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ANALYSIS OF PHARMACY TECHNICIAN WORKFLOW AND THE IDENTIFICATION OF OPPORTUNITIES FOR IMPROVEMENT

by

AMRITA SURESH CHABRIA

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ABSTRACT

Analysis of Pharmacy Technician Workflow and the Identification of Opportunities for Improvement

PURPOSE: The objective of this study was to identify opportunities for pharmacy technician workflow improvement using the principles of Lean Six Sigma. The impact of this study may streamline pharmacy technician workflow as well as eliminate/consolidate tasks resulting in increased efficiency while maintaining quality.

METHODS: This study took place at St. Luke's Episcopal Hospital (SLEH) in Houston, TX. The focus group was used to identify the problem. Two methods for data collection were utilized to establish baseline information; automated information and observational time and motion studies. Observational and automated data was presented to the focus group and the focus group was responsible for recommending and piloting changes. The focus group also identified pharmacy technician tasks that needed improvement as well as relate these tasks back to the voice of the customer and task purpose. Data was presented to the focus group and the focus group was responsible for recommending and piloting changes. The suggested changes were implemented in a pilot study.

RESULTS: The focus group identified "ordered medications not loaded" (OMNL) as an area for workflow improvement. OMNL cycle time was defined as the time from when the user logs in the Acudose machine to the point the user completed the OMNL process. There were five parts to OMNL which were conducted at various times throughout the day: restocking, pulling, assigning, unassigning and loading. Time studies were conducted and technicians were shadowed on all three shifts. Observational and

automated data findings were presented to focus group. These studies found technicians spent approximately 69.5 hours a week on OMNL for 1096 line items. On average, a patient had an active order for this medication for 2 days.

The focus group recommended two changes to the OMNL process. The first change was to consolidate the three aspects of OMNL to one step. The second was to eliminate loading scheduled daily medications during OMNL. These changes were piloted and implemented which resulted in reducing OMNL by 39.1% and a net time savings of 33.6 hours a week. Although the cart fill volume did increase, there was no impact on missing doses.

CONCLUSION: The application of Lean Six Sigma can improve operational workflow of pharmacy technicians as well as reduce waste as seen in this study. The SLEH should continue to utilize these concepts to identify further opportunities for pharmacy technician workflow improvement and reduction in waste.

TABLE OF CONTENTS

List of Figures and Appendixes:

List of Acronyms:

ADC: Automated dispensing cabinet
CQI: Contiuous Quality Improvement
CVA: Customer value added time
NVA: Non value added time
PCU: Patient care unit
OMNL: Ordered medications not loaded
SLEH: St. Luke's Episcopal Hospital
VOC: Voice of the customer
VSM: Value stream map

INTRODUCTION

Continuous quality improvement (CQI) is a widely used organizational approach that strives to improve quality by focusing on processes that meet or exceed customer expectations.[1] Key aspects of CQI are that it is a continued cycle and focused on customer expectations. Hence, defining the customer is crucial for the success of any CQI project as success can be described as subjective.

There are aspects of CQI that are composed of 3 elements: philosophical, structural and health-care specific elements.[1] Philosophical elements represent the minimal which must be present in order to be defined as a CQI effort. Some philosophical elements include strategic and customer focuses, data driven analysis and process optimization. Health-care specific elements are elements that are specific to health-care such as research driven analysis, clinical studies or use of quality assurance data. This element adds health-care specific knowledge to a generic CQI approach. Structural elements help to structure, organize the support the CQI effort through use of process improvement teams and tools.

There are a variety of quality improvement tools widely utilized in healthcare with LEAN and Six Sigma being two of the most common tools. [1,2] The Toyota Production System is well known for its work on lean process improvement which is a technique that has been employed in a variety of business settings.[1-3] Lean process improvements are mostly used in order to reduce waste and produce value to the workflow including in healthcare.[1,4]

Principles of LEAN process improvement include listening to the voice of the customer (VOC), value stream mapping (VSM), eliminating waste, visual control and "kaizen" or continuous quality improvement resulting in improving efficiency to the entire

process.[1,2,4] Value stream mapping has been used extensively in the hospital setting in order to assist with workflow issues.[4-6] Examples of this include the discharge process, time-sensitive medication therapy and reducing patient wait time.

Serrano et al applied Toyota Production LEAN principles to the histology and anatomic pathology departments at Avera McKennan Hospital in South Dakota.[4] The objectives of this LEAN effort were to gain efficiencies and reduce errors. The authors analyzed the current workflow in addition to the floor plan. A 12 step process was followed over 14 weeks. As a result of this initiative, linear workflow was reduced, turnaround time increased by 67%, customer satisfaction and staff productivity increased.

Combining the LEAN principles with Six Sigma methodology can enhance quality improvement initiatives by focusing on reducing variation and improve effectiveness.[2,7] Six Sigma methodology includes the following: defining the problem, measuring the current problem, analyzing the situation, improving the current process and controlling the project. [2,8] In the pharmacy department, LEAN Six Sigma principles can be utilized in order to improve medication therapy, reduce waste and reduce the risk of error.[2,9,10] One lean concept is the Japanese term "muda," which represents any human activities that may result in non-value added steps.[3] The 8 waste categories, also known as TIMWOODS, which can be targeted are transportation, inventory, motion, waiting, overproduction, overprocessing and skills or human potential.[1,2,8] The reduction of "muda" can increase efficiencies in a workflow. Methods to reduce each type of waste in the pharmacy setting can be found in Table 1.

