Title Page

**Evaluation of Unit Dose Dispenses by Increasing Automated Dispensing Station (ADS) Inventory**

by

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PharmD, Allegheny General Hospital, 2018

Submitted to the Graduate Faculty of

the Multidisciplinary MPH Program

Graduate School of Public Health in partial fulfillment

of the requirements for the degree of

Master of Public Health

University of Pittsburgh

Year 2018

UNIVERSITY OF PITTSBURGH

Graduate School of Public Health

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Abstract

Title Page

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**Evaluation of Unit Dose Dispenses by Increasing Automated Dispensing Station (ADS) Inventory**

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**Abstract**

The National Association of Board of Pharmacy (NABP) Model Act defines “automated pharmacy systems” to include, but not limited to, “mechanical systems that perform operations or activities, other than Compounding or Administration, relative to the storage, packaging, Dispensing, or Distribution of medications, and which collect, control, and maintain all transaction information.” Pharmacy distribution models vary across institutions to serve their specific patient population. There are three models:

1. A centralized pharmacy model is designed to fill patient medication orders from a central location and deliver to hospital units through a cart fill workflow.
2. A point of use medication distribution model is designed to dispense doses on the nursing unit; examples include satellite pharmacies and automated dispensing cabinets. This model provides real time medication delivery to patient care areas.
3. A hybridization of the two aforementioned models in varying degrees.

Allegheny General Hospital’s distribution model is a hybrid model between centralized cart fill distribution and decentralized dispensing. In 2016, Allegheny General Hospital (AGH) upgraded to the Pyxis® Medstation ES. Pyxis® automated dispensing stations (ADS) are deployed throughout the patient care areas and dispense majority of medication doses.

At AGH, cart-fill is defined as placing individual doses of medications for patients into a separate package which has the label listing the drug name, strength, number, patient name, date of birth, Medical Record Number, the date and time of filling. This process is done on a nightly basis to provide the scheduled medications for the next 24 hours for each patient. The midnight-shift pharmacy technicians pull the next day’s cart-fill medications and pharmacists check them. The entire process consumes a significant of time and effort for both technicians and pharmacists.

Delivering medications to patients at the appropriate time, being able to respond to patients needs is a few of the problems that this study reviewed. Healthcare- associated infections, heart disease and stroke, and many other public health issues are related to this study. For example by providing antibiotics to patients faster the risk of healthcare- associated infections might be lower. Being able to have pharmacists do clinical activities and direct patient care on the floors would lower the risk of readmission to the hospitals.

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Preface

**Purpose:** The National Association of Boards of Pharmacy (NABP) Model Act defines automated pharmacy systems as “systems that perform operations or activities, relative to the storage, packaging, dispensing, or distribution of medications, and which collect, control, and maintain all transaction information.” Pharmacy distribution models vary across institutions to serve each specific patient population. Allegheny General Hospital’s distribution model is a hybrid model between centralized cart fill distribution and decentralized dispensing. The purpose of this study was to evaluate the cart-fill volume and reduce the number of fills by increasing the number of medications stored in the automated dispensing stations (ADS).

**Definitions:**

Cart-fill: individual doses of scheduled, patient-specific medications that are needed for the next 24-hour period

Pharmacy distribution models: Centralized, Decentralized and Hybridized

Centralized: Medications are dispensed from the main pharmacy

Decentralized: Medications are dispensed from Automatic Dispensing Stations or satellite pharmacies which are closer to patients’ specific units

Hybridized: Combination of both centralized and decentralized distribution methods are used

**Timeline:**

In September 2017 a protocol was submitted to the Investigational Review Board (IRB). The pre-data collection was done from October to November and data were analyzed in December. From December 2017 to March 2018 the medications were stocked in ADS machines and inventory managements were placed. The post-data collection was placed in March 2018 and April through May, the final analysis took place. This research was presented on May 18th, 2018 at Clinical Research day.

