University of California, Santa Barbara
Department of Probability and Statistics

PSTAT 140 Statistical Process Control

Process Control for Decreasing Medication Error

Jianing (Julia) Chen

Professor: Dawn Holmes

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Course scenario

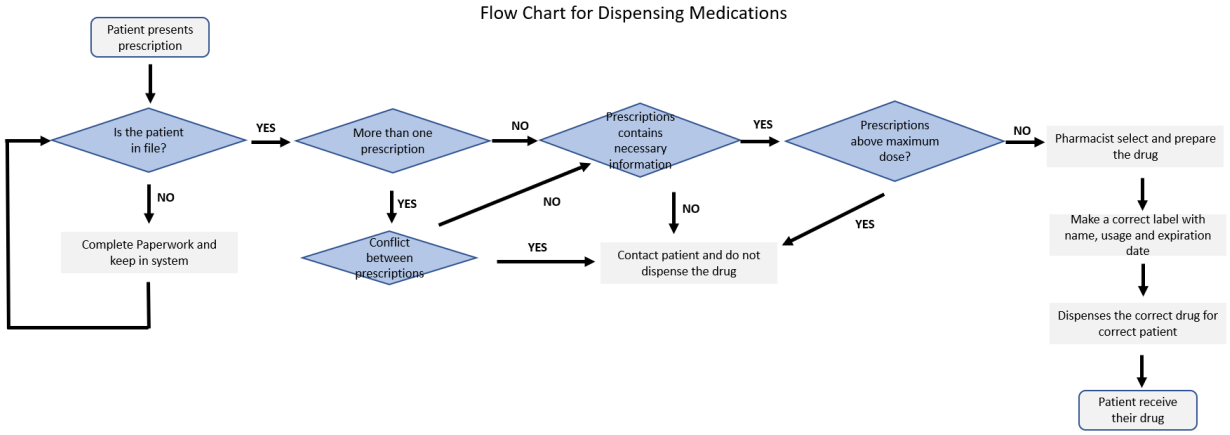
Pharmacies are where people can get medicinal drugs, and pharmacies are not only provided the services but also bundling products. That is to say, pharmacy service is the action undertaken by pharmacists to apply their health knowledge to provide the value of healthcare, specificity providing medicinal drugs.

To improving Pharmacy Quality, one of the ways is to increase patient satisfaction by **decreasing medication error**. To address this problem, we will apply DMAIC tools along with each tollage.

DMAIC 1st step: Define

The objective of the project is to lower the medication error less than 10%. To understand the problem, we define the medication error at first. According to the Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI), there are three main parts: prescribing error, monitoring error, administration error. Prescribing error is the error that occurred during the prescribing, such as inappropriate drug selection, wrong doses, drug-drug interactions; monitoring error refers to a lack of adjusting the levels for medication; administration error includes wrong instructions for drug use. Begin with the analysis, we will look at the flowchart to understand this process.

Flow chart for the process

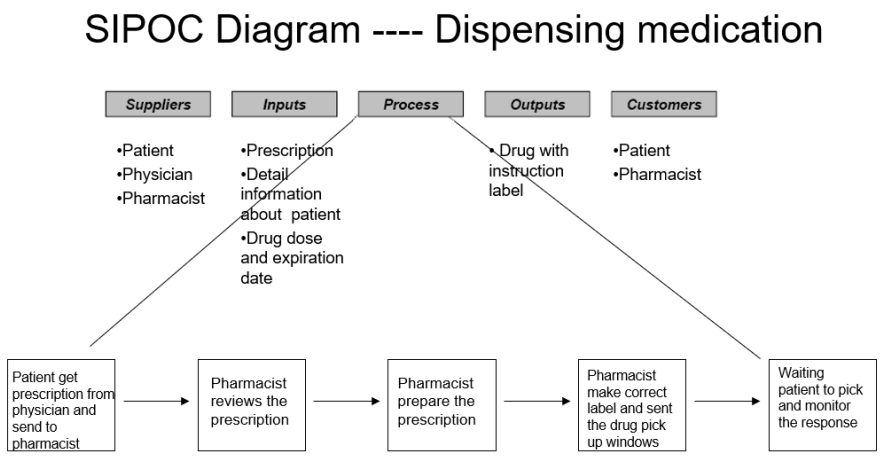


(The blue background shows the non-value-add activities, and the blank background shows the value-added activities.)