Table 1. LEAN Waste in the Pharmacy Setting [8]

Waste Defined	Examples
Transportation	Multiple trips to a patient care unit
Inventory	Low inventory turns, expired inventory
Motion	Poor pharmacy layout, multiple steps in a process
Waiting	Low productivity
Overproduction	Drugs are made, delivered to the floor and returned back to the pharmacy
Over Processing	Multiple signatures or steps required for an outcome
Skills/Resources	Pharmacists and technicians not practicing to the top of their license Employee ideas not evaluated and/or implemented

Methods to reduce such waste include streamlining, consolidating or eliminating tasks and/or workflow. Eliminating certain steps in a process can help reduce wastes such as motion, inventory and overproduction and help to improve quality and speed. Streamlining operations ensure there is less variability in the process through standardization. This is especially effective in reducing overprocessing and waiting associated wastes. Through consolidation, certain tasks can be done together reducing both motion and transportation associated wastes. Overall, any reduction in waste associated with time, can allow pharmacies to optimize their employee's skills and resources at the top of their licenses.

Previous literature supports the application of LEAN methodology in the pharmacy. Hinzten et al evaluated utilized LEAN techniques in order to improve workflow and eliminate waste in their inpatient pharmacy at the University of Minnesota Medical Center (UMMC).[2] The scope of the project was limited to the sterile products area. The goals of this process improvement project included the reduction of missing doses, errors and patent specific waste as well as the reallocation of technical staff. The impact of the

lean efforts at UMMC was that two FTEs were reallocated and $289,256 was found in cost savings through waste reduction and improved workflow.

St. Luke's Episcopal Hospital (SLEH) is a tertiary teaching hospital located within the Texas Medical Center in Houston, Texas with 864 licensed beds. It is home to the Texas Heart Institute which is consistently ranked one of the top ten heart hospitals in the nation. St. Luke's serves an adult population, specializing in acute and critical care.

The Department of Pharmacy at SLEH has a centralized drug distribution process where the majority of unit dose medications are available in automated dispensing cabinets (ADCs) on nursing units. The department has 70 technical staff, 88 automation areas and dispenses over 14,000 doses a day. In addition, it is the first hospital to fully implement tech-check-tech in the Texas Medical Center. Technicians complete a variety of value added tasks throughout the day which also contribute to non-value added tasks such as increasing the credit and return workload resulting in waste and decreased efficiency.[10] The pharmacy department has identified the central distribution process as an area for possible improvement.

Several factors have caused the pharmacy department to evaluate the technician workflow. First, the pharmacy department has experienced a reduction in technical staff which was not filled due to financial constraints. This caused the department to adjust the workflow schedule to complete the same assignments with fewer technicians. Second, SLEH has seen an increase in average daily census. St. Luke's has expanded various services such as transplant and neurology over the past couple of years. This has resulted in an increased patient volume and higher patient acuity. Lastly, the pharmacy

department has expanded services to four community emergency centers in the vicinity of Houston, TX. A technician has been assigned to deliver medications and refill Acudose machines at each center. This has also increased work load.

The use of LEAN Six Sigma techniques employed in the pharmacy department may result in the elimination/ consolidation of pharmacy technician tasks resulting in higher efficiency while maintaining the same level of quality. This purpose of this study was to analyze current pharmacy technician practices and evaluate whether there is an opportunity to optimize current distribution processes which ultimately affect patient care.

OBJECTIVES

The objective of this study was to utilize both time and motion studies and focus groups to identify opportunities for pharmacy technician workflow improvement. This was measured by reduction in time to task completion by position/assignment as well as volume metrics. The specific objectives of this study were as follows:

- Identify opportunities for streamlining pharmacy technician workflow
- Identify opportunities for eliminating or consolidating pharmacy technician tasks
- Evaluate impact of above opportunities on cycle time

HYPOTHESES

The null hypothesis is that there is no impact of workflow rearrangement and consolidation on cycle time. The alternative hypothesis is that this analysis will be impact workflow rearrangement and consolidation on cycle time.

METHODS

This study was conducted using LEAN Six Sigma methodology to identify opportunities for pharmacy technician workflow improvement. LEAN Six Sigma methodology allowed for a structured approach to increasing efficiency while reducing waste. The project was implemented in the following phases: Define the problem, measure the current problem, analyze the situation, improve the current process and control the project (Figure 1). All data was evaluated to assess what LEAN waste could be reduced. All time was measured and assessed as either value or non-value added time added to the task. Tools such as value stream mapping and the plan-do-check-act (PDCA) cycle were also utilized. A project charter (Appendix 1) and a brief proposal were created and submitted to the Department of Pharmacy. This project received full Institutional Review Board approval at SLEH and the University of Houston.

