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The Impact of Pharmacy Work Design on Pharmacist Productivity

Nicholas Allen Coblio
University of South Florida, ncoblio@gmail.com

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by

Nicholas A. Coblio

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Co-Major Professor: Grisselle Centeno, Ph.D.
Co-Major Professor: Paul McCright, Ph.D.
Kingsley Reeves, Ph.D.
Thomas Sanocki, Ph.D.
Stuart Wilkinson, Ph.D.

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DEDICATION

This work is dedicated to two of the individuals who helped me realize that what I wanted in life was not to be a pharmacist with some idea of quality and systems but rather to be a systems oriented professional with a license to practice pharmacy. Dr. Paul Givens was very instrumental in getting me into graduate school and always had a word of encouragement whenever things became difficult. He introduced me to many of the intersections of healthcare systems with industrial engineering and provided valuable insights into how to navigate the travails of graduate school, especially for older students.

This is also dedicated to the former Chief of Medicine at the James A Haley VA, Dr. Willard Harris. Dr. Harris was a friend and mentor, always willing to take time out of his busy day to provide some valuable insights into problem solving or dealing with the bureaucracies of either the VA or USF. He was a prolific author and assisted me in developing my skills in technical writing.

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A work of this kind cannot be accomplished without the support of one's wife. Doris understood those late nights at the computer were required in order to complete this work. She also understood those times that while my body may have been present, my mind was elsewhere.

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ABSTRACT

Healthcare costs in the United States continue to grow at an alarming rate. Concerning the cost of medications, there are a number of factors that drive these costs. While personnel costs are not the largest of these, they do contribute a significant portion. The cost of the cognitive component of order processing by pharmacists can range from three dollars to over six dollars per prescription depending on the production throughput of the pharmacist.

Studies at the organization which was the focus of the research, as well as reports in the literature, indicated that work disruption and other environmental factors could impact the rate at which pharmacist process physicians' orders into prescriptions. At the time of this study the collaborating facility was undergoing a re-organization; funding had been allocated to relocate and redesign the outpatient pharmacy. This provided a timely opportunity to examine the effect that changes to the physical plant, with specific attention being given to reducing interruptions to the pharmacists finishing orders, would have on pharmacists' productivity. This was measured in orders processed per hour, before and after the reorganization.

Sixteen months after the pharmacy was moved, supervisors were concerned that the outpatient pharmacy was still not performing at maximum efficiency and workload data was posted, with the intent that this information would motivate those professionals, whose output may have been below the average, to increase their production.

All outpatient prescriptions are maintained in a data base which records, among other items, the pharmacist who processed the order which generated the prescription and the time and date this was done. Data for prescriptions filled before and after each intervention were abstracted from the data base and used to determine production rates before and after the interventions.

There was a small, but statistically significant, decrease of two prescriptions per hour per pharmacist in production following the relocation. Fourteen of the twenty-one pharmacists (66.6%) had decreases in productivity averaging 4.1 prescriptions per hour while seven had an increase averaging 2.2 prescriptions per hour. All but one of the pharmacists who had an increase in productivity after the relocation also had a slight, but statistically insignificant, increase averaging 3.0 prescriptions per hour per pharmacist after the posting of the workload data.

The effect of posting the workload data was not statistically significant even though the study group processed 16,692 more orders

working only 221 more hours. Nine of the study pharmacists (42.8%) had decreases in productivity averaging 2.3 prescriptions per hour per person, while the remaining twelve increased production by an average of 2.8 prescriptions per hour per pharmacist.

An analysis of both effects, using ANOVA, indicated that the pharmacist was a significant contributor to the effect in both cases. Only in the analysis of the impact of the relocation was the effect of the intervention significant and that was to decrease productivity.

The net result of this research was that the postulated interventions to increase productivity had no real effect and the motivation of the pharmacists may be the most significant factor. The fact that a third of the study pharmacists had decreases in productivity after both interventions is telling and may indicate problems with job design and motivation.

A further review of production rates and error are indicated with an emphasis on determining if there is an association between error rate and production rate. At this point there are little published data and what is available is either conjecture, as in the case of the North Carolina Board's determination of 150 prescriptions per day being a safe upper limit, to Malone's survey based research determining an average rate of 14.1 prescriptions per hour.

CHAPTER ONE

INTRODUCTION

Background

There are many reasons for work redesign, two of which are safety and increased productivity, with a resultant decrease in cost. These two factors are related. It is an unfortunate fact of life that, at least with the court system in the United States, simply focusing on productivity, without considering possible unintended consequences, such as increased errors, can lead to litigation with resultant costs that far exceed savings from increased productivity.

The system used to process outpatient prescriptions was reviewed (Figure 1.1) and it was noted that there was a significant bottle neck in the processing of prescribers' orders by the pharmacist. With few exceptions, refill requests are handled by the mail system with no intervention by a pharmacist. Once prescriptions are in the mail queue, a major portion of the processing (90%) is handled by robotics, either at CMOP or by the ScriptPro® dispensing robot.

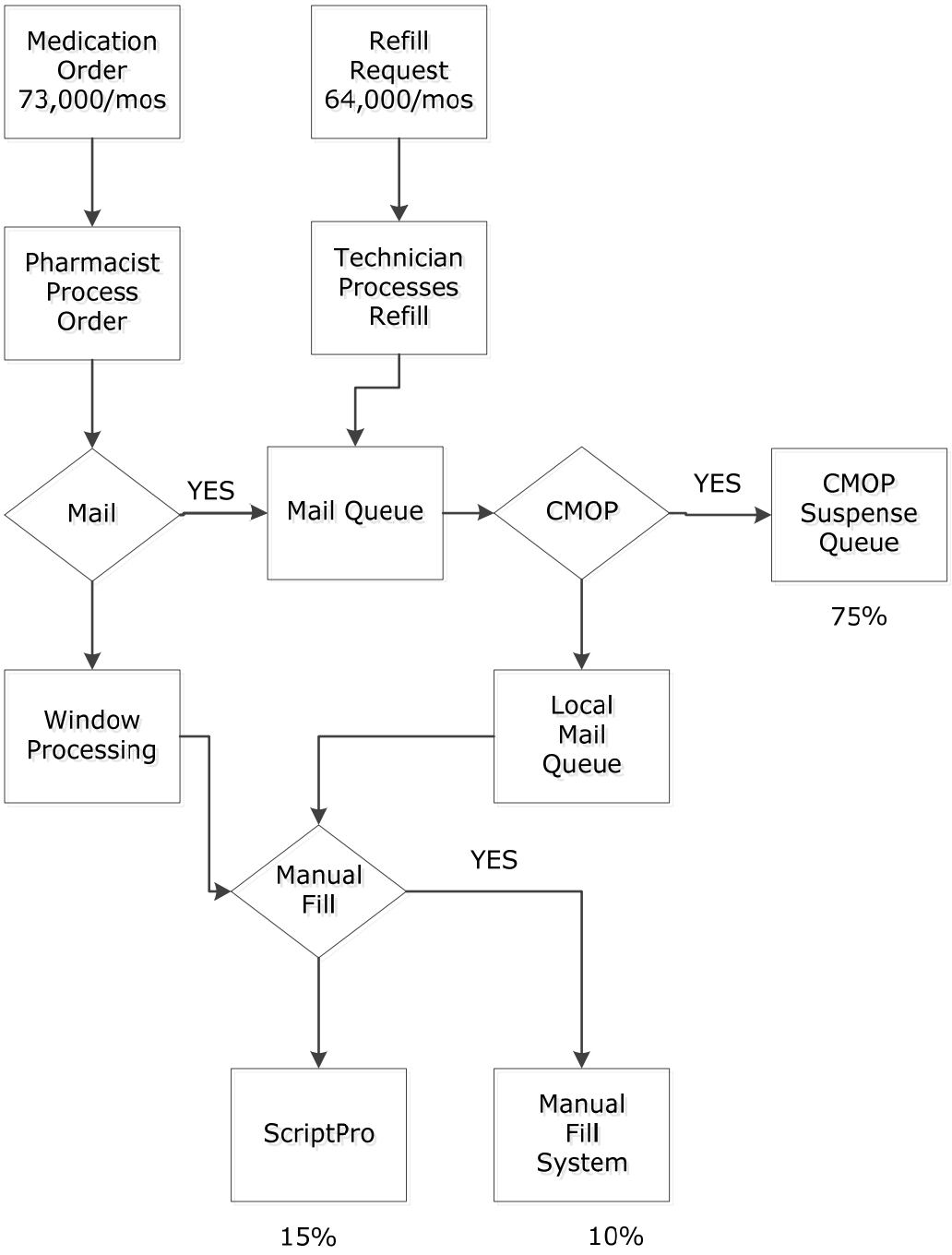

Figure 1.1 Out-Patient Processing Flow Chart

Discussing throughput for the cognitive processing of physicians' orders into prescriptions begs the question as to how many orders per hour can a pharmacist safely process. One prescription every five

minutes, every minute, every thirty seconds? At this time, there are no clear answers to this particular question but further research into this aspect of pharmacy is definitely warranted.

This research examines the effect of pharmacy work design strictly from the viewpoint of physician order processing. Error rate is examined but only in the most global of terms. While the data exist for a more detailed analysis, it is beyond the scope of this particular project but definitely warrants further investigation. Toward that end, a proposal for gathering this kind of data has already been submitted for the necessary approvals. The data generated from this research can be integrated with the detailed error data to determine if there is any correlation between cognitive throughput and error rate.

Purpose of this Research

This research is an outgrowth of earlier work by the author on the impact of internal disruptions on pharmacist production. There was evidence of numerous interruptions to workflow but little research as to what impact these interruptions had on the pharmacists' productivity. The relocation of the outpatient pharmacy provided an opportunity to do such research.

In addition to the impact on production there were concerns about the effect of these interruptions on the pharmacists' attention to detail as they were processing prescribers' orders into prescriptions.

The facility's data base includes records of all order alerts which are provided to prescribers and pharmacists and can be mined for any correlations between rate of order processing and responses to order checks.

Unfortunately there was not sufficient time to get the necessary approvals to use the complete dataset, but there was sufficient information to evaluate pharmacist productivity. This provides background data for further research into the area of rate and attention to detail, using the response to order alerts as an indicator to evaluate individuals not paying attention to these alerts.

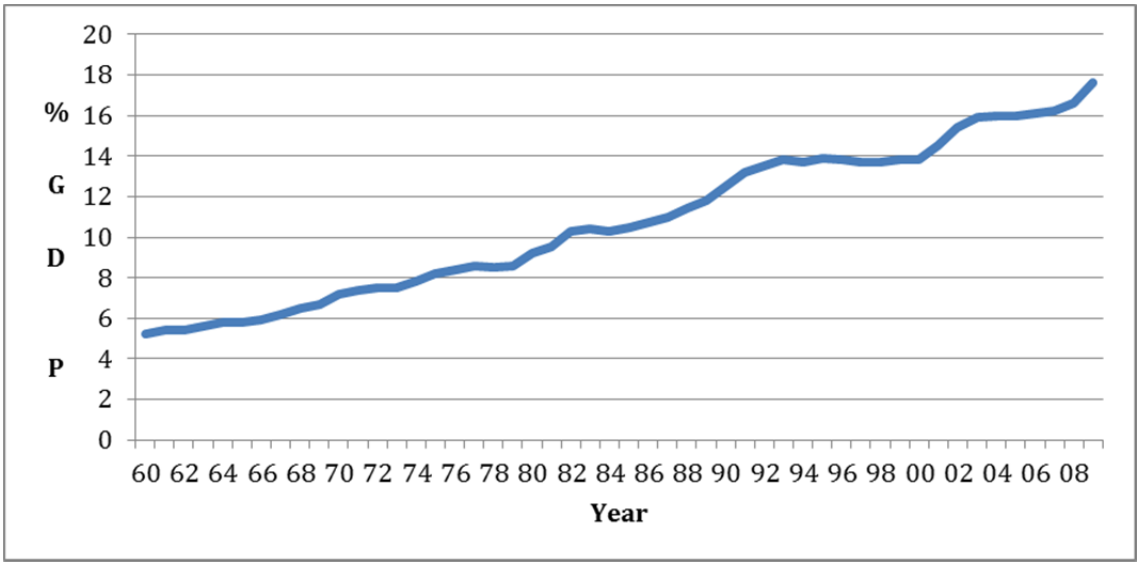

Figure 1.2 Percent US GDP Spent on Health (HHS)

Cost Factors and Significant Impact

One of the primary reasons for examining work design is quite simple; cost. This is especially true of healthcare, in particular

healthcare in the United States (US). In 2009, healthcare costs in the US amounted to over 17% of the country's Gross Domestic Product (GDP).[1] As can be seen in Figure 1.2, the percent of US GDP spent on healthcare has been rising steady and shows no sign of decreasing. If the current trend continues, there are data indicating that healthcare costs may constitute 29% of GDP by 2030 and 48% by 2050.[2] Clearly this growth cannot be sustained. Attempts to rein in these expenditures over the last 50 years have not been effective. With the notable exception of France, Germany and Denmark, healthcare expenditures for European countries is usually less than 10% of GDP. Even those countries with a higher cost of healthcare spend under 11% of their GDP compared to over 17% spent in the US.[3] Figure 1.3 compares the percent of GDP for several countries whose healthcare costs are tracked by the Organization for Economic Co-operation and Development (OECD) with that of the United States.

The reasons for these differences in cost are well beyond the scope of this research. However, it is known that there are significant differences between how prescriptions are processed in the European Union and the United States.

Unfortunately the higher cost of healthcare in the US does not necessarily equate to better or higher quality care. The World Health Organization's (WHO) report on health systems for its 191 member

nations, ranked the US 37th in the quality of healthcare.[4] There is criticism of the WHO report, based primarily on the difficulty comparing diverse health systems. Leaving their ranking system aside, there are some parameters, such as infant mortality and life expectancy that are easily comparable. In these areas the US continues to rank low at forty-eighth[5] and thirty-sixth[6] respectively.

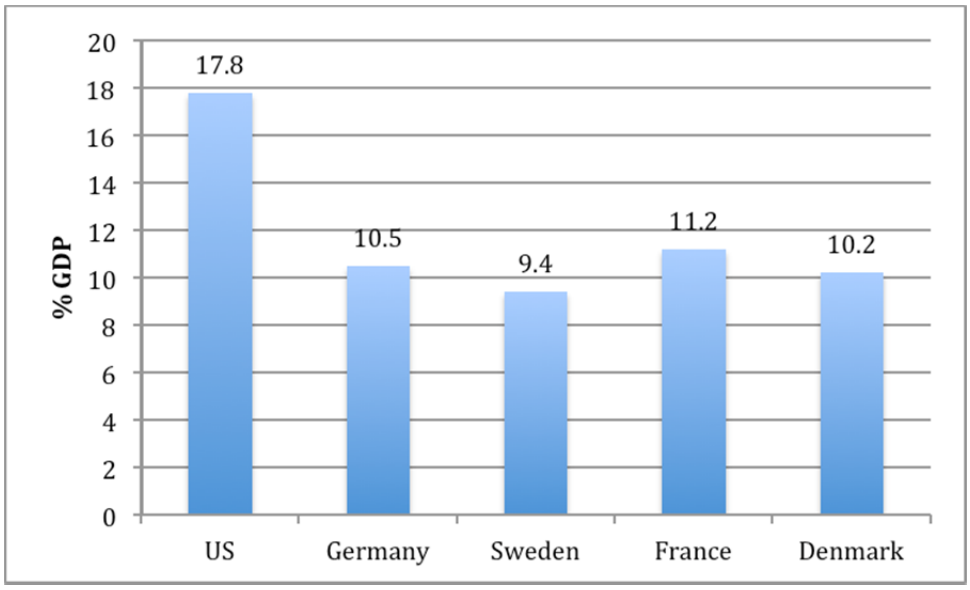

Figure 1.3 Comparison Health Costs (OECD Data)

A significant contributor to healthcare costs is related to personnel costs. Since this research is focusing primarily on pharmacy services, specifically on pharmacist productivity, attention has been placed on the contribution of pharmacist's costs to the processing of a prescription. The median salary for a pharmacist in the United States is $113,006. Pharmacists in the Tampa Bay area make $106,113 which is slightly less than the national median.[7] The salary of the

pharmacists at the study facility were indexed to the national median and are currently slightly above the local, Tampa Bar area median. Benefits in the federal system add another 28% to the personnel costs. This amounts to an average hourly cost of $65.30 to provide the services of a pharmacist. The amount of work a pharmacist can produce an hour then becomes very relevant. Any improvement in this throughput can result in savings to the organization. Table 1.1 displays the cost of finishing a prescription, pharmacist cost only, for different production rates.

Table 1.1 Rx Production Costs per Rx ($)

10	6.53
12	5.44
14	4.66
16	4.08
18	3.63
20	3.27

Increasing productivity from twelve to fourteen prescriptions per hour would save approximately 78 cents per prescription. This does not seem significant but one has to consider the volume of orders processed each year. The pharmacists at the study facility finish close to 650,000 prescriptions per year. Increasing productivity from twelve to fourteen prescriptions per hour could result in a potential savings of over $500,000 per year; equivalent to the salary and benefits of nearly four pharmacists.

Even though process improvements may reduce the need for staff, very rarely is there a reduction in force in state or federal agencies. The outpatient pharmacy always has pending prescriptions, usually between one and three thousand. In the case of severe backlogs, over-time for staff from other areas of the pharmacy is used to supplement the outpatient workforce. Increasing productivity would reduce the need for this supplementation and need for over-time; the potential savings could easily be realized by the reduction in over-time dollars.

Healthcare Safety

In 1999 the Institute of Medicine (IOM) released "To err is Human", a report on the safety of healthcare systems in the United States.[8] They discovered that health system failures accounted for anywhere from 44,000 to 98,000 patient deaths each year. The wide rage in the estimate indicated another problem with health systems; reporting of errors was not standardized and highly variable. Despite an increasing focus on quality improvement, healthcare organizations tend to significantly under report medical errors. [9,10]

The deaths estimated in the IOM report were attributed directly to system failures and were not secondary to patients' underlying pathology; they probably would not have occurred if the system had functioned properly. Such mistakes include errors in administering

treatment or failure to act on results of monitoring or testing.[11] An example of such a system failure would be an accidental over dose, in which case, the patient receives the correct drug, but at a dosage that is potentially harmful.

A classic example of a drug over dose made national headlines when Betsy Lehman, a reporter for the Boston Globe, died after receiving four times the dose of Cytoxan indicated for her body mass.[12] The tragedy in this story is that the dose was questioned by pharmacists, but due to confusion in the way the drug protocol was written, no substantial action was taken and the patient continued to receive the lethal dose.[13]

Medication errors are significant factors in healthcare system failures. It is postulated that medication errors account for over 7,000 deaths annually and injure an additional 1.3 million.[14,15] The costs associated with the morbidity and mortality of preventable medication errors in hospitals was estimated to be over $3.5 billion in 2006 dollars, with estimates of another $887 million for the ambulatory (retail) setting.[16] There is some reason to believe that medication errors, like other medical mistakes, are poorly documented, so this figure is purely an estimate. These estimates do not include factors such as lost earnings and/or time.

Studies of medication errors in retail pharmacy have estimated that one clinically significant medication error occurs anywhere from one to fifty times per thousand prescriptions.[17,18] This wide variance in the estimate reinforces the fact that error reporting is highly problematic.

A retail pharmacist fills and/or checks anywhere from 130 to 350 prescriptions per working day. Using the estimates above, this could result in a range of one to over 16 errors per retail pharmacist per day. In most cases the patient will not detect even a clinically significant error. Due to the high therapeutic to toxicity ratio of most modern medications, many patients can take a short course of therapy with the wrong agent and not have significant adverse effects. For example, a patient who receives an oral drug to lower blood sugar rather than a lipid lowering agent which was prescribed, would most likely only experience some fatigue due to abnormally low blood sugar. A normal patient would probably not go into hypoglycemic shock with normal doses of the modern drugs to treat diabetes.

The key word in this supposition is “normal”. There is a potential for this kind of error to cause significant morbidity or even mortality in patients who are not “normal”, e.g., those who are either very young or elderly or who have underlying pathophysiology that would make them more sensitive to the effects of the medication. In these

patients even a few doses of the wrong medication could result in serious consequences.

In 2005 a review of the status of health systems in the US indicated that progress towards improving patient safety has been “frustratingly slow".[19] In December of 2010, the Inspector General (IG) for the Department of Health and Human Services (DHHS) released a study of healthcare related incidents for Medicare beneficiaries.[20] The results of this study indicate that in the decade since the release of the IOM report, healthcare systems in the United States have not done much to improve patient safety. There have been no significant improvements in medication error rates despite the best efforts of organizations such as the Institute for Safe Medication Practices (ISMP) or the Joint Commission on Accreditation for Healthcare Organizations (JCAHO).

The United States Pharmacopeia (USP) was maintaining a system for reporting medication errors, MEDMARX. They have data indicating that the incident rate for harmful medication errors decreased from 1.67% in 2002 to 1.25% in 2006.[21] While a rate of even one harmful event for every 100 orders processed may sound low, in a high volume operation that would equate to over two to three harmful events per working day. While the USP maintained the dataset the information was free to any users. However in 2008,

Quantros Inc acquired MEDMARX from the USP and now requires a subscription to access the data.[22]

Healthcare systems are complex; there is no single factor that can be identified as a root cause of an organization's failure to improve patient safety. Organizational culture and fear of litigation tend to make healthcare professionals reluctant to report errors. Significant under-reporting makes it difficult to identify and ameliorate underlying sources of error. While reporting has improved in the last decade, some members of the legal profession have exacerbated the fear of litigation. Attorneys have used the IOM data to encourage individuals to file lawsuits; "A mere 13 percent of patients who are seriously injured due to medical negligence ever file a Medical Malpractice lawsuit." proclaims one web site offering to provide relief for patient who have been injured due to medical mistakes.[23] The release of the 2010 Inspector General's report on error allowed the attorneys to update their advertisements.

The increasing role of medication errors in harm has also increased litigation in this area. As the practice of pharmacy moved from the independently owned pharmacy to the chain drugstores the attorneys focused on the "deep pockets" of the chain stores and the incidence of suits involving dispensing errors is on the rise.

One example of such a suit involved a patient who was given Warfarin rather than Lomotil; an anticoagulant was given in place of an antidiarrheal. While this is a pure dispensing error the suit specifically alleged pharmacy malpractice; "...claiming that the pharmacy failed to read the prescription correctly, misfilled his medication bottle with incorrect drugs, and failed to properly analyze Stevens' medication profile, which could have prevented the medication mistake."[24] In this case the plaintiffs are asking for $200,000. There is no argument that the patient was harmed, he experienced bleeding and did require emergency treatment. There is no indication if the pharmacist who made the error had their employment with CVS terminated.

The role of organizational culture in the reporting, or lack of reporting, of errors is also a significant factor in the under reporting of such events. Healthcare practitioners are subjected to a peer review process as part of their performance. Errors are considered part of this review and a "higher than normal" error rate can subject the healthcare worker to disciplinary action. For significant deviation from the norm, this can result in termination of employment. The problem is in the definition of "normal"; if an event is under reported, the normal value is lower than it ought to be. In other words, most

professionals, if they reported any error, could easily find themselves outside the “norm”.

Any errors reported to Regulatory Boards are part of the public record and can have a negative effect on the practitioner’s professional reputation as well as a potential impact on their livelihood. While license revocations are rare, even a short suspension will have an impact on the pharmacist's income. As a result, there is a clear disincentive to report one’s own errors and social pressures not to report those of a colleague.

