In theory drug waste should decrease, however, the degree to which this occurs will depend on the efficiency of the distribution system, the degree of information system integration, and on efficient processing of returns. All of these factors, however, will occur much more readily in a new distribution facility than if production were to occur in existing facilities where these processes are already strained.

Patient safety is one of the greatest benefits of central production. As mentioned in option 2a switching the entire region to unit dose format alone might result in a threefold reduction in medication errors. By investing in a new facility the overall quality of production methods would be greatly benefited and tighter control over production more easily managed. Furthermore, because patient specific medication orders and inventory would be centralized, it would be much easier to manage the drug formulary,

with the potential to offer better treatment options and lower drug costs (inventory carrying costs, as mentioned might also be reduced by $700,000 per year). Finally, patient safety is endangered at the largest hospitals because of the pressure on hospital dispensaries from increased patient and medication numbers. Centralizing production to a new facility would enable growth in central production as well as increased capacity at the individual hospital dispensaries.

From an administrative standpoint the proposed central production facility is far superior to any other option. As inventory is consolidated so too will the number of individual SKU numbers and purchase orders decrease. Consolidation of purchasers and reassignment of stocking duties to lower paid inventory clerks at each sight is also estimated to result in savings. The Fraser Health Authority estimated these savings to be approximately $42,700 per year. By removing production from the dispensary there will also be fewer rotations at each site which could ease staff requirements and make training easier. Job satisfaction is also expected to increase, in fact, according to Steve Long this is one of the greatest benefits because production staff at the central facility is no longer burdened by the immediate needs of hospital dispensaries, they work regular hours, have well defined tasks, and take breaks together (S. Long, personal interview, June 23, 2006). Considering the shortage of qualified technicians and pharmacists and the fast turnover of employees (B. Jewesson, personal interview, June 7, 2006) such job satisfaction seems crucial to meeting future staffing needs. Repetitive strain injuries which have been a problem at St. Paul's (B. Jewesson, personal interview, June 7, 2006) would also be better managed through automation and because causality might be easier to establish with more tightly defined job descriptions.

Other benefits include:

- Some products currently purchased in pre-mixed format (e.g. Baxter products) might be produced in the central facility at a cost savings. Cost savings estimates for FHA for example were $69,881 per year.
- Ability to use robotics for automated picking (as in Fraser).
- Liquid dose packaging capability.
- Reduced transportation and infrastructure costs by collocating with materials management.
- Ability for seismic upgrades and emergency inventory will mean better disaster response (at the Fraser site a disaster planning room was built in).

6.5.2 Costs and Drawbacks

Projected construction costs (tenant improvements) for the pharmacy component of the Calgary and Fraser distribution centres were approximately $2.2 million and $2.4 million respectively (Fraser Health Authority, 2003 and Calgary Regional Health Authority, 2001). Equipment costs for Fraser (not including PacMed machines) were projected at $460,700 and IT costs at $1.6 million. A detailed budget is outside the scope of this analysis; we mention these costs only to give an idea of their scale compared to the proposed benefits. Other one time costs include design consultation, program planning, and human resource costs associated with relocating staff, providing severance for eliminated positions, and training staff on the new equipment (training will be minimized in Vancouver Coastal because PacMeds are already in operation at St. Paul's). In Calgary, staff transfers were well handled and resulted in very little employee attrition (J. Hope, personal interview, June 1, 2006) but this will depend on how staff members

and the union are treated at Vancouver Coastal sites so these transfers potentially represent a serious drawback. Obviously, the construction of a new distribution centre will involve a significant capital investment; this is only a drawback, however, in so far as capital funding is scarce in the region.

Similarly, overhead costs at the new facility are expected to be higher than either current operating costs or the costs of centralizing within existing facilities (options 2a and 2b). The Fraser site has an annual lease cost of $1.8 million; however the pharmacy production area of the building is only 15% of the total floor space. Transportation costs at Fraser are budgeted at $1 million per year but these are also shared between pharmacy and materials management. Approximately $2.4 million is currently budgeted in Vancouver Coastal for transportation from the materials management site in New Westminster and between hospitals so a new central facility might actually decrease these costs (when averaged across divisions). Total operating costs also include inventory carrying costs, which as mentioned might decrease so it is unclear whether any significant increase to operating costs will occur and in fact these will be largely dependent on the logistics of the VCH distribution centre and the degree of inventory consolidation.

Perhaps the greatest and only significant drawback to the proposed central distribution centre is the additional time required to deliver medication in a region where transportation infrastructure is highly challenging (e.g. lack of highways in Vancouver and ferries to Coastal/Garibaldi sites). This is a concern primarily for patient specific medication and in small sites where daily deliveries are not warranted. Medication orders

tend to be fairly stable at extended care sites and so we anticipate that all of the owned facilities could be serviced. Patient specific acute care needs within the Coastal Garibaldi Health Service Delivery Area would strain efficient distribution to Powell River and Sechelt and would be impossible for Bella Coola and Bella Bella because of distance. In general, the lead time required for orders will need to be managed through efficient ordering processes, well planned delivery, and careful site selection.

It also bears mentioning that although centralized distribution is generally associated with better quality product and higher patient safety there will be new sources of error introduced that must be considered and managed. Unit dosing shifts the time, effort and potential for distraction from the nursing ward to the central pharmacy. Therefore, this practice increases the amount of time nurses have to complete other tasks but increases the volume of work required by the pharmacy. Like any complex system, the central pharmacy will have their own unique distractions that may cause errors to occur.