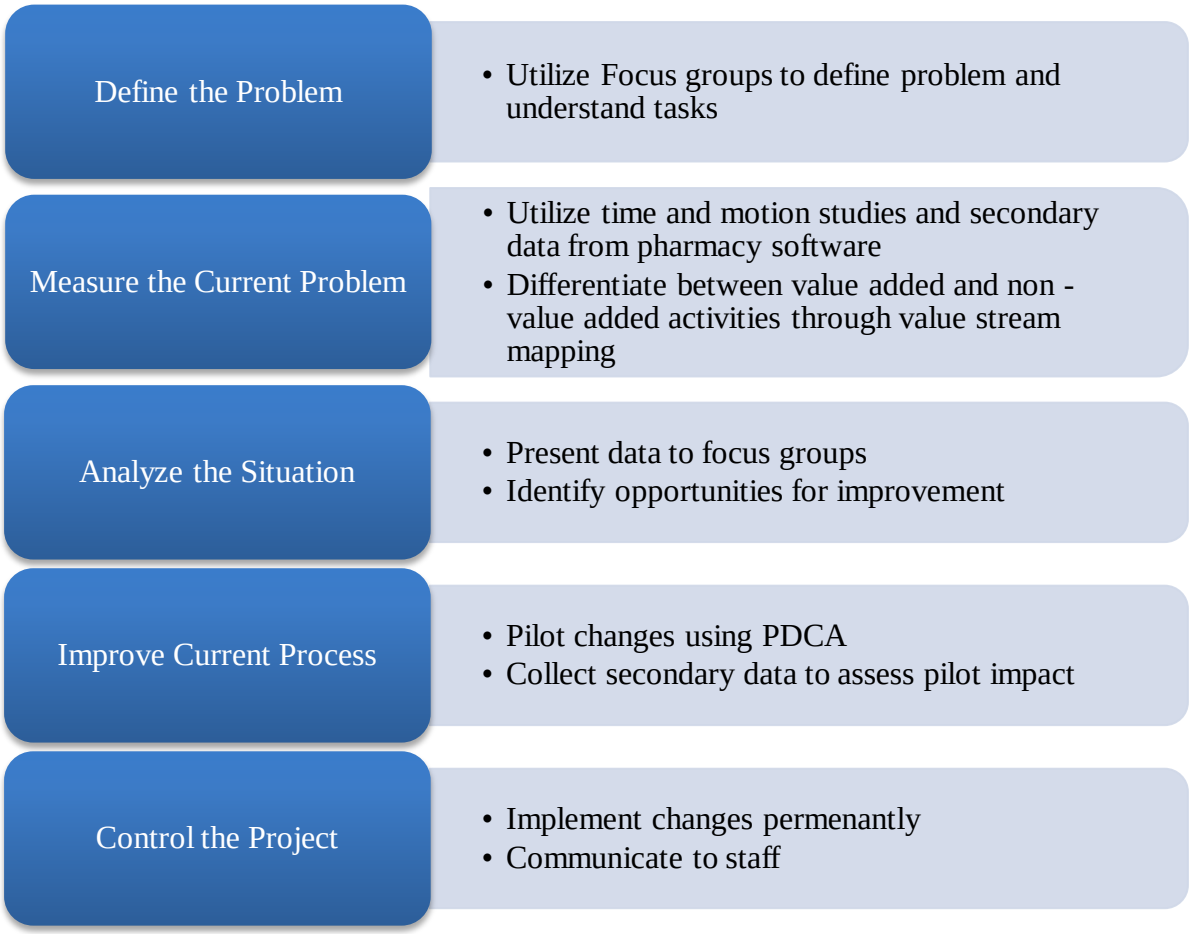
All data collection occurred in the pharmacy department by the primary investigator of this study. Data was collected via observational time studies and secondary pharmacy automated data. Secondary pharmacy automated data served as baseline data to help understand current workflow and as a comparison for any changes made during pilots. Four weeks of data available in the pharmacy software was collected and averaged over a 1 week period to serve as a baseline for any changes made. This included data such as number of medications assigned per unit and line items loaded. Direct observation studies collected the following information: Sequences of workflow steps, time (in seconds) for each step in the process and differentiate between non-value and value adding steps, workflow interruptions and detailed information regarding each workflow step

Time was separated in two categories: customer value added (CVA) or non-value added (NVA) time. CVA time was defined as any time producing an output the defined customer would find valuable. Pharmacy specific examples include medication delivery, entering patient orders, and medication preparation. NVA time was defined as any time associated with waste previously defined as TIMWOOD. These include activities associated with transportation, inventory, motion, waiting, overproduction, overprocessing and skills or human potential.

Observational time study subjects were enrolled in the time and motion study based on the shift they are working and availability after obtaining informed consent. In addition, these subjects had to be on a shift where the task identified as needed to improve was conducted. These subjects were chosen blindly at random.

Focus group subjects were included if they were a lead technician and available to participate. In addition, no subjects were enrolled if informed consent was not obtained. Supervisors' assisted in identifying lead technicians to be included in the focus group. The participants identified were sent an email regarding the study and an invite to participate. A focus group was established consisting of one manager, one morning shift supervisor and eight technicians. Informed consent was obtained and participation was voluntary with no impact on work status. All information would be summarized and de-identified.

Figure 1. Project Methodology and LEAN Six Sigma Application



Define the Problem

The first focus meeting introduced members of the focus group, established project purpose, expectations and ground rules. The primary investigator facilitated conversations and utilized probing techniques and open ended questions in a non-punitive fashion. A technician task list was also created in order to understand the potential opportunities for improvement (Table 2).

Table 2. Technician Core Tasks

Task
Ordered medications not loaded
Cabinet fill
Cart fill
Bulk delivery
Restocks
Returns and credits
Emergency Room crash carts
Deliveries
IV Deliveries
Bulk Bottle Repackaging
Cycle Counts

The focus group provided the opportunity to discuss various issues and concerns related to work activities. The activities that could be improved were identified as the following: Restocks, cycle counts, returns and credits and ordered medications not loaded. However, the focus group determined the process defined as ordered medications not loaded (OMNL) as the process which needed the most improvement and the focus of future meetings. OMNL is defined as a process by which technicians load medications with an active order in an automated dispensing cabinet (ADC). Any medications not loaded in the ADC are sent in the 24 hour nightly Cart Fill. OMNL consists of determining which medications to load, freeing up space in the ADC, loading the medication in the ADC and returning removed inventory to the pharmacy. This was the focus for pilot studies. For the purposes of this project, cycle times for OMNL were defined as the time from when the user begins an OMNL step and either moved to the next medication or the next OMNL step.

Per focus group meeting noted, the purpose of OMNL was established to be that the task reduces missing doses and allows patients and nurses to have access medications in a

timelier manner. Issues with the current process were that there is a high volume of line items associated with OMNL, lack of space in the ADC, Carousel restock is affected and many medications are repackaged for the sole purpose of OMNL. The purpose of OMNL was also related back to the voice of the customer (VOC) who was defined as patients, nurses, pharmacists and pharmacy management. Nursing and pharmacists appreciate OMNL because it reduces the need to look for doses by convenient medication placement in the ADC. Theoretically, patients are able to get their medications on time which increases patient satisfaction. Pharmacy management's goal is to have 85% of active medications available in the ADC. The loading of active orders for medications in the ADC helps achieve this goal.