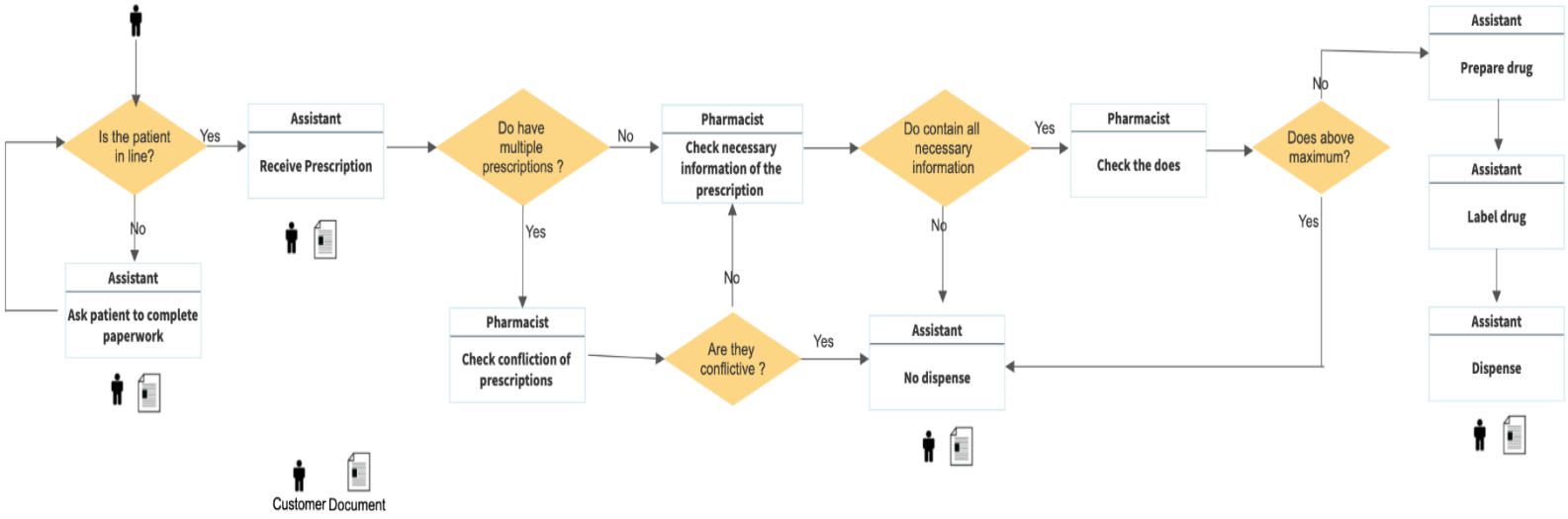
Critical-to-quality Characteristics

Critical-to-quality characteristics for pharmacy services will come from physical, sensory, and time orientation. Specifically, physical refers to store location, basic infrastructure in the store, accessible design for disabled people, and so on. Sensory refers to the hygienic and sterilization facilities of the store. Time orientation refers to time to respond for each patient, reliability of the experienced and skilled pharmacists, and quality of refill service.

SIPOC diagram



Value Stream map:



DMAIC 2nd step: Measure

In measure step, we will identify key process input (KPIV) and key process output variables (KPOV) and how the data was collected.

KPIV and KPOV

Key process input variables (KPIV): Prescription and detailed diagnostic information from physician, key process output variables (KPOV): correctness and the effectiveness of the medicine. Those are related to customers CTQs, because the goal is to reduce the prescribing medication error. For example, to have detailed diagnostic information from a physician could help pharmacists to give make correct decision weather there are any drug-to-drug interactions, any food needs to avoid when using the drug. Key process output variables can be used to measure the effectiveness of the process improvement.