Table 2: A summary of costs and benefits for each of the options analysed above is presented here. The current system is given a default value of 0, good and bad outcomes for each option are represented by positive and negative values respectively (on a scale of 2 to -2). Options 2a and 2b have been consolidated since they differ only slightly with respect to the issues in the chart.

Table 2: Cost/Benefit Analysis

	Current	Optimized	Centralized
Operating Costs	0	0	1
Investment Required	0	-1	-2
Staff Requirement	0	1	2
Patient Safety	0	1	2
Overhead Costs	0	0	-2
Waste	0	1	2
Technology Utilization	0	1	2
Inventory Control	0	1	2
Inventory Turnover	0	1	2
Growth Capacity	0	0	2
Administration Costs	0	1	2
Economies of Scale	0	1	2
Transportation Costs	0	-2	-1
Order Lead Time	0	-1	-2
Total	**0**	**4**	**12**

6.6 Stakeholder Analysis

We can also consider the three options from stakeholder perspectives. Patients might benefit, for example, from option 2a or 2b through increased use of unit dose, patient specific meds, and CIVA although the benefits to their safety would not be so good as if production were fully centralized in a custom built facility. Healthcare providers might also benefit from easier medication administration and reduced adverse events (more so for centralized). The production staff stands to benefit greatly from the central facility, as mentioned, but would be at a detriment in the optimized case as they would be working in cramped areas with outdated equipment. Likewise the dispensary staff at St. Paul's and VGH would have less room in the optimized case though additional room would be available at the other sites. Administration would benefit from the decrease in purchase orders and accounts payable. In the optimized options more staff training would be required, however, and more processes would need to be managed at St. Paul's and VGH. These perspectives are summarized below in Table 3.

Table 3: Stakeholder Analysis

	Current	Optimized	Centralized
Patients	0	1	2
Healthcare Providers	0	1	2
Production Staff	0	-1	2
Dispensary Staff	0	-1	2
Administration	0	1	2
Total	**0**	**1**	**10**

6.7 Site Analysis:

In addition to considering the impact on stakeholders the options can be considered based on the overall impact on each site within the region. St. Mary's, Bella Coola, and R.W. Large are assumed to be too far to receive any shipments in the optimized case but may be able to order unit dosed inventory from a central facility with efficient transportation. Powell River, Squamish, and Lions Gate do not currently use unit dose packaging and might therefore benefit from the services in the optimized case and more so by extended services from a central facility, the same can be said to a lesser extent for G.F. Strong, Richmond, and the extended care sites (though some degree of repackaging is employed at each). Providence sites (St. Paul's and Mt. St. Joseph's) already have efficient unit dose packaging, multi-dose packaging, and CIVA products and would not therefore benefit significantly from the optimized options (St. Paul's as a production site would in fact be at a detriment). Both Providence sites might benefit, however, from a central distribution centre, more so for St. Paul's where a significant amount of space would be freed up. UBC and VGH units are mostly unit dosed and have established CIVA programs. VGH, like St. Paul's, would be constrained by the optimized options and both sites would benefit from a central facility for the reasons previously

mentioned. The impacts of each option on the various VCH sites are summarized in Table 4 (bed counts are given simply to illustrate the size of each site)

Table 4: Site Analysis

	Beds	Current	Optimized	Centralized
Bella Coola	15	0	0	1
R.W. Large Memorial	23	0	0	1
Powell River	33	0	1	2
St. Mary's Hospital	32	0	0	1
Squamish General Hospital	25	0	1	2
Lions Gate Hospital	335	0	1	2
St. Paul's Hospital	500	0	-1	2
Mt. St. Joseph's Hospital	228	0	0	1
VGH	616	0	-1	2
UBCH	177	0	0	1
G. F. Strong Hospital	100	0	1	2
Richmond Hospital	175	0	1	2
Owned ECU's	2304	0	1	2
Total	**4563**	**0**	**4**	**21**

6.8 Polar Representations

As a means of comparison, polar representations (Slack, Chambers, and Johnston, 2004) of our two options will be compared on 5 dimensions. The five performance objectives that will be used will satisfy both internal customers (those working inside the operation) and external customers (those receiving the final product/service i.e. nurses, hospital pharmacy staff). These five performance objectives are: quality, speed, dependability, flexibility and cost.

The diagrams will be used to compare the relative performance of each objective for the products and services provided by each option. Each dimension originates from a common origin and the closer the line is to the common origin, the less satisfied the customer will be with that dimension (Slack, Chambers, and Johnston, 2004).

6.8.1 Quality

Quality is the ability to do things right and it is believed to be one of the most important dimensions. Quality is defined as the degree to which the product or service "conforms to its specifications" (Slack, Chambers, and Johnston, 2004). Therefore, the customer satisfied and will likely be a returning customer. Internally, high quality operations will result in fewer defects and therefore cost savings, increased dependability, and faster throughput.

6.8.2 Speed

Speed refers to the ability of the operation to do things fast. Speed is defined as the turnaround time between the customer ordering and receiving the product or service. This can include measures such as order lead time and frequency of deliveries. This dimension can be extremely important in the healthcare industry where the time between requiring medication and receiving medication needs to be kept to a minimum.