Measure Current Problem

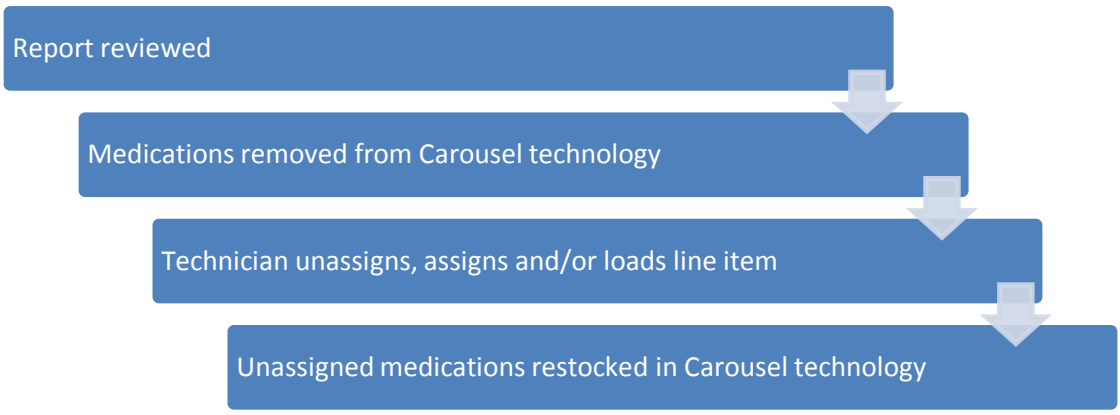
Data collected from secondary pharmacy automated data included the number of line items loaded in the ADC and frequency of administration of line items. The findings were analyzed descriptively. Five technicians were observed through time and motion studies. The times were recorded for various steps and were analyzed descriptively.

RESULTS

Analyze Current Situation

Observation data revealed that OMNL was conducted in the following steps: OMNL report reviewed to determine which medications to load, medications are removed from Carousel technology, technician goes to the floor to unassign, assign and/or load medications from the ADC, and medications are restocked in Carousel technology (Figure 2).

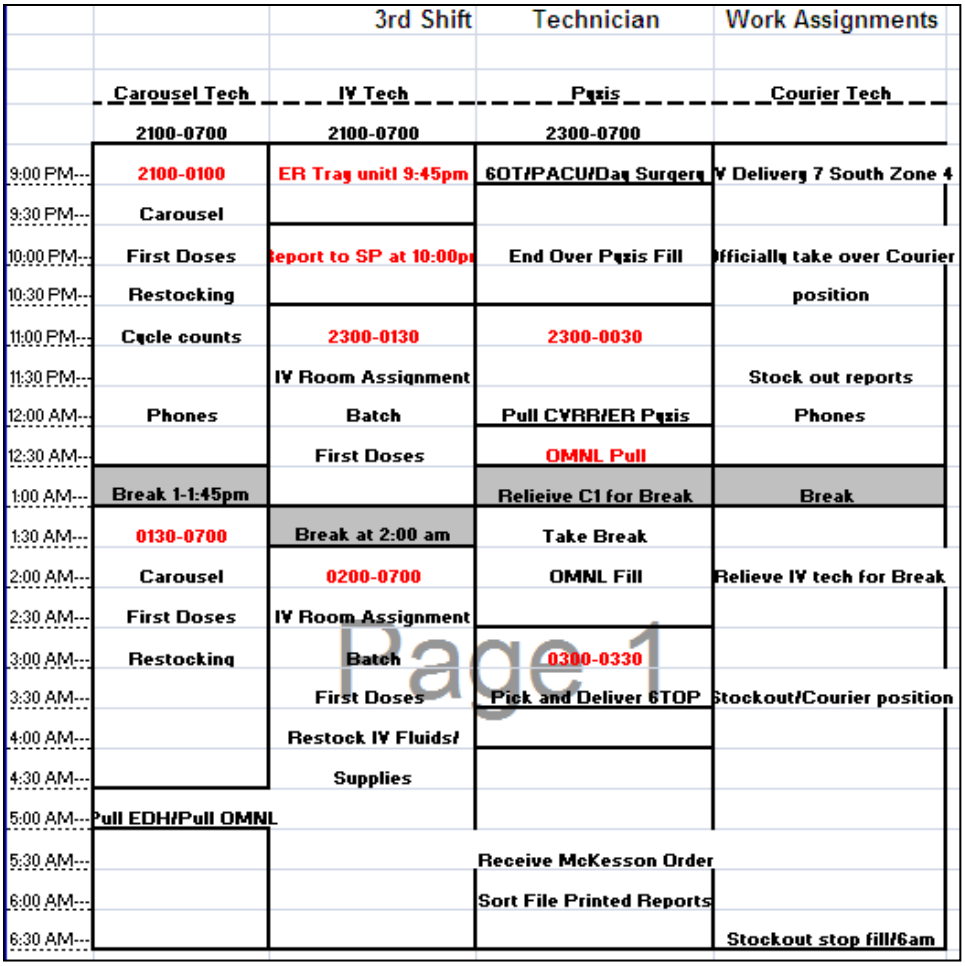
Figure 2. OMNL Steps



The work was primarily conducted during 1st and 2nd shifts at three different times. In addition, there were three variations in the OMNL process identified in regards to unassigning, assigning and loading of line items (Figure 3).

