Applicant Organization: Children's Hospital of Pittsburgh of UPMC
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Menu Item: Dashboards and Analytics

Hospital National Patient Safety Goals	Select all that apply
▪ Improve accuracy of patient identification	√
▪ Improve the effectiveness of communication among caregivers	√
▪ Improve the safety of using medications	√
▪ Reduce the risk of healthcare associated infections	
▪ Identify safety risks inherent in the patient population	√
▪ Prevent wrong site, wrong patient, wrong person surgery	√

National Priorities Partnership Goals	Select all that apply
▪ Engage patients and families in managing health and making decisions about care	
▪ Improve health of the population	
▪ Ensure patients receive well-coordinated care across all providers, settings and levels of care	√
▪ Safety: improve liability and eliminate errors wherever and whenever possible	√
▪ Compassionate palliative and end-of-life care	
▪ Remove waste and achieve effective, affordable care	√

Executive Summary

Children's Hospital of Pittsburgh of UPMC (CHP) built a new facility that had a much larger footprint than the original hospital. The new hospital pharmacy location required a longer commute to the inpatient units to deliver medications. At the original hospital, the Pharmacy Technicians would deliver medications every hour, return to the department, and then begin to prepare the next orders. Realizing that the larger hospital space would require a new approach, the pharmacy developed a strategy for medication safety. The strategy included the following areas developed to control the medication processes:

1. **Patients receive the correct medications** – Implemented Positive Patient ID (PPID) to identify a patient and the patient's orders. Prepared medications are labeled with a barcode that indicates the patient's medication order.
2. **Patients receive medications on time** – Implemented a customized medication tracking system to track pharmacy orders from order to delivery. RFID (Radio Frequency Identification) tracking to locate infusion pumps.

The Med Tracking system provides insight and transparency into medication delivery practices. This has improved delivery methods by decreasing turnaround times and evidences a reduction in missing doses. In addition, waste has been reduced, and employee time is used more effectively. The system also compiles the data needed to investigate the root cause of delay and waste.

The RFID technology is used to track the location of infusion pumps. Pumps are housed in "clean" or "dirty" areas and it is easy for the Biomedical Equipment Team to identify when pumps need to be collected for cleaning by reviewing the electronic map of the hospital and looking for the red dots on the screen that indicate the location in a dirty area.

3. **Automation and equipment to support medication safety** – Pyxis med stations, cubies, Medication carts with locked drawers, and RFID refrigerator/freezer temperature monitoring. Finally, "Talking Boxes" are used to aid clinicians and pharmacy to automate medication safety.

   Aeroscout's RFID technology is used to electronically monitor the temperature of the refrigerators and freezers throughout the hospital. This data was previously collected manually at least once a day, logged, and reviewed.

   CHP's "talking boxes" are a unique tool to warn pharmacy workers and nurses of the dangers of certain medications. Meds that look alike, sound alike, or require special considerations provide potential areas for error.

Background knowledge

Renowned for its outstanding clinical services, research programs and medical education, CHP has helped establish the standards of excellence in pediatric care. From primary care, Emergency and Acute Care to Ambulatory, including Transplantation and Cardiac Care, talented and committed pediatric experts care for infants, children and adolescents who make over 1,000,000 visits to CHP each year.

CHP is the only hospital in southwestern Pennsylvania dedicated solely to the care of infants, children and adolescents. Care is provided by more than 700 board-certified pediatricians and pediatric specialists. CHP also provides primary care and specialty care at over 30 locations throughout the Pittsburgh region, as well as clinical specialty services throughout Western Pennsylvania at regional health care facilities. Children's is ranked among the U.S. News & World Report's 2013-2014 Best Children's Hospitals Honor Roll and is ranked in all ten of the evaluated specialties.

CHP leads the way in advanced technology as the first pediatric hospital in the country to achieve Stage 7 recognition from HIMSS Analytics for its electronic medical record and has been recognized by KLAS, an independent health care research organization, as the number one pediatric hospital in its use of health care information technology.

Certified Physician Order Entry (CPOE) at CHP began in 2002 with medication orders being incorporated in 2004. Today, the pharmacy dispenses over 1.3 million doses, and 65% of those doses are manually prepared (e.g. specific oral or injectable doses drawn up in syringes) by the pharmacy staff of 140 employees. The percentage of doses manually prepared is typically much higher in a pediatric institution. This requires the staff to prioritize their workload in order to meet organizational expectations.

Local problem being addressed and Intended Improvement

The medication safety strategy was a compilation of several individual projects in an ongoing effort to improve the quality of pharmacy services and increase patient medication safety.