A total of 100 medical files were selected randomly from the pediatric medical ward to detect any medication error during prescribing. Below is a list of errors and the Pareto Diagram.

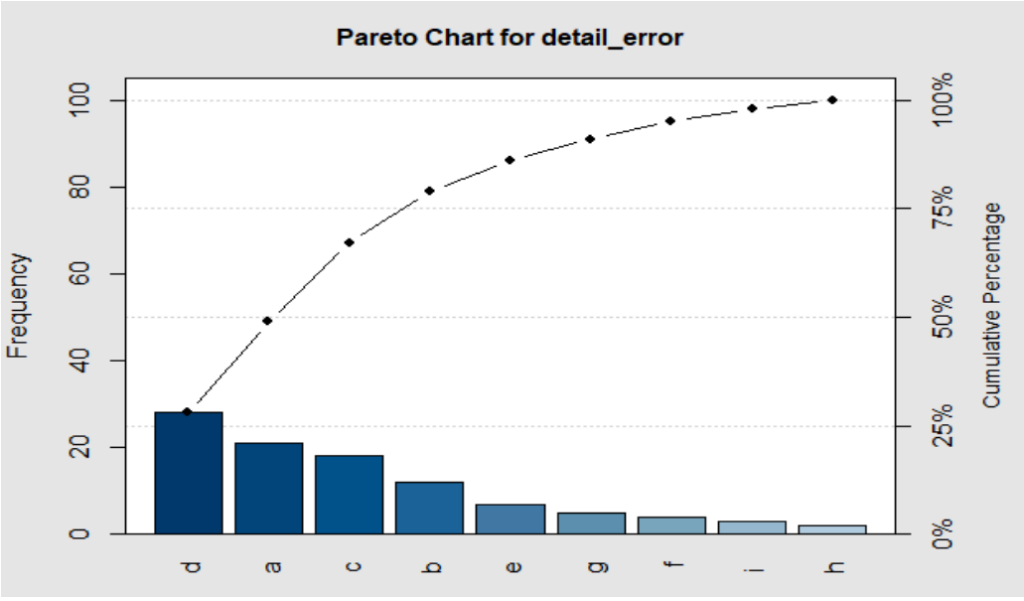
Pareto Diagram

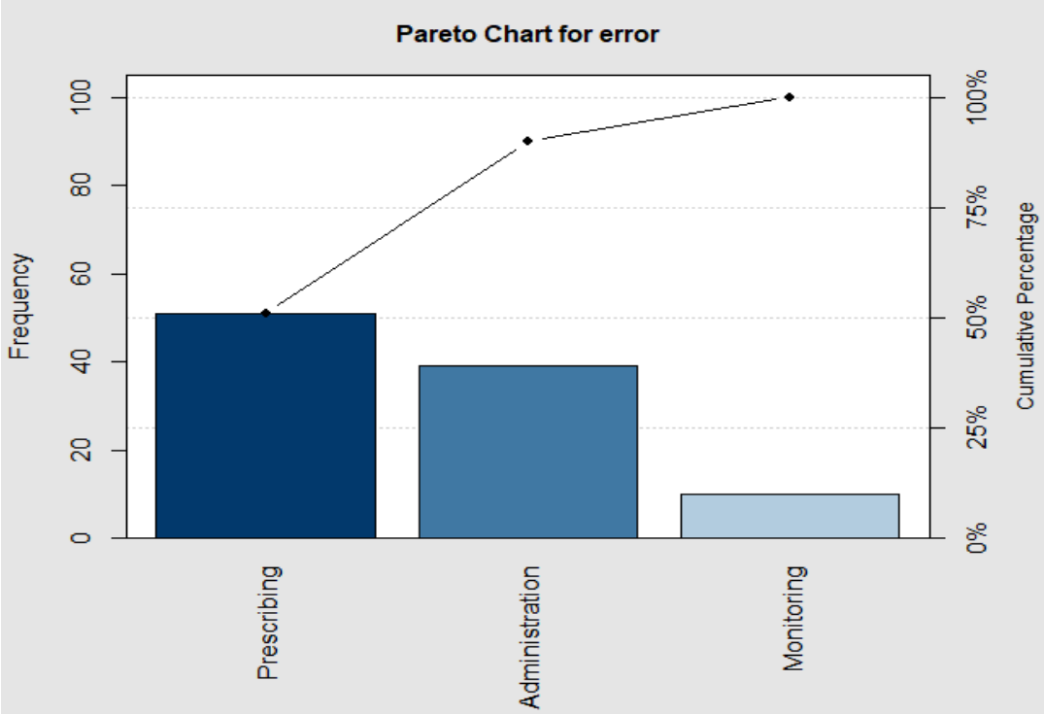
Error		Defects
Drug-drug interaction	a	21
Inappropriate length of treatment	b	12
Lack of clinical pharmacy advice	c	18
Wrong instructions for drug use	d	28
Wrong concentration in the IV admixture	e	7
Wrong rate of drug administration	f	4
Lack of adjusting aminoglycosides	g	5
Lack of adjusting antiepileptics	h	2
Lack of monitoring for electrolytes	i	3

```
Pareto chart analysis for detail_error
  Frequency Cum.Freq. Percentage Cum.Percent.
d        28        28         28           28
a        21        49         21           49
c        18        67         18           67
b        12        79         12           79
e         7        86          7           86
g         5        91          5           91
f         4        95          4           95
i         3        98          3           98
h         2       100          2          100
```