Figure 3. 1st and 3rd Shift Work Grid

	WEEKDAY	Technician	Work Assignments	Towers			
	C1 0630-1500	**PX1 0700-1530**	**PX2 0700-1530**	**PX3 0700-1530**	**PX4 0700-1530**	**C2 0700-1530**	**AUX 0700-1530**	**SWING 11-7:30**
6:00 AM								
6:30 AM	Get report from night							Mid Shift
7:00 AM	ER Trays	IV Delivery-Zone 2	IV Delivery-Zone 4	Deliver OMNL	IV Delivery-Zone 1	IV Delivery-Zone 3	Cover call in	
7:30 AM	1st doses, Stats	OMNL 16T-20T	OMNL for units	(Zone 2)	Credit returns	**Assist C1**	Assist C1	
8:00 AM	Batch Cabinet	Credit returns	Pull and Deliver	(23T-25T)		Start pulling manuals	ER trays	
8:30 AM	Zone 3	Pull and Deliver	Bulk-Zone 3		8:30-11:45		Package bulk liquids	
9:00 AM	Zone 1	Bulk-Zone1	**Deliver MEDS for**	Courier at 9AM	Pull & Deliver	**Deliver MEDS for all**	Stockouts	
9:30 AM		**Deliver MEDS for**	**3T, L & D, LDR,**	8:30-11:45	Zone 1	**areas on 6th Floor**	1st, Stats	
10:00 AM	Restock return meds	**ER's, PACU, & CV's**	**DS, and ENDO**	Pull and Deliver	Courier at 10AM		Batch Cabinet	
10:30 AM	in Med Carousel	**Stock Outs ZONE**	**Stock Outs ZONE 4**	Zone 1		Assist C1	Zones 3 & 4	
11:00 AM	Restock lists for all	IV Delivery-Zone 2	IV Delivery-Zone 4	7T, 9T, 10T, 12S	11T (2N, 4T, 6T		Restock	Courier 11A
11:30 AM	Radiology areas					11:00-11:45	Cartfill	IV Deliver Zone 1
12:00 PM	when Almetta off	**Lunch**		**Lunch**	**Lunch**	IV Delivery Zone-3		
12:30 PM	Pull OMNL	**12:30-1:15**	**Lunch**	**12:30P-1:15P**	**12:30P-1:15P**	**Assist C1**	Restock	**Credit C2's meds**
1:00 PM	**Lunch**	Courier at 1PM	**12:30-1:15**	Cover C1 Lunch	Cover C2 Lunch	**Lunch**	Pull OMNL	Bag meds, assist
1:30 PM	**1:30P-2:15P**	**Stock Outs**	**Stock Outs**	**Restock Med Carousel**	**Bag meds**	**1:15P-2P**	**Lunch**	pulling stockouts and
2:00 PM	Restock	**Zone 1 & 2**	**Zone 3 & 4**	**Unassign**	**Unassign**	**At 2PM Start**	**1:00-1:45**	cycle counts
2:30 PM	2:30-3:00	**Unassign, Assign,**	**Unassign, Assign,**	**12T,14T,15T**	**9T,10T,11T**	**Cycle Count**	**Cycle count**	Assign & Restock
3:00 PM	Clean Area/Sort Meds	**OMNL 6S1,6S2,6C,AOMNL 6CB,6CB1,7T**			**Cycle Count**	**Cycle Count**	**Cycle count**	Meds for Zone 1
3:30 PM		Return meds/sort	**Cycle Count**	Return meds/sort		**Crash Cart Area**	Clean Area/Sort Meds	**Lunch 3:30-4:15**
4:00 PM								



		3rd Shift	Technician	Work Assignments
	Carousel Tech	IV Tech	Pyxis	Courier Tech
	2100-0700	2100-0700	2300-0700	
9:00 PM	2100-0100	ER Tray until 9:45pm	6OT/PACU/Day Surgery	IV Delivery 7 South Zone 4
9:30 PM	Carousel			
10:00 PM	First Doses	Report to SP at 10:00pm	End Over Pyxis Fill	Officially take over Courier
10:30 PM	Restocking			position
11:00 PM	Cycle counts	2300-0130	2300-0030	
11:30 PM		IV Room Assignment		Stock out reports
12:00 AM	Phones	Batch	Pull CVRR/ER Pyxis	Phones
12:30 AM		First Doses	OMNL Pull	
1:00 AM	Break 1-1:45pm		Relieive C1 for Break	Break
1:30 AM	0130-0700	Break at 2:00 am	Take Break	
2:00 AM	Carousel	0200-0700	OMNL Fill	Relieve IV tech for Break
2:30 AM	First Doses	IV Room Assignment		
3:00 AM	Restocking	Batch	0300-0330	
3:30 AM		First Doses	Pick and Deliver 6TOP	Stockout/Courier position
4:00 AM		Restock IV Fluids/		
4:30 AM		Supplies		
5:00 AM	Pull EDH/Pull OMNL			
5:30 AM			Receive McKesson Order	
6:00 AM			Sort File Printed Reports	
6:30 AM				Stockout stop fill/6am

OMNL ADC activity is conducted in 3 steps in the afternoon on 1st shift. These included activities related to (1) unassign, (2) assign and/or (3) load medications from the ADC. Furthermore, the cycle times for OMNL were categorized as NVA and CVA. NVA activities included transportation time, wait time at the ADC and troubleshooting. CVA activities included unassigning, assigning and/or loading. The findings are presented in Figure 4. Overall, NVA time varied based on this variation accounts for 21.4% of floors led to a total NVA time 543 seconds per floor (Figure 4).

