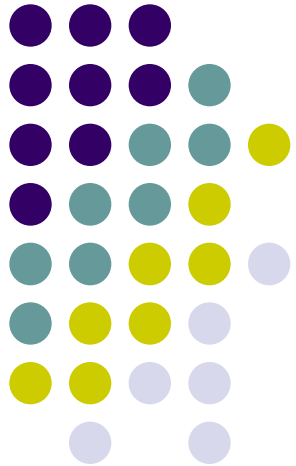
Reducing Medication Errors and Cost Through Simulation Based Lean Six Sigma and GRASP Workload Management

Thomas R. Clancy, MBA, PhD, RN
Clinical Professor, University of Minnesota, School of Nursing



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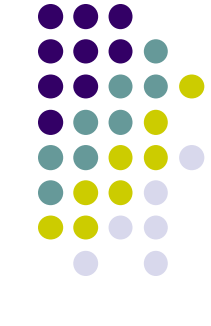


Purpose

The objective of this study was to measure cycle time, labor costs and medication errors after implementation of a bar-coded medication management system on a nursing unit located in a large academic medical center.

Methods

Using a lean six sigma approach, 13 GRASP medication administration interventions were modeled on a computer using simulation software. A "smart group" then built a revised computer model after implementation of bar-coded medication administration. The models were then run and compared for significant differences.

Results

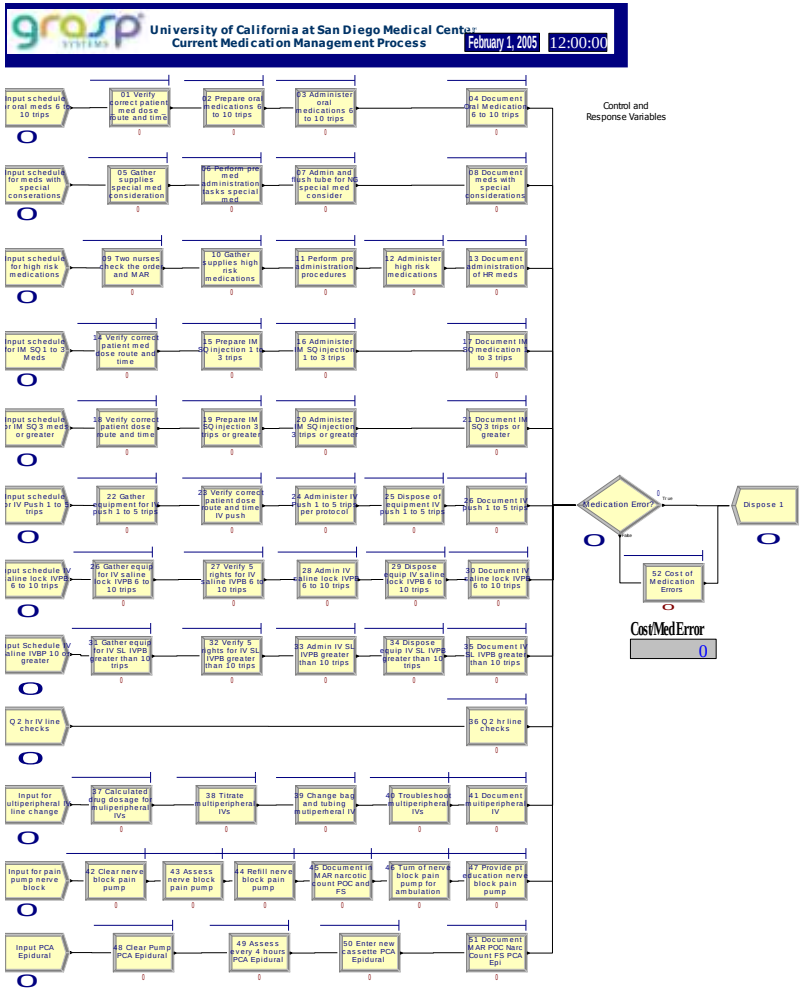
The computational model predicted there was not a significant difference in cycle time or nursing labor costs after implementation of bar-coded medication management at the $P \leq .05$ level. The model did predict a 50% reduction in medication errors. Follow up measurement at one year validated the accuracy of the predicted results from the model.