Error	Defects
Prescribing errors	51
Administration errors	39
Monitoring errors	10

```
Pareto chart analysis for error
             Frequency Cum.Freq. Percentage Cum.Percent.
Prescribing         51        51         51           51
Administration      39        90         39           90
Monitoring          10       100         10          100
```





Demerit systems

Class A Defects: Very Serious

1. Pharmacist picked up wrong drug or wrong dose
2. Ignored past health history

Class B Defects: Serious

1. Very small amount of difference in the dose, <0.01 mg
2. Did not inform the patient about special usage, such as food need to avoid, specific time to intake the medicine

Class C Defects: Moderately Serious

1. Used some abbreviate in the instruction or label that might makes patient confused
2. Inventory out of stock, patient wait longer than usual

Class D Defects: Minor

1. Spell the name wrong in the label, but give to the correct patient
2. Forget to double check with patient, such as name, date of birth

Check Sheet

Project Name:	Check Sheet - Medication Error from Jan-Jun, 2020
Location:	United States
Data Collection Dates:	2020/7/5

Defect Types/ Event Occurrence	Dates						TOTAL
	Jan	Feb	Mar	Apr	May	Jun	
Drug-drug interaction	4	4	3	5	2	3	21
Inappropriate length of treatment	2	2		3	5		12
Lack of clinical phamacy advice	3	4	1		2	8	18
wrong instructions for drug use	5	7	6	4	4	2	28
wrong concentration in the IV admixture	1		3		2	1	7
wrong rate of drug administration		2	1			1	4
Lack of adjusting aminoglycosides		1	2			2	5
Lack of adjusting antiepileptics	1			1			2
Lack of monitoring for electrolytes	1			1		1	3
TOTAL	17	20	16	14	15	18	**100**

