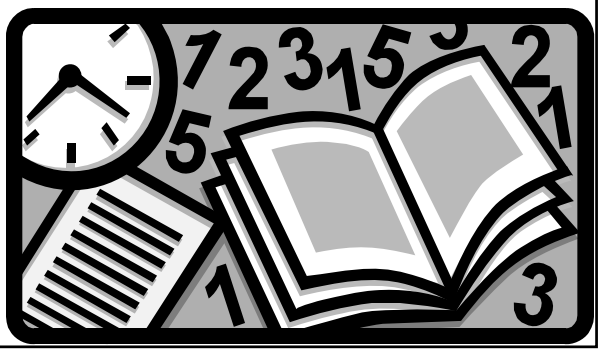
Using Data For *Improvement*!

The Toolkit

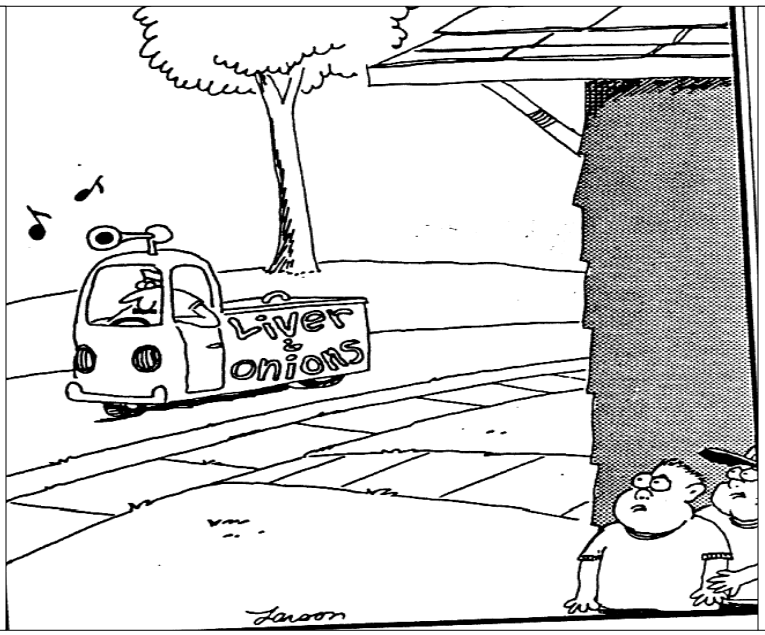


Sandra K. Murray
CT Concepts

Objectives

- **Identify fundamental differences in data used for improvement, accountability, research**
- **Interpret data on a :**
  - **Run chart**
  - **Pareto chart**
  - **Frequency Plot**
  - **Scatter Plot**
  - **Shewhart (Control) Chart (introduction only)**
- **Recognize the most appropriate tool for the measurement question you are posing**

2



Resources

Books:

1. The Data Guide: Learning from Data to Improve Healthcare. Lloyd P. Provost, Sandra K. Murray. Publication pending. 512-708-0131.
2. Total Quality Tools For Health Care. Productivity-Quality Systems, Inc. Miamisburg Ohio. ISBN: 1-882683-04-8 Tel. 1-800-777-2255.
3. The Improvement Guide. Gerald J. Langley, Kevin M. Nolan, Thomas W. Nolan, Clifford L. Normal, Lloyd P. Provost, Jossey-Bass, 1996.
4. Methods for Understanding Variation. Associates in Process Improvement (API),1998. 512-708-0131
5. Understanding Statistical Process Control, Donald J. Wheeler and David Chambers, 2nd Edition SPC Press, 1992.

Video:

Making Sense Out of Control Charts. NAHQ. 1-800-966-9392

Articles:

1. Nelson, L. S. "Control Charts for Individual Measurements." Journal of Quality Technology. Vol. 14, No. 3. pp. 172-173. 1982.
2. Nelson, L. S. "The Shewhart Control Chart – Test for Special Causes." Journal of Quality Technology. Vol. 16, No. 4. pp. 237-239. 1984.
3. Nolan, Tom W. and Provost, Lloyd P. "Understanding Variation." Quality Progress. May, 1990.
4. Provost, Lloyd and Leddick, Susan. "How to Take Multiple Measures to Get a Complete Picture of Organizational Performance." National Productivity Review. Autumn 1993. pp. 477-490.
5. Solberg, Leif I., Mosser, Gordon and McDonald, Susan. "The Three Faces of Performance Measurement: Improvement, Accountability and Research." Journal on Quality Improvement. March 1997, Vol.23, No. 3.

Software:

1. ChartRunner. PQ Systems. 1-800-777-3020.
2. VectorMaker. API. 512-708-0131

Internet:

www.nahq.org
www.qualityhealthcare.org

Purpose of Measurement

- Measurement for Improvement
- Measurement for Accountability
- Measurement for Research

5

Improvement, Accountability and Research

Aspect	Improvement	Accountability	Clinical Research
Aim:	Improve practice of health care	Comparison, choice, reassurance, spur for change	Create new clinical knowledge
Methods:			
Test observability	Test observable	No test, evaluate current performance	Test blinded
Bias	Accept consistent bias	Measure and adjust to reduce bias	Design to eliminate bias
Sample size	"Just enough" data, small sequential samples	Obtain 100% of available, relevant, data	Just in case" data
Flexibility of hypothesis	Hypothesis flexible, changes as learning takes place	No hypothesis	Fixed hypothesis
Testing strategy	Sequential tests	No tests	One large test
Confidentiality of data	Data used only by those involved in the improvement	Data available for public consumption	Research subjects' identities protected

Source: The Data Guide: Learning from Data to Improve Healthcare. Developed from Solberg, Leif I., Mosser, Gordon and McDonald, Susan. "The Three Faces of Performance Measurement: Improvement, Accountability and Research." Journal on Quality Improvement. March 1997, Vol.23, No. 3.

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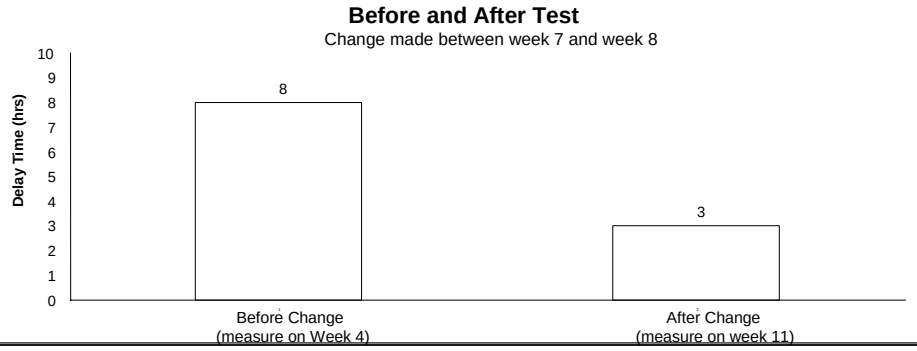
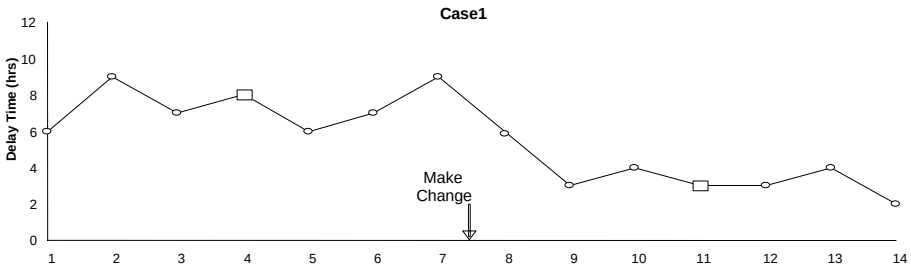
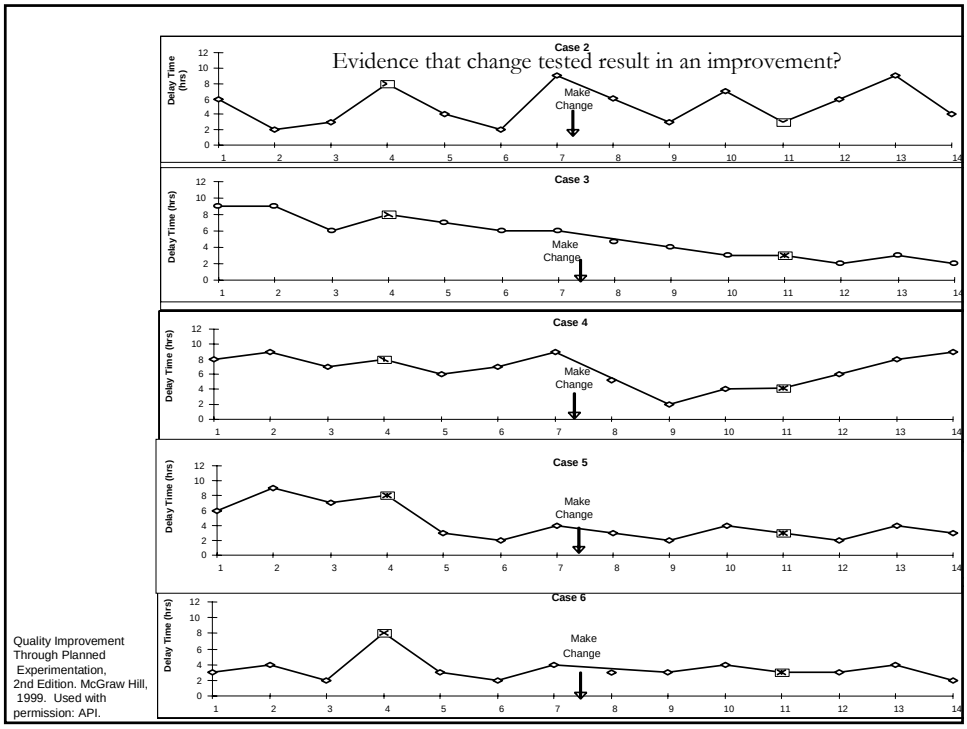




Quality Improvement Through Planned Experimentation, 2nd Edition. McGraw Hill, 1999. Used with permission: API.



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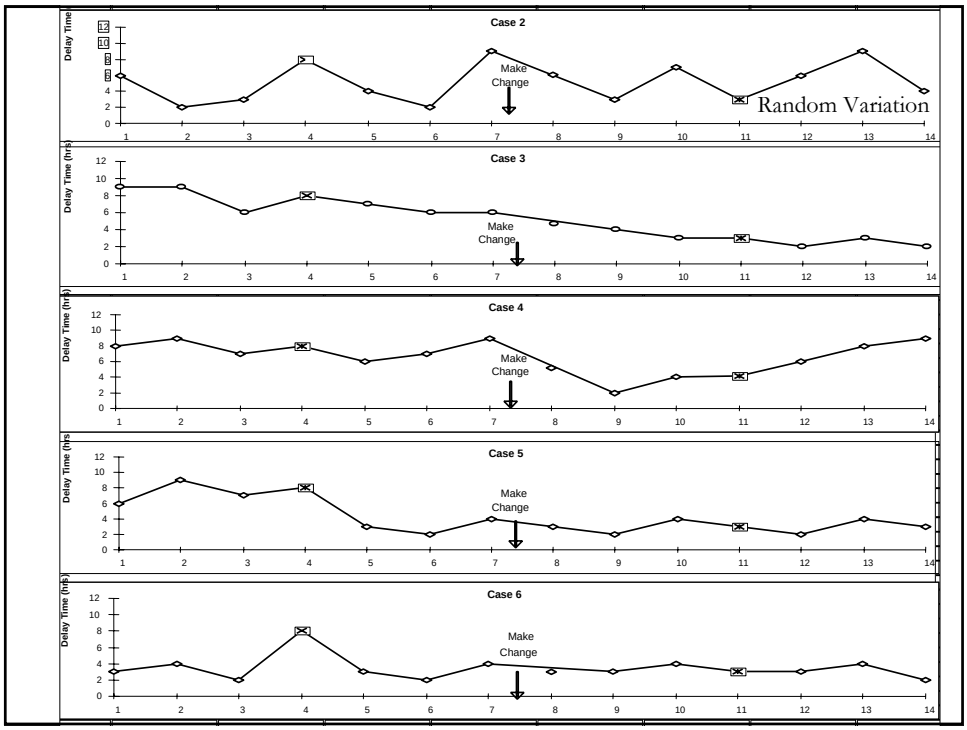
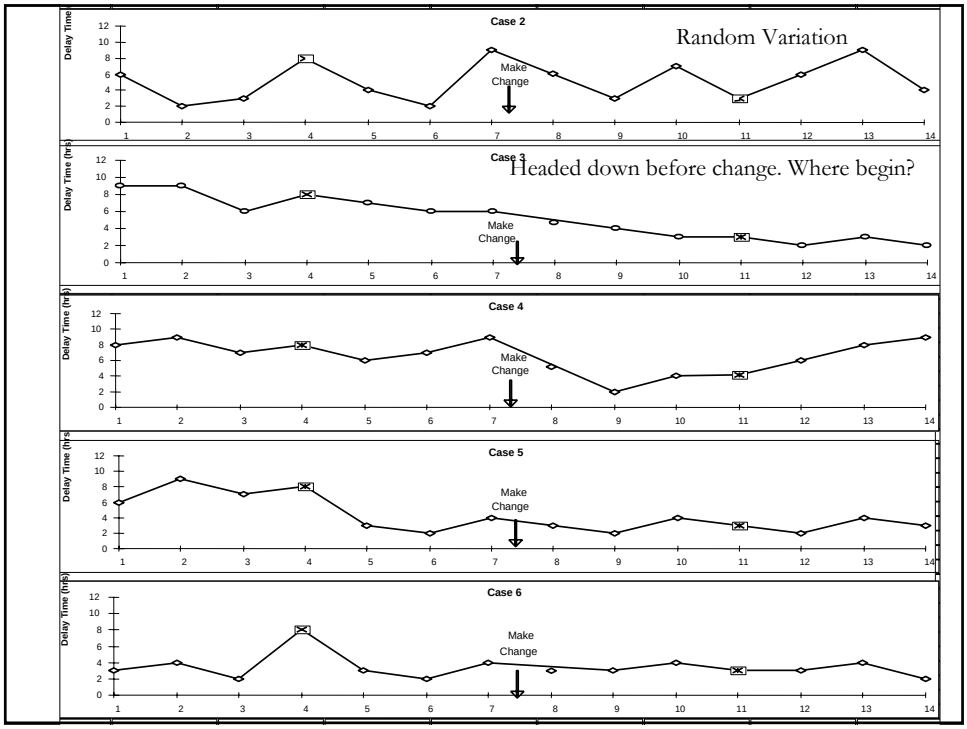
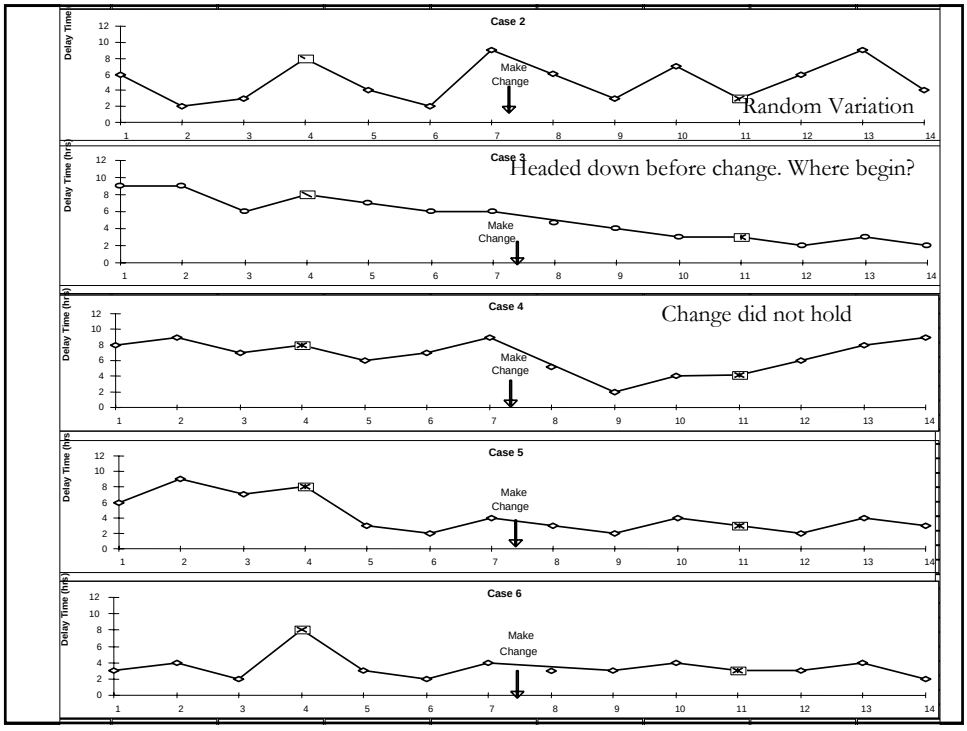
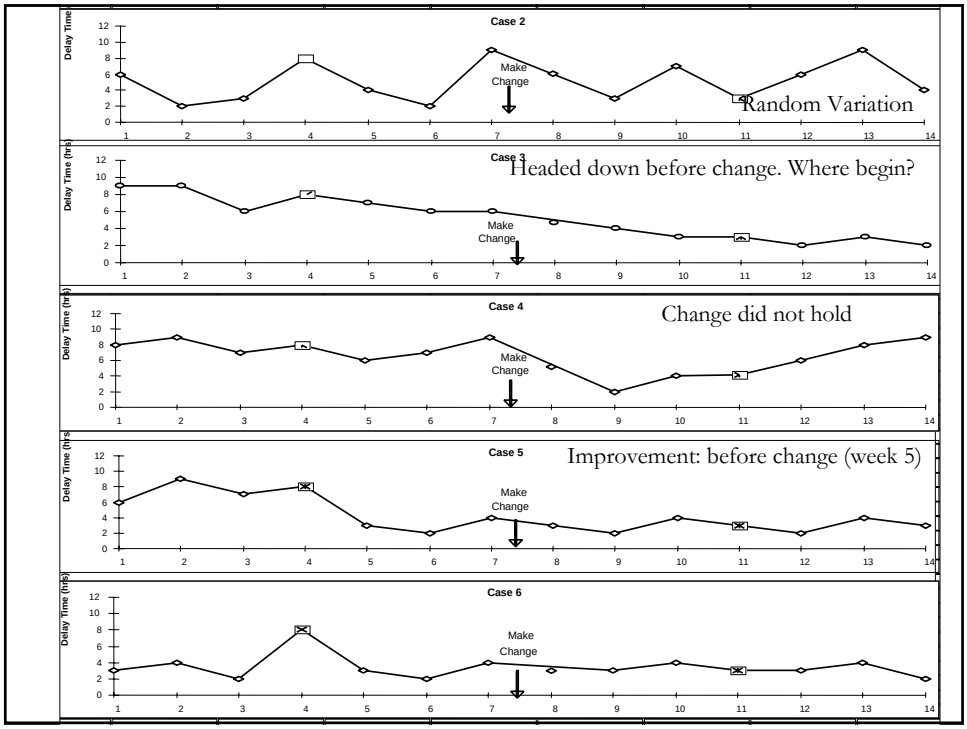
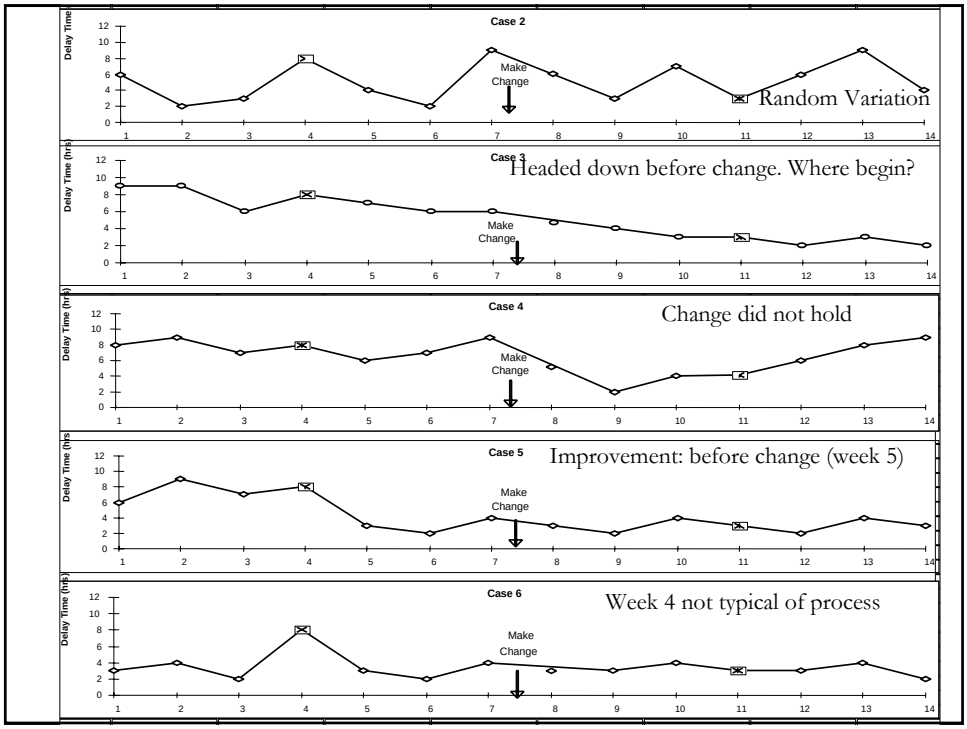



Case 2
Random Variation
Make Change
Case 3
Headed down before change. Where begin?
Make Change
Case 4
Make Change
Case 5
Make Change
Case 6
Make Change
Delay Time (hrs)


Case 2
Make Change
Random Variation
Case 3
Headed down before change. Where begin?
Make Change
Case 4
Change did not hold
Make Change
Case 5
Make Change
Case 6
Make Change
Delay Time (hrs)


Case 2
Delay Time
Make Change
Random Variation
Case 3
Delay Time (hrs)
Headed down before change. Where begin?
Make Change
Case 4
Delay Time (hrs)
Change did not hold
Make Change
Case 5
Delay Time (hrs)
Improvement: before change (week 5)
Make Change
Case 6
Delay Time (hrs)
Make Change


Case 2
Delay Time
Make Change
Random Variation
Case 3
Delay Time (hrs)
Headed down before change. Where begin?
Make Change
Case 4
Delay Time (hrs)
Change did not hold
Make Change
Case 5
Delay Time (hrs)
Improvement: before change (week 5)
Make Change
Case 6
Delay Time (hrs)
Week 4 not typical of process
Make Change

'And this is the period when the cat was away.'