Conclusions:

- Grasp data provides an accurate and convenient method for simulation based lean six sigma projects.
- Benefits include predicting cycle time, productivity and costs after implementation of new technology and changes to nursing workflow.

Model developed by the
University of Minnesota
School of Nursing

What is a Computational Model?

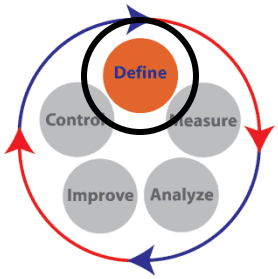


A computational model is a simulation of a process on a computer.

We simulated the medication administration process before and after bar-coded medication administration using GRASP data in a Lean Six Sigma project on a nursing unit.

This allowed us to determine the impact on nurses time, cost and medical errors before having to actually implement the new system!

Define the Opportunity



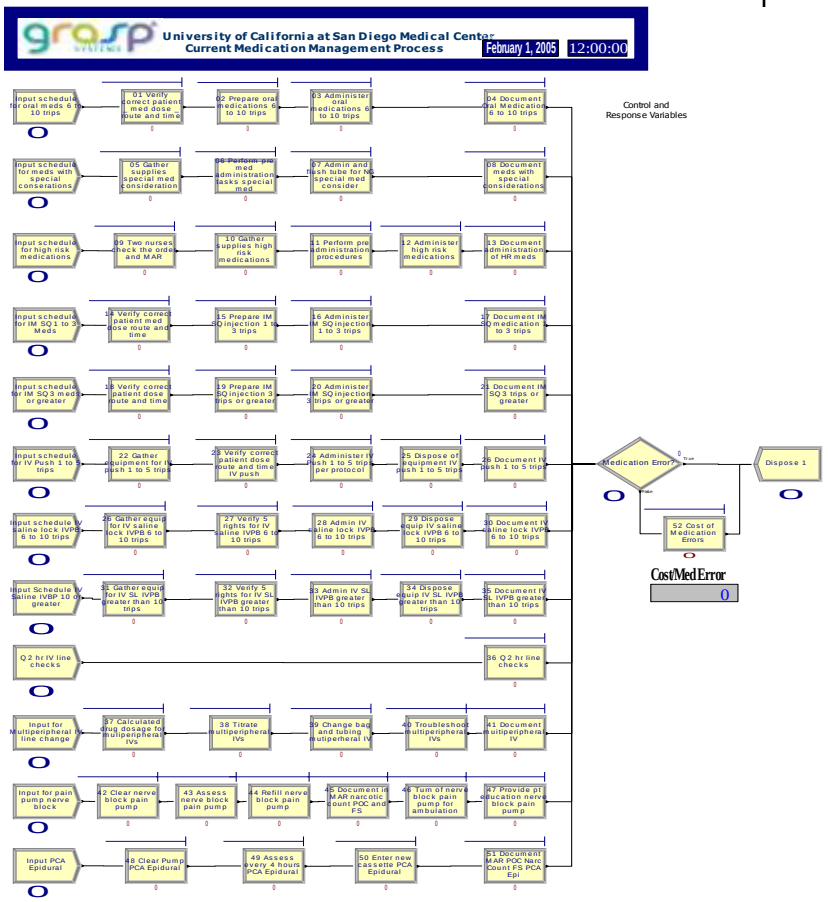
Primary Research Question

- Is there a significant difference in nursing hours, cycle time for medication administration and cost after implementation of BCMA?