Another reason not to report or admit to such errors is the case of Eric Cropp, a pharmacist who lost his license and was convicted of involuntary manslaughter for a medication error that resulted in the death of a young girl. This person lost his ability to earn a living and is now a convicted felon due to what was a tragic dispensing error. This is the first case where a dispensing error was criminalized.[25]

Publications by Evans and Pihl have increased this reluctance to report, especially among pharmacists. These researchers believe that a leading cause of dispensing errors by pharmacists is a deficit in pharmacists’ short-term memory. They state:

> …you can rework systems to reduce the likelihood of error, but there are people who tend toward making errors, people who will find a way to make an error even if they fill just one script a day. There are people who cannot

> multitask and should not be working in an environment like a chain drugstore.[26]

Their research indicated that 12% of pharmacy practitioners had deficits in working memory that could predispose them to making a dispensing error. It seems reasonable to assume that pharmacists would be reluctant to self-report errors that might categorize them as someone who "…should not be working in an environment like a chain drug store". This would be especially true if that was the environment in which the pharmacist was working. This would be tantamount to the pharmacist admitting that he or she was incapable of performing their job.

In many states, consumers are encouraged to report errors committed by any medical professional. For example, the State Board of Pharmacy for the state of Florida has a web site where consumers can easily report errors. The required forms can be found on the home page of the Florida Department of Health, division of Medical Quality Assurance.[27] The penalty for having a pharmacy error reported to the Florida Board of Pharmacy often involves a mandatory eight hour Continuing Education Requirement that involves Evans's training on multi-tasking. Evans and Pihl have set up a corporation, ForeFront Logic that charges $285 for this program required by the State Board of Pharmacy.[28] This requirement is based on an appearance before

the Florida Board of Pharmacy by Evans and Pihl wherein they presented their theories that it was the inability of the pharmacist to multi-task that was a significant contributing factor to dispensing errors. To date, there have been no hard data indicating that this is actually reducing dispensing errors.

There are other factors, such as age, stress and fatigue that affect the ability to multitask. Due to staffing cutbacks, healthcare professions tend to work long shifts, often 10 to 12 hours. There are few if any breaks taken during these shifts and pharmacists are more likely to cite their "frenetic workplace" as a source of error rather than simply an inability to multitask. Pharmacists have filed lawsuits citing such conditions as a defense in cases where they have been found to have made dispensing errors. [29]

The Board of Pharmacy's position is that the individual pharmacist is ultimately responsible for insuring that he/she is capable of practicing in a professional manner. The rule specifically state that the following would be ground for disciplinary action by the board:

> "Being unable to practice with reasonable skill and safety to patients by reason of illness or use of alcohol, drugs, narcotics, chemicals, or any other type of material or as a result of any mental or physical condition."[30]

This would mean that pharmacists are responsible for insuring that they do not work more hours per day than they can physically

tolerate, that they not go without breaks or meals if such are needed for them to maintain adequate mental functioning and they do not try to process more prescriptions per hour than they think they can fill with a reasonable margin for safety. If the pharmacist attempts to use workload, long hours, work conditions or lack of meals as contributing to an error, they are, in essence, indicating that they have worked while impaired and should not have been practicing pharmacy at that point in time; that person is solely responsible for any errors that occurred.

The board has not established rules regulating the amount of time a professional can spend on duty and be reasonably expected to work safely. Rules such as these are used in the aviation and transportation industry and are rigidly enforced by review of logbooks. When asked to work inordinately long hours, or work without a break, the pharmacist cannot cite work rules that prohibit such actions and is under tremendous pressure to comply with the request. In the state of Florida there is no longer a shortage of pharmacists; the number of pharmacists and available jobs are relatively balanced. However there are indications that the job market for pharmacists may be getting worse, with a possible surplus projected in the next few years.[31] Florida is also an employment at will state and an employer can terminate an employee without having to provide cause. As a result,

refusal to work a particular schedule or insist on a lunch break could result in loss of employment.

As efforts are made to increase productivity, some consideration must be given as to what is a safe number of orders per hour or day that a pharmacist can process. In the case of this research the only workload being evaluated is the processing of a physician's order into a prescription. The typical “new” prescription has 15 fields that must be reviewed or entered by the pharmacist. In addition to these fields the pharmacist may be presented with one or more alerts that relate to possible drug interactions, duplicate drug therapy or possible allergic reactions of the patient to the drug. In addition to a review of these alerts, the pharmacist is expected to review any potential issues with the drug and known problems the patient's underlying pathology, for example a patient with known hypokalemia being given a loop diuretic.

The prompts and response to alerts will be discussed in more detail in chapter Three. It is emphasized here to highlight the concept of optimal productivity. There is a point where the pharmacist may be able to process more prescriptions per hour but can only do so by sacrificing some of the cognitive duties required to safely finish the prescription.

Work Design Issues

If asked about work design, most pharmacy managers would describe the physical layout of the pharmacy and the workflow used to fill prescriptions. Few would discuss work environment and job characteristics; fewer still would be concerned with the social characteristics of the environment. This almost universal unfamiliarity with the current theories of work design by pharmacy managers can be a detriment to the operation of the pharmacy. This is especially true in light of the increasing workloads and work hours being experienced by today's pharmacists.

There are a number of practice environments for pharmacists and each has characteristics that are unique for that practice. The work of a retail/outpatient pharmacist differs significantly from that of a hospital/in-patient pharmacist both of which differ from the work of a pharmacist with a specialty in nuclear pharmacy.

The focus of this work is on the outpatient sector and all references to pharmacy and pharmacist, unless explicitly stated otherwise, refer to that particular sector. There are some slight differences between the work of a true retail pharmacist, e.g. a pharmacist working at a major chain drug store such as Walgreens or CVS and an outpatient pharmacist dispensing medications to outpatients in a pharmacy attached to a major hospital. However

these differences are relatively slight and would not be a major factor in work design issues. Please note the term outpatient and retail pharmacists will be used interchangeably.

The role and work environment of the pharmacist has changed significantly over the years. Prior to the “open pharmacy” design promoted by the chain drug stores starting in the mid 60’s, the pharmacist often prepared the medication in the compounding laboratory or compounding room of the pharmacy. This provided a quiet work area in which the pharmacist could function without interruption. The concept of the open pharmacy placed the pharmacist in full view of and with complete access by the public. Ostensibly this was done to make the pharmacist more accessible to the public; it also increased the number of interruptions.

Changes in Pharmacy Practice

The job function of the pharmacist has changed over time. In the 1930’s and 40’s the pharmacist prepared or compounded most of the medications that were dispensed. This involved blending and then pressing powders into a tablet or placing them in capsules, preparing elixirs, syrups or solutions. In short, with the exception of “patent medicines” very few drugs were available for direct dispensing to the patient. For example the pharmacist would purchase Digitalis extract and then would have to further dilute it for use by a patient. Between

1930 and the 1990's the compounding role of the pharmacist has decreased from over 75 percent of prescriptions requiring compounding to less than 1%.[32] At the same time, the complexity of pharmacotherapy necessitated an increase in the cognitive aspects of pharmacy. This transition from "cook book" practice or art of pharmacy, to the cognitive or science of pharmacy, resulted in more stringent requirements related to education. The program which started as a two year, associate's degree, in the 1930's became a six year Doctor of Pharmacy (Pharm.D.) in the 1990's.

The cognitive functions required for compounding differ significantly from those required to evaluate pharmacotherapy. The former process often involved following a "recipe" and was more of an art rather than a science. The latter process involves application of pharmacology, physiology and pharmacokinetics. While computer systems help with the detection of drug/food and drug/drug interactions and potential drug allergies, they do not assist much with disease state management and appropriateness of therapy.

Although the pharmacists workload has increased substantially, the work design of a typical modern pharmacy has not changed substantially in the last 30 years. The pharmacist of 20 years ago would consider filling 60 to 100 prescriptions per day a fairly heavy workload. Current practice has pharmacists filling upwards of 120 to

200 prescriptions per day. Just as there are no limitations on the work hours of a pharmacist, there are no rules that would indicate what constitutes a reasonable daily workload.

The available literature on the correlation between workload and dispensing errors is contradictory. Pharmacists believe that high workload is directly related to dispensing errors.[33] One study found that 150 prescriptions would be the median "safe" prescription workload while other studies have found no correlation between workload and dispensing errors.[34,35]

Physiological Factors

Stress, in itself, is not necessarily harmful. The concept of eustress is well known in human factors.[36] Individuals with no stress at all in their job become bored and are likely to make more errors than an individual under tolerable "stress". It is only when stress becomes excessive that it produces the physical and psychological effects that are associated with stress disorders.

Some slight exposure to high stress levels will not produce long lasting effects, though there are immediate effects on cognitive function. Chronic exposure to high stress situations can induce elevations in blood pressure, changes in blood cortisol and a host of other physiological and psychological pathologies resulting from the body's response to stress induced hormonal release.[37]

Excessive stress can alter perception, reaction time and cognition.[38,39] A stressed individual in a highly disruptive work environment is more likely to make a cognitive error than one who is not stressed. Fatigue is also well known to interfere with cognitive abilities and is included as a stressor.

Work Disruption

The sources of disruptions in the pharmacy environment are both external and internal. Examples of external disruptions include telephone calls, questions by patients, and the classic "where is the motor oil". Pharmacists who have worked in the classic "open pharmacy" design have often complained about the non-pharmacy related questions which present a common source of interruption.

The internal source of work flow disruption is primarily limited to other pharmacy employees. Individuals taking time to chat when they are not busy or when individuals are performing work which they believe require low level cognitive functions, can lose focus on the task at hand, the current order on which they are working.

A study of workflow disruptions, conducted late in 2005, found that there were, on average, fifteen interruptions of the processing pharmacist per hour.[40] Twenty percent of these were external, e.g. phone calls, with the remainder being internal and due to non-work related internal interruptions by other staff members. These were

occurring while the working pharmacists were in the processing of finishing prescriptions. It was noted that the pharmacist who was working was often multitasking, continuing to work on the electronic prescriptions while engaged in a conversation with a co-worker. Unfortunately there was no approved research protocol to allow follow-up to determine if this had any impact on prescription errors or required edits to avoid an error.

Facility Overview

The James A Haley Veterans Administration (VA) Hospital is the twelfth busiest facility in the VA Health System. In the fiscal year ending September 30, 2010 there were over 997,000 patient visits. It currently provides care to over 80,000 unique individuals and fills over 100,000 prescriptions per month.[41] The pharmacy has a staff of over 110 individuals, including 60 pharmacists, 45 pharmacy technicians, and 5 support and administrative staff.[42] The pharmacy is divided into four primary sections, in-patient, outpatient, clinical and administrative. Staff members are permanently assigned to one of the sections. The in-patient, clinical, and administrative pharmacists are cross-trained so they can assist, as needed, in the outpatient pharmacy. Clinical pharmacists assist with order verification when unverified prescriptions exceed 4,000 prescriptions on any given day or during major holidays when there are anticipated staff shortage in

the outpatient pharmacy. This is typically done with the clinical staff being authorized over-time while processing prescriptions. Since the overtime rate for VA employees is capped at one and one half time the rate for a GS 10, step 10, and the clinical pharmacists are among the highest paid individuals in the pharmacy, they are essentially working for their standard hourly rate.

The facility utilizes Physician Order Entry (POE). That is, all medications are ordered on line by the prescriber, eliminating errors due to illegible or misinterpreted medication orders. Once the physician enters the order, a pharmacist finishes it. This has the advantage that the orders can be processed by a pharmacist from anywhere, including remotely (from home). This makes the over-time requirements for the clinical staff less onerous.

Role of the Pharmacist

There are no federal pharmacy practice acts and regulation of pharmacists and pharmacies, for the most part is left to the various states. The Food and Drug Administration addresses issues with drug purity and manufacture; it does not regulate the practice of pharmacy, per se.

The primary role of the pharmacist is to dispense medication. The term, “dispense”, includes much more than packaging and placing a label on a prescription container. While there is no single federal

rule or regulation that defines this action, the National Association of Boards of Pharmacy (NABP) has suggested uniform rules for the practice of pharmacy. These are merely “suggested” legislative wording and it is up to each state’s board of pharmacy to determine how pharmacy will be practiced in that particular state. While there are state-to-state differences in many sections of the rules, the definition of the dispensing act is fairly common across all the states and Puerto Rico.

Florida statutes include in their definition of "dispense":

> “… the transfer of possession of one or more doses of a medicinal drug by a pharmacist to the ultimate consumer or her or his agent. As an element of dispensing, the pharmacist shall, prior to the actual physical transfer, interpret and assess the prescription order for potential adverse reactions, interactions, and dosage regimen he or she deems appropriate in the exercise of her or his professional judgment, and the pharmacist shall certify that the medicinal drug called for by the prescription is ready for transfer. The pharmacist shall also provide counseling on proper drug usage, either orally or in writing, if in the exercise of her or his professional judgment counseling is necessary. The actual sales transaction and delivery of such drug shall not be considered dispensing. The administration shall not be considered dispensing.”[43]

A key element in this definition is the requirement that pharmacists “…interpret and assess the prescription order for potential adverse reactions, interactions, and dosage regimen she or he deems appropriate in the exercise of her or his professional judgment…” This

requires that the pharmacist ensure that the drug, strength, dose, dosage form with the correct labeling is provided to the correct patient. It also requires the pharmacist to check the patient's profile to avoid interactions, allergic reactions to a particular drug, over or under utilization of the drug (compliance with therapy), appropriateness of dose and duration of therapy to the patient's need. An example of the last would be the use of an adult dose in a child or failure to adjust a dose for patients with renal impairment or an unusual body mass index. This latter cognitive review and methods to improve the throughput of this cognitive process are the subject of this research.

Work Environment

The cognitive and distributive of the outpatient pharmacy have been clearly delineated. The distributive functions are either handled by a Consolidated Mail-Out Pharmacy (CMOP), the dispensing robotic system[44] or a manual fill "line". The distributive component of the pharmacy is not being considered as part of this research.

The Consolidated Mail Out Pharmacy used by the facility is one of seven located throughout the United States. Once the pharmacist finishes orders entered by the physicians they are electronically transmitted to the CMOP each evening. Over 75 percent of all prescriptions filled by the facility are actually filled by CMOP.[45] While

the prescriptions are filled by CMOP, the local pharmacists have to process the order to generate the prescription that is transmitted.

The cognitive actions of the pharmacist take place at the time of order verification. The facility has Computerized Patient Record System (CPRS) which makes use of Computerized Physician Order Entry (CPOE); the prescriber creating the order enters it directly into the computer system. The system also includes all patient records, such as previous orders, test results, progress notes and other relevant medical information involving a patient. The system is totally paperless with the notable exception of a paper prescription and "wet signature" requirement for outpatient DEA Class II Controlled Substances.

Because all transactions are entered electronically, legibility errors, once both the bane and standard joke about a physician's prescription, become moot. They have been replaced by selection errors, where the prescriber picks the wrong item, which could be a patient name, drug, dose or schedule, from a "drop down" list. While interesting, this error is "upstream" from this particular research and is not a consideration at this point. This research will assume that the physician has picked the patient, drug, dose and schedule that he or she desired.

Once the order has been placed by the prescriber, it does not become an actual prescription and does not get dispensed until and unless the order is finished, or verified, by a registered pharmacist. The prescription finishing process is further subdivided into “window fills”, where medication is to be picked up by the patient at the pharmacy’s outpatient dispensing “windows” or “mail” where the medication is to be mailed to the patient, either by CMOP or filled locally and then mailed. The local fill for mail is used for those instances where the drug is very rarely used and, as a result, not carried by CMOP. This would also apply to drugs that require special shipping or handling requirements. For example, this would include items that require being shipped frozen via next day delivery. CMOP does not handle any DEA Class II controlled substances; any of these items that are mailed must be done via local mail.

Finishing an Order

When a prescriber enters an electronic order into CPRS there is an entry created in the order file. One the prescriber has entered an order for a patient, medication is not dispensed until and unless a pharmacist has finished the order. This step can be done at any terminal that is connected to the hospital network and includes users who can log into the network from home using a secured, virtual local area network (VLAN). To access the VLAN, the user must have

broadband Internet access (at least 200 kbs or better), VA software installed on the machine they intend to use to access the VLAN and a user ID and security on the VLAN. This ensures a secure connection to access sensitive information. Sensitive information includes any record that has patient specific identifiers, such as name, social security number, date of birth or address. In some cases even the complete zip code can be considered an identifier, as can a date of admission.

The finishing process is done entirely on-line and requires that the pharmacist has access to the complete electronic record. Due to the design of the system, this usually requires that the pharmacist verifying an order has open two or more “windows”. The primary system, Veterans Health Information System and Technology Architecture (VISTA) is a “roll and scroll” text only type of interface. The second window is the Computerized Patient Record System (CPRS) that incorporates a graphical user interface and is used to evaluate patient information, read notes, review lab tests and look at consult reports. There are 15 fields that must be reviewed on the electronic order for new prescriptions. In addition to these 15 elements, below, the system also generates alerts based or order checks generated at the time the order was entered by the prescriber. The system also displays the prescriber's response to these order checks. The items

included in the order check are drugs in the same therapeutic drug class, drug/drug interactions, alerts to previous adverse reactions to the drug or drug class and any allergy alerts to the drug or any ingredients in the drug. For example peanut oil used in the production of some inhaled products will generate an alert if the patient had an allergy to peanuts. An allergy and an adverse reaction to a drug are not the same.

The 15 fields that must be reviewed on each new order are:

1. Actual item ordered by the prescriber. This is known technically as the pharmacy orderable item and includes only the drug name and dosage form. When the prescriber selects a dose, this will also select a local drug, which includes the drug name and dosage form. For example an orderable item such as Acetaminophen Tablets may have doses of 325 mg, 500 mg, 650 mg, and 1000 mg. If the provider selects the 650 mg dose, the system will populate the local drug field with Acetaminophen Tablets 325 mg. If the provider selects the 1000 mg dose, the system will populate the local drug field with the Acetaminophen 500 mg tablet. There are some cases where the provider selects the pharmacy orderable item and the local drug field is not

populated, in that case the pharmacist must then enter this information.

2. Local drug being used to provide the item that was ordered.
3. Dosage of the item. This includes the strength, usually in mg or gm, the verb, such as “take” or “instill”, the noun, such as “capsule” or “drop”, the route, such as “by mouth” or “in the eye” and the schedule, such as once a day or twice a day.
4. Ancillary patient instructions, such as “take with food”.
5. Patient status, such as “non service connected”.
6. Issue date of the prescription.
7. Date the prescription is to be filled.
8. Numbers of days supply being provided in the prescription.
9. Actual quantity, e.g. tablets, milliliters, or grams dispensed.
10. Number of refills, if any, allowed.
11. Routing such as mail or window.
12. Clinic in which the patient was seen.
13. Provider (MD, DO, ARNP, PA, RPh) who wrote the order.
14. Number of copies of the label to be printed.
15. Ancillary remarks by the pharmacist.

The way the system handles alerts is one of the problems reported by users. Figure 1.3 is an example of the initial order verification screen. The system does not prioritize the alert by severity and multiple alerts will be triggered for the same interaction pair.

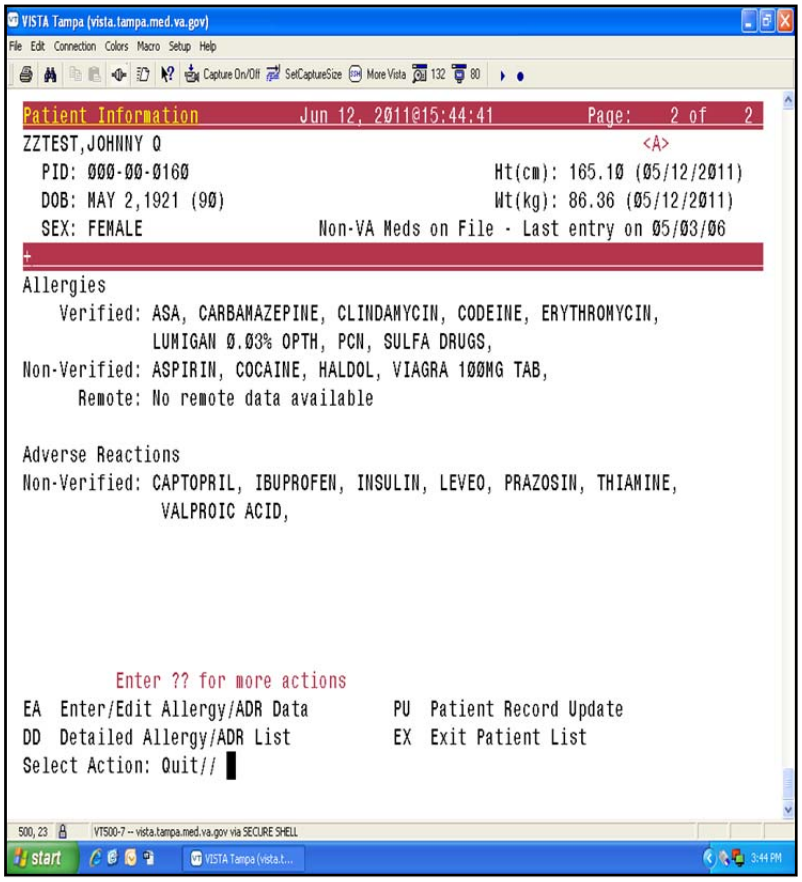

Figure 1.4 VISTA Allergy/ADR Screen

For example, two prescriptions commonly used together for the treatment of heart failure, digoxin and furosemide, will trigger two alerts for possible hypokalemia (low blood potassium); one when the digoxin is finished and the other when the furosemide is finished. This leads to concerns about alert fatigue; users are desensitized to the

multiple alerts and therefore do not really read all of them. This could, and has, led to incidence reports where a critical alert is missed due to excessive “background clutter”, i.e. the critical alert was mixed in with serious alerts. Responses to alerts such as “OK” or random key strokes such as “ASDFG” would indicate that in some cases the alerts are not really being read or intellectually processed by the prescriber.

Alerts are classified as either “critical”, i.e. immediate danger of harm or “serious”, possible danger of harm. Critical alerts must be electronically signed and acknowledged by the pharmacist. Serious alerts can be bypassed. The system does keep a record of who bypassed both types of alerts. Reviewing these alerts can add significantly to processing time and can lead to an incidents if the pharmacist bypasses an alert which ultimately results in harm to the patient.

The prescriber creates an entry in the order file at the time the order is entered, one entry per medication order. When the pharmacist finishes the order, a temporary view is created displaying the order checks and the entries which will be made in the prescription file upon finishing and verifying the order. Once the pharmacist has reviewed these fields, a final view of what will be the prescription entry is displayed and the pharmacist is asked to verify that the information is correct. The default entry in “No”; a pharmacist must enter “Y” and a

carriage return to complete the process. At this point the prescription is finished and a record is written to the prescription file. This record includes the finishing date/time and the name of the pharmacist who finished the order. At this point the prescription is sent to the processing system where it is directed to either the pharmacy dispensing robot or queued for the CMOP transmission which occurs each evening.

Once finished, a prescription can be edited, however the finishing pharmacist and date/time are not editable and any further changes to the prescription are included in an activity log. It is extremely rare, less than one to two events per 100 prescriptions, for a prescription to be edited immediately after entry. Edits are more likely to occur if an error is detected when the prescription is filled. Since most of the prescriptions (75%) are filled at CMOP, this activity usually does not occur until at least four days after the original order is finished. CMOP transmissions or error returns only occur once per day and there is an inherent two day lag in CMOP processing; one day for transmittal, two day lag and one day for the return transmittal. CMOP returns for error only account for approximately 400 prescriptions per month, an extremely small percent of total production. Approximately 15 percent of the remaining prescriptions are filled by a robotic dispensing system, ScriptPro® leaving less the 10 percent which must

be filled manually by pharmacy technicians. All prescriptions processed by either the robot or the technicians are checked by a pharmacist using the ScriptPro® System.