Anonymous

Using Measurement

"You can't fatten a cow by weighing it."

--Palestinian Proverb

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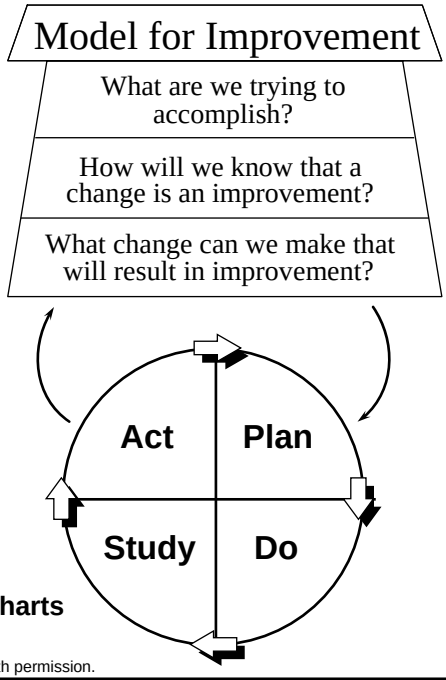
Pareto Charts

Run or Shewhart Charts

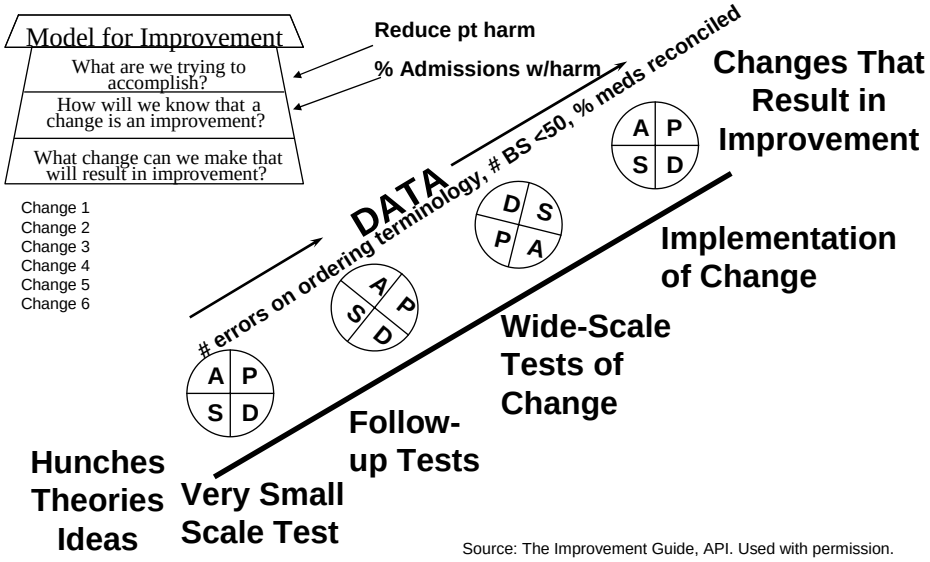
Run and Control Charts, Pareto charts, Frequency Plots, Scatter Plots



Run or Shewhart Charts

Source: The Improvement Guide, API. Used with permission.

Repeated Use of the PDSA Cycle



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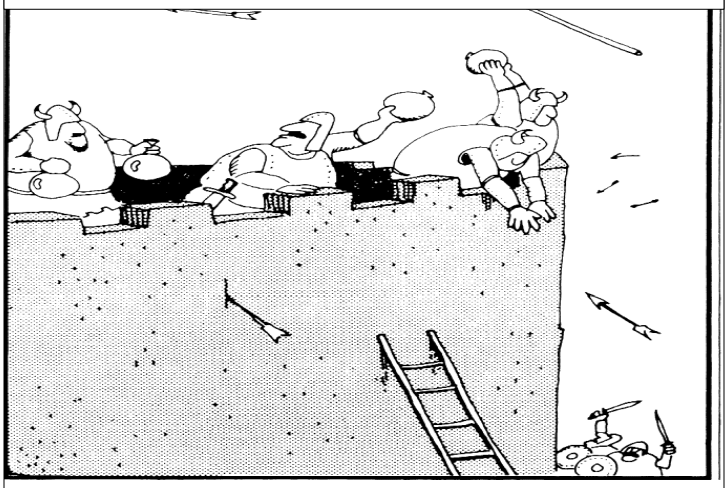


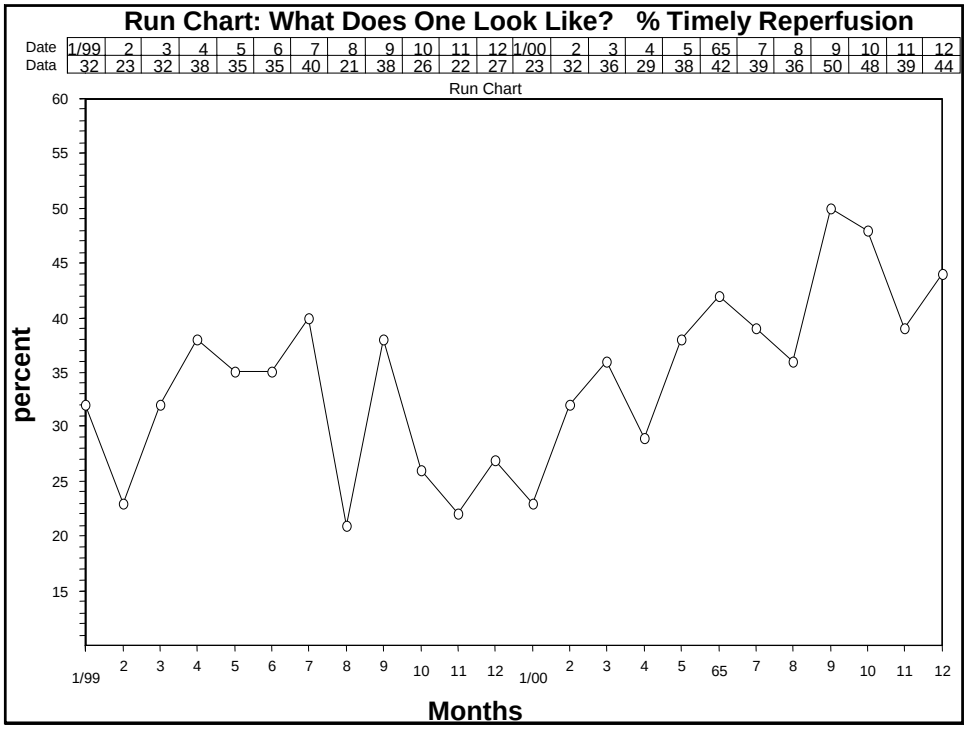
"Hot oil! We need hot oil! . . . Forget the water balloons!"

Run Chart

- A line graph of data plotted over time
- Data is kept in time order
- Can see flow of data
- Helps answer questions:
  - **How much variation do we have?**
  - **Is process changing significantly over time?**
  - **Has our change resulted in an improvement?**
  - **Did I hold the improvement?**

24

Source of all run chart material: The Data Guide: Learning from Data to Improve Healthcare, Chapter 3. . Used with permission.



The Tool List

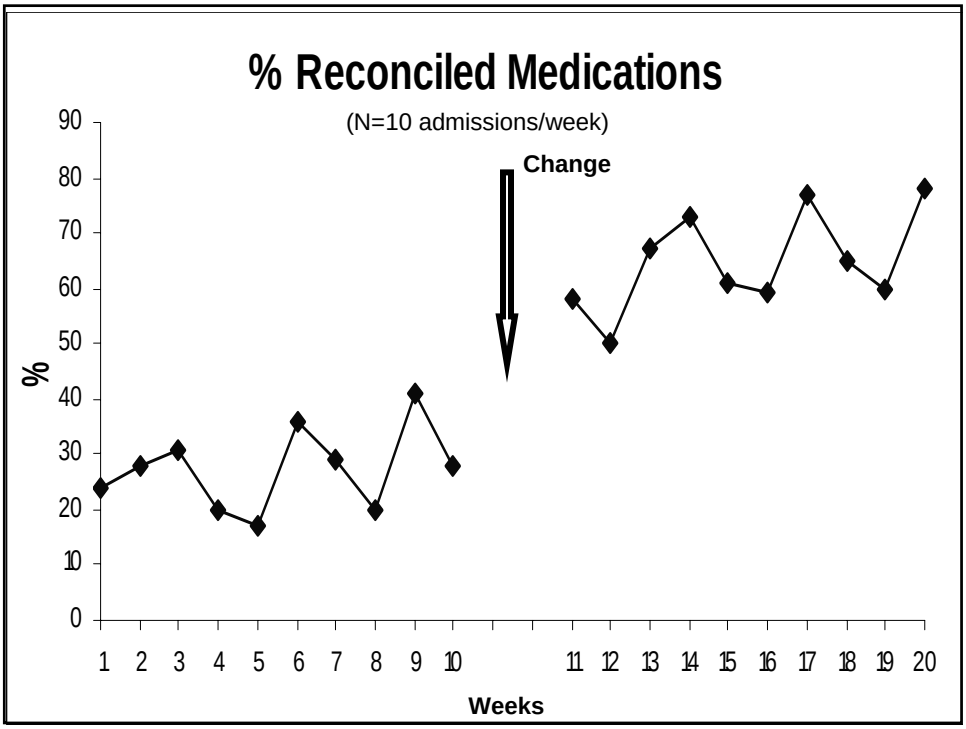
- **Run Chart:**
  - **How much variation do we have?**
  - **Is process changing significantly over time?**
  - **Has our change resulted in an improvement?**
  - **Did I hold the improvement?**

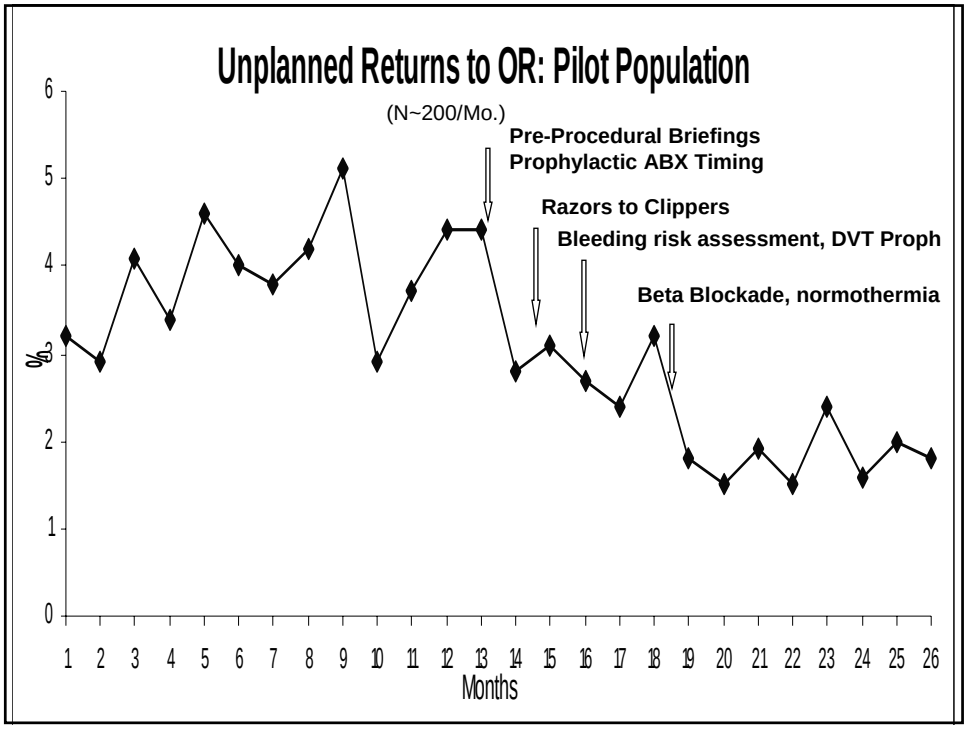
26

How Do We Tell a Change is an Improvement?

- Run charts speak for themselves
- Analyze with statistically based rules

27

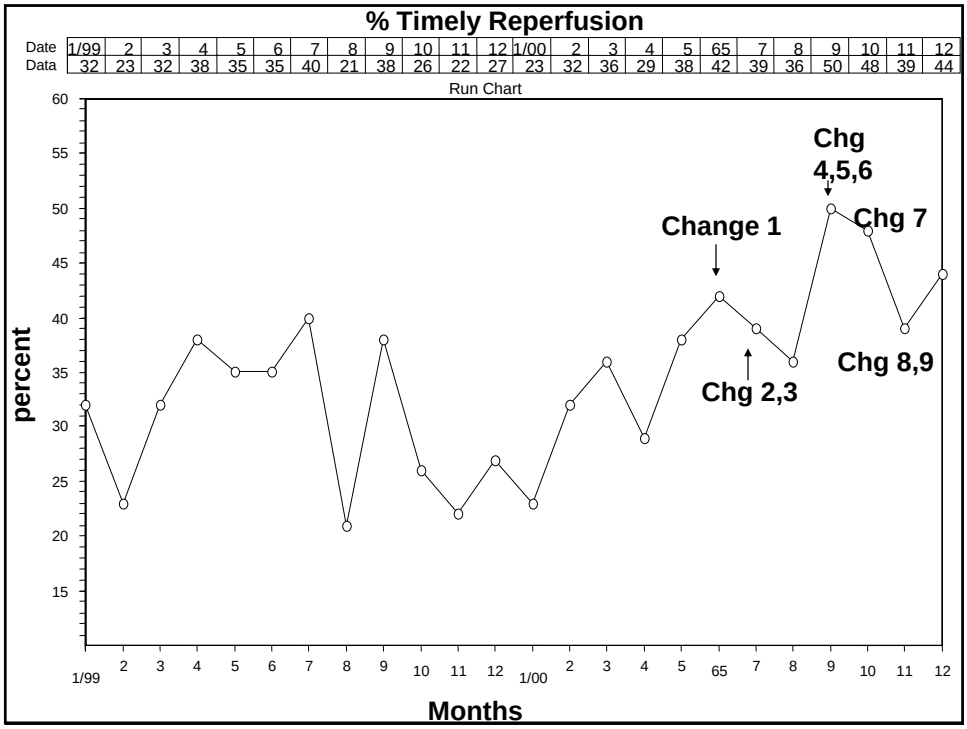




How Do We Tell a Change is an Improvement?

- Run chart may speak for itself
- If run chart does not speak for itself we can analyze it further using statistical rules
  - Can determine evidence of statistically significant change

30



Looking at Timeliness

The percent reperfusion in a timely manner per month from 1/00 through 12/01 reading from left to right:

32 23 32 38 35

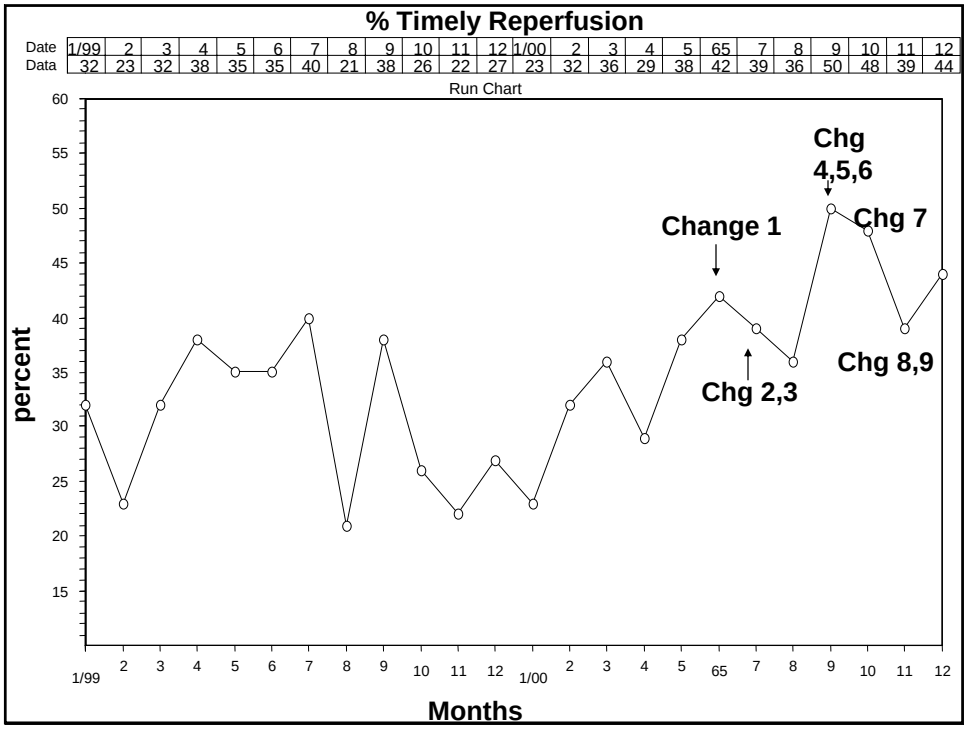
35 40 21 38 26

22 27 23 32 35

29 38 42 39 36

50 48 39 44

32



MEDIAN

MEDIAN:

In a series of numbers, the median is **physically the middle number** .

It has the same number of points equal to it or above it as it has equal to it or below it.

MEAN: The average.

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HOW TO FIND THE MEDIAN:

- After plotting the data on the graph, rewrite the data points , reordering them from high to low. Either count down to find the middle point, or cross off in a high/low fashion.
  - If you have an odd number of data points you will find a single point representing the median.
  - If you have an even number of data points you will have two remaining on your list. Add them together and find their average so your median is half way between these two points.

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Looking at Timeliness

The percent reperfusion in a timely manner per month from 1/00 through 12/01 reading from left to right:

32	**23**	**32**	**38**	**35**
35	**40**	**21**	**38**	**26**
22	**27**	**23**	**32**	**35**
29	**38**	**42**	**39**	**36**
50	**48**	**39**	**44**	

36

Finding the Median: Reordering the Data

50
48
44
42
40
39
39
38
38
38
36
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35
35
32
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32
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27
26
23
23
22
21

- **To find the median reorder the numbers from high to low and find the number physically in the middle. If you have two numbers left in the middle, add them together and divide by two.**

37

Finding the Median: Reordering the Data

~~50~~
~~48~~
~~44~~
~~42~~
~~40~~
~~39~~
~~39~~
~~38~~
~~38~~
~~38~~
~~36~~
35
35
~~35~~
~~32~~
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29
~~27~~
~~26~~
~~23~~
~~23~~
~~22~~
~~21~~

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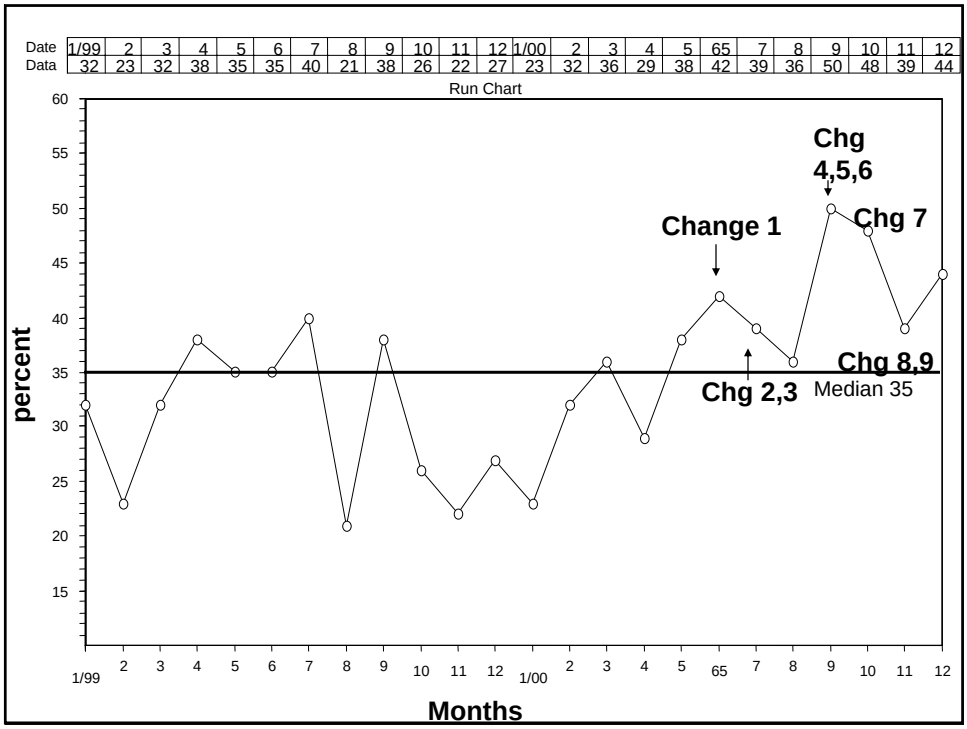

Mean and Median

- 8,10,11,14,16,18,20 Mean= 13.8 Median=14
- 8,10,11,14,16,18,**95** Mean= 24.5 Median=14
- **1**,10,11,14,16,18,20 Mean= 12.8 Median=14

Mean = arithmetic average of data
Median = middle value of ordered data

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How Do We Tell a Change is an Improvement?