Define the Opportunity

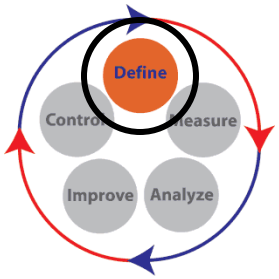
Secondary Research Question

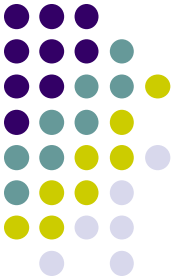
- Is there a significant difference between actual and predicted nursing hours, cycle time, and cost using GRASP PCH's and smartgroups.



Define Phase

What are the Critical to Quality Indicators (CTQ's) we are most interested in?





CTQ Indicators

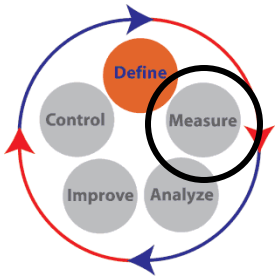
- Med. errors/GRASP intervention
- Cycle time per intervention
- Productivity (Total nursing labor hours per intervention
- Total cost per intervention

Metrics

- 50% – 70% improvement
- ≤ to paper-based process
- ≤ to paper-based process
- ≤ to paper-based process

Measure the Current State;

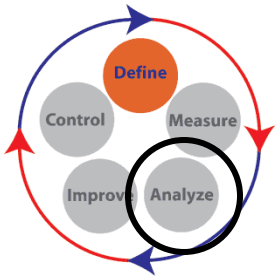
What are the PCH's for current interventions?



GRASP Interventions	Minutes
• Oral medications (supp, topical, gtts) 6-10 trips	23.29
• Meds with Special considerations-	2.20
• High Risk Meds- Hep/Insulin/PCA	2.20
• IM/SQ Injections (PRN) 1-3 trips to room/ 24hrs	12.94
• IM/SQ Injections (PRN) >3 trips to room /24hrs	32.35
• IVPB/IV saline lock/ IVpush meds 1-5 trips/ 24 hrs	19.41
• IVPB /IV saline lock/IV push meds 6-10 trips/24hrs	51.76
• IVPB/IV saline lock/IV push meds >10 trips/ 24 hrs	77.65
• IV 1 line includes IV starts/q2h checks/tubing	29.41
• Med Infusion/ mult peripheral IV's/ central line	25.88
• Pain Pump, Nerve Blocking	49.18
• Patient Controlled Analgesia/Epidural	19.41
• Parenteral nutrition/ TPN/ Lipids	22.65

Analyze Phase

How long does each GRASP medication intervention take per trip?

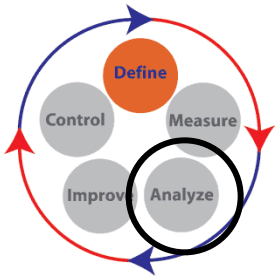


			Oral Meds	Meds with	High Risk	IM/SQ	IM/SQ
Inputs	Data Collection Period		**6 -10 per day**	**Special Considerations**	**Meds**	**1-3 Trips**	**>3 Trips**
Total Days (24 hour periods)	2/1/2007	12/15/2007	317	317	317	317	317
Hours			7,608	7,608	7,608	7,608	7,608
Minutes			456,480	456,480	456,480	456,480	456,480
Patients			1,555	1371	1434	965	1197
Patients per Day			5	4	5	3	4
Frequency per day			6	1	1	2	5
Adjusted time (GRASP)			23.3	2.20	2.20	12.94	32.35
Time per patient per trip (seconds)			233	132	132	388.2	388.2
Hours between patients			4.89	5.55	5.31	7.88	6.36
Minutes between patients			293.56	332.95	318	473	381

There are a total of 317 days between 2/1/2007 and 12/15/2007. During that period 1,555 patients received an "Oral Med 6-10 times per day". That is an average of 5 patients per day that received an oral med 6-10 times per day. A schedule of 6 times per day is once every 4 hours. Therefore every 4 hours 5 patients should receive medications. So the total time for one patient 6 times per day is 23.29 (GRASP adjusted time). So 23.29 minutes/6times per day = 3.89 minutes or 233 seconds per trip.