Dispensing also includes selecting the drug, placing it in a suitable container with a suitable label and providing it to the correct patient. This latter aspect of dispensing, the actual preparation of the drug, is more distributive in nature and can be done with automation with very high accuracy, approaching six sigma levels. This research will focus primarily on the cognitive rather than the distributive aspect of pharmacy.

In addition to the new prescription, there is a quasi-new prescription which is done via the “renewal” process. “Renewal” is an option to allow the prescriber to rapidly rewrite an order for a medication that the patient has already been taking. This is often done when the patient has used up the refills on his prescription and the prescriber wishes to maintain the same therapy. A prescription that is renewed only has 8 items that can be edited:

1. Issue date
2. Fill date
3. Number of refills
4. Routing (mail or window)
5. Clinic

6. Provider

7. Copies

8. Remarks

Typically, only the routing is edited. In most cases the finishing pharmacist simply accepts all of the default entries. The renewal process does trigger “order checks”, whereby the system checks for and alerts the pharmacist to any drug interactions or potential allergic problems. However, since the medication is a renewal and the patient has been on the medication previously, sometimes for a rather lengthy time, these alerts are relatively meaningless. Even if a new medication had been started, the alerts to the medication being renewed would have been triggered by the addition of the new medication and hopefully already reviewed by the pharmacist who finished the order for the new medication. Clearly, there is significantly less effort required to finish a renewed prescription than there is for a new prescription.

In addition to the order checks for allergies, drug interactions and duplicate therapy, there are questions related to whether or not the patient will be charged a co-pay based on the drug and the patient's service connected conditions. Failure to answer these questions correctly can result in the patient being charged a co-pay for the prescription when none is due, or not being charged a co-pay

when one is required. This may seem trivial but the latter problem has resulted in pharmacists being audited by the Inspector General's office. Failure to charge a copay when one is required is considered a theft of government resources.

In order to facilitate prescription processing a report generator was written which allows the outpatient pharmacy supervisor to generate a report of pending prescriptions which were renewed. These should be capable of being processed faster than new prescriptions. The intent was to use this report to more equitably divide workload and balance the distribution of new and renewed orders among the pharmacists. There is a concern that this report was not being used equitably, which is another reason for the workload statistics to include the new and renew prescriptions per pharmacist; any uneven distribution of renew to new prescription processing would be evident to pharmacy administration.

Chapter Summary

The intent of this chapter was to examine some of the cost and safety issues associated with processing a prescription and to provide an understanding of why productivity, in terms of prescriptions processed per hour, is a significant organizational concern. The focus of this research is limited to the cognitive function of the pharmacist,

that activity associated with the process of converting a physician's order into a prescription.

Previous studies by the author had discovered that disruptions to work flow were relatively common. A redesign/relocation of the pharmacy provided an opportunity to examine if these disruptions had an impact on productivity. The new pharmacy was designed to minimize such disruptions and the facility had a database that captured the time, to the second, when an order was finished by a pharmacist. These two events provided an opportunity to evaluate the impact of such disruptions.

The remaining chapters in this document will discuss the following topics. Chapter Two will review existing literature related to this topic. Chapter Three is a discussion of the methods used to examine the impact of the two experimental interventions being used. Chapter Four is a review of the results obtained from the data extract of the workload data. Chapter Five is a discussion of the results of the research and the relevance of these to the organization. Chapter Five will also detail the conclusions that can be drawn from this research. This would include the relevance of this research to other organizations. Finally, justification for further research in the area of the effect of production rate on medication error is provided.

CHAPTER TWO

LITERATURE REVIEW

Changes in Work

Workload and stress were not major issues in the practice of pharmacy through the first half of the twentieth century. It was not until the practice of pharmacy moved from a sole proprietorship, with the pharmacist compounding most of the prescriptions dispensed, to the current "chain store" era that concerns about workload and stress began to surface. The practice is undergoing another sea change and an increasing number of prescriptions are being filled by mail order pharmacies with the large-scale use of robotics to count, bottle and label the prescription container. As robotics are more commonly used to prepare the actual medication, the function of the pharmacist is becoming more cognitive in nature, with emphasis placed on detecting inappropriate doses and drug-drug interactions.

This shift in function is accompanied by an increasing reliance on automation for order entry. As will be discussed in Chapter Three, the study facility is entirely paperless and all orders are electronic in nature, utilizing a Computerized Patient Record System (CPRS) and

Computerized Physician Order Entry (CPOE). While this removes issues with legibility it creates new issues, primarily dealing with the system generated alerts and responses to these alerts. There is data to suggest that vigilance performance, required for detecting, and more importantly reacting to, system alerts can be eroded by continual exposure. The requirement for continued vigilance can have a significant impact on performance over time. Pharmacists assigned to processing prescriptions at the study facility may only do it for a portion of their workday, while others have such processing as their only responsibility. The erosion of performance described in the Tiwari paper can be seen in a few as fifteen minutes; the increased stress leading to decreases in motivation. [46]

The issue of vigilance and response to alerts is relevant to the manner in which pharmacists process orders in a CPOE environment. In most cases the pharmacist verifying the orders is not responding to prompts, but rather is reviewing fields which have already been populated by the prescriber and are checked for accuracy, appropriateness and proper responses to order checks. An example of the latter action would be over-riding a prescription for Warfarin, an anticoagulant, when used with Sulfamethoxazole, commonly used in the treatment of urinary tract infections. This drug-interaction has

been known to cause hospital admissions and there are many ways to deal with it, such that harm from this combination is inexcusable.

Since the fields are already populated the pharmacist merely has to press the enter key to review the next page, then enter “FI” to finish the order, review an example of the finished label and then enter “AC” to accept the label. Some pharmacists have installed shortcuts on their keyboard, for example, assigning “A”, “C” and an enter to a hot key. By doing this an order can be completed in as few as three strokes

Stress as a Concern

In 1978 Curtis et al examined the differences in stress and job dissatisfaction between hospital and community based pharmacists.[47] During the latter part of the 1970’s and all through the 80’s, researchers were examining workload and stress and their effect on pharmacist “burn-out”. The works of Curry, Huff, Radde and Wolfgang all examined the effects of stress and work environment and the likelihood of pharmacists to become dissatisfied with their work environment and change jobs. [48,49,50,51] Their concern was focused on pharmacist retention and turn-over rather than dispensing errors. Wolfgang, in particular, was interested in the effect of job stress in the health professions; as with the other authors of the time, the focus was more on staff turn-over than medical mistakes.[52,53]

The Health Professions Stress Inventory was developed by the Wolfgangs to measure stress in healthcare professionals.[54] Their survey instrument measured such factors as interruptions, inadequate staffing levels and excessive workloads.[55]

Buchanan et al examined the effect of illumination on pharmacy dispensing errors and found that there was a direct correlation. The methodology employed direct, undisguised observation and found that there was a direct correlation between error rate and illumination levels. [56] While illumination levels may be a component of dispensing errors, one has to question if the Hawthorne Effect may have been a factor in Buchanan's results. Further, illumination levels have more of an effect on the distributive rather than the cognitive aspect of pharmacy and as automation is adopted for the distributive phase, this type of error will depend less-and-less on the human element and will be more dependent on the design of the automated dispensing systems.

Flynn reviewed the effect of ambient noise in the pharmacy workplace and found no real association between noise levels and error rate.[57] Flynn also examined the susceptibility of pharmacists to distractibility, using the Group Embedded Figures test and found an association between distractibility, interruptions and medication error

rate. The paper also noted a general association between interruptions and error rate.[58]

Evans's paper reinforced the concept of "distractibility" as a contributor to dispensing errors. Pharmacists who had, in Evans's terms, deficits in working memory, i.e. those more easily distracted or less capable of multi-tasking, were more likely to make errors.[59] Neither of these authors considered work design issues and were of the opinion that reducing the pharmacists' "distractibility", i.e. teaching them techniques to facilitate multitasking, was an effective technique to reduce error. In other words modify the operators ability to deal with the distractions rather than reduce the source of the distractions.

An Australian study by Peterson et al surveyed pharmacists as to their beliefs as to the cause of dispensing errors. Most believed likely causes were high prescription volumes, fatigue and interruptions to dispensing.[60] Bond et al established that US Pharmacists held similar opinions.[61]

Mott et al conducted surveys examining the reasons for pharmacist turn-over. They found that the stress was increasing as a component for job dissatisfaction and turn-over.[62] Their concern, like those conducted during the preceding three decades, was focused more on staff retention than error reduction.

As the supply of pharmacists rose relative to demand, many organizations became less concerned with turn-over. The Aggregate Job Index for pharmacists in Florida had dipped to 2.5 in January 2011. The index is based on a scale from 1 to 5, with 3 indicating that the supply of workers to jobs is balanced. An index greater than 3 indicates a shortage of pharmacists, less than 3 indicates a surplus. Figure 2.1 compares the pharmacy manpower index trends over the last three years, comparing Florida and National trends.[63] As can be seen in the chart, pharmacists were in short supply (demanded exceeded supply) until mid-2009. [64] The trends for Florida are displayed as the lower line on the chart.

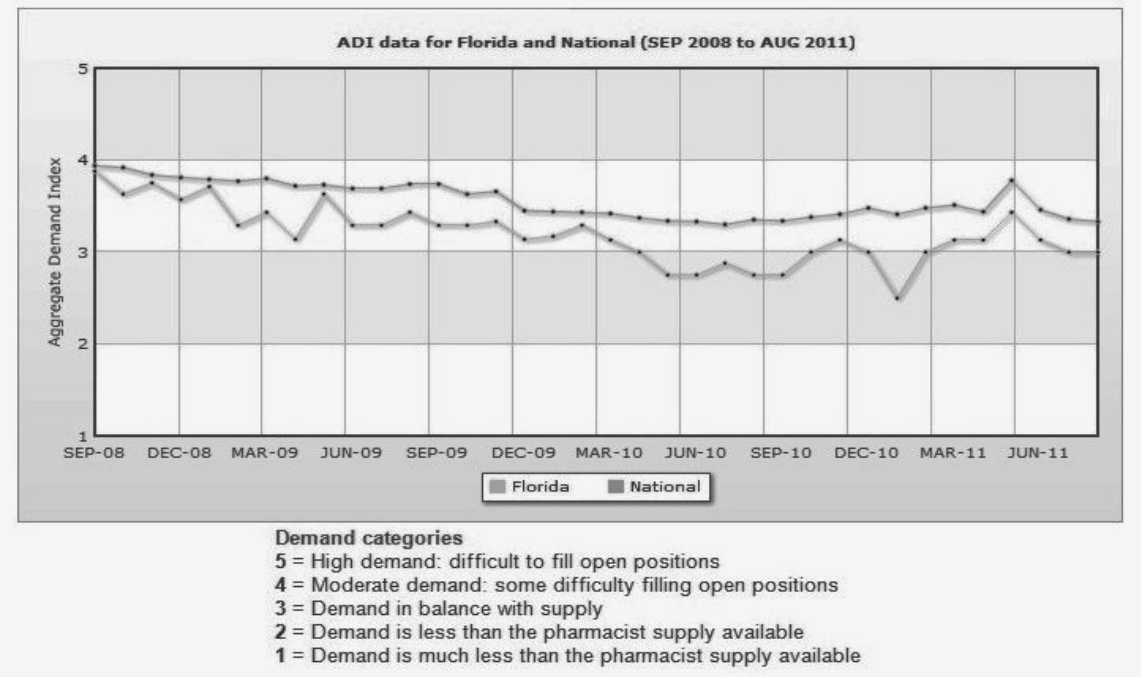

Figure 2.1 Manpower Index Trends

Due to the relatively high starting salaries for pharmacists, there was an increasing enrollment in pharmacy colleges. Pharmacy schools had projected manpower shortages for the remainder of the decade and increased the size of their classes. Also, some states, such as Florida, increased the number of pharmacy colleges. The financial crisis of 2008 decreased the demand for pharmacists at the same time schools were beginning to increase the number of graduates. While this is a national phenomenon, some states have been more impacted than others; Florida is one of the states where manpower and available jobs are close to being balanced but is trending toward a surplus of pharmacists. Unfortunately it is expected that the trend will continue downward, especially when two new pharmacy colleges in the state start graduating their first classes.

Schell et al examined the effects of anxiety and workload on stress in a simulated pharmacy environment. Grasha also used a simulated work environment to measure the effects of stress and interruptions on dispensing errors.[65,66,67] Some of his observations included “Pharmacists were more vulnerable to mistakes under low workload conditions and when shifting from high to low activity. Boredom, reduced task focus, and disruptions in personal work rhythms made it hard to focus on tasks, even though pharmacists with both low and high workloads were equally concerned about their

performance and were motivated to do well."[68] It must be noted that these studies were either based on direct observation or simulations.

This research will evaluate changing the physical environment, reducing disruptions to the pharmacists entering orders, and the use of published workload reports as a mechanism to increase productivity. An indicator for error, based on CMOP reported incidence rates, will be used to evaluate the errors that are not caught by pharmacists during order verification and get passed through to prescriptions sent to CMOP. The errors reported by CMOP do not consider those due to ignoring alerts such as those for drug interactions, allergy or duplicate drug therapy however they would be considered an indicator of how thoroughly the pharmacist has reviewed the order. Another indicator of error will be the trends in orders which are discontinued by the pharmacist during the order verification process. The rationale for this approach will be discussed further in Chapter Three.

Rolland reviewed medication errors at a VA facility and reported that drug and patient selection were the two most common sources of errors. It was concluded that "Focusing error reduction efforts on selection of the correct drug and correct patient would likely yield the best results in reducing dispensing errors since these errors combined accounted for 55 (67.1%) of the 82 reported errors". [69] It is not

known, at this time, what modifications to work design are being recommended by Rolland.

Pharmacy Workload

The number of prescriptions being filled in the United States is increasing more rapidly than the population. Per capita prescription drug use increased from 10.1 prescriptions per person in 1999 to 12.6 in 2009.[70] A study by the University of North Carolina (UNC) found that a "typical" pharmacist increased productivity from one prescription every eight minutes, in 1999, to one every five minutes in 2000.[71] As will be seen, there are studies indicating that this production rate is now closer to just over four minutes per prescription, more than 14 prescriptions per hour, sometimes much higher. The UNC study indicated that it was a shortage of pharmacists that was responsible for this increase in individual workload. This may be true for North Carolina, which tends to have a shortage of pharmacists, relative to the available jobs, and historically tends to have better job outlooks for pharmacists than the national average. This is not reflective of conditions in the southeast US, the location of the study facility.[72]

The reasons for this increase in prescription drug use per capita is beyond the scope of this research but one significant factor may be the ability of pharmaceutical companies to market their products direct

to the consumer, spending twice as much on marketing than they do on research.[73] In addition to direct to consumer advertising, drug companies have expanded their marketing activities with physicians. In 2006 there was one marketing representative for every nine physicians compared to one for every eighteen in 1996.[74] The net effect of all of this is the concept of a "pill for every ill" and an increase demand for pharmaceuticals.

Malone et al examined the effect of workload on pharmacists dispensing errors and determined that there was "...an increase in the risk of dispensing a potential DDI with higher pharmacist and pharmacy workload..."[75] This was strictly a survey of "potential" drug-drug interactions and there was no indication of any actual patient harm. While a significant correlation was found between workload and potential errors there were no changes made to the work environment of the pharmacies that were surveyed. One of the interesting items to come out of the study was an estimate of the number of prescriptions filled per pharmacist per hour. Their calculation was based on the total number of prescriptions filled per week divided by the total number of pharmacists' hours per week. The mean prescriptions filled per pharmacist per hour were 14.1 with a range of 2.9 to 41.5. The method for processing prescriptions was significantly different from that of the study facility where the duties of the pharmacists

processing orders was separated from the pharmacists and technicians filling the actual prescription.

An article in Pharmacy times reviewed survey results of pharmacists' perception of their work environment. The survey indicated that pharmacists were becoming alarmed about the impact of workload on possible errors. Two interesting results of the survey were "36% of the pharmacists surveyed said that the growing workload has negatively affected their ability to reduce medication errors;" and "33% said that workload pressures are harming their ability to solve drug-therapy problems."[76]

Another indicator that workload may be a factor in medication errors is based on a study which found a 25% increase in medication error related deaths at the beginning of each month. The authors postulated that since government payments to beneficiaries occurred the first part of each month, and there were noticeable spikes in prescription workload the first of each month, these deaths might be related to increased workload.[77] This argument is somewhat tenuous but does merit further review.

At this time the boards of pharmacy of only a few states have recognized the potential impact of workload and stress on error. North Carolina has taken enforcement action limiting work load and hours against a pharmacist brought before the board of pharmacy for

dispensing errors. That action included a restriction on the pharmacist to fill no more than 150 prescriptions per day and further limited his work week to no more than 40 hours per week and no more than eight hours per day. This could amount to filling more than 19 prescriptions per hour; a volume that other reports indicate may still be too high for safety. One of the problems with this assumption is that it presumes prescriptions come in at a constant rate. Anyone who has worked in the retail sector knows that this is not true and there are peak times for prescription load; the work does not come in at a constant rate. Fortunately the subjects of this research controlled their own rate, the work queue was saturated so there was no cyclical change in load for the study pharmacists.

Pharmacists often cite workload in an attempt to mitigate adverse board actions. In a response to the above mentioned board action in North Carolina, the pharmacist used as his defense:

> "Respondent testified that he believed that the errors were due to filling high volumes of prescriptions, working long hours, and improper supervision of pharmacy technicians, as well as due to significant life stressors that he was experiencing at the time the above-stated errors occurred."[78]

North Carolina has also set rules limiting a pharmacist's workday to no more than twelve hours. The rules also provide for a thirty-minute meal period and an additional fifteen-minute break for any

pharmacist working more than six hours.[79] The effect of breaks and meal periods will not be an issue for the test site. Labor rules for federal employees dictate a 30-minute meal period and two fifteen minute breaks for every eight-hour shift.

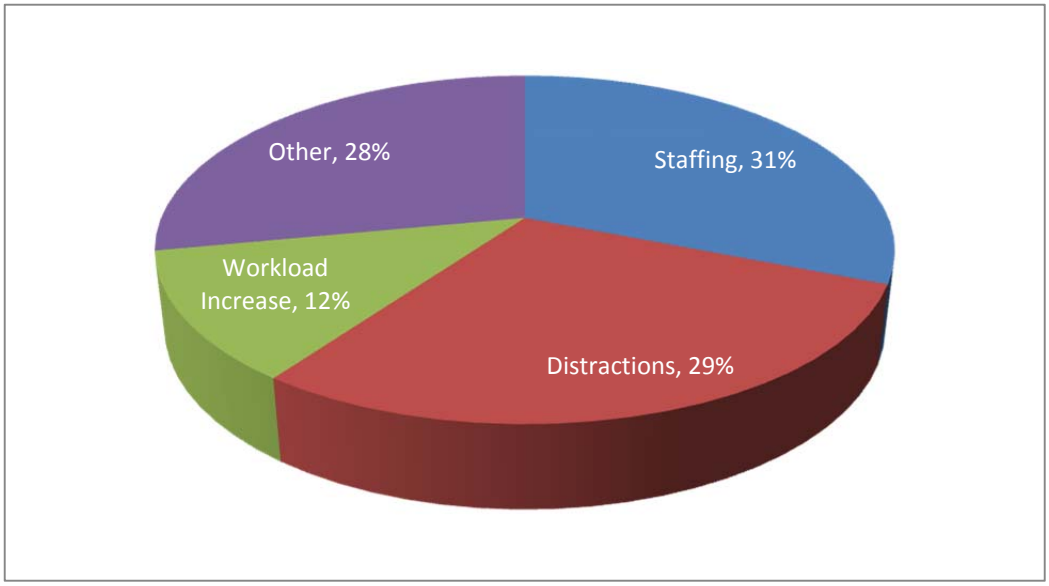

Figure 2.2 MEDMARX Data

As can be seen in Figure 2.2, Data from MEDMARX® indicates that close to three-quarters of the contributing factors to high alert medication errors were staffing (31%), distractions (29%) and Workload Increase (12%). While it might seem counter-intuitive, based on board actions where the defendant pharmacist cited stress and fatigue as factors in the error, the MEDMARX data indicated only 2% of high alert medication errors were due to fatigue. [80] One possible observation for this may be the fact that the MEDMARX data is primarily accumulated from approximately 400 large healthcare

facilities while the board actions cited occurred in community based pharmacies. Of particular interest is the effect of distractions on these errors. It was disruptions to workflow that were discovered in the study by Coblio et al that prompted further research at the facility.

Alarm Fatigue

The role of system false alerts and high alert rate cannot be minimized. A false alert results when the system alerts the pharmacist or prescriber to an allergy or drug/drug interaction that does not really exist. For example, generating an alert for a drug interaction alert to topical ketoconazole and some drugs, such as Amiodarone, used to manage cardiac dysrhythmias. While this would be a serious interaction for orally administered ketoconazole, there is practically no absorption of the drug through intact skin and thus no real drug/drug interaction.

There is growing evidence that while automation can reduce some types of error, other types of errors can actually be induced by systems. The effect of repeated low-level or false alarms contributes to “alarm or alert fatigue”; crucial information is lost in the “noise” of the other alerts.[81,82,83] It is beyond the scope of this research to examine the effect of alert overload or fatigue on error rate; this research focuses on productivity. However, as will be discussed in Chapter Five, these effects must be kept in mind when evaluating

systems changes made to increase productivity. As the number of orders to be processed per unit time increases, and the number of alerts also increases, is less time being spent evaluating these alerts? This is particularly an issue if the pharmacists are aware that there is a high incidence of false or very low level alerts.

Staff Turn-Over and Stress

Much of the early research on pharmacist stress and burnout has been focused on staff retention and recruitment. Stress, burnout, high staff turn-over and error rates are most likely related. As noted in the Peterson and Bond papers, surveys of working pharmacists indicated that work design was a significant factor in dispensing errors. Work design is also a significant factor in stress, burnout and turn-over.

Pharmacists often find themselves in situations where they are either confronted with high workloads or long hours or both. High turn-over increases staff pressure as they strive to keep up with work while training new pharmacists to eventually assist in the work. This in turn leads to more stress and further loss of staff. In some organizations this has led to spiraling changes in personnel such that few staff members have a grasp on the subtle, unwritten, “procedures” that facilitated operation of the department.

Another causative factor for increased work hours is quite simply a factor of management focus on reducing salaries. While this is not

yet a common factor in government facilities there is an incentive in the private sector to use two full time employees working sixty hours each to accomplish the work of three employees. The economics of this management decision becomes self-evident when viewed in light of the facts which are detailed below.

Pharmacists typically are paid more than the Social Security Maximum tax. In 2011 this was 106,800.[84] There is no requirement for over-time pay for pharmacists. Even in the government sector, over-time rate is capped at one and one half times the salary of a GS10, step 10. This is slightly lower than the salary of most of the pharmacist who are in the GS12 wage grade or higher. Office of Personnel Management directives dictate a person cannot be paid less than their normal hourly rate for over-time, so in most cases, pharmacists are working over-time for their normal hourly rate.

Since the benefits are fixed, the rationale for using two individuals working sixty hours each, to cover one hundred twenty hours, results in a savings of approximately 28% (approximately $30,000 per year) of a person's salary. In addition to the cost advantage of working pharmacists long work weeks there was also a scheduling advantage for assigning pharmacists to twelve hour days. It was far easier for pharmacy district managers to schedule two pharmacists working twelve hour shifts than scheduling three

pharmacists. Many pharmacists in the retail sector have been working 12-hour days for 60-hour shifts since the mid 1970's. Initially this was due to a shortage of pharmacists; there were not enough individuals to cover the available hours. However as noted in the pharmacy manpower data, above, there is currently an adequate supply of pharmacists so one has to consider the cost and ease of scheduling as primary factors for these schedules.