# Introduction

The National Association of Board of Pharmacy (NABP) Model Act defines “automated pharmacy systems” to include, but not limited to, “mechanical systems that perform operations or activities, other than Compounding or Administration, relative to the storage, packaging, Dispensing, or Distribution of medications, and which collect, control, and maintain all transaction information.” 1

An area of great progress in healthcare technology has been the adoption of automated Dispensing Stations (ADS) or Automated Dispensing Cabinets (ADC) for medications in healthcare facilities. ADSs are decentralized medication distribution systems that provide computer-controlled storage, dispensing, and tracking of medications at the point-of-care in patient care units. This technology was introduced to the hospitals in late 1980s. Based on Institute for Safe Medication Practices (ISMP), as of 2007, more than 80% of hospitals used ADCs to replace manual floor stock systems and/or medication carts that previously held a 24-hour supply of patient specific medications in individual patient bins.2,3

Pharmacy distribution models vary across institutions to serve their specific patient population. There are three models:

1. A centralized pharmacy model is designed to fill patient medication orders from a central location and deliver to hospital units through a cart fill workflow.
2. A point of use medication distribution model is designed to dispense doses on the nursing unit; examples include satellite pharmacies and automated dispensing cabinets. This model provides real time medication delivery to patient care areas.
3. A hybridization of the two aforementioned models in varying degrees.

Healthcare facilities are always working on reducing the cost an enhance efficiency without sacrificing the quality of care but at the same time they must improve the quality of care while reducing the costs. These pressures are a few of the challenges that hospital and healthcare administrators deal with and try to find ways to meet these goals.

A centralized medication distribution system used to be the standard model for a lot of health systems and medication facilities but now they are moving towards a hybrid model which is the combination of decentralized and centralized medication distribution system. Different models are used based on the size of facility. In a medium and large facilities, and some small facilities, having a single centralized distribution station can cause over 50% of a clinician’s time to spent away from the patient, negatively impacting the patient’s experience8.

Caregivers in small facilities are much less likely to feel that the distance and time spent moving between patients and the centralized medication distribution model works for them. This is very different in comparison with large facilities where caregivers need to take care of more patients and have less time to go to a centralized location to retrieve the medications for each of their patients.

Decentralizing the medication distribution system allows nurses to dispense about 80% or more of inpatient medications from automated dispensing stations. One great advantage of automatic dispensing stations is that allow access to medications with scanning the barcodes, also under patient’s name. This helps pharmacy personnel to review the inventory, expiration dates, and closely monitor the discrepancies for controlled substances.

Decentralized distribution model has less incidence of missing medications and faster turnaround times for STAT or first doses.

Previously, filling the Pyxis**®** Medstation system was very tedious and inefficient because there was no barcode scanning. But now, pharmacy technicians utilize barcode technology for fulfillment, which helps promote a higher level of efficiency, medication safety and accuracy. This improvement has led to more than 90% compliance rate with the technology4. Pyxis**®** stations have made medication delivery to patient much easier. In the past where most of the hospitals were centralized model, pharmacists had to spent a lot of time on verification of the medications and delivery to nurses. But now the pharmacists are having more clinical interventions, patient education, discharge counseling and etc. for patients on the units.5 At Allegheny General Hospital, there are five centralized pharmacists who are responsible for answering the phone calls, check the first doses, cart-fill and intravenous medications.

With the decentralized model, facilities are able to shift inventory from shelves in the pharmacy to the Pyxis**®** Medstation systems, which has given them better control of dating, inventory control and formulary management.

Allegheny General Hospital’s distribution model is a hybrid model between centralized cart fill distribution and decentralized dispensing. In 2016, Allegheny General Hospital (AGH) upgraded to the Pyxis**®** Medstation ES. Pyxis**®** automated dispensing stations (ADS) are deployed throughout the patient care areas and dispense majority of medication doses.

The process of dispensing medications starts with physician puts in the order in patient’s Electronic Health Record (EHR), the order appears in the pharmacist work queue, the pharmacist verifies the order after checking all the adverse effects, appropriateness of therapy and clinical advantages of the medication, if the medication is stored in the ADS in that patient’s unit the EHR automatically changes the dispensing location to that specific ADS, if the medication is not stored in ADS close to patient then it will be dispensed from central pharmacy. And technicians take the medications to the units to be administered by patient’s nurse.7,8

Practitioner orders are processed by the pharmacist and with decentralized model the medications are located closer to the patient’s rooms. Checking and filling of medications into ADS are part of pharmacy responsibilities which ultimately help nurses to have quicker access to patients’ medications. (Figure.1)



Figure . Process of Central Dispensing

At AGH, cart-fill is defined as placing individual doses of medications for patients into a separate package which has the label listing the drug name, strength, number, and patient name, date of birth, Medical Record Number, the date and time of filling. This process is done on a nightly basis to provide the scheduled medications for the next 24 hours for each patient. The midnight-shift pharmacy technicians pull the next day’s cart-fill medications and pharmacists check them. The entire process consumes a significant of time and effort for both technicians and pharmacists.