Patient medication safety was addressed in conjunction with planning for a move to a new hospital facility that was 1.5 million square feet and significantly larger than the original facility. The pharmacy footprint tripled in size, and the number of pharmacy medication cabinets doubled. It became apparent in the planning that the original method of Pharmacy Technicians preparing and delivering meds would not be effective. The strategy focused on the following areas:

Patients receive the correct medication: When assessing the root cause of medication errors, we identified two common issues.

- There are mistakes in identifying the medicine and remembering special cautions – this can be an issue for the pharmacy staff and for the clinical staff. Medications are look-alike and sound-alike, and it is easy to confuse these drugs. Also, some medications have inherent dangers in administration, and it is easy to overlook the dangers and special needs in administration of the medicine. "Talking Boxes" were created to warn pharmacy staff and clinicians to dangers.
- There are mistakes in administering the medication. It is easy to mistake the patient or the medication without an automated tool to verify. PPID was implemented as the solution to verify patients with the medications ordered.

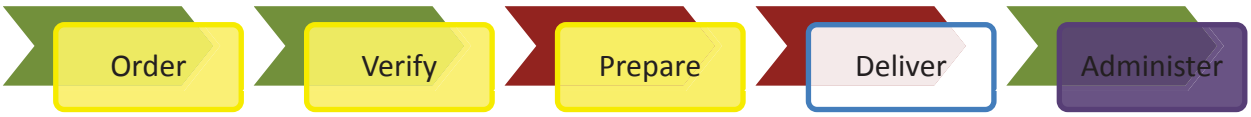
On-time Medication: Almost 1/3 of all doses are ordered stat, which equates to the need for over 1188 stat doses per day to be prepared and delivered within 30 minutes.

The intra-hospital vacuum tube system was utilized to send medications initially; however, the missing medication issue continued. The drugs arrived at the nurse's station timely, but the drug was not tracked to the exact location on the floor (drug cabinet, drawer, med cart, person, etc.), so the medication appeared to be lost.

There were significant issues with missing medications that interrupted the flow of the pharmacy. On average, there were 324 missing medications every week where the dose needed to be prepared twice, resulting in increased med costs and lost time (in preparation, searching, and delivery).

The Cerner EHR (Electronic Health Record) system at CHP is only able to timestamp a medication when it is ordered, verified by a pharmacist and administered by a nurse. The red arrows in Figure 1 below to identify where there was no tracking in the EHR medication process between verify and administer. The purple blocks show where the nurse could view the medication process, and the yellow blocks show where the pharmacist could view the medication process. Management had no visibility to the real-time process.

Figure 1



Due to the gaps in tracking, the CHP pharmacy received approximately 50 calls daily from nursing units when they were unable to locate a medication for a patient. Neither the pharmacy nor the nurse could determine when or where the medication was delivered. The pharmacy and the clinicians spent valuable time trying to locate medications within the pharmacy or in the nursing units. As patients transfer to different rooms, the medications that were in route had the potential to be delivered to a wrong location. In many cases, the pharmacy was forced to prepare the missing dose again to avoid excessive administration delays.

It was a chronic problem that infusion pumps were difficult to find. Often there are not enough pumps on a floor available for use. They may be waiting for cleaning. RFID tags for infusion pumps were implemented to track infusion pumps when they are clean, dirty, and in-use. The system presents a facility map with dots to indicate the room where the RFID-tagged device is located. With an accurate map showing which pumps are in clean rooms, dirty rooms, or in use, the Biomedical team is able to effectively evaluate when pumps are available for cleaning and which floors need additional pumps. The system is also viewable from the nurse's stations so nurses and technicians are able to easily locate devices.

Automating Refrigerator/Freezer Monitoring: A manual process that was automated included monitoring refrigerators and freezers.

Refrigerator monitoring must occur at least daily, recorded, and documented. The documentation must be reviewed to ensure completeness. This is a simple but onerous task that was resolved with an RFID solution for temperature monitoring that allows centralized monitoring and automated alerting of issues. Manually performing this task resulted in missed monitoring (or missing documentation of monitoring) and did not timely identify when refrigerator/freezer doors were not completely shut or the unit failed, which could result in lost inventory.

Design and Implementation

The pharmacy created a new job position called the Medication Delivery Assistant (MDA) because of the new larger footprint of the hospital. The Medication Delivery Assistant's responsibility is to deliver medications to one floor of the hospital. This process has resulted in meaningful relationships between the MDA's and the inpatient staff, and it provides a single point of medication issue resolution for clinicians. The MDA's carry Wi-Fi phones and are "on call" for their floor.