Rules in Other Industries and Countries

This increase in workload and resultant increase in stress is not isolated to the practice of pharmacy. WFD, a consulting company surveyed business leaders and "work life experts" found that "Eight out of 10 respondents report that managers and employees workloads have increased, along with employee stress. At the same time, half of respondents report that employee motivation, energy, and endurance have all decreased."[85]

The aviation industry has established a fairly impressive record for safety and is often cited in the medical literature as a model for developing safe systems. This has been done through formalized rules for work processes for all members of the flight crew and air traffic control The Federal Aviation Administration (FAA) has imposed limits on the number of hours pilots can fly and the number of crew required for each type of aircraft; accidents are thoroughly investigated to

determine if changes in these standards are necessary. This not only applies to the pilots and crew of the aircraft but to air traffic controllers.[86]

The FAA constantly reviews issues that may have an impact on an air crew's or air traffic controller's cognitive abilities and is acutely aware of the effect of stress and fatigue on these abilities. As a result, time at work and rest requirements are continually being updated.[87]

Unfortunately, organizational culture in the healthcare industry has prevented the wholesale adoption of similar regulations. A possible reason for this failure to adopt such guidelines is the fact that there is no "Federal Pharmacy Administration"; the profession of pharmacy is regulated at the level of the state rather than the federal government.

From the international perspective, the European Union has established standards for allowable work hours for all employees. The motives for the EU standards are not only for safety, there are economic incentives to limit the workweek; limiting over-time makes jobs available for other workers. In most EU countries these rules currently limit the hours an individual can work to no more than 48 hours per calendar week.[88]

Chapter Summary

Stress and fatigue are cited by pharmacists as factors contributing to medications errors made by pharmacists. Unlike other industries, such as transportation, there are no federal regulations that set work hours or workload. There are few state guidelines; those that exist are often recommendations or guidelines as opposed to enforceable regulation. The workload for pharmacists is increasing and while there is no shortage of pharmacists in Florida, and the national workload index seems to be trending toward balance, there is a both a financial and ease of staffing incentive for pharmacy managers to increase per pharmacist workload rather than hire more pharmacists. At this point in time there is no agreement on what constitutes a safe prescription workload, with an apparent range of 14 prescriptions per hour to over 19 prescriptions per hour. In the United States there are no limits on the total hours a pharmacist can work per calendar week.

CHAPTER THREE

RESEARCH METHODS

Design Overview and System Limitations

In an effort to reduce operating costs, the facility has initiated process improvement activities for all departments within the organization. Within the organization, pharmacy costs are among the highest. Unlike community hospitals, which have small outpatient sections, if they have one at all, VA facilities provide total outpatient care. As a result, the outpatient pharmacy accounts for a majority of pharmacy staff, incurs the highest departmental costs and is the busiest part of the pharmacy. This would make it the most likely candidate for process improvement activities.

There are data indicating that some of the processing problems in the outpatient pharmacy are due to design issues with the pharmacy software. The department of Veterans' Affairs removed the Office of Information and Technology (OI&T) out from under the Under Secretary for Health, creating a separate office that reported directly to the Secretary, Department of Veterans Affairs. This added level of bureaucracy makes software changes difficult to make. Requests for

changes, New Service Requests (NSR's), must be sent up the VHA chain of command and then are routed to OI&T, where there the process of review starts all over again. NSR's are required for any requested changes. Due to staffing cutbacks in OI&T, most of the system design changes are handled by contract. As a result, the processing of NSR's can take years to accomplish.

The reason for this organizational change at the National Level is beyond the scope of this document but is related to system management issues. These related to problems with a project, the Core Financial and Logistics systems (CoreFLS), a financial management system which was a total failure and cost the VA over 249 million dollars.[89] This project management failure resulted in the forced resignations of an under-secretary for health, a facility director, chief of staff and other individuals in management positions with the project. This occurred in 2004 and due to the projects poor over-sight by VHA, led to the creation of OI&T. Unfortunately, the VA Office of Inspector General's report on OI&T project management indicated, at least as recently as September 30, 2009, that there were still major problems with project management within OI&T.[90]

Because system design changes are not possible at this point, it was decided to focus on work design in the outpatient area as the focus for process improvement. The distributive aspects of the

pharmacy are highly automated. The facility uses a robotic fill system designed by ScriptPro®. This system is very efficient and fault tolerant. As mentioned in Chapter One, the robotic dispensing systems in pharmacy are close to operating at a six-sigma level and dispensing errors where the wrong medication is in the prescription container is extremely rare. In instances where such events were reported by the patient, it was discovered that the patient had inadvertently transferred the contents of one container to another. Due to the high efficiency of the robotic systems, it was decided that the finishing of the prescription, the processing component, was the most viable candidate for process improvement.

The current design and operation of the outpatient pharmacy was discussed at length in Chapter One. As a quick summary, the functions of the outpatient area are clearly delineated into the production and processing areas. The processing areas are further divided into the 'window fill" area, where pharmacists interact with patients while finishing their prescriptions on line, and the mail area where the pharmacists primarily work on the computer finishing prescriptions with no patient interaction. The majority of disruptions to flow for the pharmacists processing mail prescriptions were identified as either from phone calls or other staff members. [91,92] The processing pharmacists require more attention to detail than the

pharmacists and technicians working in the production area. The production area is more oriented towards order fulfillment, the primary responsibility of staff there is to ensure that the correct medication is in the prescription container and that the correct label is attached to the container. That is primarily controlled by the robotic system. It is the finishing or processing pharmacist who must ensure that there are no interactions, the drug is appropriate and exercise all of the other "clinical" functions of the pharmacist.

Those prescriptions, which are filled locally, are processed by the robotic dispensing system, ScriptPro® or are filled manually. All prescriptions filled locally are processed by ScriptPro® but only approximately 200 drugs are filled by the robot. The remainder are filled with manual fill systems, either picking unit–of-use packages such as ointments, ophthalmic solutions or bottles of oral liquids or using manual tablet counting devices such as those made by Kirby-Lester.

No matter which process is used, all items are processed using the ScriptPro® systems which uses bar code technology to ensure the correct mediation is in the prescription container. Both of these systems, ScriptPro and CMOP operate at close to six sigma levels for accuracy. Since finishing the prescription is the critical point in the process and is required for all prescriptions, this cognitive component,

the finishing or processing of prescriptions by the outpatient pharmacy was selected for study.

Consolidated Mail-Out Pharmacy

While all prescriptions to be filled must be finished by a pharmacist, most of the actual production of the finished order is done by the Consolidated Mail-Out Pharmacy (CMOP). Over 75% of all prescriptions finished by the outpatient pharmacy are sent to CMOP to be mailed to the patient. CMOP has invested heavily in automated dispensing equipment and can process close to one hundred thousand prescriptions per day. The CMOP in Charleston in one of seven VA CMOPs located throughout the United States. Prescriptions are electronically transmitted to CMOP once a day, in the evening.

The CMOP uses automation to not only fill and process prescriptions but has systems to detect simple errors in prescriptions. For example, CMOP will reject back to the facility any prescription which contains prohibited abbreviations, for example “cc” rather than “ML” and “U” when used as an abbreviation for “units”.

Figure 3.1 is a photograph of one of the automated CMOP fill lines. At this point, the prescription containers are already labeled with a suitable prescription label and are in “pucks” which have RFID devices which are encrypted with the prescriptions information including the patient, drug, strength and number of oral solid doses to

place in the prescription container or containers. The VA encourages the use of 90 days' supply of medication whenever it is prudent to do so; as a result there is often a need to place large quantities of medication in multiple containers for the same prescriptions; the system can accommodate multiple containers.

Figure 3.1 CMOP Fill Line

One of the advantages of using CMOP is that the system can also accommodate handling the unit-of-use packaging. The system uses an "A Frame" rack and the packages are labeled with an appropriate label and dropped into "tote" with one "tote" for each patient. All prescriptions are sent to packaging stations where bar codes are used to ensure that all of the medications are for the patient being checked and that the patient has all of the prescriptions which are supposed to be in the order.

A photograph of one of the “A Frames” is included as Figure 3.2. As can be seen in the photo each rack carries a large selection of different pre-packed items.

Figure 3.2 CMOP A-Frame

The production costs for CMOP, per prescription, are estimated to be $1.50 to $1.75 less those of the local facility.[93] The reason for this is due to the economies of scale that result from such a large operation. Their lower costs are due to the high use of automation and the use of mail consolidators that reduce postage costs. This is the reason that facilities keep track of percent CMOP utilization for their mailed prescriptions. It must be kept in mind that CMOP does not provide any cognitive services. All prescribers’ orders which are

finished into prescriptions are processed by pharmacists at the local facility.

While not part of the study, the CMOP also fills the refilled prescriptions which are processed by the pharmacy technicians at the local facility. Refill prescriptions account for slightly less than half (48%) of all prescriptions processed.

Design of Physical Plant

As mentioned previously, earlier studies found that there were many internal disruptions to work flow, i.e. disruptions due to other employees interrupting pharmacists who were finishing prescriptions. These disruptions were due in large part to the design of the outpatient pharmacy which caused a great deal of traffic along the cubicles where the pharmacists were finishing prescription. A schematic of the general design of the area is included as Appendix A.

The outpatient pharmacy was relocated from the first floor of the hospital in the early 90's, circa 1992. This move was required due to a need to open more patient clinics on the first floor of the hospital. It was at this time that the pharmacy administrative offices were moved from an area opposite the outpatient pharmacy to a modular building outside the hospital.

The outpatient pharmacy was split into two levels, one on the basement level and the other on the first floor of the hospital,

immediately above the lower level and connected to it via two, small, side-by-side elevators capable of carrying approximately a one hundred pound load. The actual processing area was in the basement where prescriptions were finished, placed in bags and sent up to the first floor via one of the elevators. The first floor pharmacy was for prescription drop off and pick up.

The outpatient pharmacy was moved to an open work area of approximately 9,800 square feet. The only area which had a floor to ceiling wall was a small office area, designated as “Printers” in the drawing where all of the outpatient label and report printers were located. All four walls and ceiling of this large area were concrete (ceiling) or concrete block so there was no need to have floor to ceiling walls for the narcotic storage area. However, to ensure adequate security for the outpatient controlled substances area, the entire pharmacy was under positive security and the only access was via a magnetic key card and a punch lock, latter replaced by a biometric hand reader. VA rules for storage of medications require at least two locks at all times.

The pharmacists finishing orders were located in cubicles located in the same area as the outpatient dispensing area. This area included the break area, the working stock storage area, the prescription fill area and the pharmacy dispensing robotic device. This system

contributed to the ambient noise level in the area. The robotic dispensing system, in particular has a relatively high noise level.

The room had a concrete ceiling so there was no acoustic damping of any environmental noise. In addition to the noise of the robot, the technicians used Kirby Lester tablet counters for the manual fill of medication not in the robot. These make a clacking sound as tablets or capsules are poured through the shoots into the prescription container. Such manual fills account for only 10% of the pharmacy workload but that would include refills as well and amount to 200 to 300 prescriptions per working day.

Adding further environmental “noise” was the fact that the coffee and break area was located at the end of the row of cubicles used by the pharmacists assigned to finish orders. It was not uncommon for individuals on their way to get coffee, or take a break, to stop by the cubicles and chat with their colleagues who were processing prescriptions.

The entry door for mail room staff to pick up the prescriptions which were mailed locally was located at one end of the cubicles and the main entry door to the outpatient pharmacy was at the other. The pharmacy is a secure area and entry was via a magnetic card. Anyone wanting to come in to the pharmacy had to ring a bell. Since the pharmacists in the end cubicle (labeled Cubicle 4 in the diagram) were

closest to the door, one of them often was interrupted to open the door. Mail room staff also had to ring for admission to the mail room entry door, but this interruption was limited to once per day. Local mail only accounts from approximately 4,200 prescriptions per month.

This design was patently inefficient. The elevators were consistently requiring maintenance and there was continual movement of stock into and out of the department within yards of where the pharmacists were finishing orders. As mentioned previously, there was also a great deal of moment of staff along the isle where the cubicles were located as they went to get coffee.

The cubicles were designed to accommodate two pharmacists, working with their chairs back to back. The walls facing the isle were four feet high and there were no doors on the cubicles. There had been no budget for office furniture when the cubicles were set up so chairs were not standardized and were what was available from facility surplus.

The walls between cubicles were six feet high and included a bookcase for references with a fluorescent light under the bookcase. All of the cubicles used Herman Miller modular units which had been used in the outpatient pharmacy when it had been located on the first floor of the hospital and was relocated in 1993.

There was no back wall to the cubicle as the desk units were up against the block wall of the pharmacy. This, and all of the walls of the outpatient pharmacy, was painted in the traditional “institutional” yellow which was common for non-patient care areas.

Relocation and Redesign of the Outpatient Pharmacy

The facility has very little available space to provide additional services, and has moved a number of modular buildings on to an already crowed campus. Changes in federal regulations required additional requirements for the inpatient IV room. In order for the facility to meet United States Pharmacopeia (USP) standards it was necessary to relocate the inpatient pharmacy. [94] The only space available to the hospital was the existing outpatient pharmacy.

The facility administration decided that it was time to move the outpatient pharmacy offsite. This would not only resolve some of the problems with space but offload some of the parking problems that were being compounded by having to convert parking lots into locations for temporary structures. A suitable building, approximately one quarter mile from the hospital became available when Tower Diagnostics decided to relocate one of their facilities and the facility made arrangements to lease slightly less than 10,000 square feet of space in this facility. Any lease of 10,000 square feet or more would

have required approval from Central Office and would have substantially delayed the lease negotiations.

This relocation was first suggested in 1996, during a functional analysis of the VA Outpatient Pharmacy by a team from the Department of Industrial and Management Systems, College of Engineering of the University of South Florida.[95] The relocation was suggested due to many problematic areas noted in the physical plant. This 1996 study first mentioned the disruptions to work flow due to the poor design and that the separation of the department into two floors built lag into the system at a time when the organization was attempting to reduce pharmacy wait time.

The relocation of the outpatient pharmacy allowed pharmacy administration an opportunity to redesign the physical layout. The design was coordinated by the director of pharmacy and the facilities interior designer. A schematic of this new design is located in Appendix B. The leased building was essentially gutted and the facility interior decorator and facility safety office coordinated with the director of pharmacy to design the new pharmacy.

The pharmacists finishing prescriptions were physically separated from the dispensing area and were not in a high traffic area. The pharmacists finishing orders were located in individual offices. These offices were designed to have optimum lighting and the budget

for the move included monies for new furniture, including IKEA desktops, bookcases and ergonomic chairs and keyboard wrist supports. All computer displays were fitted with anti-glare screens and the office lighting used fluorescent lighting fixtures recessed into the ceiling.

There was not traffic flow around the offices and the dispensing area and robot were located in another work area separated by fire doors. The main entrance to the outpatient pharmacy opened into the patient waiting area and access to the finishing area did not require going through locked doors. There was an outside entrance which was locked however that was not for general use and was only used for deliveries. When this door was required to be opened it was done so by the pharmacy receiving clerk and not the pharmacists. While the processing area was separated from the dispensing area, the area was still considered a high security area and as a result there were no windows in the offices. However the walls were drywall painted a light shade of green.

Pharmacy management was concerned about productivity and was aware that the previous pharmacy design had many internal disruptions that could have an impact on productivity. The relocation provided the opportunity to see if this was indeed the case or if there

were other factors that may have had an impact on prescription throughput by the pharmacists assigned to finishing prescriptions.

While it is not related to workload, the new pharmacy included a drive-through pharmacy window to facilitate the pickup of medications. This did not have an impact on productivity and was not well received by pharmacy staff, whose main concern was the image of a drive-through window and associated that with “retail” pharmacy. During an accreditation visit for the PGY-2 Pharmacy Informatics Residency by the American Society of Health-Systems Pharmacist (ASHP) comments were also made about the drive-through window.[96] While not held in high regard by staff or professional organizations the Redesign of the outpatient pharmacy included a drive-through window whereby patients could pick up medication without leaving their vehicle. This and the general organization were well received by the patients as evidenced by the Survey of the Healthcare Experiences of Patients (SHEP) scores on pharmacy satisfaction before and after the redesign and relocation.

Productivity Reports

As discussed in the previous chapter, another effective tool in increasing productivity is to publicly post the outcomes monitors; individuals can see where they stand relative to their peers. In the summer of 2010 the pharmacy staff was consistently one to three

thousand prescriptions behind. This was no demonstrable improvement over the number of pending prescriptions prior to the pharmacy relocation.

Unfortunately the pharmacy software had no standardized reports that dealt with individual productivity. There were two fields in the prescription record that indicated when and who actually finished the prescription and it was decided to use these to develop a local pharmacy workload database. This data base was then used to generate monthly reports, one of supervisors and one which was posted for the staff.

A union, the American Federation of Government Employees (AFGE), represents pharmacy staff. In order to avoid any possible issues with the union, the names of the pharmacists were not included on the publicly available information. The names were de-identified, using a random key, and only these id numbers and a monthly summary were posted. The pharmacy data manager maintained the key to identify the specific pharmacist for each ID number and provided that information, on an individual basis, so that pharmacists could track their own performance relative to their peers. Since the data was a monthly total, and includes data from all pharmacists who may fill a prescription it was determined that it would be very difficult, if not impossible, for a pharmacist to deduce another pharmacists ID

simply by knowing if a person was on vacation that month. The chart includes a number of low monthly totals. This can be due to a number of reasons, for example, clinical staff helping out to catch up on backlog or working over-time to perform mandated drug therapy conversion. The numbers are re-assigned yearly, so that even if an individual were to deduce another pharmacist's ID number, it would be changed at some random point in the year. So that they can request their new ID number, all staff members are advised when the numbers are again randomized.

Supervisors are given both summary and detail charts (by day) that include the names of the pharmacists. Individuals who are not performing to expectation are counseled by the outpatient pharmacy supervisor and encouraged to do better.

Pharmacy administration was curious as to which of either of these changes to the outpatient pharmacy had an impact on productivity and if so, how much. Table 3.1 is an example of the data that is publicly posted for the preceding month. This is usually posted by the end of the first full week in the next month. It was determined that, for posting purposes, the monthly total Renewed (R) and New (N) would provide users with a fairly good overview of finished prescriptions and where they placed relative to the other pharmacists in the department. Supervisors are provided with a copy of a detailed

report which includes the pharmacists' names and productivity by day, with summation by total per day and total per month. The difference in complexity and therefore processing time between New and Renewed prescriptions will be discussed later.

Table 3.1 Sample Productivity Report

Person ID	Total R	Total N	Grand Total
9342063	600	1,546	2,146
58934913	672	595	1,267
167274147	1,161	2,940	4,101

This is just a representative sample and does not include all of the data. Appendix C is a complete chart, for the month of April 2011 for the satellite pharmacy in New Port Richey (Pasco County).

HIPAA and IRB Compliance

The study does not capture any patient information. The data is extracted from an existing workload database which itself is based on an extract from the facility's data store. The only data in the database is the date and time a pharmacist finishes a prescription, the identity of the finishing pharmacist, whether the prescription was a new or renewed prescription and whether or not it was mailed or filled locally. As a result, no waiver of HIPAA is required. Since no patient information is captured and the tool in use is part of the pharmacy workload reporting system, IRB approval is not required.

Data Collection

Four data elements were collected, the finish date/time, finishing pharmacist, prescription routing (mail or window) and prescription type (new or renew) was extracted from the pharmacy workload database for the period April 1, 2008 through April 30, 2011. The "finish date/time" is the date and time, to the second, that a pharmacist processed a physician's order into a prescription. Only pharmacists can perform this task and requires a specific electronic key (PSORPH). The finishing pharmacist is the pharmacist who processed the order. This database itself is based on an extract from the prescription file and is used solely to measure pharmacist productivity. As mentioned above, this extract contains no patient information and the pharmacist's information has been de-identified.

In addition to the standard workload extracts, an extract of CMOP reported errors for the facility was obtained from the CMOP error reporting system. Unfortunately the CMOP data does not cover the entire study interval; the available data is only from December 2009 through April 2011. The CMOP errors would be limited to those that indicated an error on the prescription that would prevent it from being processed by CMOP and rejected back to the facility. These can be rather trivial such as a misspelled word in the patient instructions or a dispense quantity which was not an integer multiple of items

dispensed by CMOP, for example a prescription indicating a dispense quantity of 90 for items which can only be dispensed in multiples of 100. Since the acceptable dispense quantity is included in the processing screen, a prescription processed with a non-integer multiple of the quantity would indicate a lack of vigilance on the part of the pharmacist processing the order. While this error may seem trivial, it can result in a significant delay in the patient receiving their medication. The rejected prescription is sent back to the facility, has to be edited, re-transmitted back to CMOP and then processed by CMOP. This can add five days or more to the processing time, so that rather instead of 10 days, the normal time allowed for processing, a rejected prescription can take 15 days or longer to get to the patient. There is no argument that there should be systems in place to automatically populate the quantity to be dispensed field with integer multiples of the allowed dispense quantity, based on the day's supply of medication to be provided. Unfortunately, at this time, the system does not have that capability.

The data elements captured from CMOP are simply month, and rejected prescriptions by reject category. Only those categories due to an error were used. A category for rejects beyond the control of the finishing pharmacist; for example, "out of stock" or "item on back order" was excluded.

Another possible error indicator would be orders that were either discontinued by the pharmacist for cause, e.g. a drug that caused a serious drug interaction and was not processed, or due to an edit of one of the fields in the orders that automatically generates a new order. For example if the pharmacist edits the dose of the drug, the system automatically generates a new order to be signed by the prescriber. Unfortunately the study did not have approval from IRB to extract patient sensitive information so the exact reason for the discontinuance or edit cannot be elucidated.

While the number of orders discontinued or discontinued due to edit cannot be used to determine error rates, they may be an indicator of how much attention the pharmacist is paying to the various fields of the order. A decrease in discontinued orders associated with an increase in per hour productivity could indicate a lower level of vigilance of the various fields in the order processing screens. A counter argument to the above would be that the prescribers were becoming more familiar with the system and making fewer mistakes on order entry. This cannot be resolved with the data at hand, but the data is available and can be used with IRB approval. The results from this study can be used in a submission to IRB as justification for access to the data.

Study Design

A before and after-after (pre-post) or interrupted time series study was selected as the most viable methodology for this research. Both the redesign and relocation of the outpatient pharmacy and the posting of the productivity reports were known events (interventions). The date the changes were made is fixed and the intervention occurred once for the relocation. While the workload reports are posted each month, since October 2010 there has been no change in their design. The effect will only be measured for those individuals who were assigned to the outpatient pharmacy for at least fourteen months before and after the pharmacy relocation and six months before and after the posting of the new workload report.

One of the criticisms of such an approach is the lack of a concurrent control group.[97] While this is a valid criticism, there are advantages to using such an approach, especially if precautions are taken to avoid some of the pitfalls associated with this kind of study. Care has to be taken to avoid the "post hoc propter hoc" ("After this therefore because of this") logic fault, i.e. something that occurred first therefore caused something that follows. For example if the pharmacy is relocated and redesigned and pharmacist productivity increases after the move, the increase in productivity can be attributed to the move and only the move.

One of the first concerns is the existence of any temporal trends. Are the cyclical or time related changes in the environment that would have an impact on individual workflow? For example, where there any trends in individual productivity that existed prior to the intervention and would these trends “dampen” out the intervention's effect? This objection can be countered by subjecting the productivity data to regression analysis to determine the existence of any trends prior to the intervention.