- Run charts speak for themselves
- Analyze with probability based rules for evidence of statistically significant change
  - Improvement or degradation
  - We don't use special/common cause terminology

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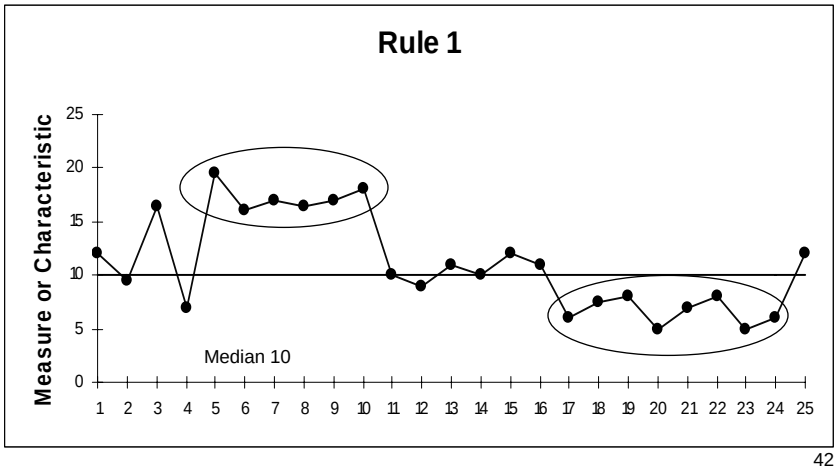
Rule 1

☺ **Six** or more consecutive **POINTS either all above or all below the median. Skip values on the median** and continue counting points. Values on the median DO NOT make or break a shift.



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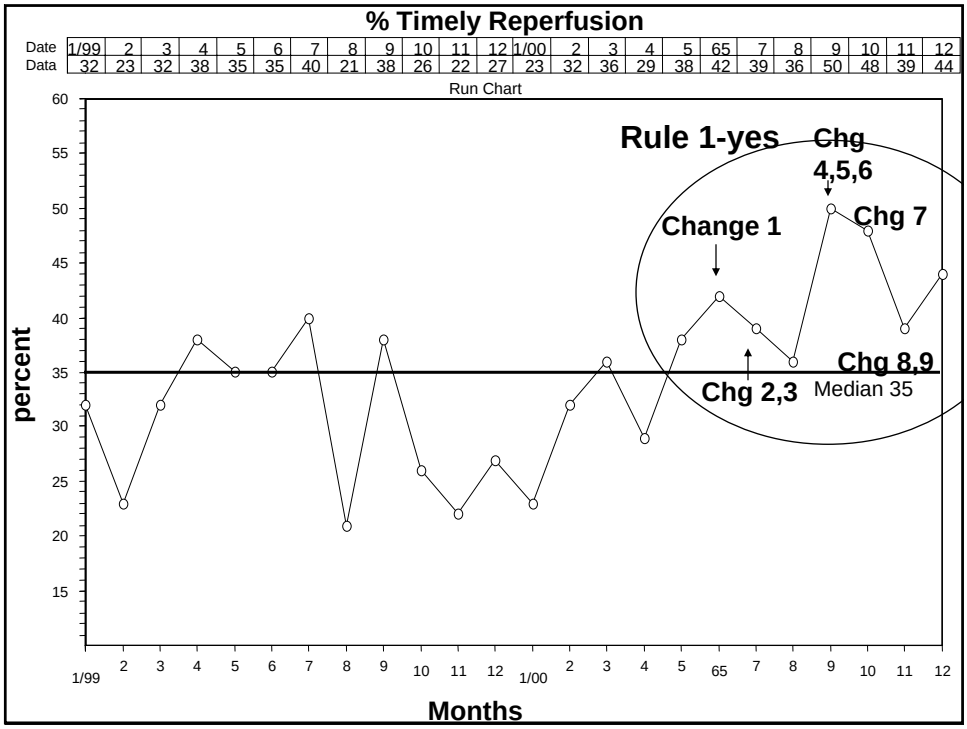
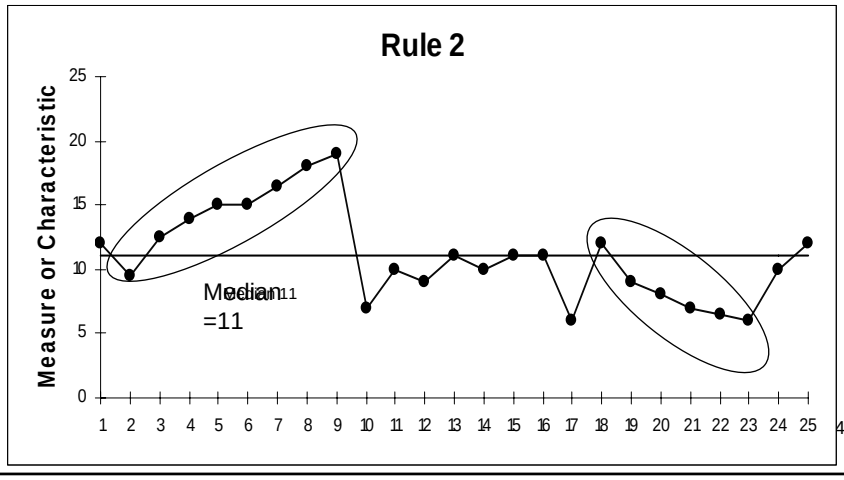
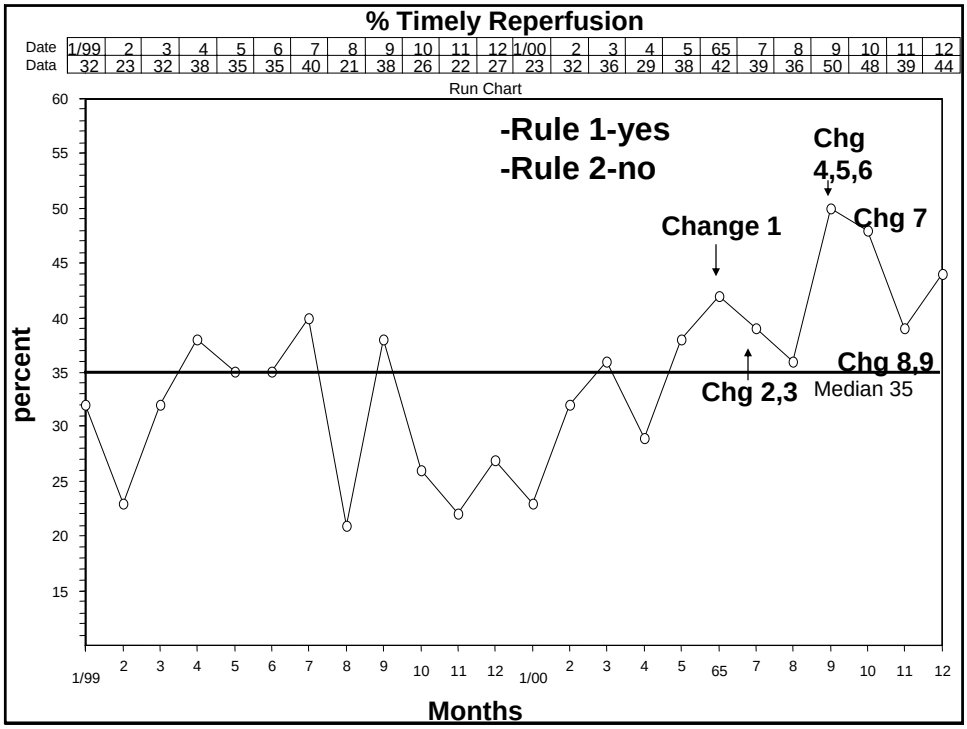


Rule 2

☺Five points all going up or all going down. If the value of two or more successive points is the same, ignore one of the points when counting; like values do not make or break a trend.

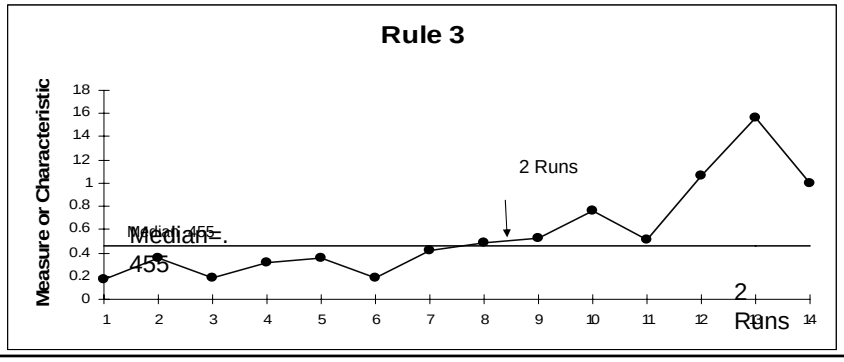


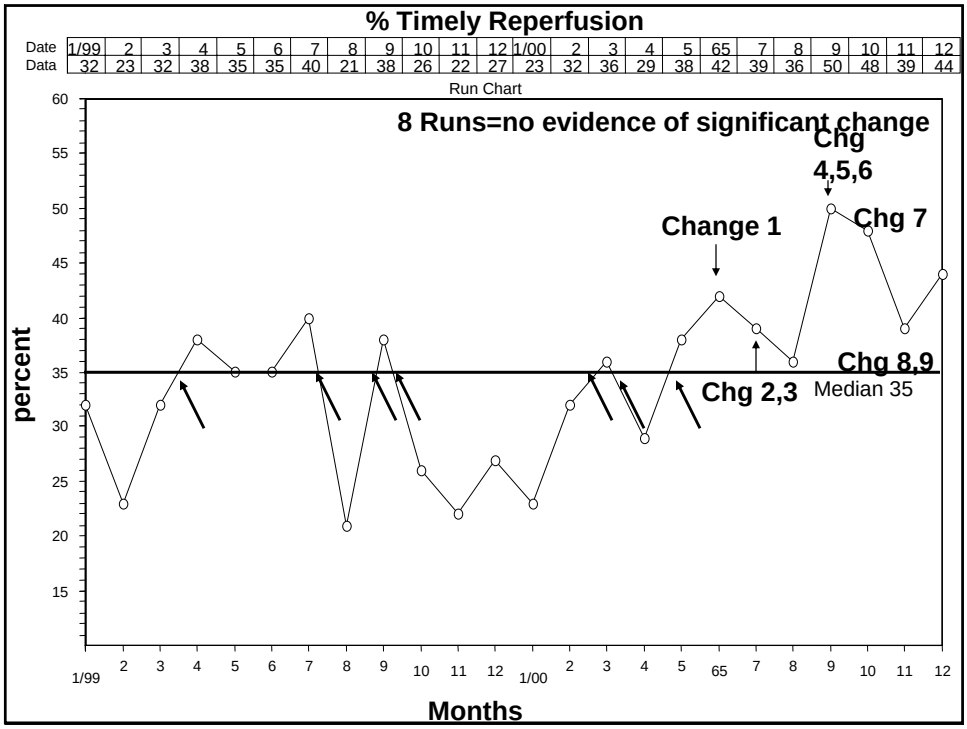


Rule 3

Microsoft Word Document

- **To Determine The Number of Runs Above and Below the Median:**
  - **A run is a series of points in a row on one side of the median.** Some points fall right on the median, which makes it hard to decide which run these points belong to.
  - So, an easy way to determine the number of runs is to **count the number of times the data line crosses the median and add one.**
  - Statistically significant change signaled by too few or too many runs.





Rule 3: # of Runs

Table for Checking for Too Many or Too Few Runs on a Run Chart

Total number of data points on the run chart that do not fall on the median	Lower limit for the number of runs (< than this number of runs is "too few")	Upper limit for the number of runs (> than this number of runs is "too many")
10	3	9
11	3	10
12	3	11
13	4	11
14	4	12
15	5	12
16	5	13
17	5	13
18	6	14
19	6	15
20	6	16
21	7	16
22	7	17
23	7	17
24	8	18
25	8	18

Table is based on about a 5% risk of failing the run test for random patterns of data.
Adapted from Swed, Feda S. and Eisenhart, C. (1943). "Tables for Testing Randomness of Grouping in a Sequence of Alternatives. Annals of Mathematical Statistics. Vol. XIV, pp.66 and 87, Tables II and III.

Rule 3: NUMBER OF RUNS

Microsoft W
Documer

- **To Determine The Number of Runs**
  - **A run is a series of points in a row on one side of the median.** Some points fall right on the median, which makes it hard to decide which run these points belong to.
  - So, an easy way to determine the number of runs is to **count the number of times the data line crosses the median and add one.**
  - Improvement is signaled by too few, or too many runs.
- **Steps**
  - Count the # of data points not falling on the median (in this example 22)
  - Count the # of runs (# times data line crosses the median + 1) (in this example 8)
  - Go to table and find out if you have too few or too many runs (table indicates between 7 and 17 runs means no signal of anything unusual going on. Below 7 runs or above 17 runs would be unusual for this amount of data)

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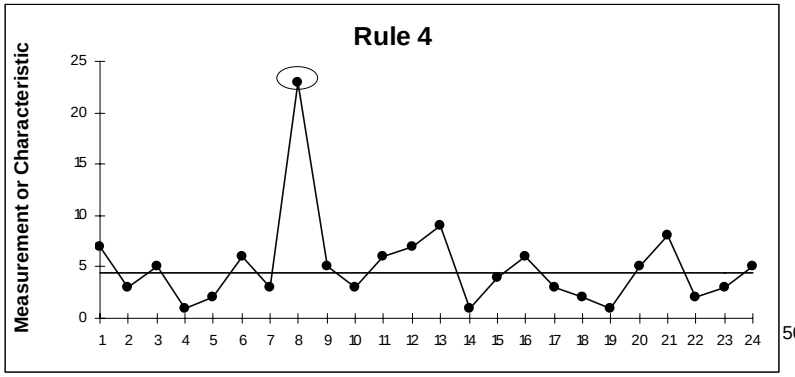
RULE 4

For detecting **unusually** large or small numbers:

- Data that is **Blatantly Obvious** different value
- Everyone studying the chart agrees that it is unusual
- Remember:
  - Every data set will have a high and a low - this does not mean the high or low are astronomical



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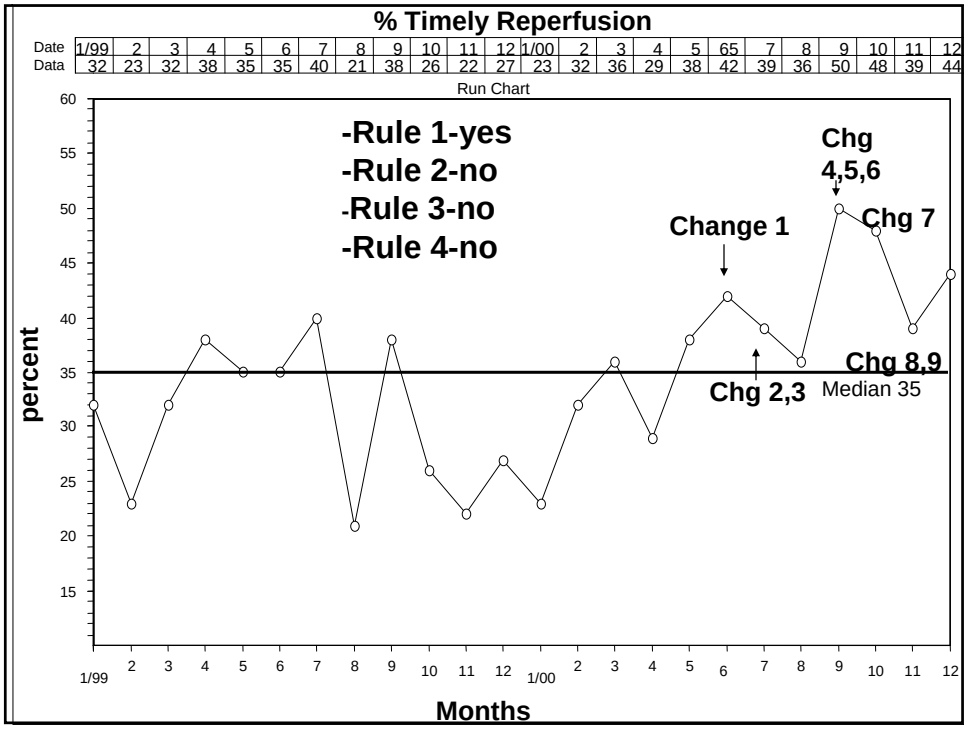
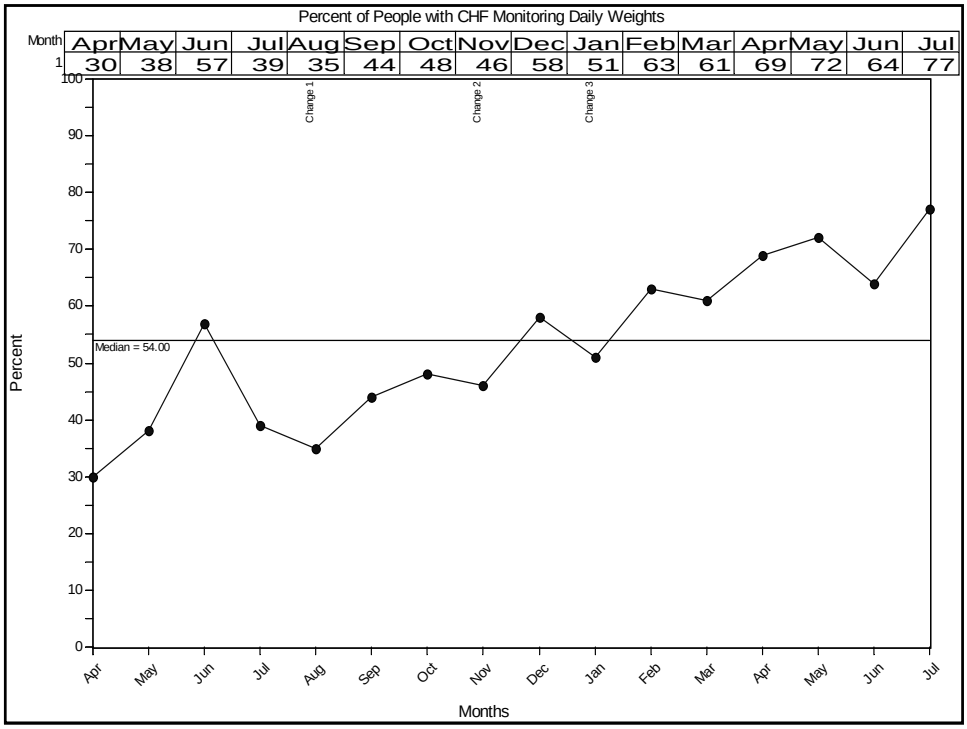
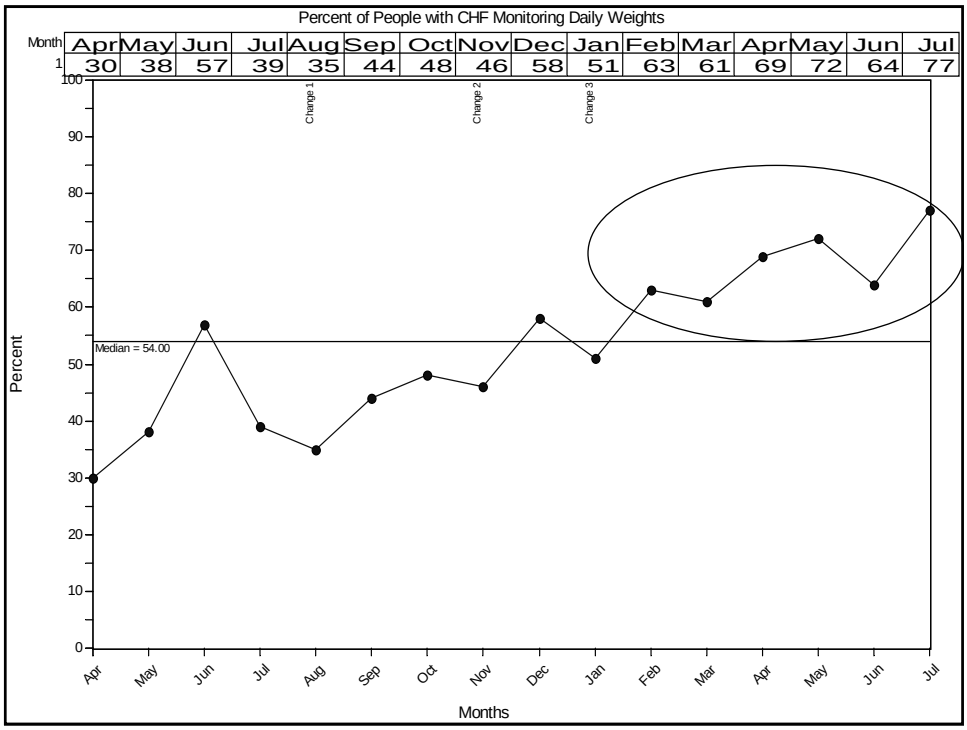