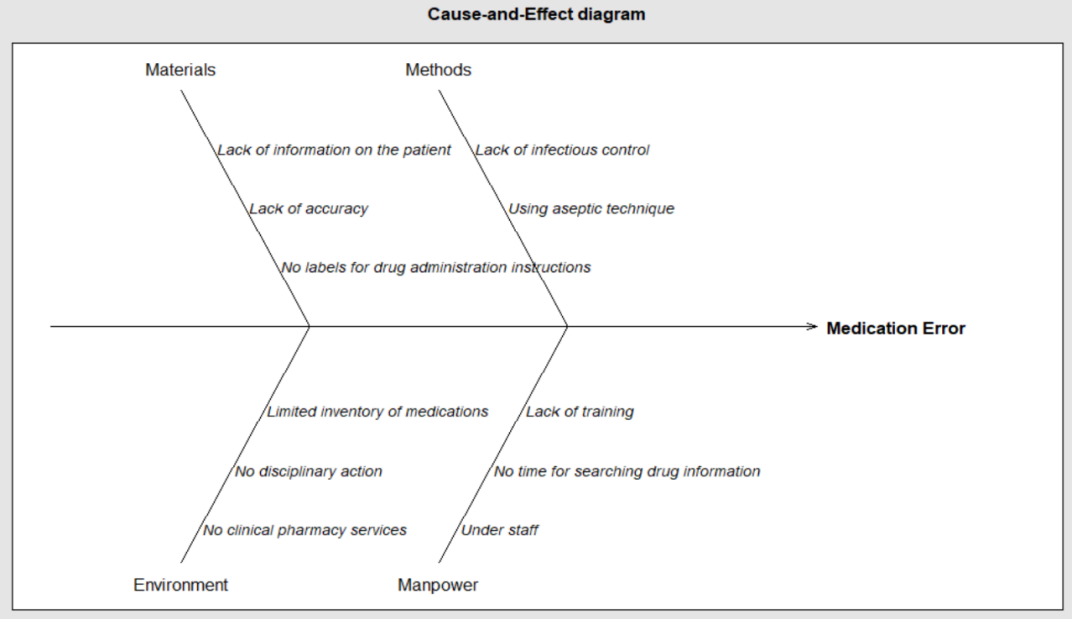
DMAIC 3rd step: Analyze

Now we will go deeper into the 100 medical files to identify the cause. To do this, we will have people as a team which including the pharmacy director, the director of the quality department in the hospital, and so on to detect the possible causes for the problem. All the following causes were the root cause that recorded for this problem: (i) pharmacists' carefulness (no double-check), (ii) poor documentation about the patient, such as past illness, (iii) lack of pharmacy supervision.

Description of chance and assignable causes

The chance causes are defined as the sources of variability that are embedded in the system or process itself, while assignable causes are defined as the sources which usually arise from an external source. Removing a chance cause of variability usually means changing the process, while removing an assignable cause usually involves eliminating that specific problem.

In our case, the chance cause of variability might be the inadequate training of pharmacy workers, or the system does not input the complete information about patients. The assignable cause could be the patient's own fault, such as did not follow the instruction. Below shown the Cause-and-Effect diagram.



DMAIC 4th step: Improve

In this process, we will be focusing on the improve the workflow and reduce the bottlenecks. The objective of this quality improvement is to reduce the incidence of medication errors in each stage (prescribing, administration, and monitoring) less than 10%. By reading related papers, I found some useful tools to reduce medication error. Nadin Yousef and Farah Yousef in 2017 comes up with 11 ideas, some of the idea I think are very important. One is to have education and training for pharmacy staff, and one is to have an automation system hospital to pharmacy, another one is to establish drug information center. (See Action Plan for more information)