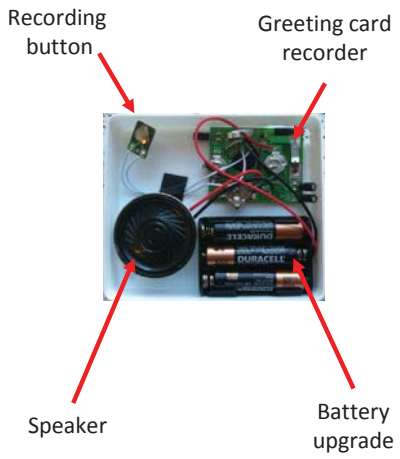
This was a change from the smaller original hospital when a Pharmacy Technicians delivered the prepared medications hourly, which also interrupted their work. This also did not meet the needs of stat medication delivery. Management identified that Technicians would spend much more time delivering instead of preparing medications, so they decided that the MDA position was warranted.

The pharmacy also created a hospital policy on medication delivery. This established the Pharmacy service level agreement that stat drugs would be delivered within 30 minutes and routine drugs would be delivered within 120 minutes. This set expectations with the clinicians and pharmacy to work within these parameters.

Patients receive the correct medication: "Talking Boxes" were designed at CHP (See Figure 1). A talking box is a clear acrylic box with a pre-recorded warning that sounds when the door to the box is raised. It works similarly to a greeting card that plays music when it is opened. It was developed to introduce another sense (hearing) into the drug picking process. On the inpatient units, one example of the safety use for the talking box is with Heparin where extreme caution is required to avoid medication error. In the pharmacy, dangerous pills that are look-alike or sound-alike are housed in the boxes to warn the staff of potential danger. Examples of the messages:

- "For Intrathecal use only! Pediatric Gentamicin 20 mg per 2 ml."
- "Potassium Chloride 2 mEq/ml vial. Dilute prior to dispensing!"
- "Acetadote! Must keep at least 8 on hand at all times."

Figure 1



Positive Patient ID was implemented in 2008. With this technology, all meds are labeled with a barcode that tie to the medication order in the EHR. The Patient wristband has a barcode to identify the patient in the EHR. Validating the two barcodes ensures that the med prepared for that patient is tied to the physician order, thereby reducing human error in the medication dispensing process. Clinical informatics uses reports to verify the use of PPID and ensure compliance. See Figure 2.

Figure 2

Medication Delivery Tracking: The idea behind the medication delivery tracking system is similar to how UPS tracks packages from package check-in to delivery in real time. The pharmacy tracking system is built to track medication after the pharmacist's verify step to delivery.

The pharmacy uses the system to locate medications to determine if the dose is still in the pharmacy or already delivered to the unit. The previous missing dose rate was measured to be 1.02%, which equates to approximately 7,300 doses annually.

By developing the software to report not only the time and location of each medication delivery, but to give the pharmacy a "running lapse" time, the pharmacy is able to respond to medication orders that have the potential for delay. The hospital's medication turnaround time expectation was established to be 30 minutes for "stat" orders and 120 minutes for "routine" orders (time from order to delivery). This was a change from the Pharmacy Technicians hourly delivery where all meds were treated with the same urgency.

A team of pharmacy and IT professionals were pulled together to review the pharmacy director's vision for a medication tracking system, and the system was developed with in-house talent. His vision was to eliminate or reduce medication delays before they happened. The system was created with in-house resources and a consultant familiar with Android technology for the handheld devices. The system uses the order ID barcode generated from the EHR when the order is placed. This barcode is the same barcode used for positive patient identification (PPID). By using the same barcode that nurses use, the

pharmacy is performing a verification check that the barcode is readable. This enables a higher achievement in PPID reporting scores. Nurses benefit by achieving improved barcode compliance rates that are reflected in management's weekly PPID reports.

Each potential medication delivery location is barcoded. This includes the Automated Dispensing Cabinets (ADC) and individual medication cart drawers. Deliveries handed directly to a nurse can be tracked by scanning the barcode on the clinician's ID badge. This final location barcode scan completes the tracking cycle.

The tracking system project was broken down into three major technical initiatives; 1) mobile application development; 2) EHR interface with backend database; 3) dashboards and reports.