# Objectives

**Hypothesis:**

* Increasing number of medications in the ADS will decrease number of cart-fill medications, allowing pharmacists and technicians to spend more time on clinical aspect of patient care.

**Null Hypothesis:**

* There will not be any differences before and after increasing number of medications in the Pyxis**®** Medstations

**Primary Objective:**

* Evaluate number of medications dispensed from central pharmacy pre- and post-intervention.

**Secondary Objective:**

* Evaluate number of doses dispensed for Automated Dispensing Stations pre- and post-intervention.

**Study Design:**

* IRB granted single-center, quality, prospective improvement study

# Methods

The primary objective of this prospective quality improvement study was to evaluate the number of medications filled in cart-fill reports before and after loading medications into ADS. Data was collected from electronic health record cart fill reports during October through November 2017 and February through March 2018. Fourteen random days were monitored to represent the average dispenses per month. The medications were filled in ADS from December 2017 through February 2018. Non-formulary medications, controlled substances, intravenous medications were excluded from this study.

The intervention was defined as loading medications that were dispensed from central pharmacy ≥2 times per day for each Pyxis**®** Station

Prior to the intervention, planning for transition to ADS was from October 2nd through November 2nd 2017, during data collection. Intervention was conducted from December 1st 2017 through February 28th 2018 and post-intervention was March 1st through 28th 2018, during which data were gathered for analysis relative prior to the intervention.

Average daily dispensed data was determined per patient care area and par levels were identified based on need. Clinical specialists are engaged to determine par levels to compare dispense metrics versus clinical need. Machines are designated for additions to optimize patient room locations for dispenses to nurse and minimize potential for outdated stock. The minimum and maximum par level calculations followed the CareFusion 3/10-day max rule – where the goal was to have a 3-day minimum inventory and maximum 10-day inventory.9,10

Inclusion criteria were the dispensed medications and specific units at Allegheny General Hospital including: Trauma, Medical, Neuro, Surgical, Cardiac intensive care units, and Telemetry. (Table 1)

Exclusion criteria were Controlled II-V substances defined by the Pennsylvania Controlled Substance, Drug, Device and Cosmetic Act, intravenous medications, non-formulary medications, hazardous medications, patients-own medications, inhalers, drops (including but not limited to ophthalmic and otic), sprays, and enemas.

PGY-1 Pharmacy Practice Residents were assigned ADS machines to conduct the report reconciliation process and create initial recommendations. Staff and clinical pharmacists were consulted to provide inter-departmental input. After consultation, each resident submitted final recommendations to pharmacy administration. Once approved, each resident implemented the approved changes prior February 28th, 2018.

Table 1. Machine Designation to Patient Care Areas

|  |  |
| --- | --- |
| **Pyxis® Machine** | **Patient Care Area** |
| 3 High | Trauma |
| 3 Low | Trauma |
| 4 M1  | Medical-ICU or MICU |
| 4 M2 | Medical-ICU or MICU |
| 5A | Observation |
| 5C | Telemetry  |
| 7C | Neuro-ICU or NICU |
| 8A  | Cardiology |
| 8C | Surgery |
| 10A | Telemetry  |
| 10C | Telemetry |
| 11C  | Cardiac Care- ICU or CCU |
| 12C | Transplant- Surgical ICU or SICU |

# Results

A descriptive analysis was conducted to review the optimization intervention. After reviewing the data collected from Pyxis**®** report and Electronic Health Record, there were no significant changes pre and post intervention.

The mean number of medications that were added to Automated Dispensing Stations was 8 and Figure 2 shows the average number of medications that were added to each ADS. Table 2 shows the number of medications that were stored in Pyxis**®** before and after intervention.