Analyze Phase

How do we code the inter-arrival times of each GRASP intervention into a computational model?

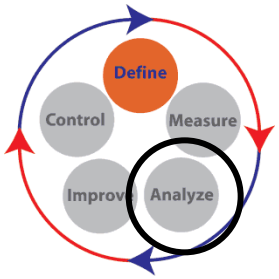


Prompt	Entry
Name	Input schedule for "Oral meds 6 to 10 trips"
Entity Type	GRASP Intervention
Type	5 trips every 4 hours
Schedule Name	Schedule for "Oral meds 6 to 10 trips"
Entities per Arrival	One
Max Arrivals	Infinite

Law, A. & Kelton, W. (2000). Simulation Modeling and Analysis. Boston. McGraw Hill

GRASP Interventions

What percent of total time is assigned to each step in a medication trip?



GRASP® Systems International, Inc.
370 - Unit Reference Manual (Instruments)
for *University of California San Diego Medical Center*
Generated on *8/25/2008* at *1:45:16PM*

10 East
10 East
2/1/2007 - 12/15/2007

WORKLOAD MEASUREMENT INSTRUMENT
ASSESSMENT CRITERIA, OPERATIONAL DEFINITION
& TIME STANDARDS

Unit Type	Medical Surgical
Intervention Section	
MISCode	
Element	Medications / Fluids (select as applicable)
Intervention/Activity	**Oral medications (supp, topical, gtts) 6-10 trips(11.07)**

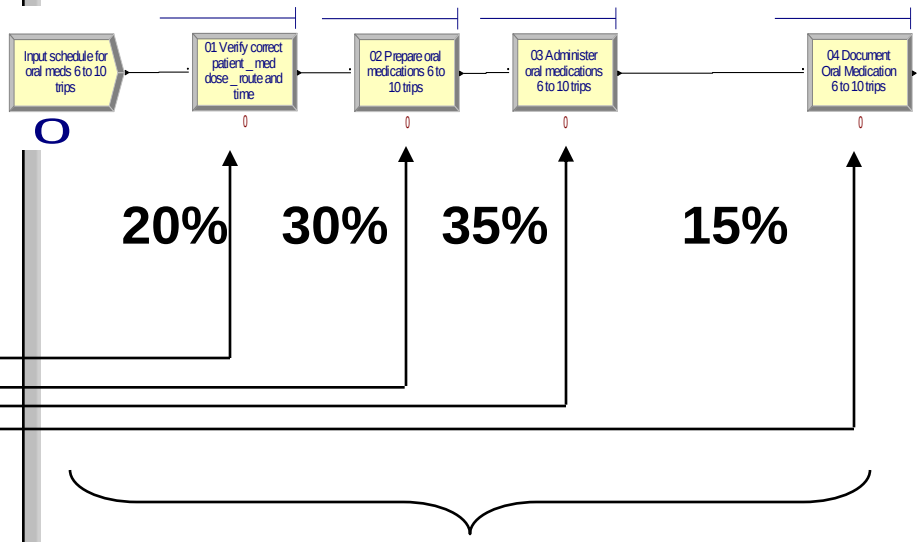
ASSESSMENT CRITERIA

Based on physician orders, using MAR as a reference, the intervention chosen is determined by average number of visits to the patient to pass meds (PRNs estimated based on progress notes).

OPERATIONAL DEFINITION

1. Verify correct patient, med dose, route and time.
2. Prepare medications (including oral meds, drops, suppositories, patches, ointments, also includes PRNs).
3. Administer meds.
4. Document.