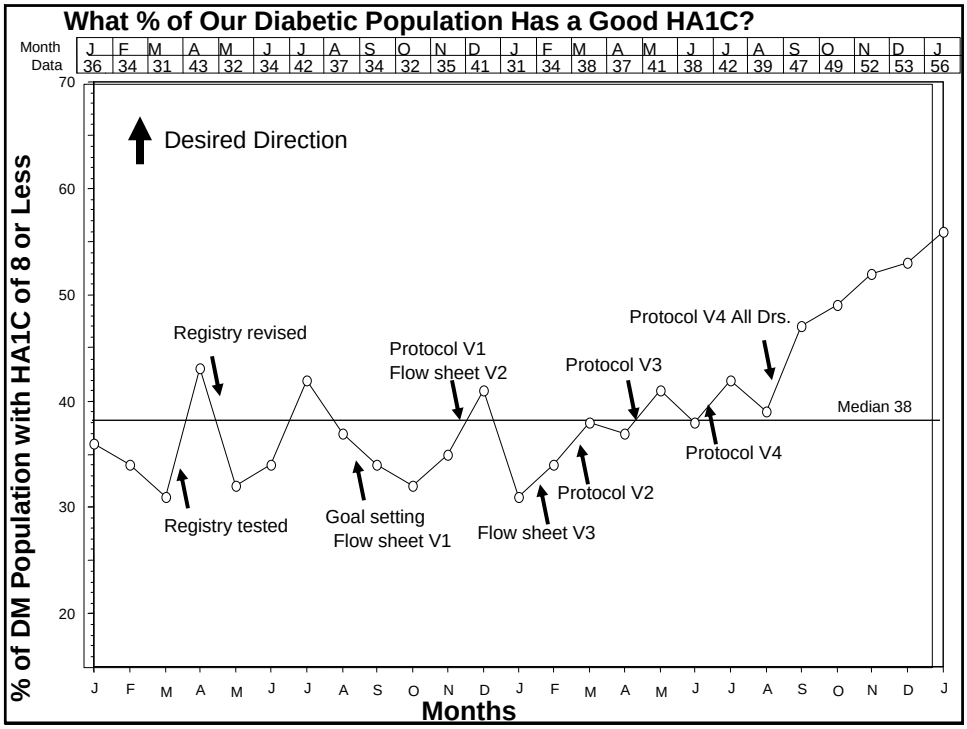
Let's Practice:

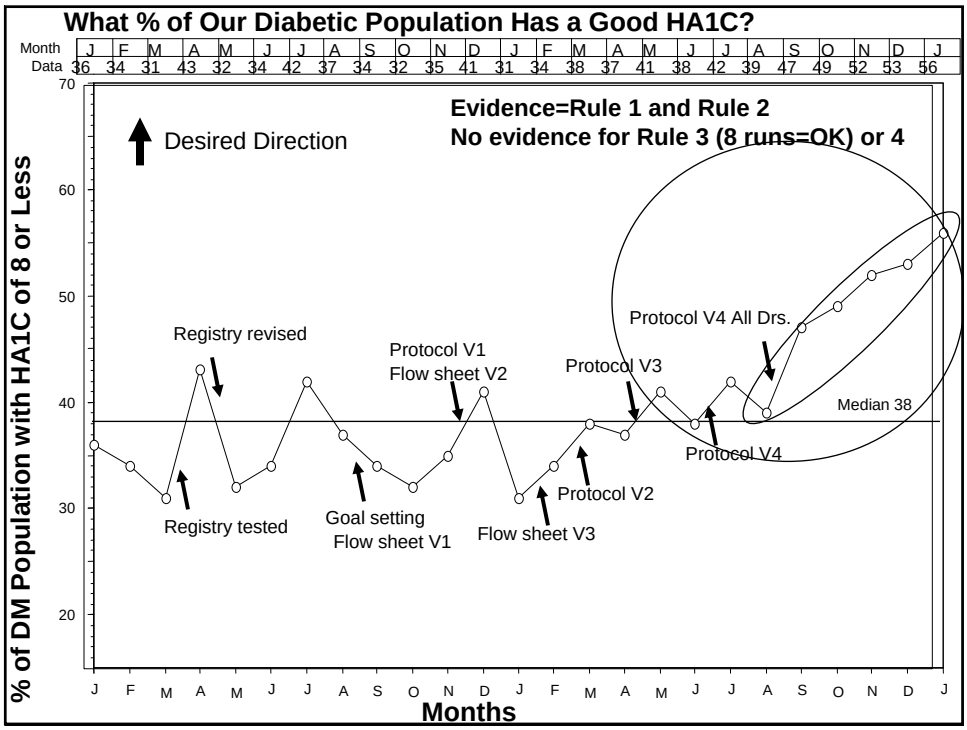
- **Please work in pairs**
- Evaluate the following run charts to determine :
  - Does the chart show evidence of improvement (significant change)
  - If significant change is noted - **which of the four rules** did you use to find it?

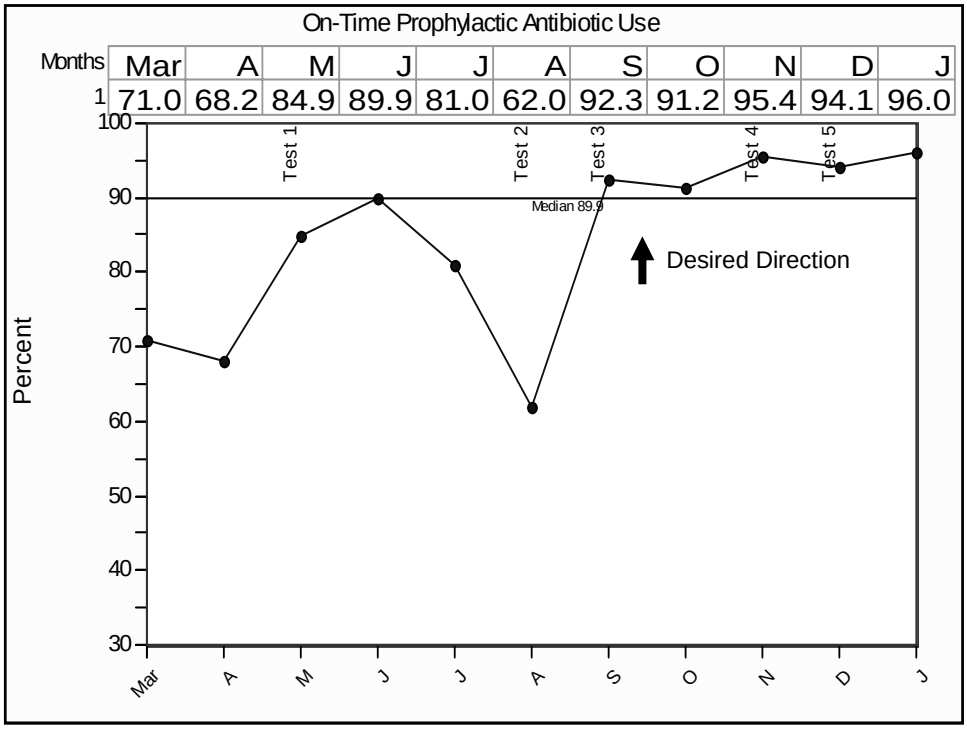
52

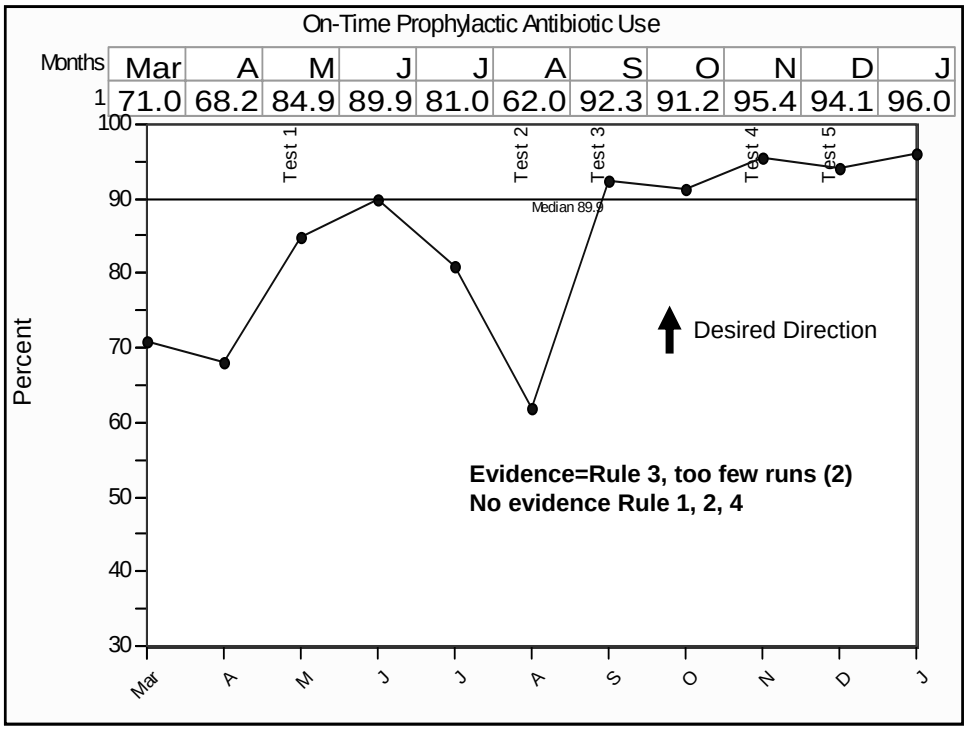

Percent of People with CHF Monitoring Daily Weights
Month
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
1 30 38 57 39 35 44 48 46 58 51 63 61 69 72 64 77
Change 1
Change 2
Change 3
Median = 54.00
Percent
Months

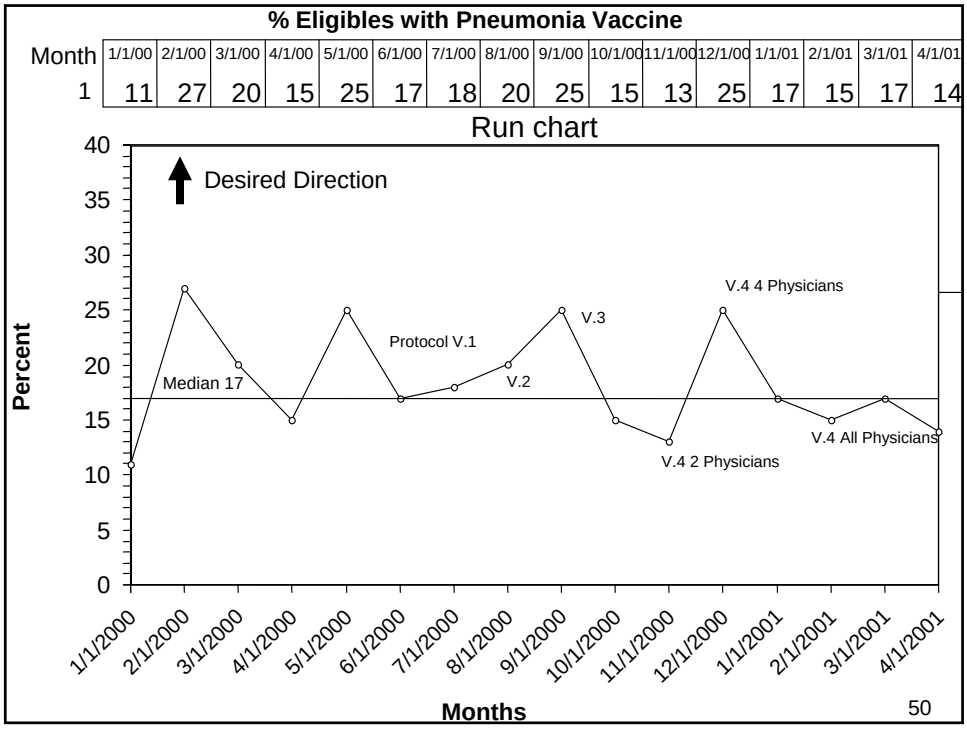

Percent of People with CHF Monitoring Daily Weights
Month
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
1 30 38 57 39 35 44 48 46 58 51 63 61 69 72 64 77
Change 1
Change 2
Change 3
Median = 54.00
Percent
Months

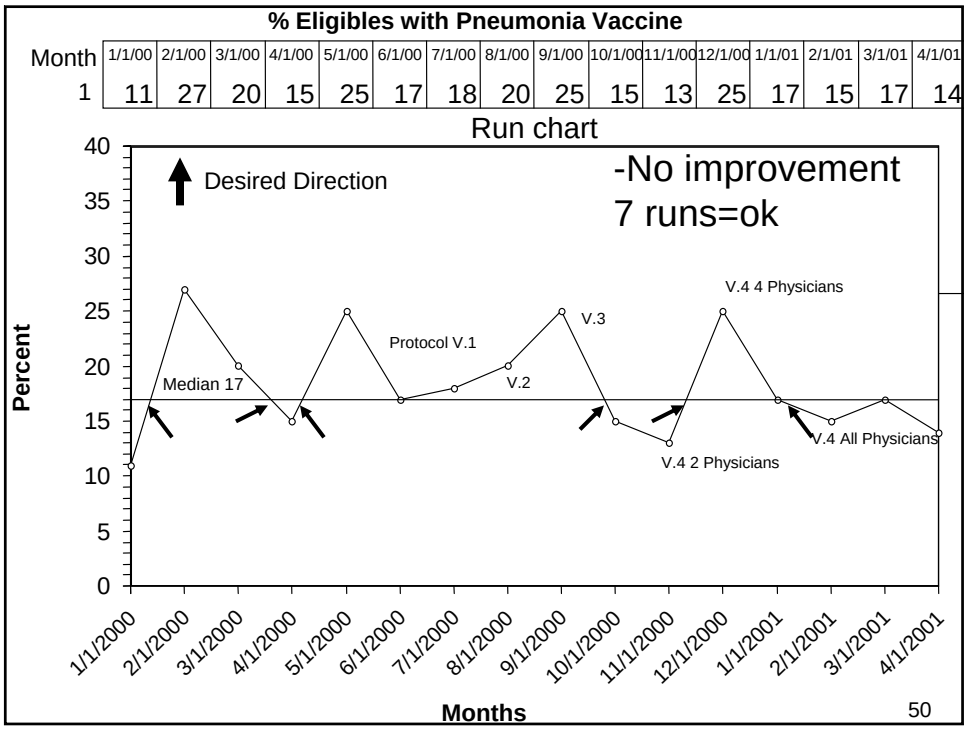

What % of Our Diabetic Population Has a Good HA1C?
Month J F M A M J J A S O N D J F M A M J J A S O N D J
Data 36 34 31 43 32 34 42 37 34 32 35 41 31 34 38 37 41 38 42 39 47 49 52 53 56
% of DM Population with HA1C of 8 or Less
Desired Direction
Registry revised
Registry tested
Goal setting
Flow sheet V1
Protocol V1
Flow sheet V2
Flow sheet V3
Protocol V2
Protocol V3
Protocol V4
Protocol V4 All Drs.
Median 38
Months

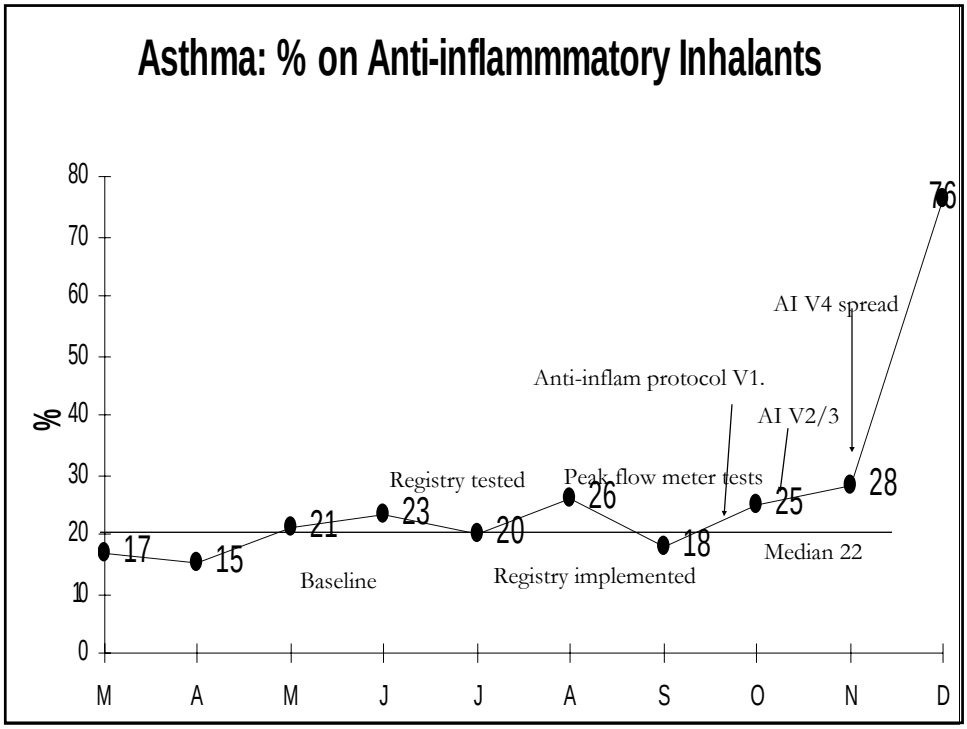

What % of Our Diabetic Population Has a Good HA1C?
Month J F M A M J J A S O N D J F M A M J J A S O N D J
Data 36 34 31 43 32 34 42 37 34 32 35 41 31 34 38 37 41 38 42 39 47 49 52 53 56
% of DM Population with HA1C of 8 or Less
Desired Direction
Evidence=Rule 1 and Rule 2
No evidence for Rule 3 (8 runs=OK) or 4
Registry revised
Registry tested
Goal setting
Flow sheet V1
Protocol V1
Flow sheet V2
Flow sheet V3
Protocol V2
Protocol V3
Protocol V4
Protocol V4 All Drs.
Median 38
Months

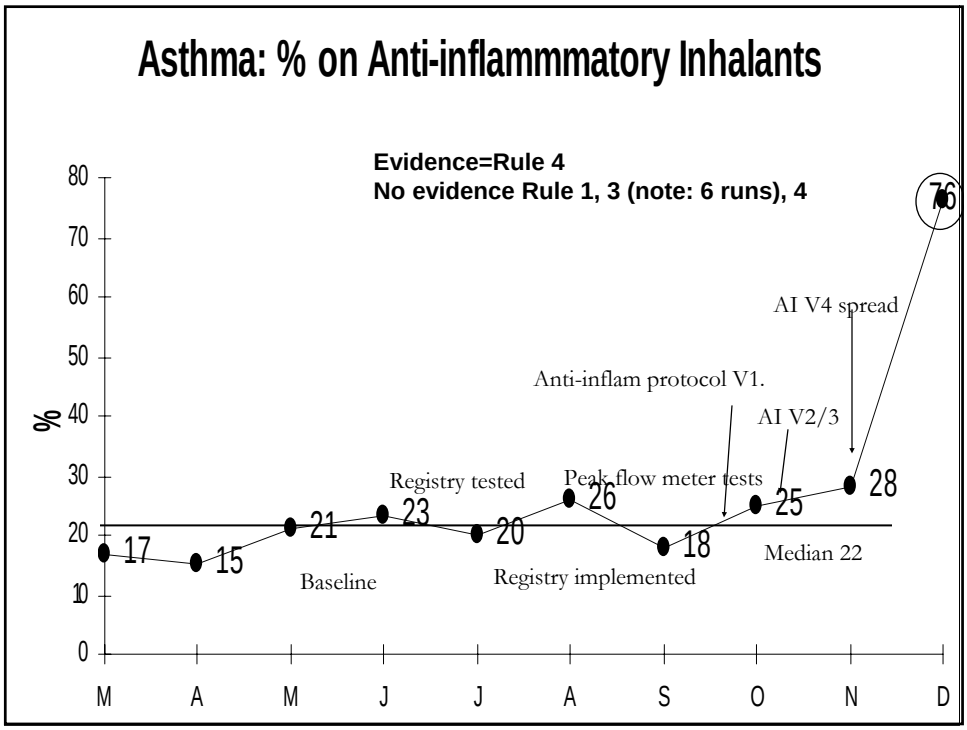

On-Time Prophylactic Antibiotic Use
Months
Mar A M J J A S O N D J
1 71.0 68.2 84.9 89.9 81.0 62.0 92.3 91.2 95.4 94.1 96.0
Test 1
Test 2
Test 3
Test 4
Test 5
Median 89.9
Desired Direction
Percent
100
90
80
70
60
50
40
30
Mar A M J J A S O N D J