Another concern would be is the study group representative of the population being studied? In this case the study group is restricted to those pharmacists who are responsible for finishing prescriptions in the outpatient pharmacy. This can be confirmed by reviewing their production as a percentage of total outpatient prescriptions processed. The individuals in the post intervention group will be limited to the individuals who were assigned to outpatient prior to the intervention. Since pharmacy staff turn-over is very low, the study group comprised individuals who process the majority of outpatient prescriptions.

Two of the advantages of a before-after design are its simplicity and low cost of data collection. Another advantage is that since the workload database already existed and did not contain patient specific information, the data could be obtained with minimal requirements

from the Research and Development Committee and Institutional Review Board. This allowed an expeditious review of the data.

There is concern that the organization's emphasis on productivity may increase the incidence of processing errors, i.e. errors made at the time of prescription finishing. A useful follow up to this study would be to determine if any of the interventions had an impact on prescription error. A detailed review is possible using the response to order alerts but such a review would require R&D and IRB approval. An indicator, which would not require such an approval, would be the reported aggregate errors reported for outpatient pharmacy.

These aggregates only indicate the reported errors per unit time, for example reported errors per month. They are not broken down to type, i.e. dispensing versus a verification error or whether or not the error was reported as a result of an admission due to a missed drug or allergy interaction. Also it is known that, due to many of the factors discussed in Chapter One, such errors are woefully underreported. These errors will be tabulated for the interval before and after the interventions, however this can only be done as an anecdotal observation and no real conclusions can be drawn without more detail.

One of the major disadvantages is that it is not as powerful as a randomized controlled study in determining cause and effect. [98] The second part of the study, the impact of posting the outpatient

workload statistics, is also subject to the Hawthorne Effect, a portion of the improvement could be attributed to the very fact that employees knew they were being monitored.[99]

The most significant change was made to the area where pharmacists finished prescriptions, offices replaced the cubicles and there was no through traffic. It was noted in a previous paper that much of the staff disruption in the outpatient pharmacy was internal, i.e. other staff as opposed to external, e.g. numerous phone calls.[100] The new pharmacy design eliminated or significantly reduced this type of disruption. The break area was also relocated so there was minimal traffic in the area where pharmacists finished prescriptions.

The outcome indicators are the number of prescriptions finished per unit time. These are further broken into the type and route of the prescription, both of which would have an impact on processing time. The posted report is summarized by month. This study spans such a long interval (37 months) that the impact of vacation time must be considered when evaluating the data. Federal vacation is determined by years of service. Employees working less than five years earn four hours per pay period (104 hours per year), five years to less than fifteen earn 160 hours per year and those with fifteen or more years of experience earn 8 hours per pay period or 208 hours per year. In

addition all federal employees earn 4 hours of sick leave per pay period (104 hours per year) and have 10 paid federal holidays.

The breakdown on service time and available paid time off for the individuals involved with the study in included as Table 3.2. The median length of service for the study pharmacists was eight years, with the shortest length of service being 2.3 years and the longest being over 24 years. This equates to over 5,400 hours of vacation and holiday hours which can be accrued per year, or more than 16,000 hours of vacation or holiday time which could have been used during the more than 3 years of the study period.

Table 3.2 Length of Service

Years of Service	# of staff	Vacation (Hrs)	Holiday (Hrs)	Total Hrs per year
Less than 5	4	832	320	1,152
5 to < 15	12	1,920	960	2,880
15 or more	5	1,040	400	1,440

This is close to eight man-years of non-work time by the pharmacists included in the study, and these time estimates do not include possible use of sick leave. As a result, in addition to the monitor that is actually used, the prescriptions filled per month, a better indicator for this study would be to utilize the granularity of the data, i.e. time is trapped down to the second, and use prescriptions

filled per hours worked during the calendar month for each pharmacist in the study.

In light of the foregoing, it was determined that using prescriptions filled per day or month would not be a true representation of an individual's work. Pharmacists spend different amount of time each day processing orders and any time taken off would be reflected in daily or monthly reports. As a result, prescriptions processed per hour appeared to be a better indicator of a pharmacist's throughput.

This was calculated by only counting hours in which an order was processed. The total orders processed per day per pharmacist were divided by the number of hours each pharmacist was processing orders. This provided an average production rate in prescriptions (orders) per hour per day per pharmacist. The daily average per pharmacist was then averaged for the calendar month and reported as an average rate per pharmacist per month. Functions within MS Access make this a fairly simple process. This will eliminate the variability seen in the raw data due to individuals using vacation time or other time off during the month.

In addition to the ratio of total prescriptions to hours for the calendar month per person, the study will also look at the ratio of new and renew to total and mail and window to total, per person, per unit

hours worked in each calendar month. A shift in a pharmacists renew/new or mail/window ratios would indicate that the pharmacist was using easier prescription types to artificially increase their workload numbers. When the workload data started being publicly posted, administration also established minimum workload standards based on total prescriptions processed per calendar month. The new and renewed prescriptions are included in the workload that is posted, but the mail/window are not. If results from this research indicate that it is a factor, than future charts will include this data.

As mentioned previously, the pending workload queue for the outpatient pharmacy consistently is between one and three thousand prescriptions on any given day. This is usually lower on Mondays and gradually increases during the week. The outpatient pharmacy is operational on weekends but new orders tend to be lower, so that pharmacy staff uses that time to reduce the pending orders.

The outpatient pharmacy is always behind, i.e. there is no slack in the system, and so it can be assumed that any changes in per person productivity are due strictly to changes in performance. In order to meet increased production needs, for example on major holidays such as Christmas, individuals from the clinical section supplement the outpatient pharmacy staff. The clinical staff are less proficient in finishing physicians' orders into prescriptions and, as a

result, have less throughput per hour than the staff assigned to out-patient.

A review of any changes in total outpatient pharmacy production will include growth trends over the three years of the study. These will indicate why methods to increase throughput and performance are essential. The organization is currently in a hiring freeze, so the only way to meet increased demand is to increase individual productivity.

Analytical Methods and Tools

The relocation of the pharmacy took place during the second weekend in June 2009. Data was collected through April 2011 with the posting of the Outpatient Workload reports occurring in October 2010. It is presumed that the impact of workflow due to the relocation would have stabilized within a few months of the move.

The total workload will be reviewed and trends over the last three years will be measured. The same indicators for the pharmacists being reviewed with be gathered and the percent of total workload for these pharmacists will be calculated.

MS Access 2007 will be used to store and extract data from the Pharmacy Workload Database and MS Excel 2007 and SAS Software 9.2 will be used to analyze the data. Pursuant to VA requirements, for data storage, which applies even to data that does not contain patient sensitive information, the working extract will be stored on a secure

folder on the Principal Investigators workspace on the organization internal network located behind the VA Firewall.

Workload per hour worked will be calculated for each outpatient pharmacist used in the study for the 14 months before the move and 14 months after the move/relocation, excluding June 2009 the month of the move. For the workload reporting, data will be collected for six months before and six months after the posting excluding October 2010, the month data was first posted.

This results in four test groups. Group 1 is data collected from April 1, 2008 through to May 31, 2009. Group 2 is the post move data and includes data from July 1, 2009 through August 31, 2010. Group 3 is the pre-reporting group and includes data from April 1, 2010 through September 30, 2010. Group 4 is the data from November 1, 2010 through April 30, 2011.

Table 3.3 Data Collection Time Line

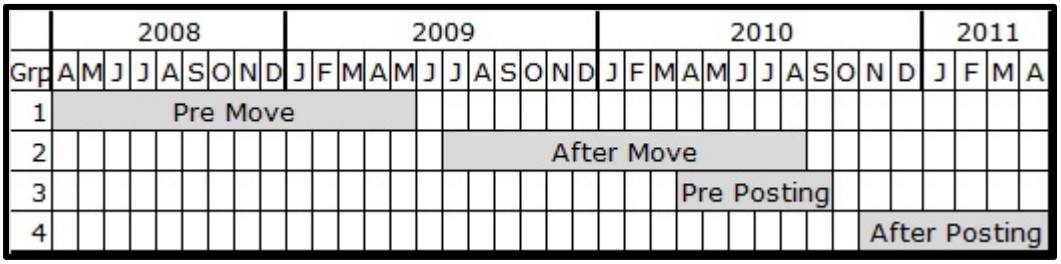

Table 3.3 represents the time line over which the data was collected. While there were over-laps between the pre-posting and after move intervals the effect of this overlap would be moot. The

changes in the operating characteristics induced by the move were irreversible and would still exist for both groups 3 and 4. The end of the data collection post move was simply to keep the design balanced. Group 3 is prior to the posting of the workload data, i.e. no intervention has occurred. Groups 3 and 4 are both equally affected by the intervention in June, 2009.

The same individuals were involved with all four groups so Student's Paired T will be used to determine if there is any difference between groups. The hypothesis being tested are quite simply:

H_0: $\mu_{Group\ 1} - \mu_{Group\ 2} = 0$

H_a: $\mu_{Group\ 1} - \mu_{Group\ 2} \neq 0$

H_0: $\mu_{Group\ 3} - \mu_{Group\ 4} = 0$

H_a: $\mu_{Group\ 3} - \mu_{Group\ 4} \neq 0$

The reported errors rates will be evaluated pre and post intervention. This data will simply be reported as an anecdote; it will have to be aggregated with no identifiers; as a result there is limited usability in the reports. It is well established that medication errors are woefully under-reported so that simply reviewing published aggregate data will not provide much specificity. A further study is planned, requesting IRB approval to match order checks, alerts and

over-rides to the prescription processing but that is beyond the scope of this research.

CHAPTER FOUR

RESULTS

Overall Characteristics

The dataset had already been de-identified so that work schedules could not be used to determine who had been assigned to process outpatient orders during the interval April 1, 2008 through April 30, 2011. To determine which records to keep, the average output per pharmacist per month was used to determine who was primarily assigned to process outpatient orders. A pharmacist was considered to be primarily assigned to outpatient if they consistently processed more than 100 orders per month for at least 35 months of the 37 month data collection period. One notable exception was found. A pharmacist had no entries for the first nine months of the study but significantly high production numbers thereafter. The records for this person were included in the study group. The records for these pharmacists were then extracted from temporary file on the hospital system to the research database which was located on a secure server inside the facility's firewall but separate from the facility's data store.

This resulted in 1,507,530 data points for the entire interval. It was anticipated that the actual move of the pharmacy would be disruptive so the data for the month of the move, June, 2009 was excluded from the study. The month that the workload reports were first posted was also removed. After removing the data for June 2009 and October 2010, there were 1,422,711 data points. The study was limited to twenty-one pharmacists who were identified by the above method. All but one of them worked in the outpatient pharmacy for the entire 37-month interval. There were two other pharmacists who did not process orders during a one month period during the study interval. The one pharmacist who was not present for the entire interval started having records appear in January 2009, six months before the move, and was still working in outpatient at the end of the study period.

The data was first aggregated by using MS Access to count the number of orders processed per hour spent finishing orders per pharmacist. These results were then further aggregated into hours spent per calendar day and number of orders processed for each hour. The average number of orders processed per hour per day for each day the pharmacist had reported hours spent finishing prescriptions was then averaged per calendar month for all of the months of the study.

A summary of the total output of the outpatient pharmacy for all of the prescriptions filled by the study individuals as compared to the total outpatient production for the same interval is included as Appendix D. The percentage of all prescriptions filled by the study pharmacists ranged from 59 % to 83% with an average of 71%. The number of hours spent finishing orders, per person per day, was highly variable. This was due to several factors. For example, requesting leave for part of a day or being temporarily assigned to other duties that did not involve finishing prescriptions. In addition, some of the pharmacists may have had missing data for a month or more. This could be attributed to the use of extended vacation, or medical care leave, for example as in the case of pregnancy or family care leave or a temporary reassignment to other areas of the pharmacy. Figure 4.1 is a plot of total hours spent finishing prescriptions per month by the study pharmacists. The total number of hours per month was highly variable, with a minimum of 312.0, a maximum of 414.7 and a mean of 367.7. As mentioned previously, the total available hours for the study pharmacists will vary due to vacation time, sick leave and other duty assignments. It is for this reason it was determined that prescriptions processed per hour is a better tool for measuring productivity. The total hours per day finishing prescriptions was determined by counting the number of hours each day for any hour in

which a pharmacist processed an order into a prescription. Any hour in which the pharmacist did not process at least one prescription would not be included in this summary. Conversely, even filling one prescription would include that hour in the summary. For example a pharmacist who normally works from 8:00AM to 4:30 PM, an 8-hour day would be credited for 9 hours if they filled a prescription at 7:59 AM. Conversely, a pharmacist who worked the same 8 hour day, but only had order processing activity for a portion of the day would only have that time spent processing prescriptions include in the total. The typical study pharmacist spent between 54% and 78% (average 67%) of their working day finishing prescriptions. While they did not spend their entire workday finishing prescriptions, they did fill, on average 71% of all prescriptions finished by the outpatient pharmacy.

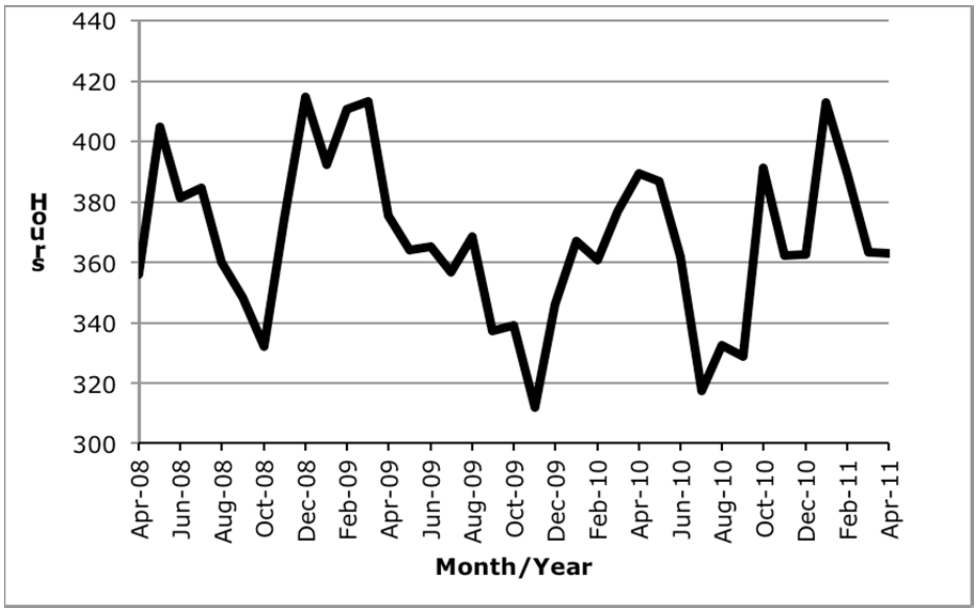

Figure 4.1 Total Hrs/Month Finishing Rx's

A plot of the percentage of prescriptions finished by the study pharmacists as compared to the total finished by all pharmacists working in the outpatient pharmacy is included as Figure 4.2. A graph of the total of all finished orders processed by the outpatient pharmacy, by month can be seen in Figure 4.3. This would indicate that the decrease in percentage of the total production by the study pharmacists might be the result of the total increase in workload.

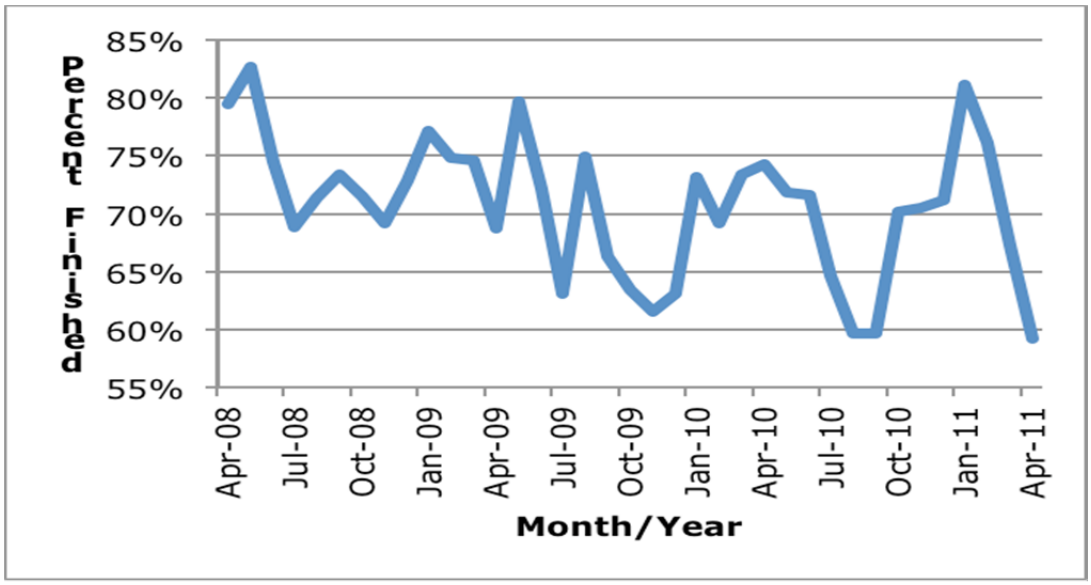

Figure 4.2 Percent Rxs Finished by Study RPhs

In order to standardize the data it was necessary to consider the hours a pharmacist spent, per day, finishing prescriptions and the number of prescriptions finished in that interval. This was determined using data management software (MS Access 2007). The data element for the date included date and time. The data was grouped by the person ID, then by the date, then by the hour of the

day for which prescription were finished. The number of prescriptions processed for each hour was counted. Then two summary queries were written, counting the number of hours during which prescriptions were finished and the sum of the prescriptions processed for all hours that day.

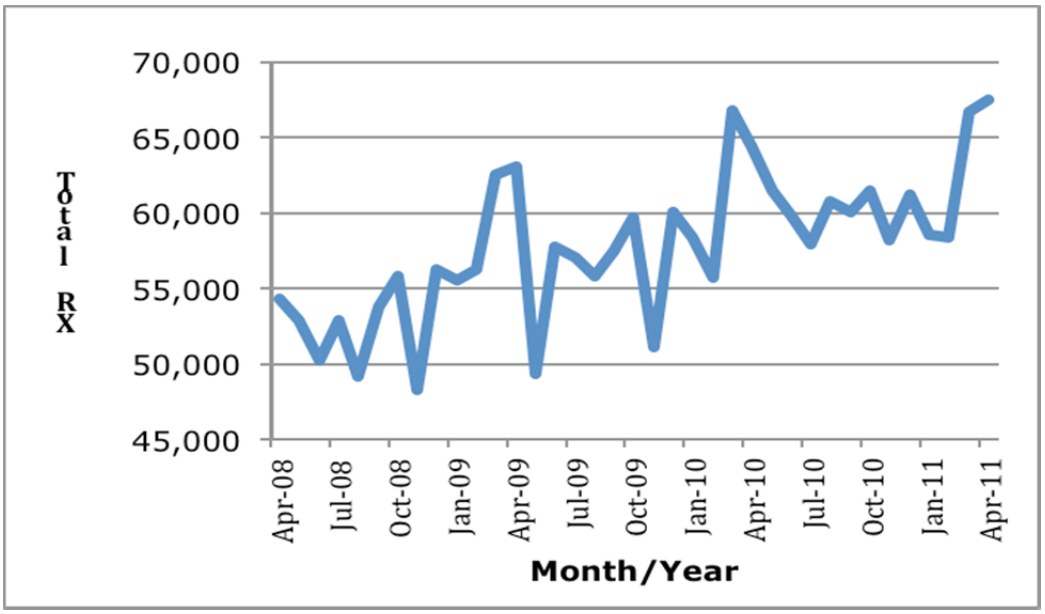

Figure 4.3 Total RXs Finished, All RPh

A second query then averaged the production rate per day by pharmacist to determine an average prescriptions/hr production rate for each pharmacist for each month of the study. The number of prescriptions per hour is the outcome measure that was used to determine the effectiveness of the two “treatments”, i.e. the pharmacy Redesign/relocation and the posting of workload statistics.

As can be seen in Figure 4.4, the total production over the entire period was variable, with a range of approximately 16 to 21, (average of approximately 18) prescriptions per hour spent finishing prescriptions. A linear trend line is superimposed in the data.

The average overall productivity over the entire study period, in prescriptions per hour, for each of the study pharmacists is included in Appendix E. When the data is examined per person/per month there is an apparent trend which will be discussed further in the sections below.

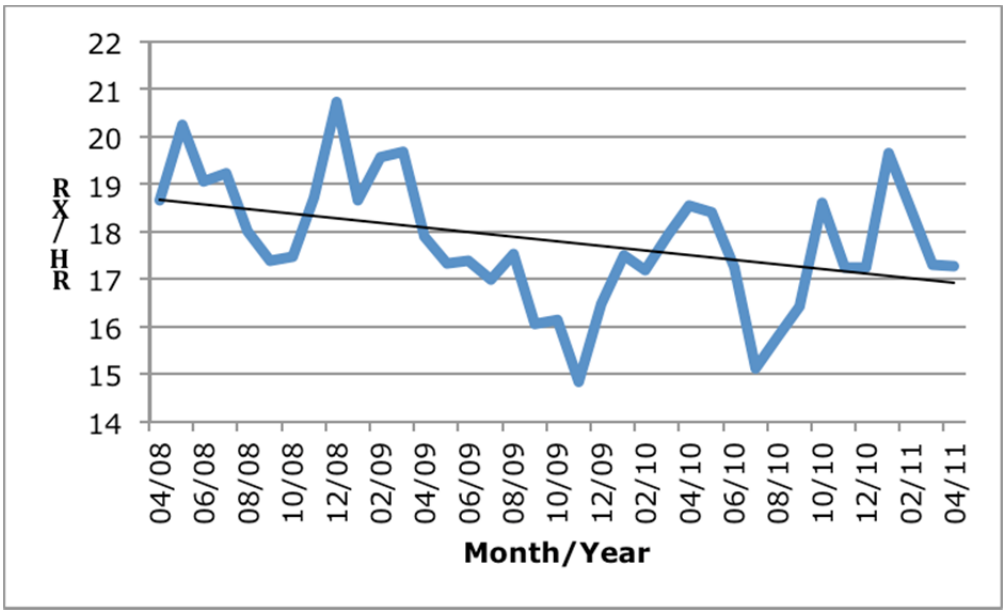

Figure 4.4 Average Prescriptions Finished Per Hour Study RPhs

As mentioned previously, the pending orders to be processed are in the range of two to three thousand. The system has no slack so that any changes in productivity are due to changes in the processing

capability of the outpatient pharmacists. The first outcome to be measured was the average productivity of all the study pharmacists before and after the pharmacy relocation.

While the data was granular to the point of minute the order was processed, it was decided to use the average hourly production rate per person per month. A daily average could have been used but there was a great deal variability in the daily production. Part of the difficulty in using a daily average was the fact that on any given day an outpatient pharmacist may spend anywhere from one hour to ten hours processing prescriptions. This depended on where the pharmacist was assigned on a particular day. Over the course of a month, the pharmacists' productivity "averaged" out. It must be remembered that the pharmacists included in the study processed most of the outpatient orders.