6.8.3 Dependability

Dependability of an operation is the ability to do things on time. It is defined as the ability to provide products or services with on-time deliveries. Therefore, an operation with a high degree of dependability will be reliable, predictable, and will develop a level of trust with its customers.

6.8.4 Flexibility

Flexibility is the ability to change what you do. This is defined as the ability to change the operation by either changing what it does, how it does it or when it does it (Slack, Chambers, and Johnston, 2004). Flexibility can come in many forms depending

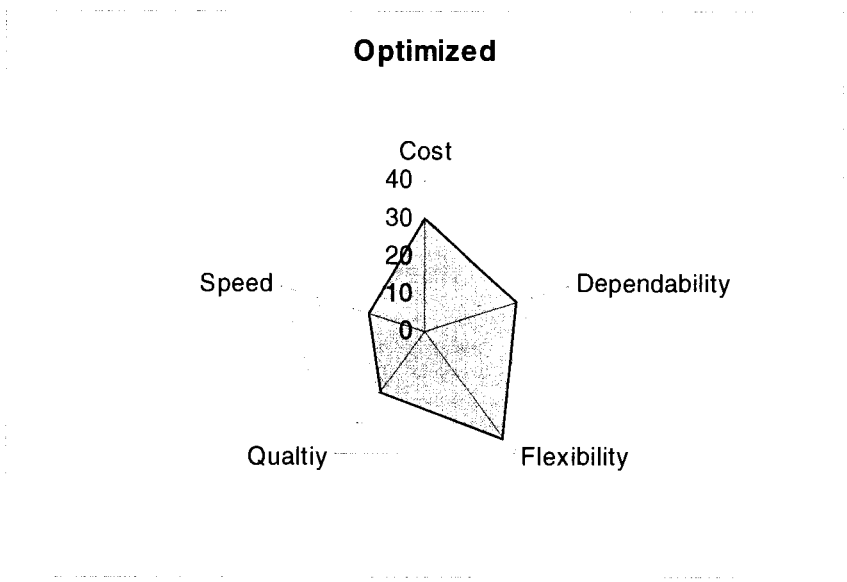
on the requirements of the customer. The operation can have product/service flexibility and be able to introduce new products or services or it could vary the range or mix of products/services, or it could have volume flexibility or delivery flexibility. Flexibility gives the customer greater variety, customization, and the ability to deal with volume fluctuations.

6.8.5 Cost

Costs are operational costs that include labour costs, facilities, technology, and equipment costs and the costs of materials and supplies.

6.8.6 Optimized vs. Centralized Option

Figure 6: Polar Diagram for the Optimized Option



Costs: lower facilities costs, greater inventory costs, lower overhead costs, slightly higher administration costs

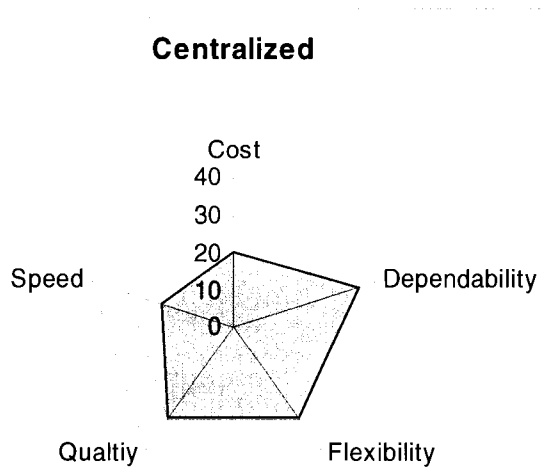
Dependability: since most of the facilities and beds serviced are located centrally, transportation and transportation routes shorter, more reliable and therefore lead to more dependable delivery schedules

Flexibility: less volume flexibility, more flexible delivery times since they do not need to be coordinated with Materials Management, lower volumes will allow for greater product variety

Quality: due to the limited amount of space, the CIVA facilities will likely have lower standards

Speed will be affected by potentially faster turnaround times, shorter delivery times for hospitals in the immediate area

Figure 7: Polar Diagram for the Centralized Option



Costs: higher facilities costs, technology costs, higher costs due to higher level of standards (i.e. USP 797 standards for the CIVA program), shared transportation costs with Materials Management transportation costs, and lower inventory carrying costs

Dependability: should be high with frequent and regularly scheduled deliveries

Flexibility: higher volumes with batch processing will result in lower product variety; however this larger facility will be able to accommodate greater volume flexibility and growth

Quality: standardization of processes and the formulary will create a higher level of quality, fewer defects, a more sophisticated CIVA program (USP 797 standards)

Speed: high operational speed, longer transportation routes will create longer turnaround times for rush orders

6.9 Risk Assessment

The following risk assessment applies to all options to varying degrees. Obviously maintaining two inventories as in option 2a will minimize the risk of shortages. Seismic upgrades and ideal disaster locations are not an option using current facilities. Containment strategies should become part of the institution's policies and training.