Figure 4. OMNL Value Stream Map in 3 Steps

OMNL in 3 Steps				
	Unassign	Assign	Load	TOTAL
CVA*	43.8s (±5.6)	20.9s (±5.1)	39.2s(±16.4)	103.9s
NVA*	*181s (±26)*	*181s(±26)*	*181s(±26)*	*543s*

*Time per line item

**Time per floor

OMNL ADC activity, which account for 60.7% of floors, is conducted in 2 steps. These steps include (1) unassign and assign and (2) load medications which led to a total NVA time of 325 seconds per floor. For this variation, it was found the unassigning and assigning only occurs during 3rd shift. Important to note is that there were no workflow interruptions on third shift by nursing and elevators were more accessible at this time resulting in a lower NVA time during 3rd shift (Figure 5).

Figure 5. OMNL Value Stream Map in 2 Steps

OMNL in 2 Steps			
	Unassign and Assign	Load	TOTAL
CVA*	64.7s (±7.8)	39.2s (±16.4)	103.9s
NVA*	*144s(±65.2)*	*181s(±26)*	*325s*

*Time per line item

**Time per floor

OMNL ADC activity is conducted in one step for 17.9% of floors on 1st shift. This one step process included activities related to unassign, assign and loading medications. This process led to a total NVA time 156 seconds per floor (Figure 6). This variation is most effective from the standpoint that it is associated with the lowest overall NVA time per floor.

Figure 6. OMNL Value Stream Map in 1 Step

OMNL in 1 Steps		
	Unassign, Assign and Load	TOTAL
CVA*	124.4s (±7)	124.4s
NVA*	*156s(±90)*	*156s*

*Time per line item

**Time per floor

After reviewing secondary data available in the pharmacy software, on average, 1096 (±80.9) line items were being loaded in the ADC's weekly. Using this information in conjunction with the time studies, it was estimated that 55.2 hours were spent on CVA and 14.3 hours on NVA. This resulted in a total of 69.5 estimated hours being spent on OMNL weekly (Table 3).

Table 3. Estimated pre-pilot Time Spent on OMNL Weekly

	CVA	NVA	Total Time
3 Steps	12.6 hours	6.3 hours	18.9 hours
2 Steps	34.4 hours	6.5 hours	40.9 hours
1 Step	8.2 hours	1.5 hours	9.7 hours
Overall Time	55.2 hours	14.3 hours	69.5 hours

The OMNL reports were reviewed in order to determine the administration frequency of loaded line items. A review of the frequency of administration of line items loaded revealed the following estimated frequency: Daily (58$\pm$8.7%), twice daily (BID) (25.9$\pm$5.9%)), three times daily (TID) (12.8$\pm$3.4%), four times daily (QID) (2.8$\pm$0.83%) and six times daily (Q4H) (0.5%).

SLEH pharmacy protocol is that for daily frequency line items, 10 unit dose items will be the minimum quantity loaded in the ADC. Line items with more frequent scheduled administrations will have a minimum of 20 line items loaded in the ADC. Using the minimum quantity loaded, the average frequency and number of line items loaded, approximately 15,560 unit doses are dispensed to the floor weekly (Table 4).

Table 4. Estimated pre-pilot OMNL dose frequency and inventory assessment

Frequency	Number of doses	Percentage	Estimated unit dose medications dispensed
Daily*	636	58% (±8.7%)	6360
BID**	284	25.9% (±5.9%)	5680
TID**	140	12.8% (±3.4%)	2800
QID**	31	2.8% (±0.83%)	620
Q4H**	5	0.5%	100
		TOTAL	**15,560**

*Assumes 10 units loaded per line item

** Assumes 20 units loaded per line item

An active order for a line item ranges from 1 to 3.5 days. In addition, there are two ADC's on each unit that are mirrored. Hence, 1 active line item would be loaded twice per floor. Using this information, it can be assumed that a minimum of 20 unit dose medications are loaded on one floor for a daily frequency line item and that a patient would only utilize 1 to 4 unit doses of the 20 unit doses in the ADC.

Improve Current Process: Focus group Input

Observational and secondary data were presented to the focus group and the focus group was asked to formulate a solution to improve the process. The focus group decided to initially focus on consolidating OMNL to 1 step. As the NVA time was lowest on 3rd shift, the focus group decided to pilot consolidating the loading of OMNL to 3rd shift. It was determined technician assignment, PX2, would be the pilot assignment as they had

the most responsibilities in comparison to other assignments between the time periods of 7-9AM. In addition, there was a desire to reduce the need to access the ADC between 7 and 9AM as nursing needed access to morning medications at this time.

Improve Current Process: Changes in OMNL

The PX4 pilot change was successful and 3rd shift was able to handle the additional workload. The focus group concluded that they were able to save time and have technicians return to the pharmacy to assist with the batch more quickly. In addition, there were less workflow interruptions at the ADC. It was concluded this consolidation should apply to all floors.

At this time the focus group also explored the option of eliminating aspects of OMNL. Any line items not loaded as a part of OMNL is sent in the nightly 24 hour Cart Fill. This CVA activity offers the same value, is less time consuming, hand delivered but easily misplaced on the patient care unit as it is not in the ADC but in the medication room. As daily frequency line items account for more than 50% of OMNL, a recommendation to eliminate loading daily frequency line items and move this to the Cart Fill was made. Nursing was consulted at the management level and supported reducing OMNL. This would allow for more space in the ADC and allow for the loading of PRN medications.

Baseline observational time study data conducted pre-pilot was utilized for post-pilot CVA and NVA time estimates associated with OMNL line items. The elimination of daily frequency line items reduced the number of line items a part of OMNL to 460 (± 47.8) line items (estimated 57% decrease). The elimination did increase the Cart Fill from 560 to 619 line items on average (estimated 10% increase) which resulted in an additional

1.7 hours of work weekly. Using the pre-pilot line item frequency data, the estimated decrease in inventory dispensed for OMNL is 5,640 unit doses or 36% (Table 5).