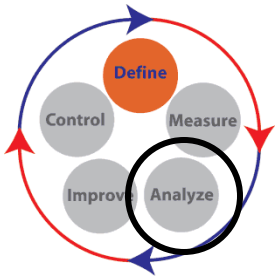
Normal Time	3.00	**% Fatigue and Delay**	10.00
Standard Time	3.30	**Adjustment**	85.00
Frequency	6.00	**Intervention Type:**	SelectOnly
Total Time	19.80		
Adjusted Time	23.29		



100% Total Adjusted Time/Trip (233 seconds)

Analyze Phase

What percent of total time is assigned to all steps in all medication trips ?



GRASP® Systems International, Inc. 10 East
370 - Unit Reference Manual (Instruments) 10 East
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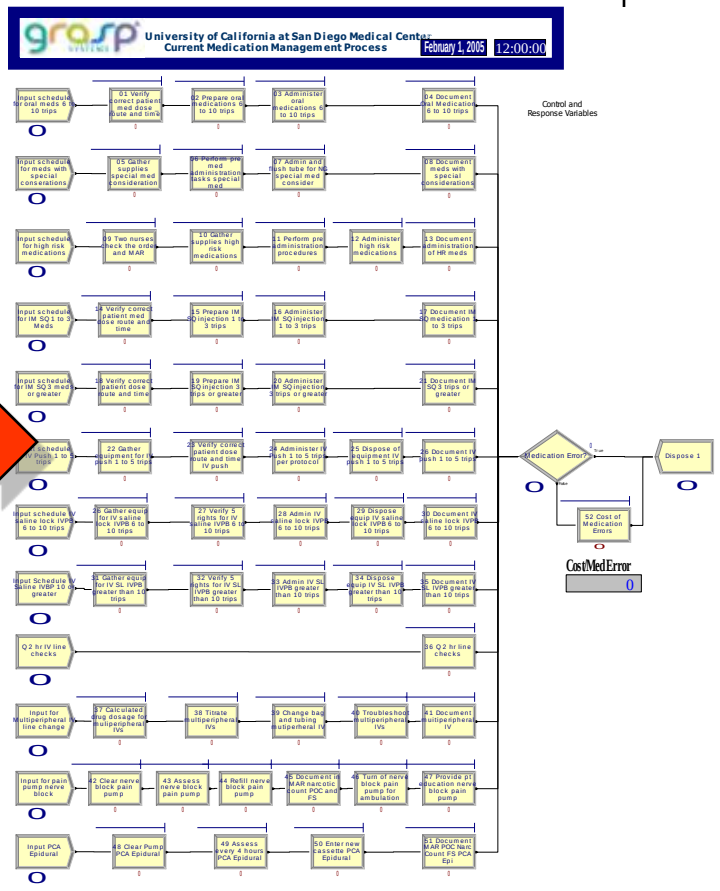
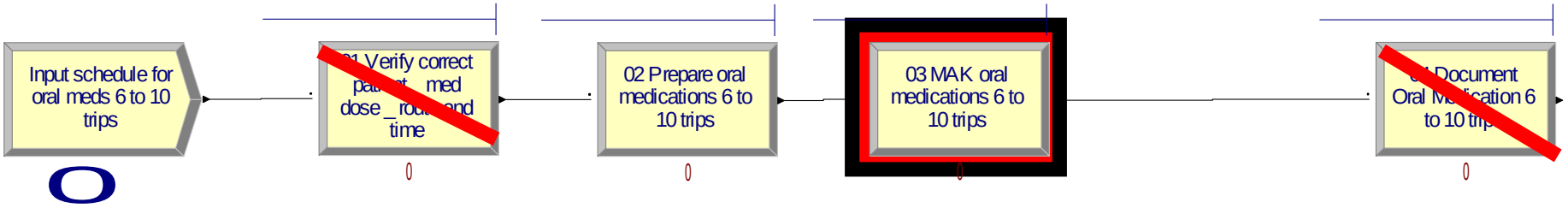


Improve Phase

What are the steps in the new bar coded medication process?