Table 5: Risk Assessment

Risk	Strategy	Probability
PacMed(s) breakdown	-Regular maintenance schedule and in house service -Keep spare parts -Collaborate with Fraser -Have Cadets on hand -Maintain ability to increase staff and hours of operation -Have emergency training to simulate loss of machines	High
Staff Shortage	-Standardize regional training to facilitate transfer -Train staff on all rotations where possible	Medium
Drug Shortage	-Source alternate suppliers and other sources of inventory (other regions or commercial pharmacies) -Document all delays to facilitate planning and optimize inventory levels	Medium
Delivery Vehicle break down or loss	-Enable communication with drivers and train them for emergencies -Outfit vehicles with GPS tracking devices -Scheduling personnel at distribution centre should be trained for emergencies	Medium
Natural Disaster	-Seismic upgrades for distribution centre -Locate distribution centre away from possible Fraser flood plain -As at FHA PDDC maintain separate emergency inventory and capability to feed and board essential staff	Low

6.10 Conclusion

There are clear benefits to centralizing inventory, purchasing, production and distribution that relate to significant financial savings for the region as well as increases to patient safety. Centralizing within existing facilities (options 2a and 2b) will come at the cost of valuable space and patient safety creating critical situations at two of the country's busiest hospitals. Building a new central distribution centre will involve

significant upfront costs but will offer the greatest long term benefits in terms of growth, production standards, employee satisfaction, patient safety, inventory control and cost, formulary management, and administration costs. The proposed centralized distribution centre is preferred in terms of the issues it satisfies, the stakeholders involved, and the sites serviced.

7 Recommendations

7.1 Short Term (1-2 years)

The Fraser Health Authority completed a Pharmacy Distribution Centre (PDC) business plan in September of 2003 and has only just begun to transfer operations to the newly built facility. Considering the lengthy process involved we recommend that the Vancouver Coastal Health Authority begin more formal research and planning immediately. The various steps involved in planning, design, construction, and implementation of the PDC are presented in a Gantt chart in figure 8. In the short term it will not be possible to consolidate materials management and pharmacy in a single distribution centre because of the existing four year lease obligation in New Westminster. However, materials management should be brought into discussions now and so that they can begin the planning process concurrently. Outcomes from the Fraser Health Authority's PDC should be followed closely in order to ascertain which benefits are realistic and which drawbacks were unanticipated or greater than expected. In addition, a business case for centralized production is in the works for a group of Ontario Hospitals (Lakeridge Health, Rouge Valley Health, and Scarborough Hospital) and was due last month. Contacts from these hospitals did not reply to requests at the time of this report but their business case should be obtained as reference.

We recommend that the region implement option 2a or 2b immediately as centralizing within existing facilities will provide a number of significant benefits and

will better prepare the region for fully centralized distribution. Using data from Providence Health Care we have estimated the region's total solid oral medication use at 46,326 doses (see appendix 2). The new PacMed machine, run ten hours per day has a capacity of approximately 36,000 doses and the second older PacMed has a similar capacity so the regions needs can be easily met. Multi-doses are just less than half of the regions dose consumption so it might make sense to use one PacMed strictly for unit dosing and another for multi-dosing. It is more likely that transportation and shipping/receiving at St. Paul's and VGH will be limiting factors. We therefore recommend that facilities be added to central production in a stepwise manner until distribution capacity is met.

Other short term recommendations include:

- Investing in enabling technologies that will be needed in order to realize the full benefits of centralized distribution. These include patient profiled automated dispensing machines (which must be integrated into hospital systems in order to allow for inventory control) and system integration (e.g. inventory, purchasing, and pharmacy management).
- Manage the factors likely to produce errors in the production setting. Policies should be developed to ensure that production runs are uninterrupted even if it means scheduling extra staff. Production work should also be scheduled at off peak hours and may necessitate night shifts in order to manage the workflow of the entire dispensary.
- Make the distribution centre a focal point of the strategic vision of the organization. Staff members should be apprised sooner rather than later of the

intention to centralize, this will minimize employee attrition and enable for valuable input from those in the front line during planning (employees consulted with architects, for example, in the planning stages of the Calgary distribution centre (Calgary Regional Health Authority, 2001).

- Develop better measurement systems or optimize the current systems to deliver timely information regarding inventory value and cost, inventory turns by facility, medication use (by brand, by patient, by production method), waste, spoilage, etc. Where these cannot be directly measured (e.g. where constrained by information systems) best estimates should be used. It is important to establish these measurements for the current system in order to justify capital investments such as the pharmacy distribution centre. The fact that these measures are not easily accessed by operational directors suggests that they are not being adequately managed.
- Implement a tech check tech system, eliminating the need for more costly pharmacist checking.
- Assign staff to return sorting rather than relying on their good will to do so. (Spear, 2005).

7.2 Medium Term (2-5 years)

In the next two to five years financing, construction, and implementation of the central pharmacy distribution centre should begin. Given Vancouver's aging and growing population as well as many of the other factors discussed in the external analysis of this report we believe quality patient service to be untenable in the long term using current

facilities. We therefore recommend that construction of the PDC begin no later than 2009 in order to meet long term growth and to collocate with materials management. The Providence Legacy Project, which is proposed to replace St. Paul's, Mt. St. Joseph's, and Holly Family Hospital, is also likely to begin planning and construction within this time frame which may offer additional benefits for the PDC. If site selection for the Legacy project is finalized within the next two years then additional shared infrastructure benefits might be realized. The new hospital's current site suggestion along Terminal Avenue would also be an excellent site for the PDC as it is approximately in the middle of the region in a warehouse district. The region may consider purchasing additional land for construction of the PDC

Other medium term recommendations include:

- Invest in bedside bar coding which along with bar codes placed on medication by the PacMed machines will greatly increase patient safety and facilitate efficient distribution and returns. The FDA, for example, estimates that bar coding could decrease medication errors by 50% and save US hospitals $93 billion over the next twenty years (Blank, 2006).
- Invest in a Computerized Physician Order Entry system. This would help eliminate ordering and transcription errors which combined make up more than half of all medication errors (Bates et al, 1995).
- Increase management presence in production areas, set production goals, and monitor employee performance. One employee pointed out the pace of production work is determined by the employee and with no supervisors on the floor there is

no incentive to work hard (Vancouver Coastal Health Informant, personal interview, June 13, 2006).