Control Plan for Reducing Medication Errors

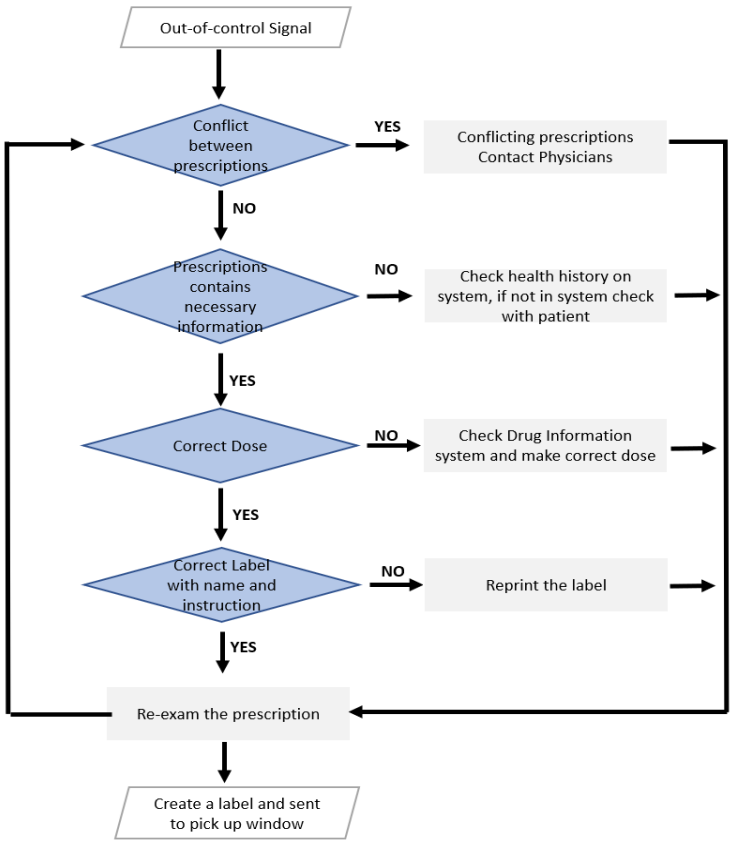
Action	Goal	Steps	Achieved
Conducting an educational program to staffs (physicians, nurses and pharmacists)	Reduce prescribing error	1. Preparing detected drug-related problems to physicians and pharmacists. 2. Preparing guidelines and working procedures for nurses and other healthcare staffs. 3. Reservation for the conference room 4. Putting the schedule for the lectures 5. Distributing the schedule	1.5 months
Establishing automation system	Reduce monitoring error	1. Adopting electronic prescription instead of the paper prescription 2. For first vistited patient, keep he/she in file and double check the health information 3. For each visited patient, modify the personal information.	2 months
Establishing drug information center (such as IV admixture units)	Reduce administration error	1. Collecting drug information resources and input into system 2. Update drug information regularly 3. Preparing policies/procedures, stability charts, compatibility charts and labels	2 months

DMAIC 5th step: Control

In this step, I will use out-of-control plan to design the new system to automatically keep whole process works. Below is the out-of-control chart for control the error in dispensing drugs. The system

contains four important steps, which are all ideal for reducing prescribing error. To complete this loop also need to training staffs to finish it quickly.

Out-of-control Chart for Dispensing Medications



For monitoring error and administration error, we need a create a system and drug information system to keep in track of patient health history and drug information.

The results of the experiment demonstrated that there was a statistically significant difference in the CTQs resulting from implement staff training, automation, and drug information system. Hence it expected to significantly improve customer satisfaction by decreasing medication error.

Reference

Abuelsoud N. (2019). Pharmacy quality improvement project to enhance the medication management process in pediatric patients. *Irish journal of medical science*, 188(2), 591–600. https://doi.org/10.1007/s11845-018-1860-8

Yousef, N., Yousef, F. Using total quality management approach to improve patient safety by preventing medication error incidences** . *BMC Health Serv Res* **17**, 621 (2017). https://doi.org/10.1186/s12913-017-2531-6

Data

Data was generated by my own

Code for the Plot

```
library(qcc)
cause.and.effect(cause=list(
  Materials=c("Lack of information on the patient",
              "Lack of accuracy",
              "No labels for drug administration instructions"),
  Methods=c("Lack of infectious control",
            "Using aseptic technique"),
  Environment=c("No clinical pharmacy services",
                "No disciplinary action",
                "Limited inventory of medications"),
  Manpower=c("Under staff",
             "No time for searching drug information",
             "Lack of training")),
  effect="Medication Error")

detailerror = c(21,12,18,28,7,4,5,2,3)
names(detailerror) = c("Drug-drug interaction",
                       "Inappropriate length of treatment",
                       "Lack of clinical phamacy advice",
                       "wrong instructions for drug use",
                       "wrong concentration in the IV admixture",
                       " wrong rate of drug administration",
                       "Lack of adjusting aminoglycosides",
                       "Lack of adjusting antiepileptics",
                       "Lack of monitoring for electrolytes "
)

pareto.chart(detailerror)
detail_error = c(21,12,18,28,7,4,5,2,3)
names(detail_error) = c("a", "b","c","d","e","f","g","h","i ")
pareto.chart(detail_error)

error=c(51,39,10)
names(error)=c("Prescribing",
               "Administration",
               "Monitoring")

pareto.chart(error)
```