Table 5. Estimated post-pilot OMNL dose frequency and inventory assessment

Frequency	Number of doses	Percentage	Unit dose medications dispensed
Daily	0	0%	0
BID	288	61.7%	5760
TID	142	30.4%	2840
QID	31	6.7%	1220
Q4H	5	1.2%	100
		TOTAL	9,920

This estimated decrease in volume allowed for the consolidation of all OMNL steps between the hours of 7-9AM to 3rd shift. It also allowed for the consolidation of OMNL from the auxiliary and swing shift to two other technician assignments on 1st shift in the afternoon. Overall time savings post-pilot was estimated 33.6 hours weekly, or 1,747 hours annually (Table 6).

Table 6. Estimated post-pilot Time Spent on OMNL Weekly

	Pre-pilot	Pilot	Time Change	Percent Change
CVA: OMNL	55.2 hours	25.8 hours	-29.4 hours	-53%
NVA	14.3 hours	8.4 hours	-5.9 hours	-41.2%
CVA: Cart fill	16.3 hours	18 hours	+1.7 hours	+10%
TOTAL Time	85.8 hours	52.2 hours	33.3 hours	-39.1%

Controlling the Process

The pilot results were presented to the Operations Leadership meeting and to the focus group where these changes were approved to be permanent. These changes were communicated to technical staff through staff meetings and email. The investigator collaborated with the lead technicians and dayshift supervisor in order to make these changes on the work grid. (Figure 7).

The project was closed and handed over to the pharmacy operations manager. While tracking project impact, it was found that the Cart Fill increase was negatively affecting Cart Fill cycle time. Recommendations to analyze the Cart Fill contents were made. In addition, a recommendation for future consolidation of OMNL on first shift with batch refill was made in order to further reduce waste associated with transportation.

Figure 7. Post-Pilot 1st Shift Work Grid

	WEEKDAY	Technician	Work Assignments	Towers		
PX2	PX3	PX4	C2	AUX	SWING	DCT Swing
0700-1530	0700-1530	0700-1530	0700-1530	0700-1530	11-7:30	
For all IV delivery zones at 7AM check SPP for IVs					Mid Shift	
IV Delivery-Zone 4	Assist C1	IV Delivery-Zone 1	IV Delivery-Zone 3	Cover call in		
Pull and Deliver	ER Trays	Credit returns	Assist C1	Assist C1		
Bulk-Zone 3	Courier at 8AM		Start pulling manuals	ER trays		
		8:30-11:45		Package bulk liquids		
Deliver MEDS for 3T, L & D, LDR, DS, and ENDO	Courier at 9AM	Pull & Deliver	Deliver MEDS for all	Stockouts		IV Delivery Zone 1
	8:30-11:45	Zone 1	areas on 6th Floor	1st, Stats	Med Restock Zone 3	Credits
	Pull and Deliver	Courier at 10AM		Batch Cabinet		Fill in for call in
Stock Outs ZONE 4	Zone 1		Assist C1	Zones 3 & 4	Courier 1PM	Courier at 2PM
IV Delivery-Zone 4	7T, 9T, 10T, 12S	11T 12N, 14T, 15T		Restock	Credit C2's meds	PCU Inspections
			11:00-11:45	Cartfill	Bag meds, assist	and Audits
	Lunch	Lunch	IV Delivery Dialysis bags		pulling stockouts and	Fill in for
Lunch	12:30P-1:15P	12:30P-1:15P	Assist C1	Restock	Restock Day Surgery	second shift call in
12:30-1:15	Cover C1 Lunch	Cover C2 Lunch	Lunch	Pull OMNL	cycle counts	
Stock Outs	Restock Med Carousel	Bag meds	1:15P-2P	Lunch	QA Refrigrators	
Zone 3 & 4	Assign, Unassign	Assign, Unassign	At 2PM Start	1:00-1:45	Meds for Zone 1	
Unassign, Assign,	OMNL 12T,14T,15T	OMNL 9T,10T,11T	Cycle Count	Cycle count	Lunch 3:30-4:15	
OMNL 6CB,6CB1,7T		Cycle Count	Cycle Count	Cycle count		
Cycle Count	Return meds/sort		Crash Cart Area	Clean Area/Sort Meds		

DISCUSSION AND CONCLUSIONS

The results of this research demonstrate the successful application of Continuous Quality Improvement (CQI) and LEAN Six Sigma principles to pharmacy technician workflow. This study utilized key concepts of Continuous Quality Improvement elements which allowed for the success of this project.

The role of technicians in health-system pharmacy is rapidly expanding to allow for technicians shoulder more responsibility, allowing for the optimization of the role of pharmacists. The SLEH Department of Pharmacy mission is "To provide and advance patient care through collaboration, continual optimization of pharmacy services, research and education." Using this strategic focus, the time saved through the improved OMNL workflow, allowed technicians to expand tech-check-tech responsibilities during the day shift. This has freed up pharmacist time to provide more clinically focused patient care.

This study also utilized data driven analysis based on objective data through the pharmacy software. This observation methodology was able to accurately assess the impact changes of streamlining, eliminating and consolidating OMNL by using this information. In addition, there was a focus on the identified customers by separating the data by NVA and CVA time based on the voice of the customer. This study was also able to assess the impact of the changes on NVA and CVA time.

Management commitment was crucial in order for this project to succeed. The members of the focus group were aware that management supported this project and were willing to provide the time to technicians to meet and discuss this project.

The focus group was the reason for the success of this project as they were the performance improvement team. By including those considered the front line workers of OMNL, an in depth understanding of the process was established. Although the primary investigator collected the data, the data was presented to the focus group to identify the opportunities to improve. In addition, employees were engaged throughout the process and felt ownership in the changes that were implemented. Several solutions were identified to improve workflow using value stream maps and flow charts: consolidate and streamline OMNL into one step and eliminate loading daily frequency line items. These improvements were made while still ensuring that customer needs would be met.