- Enter into discussions with pharmaceutical suppliers, perhaps in conjunction with Fraser, in order to determine whether the burden of transportation, which previously fell on suppliers, can be recouped at all in the way of discounts.
- Tighten control over medications to prevent theft. One Operational Director within the region pointed out that they could not keep up with the demand for a certain new sleeping medication but that demand decreased by 40% when they began managing it as a narcotic (L, Frighetto, personal interview, June 6, 2006). Bar coding and better inventory control should help in this regard as will centralizing bulk
- Consolidate the various hospital formularies into a single formulary. With better drug use measurement and more integrated information systems it will be possible to manage the formulary more tightly and to evaluate treatment options based on cost and efficacy as well as predicting prescription trends and setting drug use policy (Wolper, 2004).
- Increase formulary management using data gained through measurement systems. Patient specific medication use and measured patient outcomes in addition to drug costs can be used to develop profiles for each drug that can be used to decide between various treatments options at the administrative level.

7.3 Long Term (5-10 years)

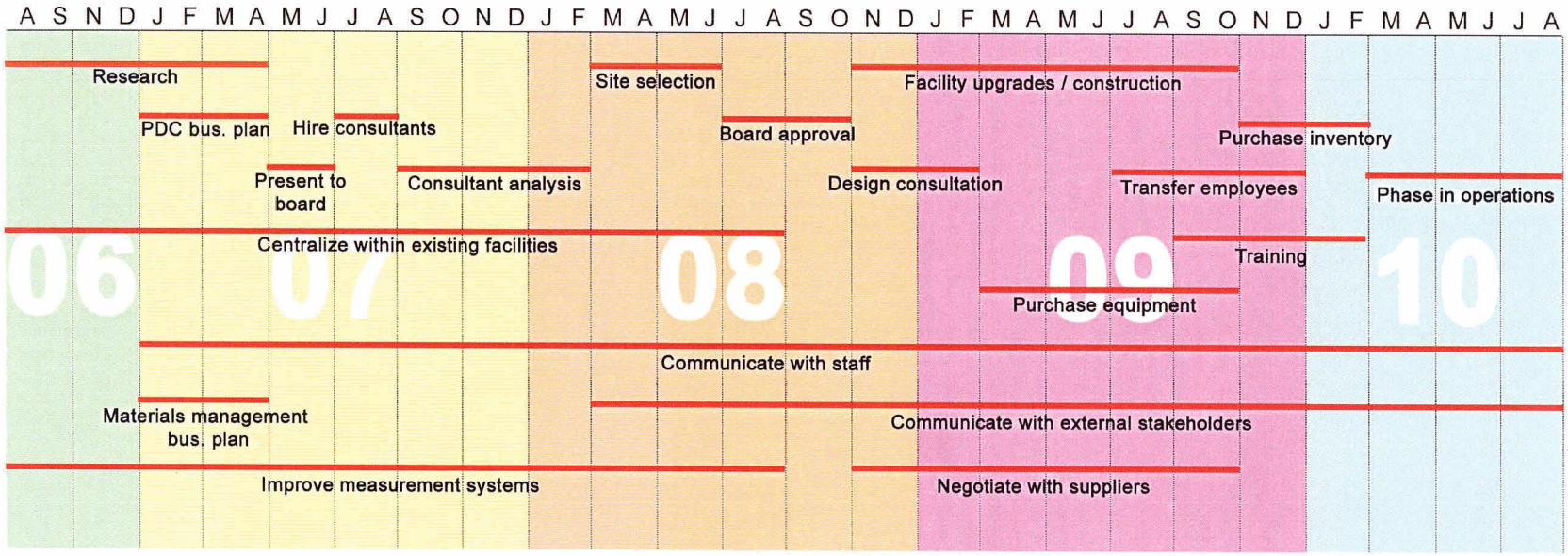
The difficulty in managing numerous concurrent projects is that long term goals are often overlooked. Pharmacy Services is a department in its infancy and cannot afford to overlook larger organizational issues that may not be as pressing as day to day operations. Research has correlated organizational performance to aspects of organizational culture, namely a highly involved staff, consistently held values, the ability to change to meet internal and external stimuli, and a clear sense of mission (Denison, 1990). In order to create value for the public and other hospital departments, pharmacy must provide quality cost effective treatment in a timely manner. We therefore recommend that quality, cost, and efficiency become part of the daily language used by all employees. Quantifiable objectives in each of these areas may require investment but they will also yield dividends if the average worker is able to see how their own performance helps fulfill the organizations mission.

More specifically we make the following recommendations:

- Develop a proactive stance on medication errors dedicating resources to better track the sources and incidence of errors. Some of these errors may be inherent to the healthcare system but others may be specific to the region or site. Principles of total quality management might be applied - employees should be constantly working towards zero waste and zero defects.
- A culture of experimentation should be encouraged. Front line staff is currently an untapped source of innovation. Resources should be made available to employees with ideas and they should be rewarded for any improvement attributable to their suggestions.