1.) A mobile application was developed using the same device used by nursing staff when administering medications. The application is simple to use and captures key information for tracking. The Medication Delivery Assistant (the pharmacy delivery person) logs into the application by scanning the barcode on their ID badge. Once they arrive at the delivery location, they scan the order ID barcode on the medication(s) label, and then scan the barcode on the delivery location (or staff member's ID badge if delivering to a nurse). The delivery transactions are transferred to a database that links the destination data to the original order.
2.) A new HL7 interface was built between the EHR and the tracking system. This interface sends medication orders outbound from the EHR into the tracking system. The pharmacy and developer reviewed all information received on the interface message to ensure that the key fields to properly identify the order date, priority, drug description, and dispense category were included. The messages from the EHR are then linked to the messages from the mobile application to complete the delivery picture.
3.) The final step was to develop reports that can be used for both delivery tracking and workload prioritization. An intranet reporting tool was developed that provides two main dashboards for pharmacy.

*Note – Medications not affixed with a Cerner label and barcode are not able to be fully tracked through this system. There is no EHR order ID barcode generated for these medications. The only barcode available for scanning is the manufacturer's barcode which does not link back to the order ID. Incorporation of NDC (National Drug Code) deliveries is planned in the EHR's plans for the next upgrade.

See Figure 3 for an example of the equipment used in the Medication Tracking system.

Figure 3

Overview of the Pharmacy Tracking Dashboards

Figure 4 displays the "delivered medication" dashboard that allows pharmacy users to view all information about delivered medications. If a nursing unit calls because they cannot locate a medication, the pharmacy is able to easily identify its location.

Figure 4

Options	PatientName	POC	Room	Priority	RxDrugDescription	Duration	DlvrByName	DlvrTo	DlvrDate	DlvrByID	OrderDate	Type
View		7B	0730	STAT	tacrolimus oral susp 0.5 mg / 1 ml oral susp PO ONCE	**37**	Jackson, Ron	730	02/12/2014 11:42	640010918	02/12/2014 11:05	Initial Doses
View		7B	0730	STAT	tacrolimus oral susp 0.5 mg / 1 ml oral susp PO ONCE	**36**	Jackson, Ron	730	02/12/2014 11:41	640010918	02/12/2014 11:05	Initial Doses
View		Emergency Dept		STAT	azithromycin 200 mg / 5 ml oral susp PO ONCE	**17**	Boarts, Sarah	Tubed from Pharmacy	02/12/2014 11:41	640024625	02/12/2014 11:24	Initial Doses
View		NICU	0861	Routine	palivizumab inj 73.2 mg/ 0.73 ml inj IM ONCE	**68**	nelson , toshia	NICU_8784C Pyxis CareTeam Station 5	02/12/2014 11:38	000134979	02/12/2014 10:30	Initial Doses
View		NICU	0849	Routine	Sodium Chloride 0.2% inj + heparin 100 units/ml inj IV 1 ml/hr	**54**	nelson , toshia	000134979	02/12/2014 11:36	000134979	02/12/2014 10:42	Initial Doses

Figure 5 displays the "pending deliveries" dashboard. This dashboard is used by the pharmacy to prioritize the workload so that patients receive medications timely. The dashboard lists the medications by priority. Stat orders appear at the top of the dashboard and the font will change to bold red when the specified time has elapsed. This dashboard has changed how the department operates to meet the needs of the patients.

Figure 5

Options	Duration	PatientName	POC	Room	Priority	Type	RxDrugDescription	OrderDate
View Ignore	37		8A	0811	STAT	Initial Doses	furoSEMIDE inj 20 mg / 2 ml inj IV ONCE	02/12/2014 11:27
View Ignore	2		CICU	0410	STAT	Initial Doses	albumin 5% inj 0.75 g / 15 ml inj IV *ONCE	02/12/2014 12:02
View Ignore	63		6B	0642	Routine	Initial Doses	cefoxitin inj 202 mg/ 2.02 ml inj IV Q6HR	02/12/2014 11:01
View Ignore	47		7C	0758	Routine	Initial Doses	ceftriaxone in dextrose inj 209.5 mg / 5.24 ml inj IV Q24HR	02/12/2014 11:17
View Ignore	30		CICU	0407	Routine	Initial Doses	magnesium sulfate inj + Dextrose 5% in Water inj IV Q6HR PRN Other (enter in comments) 3.75 ml/hr	02/12/2014 11:34
View Ignore	30		NICU	0851	Routine	Extra Dose	ranitidine (ZANtac) 7 mg / 0.47 ml syrup NG Q8HR	02/12/2014 11:34
View Ignore	30		CICU	0407	Routine	Initial Doses	potassium chloride 0.4 mEq/ml in SWFI inj 2.5 mEq / 6.25 ml inj IV Q1HR PRN For Potassium < 3.5	02/12/2014 11:34

Overview of Medication Tracking Management Reporting

Management obtained value from the system in the ability to analyze complete data to obtain actual results. In one report (Figure 6), management is able to identify what times of day are the most challenges for timely compliance. In the report identified in Figure 7, it is easy for management to analyze how far out of compliance stat drugs are for the timeframe studied.