Although not all wastes were directly measured, this study reduced the following wastes: Transportation, inventory, motion, waiting, overproduction, over processing and skills/resources (Table 7).

Table 7. Waste Reduced

Waste Reduced	**Method**
Transportation	Reduced need to go to the floor through consolidation of OMNL steps
Inventory	Reduced amount of inventory placed in the ADC
Motion	Reduced inventory pull and return to and from Carousel
Waiting	Reduced waiting time for elevators Reduced need to wait for another technician to complete task when completing OMNL in > 1 step
Overproduction	Reduced amount of inventory requiring repackaging for placement in ADC
Over Processing	Reduced labor associated with inventory repackaging
Skills/Resources	Optimized technician labor in quality assurance checks, 8AM courier run and tech-check-tech

Previous literature has demonstrated the value of LEAN applications in the hospital. Serrano et al demonstrated the application of LEAN principles in order to reduce turnaround time and increase efficiency in histology and anatomic pathology.[2] The study used LEAN concepts such as observational studies, VSM, flow charting, spaghetti diagram, listening to the VOC and single piece flow in order to increase customer satisfaction, increase turnaround time by 67% and eliminating waste. Hinzten et al were able to apply LEAN methodology to the sterile products area of the pharmacy department. [1] The LEAN project reduced waste and allowed for the reallocation of technical staff.

The project findings are similar to the above studies. This project reduced waste through tools such as VSM, observational time studies, flow-charting and data driven analysis. The amount of inventory that required repackaging or that was placed in the ADCs was reduced by 5,640 unit doses weekly. In conjunction with improving technician satisfaction, the time savings post-pilot was estimated at 33.6 hours weekly, or 1,747 hours annually. Operationally, the pharmacy was able to become more efficient in the process defined as OMNL, improve customer satisfaction and allow for reallocation of technicians to other duties such as tech-check-tech and more quality assurance checks.

The selection of the technicians for the focus group was important for successful implementation of this project. Engagement and support from front line lead technicians was crucial. The technicians in the focus group suggested the pilot changes and helped implement the pilots on their respective shifts. Post-pilot feedback was important for understanding the impact of the changes to overall workflow. In addition, management support for analyzing technician workflow helped support and implement these changes.

There are several limitations to this study. When applying LEAN principles, there is normally one voice of the customer. However, this study used multiples voices of the customer which underestimates what would be defined as waste from the sole customer's viewpoint. This study only evaluated waste in terms of transportation waste. However, the study did reduce inventory, overprocessing and labor costs associated with repackaging which were not taken into account for the purpose of this project. The NVA time was calculated per floor and it was assumed that there would be a delivery every day. However, post-pilot, there were some floors which had less than 7 line items over a one week period. This would overestimate the NVA time for that floor.

Technicians who took part in the observational time studies may be subject to the Hawthorne Effect. This is important as the data which served as baseline information is based off of these observational time studies. In addition, time savings may vary from technician to technician. Lastly, other projects in the department may impact some of the automated information collected from pharmacy software. Drug shortages have caused technicians to unassign, assign and load medications based on drug availability. Another project which may impact this data is separate optimization projects resulting in the unassigning of medications. This project results in free real estate in the ADC where a technician would not have to unassign when at the ADC during OMNL. For the purpose of this project, it was assumed all ADC's were not optimized.

The application of Lean Six Sigma can improve operational workflow of pharmacy technicians as well as reduce waste as seen in this study. These principles of CQI and Six Sigma Lean should continue to be applied in pharmacy departments to identify further opportunities for workflow improvement and reduction in waste. The study found that

LEAN Six Sigma application at SLEH found a 33.6 hour reduction in time spent on OMNL and a reduction in 5,640 unit doses placed in the ADC per week. Future studies are needed to continually monitor and evaluate progress and other ramification including any collateral damage.

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Appendix 1. Project Charter: Technician Workflow Analysis

Date:	August 29, 2011
Project Type: KZ, BB, PI	Process Improvement
Primary Metric	Primary Productivity metric: Reduction in time to task completion by position/assignment Secondary Productivity metrics: ordered medications not loaded, charges, credits
Created By:	Amrita Chabria, PharmD
Accepted By:	Joseph Greco, RPh; Divya Abraham, PharmD, MS
Financial Impact Estimate:	N/A
Problem / Opportunity Statement:	The pharmacy department has experienced a reduction in technician labor resulting in a decreased labor pool for the same amount of work. The workload has increased.
Business Impact	The impact of analyzing technician workflow may result in the elimination and/or consolidation of tasks. It may also result in reducing cycle time affecting overall efficiency.
Project Objectives	Using focus groups to analyze workflow, streamline workflow as well as eliminate/consolidate tasks resulting in an increase in efficiency.
Scope	All work grids will be analyzed; Changes will be focused on weekday dayshift
System for measuring defect	The defect is the change in workload per a technician. A time study will be conducted in order to design a time-based process map prior to implementing any changes.
Customer / Beneficiary	Technicians, Pharmacists, Management, Nursing and Patients
Team Selection	Teams will be selected by study team
Dependencies:	Technician Labor

Project Attractiveness:	Item Impact (1-9)	Impact Weight	Score
Financial Impact	1	1	1

Alignment with Strategy	9	5	45
Management commitment	9	5	45
Urgency	5	5	25
Total Score-→	----------24-------	----------	111
Ease of Completion	Item Impact (1-9)	Impact Weight	Score
Time to Complete	4	1.5	6
Resource availability	9	1	9
Technology	6	1	6
Risk	4	1	4
Total Score →	----------11--------	----------	25
Strategic Alignment	The pharmacy department vision is to advance pharmacy best practices through collaboration, continual optimization of pharmacy services, research and education. This project will analyze current practices and evaluate whether there is opportunity to optimize current distribution processes which ultimately affects patient care.		