- Pharmacy's organizational boundaries should be fluid encompassing other regions and other parts of the healthcare network as much as possible. Knowledge transfer can be facilitated by sharing employees, hiring from afar, and by using or creating pharmacy bodies to disseminate ideas (Leonard, 1998).
- Create organizational structures and processes that ensure safety by mimicking organizations such as nuclear power plants where safety is paramount. Such systems are characterized by flexible organizational structures, attention to reliability over efficiency, avoiding core incompetencies, developing sense making abilities, and maximizing group performance and interaction (Bea & Roberts, 2001)

Figure 8: Gantt Chart



8 Conclusion

The recent consolidation of management into a single shared Pharmacy division within Vancouver Coastal Health was a major undertaking. The region is one of the largest healthcare regions in Canada servicing over 4500 acute and residential beds at a variety of facilities spanning the gamut from small rural community hospitals to large urban teaching hospitals. These facilities not only have varying needs but are also decades apart in terms of the evolution of their pharmacy practice. The pharmacy department as a whole has numerous strengths and capabilities but these must be developed further in order to effect change and modernization. Staff and management, however, have already gone through restructuring and major policy shifts to the point of exhaustion.

External pressures will continue to drive change within pharmacy, like it or not. Vancouver's population is booming and the post war boomers are reaching the age of illness. Consumers will continue to demand new treatments as they come available, and these increasingly small market biotech treatments pose enormous challenges for pharmacy in their cost and management. Not surprisingly, drug costs are driving increases to healthcare budgets leaving the healthcare system to chase its tail under the demands of ballooning operating expenses. At some point healthcare managers need to make difficult choices in order to invest in technologies like bar-coding and centralized drug distribution if there is to be any containment of these expenses. Unfortunately, as we

have seen at VCH, the costs and benefits to such investments are not clear cut because the healthcare system is not accustomed to tracking resources the same way that top notch competitive firms do. Any number of new technologies represent the opportunity to reduce costs, increase efficiency, and reduce medical errors but deciding between them requires an understanding of cause and effect and the ability to make accurate measurements.

In completing this project we have come to understand some of the complexity involved in hospital pharmacy and the healthcare system. We set out to measure the costs and benefits to centralized distribution but in the process we realized the proposed system depends on many other variables such as the implementation of automated dispensing machines and the integration of information systems. It is very difficult to look at any single system in isolation, rather all of the pharmacy systems must be improved upon and aligned in order to coordinate and realize new efficiencies at a regional level. We have recommended that VCH immediately work towards centralizing certain production activities and planning for a centralized pharmacy distribution centre because the present system has grown so far beyond capacity that it is unimaginable that patient safety could be adequately provided for in current facilities, particularly in the long term. Modernizing a single aspect of production, for example adding automated unit dose machines to existing hospital dispensaries, will undoubtedly strain other parts of the system and lead to new causes of medical error. Our recommendations therefore have dealt with various aspects of the organization that should be given equal consideration.

By investing in new technologies, increasing measurement systems, implementing the proposed pharmacy distribution centre, and developing an organizational culture focused on quality, reliability, cost, and efficiency pharmacy can lead the healthcare system in providing patient value. Such changes may cause change fatigue but there is not likely to be much chance for rest in a system trying to catch up.

Reflections

We should have done more research going into our interviews, it was tough because very little information was provided at the outset. However, we could have looked up bed numbers, sites and HSDA's on the internet.

Our expectations at the outset were unrealistic. We imagined ourselves doing a much more detailed analysis than what was possible with the information we obtained.

The Fraser or Calgary business case should have been provided at the outset in order to give us the necessary background information to ask the right kinds of probing questions. We did not obtain either report until we had conducted more than half our interviews.

Very little literature on hospital management was found at Simon Fraser University's Bennett Library. Centralized pharmacy distribution is a relatively new idea.

The central distribution centre is seen more as an inevitability in the region than a priority, the quality and amount of information we received suggests that there is as yet little buy in among middle management.

Our methodology of interviewing various levels within the organization was sound but the order in which interviews were granted was somewhat confusing. Steve Shalansky, our first interview, was not familiar with many of the issues since he is new to the region. Robin ultimately was the best source of information but also the hardest

person to schedule time with. An 'information dump' at the outset would have been helpful to familiarize us with the issues. Also, we interviewed all of the Operations Directors and the pharmacy directors for Fraser, Calgary, and the Interior but it would have been helpful to get a broader perspective by interviewing other stakeholders such as pharmacy distributors, patient groups, nurses, and doctors. Robin was concerned that in doing so we might unduly alarm certain stakeholders at a stage where nothing was certain.

APPENDICES

Appendix 1 Traditional versus Unit dose systems

In the traditional system, the pharmacy receives a medication order for a patient and prepares and dispenses a five day supply to the nursing wards. The nurses then take the medication out of the vial, put it into a medication cup and take it to the patient. This system also creates a significant amount of waste since medications that are not packaged and labelled cannot be reused in accordance with the College of Pharmacists.

The unit dose system was developed in the 1960s in order to support medication administration and to reduce the waste of increasingly expensive medications. Most of the studies conducted on medication errors and unit-dosing systems took place between 1970 and 1976. Even though the practice of unit-dose dispensing is generally well accepted and is considered a "best" practice in hospitals, the evidence for its effectiveness is modest. Most studies show a positive impact on the reduction of medication errors of omission and commission with unit-dose dispensing (Hynniman (1970), Schnell (1976), and Taxis (1998).