Figure 6

Non-Compliance for stat delivery by Time of Day

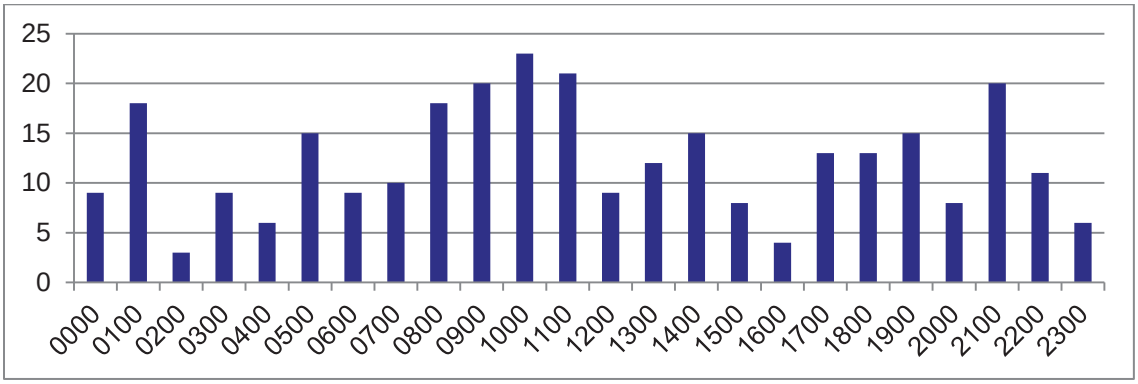
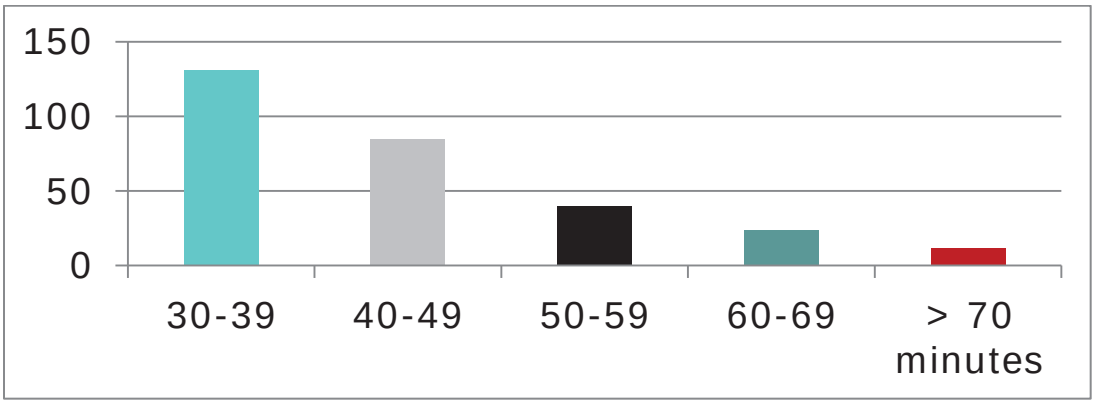


Figure 7

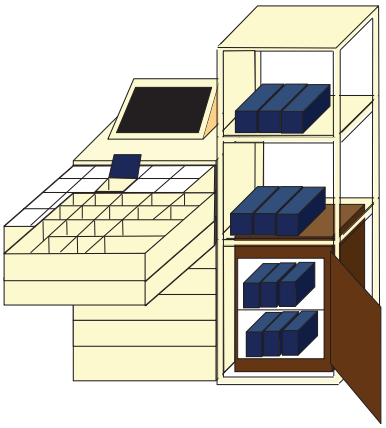
Analysis of non-compliant stats



Med Cabinets and Refrigerators

The Pyxis 3500 MedStations have cubie drawers for narcotics (Figure 8). Each drawer and location in the cabinet is labeled with a barcoded location code used for the Medication Tracking system.

Figure 8



RFID solutions for Refrigerators and Infusion Pumps:

CHP utilized an RFID solution to monitor temperature in refrigerators. There is now centralized reporting for temperatures that fall above or below range and if the door isn't closed within timeframes set.

CHP utilized an RFID solution to locate Infusion Pumps. Infusion pumps are placed in "clean" rooms when ready for use or dirty rooms, when ready for cleaning. The clean and dirty rooms are assigned a location in the system floor diagram. It is easy for Bio Medical staff to see when pumps are awaiting cleaning, when there are pumps available for use on the floor.