On-Time Prophylactic Antibiotic Use
Months
Mar A M J J A S O N D J
1 71.0 68.2 84.9 89.9 81.0 62.0 92.3 91.2 95.4 94.1 96.0
Test 1
Test 2
Test 3
Test 4
Test 5
Median 89.9
Desired Direction
Evidence=Rule 3, too few runs (2)
No evidence Rule 1, 2, 4
Percent
100
90
80
70
60
50
40
30
Mar A M J J A S O N D J


% Eligibles with Pneumonia Vaccine
Month
1/1/00 2/1/00 3/1/00 4/1/00 5/1/00 6/1/00 7/1/00 8/1/00 9/1/00 10/1/00 11/1/00 12/1/00 1/1/01 2/1/01 3/1/01 4/1/01
1
11 27 20 15 25 17 18 20 25 15 13 25 17 15 17 14
Run chart
Desired Direction
Percent
Median 17
Protocol V.1
V.2
V.3
V.4 4 Physicians
V.4 2 Physicians
V.4 All Physicians
Months
50


% Eligibles with Pneumonia Vaccine
Month
1/1/00 2/1/00 3/1/00 4/1/00 5/1/00 6/1/00 7/1/00 8/1/00 9/1/00 10/1/00 11/1/00 12/1/00 1/1/01 2/1/01 3/1/01 4/1/01
1
11 27 20 15 25 17 18 20 25 15 13 25 17 15 17 14
Run chart
Desired Direction
-No improvement
7 runs=ok
Percent
Median 17
Protocol V.1
V.2
V.3
V.4 4 Physicians
V.4 2 Physicians
V.4 All Physicians
Months
50

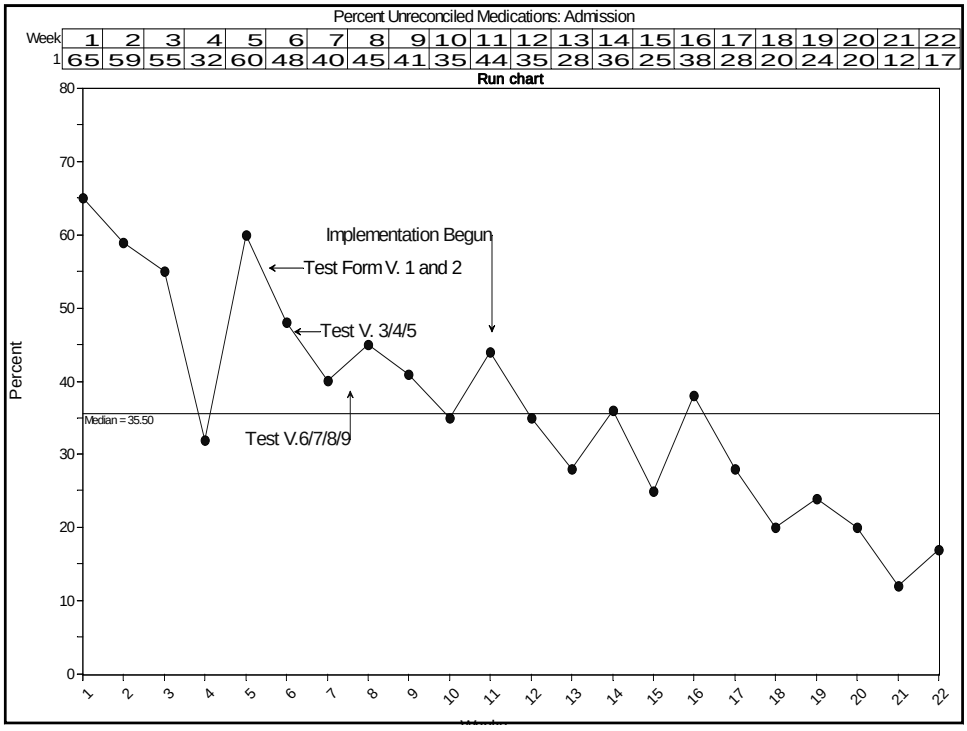

Asthma: % on Anti-inflammmatory Inhalants
%
80
70
60
50
40
30
20
10
0
M A M J J A S O N D
17
15
21
23
20
26
18
25
28
76
Baseline
Registry tested
Registry implemented
Peak flow meter tests
Anti-inflam protocol V1.
AI V2/3
AI V4 spread
Median 22


Asthma: % on Anti-inflammmatory Inhalants
Evidence=Rule 4
No evidence Rule 1, 3 (note: 6 runs), 4
%
80
70
60
50
40
30
20
10
0
M A M J J A S O N D
17
15
21
23
20
26
18
25
28
76
Baseline
Registry tested
Registry implemented
Peak flow meter tests
Anti-inflam protocol V1.
AI V2/3
AI V4 spread
Median 22

The Tool List

- **Run Chart:**
  - **How much variation do we have?**
  - **Is process changing significantly over time?**
  - **Has our change resulted in an improvement?**
  - **Did I hold the improvement?**

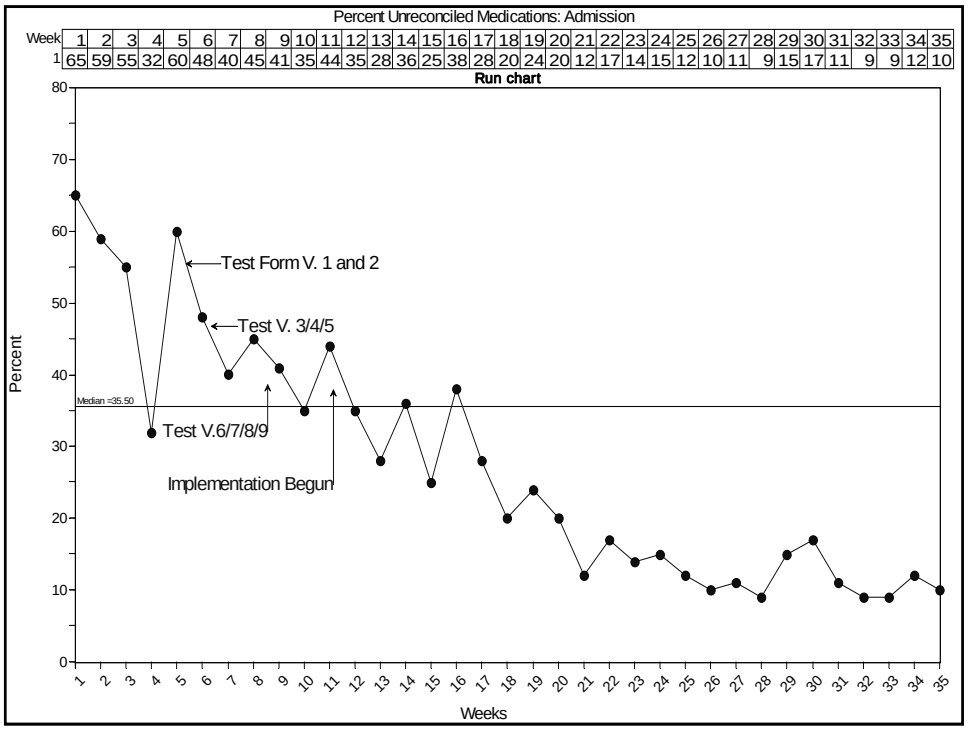
63

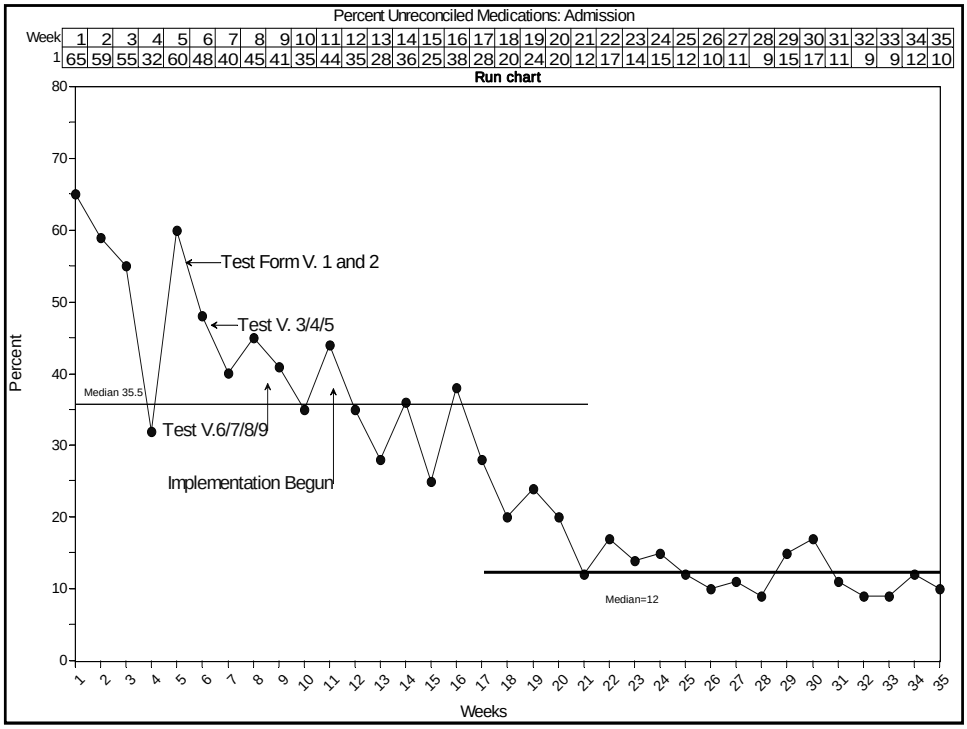


The Tool List

- **Run Chart:**
  - **How much variation do we have?**
  - **Is process changing significantly over time?**
  - **Has our change resulted in an improvement?**
  - **Did I hold the improvement?**

65

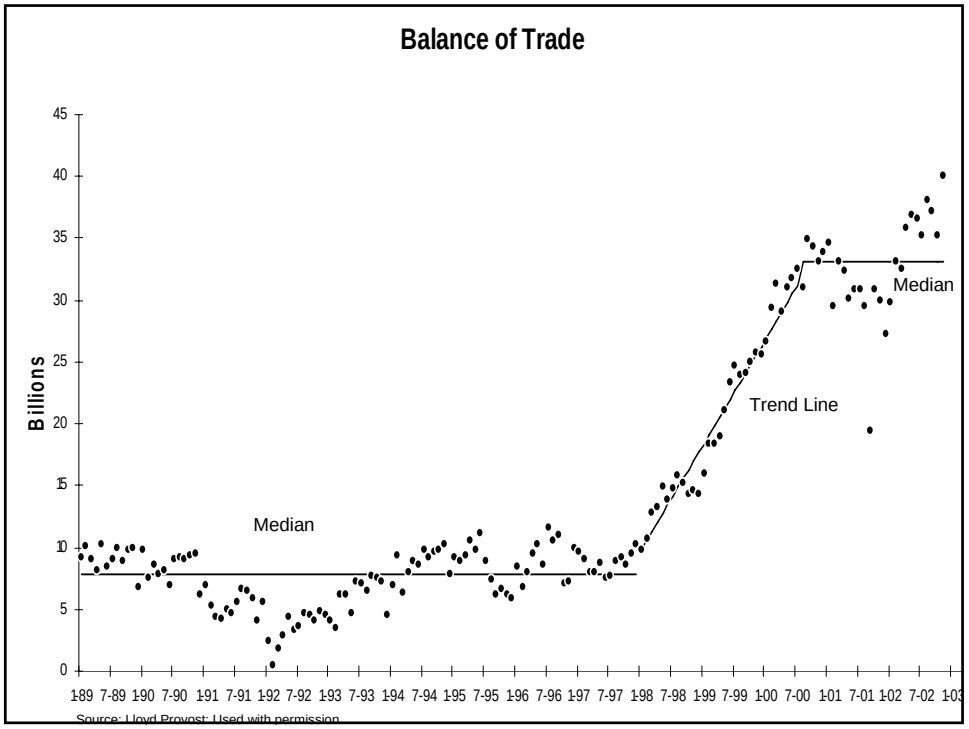




Trend Lines

- Do not place on run chart if no statistically significant evidence of change (the four rules)
- May place on run chart if do have statistically significant evidence of change and want to illustrate directionality and magnitude with a trend line

68



Additional Ways to Display Data on a Run Chart for Learning

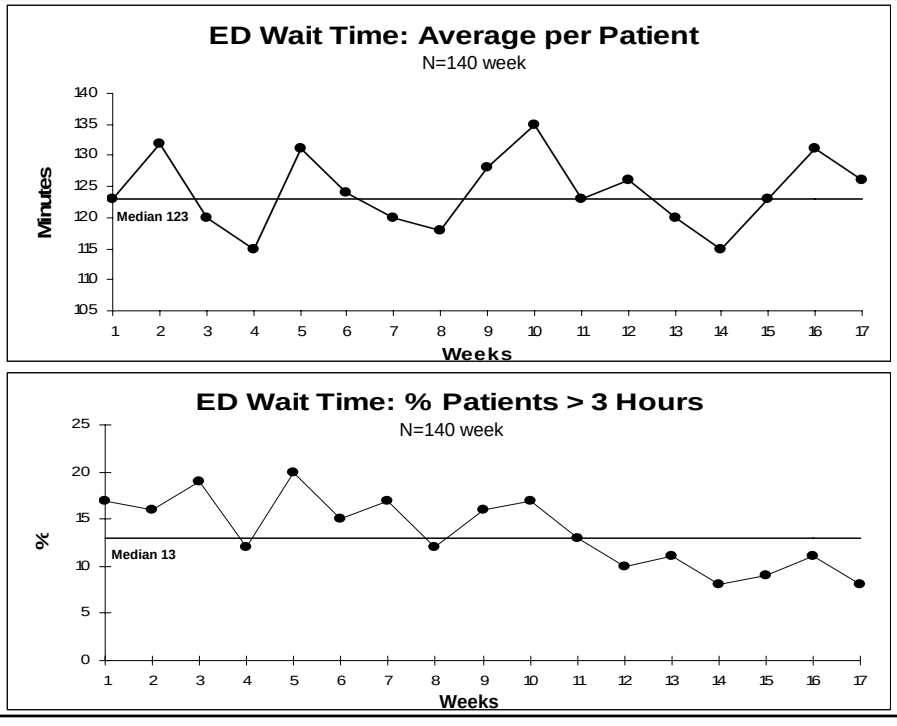
- Extreme percentage" statistics to measure high or low end of scale
- Use ratios (percents) to adjust for impact of natural changes to the systems
- Avoid measures and statistics that result in all "zeros" and "100%'s"
- Cases or time between events
- Small multiples
- Family of measures
- Display competing events
- Multiple measures on the same chart
- Multiple statistics for same measure
- Stratification using run chart

70

Use of “Extreme Percentage” to Measure Improvement at High or Low End of Scale

- **Can be used to focus on the outliers and extreme cases:**
- **Percent of patients giving our service the highest rating of “Excellent”**
- **Percent of patients waiting in ED longer than three hours**
- **Percent of STAT labs not received within one hour**
- **Percent of patients receiving same-day appointment**
- **Percent of surgeries delayed more than 60 minutes**

71



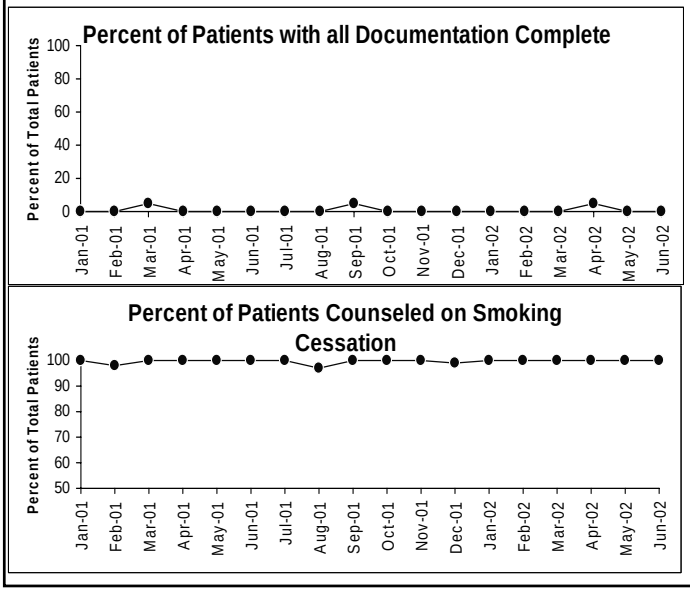
Use of Ratios

- **Ratio: numerator - key measure**
  denominator - unit of production or volume
- **Minimizes confusion from changes in volume on key measure**

Key Measure	Standard Unit	Ratio
# ADEs	**#of doses dispensed**	**ADE / dose**
OR costs	**#of surgeries**	**cost / surgery**
# Peri-op adverse events	**# admissions**	**POAE / admission**
patients leaving	**total ED arrivals**	**leaving / total arrival**

73

Measures or Statistics That Result in all "Zeros" and "100%'s"



Can the definitions of the measures be modified to see some variation in the data?

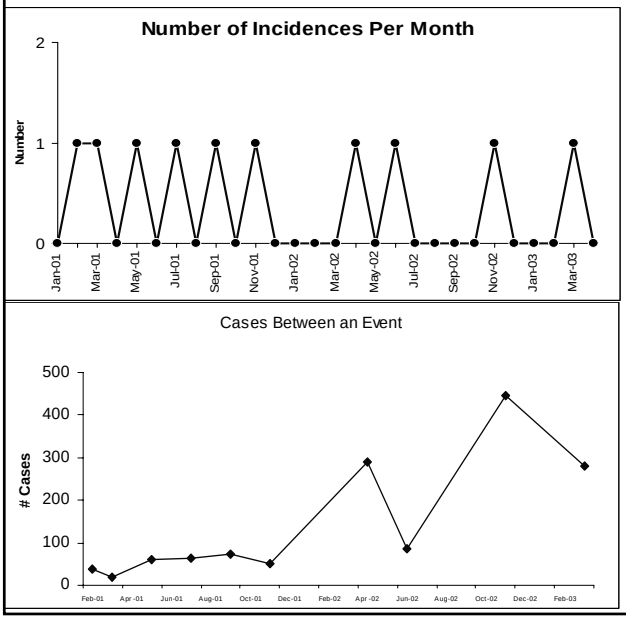
74

Why Display Cases or Time Between Events?