Compared to the traditional system, the unit dose system of distribution requires the pharmacy to dispense medications in individually packaged and labelled unit doses. Therefore, this system targets the safety problems in the dispensing and administration stages of the drug distribution process. A unit dose system decreases wastage because

unused unit doses can be returned and re-dispensed. The system will also reduce medication errors and save nurses preparation time.

Table 6: Traditional vs. Unit-dose systems

System	Advantages	Disadvantages
Traditional system	less costly less time consuming for pharmacy staff	more time consuming for nurses, greater medication wastage, increased chances for errors
Unit-dose system	less time consuming for nurses, less wastage, decrease error of commission or omission	increased cost, more time consuming for pharmacy, more storage space required

Appendix 2: Cost/Benefit Analysis

	Providence			Coastal / Garibaldi							Vancouver Acute				RHS / VC		Total
	St. Paul's	Mt. St. Joseph's	Residential	LGH	Squamish	Powell River	Bella Coola	R.W. Large	Sechelt	Residential	VGH	UBC	GFS	Residential	Richmond Hospital	Residential	
Beds	500	228	695	335	25	33	15	23	32	573	616	177	100	460	175	576	**4563**
Patients/Year																	
Unit doses/day*	5715	2606		689	0	0	0	0	0		6337	2023	572		1700		**19642**
Inferred Non Unit Doses/day	0	0		3140	286	377	171	263	366		704	0	572		300		**6178.4865**
Multi-doses/day**			6186							5100				4094		5126	**20506**
% UD	100%	100%		18%	0%	0%	0%	0%	0%		90%	100%	50%		85%		
Medication Error Rates***	114	52		532	47	62	28	43	60		243	40	106		84		**1412**
Medication error with 100% UD	114	52		77	6	8	3	5	7		141	40	23		40		**516**
Cost of Medication Errors																	
TPN/day	8			6							10	3			3		
Batched CIVA Products	122	61		50							223				27		**482**
Inventory Turns/year																	
Purchasing Agents	1.5			1.5							3	2	0.25		0.25		**9**
Value of Inventory																	
Repackaging FTE's	5.2										6.3				1.0		**13**

*Unit Dose data based on average usage of 8321 unit doses/day in providence (8321/728 beds = 11.43 UD/bed) (L. Frighetto, personal interview, June 6 2006)

**Multi-dose data based on average usage of 6186 multi-doses/day in providence (6186/695 beds = 8.9 MD/bed) (L. Frighetto, personal interview, June 6, 2006)

***Non Unit Dose error rates based on average between ward stock error (20%) and Pt. Prescription error (10-16%) = 16.5% total average error (R. Ensom, personal interview, July 5, 2006)

Data Points

Total Doses / Day 46326	PacMed Capacity (60 packages/minute) 43200	
Doses / Year 16908979	Medication Errors / Year (based on UD) 515485.1	Additional Patient Days / Year (Current) (Bates et al, 2004) 1855746
Total Average Regional UD 0.773728	Medication Errors / Year with 100% UD 188488.7	Additional Patient Days / Year with 100% UD (Bates et al, 2004) 678559.3
	Patient Deaths / Year (Current) (Bates et al, 2004) 3402.2017	Reduction in Patient Days and Patient Deaths with 100% UD 273%
	Patient Deaths / Year (100% UD) (Bates et al, 2004) 1244.0254	

REFERENCES

Baker, G.R., Norton, G., Flintoft, V., Blais, R., Brown, A., Cox, J, et al (2004). The Canadian adverse events study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Journal Association 170 (11)*, 1678-86. Retrieved June 13, from Medline database.

Bates, D.W, Cullen, D.J., Laird, N., Petersen, L.A., Small, S.D., Servi, D. et al. (1995) Incidence of adverse drug events and potential adverse drug events: Implications for prevention. *Journal of the American Medical Association*; *274*:29-34.

Bates, D.W., Spell, N., Cullen, D.J., (1997). The costs of adverse drug events in hospitalized patients. *Journal of the American Medical Association*; 277, 307-311.

British Columbia Health Planning (2002). The picture of health: How we are modernizing British Columbia's health care system. Retrieved June 7, 2006, from http://www.health.gov.bc.ca/cpa/publications/picture_of_health.pdf

Province of British Columbia PharmaCare Ministry of Health (2003). PharmaCare trends 2003. Retrieved June 7, 2006, from http://www.healthservices.gov.bc.ca/pharme/pharmacare_trends_2003.pdf

Bea, Robert G. and Roberts, Karlene H. (2001). When systems fail. Organizational Dynamics, 29 (3), 179-191.

Blank, Dennis (2006). Bedside bar-coding still lagging in hospitals. Drug Topics, 150 (10), 12. Retrieved July 5, 2006, from ABI Inform database.

British Columbia eHealth Steering Committee (2005). eHealth strategic framework. Retrieved June 7, 2006 from http://www.healthservices.gov.bc.ca/cpa/publications/ehealth_framework.pdf

Calgary Regional Health Authority (2001) Acute Care Pharmacy Services Central Production Facility: Functional Program Update and Concept Design. Kasian Kennedy Architecture Interior Design and Planning, Resource Management Consultants; January 2, 2001.