How was Health IT Utilized

PPID: Health IT was utilized with Positive Patient Identification (PPID) implemented in 2008. After the implementation of PPD, there was a reduction in medication errors.

While adverse medication errors reduced with PPID, there were opportunities to improve medication distribution throughout the inpatient hospital units. The Medication Tracking System uses orders from the EHR and delivery information from the Medication Tracking System.

Medication Tracking: A customized medication tracking system was developed by ISD staff with consultant assistance that integrates data from the EHR with data gathered from a mobile application. The mobile application captures the delivery information that includes: the individual who transported the medication, the delivery location, the delivery date and time stamp. The mobile application uses the same handset and barcodes used for positive patient identification.

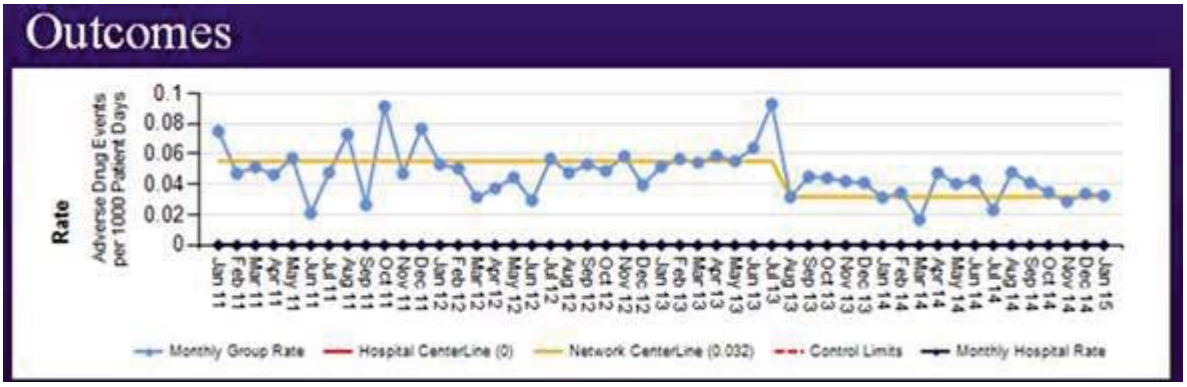
The tracking system uses information from both systems to display dashboards that are web-based applications published on the hospital Intranet and visible to individuals who have user permissions for access. Pharmacy users and IT support are the only users authorized at this time. The tracking system can be viewed on a variety of hardware including iPads and smart phones. The data is presented to the

pharmacy through the intranet with two distinct views that present real-time data on medication delivery. The pharmacy can view outstanding orders by priority to see which orders need to be prepared first and they can also view the delivered orders with the delivery details.

Value Derived/Outcomes

Overall Results: The overall medication safety strategy has proven results with an overall decrease in serious medication events. See Figure 9 below that shows that CHP (blue line) has had a reduction in adverse drug events. The yellow line indicates the midline average.

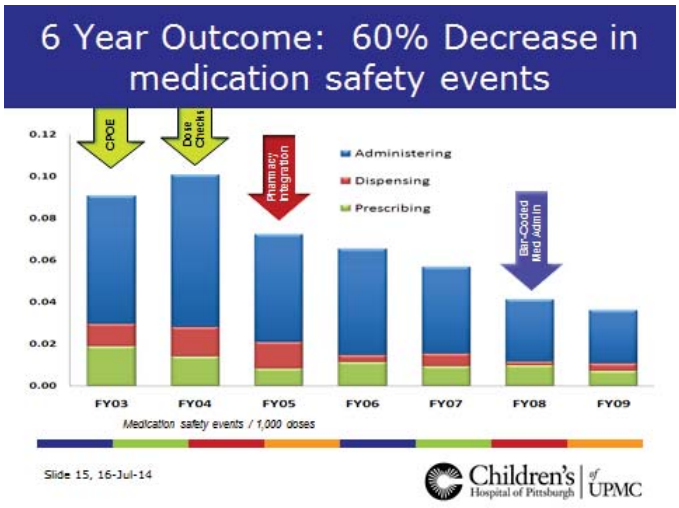
Figure 9



PPID:

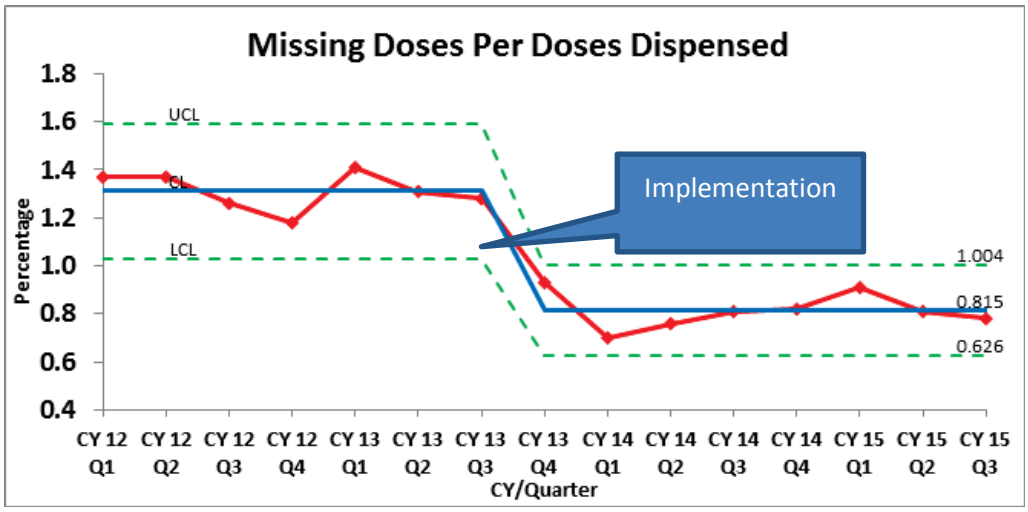
PPID was implemented in 2008. See Figure 10 below to identify the improvement in medication safety with the implementation in PPID. In 2008 (the purple arrow) there was a significant reduction in medication errors.

Figure 10



Medication Delivery Tracking Results: By implementing the medication delivery tracking system, the pharmacy now has the data to more accurately assess turnaround time as well as missing doses. See Figure 11 that shows the reduction in missing doses that was a significant decline in 2013 Q3 when the tracking system was implemented. Also note that the reporting previous to that time is proven to inaccurately portray the results of the whole; therefore the results are actually a more dramatic improvement.

Figure 11

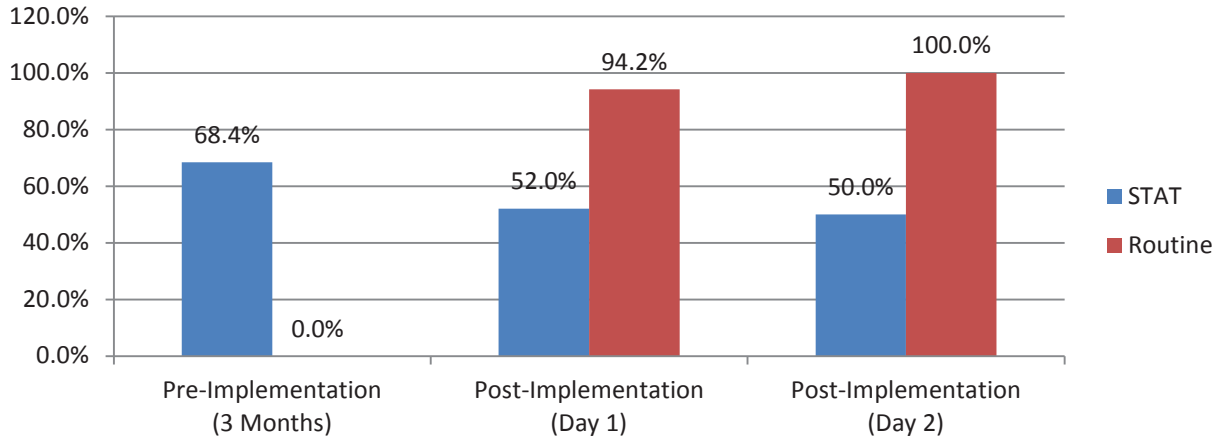


The pharmacy uses the data to identify potential sources of delay and modify processes to improve performance. Improving medication availability has a significant impact on nursing and pharmacy resources. This is compounded in a pediatric setting since medication preparation most often requires some form of 'manual' preparation. The elimination of one late or missing dose may prevent a nurse from calling the pharmacy, a pharmacy employee from reprioritizing their work to answer the phone and take a message, a pharmacist from reprioritizing their work to assess the patient's needs and regenerate a label, a technician from having to pull the needed medication(s) and prepare them for the IV room, a technician from drawing up the medication(s) and IV diluent, a pharmacist from checking the prepared ingredients, a technician from putting these ingredients into one final syringe, a pharmacist from doing a final check and labeling the medication, and a pharmacy employee from delivering the medication to the nurse who has been waiting to administer the medication.