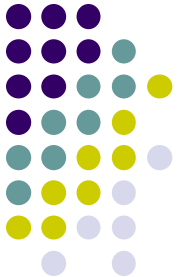
Eliminate

Combine

Eliminate

Improve Phase

What are the steps in the new bar coded medication process?

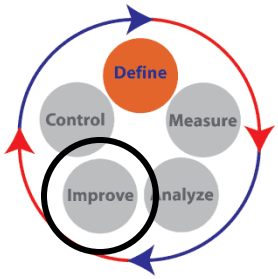


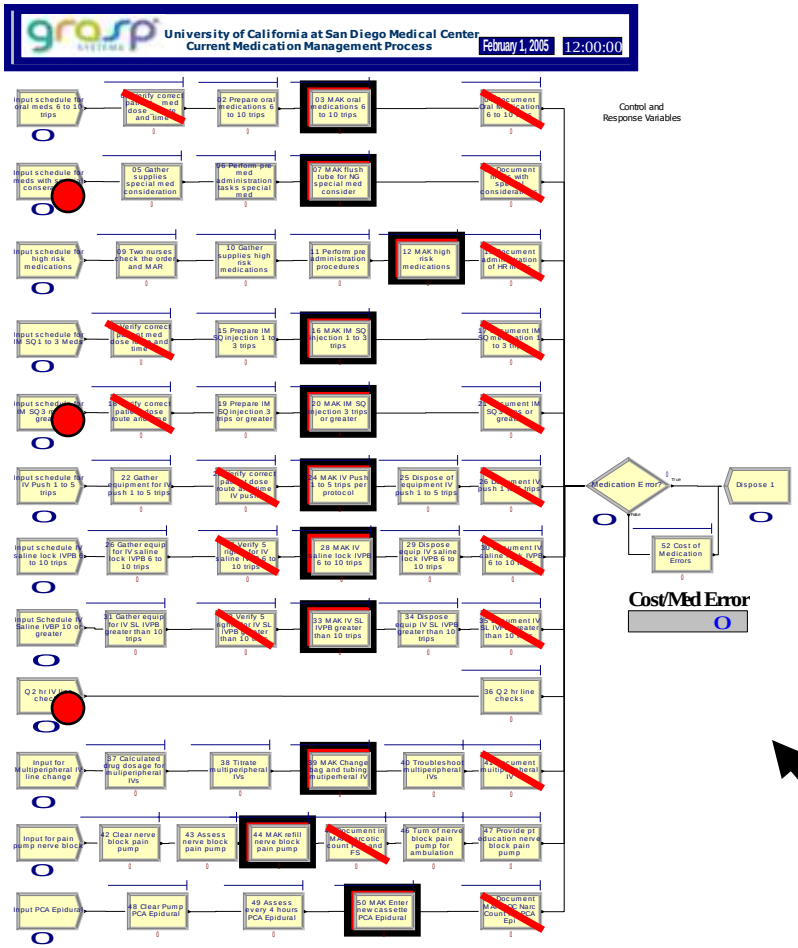
Tips for Administering Medications in MAK

1) Take meds and the scanner from pyxis to patient's room
2) Connect your scanner to the computer by scanning on the barcode on the bluetooth modem
3) Sign on to MAK- Logon ID-(pcis user ID), password(your personal password) and then scan your badge or enter your 6 digit employee ID number
4) Select your patient
5) Highlight the medication to be scanned
6) Scan the medication
7) Confirm correct medication -the line will turn green
8) Scan all medications
9) Click on the ID patient button and scan the barcode on the patient's wristband to confirm correct patient
10) Enter any vitals or other info required on the Admin List
11) Click on the Chart button to sign the MAR
12) Log off and disconnect the scanner by scanning on the disconnect bar code on the monitor

Improve Phase

How do we revise the current computational model to fit the new BCMA model?