- When events are relatively rare the monthly statistic is a very small number -- or frequently zero
- It' harder to detect patterns of change
- One useful approach is to track and display "time between" events

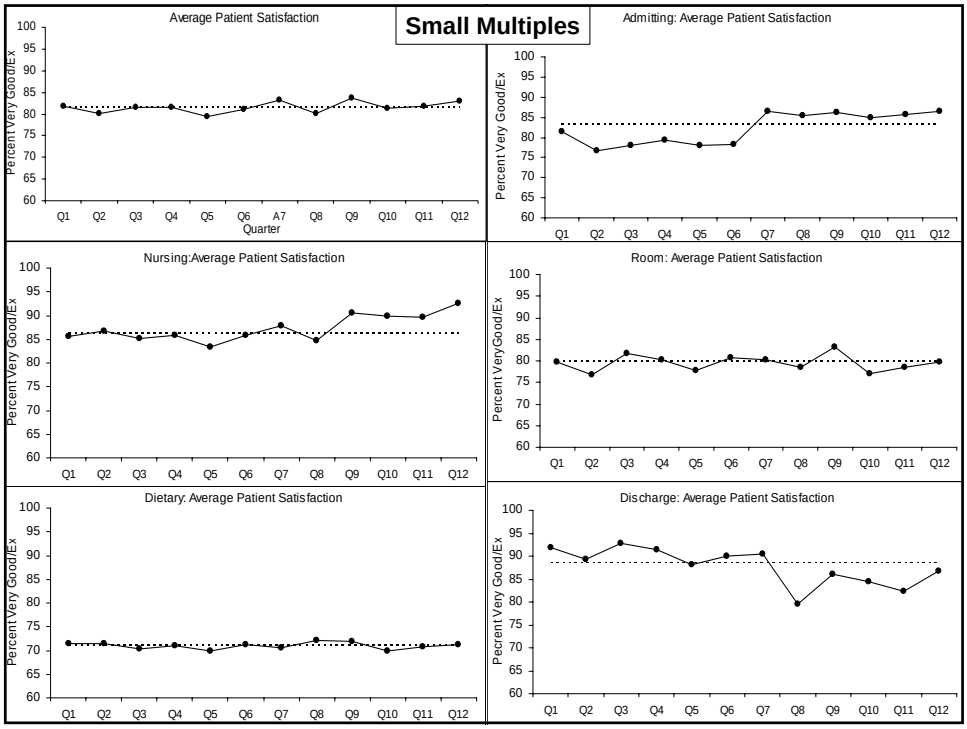
75

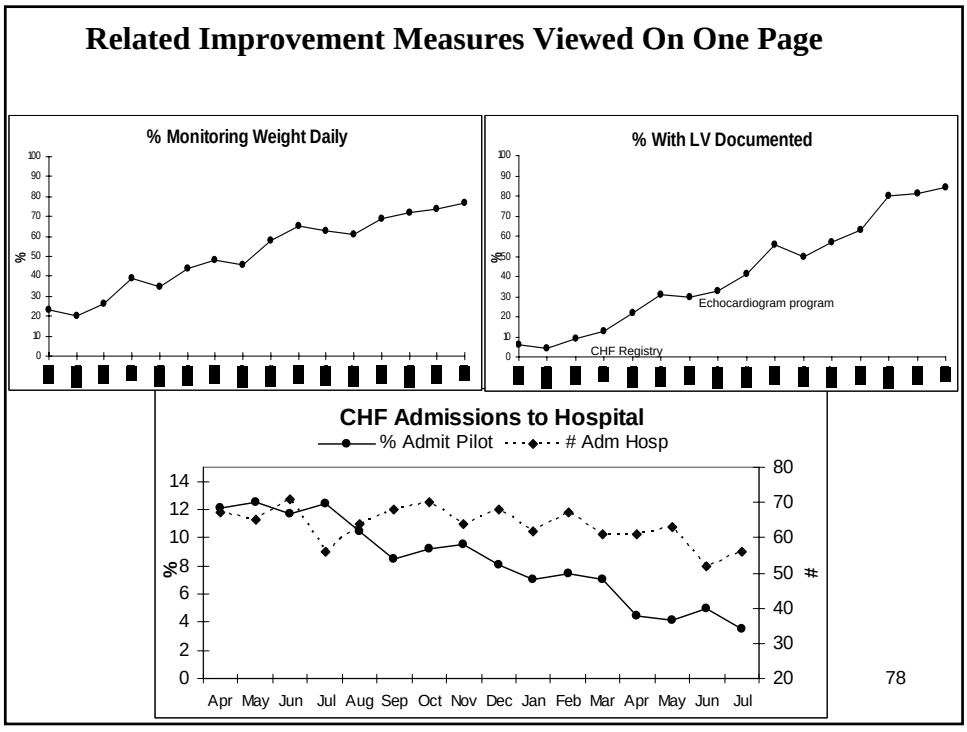
Use "Time Between" for Rare Events



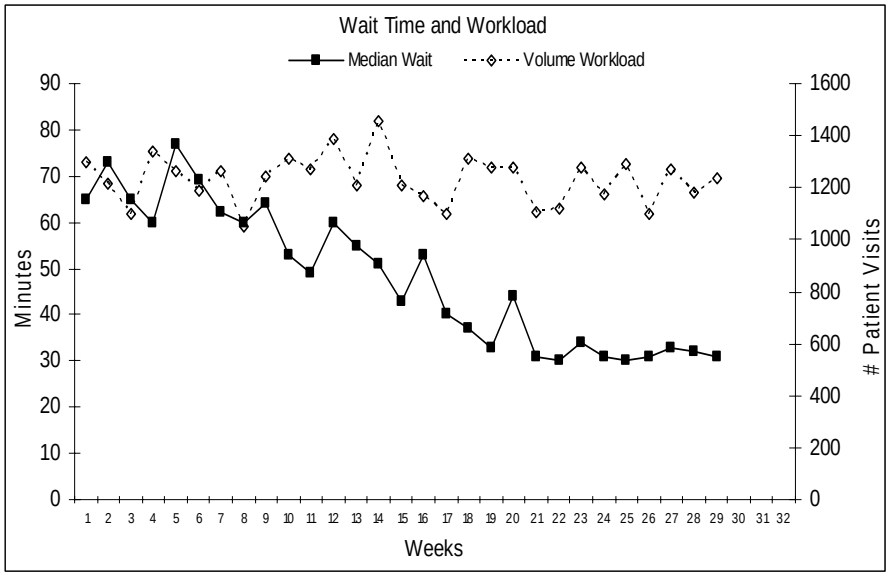
Instead of plotting the number of incidences each month, plot the time (or number of cases, patients, visits, etc) between incidences.

76

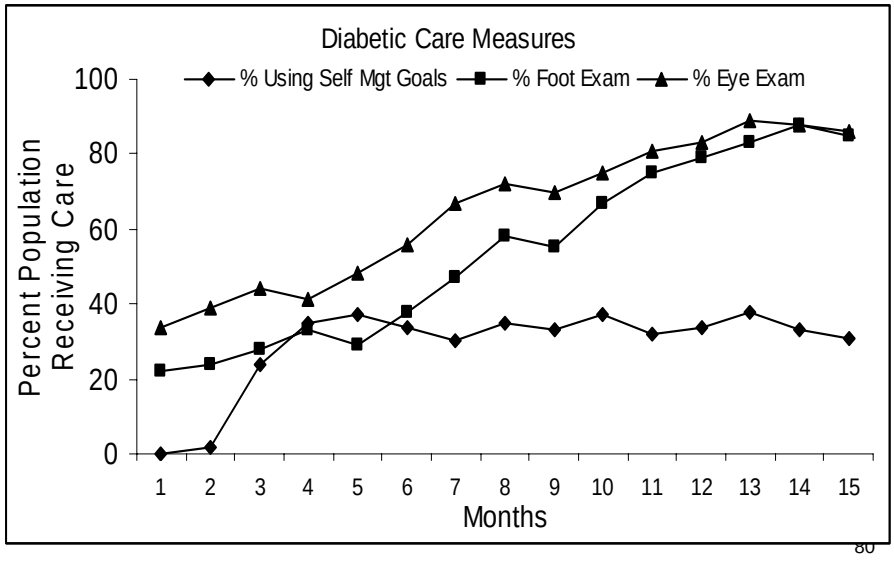

Small Multiples
Average Patient Satisfaction
Admitting: Average Patient Satisfaction
Nursing:Average Patient Satisfaction
Room: Average Patient Satisfaction
Dietary: Average Patient Satisfaction
Discharge: Average Patient Satisfaction
Percent Very Good/Ex
Quarter
Q1 Q2 Q3 Q4 Q5 Q6 Q7 Q8 Q9 Q10 Q11 Q12


Related Improvement Measures Viewed On One Page
% Monitoring Weight Daily
% With LV Documented
Echocardiogram program
CHF Registry
CHF Admissions to Hospital
% Admit Pilot
# Adm Hosp
Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul
78

Using a Run Chart to Display Competing Events

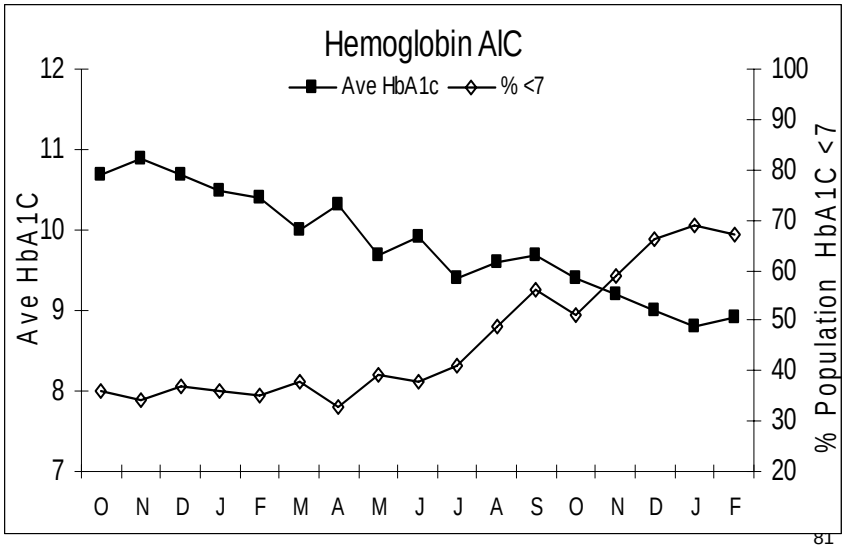


Multiple Measures on a Single Run Chart



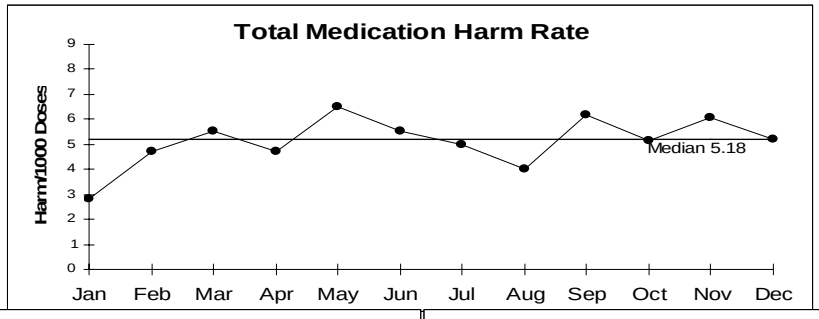
80

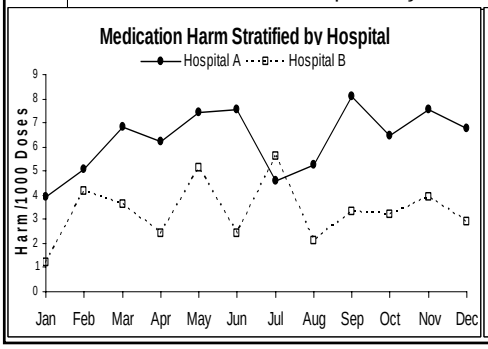
Run Chart Displaying Multiple Statistics for the Same Measure

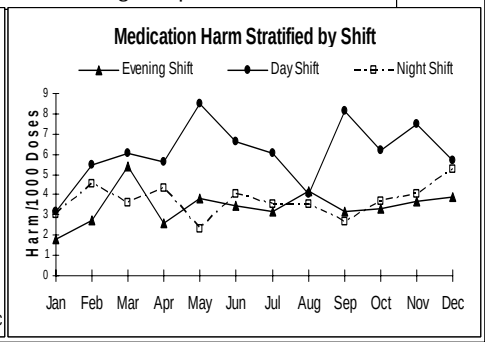


81

Stratification Using a Run Chart



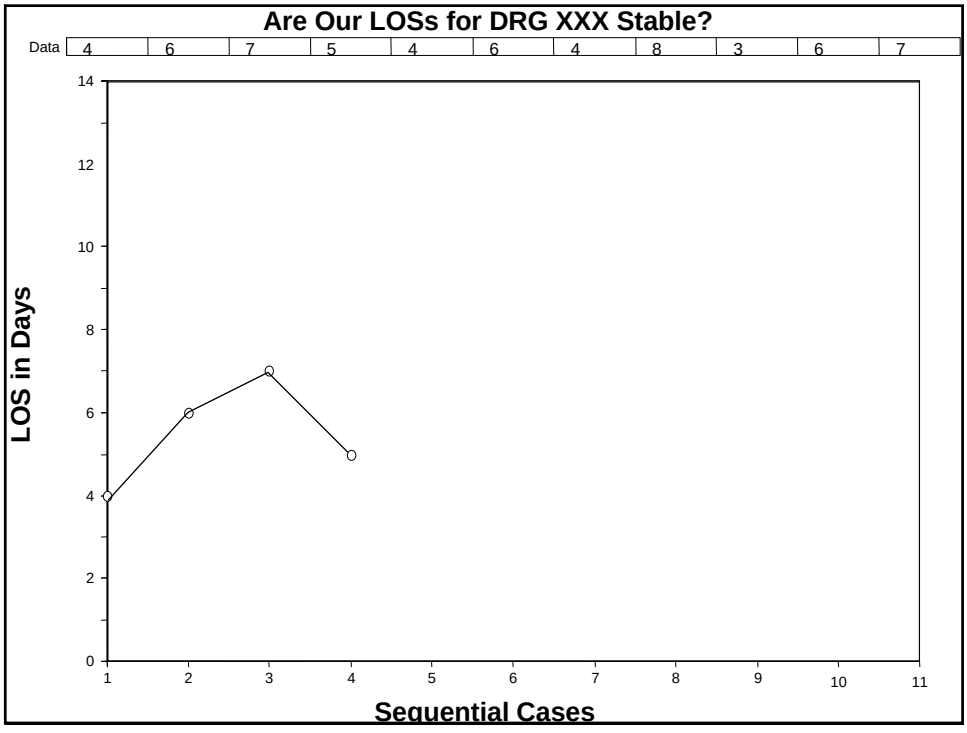




Some Basics on Building a Run Chart

- Start with a single data point if that is all you have

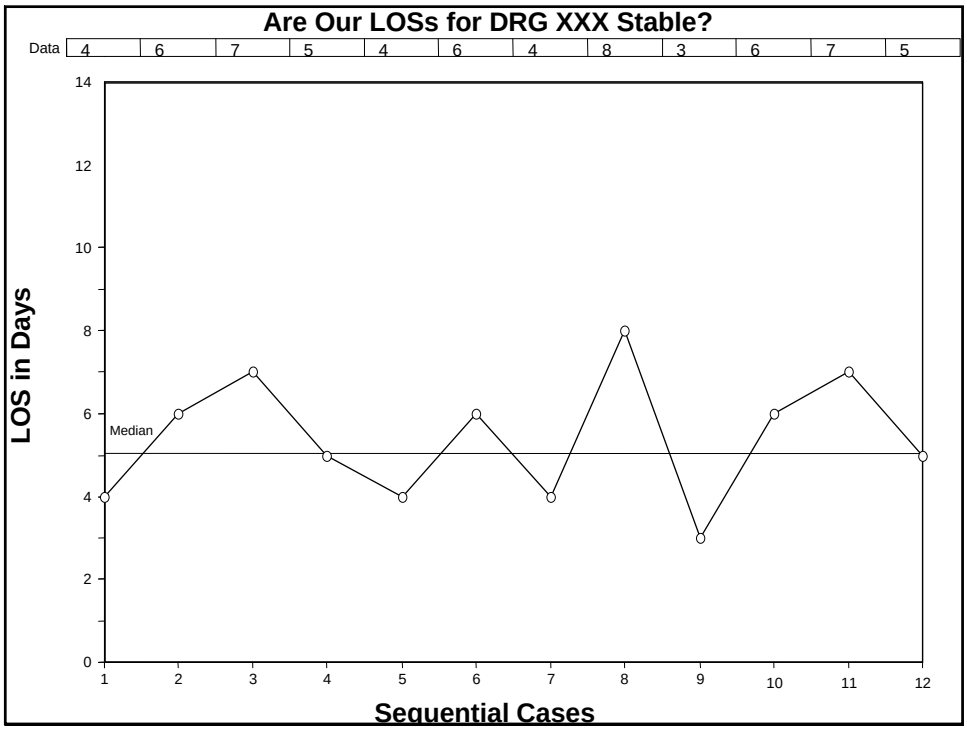
83



Some Basics on Building a Run Chart

- Start with a single data point
- Somewhere around 10-12 data points determine median
- Apply rules to detect statistically significant change

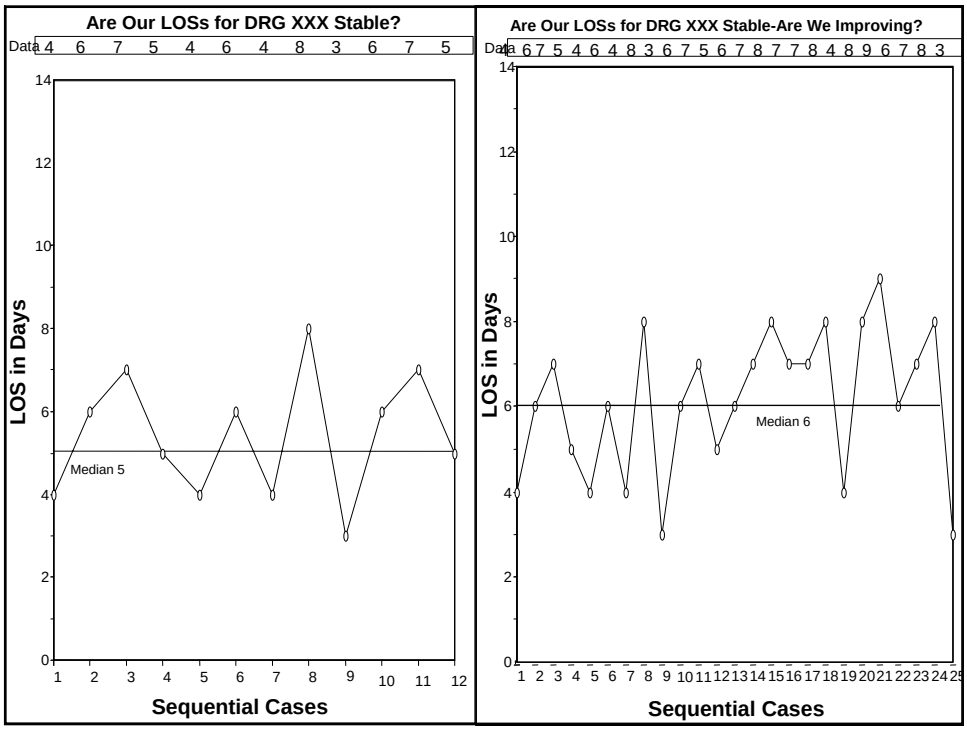
85



Some Basics on Building a Run Chart

- Start with a single data point
- Somewhere around 12 data points determine median
- Apply rules to detect statistically significant change
- When 20-30 data points revise median

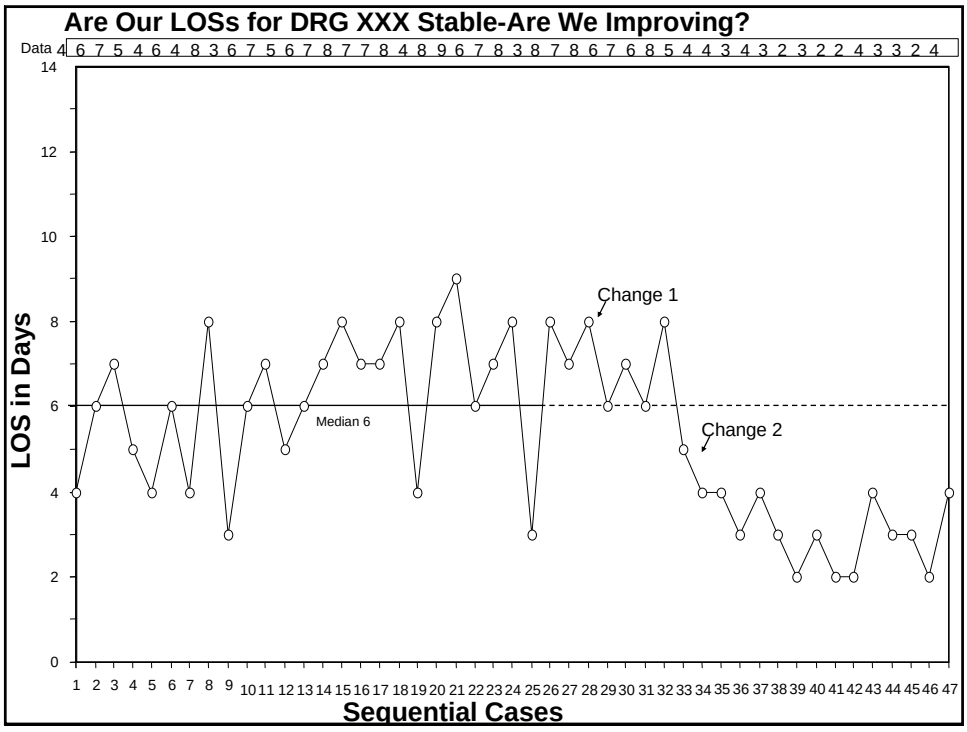
87

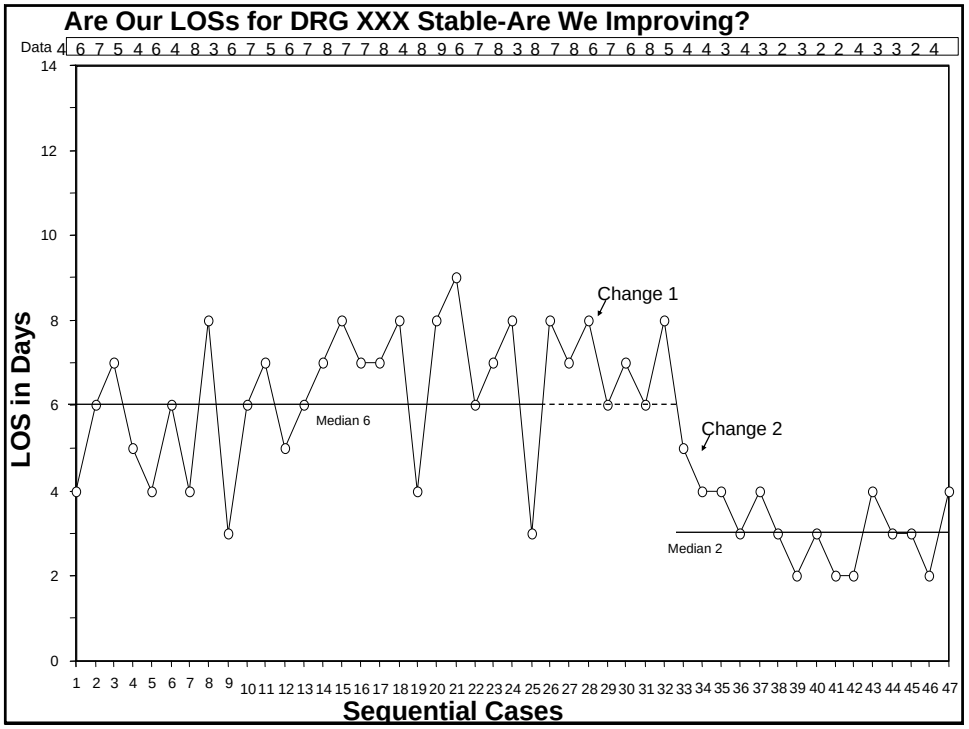


Some Basics on Building a Run Chart

- Start with a single data point
- Somewhere around 12 data points determine median
- Apply rules to detect statistically significant change
- When 20-30 data points revise median
- After this, revise median when current median no longer useful

89





Run Chart

- A line graph of data plotted over time
- Data is kept in time order
- Can see flow of data
- Helps answer questions:
  - **What is our baseline variation?**
  - **How much variation do we have?**
  - **How is process changing over time?**
  - **Has our change resulted in an improvement?**
  - **Did I hold the improvement?**

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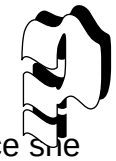
Pop Quiz



- Tabitha is sure the outcome is much better since she made that change you discussed. What tool do you hope she has to support her claim?
  - What might that tool look like if Tabitha is correct?
- Carl says things are much worse this month, Ali says he's seen other months this bad. What tool will you recommend to reconcile this dilemma?
  - What would that tool look like if Carl is correct? If Ali is correct?
- Janeel is concerned that the improvement in admissions medication reconciliation that they achieved is slipping away. What tool could she use to tell if this was so?
  - What might this tool look like if Janeel's concern is correct?