Pre-implementation analysis on turnaround time for stat orders was completed using random sampling over a period of time. The random sampling showed that stat orders met the turnaround time 68.4% of the time; however, the post implementation report (without workflow modifications) shown below shows that there was a failure of 50% and 52% respectively. The manual random sampling method did not accurately reflect the percentage of failure to meet the delivery times. There was no data for routine orders prior to implementation, as this criterion was not sampled; however, timely delivery for routine

orders was between 94% and 100% on the two days reported before workflow was modified. This is illustrated in figure 9.

Figure 12



This new accurate data helped to identify that the root cause of late stat orders was the high percentage of IV stat orders that required a second check. Of the stat orders that were evaluated in the two days of data post implementation, 73.5 percent of the orders were IV room preparations where 83.6 percent required a "second check" or verification of the components for the IV order. The new data allowed the pharmacy director to take action that improved performance. Now the pharmacy has a process to support "second checks" so that they are completed timely. Performance reports for 2015 shows that there is on-time delivery of stat orders 67% of the time, an improvement of 17% over the baseline. The data further shows that most of the 33% of stat orders that did not meet the delivery time were delivered within a few minutes of the 30 minute time frame.

Now that the pharmacy can identify where and when medications are delivered to the units, the number of missing doses has decreased which saves time and money and improves patient safety. Comparing the 3 months post implementation with the same 3 months from the previous year (pre-implementation random sampling), the missing doses generated were decreased by 14 percent (figure 5). The CHP pharmacy has sustained the improved performance of on-time delivery through present.

Without such a tracking board, hospitals determine their turn-around compliance by sampling. This sampling is often insufficient to accurately reflect doses dispensed 24/7/365. Sampling often is done during shifts when volumes are low and staff is available, so compliance is more apt to be favorable. The advantage of this system allows all data points to be accurately determined, and the reports reflect the actual performance rather than a sample. Without it we would not be implementing needed change. We have embraced this transparency and continue to improve our processes to obtain an efficient staffing model.

Lessons Learned

The pharmacy department thought the major benefit of the Medication Tracking system would be to track the exact location of medication and reduce the amount of time spent searching for missing doses. While that is an important factor, the major benefits from the system are the pending deliveries dashboard and comprehensive data available for analysis to provide an accurate, real-time picture of pharmacy performance. Past performance analysis was generated from random sampling performed on a fraction of transactions, usually on the least busy days, which gave the pharmacy director a false sense of productivity.

The pending deliveries dashboard has dramatically improved how the pharmacy prioritizes their workload. The dashboard provides the information to track the turnaround times on medications and allows pharmacy supervision to set priorities for the pharmacists. The pharmacy can now provide a status and delivery information for any medication order. This was not possible pre-implementation, and it has improved productivity within the pharmacy.

It was necessary to establish standards for stat and routine medication orders. There is a hospital policy that was created to document the service levels and methods for delivery. Establishing expectations with clinicians and pharmacy staff was important to ensure that all participants are held accountable.

Due to the success of the pharmacy project, the tracking board concept is being remade in other areas of the hospital. Most recently, the physician wait list for ambulatory went "live." This dashboard was made to show patients how soon the physician will be ready for their child. The parent can better make plans to be in the area on time without waiting unduly with restless children.

Financial Considerations

Development of the medication delivery tracking system was within the scope of the IT department's operational work responsibilities. There were consulting costs associated with the project for development of the mobile application, interface with the EHR, and dashboard reporting totaling $13,775. In addition, there was no cost for training and support as the mobile application was intuitive and dashboard reporting was predetermined.

Financial Return on Investment

Medication Tracking Return on Investment:

Year	Avg Cost of each dose	Performance improve % (1.40%-.86%)	# of Doses dispensed	Missing Dose Improved /year	Med Cost Savings/year after go-live	Personnel Time @ $17.00/hour	Manual Reporting	Total
2013	$22.61	0.54%	1,203,218	6,497	$146,905.70	$56,852.05	$10,000.00	$213,757.75
2014	$22.59	0.54%	1,293,890	6,987	$157,836.47	$61,136.30	$10,000.00	$228,972.77
2015	$26.76	0.54%	1,304,291	7,043	$188,475.27	$61,627.75	$10,000.00	$260,103.02
				Savings Totals	**$493,217.43**	**$179,616.10**	**$30,000.00**	**$702,833.53**
				Expenses				**$13,775.00**
				Return on Investment				**$689,058.53**

Soft Return on Investment:

- Improved medication safety is improved and sustained with each initiative
- Improved pharmacy management and reporting
- Less nursing time and pharmacy time needed to provide safe medication
- Patients receive medication on-time
- Method to track medication waste