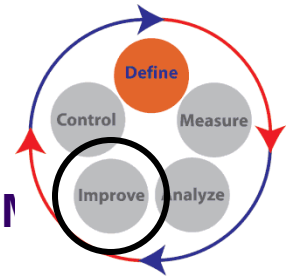




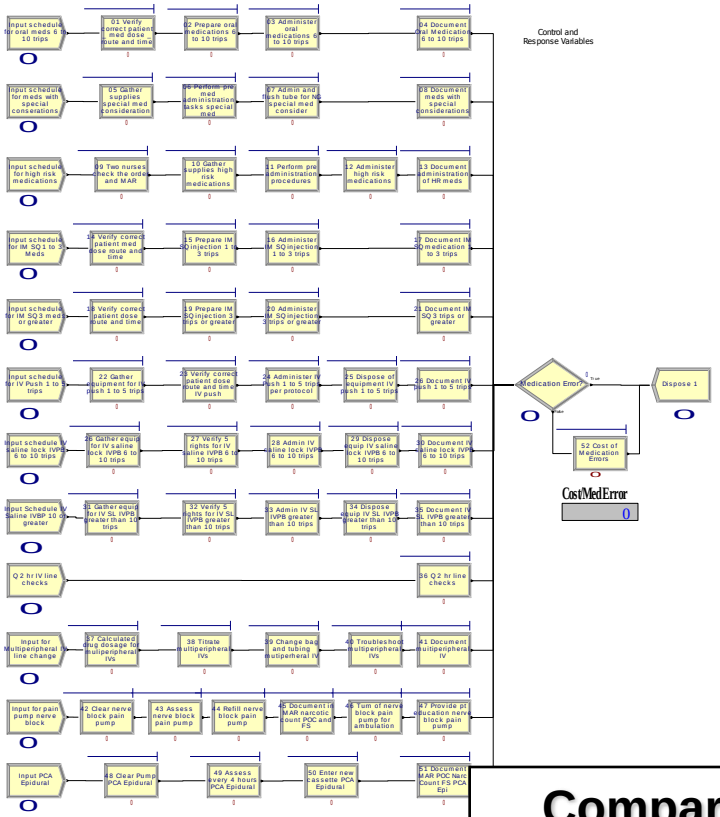
Shows changes in time and labor costs after BCMA

Improve Phase

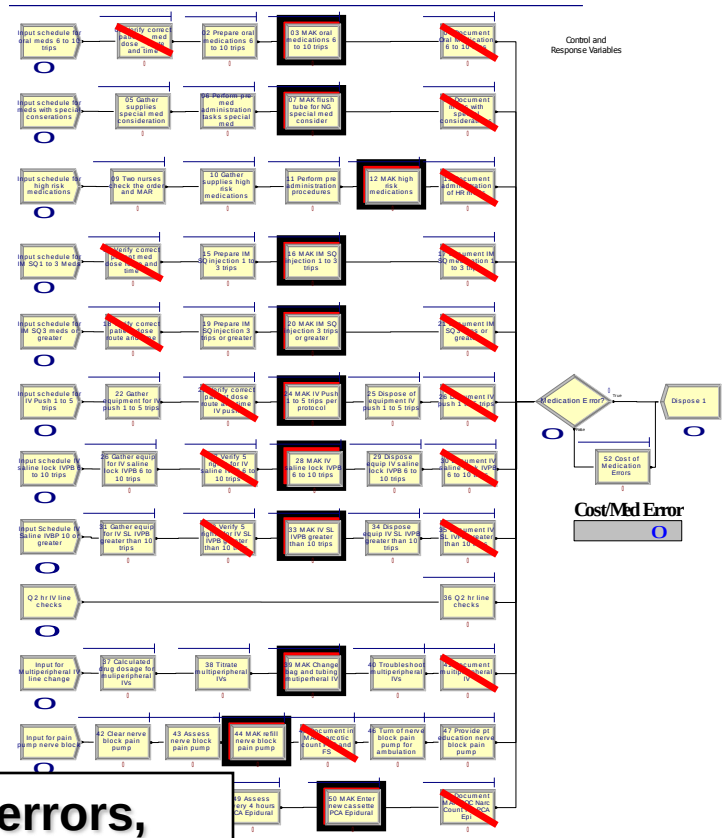
We now run the models and compare medication administration before and after implementation of BCM