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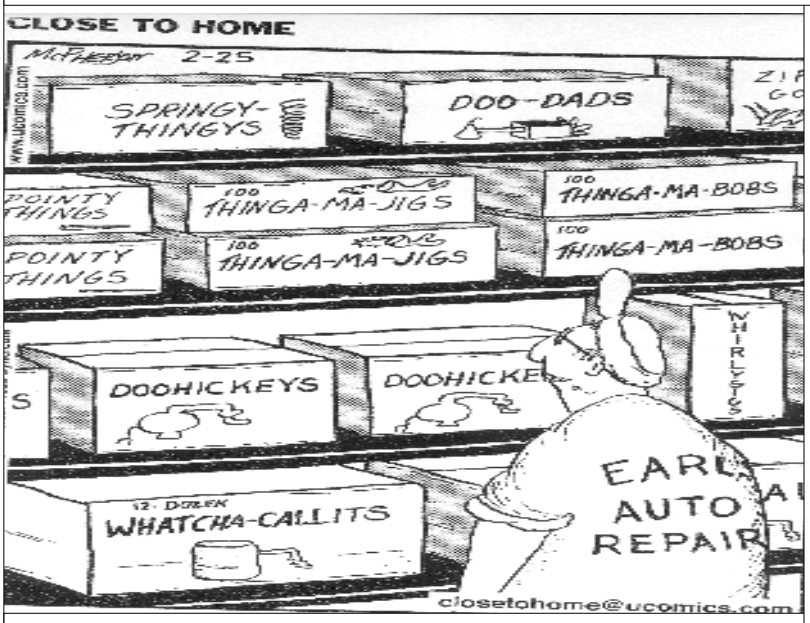
The Tool List

- **Run Chart: How much variation do we have? Is our change an improvement? Are we holding it?**
- **Pareto chart: Which variables out of many are occurring most? Which variables of causes should we focus on?**

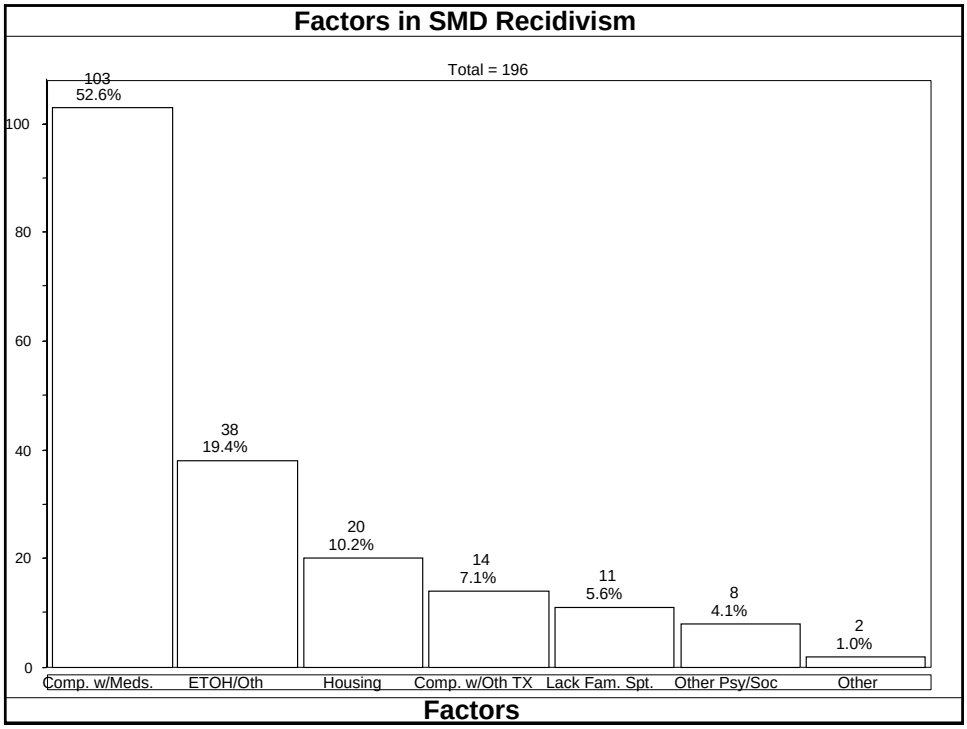
94

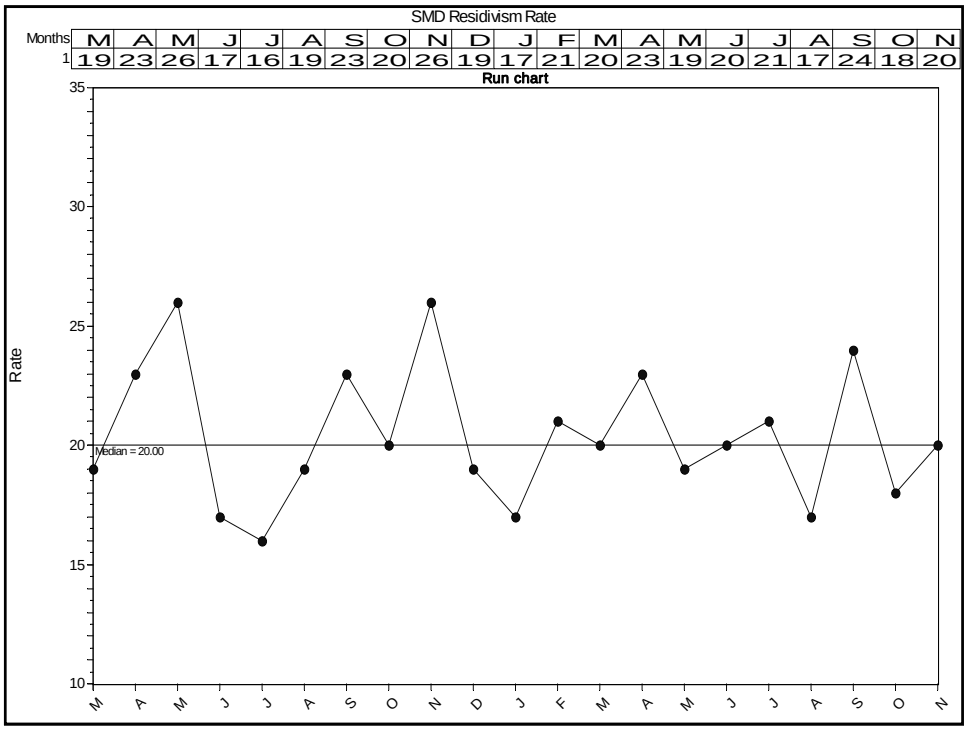


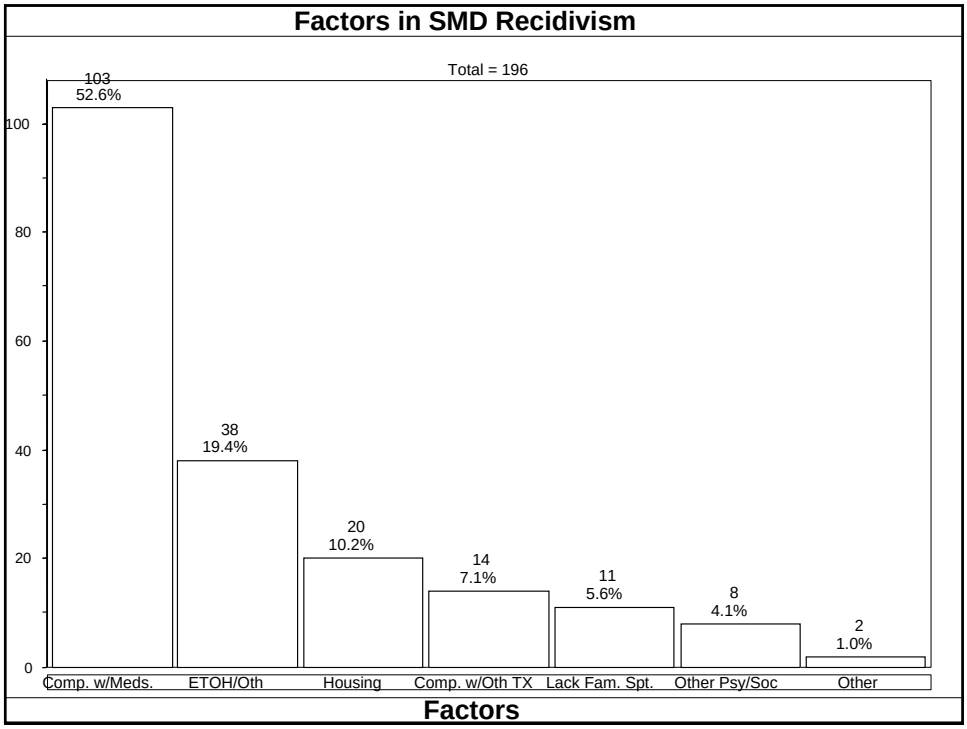
Pareto Chart: What Is It?

- **Bar chart**
  - **Bars in rank order of occurrence from highest to lowest**
  - **Each bar about different problem/variable**
- **Separates "Vital Few" from "Useful Many"**
  - **80/20 Rule**
    - **80% of gain from 20% of categories**
  - **Used to focus improvement on leveraged problems or variables**

96


Factors in SMD Recidivism
Total = 196
103
52.6%
38
19.4%
20
10.2%
14
7.1%
11
5.6%
8
4.1%
2
1.0%
100
80
60
40
20
0
Comp. w/Meds.
ETOH/Oth
Housing
Comp. w/Oth TX
Lack Fam. Spt.
Other Psy/Soc
Other
Factors

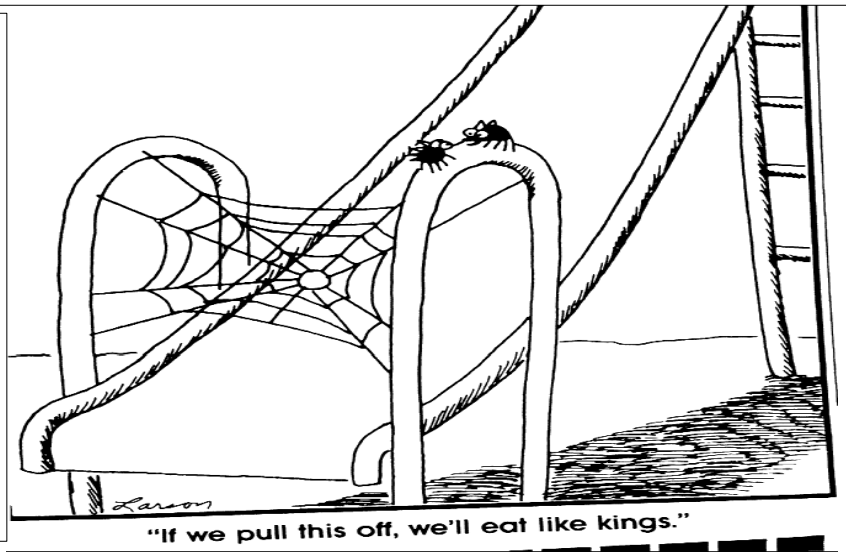

SMD Residivism Rate
Months
M A M J J A S O N D J F M A M J J A S O N
1 19 23 26 17 16 19 23 20 26 19 17 21 20 23 19 20 21 17 24 18 20
Run chart
Rate
35
30
25
20
15
10
Median = 20.00
M A M J J A S O N D J F M A M J J A S O N



When Is It Used?

- When data can be arranged into categories
- When the rank of each category is important
- When we need to focus on the most important problems or causes of variation

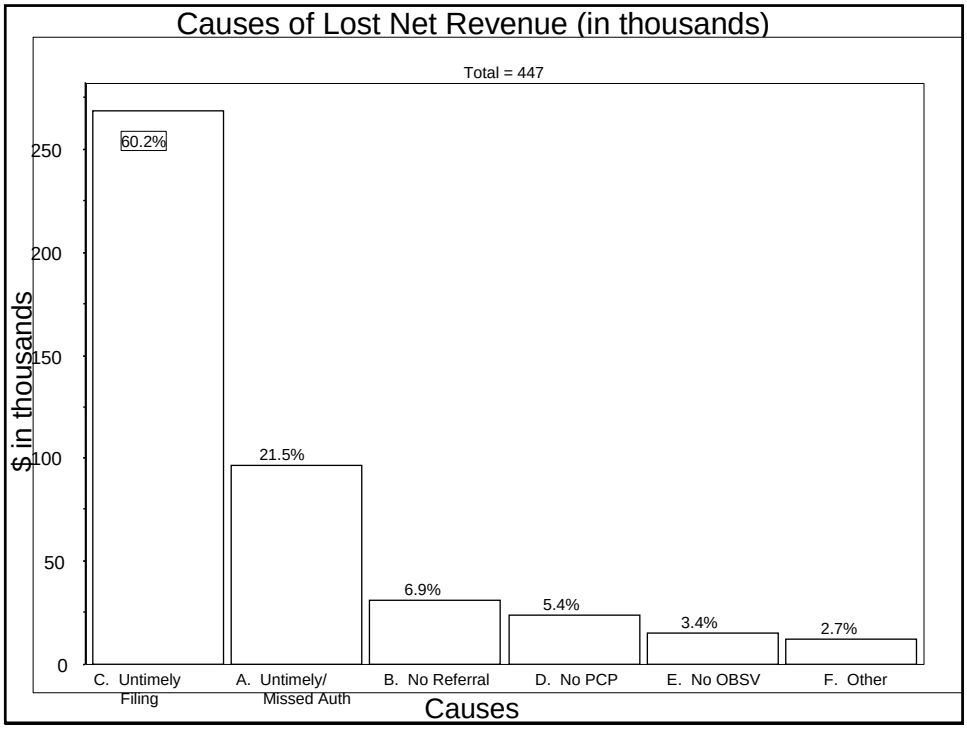
100



How Is It Interpreted?

- Look for the Pareto effect

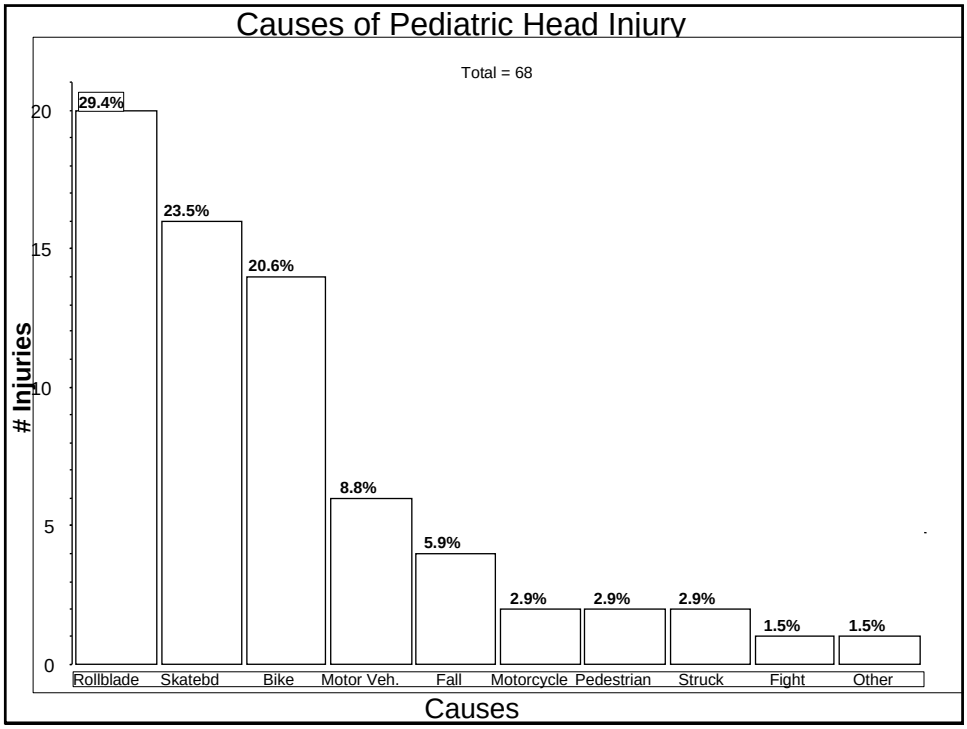
102



How Is It Interpreted?

- Look for the Pareto effect
- We won't always find it!
  - –Is entire chart speaking to us?
  - –Can we re-stratify?
  - –Last choice is selecting a column and tackling it!

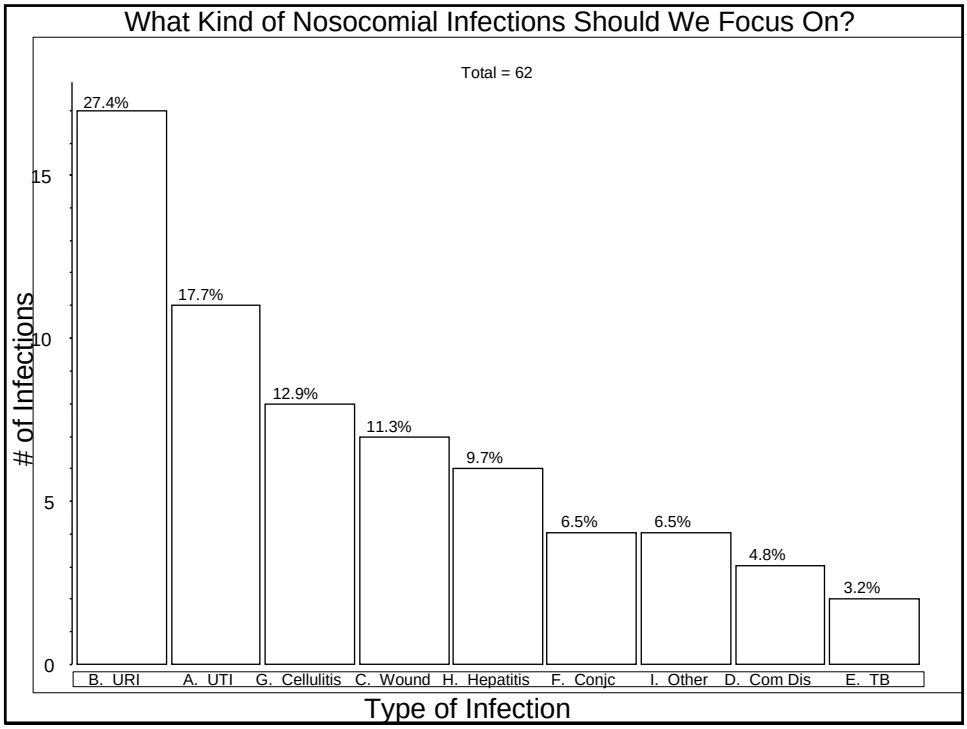
104

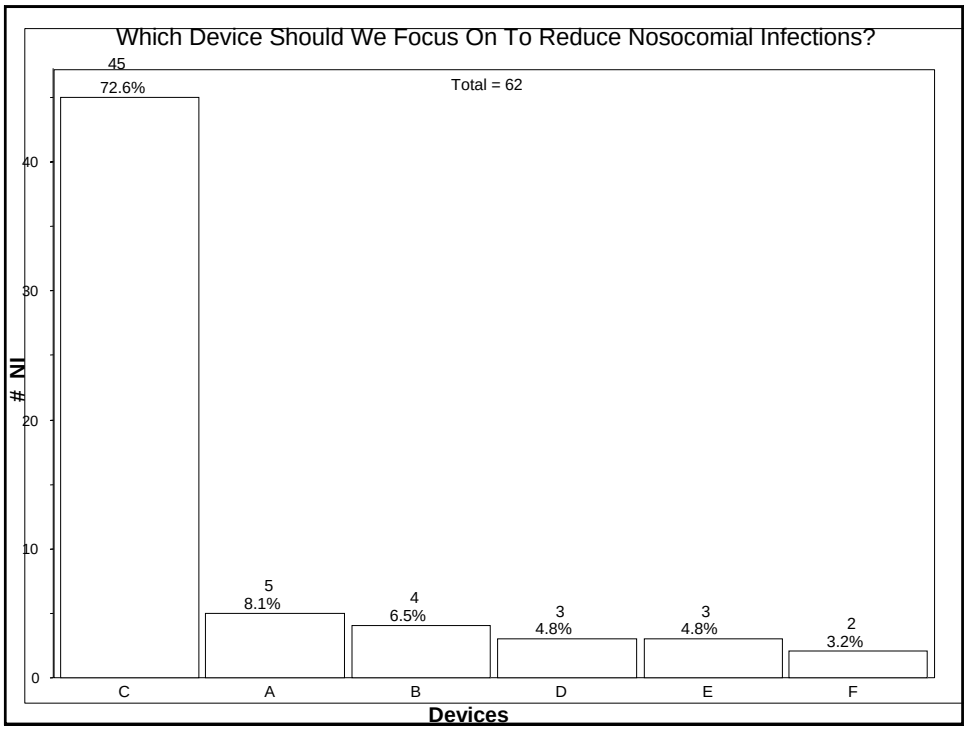


How Is It Interpreted?