Reported Errors

Figure 4.5 is a plot of all outpatient pharmacy orders discontinued for cause during the study period. There is an apparent decrease in discontinued orders per month. Orders are discontinued during processing for a number or reasons, from simple adjustments to a dosage form to discontinuing the order due to a drug interaction or serious allergy to the drug. While the actual number of orders discontinued during processing significantly decreased, a decrease in

pharmacist attentiveness is only one explanation. Physicians could be more familiar with the system, over time, and therefore entering fewer orders that needed adjustment or discontinuation during order

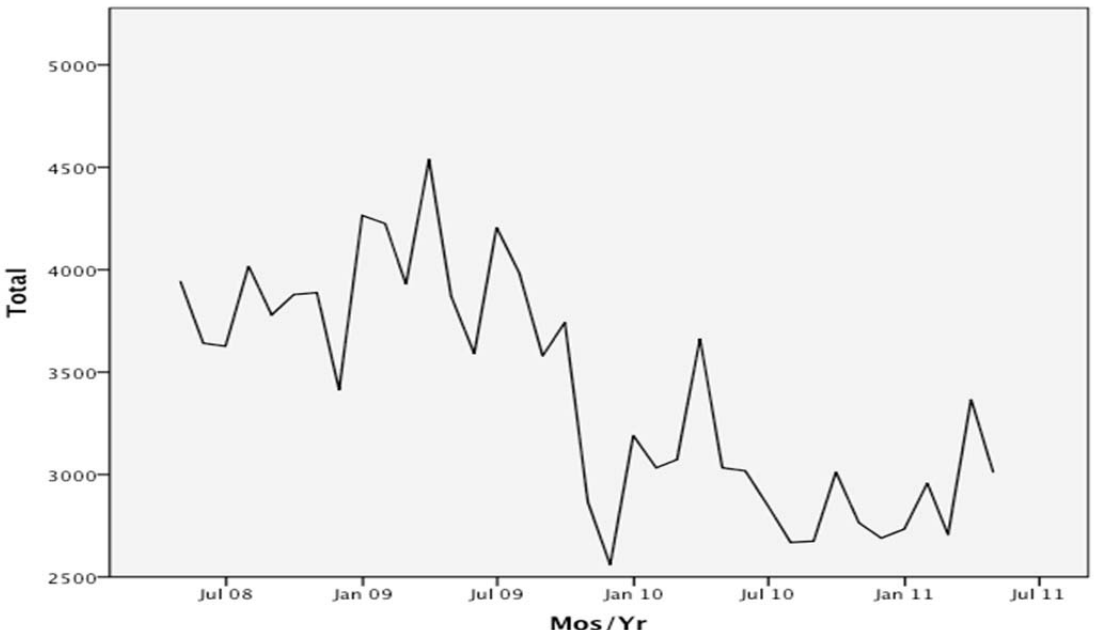

Figure 4.5 Total DC'd Orders OP Pharm

processing. Also the system generated order alerts could be acted upon by the provider, again eliminating the need for the pharmacist to take further action.

Another indicator of error is the CMOP reject rate for cause. Figure 4.6 is a graph of the CMOP rejects for errors in the prescription and does not include rejects for reasons such as “CMOP out of stock” or “drug on backorder”. This data is only available back to December of 2009. There was a decrease of over 500 rejects between December

2009 and January 2010. This cannot be explained by the data at hand.

There is also an apparent decrease in reported rejects between October 2010 and February 2011. Again, the reason for this decrease cannot be easily explained. A further discussion of this effect, in relation to the posting of the pharmacy workload data will be discussed in Chapter 5.

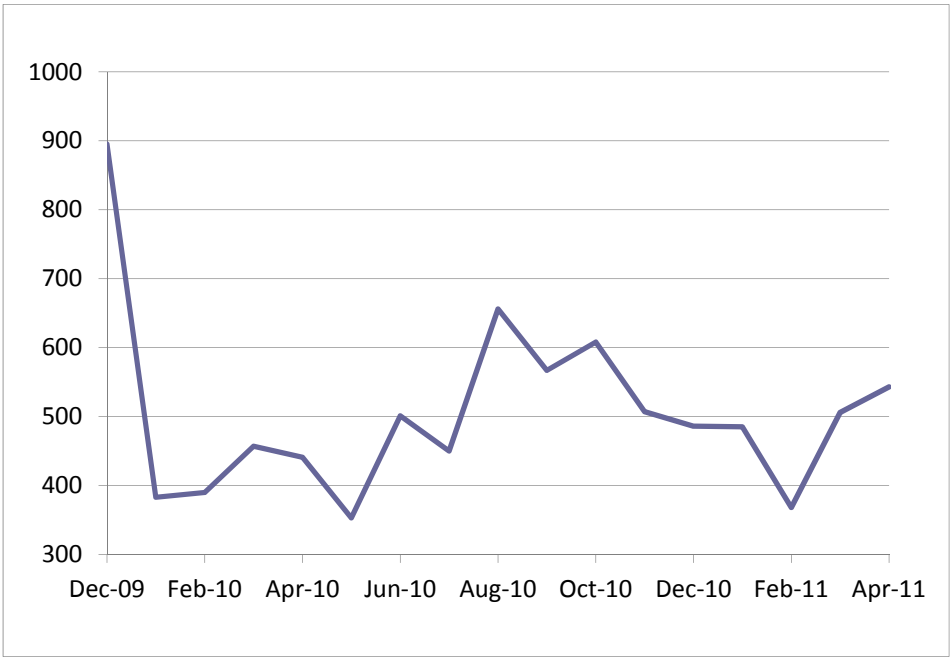

Figure 4.6 CMOP Error Rejects

Pharmacy Relocation

The data for the study pharmacists was aggregated by month for the interval April 1, 2008 through August 30, 2010. Data for the month of June 2009, the month of the move, was excluded. This resulted in 578 observations. 588 would have been expected; data for

21 pharmacists over 28 months. The one pharmacist who did not start until January 1, 2009 accounts for nine of these "missing" observations. One pharmacist did not process any orders in July 2008 and would account for the other missing observation. This is another reason why average production per hour, for hours spent processing orders was used as the outcomes measure.

Table 4.1 Production data by Group, Groups 1 and 2

Group	Hours	RX	RX/Hr
1	28,773	563,679	19.59
2	31,338	561,852	17.92
2-1	2,565	-1,827	-1.67

The data in Table 4.1 is production data for group 1, 14 months prior to the Redesign/relocation and group 2, which is the 14 months after the Redesign/relocation, excluding the month of the move. It should be noted that while the number of hours spent processing orders by the study pharmacists increased, the actual number of orders processed decreased, which resulted in a reduction in total output in RX/Hr.

While the duties assigned to the pharmacists were supposed to be the same for all study pharmacists, as can be seen from the tables in Appendix F and Appendix G, there was a lot of variability among the pharmacists both pre and post relocation and redesign of the pharmacy. Fourteen of the study pharmacists had a decrease in

processing orders, averaging 4.1 prescriptions per hour. The remaining seven had an increase in production averaging 2.2 prescriptions per hour. Total orders processed over the study interval decreased by over 1,800 prescriptions after the redesign/relocation of the outpatient pharmacy. During the same period the time spent processing orders increased by over 2,500 hours with the net result of a decrease of over 41 orders processed per hour for the study group. The change in productivity per study pharmacist before and after the move is included in Appendix H. Appendices J and K include the changes in productivity before and after the posting of workload data.

The data for the Redesign/Relocation was coded as Group 1 for the 14 month period prior to the move and Group 2 for the 14 months following the move, excluding June 2009, the actual month of the move. SAS paired sample analysis was used to evaluate the production rate per hour for the study pharmacists. The mean production rate for groups 1 and 2 is included in Table 4.2.

Table 4.2 Paired Sample Statistics Groups 1 and 2

Group	N	Mean (S.D.)	Std Error of Mean
1	21	19.10 (12.0)	2.63
2	21	17.11 (11.2)	2.44

A summary of the paired samples statistics for Groups 1 and 2 is included in Table 4.3. There was a mean difference (p-value = 0.028) between the two groups of two prescriptions per hour.

Table 4.3 Paired Samples Test Groups 1 and 2

	Mean (S.D.)	Std. Error Mean	Degrees of Freedom	Test Statistic	P-Value (2 Tailed)
1 -2	1.997 (3.870)	0.844	20	2.365	0.028

Posting Productivity Data

The data for the first month that Pharmacist Productivity was publically posted, October 2010, was excluded from the analysis. This resulted in 251 observations for the interval; 252 would have been expected. A pharmacist did not have any hours for processing orders during the study interval, which accounts for the missing observation.

Nine of the study pharmacists (42.8%) had an average decrease of 2.3 prescriptions per hour per pharmacist while the remaining twelve had an average increase of 2.8 prescriptions per hour.

Table 4.4 examines the productivity of the study pharmacists for Group 3, six months prior to posting productivity data and Group 4, six months after posting such data. The month in which the report was first posted is excluded from the analysis. As with the previous groups there were significant differences in per pharmacist productivity.

Table 4.4 Production Data by Group, Groups 3 and 4

Group	Hours	RX	RX/Hr
3	13,537	244,390	18.1
4	13,758	261,352	19.0
4-3	221	16,962	0.90

There was a very slight increase in reported productivity in Group 4, the effect after the intervention. The basic statistics for each group is included in Table 4.5

Table 4.5 Paired Samples Statistics Groups 3 and 4

Group	N	Mean (S.D.)	Std. Error Mean
3	21	17.33 (10.23)	2.23
4	21	17.92 (8.85)	1.93

The results of the comparison are included in Table 4.6. There was no statistical significance in the results between Groups 3 and 4 (p-value= 0.546) which indicated that the posting of the workload data had no effect on pharmacists productivity.

Table 4.6 Paired Samples Test Groups 3 and 4

Group	Mean (S.D.)	Std Error of Mean	Degrees of Freedom	Test Statistic	P-Value (2 Tailed)
3-4	-0.59 (4.365)	0.95	20	-0.615	0.546

As with Group 1 and Group 2 there was an observed high variability among the pharmacists. A comparison of the differences in pharmacist response to both interventions is included in Appendix L.

Chapter Summary

The conclusions for the original hypotheses are included in Tablet 4.7. The Redesign/relocation appeared to have a negative effect on productivity with a net loss of 2.0 prescriptions per hour (p-value = 0.028), while the posting of production data had no significant effect (p-value=0.546).

Table 4.7 Summary of Hypothesis Testing

H_0	The pharmacies Redesign/ relocation had no effect on per pharmacist productivity.	Rejected
H_0	The public posting of pharmacist monthly workload data had no effect on productivity.	Accepted

Since there appeared to be a great deal of variation in productivity among the study pharmacists, a repeated measures ANOVA was used to examine these differences. This indicated that there was a significant difference (p-value < .0001) between the pharmacists over all interventions. The effects of the pharmacist and both treatments are included in Table 4.7. As can be seen, the overall effect of both treatments was not significant, while the pharmacist and pharmacist treatment interaction were significant.

Table 4.8 Repeated Measures ANOVA Both Treatments

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Treatment	1	56.46903	56.46903	3.05	0.0823
Person	20	19949.52994	997.47650	53.86	<0.0001
Treatment*Person	20	1206.51936	60.32597	3.26	<0.0001

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND AREAS FOR FUTURE RESEARCH

Research Summary

One of the benefits of performing this kind of research is the discovery that what the organization presumes to be happening is not always the case, theories regarding pharmacists being distracted while finishing physicians' orders as a factor in low productivity were not substantiated by the data. Quite the contrary, there was a statistically significant decrease in productivity when the outpatient pharmacy was located to a more modern, redesigned facility with minimal interruptions to pharmacists finishing orders.

Posting workload data appeared to have a small positive impact on overall productivity however this was not statistically significant. One reason for these apparent contradictions to accepted management theory may be quite simply that the majority of the pharmacists were already working at or beyond the maximum safe production rate. The data for both experiments indicated that productivity was highly variable among the pharmacists.

Table 5.1 is a summary comparison of the results of the relocation redesign and the posting of workload statistics for all of the study pharmacists. The redesign/relocation resulted in a net loss in productivity of close to 42 orders per hour for the 21 study pharmacists. The posting of workload data resulted in a net increase of over 12 orders per hour for the study pharmacists. In short, after the relocation another 2,500 hours were required to produce 1,800 fewer prescriptions. The effect of the posting was to produce over 16,000 additional prescriptions with only 221 additional hours. Unfortunately when looking at the per pharmacist comparison, (Appendix L) it was clear that the effect was more related to the pharmacist then either the move or the posting of workload data.

Table 5.1 Comparison Redesign and Posting of Data

	HRS	Rx	Rx/Hr
Redesign	2,565	-1,827	-41.9
Posting	221	16,962	12.3

A summary of the Paired Tests for the two pairs, group 1-2, and group 3-4 is included as Table 5.2. In addition to these summaries, a review of the pharmacist contributions to these results is included at Table 5.3. The response of the pharmacists to the treatments was highly variable. It is interesting to note that six of the pharmacists had decreases in productivity after both treatments and six had increases in productivity after each treatment.

Table 5.2 Pharmacist Responses to Treatment

			Change in productivity	
Treatment	Number of Pharmacists	Percent Total	Avg	Std
Move	14	66.7	-4.22	3.16
	7	33.3	2.18	1.18
Posting	9	42.9	-2.40	2.94
	12	57.1	3.27	3.67

Effect of the Redesign/Relocation

The effect of the Redesign/relocation was statistically significant with an average decrease in productivity of two prescriptions per hour per person. Over 2,500 additional hours resulted in the production of 1,800 fewer prescriptions. There was a significant difference in how individual study pharmacists reacted to the change. Fourteen of the twenty-one study pharmacists (66.6%) had a decrease in productivity, while the remaining seven pharmacists increased their productivity. The increased productivity by these seven pharmacists was dwarfed by the reduction in productivity by the other fourteen.

Table 5.3 Paired Samples Test Summaries

	Paired Differences					
Group	Mean	Std. Deviation	Std. Error Mean	DF	T	Sig (2 Tailed)
1 -2	1.997	3.870	0.844	20	2.365	0.028
3-4	-.059	4.365	0.950	20	-0.615	0.546

The reduction, or at least no increase in productivity, after the pharmacists moved to “the palace”, as the area was referred to by one pharmacy supervisor, was a concern of pharmacy administration even before this study was conducted. It was this concern for productivity which led to the development of the monthly reports which were provided to pharmacy management. It was when these reports seemed to indicate that there was no increase in productivity, even after the move, that management decided it may be worthwhile to let the staff know that their output was being monitored and the posting of the workloads began in October 2010. This was fifteen months after the relocation of the outpatient pharmacy.

There are several plausible explanations for this decrease. In addition to providing a quieter environment, the new outpatient work area was divided into four compartmentalized areas separated by solid doors. In the old environment the pharmacists processing orders worked in cubicles in the same open workspace where the supervisors were constantly moving about, working with technicians, supervising vault technicians and helping out where there were difficulties. While there was one office for both supervisors, they were seldom in their office.

In the new environment, the supervisors tend to stay in their own individual offices. While they do make “rounds” of the area, they

are neither as visible nor as available as in the old environment. This would allow pharmacists processing orders to have “down time” when they were not actively processing orders, for example using the computer system to “surf the internet”. The current productivity reports, as seen by the staff are a monthly summary. The supervisors are provided with a detailed report, by person and day. The report simply indicates how many prescriptions a pharmacist filled that working day. The fact that a pharmacist fills their quota, currently 120 prescriptions, there is no indication to the supervisors as to whether the person kept a consistent pace throughout the day or filled their quota early and the slowed down the remainder of the day. The pharmacists are aware that the report given to the supervisors is a summary of total output by day. That particular problem was addressed by using the workload per processing hour for the study. While this still leaves open the possibility that the pharmacist could have slack time during each work hour, the data is more robust than work units per day.

In order to close this particular gap in workload reporting, the pharmacy service data manager is going to redesign the extract report to include the minutes between finish date/time per work hour per pharmacist as another field in the extract. The workload reports are not official VA reports and there is no standard workload reporting tool

in the system. This is fortunate in that it gives the facility the ability to design the reports and then Redesign them as needed.

The time between finishing prescriptions per processing hour per pharmacist can be used to determine the actual mean time between processing prescriptions. A fairly lengthy time between processing, for example 15 minutes, would indicate break periods. Supervisors could review the output of pharmacists who consistently had such long breaks over multiple periods.

While this will provide some conclusive data as to whether or not pharmacists are taking advantage of slack time due to lack of supervision it is doubtful that this is the cause for the apparent decrease in productivity. In order to achieve the averages found in this study the pharmacist would have to finish one prescription every 3.3 minutes. It can be done in less time and two pharmacists had been able to fill one prescription approximately every one and a half minutes.

Yet another possibility for the apparent decrease in productivity had to do with the use of clinical staff to supplement the outpatient staff when pending prescriptions exceeded 3,000 prescriptions. Pharmacy administration was well aware that the clinical staff would not be as efficient and it was decided to find a way for them to process

the less problematic prescriptions, those that required less knowledge of the outpatient system to process.

While all new orders have to be reviewed by a pharmacist, there are two types of new order, new and renewed prescriptions. Renewed prescriptions are simply copies of previous orders, which are carried forward by the prescriber. They still trigger alerts but these alerts have usually already been dealt with when the drugs or condition, e.g. an allergy, was first entered. They must be reviewed by a pharmacist but the review is more cursory that would be required for a real "new" order.

The normal process for completing orders is to use the "complete orders" option in the computer. This is a first in, first out system whereby the pharmacist cycles through all pending orders in the sequence in which they were entered. The easy, "renewed" orders are mixed in with the regular orders.

In order to facilitate prescription processing by clinical staff the pharmacy data manager wrote a report which would allow printing of the "renewed" orders only. The report was designed to include those data elements of an order which would allow a clinical staff member to rapidly access the patient record with the "renewed" prescription. If the clinical staff processed more of the "renewed" orders this would

leave the more difficult orders for processing by the outpatient staff, which would tend to slow them down.

Prior to the move of the outpatient pharmacy the service had been using overtime for outpatient staff to keep the pending order queue from getting to excessive. In October of 2009 overtime hours were severely cut and it was at this point that clinical staff began to be used to supplement outpatient staff. They were assigned a menu option allowing them to print a report of the pending orders and they used that to select the pending renew orders for processing. This should have reduced the number of renewed orders available to the outpatient staff with the result that they were left with a higher number of new orders which take longer to process. This could also explain the sharp decrease in production of the pharmacists who were processing a very large number of orders; in the past they may have been provided with copies of the pending renew orders by the outpatient supervisor, who also had access to the menu option created by the pharmacy data manager. When these orders were no longer available, having been filled by the clinical staff, these pharmacists would have been left with a higher proportion of new orders.

Unfortunately there is no field in the prescription record indicating whether an order is the result of a renew action. There is such an entry in the actual order, and the prescription number for all

prescriptions which are the result of a renew order contain a letter suffix, A though Z. The report written for pharmacy management made use of this fact and used a simple query to determine if the right most character of the prescription number contained a character entry, ASCII > 64 and < 91; the legacy system only uses upper case letters. The pharmacy management database included a logical field (RENEW) populated by the examination of the prescription number. It was this logical variable which was used in the research extract.

While the supposition that clinical staff, and a select few outpatient staff, used copies of the pending prescription report so that fewer renewed orders were available to the remaining outpatient pharmacists has merit, it is not supported by the data. As can be seen in Figure 5.1 the rate of renewed orders processed by study pharmacists had a slight upward trend over the study period.

Before assuming that pharmacists were cutting back on their work due to their ability to relax a bit behind closed doors or clinical staff members were taking all of the “easy” orders, another explanation for the slight decrease in productivity has to be examined as well. This would be the possibility that the pharmacists may already be producing at close to peak capacity and are now becoming demotivated. This particular aspect will be discussed further below.

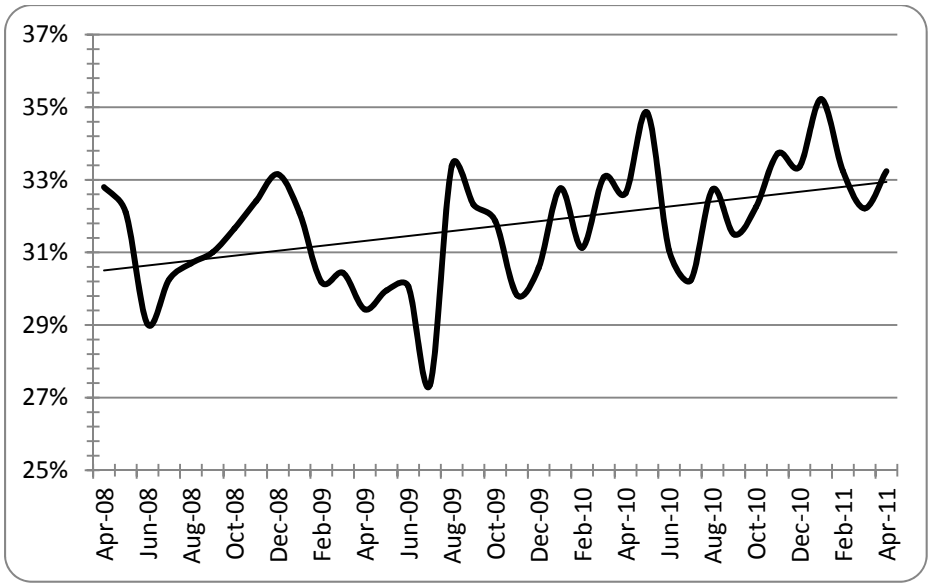

Figure 5.1 Percent Renew Study Pharmacist

Effect of Posting Workload Data

When the individual data was reviewed for effects due to posting workload data, it was obvious that one of the pharmacists had a significant decrease in productivity. It is presumed that the person noticed they were processing orders at a rate well above the mean and decreased the rate somewhat, trending toward the "average" production rate. It was not, but probably should have been, anticipated that posting prescription workload data would have a significant negative impact on individuals working well above the mean.

Another possible explanation for the decrease in productivity may be due to the fact that since the pharmacists were having fewer interruptions they were paying more attention to the order checks and

alerts. A though review of these alerts would add to the to the prescription processing time, thereby decreasing prescription throughput. Since the data is available in the system, a future study is planned that will expand on the current research and evaluate how the pharmacists responded to the order checks.

A simple application of Adam's equity theory probably should have predicted this outcome. Adam's definition for inequity:

> Inequity exists for Person whenever he perceives that the ratio of his outcomes to inputs and the ratio of Other's outcomes to inputs are unequal. This may happen either (a) when he and Other are in a direct exchange relationship or (b) when both are in an exchange relationship with a third party and Person compares himself to Other.[101]

The pharmacist in question was performing at a rate of over 52 prescriptions per worked hour prior to the posting of the workload dada and was still performing high about the average, 41 prescriptions per hour, after the posting of the data. There was no reward for processing more prescriptions than the norm and increased exposure to making an error. While the postings are de-identified, each individual knows their own ID code. In the absence of a reward and the risk associated with a dispensing error, it should have been predicted that an individual would decrease their productivity once they saw how they were performing relative to the group as a whole.

Effect on Error

As noted in Chapter Four, there was a significant decrease in the orders discontinued during processing. Orders discontinued by a pharmacist during processing could be considered an indicator of how attentive the pharmacist was while processing that particular order. There was no IRB approval to obtain patient sensitive information so that only global error indicators could be obtained. Unfortunately without the IRB approval to look at order alerts for all orders processed, which would require access to patient sensitive information, only the total discontinued orders can be included. This request is pending for future research.

A resolution to this issue can be had by using the order check data to determine the response of the prescriber and pharmacist to the order checks. A comparison of response over time could be used to determine whether the physicians were discontinuing orders with alerts prior to processing by the service, or if the pharmacists were taking fewer actions on the same kinds of orders checks on which actions had been taken in the past.

Observations on Pharmacy Work Design

It is interesting to note that when examining changes in order processing per hour for both interventions, seven of the study pharmacists had a decrease in productivity after each intervention, i.e.

seven of the pharmacists who had a decrease after the relocation also had a decrease after the posting of workload data. These differences were significant.