Before BCMA



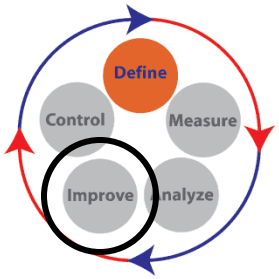
After BCMA



Compare med errors, cycle time and cost before and after BCMA.

Improve Phase

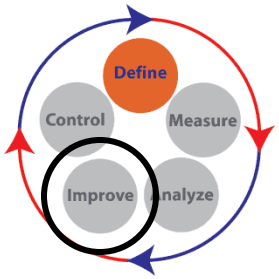
Results: There was not a significant difference between predicted cycle time and labor costs post implementation of BCMA using GRASP.



CTQ Indicators	Significance
• Cycle time per intervention	• P ≤ .05
• Productivity (Total nursing labor hours per intervention	• P ≤ .05
• Total cost per intervention	• P ≤ .05

Improve Phase

Results predicted a 50% reduction in medication errors with no increase in labor costs.



Paper Based System

- Annual trips 45,000
- Med error rate 00.05%
- Total errors 234
- Cost/error $1,000
- Annual cost $234,000

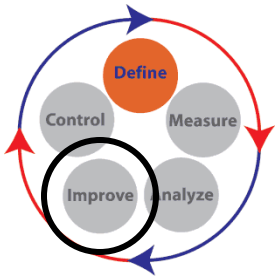
Bar Coded Med Admin.

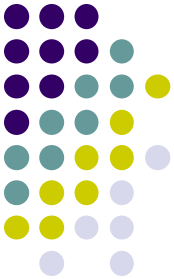
- Total trips 45,000
- Med error rate .025%
- Total errors 124
- Cost/error $1000
- Annual cost $124,000

Cost savings from a 50% reduction in medication errors. $110,000

Improve Phase

Models allow scenario analysis. For example: What is the optimum number of nurses needed to minimize medication administration wait time?

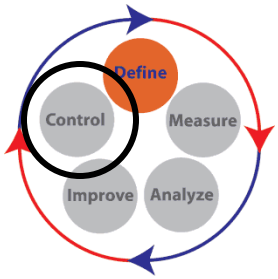




GRASP Interventions	**Wait Time (min)**	
	1 FTE	**6 FTE**
• Oral medications (supp, topical, gtts) 6-10 trips	43.5	3.7
• Meds with Special considerations-	26.6	2.1
• High Risk Meds- Hep/Insulin/PCA	29.4	2.1
• IM/SQ Injections (PRN) 1-3 trips to room/ 24hrs	51.3	6.5
• IM/SQ Injections (PRN) >3 trips to room /24hrs	41.0	6.5
• IVPB/IV saline lock/ IVpush meds 1-5 trips/ 24 hrs	61.5	6.4
• IVPB /IV saline lock/IV push meds 6-10 trips/24hrs	37.9	6.4
• IVPB/IV saline lock/IV push meds >10 trips/ 24 hrs	44.8	6.4
• IV 1 line includes IV starts/q2h checks/tubing	10.5	2.4
• Med Infusion/ mult peripheral IV's/ central line	93.1	26.0
• Pain Pump, Nerve Blocking	111.3	24.0
• Patient Controlled Analgesia/Epidural	9.7	57.0

Control Phase

Check the Results. At one year the actual results were validated against the models predicted results.



Actual Results

- BCMA does not take longer than the paper-based process.
- Labor costs are not significantly different.
- Medication error rates dropped by 50%.
- GRASP data provides an accurate metric for simulation based lean six sigma projects.

East Jefferson General Hospital Success Story