Figure 2. Number of Medications Added to ADS

It is very important to include the fact that the Pyxis**®** Optimization project was being conducted at the same time of this research by another pharmacy resident. Pyxis**®** Optimization project included, reviewing all the medications that are dispensed at each Pyxis**®** station, removing the medications that haven’t been dispensed for three months or more, removing the medications that were not going to be utilized because of renovations and changing the patient population at each unit.

Table 2. Number of medications in Pyxis® Stations Pre and Post Intervention

|  |  |  |
| --- | --- | --- |
|  | **October 2017** | **March 2018** |
| Unit | # of times the medications were dispensed from the Pyxis**®** Station | # of medications stored in Pyxis**®** Stations | # of times medications were dispensed from the Pyxis**®** Station | # of medications stored in Pyxis**®** Stations |
| Trauma | 11145 | 5990 | 8552 | 4027 |
| MICU | 9860 | 5123 | 7870 | 3606 |
| 5A | 3114 | 1800 | 2373 | 958 |
| 5C | 8224 | 4291 | 6278 | 2573 |
| 7C | 12049 | 6487 | 5755 | 3878 |
| 10A | 2125 | 1099 | 990 | 409 |
| 10C | 7569 | 4093 | 4432 | 1763 |
| 11A | 9647 | 4966 | 7168 | 2683 |
| 11C | 6688 | 4164 | 5928 | 3007 |
| 12A | 9257 | 5443 | 7812 | 3233 |
| 12C | 10923 | 7053 | 042 | 4429 |

Table 3. Results of the Study

|  |  |  |
| --- | --- | --- |
|  | **Pre- Intervention** | **Post- Intervention** |
| **Average Number of Dispenses/Fills From Central Pharmacy per day** | **91** | **133** |
| **Average Number of doses dispensed per day from ADS** | **3080** | **3055** |
| **Total dispenses per day** | **3171** | **3188** |

This result happened due to the limitations and bias that were present throughout this research. Some of the limitations and bias were:

* There was variation in residents or physicians prescribing practices for example some physicians would rather to order a specific blood pressure medication that is not used commonly by another physician
* Pyxis**®** optimization project was being done by another resident throughout this research which include removing the unused medications from each Pyxis**®** based on clinical specialist recommendations and medications that were not dispensed for three months or more
* Data analysis and collection were limited to Electronic Health Record System (EPIC)
* Inventory control by other staff members which means any other pharmacist could change the inventory if they find any problem with it and there was no close monitoring in that aspect
* There were multiple study participants throughout this project that were not able to complete the tasks
* Seasonal changes and patient population were different pre- and post- intervention for example the flu season could have affected the medications prescribed
* There were many drug shortages occurring during that time which limited Allegheny General Hospital to have a more stable inventory
* The short time frame for this research was another limitations of this study
* There were many constructions and remodeling of the participatory units occurring during this time frame

# Discussion

Our conclusion was that changing inventory of Automated Dispensing Stations based on medications which were more than twos dispenses per day did not show a difference in the overall dispenses from central pharmacy. Evaluating number of medications dispensed from central pharmacy may help analyzing pharmacy operations.

The project’s current recommendations were reviewed by leadership team at Allegheny General Hospital in addition to designated pharmacists, technicians, and analysts to continue the quality initiative. A few of the potential opportunities of this project were financial cost saving, reducing the central pharmacy workload and reprioritizing the work force at the inpatient pharmacy.

By making adjustments in inventory, there are many opportunities in the future to increase the time spent by technicians during the day stocking and maintaining Automated Dispensing Station inventories, and decreasing the time elapsed between verification to administration. This will ultimately affect patient care positively by providing the nurses with quicker access to medications when they are stored at the Automated Dispensing Stations at each unit as compared to having to wait for their traverse from the central pharmacy.

This research might have not shown any differences between before and after intervention but this might be an important founding. It is a possibility that the medications that were needed at each unit were already located in the ADS and adding just a few medications to each ADS didn’t make any tremendous changes. Pyxis**®** optimization is reviewing data collected from Pyxis**®**, analyzing the inventory at each unit and stores the best medication at each unit.

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