While there have been retirements and termination due to medical events, there has been no turn-over in pharmacists, where an individual has left for other employment, in the last three years. The reasons for this are due to the poor job prospects for pharmacists in the Tampa Bay Area. The job index score for the entire state of Florida hovers around 3 and has been below that for several months in early 2011.[102] It must be remembered that 3 means that the employer to employee ratio is balanced; changing jobs would be difficult. Below 3 indicates a slight over-supply of pharmacists; changing jobs may be impossible.

As a result, even if pharmacists were dissatisfied with their work environment, the chances of them finding other employment would be difficult. This could result in issues with motivation and a resultant loss of productivity. The fact that seven (1/3) of the study pharmacist had decreases in productivity after both interventions would indicate that there could possibly be other factors affecting production.

Relevance to Researchers

There is little work on prescription throughput as measured in prescriptions per hour. The traditional measure of outpatient

productivity is the number of prescriptions filled per day by each pharmacist. The hours worked by each pharmacist are not usually considered and the workload reported as an aggregate number of prescriptions filled that working day.

This research examined a variety of reporting systems, including prescriptions per working day per person and prescriptions per working month per person. When it is necessary to evaluate work throughput and cognition, workload per hour may be a more reliable indicator and more readily tied to the effects of fatigue. Research can examine hour numbers to see if there is any correlation between high numbers of prescriptions throughput at the end a working day and a reductions in positive actions to system alerts.

Relevance to the Profession

Current models for staffing include determining the number of staff pharmacists based on an arbitrarily assigned prescription load per year, “X” prescriptions per year equate to “Y” pharmacists where “X” and “Y” are determined by the organization. In many cases these models are not true models but rather estimates made by an organization’s upper management.

While this particular research cannot answer as to what is an optimum processing rate for safety; it does provide a basis for further research in this area. Logic dictates that the prescription fill rate is not

infinite and there must be a number which would be optimum, balancing high production rates with the ability to appropriately deal with the growing number of alerts for drug/drug interactions or allergies.

The prescription per hour measure also allows supervisors to evaluate the performance of individuals without having to try and tie workload measures to schedules. There are a number of reasons a daily report can be misleading. The pharmacist may have had to be temporarily assigned to other duties, may have had a doctor's appointment or for any other reason was not able to work their full shift. Order processing rate per hour, averaged over a working month, would dampen out these effects.

Job Characteristics

This research focused on the physical design associated with production and the motivational effect of posting workload data and did not consider any of the job characteristics models established by Hackman, Oldham, Parker and others. The fact that six pharmacists had declines in productivity after both interventions and six pharmacists has increases in productivity after both interventions implies that a major factor in the productivity may not be so much the physical environment bur rather motivation of the staff.

The organization has been increasingly moving toward management by directive from the Central Office as well as the local regional office. The end result was that the pharmacists were constrained in what they could do and had to ensure that they were performing to achieve VISN and National outcomes indicators. For example, rather than focus on total drug cost per patient, individual indicators were set up for specific drugs. The organization could be doing very well in controlling overall pharmaceutical costs yet be an outlier in one of the indicator costs. Thus the organization would have pressure placed on the pharmacists to improve performance on that particular indicator rather than recognizing them for overall high performance.

While the processing of physicians' orders into prescriptions required a great deal of cognitive involvement, the emphasis on both productivity and adherence to national use guidelines minimized, at least to some extent, the pharmacist's clinical involvement with processing of the prescription. The pharmacist in this case is reduced almost to an extension of the system relying on computer prompts and referring to guidelines to determine a particular course of action. It is not surprising that a third of the study pharmacists showed declines in productivity after both interventions.

This particular aspect of pharmacy is not unique to the study organization. The pressures and environment found at the outpatient pharmacy is very similar to that in a chain pharmacy. Hardigan and Carvajal noted in their review of job satisfaction among different types of pharmacy practice:

> It is established in past research that chain pharmacists report the lowest levels of job satisfaction. Studies that look at various latent predictors of job satisfaction, such as job autonomy and workload, show that chain pharmacists are the least satisfied. Research also demonstrates that independent pharmacists report the highest level of satisfaction and chain pharmacists the lowest.[103]

In general, there should be concern that the "fast and accurate" philosophy of what makes a good practicing pharmacist in a high volume pharmacy may lead to less attention being paid to drug interactions by the pharmacist. In order to minimize or eliminate errors which could result in fatal consequences to the patient, corporations must assess how much reliance is being placed on automated systems to detect these interactions and other possible therapeutic issues with the prescription.

Limitations of this Research

Any research conducted outside of a laboratory environment encounters some aspects which cannot be controlled as well as the

researcher would like. There were several such issues with this research.

The first major concern was the inability to have direct observation of the pharmacists, as was done in the research which led to this project. The old pharmacy design was open; students and other staff could be used for indirect observation of the pharmacists' workstations. It was possible to count the number of interruptions while staff thought the reviewer was monitoring the production of the pharmacy robot or examining problems with the mail processing system. The person doing the indirect observations has, as his primary duties, maintenance of the various pharmacy interfaces and was working with both the robotic dispensing system and the mail processing system on a fairly regular basis.

The new pharmacy location does not allow this indirect observation. The production area is far removed from where the orders are processed and the staff are well aware when any one from the "front office" is in the area. As a result indirect observation of the number and type of interruptions is not possible. Any place where such observations could be made would be very noticeable by the staff.

Another possible issue with the data is the inability to determine the actual time spent processing an order. It can only be

approximated by average time to process the order. For example a production rate of 15 prescriptions per hour, would equate to one prescription every four minutes. However it is not known if the pharmacist worked rapidly processing orders as fast as possible for the first portion of any given hour and then relaxed the remainder of the hour. This is highly unlikely, but cannot be proven or disproven with the data at hand.

Areas for Future Research

As noted in the Malone paper, there is a presumed correlation between the numbers of prescriptions filled per hour and possible cognitive errors, for example, ignoring a potential drug interaction or patient allergy. In most studies of ambulatory care pharmacy, the act of filling a prescription includes entry of information into the computer, selection or verification of the medication in the container, response to any system generated alerts and verification that the medication container is suitably labeled. As a result, estimates of a safe workload would not correspond well to the processes in place at the organization studied.

On average, the pharmacists at the study facility processed orders at a rate close to 18 prescriptions per hour; one order every 3.3 minutes. The average rate cited in the Malone paper was 14.1 prescriptions per hour. The calculation for the hourly rate in the

Malone paper was simply the total number of prescriptions filled divided by the total number of pharmacists' hours available. This was performed in a traditional retail setting where the pharmacist was responsible for all of the processing, including checking the final container to be given to the patient. This is significantly different from the process at the study facility where the pharmacists processing orders are only required to perform the cognitive actions, insuring that the order is correct in all details and that any order alerts were appropriately addressed. Distributive functions are handled "downstream" and by other individuals.

However, this leads to other potential problems, most notably alarm or alert fatigue and issues with vigilance. Unlike most out-patient pharmacy operations, the pharmacists do not usually have to enter any data. The order fields are already populated. An ideal order, one that had been entered perfectly by the prescriber, and where the prescriber has appropriately responded to any order checks, would require that the pharmacist only have to press enter, accept the order, and press enter again.

As pharmacists continue to process orders there has to be concern with vigilance fatigue, especially when the order processing rate increases. At this point there is little data on how many orders can safely be processed per hour per pharmacist. This is of particular

concern in an environment where the pharmacist does not necessarily have to provide any input into the order but merely has to accept it. The Malone paper raises the issue of rate[104]. As noted in the literature review, various states have recognized that the rate of production may be a factor in error and have, in disciplinary actions have limited the rate of production to 150 prescriptions per 8 hour day, roughly 19 prescriptions per hour. Other than surveys of what pharmacists considered to be excessive workload, there does not seem to be any hard evidence to support this number.

There was a lot of variability in pharmacist response to the interventions. While the theories of Pihl and Evans, that dispensing errors are due to the inability of some pharmacists to multi-task, it is clear that there is a great deal of individual variability in the cognitive function of order processing. The study facility has an abundance of data to examine not only production rate per hour per person and, due to links to other files, the number of alert over-rides, the nature and action taken during the over-ride and whether or not a particular order was discontinued by a pharmacist due to the over-ride. With IRB approval it would also be possible to gather demographic data, age and gender, for the pharmacists. This would be an interesting topic for future research and would help determine maximum safe production rates for prescriptions.

There may be no one safe processing rate that would apply to all pharmacists and the arbitrary 150 prescription per day limit imposed by North Carolina may not be appropriate for all. Conversely, assuming that the rate is dependent only on the working memory of the pharmacist does not take into consideration the other factors that impact working memory. It would be interesting to see if some characteristics could be identified to allow for the development of a safe production rate based on various characteristics of the pharmacist, in a manner analogous to the one used by Pihl and Evans.

In addition, as was previously discussed, one thing this study made abundantly clear was that the current workload report is inadequate. First, the report which is published for staff is summarized by month which grossly distorts the data. Pharmacists could get a false sense of security by looking at only their monthly numbers and "front load" their work, working faster, and possible at an unsafe rate, early in the day and then slowing down latter in the day.

The pharmacy data manager has already approached pharmacy administration about modifying the report to use monthly average production rate per hour spent finishing prescriptions, rather than prescriptions per day, as the standard. In addition, the time between finishing prescriptions would be included as a data element and the mean time between prescriptions reported. Supervisors would be

provided with a report of any time between finished prescriptions that exceeds 10 minutes. If an individual had multiple events of such lengths during a single day, it might merit further review of that individual's work.

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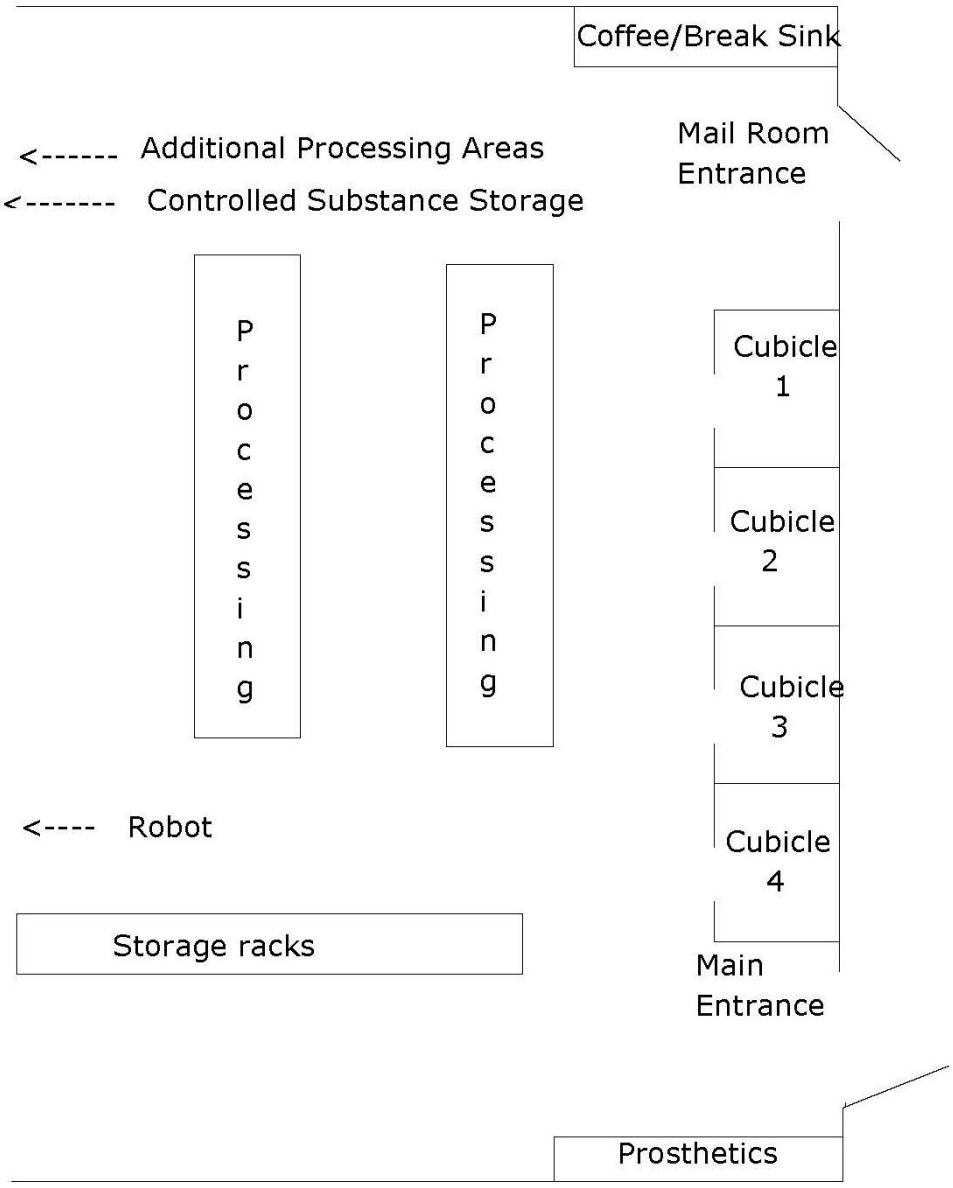
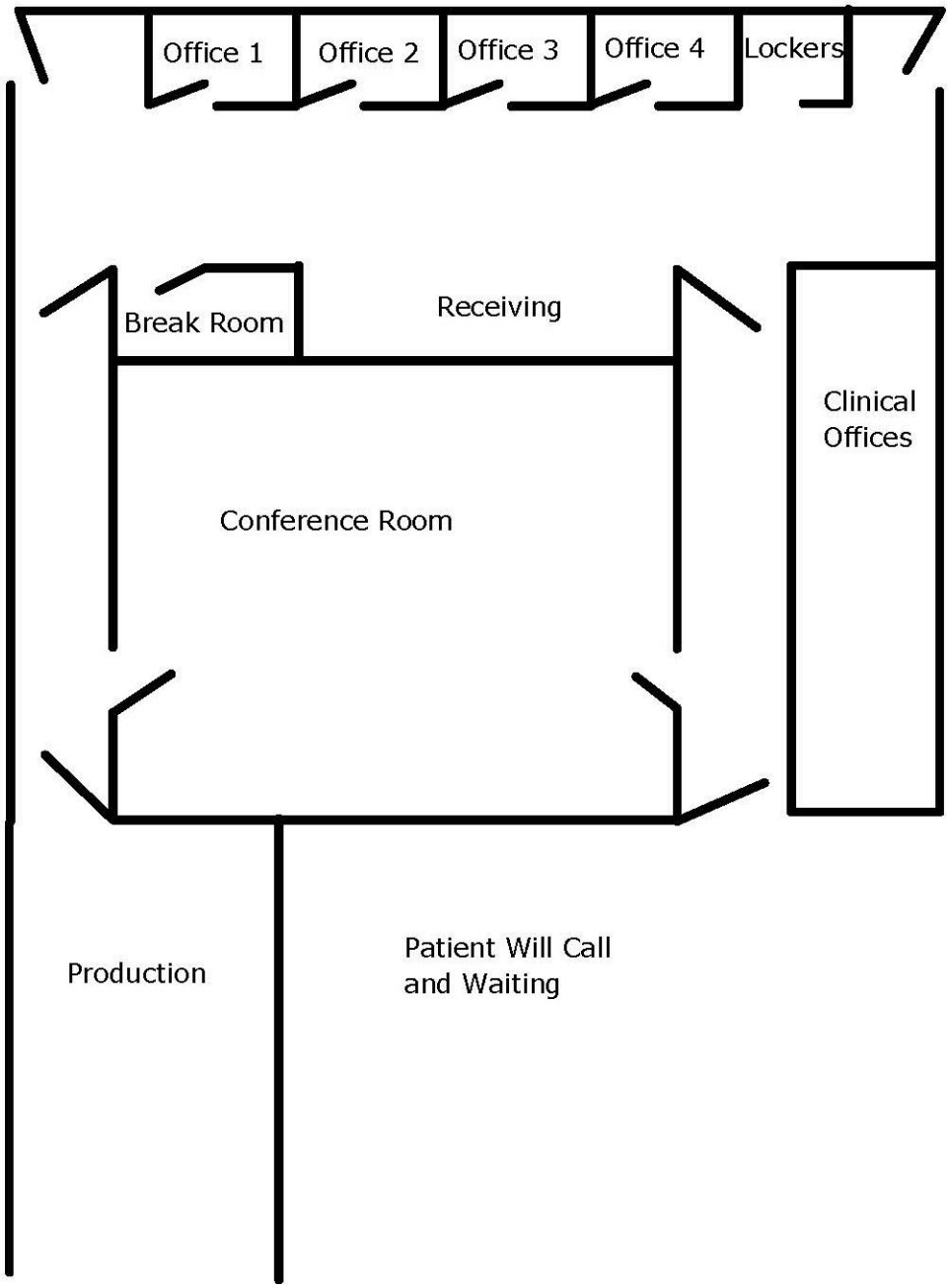
APPENDICES

Appendix A: Old Pharmacy Cubicle Arrangement



Appendix B: New Pharmacy Office Arrangement



Appendix C: Sample Productivity Report

April 2008 Workload Report

By Person ID
R= Renew N= New

Person ID	Total R	Total N	Grand Total
240786754	257	730	987
770448557	794	1,731	2,525
1080504808	0	28	28
1471659097	1,011	1,668	2,679
1548686001	844	1,456	2,300
1608285430	0	67	67
1701215088	1	9	10
1709256309	0	49	49
1748758106	0	28	28
1807186054	0	2	2
1807501970	724	1,467	2,191
2132870282	1,079	1,673	2,752
Grand Total	4,710	8,908	13,618

Appendix D: New Prescription Production

Study Pharmacists Only				Percent	
Period	New	Renew	Total	All	New
Apr-08	29,019	14,163	43,182	79.4%	54,352
May-08	29,663	14,024	43,687	82.6%	52,859
Jun-08	26,546	10,856	37,402	74.4%	50,252
Jul-08	25,389	11,015	36,404	68.8%	52,915
Aug-08	24,334	10,779	35,113	71.4%	49,185
Sep-08	27,242	12,241	39,483	73.4%	53,815
Oct-08	27,236	12,616	39,852	71.4%	55,790
Nov-08	22,537	10,809	33,346	69.1%	48,237
Dec-08	27,370	13,574	40,944	72.8%	56,226
Jan-09	29,117	13,755	42,872	77.2%	55,569
Feb-09	29,416	12,718	42,134	74.8%	56,293
Mar-09	32,419	14,184	46,603	74.5%	62,527
Apr-09	30,590	12,758	43,348	68.7%	63,105
May-09	27,544	11,777	39,321	79.6%	49,383
Jun-09	29,124	12,520	41,644	72.1%	57,733
Jul-09	26,150	9,846	35,996	63.1%	57,052
Aug-09	27,864	13,960	41,824	75.0%	55,800
Sep-09	25,790	12,313	38,103	66.2%	57,521
Oct-09	25,808	12,072	37,880	63.4%	59,760
Nov-09	22,079	9,383	31,462	61.5%	51,167
Dec-09	26,292	11,580	37,872	63.0%	60,072
Jan-10	28,714	13,993	42,707	73.1%	58,430
Feb-10	26,510	11,981	38,491	69.1%	55,694
Mar-10	32,778	16,196	48,974	73.4%	66,767
Apr-10	32,225	15,610	47,835	74.2%	64,447
May-10	28,787	15,398	44,185	71.8%	61,527
Jun-10	29,496	13,288	42,784	71.6%	59,765
Jul-10	26,134	11,325	37,459	64.7%	57,932
Aug-10	24,419	11,884	36,303	59.7%	60,811
Sep-10	24,545	11,283	35,828	59.7%	60,058
Oct-10	29,220	13,909	43,129	70.2%	61,480
Nov-10	27,190	13,836	41,026	70.4%	58,241
Dec-10	29,012	14,521	43,533	71.1%	61,219

Appendix D: (Continued)

Study Pharmacists Only				Percent	
Period	New	Renew	Total	All	New
Jan-11	30,783	16,738	47,521	81.1%	58,604
Feb-11	29,675	14,777	44,452	76.2%	58,356
Mar-11	30,406	14,449	44,855	67.2%	66,722
Apr-11	26,689	13,287	39,976	59.2%	67,512

Appendix E: Over-All Average Prescription Production per Hour per Study Pharmacist

	Avg		
PID	Hrs_day	Rx	Rx/Hr
1	8.2	126	15.3
2	4.3	44	10.3
3	7.9	390	49.5
4	6.5	86	13.3
5	9.4	113	12.1
6	3.4	54	15.8
7	8.9	141	15.8
8	4.1	38	9.2
9	4.9	55	11.1
10	4.9	223	45.7
11	6.5	92	14.2
12	9.0	231	25.6
13	8.8	165	18.7
14	8.9	88	9.9
15	7.5	160	21.4
16	7.2	124	17.2
17	7.8	96	12.3
18	8.6	130	15.2
19	6.2	111	18.0
20	8.4	109	13.0
21	5.7	80	14.0

Appendix F: Group 1 Productivity per Person

Person	Hours	RX	RX/Hr
1	1,917	34,824	18.17
2	687	8,910	12.97
3	2,258	112,630	49.88
4	684	9,377	13.71
5	1,600	10,003	6.25
6	250	3,860	15.44
7	964	14,652	15.20
8	765	8,340	10.90
9	1,503	19,871	13.22
10	1,034	54,683	52.88
11	493	10,624	21.55
12	2,253	62,802	27.87
13	1,979	37,608	19.00
14	1,764	16,009	9.08
15	703	19,438	27.65
16	1,575	21,785	13.83
17	2,005	23,627	11.78
18	2,244	41,583	18.53
19	644	13,007	20.20
20	2,003	23,446	11.71
21	1,448	16,600	11.46
TOTALS:	28,773	563,679	19.59

Appendix G: Group 2 Productivity per Person

Person	Hours	RX	RX/Hr
1	2,079	29,415	14.15
2	813	7,201	8.86
3	2,135	112,581	52.73
4	891	12,033	13.51
5	1,762	14,703	8.34
6	447	6,557	14.67
7	976	16,294	16.69
8	1,206	9,919	8.22
9	1,042	9,206	8.83
10	1,248	54,412	43.60
11	823	10,973	13.33
12	2,043	45,975	22.50
13	1,760	30,130	17.12
14	1,727	13,555	7.85
15	2,169	43,277	19.95
16	1,505	27,640	18.37
17	2,124	27,145	12.78
18	2,079	26,738	12.86
19	914	17,072	18.68
20	2,071	26,313	12.71
21	1,524	20,713	13.59
TOTALS:	31,338	561,852	17.93

Appendix H: Change in Productivity per Person Groups 1 and 2

Person	Hrs	RX	RX/Hr
1	162	-5,409	-4.02
2	126	-1,709	-4.11
3	-123	-49	2.85
4	207	2,656	-0.20
5	162	4,700	2.09
6	197	2,697	-0.77
7	12	1,642	1.50
8	441	1,579	-2.68
9	-461	-10,665	-4.39
10	214	-271	-9.29
11	330	349	-8.22
12	-210	-16,827	-5.37
13	-219	-7,478	-1.88
14	-37	-2,454	-1.23
15	1,466	23,839	-7.70
16	-70	5,855	4.53
17	119	3,518	1.00
18	-165	-14,845	-5.67
19	270	4,065	-1.52
20	68	2,867	1.00
21	76	4,113	2.13
TOTALS	2,565	-1,827	-41.94