Canada politics: Provinces push for healthcare reform (May 16, 2006). EIU ViewsWire. Retrieved June 7, 2006 from ABI / Inform database.

Canadian Society of Hospital Pharmacists (2004) Statement on unit dose & IV admixture drug distribution. CSHP Official Publication 2003/2004: 163-164.

CBC News Online (September 15, 2004). Price of Care. Retrieved June 19, 2006, from http://www.cbc.ca/news/background/healthcare/priceofcare.html

Chambers, L. (2003). The hi-tech solution: Information technology can help solve many of the challenges facing Canada's beleaguered healthcare system. But first, we need to get into providers' hands. Canadian Healthcare Manager, 10 (7). Retrieved June 7, 2006, from ABI / Inform database.

Denison, Daniel R. (1990). Corporate culture and organizational effectiveness. Toronto, Wiley.

Fraser Health Authority (2003). A Proposal for a Pharmacy Drug Distribution Centre Fraser Health Pharmacy Department; May 2003.

Greater Vancouver Water District (2005). Water quality control annual report. Retrieved June 18, 2006, from http://www.gvrd.bc.ca/water/pdfs/QualityControlAnnualWaterReport2005-Volume1.pdf

Greater Vancouver Regional District (GVRD) Policy and Planning Department (2005). Lower Fraser valley ambient air quality report 2004. Retrieved June 18, 2006, from http://www.gvrd.bc.ca/air/pdfs/AmbientAirQualityReport2004.pdf

Greater Vancouver Regional District (GVRD) Strategic Planning Department (1997). Greater Vancouver – the fastest growing metropolitan area in Canada 1991 – 1996. Retrieved June 18, 2006, from http://www.gvrd.bc.ca/growth/pdfs/Census1996-Growth.pdf

Greater Vancouver Regional District (GVRD) Strategic Planning Department (1997). Greater Vancouver's population over 60 years of age will nearly double by the year 2021. Retrieved June 18, 2006, from http://www.gvrd.bc.ca/growth/pdfs/Census1996-PopulationGrowth.pdf

Hynniman, C.E., Conrad, W.F. Urch, W.A., Rudnick, B.R., Parker, P.F., (1970) A comparison of medication errors under the University of Kentucky unit dose system and traditional drug distribution systems in four hospitals. American Journal of Hospital Pharmacist; 29:85-90.

Johnson, G. & Scholes, K. (2002). Exploring corporate strategy (6th ed.). Harlow, England: Prentice Hall.

Kuyumku, N. (2005). Saskatchewan launches electronic drug record. Canadian Healthcare Manager, 12 (7), 7. Retrieved June 7, 2006, from ABI / Inform database.

Laudrum, K. (2005). Under review: The common drug review: Is it meeting expectations. Canadian Healthcare Manager, 12 (2), 12-15. Retrieved June 7, 2006 from ABI / Inform database.

Lazarou, J., Pomeranz, B.H., Corey, P.N., (1998). Incidence of adverse drug reactions in hospitalized patients. A meta-analysis of prospective studies. Journal of the American Medical Association; 279: 1200-1205.

Leonard, Dorothy (1998). Wellsprings of knowledge. Boston, Harvard Business School Press.

Ministry of Health. (2002). Draft of Internal Audit Report on Drug Procurement.

Ng, R. (2004). Drugs from discovery to approval. Hoboken, New Jersey: John Wiley & Sons

Schnell, B.R., (1976) A study of unit-dose drug distribution in four Canadian hospitals. Canadian Journal of Hospital Pharmacists; 29:803-814.

Slack, N., Chambers, S., Johnston, R., (2004). Operations Management, 4th Edition. Financial Times Prentice Hall, 2000: 57-59, 640-641.

Spear, S.J. (2005). Fixing healthcare from the inside, today. *Harvard Business Review. 2005 Sep*; 83(9):78-90.

Taxis, K., Dean, B., & Barber, N., (1998) Hospital drug distribution systems in the UK and Germany – a study of medication errors. Pharmacy World & Science; 21:25-31.

United States Department of Health and Human Services Food and Drug Administration (2005). Guidance for industry pharmacogenomic data submission. Retrieved June 24, 2006 from http://www.fda.gov/cder/guidance/6400fnl.pdf

United States Pharmacopeia (2006). <797> Pharmaceutical Compounding – Sterile Preparations. The United States Pharmacopeial Convention. Retrieved July 15, 2006 from http://www.usp.org/pdf/EN/USPNF/PF797.pdf

Vancouver Coastal Health (2006). Health Facilities: Hospitals. *Vancouver Coastal Health Website.* Retrieved June 5, 2006 from http://www.vch.ca/facilities/hospitals/index.htm

Vancouver Coastal Health (2005). Strategic Priorities. Retrieved June 13, 2006 from http://www.vch.ca/accoutability/docs/2005-2006_strategic_priorities.pdf.

Vu, Uyen (2005). Aging nurses spell trouble. Canadian HR Reporter, 18 (1), 1-2. Retrieved June 21, 2006, from ABI / Inform database.

Wayne, Critchley (2006). Balancing act. Canadian Healthcare Manager, 13 (2), 31. Retrieved June 7, 2006, from ABI / Inform database.

Wolper, Lawrence F. (2004). Health care administration (4th ed.). Sudbury, MA, Jones and Bartlett Publishers.