Appendix I: Group 3 Productivity per Person

Person	Hours	RX	RX/Hr
1	864	11,563	13.4
2	496	5,596	11.3
3	940	49,376	52.5
4	312	3,841	12.3
5	760	9,695	12.8
6	235	4,289	18.3
7	468	6,663	14.2
8	682	6,786	10.0
9	484	3,862	8.0
10	410	14,890	36.3
11	295	2,929	9.9
12	815	21,754	26.7
13	734	10,631	14.5
14	819	9,968	12.2
15	816	15,741	19.3
16	651	12,841	19.7
17	874	11,407	13.1
18	919	11,849	12.9
19	363	5,068	14.0
20	969	14,216	14.7
21	631	11,425	18.1
TOTALS:	13,537	244,390	18.1

Appendix J: Group 4 Productivity per Person

Person	Hours	RX	RX/Hr
1	911	11,953	13.1
2	455	3,718	8.2
3	873	35,833	41.0
4	394	4,375	11.1
5	976	24,854	25.5
6	177	3,148	17.8
7	398	6,376	16.0
8	636	5,747	9.0
9	445	4,753	10.7
10	563	20,948	37.2
11	375	3,149	8.4
12	891	24,766	27.8
13	851	18,649	21.9
14	807	11,637	14.4
15	611	11,657	19.1
16	732	15,209	20.8
17	863	11,258	13.0
18	940	12,613	13.4
19	342	4,234	12.4
20	894	14,526	16.2
21	624	11,949	19.1
TOTALS:	13,758	261,352	19.0

Appendix K: Change in Productivity per Person Group 3 and 4

Person	Hrs	RX	RX/Hr
1	47	390	-0.3
2	-41	-1,878	-3.1
3	-67	-13,543	-11.5
4	82	534	-1.2
5	216	15,159	12.7
6	-58	-1,141	-0.5
7	-70	-287	1.8
8	-46	-1,039	-0.9
9	-39	891	2.7
10	153	6,058	0.9
11	80	220	-1.5
12	76	3,012	1.1
13	117	8,018	7.4
14	-12	1,669	2.2
15	-205	-4,084	-0.2
16	81	2,368	1.1
17	-11	-149	0.0
18	21	764	0.5
19	-21	-834	-1.6
20	-75	310	1.6
21	-7	524	1.0
TOTALS:	221	16,962	12.3

Appendix L: SCHEFFE's Test for Rx per Hour

Alpha	0.05
Error Degrees of Freedom	703
Error Mean Square	27.09255
Critical Value of F	1.58551

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
3 - 10	4.680	-2.378	11.738	
3 - 12	23.822	16.816	30.829	***
3 - 15	29.285	21.696	36.874	***
3 - 13	31.136	24.130	38.143	***
3 - 19	31.576	24.519	38.634	***
3 - 16	32.578	25.571	39.584	***
3 - 11	33.608	26.602	40.615	***
3 - 6	33.928	26.922	40.935	***
3 - 7	33.932	26.926	40.939	***
3 - 1	34.204	27.198	41.211	***
3 - 18	34.564	27.557	41.570	***
3 - 21	35.725	28.719	42.732	***
3 - 20	36.827	29.821	43.834	***
3 - 4	36.881	29.875	43.888	***
3 - 17	37.356	30.350	44.363	***
3 - 9	38.912	31.906	45.919	***
3 - 5	39.213	32.206	46.219	***
3 - 2	39.902	32.895	46.908	***
3 - 14	40.009	33.002	47.015	***
3 - 8	40.570	33.563	47.577	***
10 - 3	-4.680	-11.738	2.378	
10 - 12	19.142	12.084	26.200	***
10 - 15	24.605	16.969	32.241	***
10 - 13	26.456	19.398	33.514	***
10 - 19	26.896	19.788	34.005	***
10 - 16	27.898	20.840	34.956	***
10 – 11	28.928	21.870	35.986	***
10 – 6	29.248	22.190	36.306	***
10 – 7	29.252	22.194	36.310	***

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
10 – 1	29.524	22.466	36.582	***
10 – 18	29.883	22.826	36.941	***
10 – 21	31.045	23.987	38.103	***
10 – 20	32.147	25.089	39.205	***
10 – 4	32.201	25.143	39.259	***
10 – 17	32.676	25.618	39.734	***
10 – 9	34.232	27.174	41.290	***
10 – 5	34.533	27.475	41.591	***
10 – 2	35.222	28.164	42.280	***
10 - 14	35.329	28.271	42.387	***
10 - 8	35.890	28.832	42.948	***
12 - 3	-23.822	-30.829	-16.816	***
12 - 10	-19.142	-26.200	-12.084	***
12 - 15	5.463	-2.126	13.052	
12 - 13	7.314	0.307	14.321	***
12 - 19	7.754	0.696	14.812	***
12 - 16	8.756	1.749	15.762	***
12 - 11	9.786	2.779	16.793	***
12 - 6	10.106	3.100	17.113	***
12 - 7	10.110	3.104	17.117	***
12 - 1	10.382	3.376	17.389	***
12 - 18	10.741	3.735	17.748	***
12 - 21	11.903	4.897	18.910	***
12 - 20	13.005	5.999	20.012	***
12 - 4	13.059	6.053	20.066	***
12 - 17	13.534	6.527	20.541	***
12 - 9	15.090	8.084	22.097	***
12 - 5	15.391	8.384	22.397	***
12 - 2	16.080	9.073	23.086	***
12 - 14	16.187	9.180	23.193	***
12 - 8	16.748	9.741	23.754	***
15 - 3	-29.285	-36.874	-21.696	***
15 - 10	-24.605	-32.241	-16.969	***
15 - 12	-5.463	-13.052	2.126	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
15 - 13	1.851	-5.738	9.440	
15 - 19	2.292	-5.345	9.928	
15 - 16	3.293	-4.296	10.882	
15 - 11	4.323	-3.266	11.912	
15 - 6	4.643	-2.945	12.232	
15 - 7	4.647	-2.941	12.236	
15 - 1	4.919	-2.669	12.508	
15 - 18	5.279	-2.310	12.867	
15 - 21	6.440	-1.148	14.029	
15 - 20	7.542	-0.046	15.131	
15 - 4	7.596	0.008	15.185	***
15 - 17	8.071	0.482	15.660	***
15 - 9	9.627	2.039	17.216	***
15 - 5	9.928	2.339	17.516	***
15 - 2	10.617	3.028	18.205	***
15 - 14	10.724	3.135	18.312	***
15 - 8	11.285	3.696	18.874	***
13 - 3	-31.136	-38.143	-24.130	***
13 - 10	-26.456	-33.514	-19.398	***
13 - 12	-7.314	-14.321	-0.307	***
13 - 15	-1.851	-9.440	5.738	
13 - 19	0.440	-6.618	7.498	
13 - 16	1.442	-5.565	8.448	
13 - 11	2.472	-4.535	9.479	
13 - 6	2.792	-4.214	9.799	
13 - 7	2.796	-4.210	9.803	
13 - 1	3.068	-3.938	10.075	
13 - 18	3.427	-3.579	10.434	
13 - 21	4.589	-2.417	11.596	
13 - 20	5.691	-1.315	12.698	
13 - 4	5.745	-1.261	12.752	
13 - 17	6.220	-0.787	13.227	
13 - 9	7.776	0.770	14.783	***
13 - 5	8.077	1.070	15.083	***

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
13 - 2	8.766	1.759	15.772	***
13 - 14	8.873	1.866	15.879	***
13 - 8	9.434	2.427	16.440	***
19 - 3	-31.576	-38.634	-24.519	***
19 - 10	-26.896	-34.005	-19.788	***
19 - 12	-7.754	-14.812	-0.696	***
19 - 15	-2.292	-9.928	5.345	
19 - 13	-0.440	-7.498	6.618	
19 - 16	1.001	-6.057	8.059	
19 - 11	2.032	-5.026	9.090	
19 - 6	2.352	-4.706	9.410	
19 - 7	2.356	-4.702	9.414	
19 - 1	2.628	-4.430	9.686	
19 - 18	2.987	-4.071	10.045	
19 - 21	4.149	-2.909	11.207	
19 - 20	5.251	-1.807	12.309	
19 - 4	5.305	-1.753	12.363	
19 - 17	5.780	-1.278	12.838	
19 - 9	7.336	0.278	14.394	***
19 - 5	7.636	0.578	14.694	***
19 - 2	8.325	1.267	15.383	***
19 - 14	8.432	1.374	15.490	***
19 - 8	8.994	1.936	16.051	***
16 - 3	-32.578	-39.584	-25.571	***
16 - 10	-27.898	-34.956	-20.840	***
16 - 12	-8.756	-15.762	-1.749	***
16 - 15	-3.293	-10.882	4.296	
16 - 13	-1.442	-8.448	5.565	
16 - 19	-1.001	-8.059	6.057	
16 - 11	1.030	-5.976	8.037	
16 - 6	1.351	-5.656	8.357	
16 - 7	1.355	-5.652	8.361	
16 - 1	1.626	-5.380	8.633	
16 - 18	1.986	-5.021	8.992	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
16 - 21	3.148	-3.859	10.154	
16 - 20	4.250	-2.757	11.256	
16 - 4	4.303	-2.703	11.310	
16 - 17	4.778	-2.228	11.785	
16 - 9	6.335	-0.672	13.341	
16 - 5	6.635	-0.372	13.641	
16 - 2	7.324	0.317	14.330	***
16 - 14	7.431	0.424	14.437	***
16 - 8	7.992	0.986	14.999	***
11 - 3	-33.608	-40.615	-26.602	***
11 - 10	-28.928	-35.986	-21.870	***
11 - 12	-9.786	-16.793	-2.779	***
11 - 15	-4.323	-11.912	3.266	
11 - 13	-2.472	-9.479	4.535	
11 - 19	-2.032	-9.090	5.026	
11 - 16	-1.030	-8.037	5.976	
11 - 6	0.320	-6.686	7.327	
11 - 7	0.324	-6.682	7.331	
11 - 1	0.596	-6.410	7.603	
11 - 18	0.955	-6.051	7.962	
11 - 21	2.117	-4.889	9.124	
11 - 20	3.219	-3.787	10.226	
11 - 4	3.273	-3.733	10.280	
11 - 17	3.748	-3.259	10.755	
11 - 9	5.304	-1.702	12.311	
11 - 5	5.605	-1.402	12.611	
11 - 2	6.294	-0.713	13.300	
11 - 14	6.401	-0.606	13.407	
11 - 8	6.962	-0.045	13.968	
6 - 3	-33.928	-40.935	-26.922	***
6 - 10	-29.248	-36.306	-22.190	***
6 - 12	-10.106	-17.113	-3.100	***
6 - 15	-4.643	-12.232	2.945	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
6 - 13	-2.792	-9.799	4.214	
6 - 19	-2.352	-9.410	4.706	
6 - 16	-1.351	-8.357	5.656	
6 - 11	-0.320	-7.327	6.686	
6 - 7	0.004	-7.003	7.011	
6 - 1	0.276	-6.731	7.283	
6 - 18	0.635	-6.371	7.642	
6 - 21	1.797	-5.210	8.804	
6 - 20	2.899	-4.108	9.906	
6 - 4	2.953	-4.054	9.959	
6 - 17	3.428	-3.579	10.434	
6 - 9	4.984	-2.023	11.991	
6 - 5	5.284	-1.722	12.291	
6 - 2	5.973	-1.033	12.980	
6 - 14	6.080	-0.926	13.087	
6 - 8	6.642	-0.365	13.648	
7 - 3	-33.932	-40.939	-26.926	***
7 - 10	-29.252	-36.310	-22.194	***
7 - 12	-10.110	-17.117	-3.104	***
7 - 15	-4.647	-12.236	2.941	
7 - 13	-2.796	-9.803	4.210	
7 - 19	-2.356	-9.414	4.702	
7 - 16	-1.355	-8.361	5.652	
7 - 11	-0.324	-7.331	6.682	
7 - 6	-0.004	-7.011	7.003	
7 - 1	0.272	-6.735	7.278	
7 - 18	0.631	-6.375	7.638	
7 - 21	1.793	-5.214	8.800	
7 - 20	2.895	-4.112	9.902	
7 - 4	2.949	-4.058	9.955	
7 - 17	3.424	-3.583	10.430	
7 - 9	4.980	-2.027	11.987	
7 - 5	5.280	-1.726	12.287	
7 - 2	5.969	-1.037	12.976	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
7 - 14	6.076	-0.930	13.083	
7 - 8	6.638	-0.369	13.644	
1 - 3	-34.204	-41.211	-27.198	***
1 - 10	-29.524	-36.582	-22.466	***
1 - 12	-10.382	-17.389	-3.376	***
1 - 15	-4.919	-12.508	2.669	
1 - 13	-3.068	-10.075	3.938	
1 - 19	-2.628	-9.686	4.430	
1 - 16	-1.626	-8.633	5.380	
1 - 11	-0.596	-7.603	6.410	
1 - 6	-0.276	-7.283	6.731	
1 - 7	-0.272	-7.278	6.735	
1 - 18	0.359	-6.647	7.366	
1 - 21	1.521	-5.486	8.528	
1 - 20	2.623	-4.383	9.630	
1 - 4	2.677	-4.330	9.684	
1 - 17	3.152	-3.855	10.158	
1 - 9	4.708	-2.298	11.715	
1 - 5	5.008	-1.998	12.015	
1 - 2	5.697	-1.309	12.704	
1 - 14	5.804	-1.202	12.811	
1 – 8	6.366	-0.641	13.372	
18 – 3	-34.564	-41.570	-27.557	***
18 – 10	-29.883	-36.941	-22.826	***
18 – 12	-10.741	-17.748	-3.735	***
18 – 15	-5.279	-12.867	2.310	
18 – 13	-3.427	-10.434	3.579	
18 – 19	-2.987	-10.045	4.071	
18 – 16	-1.986	-8.992	5.021	
18 – 11	-0.955	-7.962	6.051	
18 – 6	-0.635	-7.642	6.371	
18 – 7	-0.631	-7.638	6.375	
18 – 1	-0.359	-7.366	6.647	
18 – 21	1.162	-5.845	8.168	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
18 - 20	2.264	-4.743	9.271	
18 - 4	2.318	-4.689	9.324	
18 - 17	2.793	-4.214	9.799	
18 - 9	4.349	-2.658	11.355	
18 - 5	4.649	-2.357	11.656	
18 - 2	5.338	-1.668	12.345	
18 - 14	5.445	-1.561	12.452	
18 - 8	6.007	-1.000	13.013	
21 - 3	-35.725	-42.732	-28.719	***
21 - 10	-31.045	-38.103	-23.987	***
21 - 12	-11.903	-18.910	-4.897	***
21 - 15	-6.440	-14.029	1.148	
21 - 13	-4.589	-11.596	2.417	
21 - 19	-4.149	-11.207	2.909	
21 - 16	-3.148	-10.154	3.859	
21 - 11	-2.117	-9.124	4.889	
21 - 6	-1.797	-8.804	5.210	
21 - 7	-1.793	-8.800	5.214	
21 - 1	-1.521	-8.528	5.486	
21 - 18	-1.162	-8.168	5.845	
21 - 20	1.102	-5.904	8.109	
21 - 4	1.156	-5.851	8.163	
21 - 17	1.631	-5.376	8.637	
21 - 9	3.187	-3.820	10.194	
21 - 5	3.487	-3.519	10.494	
21 - 2	4.176	-2.830	11.183	
21 - 14	4.283	-2.723	11.290	
21 - 8	4.845	-2.162	11.851	
20 - 3	-36.827	-43.834	-29.821	***
20 - 10	-32.147	-39.205	-25.089	***
20 - 12	-13.005	-20.012	-5.999	***
20 - 15	-7.542	-15.131	0.046	
20 - 13	-5.691	-12.698	1.315	
20 - 19	-5.251	-12.309	1.807	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
20 - 16	-4.250	-11.256	2.757	
20 - 11	-3.219	-10.226	3.787	
20 - 6	-2.899	-9.906	4.108	
20 - 7	-2.895	-9.902	4.112	
20 - 1	-2.623	-9.630	4.383	
20 - 18	-2.264	-9.271	4.743	
20 - 21	-1.102	-8.109	5.904	
20 - 4	0.054	-6.953	7.060	
20 - 17	0.529	-6.478	7.535	
20 - 9	2.085	-4.922	9.092	
20 - 5	2.385	-4.621	9.392	
20 - 2	3.074	-3.932	10.081	
20 - 14	3.181	-3.825	10.188	
20 - 8	3.743	-3.264	10.749	
4 - 3	-36.881	-43.888	-29.875	***
4 - 10	-32.201	-39.259	-25.143	***
4 - 12	-13.059	-20.066	-6.053	***
4 - 15	-7.596	-15.185	-0.008	***
4 - 13	-5.745	-12.752	1.261	
4 - 19	-5.305	-12.363	1.753	
4 - 16	-4.303	-11.310	2.703	
4 - 11	-3.273	-10.280	3.733	
4 - 6	-2.953	-9.959	4.054	
4 - 7	-2.949	-9.955	4.058	
4 - 1	-2.677	-9.684	4.330	
4 - 18	-2.318	-9.324	4.689	
4 - 21	-1.156	-8.163	5.851	
4 - 20	-0.054	-7.060	6.953	
4 - 17	0.475	-6.532	7.481	
4 - 9	2.031	-4.975	9.038	
4 - 5	2.331	-4.675	9.338	
4 - 2	3.020	-3.986	10.027	
4 - 14	3.127	-3.879	10.134	
4 - 8	3.689	-3.318	10.695	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
17 - 3	-37.356	-44.363	-30.350	***
17 - 10	-32.676	-39.734	-25.618	***
17 - 12	-13.534	-20.541	-6.527	***
17 - 15	-8.071	-15.660	-0.482	***
17 - 13	-6.220	-13.227	0.787	
17 - 19	-5.780	-12.838	1.278	
17 - 16	-4.778	-11.785	2.228	
17 - 11	-3.748	-10.755	3.259	
17 - 6	-3.428	-10.434	3.579	
17 - 7	-3.424	-10.430	3.583	
17 - 1	-3.152	-10.158	3.855	
17 - 18	-2.793	-9.799	4.214	
17 - 21	-1.631	-8.637	5.376	
17 - 20	-0.529	-7.535	6.478	
17 - 4	-0.475	-7.481	6.532	
17 - 9	1.556	-5.450	8.563	
17 - 5	1.857	-5.150	8.863	
17 - 2	2.546	-4.461	9.552	
17 - 14	2.653	-4.354	9.659	
17 - 8	3.214	-3.793	10.220	
9 - 3	-38.912	-45.919	-31.906	***
9 - 10	-34.232	-41.290	-27.174	***
9 - 12	-15.090	-22.097	-8.084	***
9 - 15	-9.627	-17.216	-2.039	***
9 - 13	-7.776	-14.783	-0.770	***
9 - 19	-7.336	-14.394	-0.278	***
9 - 16	-6.335	-13.341	0.672	
9 - 11	-5.304	-12.311	1.702	
9 - 6	-4.984	-11.991	2.023	
9 - 7	-4.980	-11.987	2.027	
9 - 1	-4.708	-11.715	2.298	
9 - 18	-4.349	-11.355	2.658	
9 - 21	-3.187	-10.194	3.820	
9 - 20	-2.085	-9.092	4.922	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
9 - 4	-2.031	-9.038	4.975	
9 - 17	-1.556	-8.563	5.450	
9 - 5	0.300	-6.706	7.307	
9 - 2	0.989	-6.017	7.996	
9 - 14	1.096	-5.910	8.103	
9 - 8	1.658	-5.349	8.664	
5 - 3	-39.213	-46.219	-32.206	***
5 - 10	-34.533	-41.591	-27.475	***
5 - 12	-15.391	-22.397	-8.384	***
5 - 15	-9.928	-17.516	-2.339	***
5 - 13	-8.077	-15.083	-1.070	***
5 - 19	-7.636	-14.694	-0.578	***
5 - 16	-6.635	-13.641	0.372	
5 – 11	-5.605	-12.611	1.402	
5 – 6	-5.284	-12.291	1.722	
5 – 7	-5.280	-12.287	1.726	
5 – 1	-5.008	-12.015	1.998	
5 – 18	-4.649	-11.656	2.357	
5 – 21	-3.487	-10.494	3.519	
5 – 20	-2.385	-9.392	4.621	
5 – 4	-2.331	-9.338	4.675	
5 – 17	-1.857	-8.863	5.150	
5 – 9	-0.300	-7.307	6.706	
5 – 2	0.689	-6.318	7.696	
5 – 14	0.796	-6.211	7.803	
5 – 8	1.357	-5.649	8.364	
2 – 3	-39.902	-46.908	-32.895	***
2 – 10	-35.222	-42.280	-28.164	***
2 – 12	-16.080	-23.086	-9.073	***
2 – 15	-10.617	-18.205	-3.028	***
2 – 13	-8.766	-15.772	-1.759	***
2 – 19	-8.325	-15.383	-1.267	***
2 – 16	-7.324	-14.330	-0.317	***
2 – 11	-6.294	-13.300	0.713	

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
2 – 6	-5.973	-12.980	1.033	
2 – 7	-5.969	-12.976	1.037	
2 – 1	-5.697	-12.704	1.309	
2 – 18	-5.338	-12.345	1.668	
2 – 21	-4.176	-11.183	2.830	
2 – 20	-3.074	-10.081	3.932	
2 – 4	-3.020	-10.027	3.986	
2 – 17	-2.546	-9.552	4.461	
2 – 9	-0.989	-7.996	6.017	
2 – 5	-0.689	-7.696	6.318	
2 – 14	0.107	-6.900	7.114	
2 – 8	0.668	-6.338	7.675	
14 – 3	-40.009	-47.015	-33.002	***
14 – 10	-35.329	-42.387	-28.271	***
14 – 12	-16.187	-23.193	-9.180	***
14 – 15	-10.724	-18.312	-3.135	***
14 – 13	-8.873	-15.879	-1.866	***
14 – 19	-8.432	-15.490	-1.374	***
14 – 16	-7.431	-14.437	-0.424	***
14 – 11	-6.401	-13.407	0.606	
14 - 6	-6.080	-13.087	0.926	
14 - 7	-6.076	-13.083	0.930	
14 - 1	-5.804	-12.811	1.202	
14 - 18	-5.445	-12.452	1.561	
14 - 21	-4.283	-11.290	2.723	
14 - 20	-3.181	-10.188	3.825	
14 - 4	-3.127	-10.134	3.879	
14 - 17	-2.653	-9.659	4.354	
14 - 9	-1.096	-8.103	5.910	
14 - 5	-0.796	-7.803	6.211	
14 - 2	-0.107	-7.114	6.900	
14 - 8	0.561	-6.445	7.568	
8 - 3	-40.570	-47.577	-33.563	***
8 - 10	-35.890	-42.948	-28.832	***

Appendix L: (Continued)

Comparisons significant at the 0.5 level are indicated by ***

Person Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
8 - 12	-16.748	-23.754	-9.741	***
8 - 15	-11.285	-18.874	-3.696	***
8 - 13	-9.434	-16.440	-2.427	***
8 - 19	-8.994	-16.051	-1.936	***
8 - 16	-7.992	-14.999	-0.986	***
8 - 11	-6.962	-13.968	0.045	
8 - 6	-6.642	-13.648	0.365	
8 - 7	-6.638	-13.644	0.369	
8 - 1	-6.366	-13.372	0.641	
8 - 18	-6.007	-13.013	1.000	
8 - 21	-4.845	-11.851	2.162	
8 - 20	-3.743	-10.749	3.264	
8 - 4	-3.689	-10.695	3.318	
8 - 17	-3.214	-10.220	3.793	
8 - 9	-1.658	-8.664	5.349	
8 - 5	-1.357	-8.364	5.649	
8 - 2	-0.668	-7.675	6.338	
8 - 14	-0.561	-7.568	6.445	