- Look for the Pareto effect
- We won't always find it!
  - –Is entire chart speaking to us?
  - –Can we re-stratify?
  - –Last choice is selecting a column and tackling it!

106

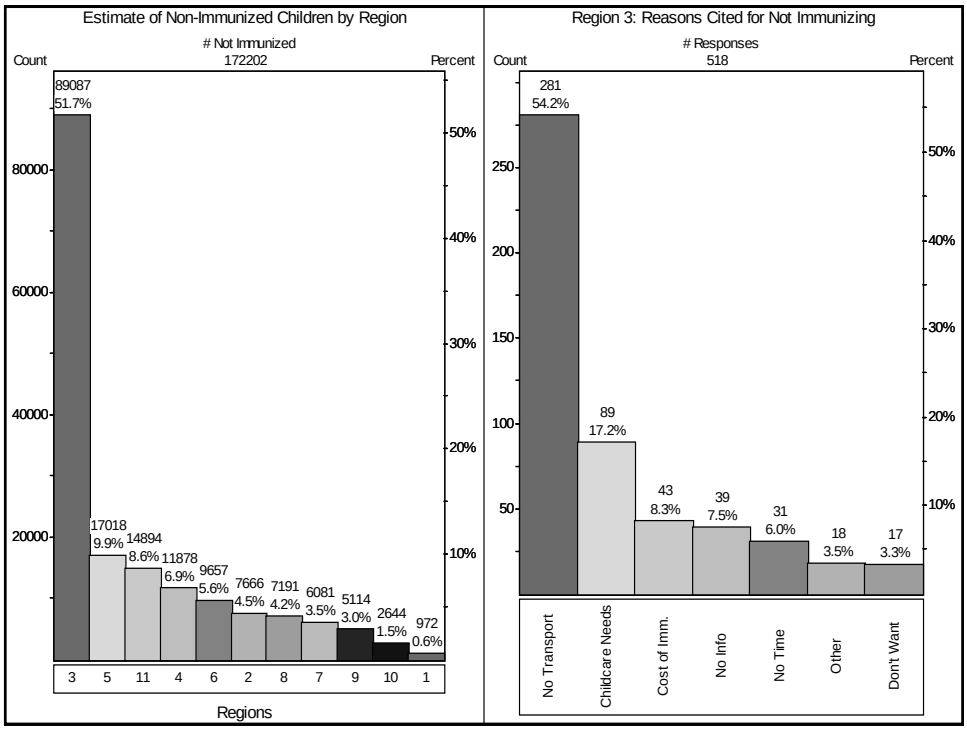

What Kind of Nosocomial Infections Should We Focus On?
Total = 62
# of Infections
0
5
10
15
27.4%
17.7%
12.9%
11.3%
9.7%
6.5%
6.5%
4.8%
3.2%
B. URI
A. UTI
G. Cellulitis
C. Wound
H. Hepatitis
F. Conjc
I. Other
D. Com Dis
E. TB
Type of Infection

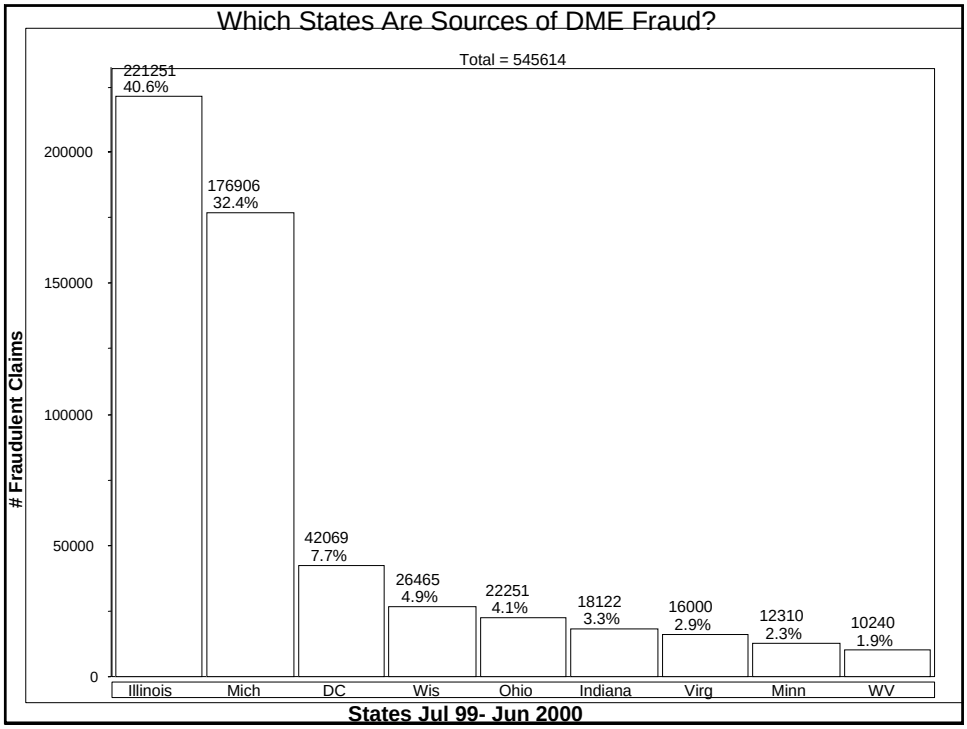

Which Device Should We Focus On To Reduce Nosocomial Infections?
Total = 62
# NI
0
10
20
30
40
45
72.6%
5
8.1%
4
6.5%
3
4.8%
3
4.8%
2
3.2%
C
A
B
D
E
F
Devices

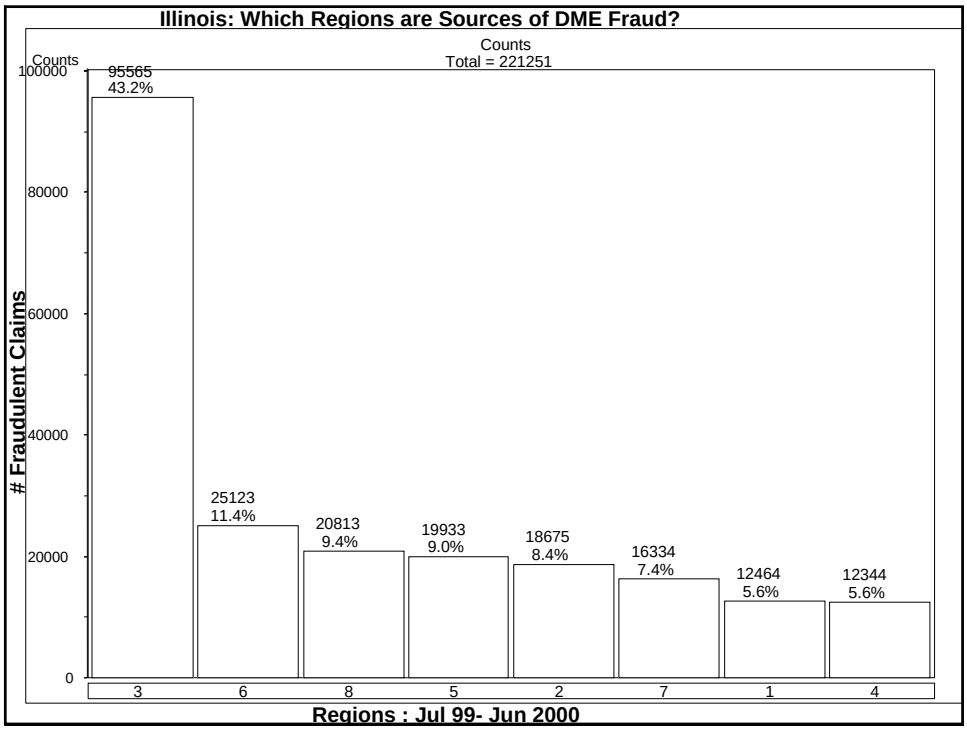
How Is It Used?

- Look for the Pareto effect
- Using to drill down

109




Which States Are Sources of DME Fraud?
Total = 545614
# Fraudulent Claims
0
50000
100000
150000
200000
221251
40.6%
176906
32.4%
42069
7.7%
26465
4.9%
22251
4.1%
18122
3.3%
16000
2.9%
12310
2.3%
10240
1.9%
Illinois
Mich
DC
Wis
Ohio
Indiana
Virg
Minn
WV
States Jul 99- Jun 2000


Illinois: Which Regions are Sources of DME Fraud?
Counts
Counts
Total = 221251
# Fraudulent Claims
0
20000
40000
60000
80000
100000
95565
43.2%
25123
11.4%
20813
9.4%
19933
9.0%
18675
8.4%
16334
7.4%
12464
5.6%
12344
5.6%
3
6
8
5
2
7
1
4
Regions : Jul 99- Jun 2000

Pareto Chart

- Bar chart with bars in rank order
- **Each bar represents a different variable or problem**
- Looking for 20% of bars representing 80% of problem
- **Want to know where to focus our efforts**

113

Pop Quiz

- What are the major sources of cost for people with CHF?
- Sandy thinks Long Term Care Facility L's infection rate shows improvement. Which tool could she use to tell?
- Which providers have highest use of antibiotics for URI?

114

What Have Others Used Pareto For?

- **Reasons for delays? (in discharge, in labs, in meds, etc.)**
- **Types of errors detected**
- **Sources of referrals to home care**
- **Reasons for same day surgery cancellations**
- **What customers called most about in Managed Care Organization (what benefits)**
- **Causes of re-admission (DRGs)**
- **Reasons for patients switching physicians**
- **Causes of falls, needlesticks, medication errors**
- **Reasons for Monday phone calls**

115

The Tool List

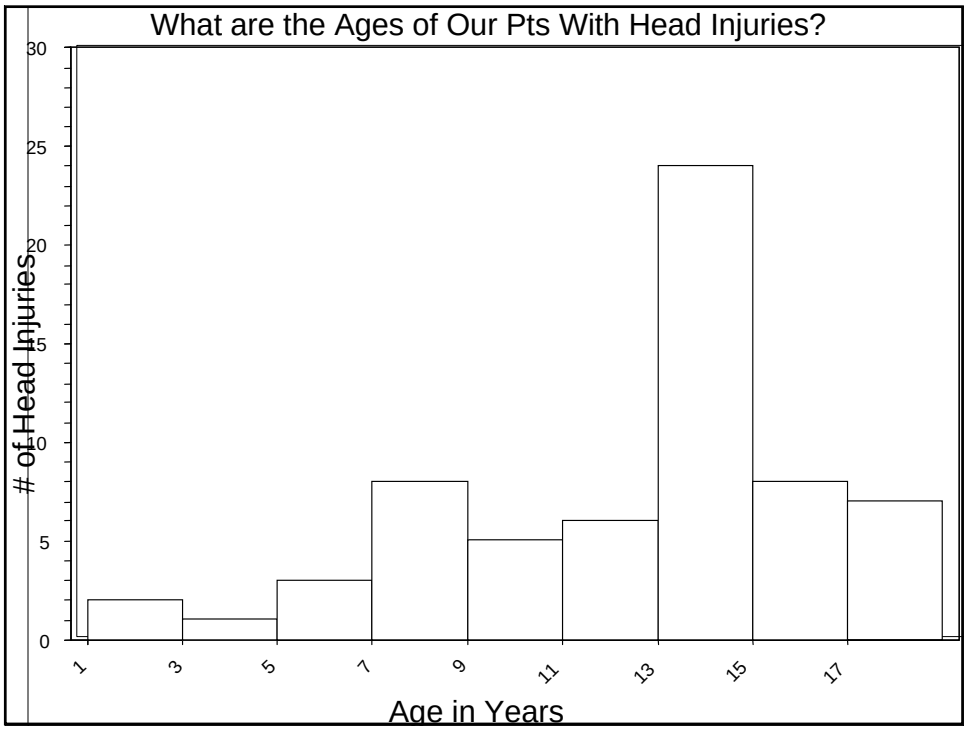
- **Run Chart: How much variation do we have? Is our change an improvement? Are we holding it?**
- **Pareto: Which variables out of many are occurring most?**
- **Frequency Plot: How is this one variable distributed (what is the spread of LOS, Cost, etc.)**

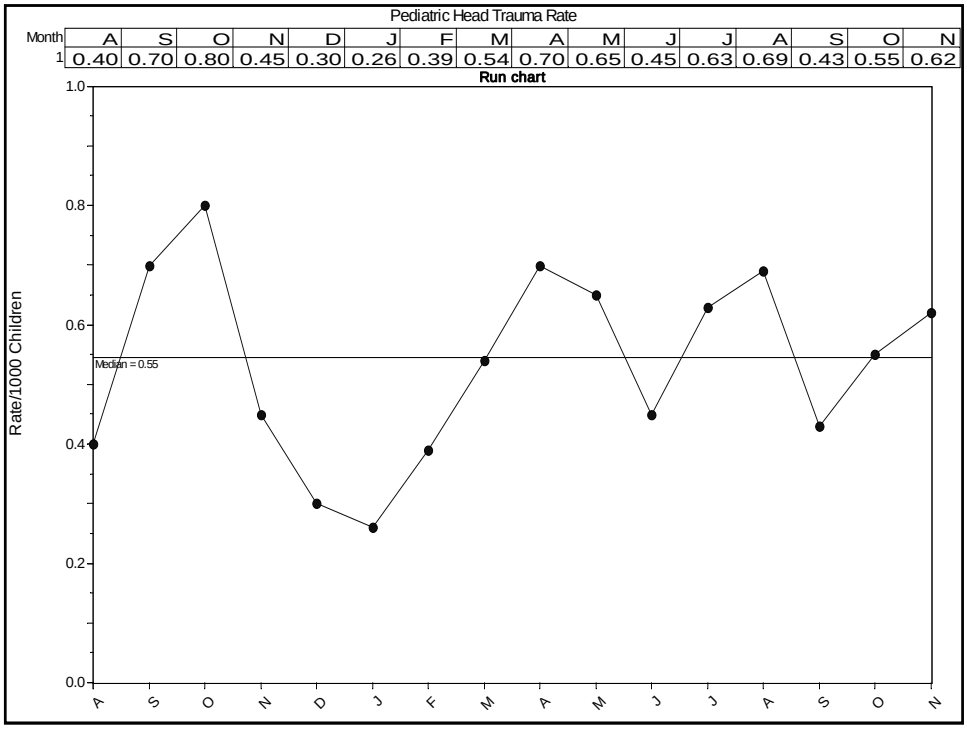
116

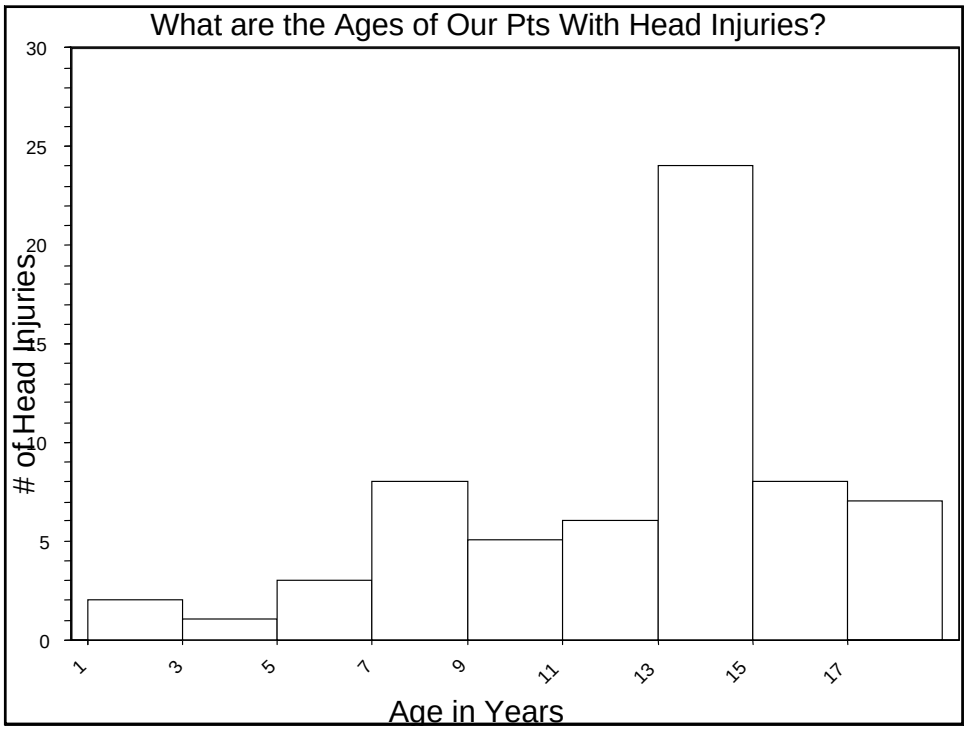
Frequency Plot: What Is It?

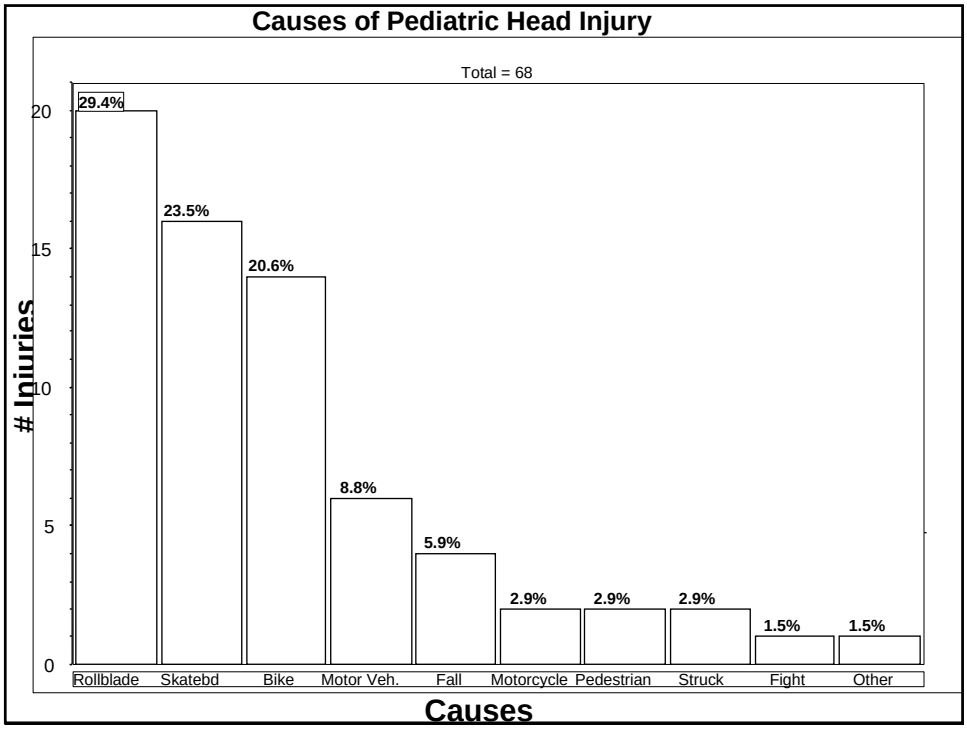
- **A bar chart for one variable**
- **Used to visualize central location, shape and spread of the data**
- **Each bar equal, each distinct**
- **Most often used with time, money, throughput or a scaled measurement (i.e. dollars, weight, age, mm, height,)**
  - Frequency Plot does little good for interpretation if process not stable
    - Doesn't show stability or capability in and of itself!!

117




Pediatric Head Trauma Rate
Month A S O N D J F M A M J J A S O N
1 0.40 0.70 0.80 0.45 0.30 0.26 0.39 0.54 0.70 0.65 0.45 0.63 0.69 0.43 0.55 0.62
Run chart
Rate/1000 Children
Median = 0.55
1.0
0.8
0.6
0.4
0.2
0.0
A S O N D J F M A M J J A S O N


What are the Ages of Our Pts With Head Injuries?
# of Head Injuries
30
25
20
15
10
5
0
1 3 5 7 9 11 13 15 17
Age in Years



When Is It Used?

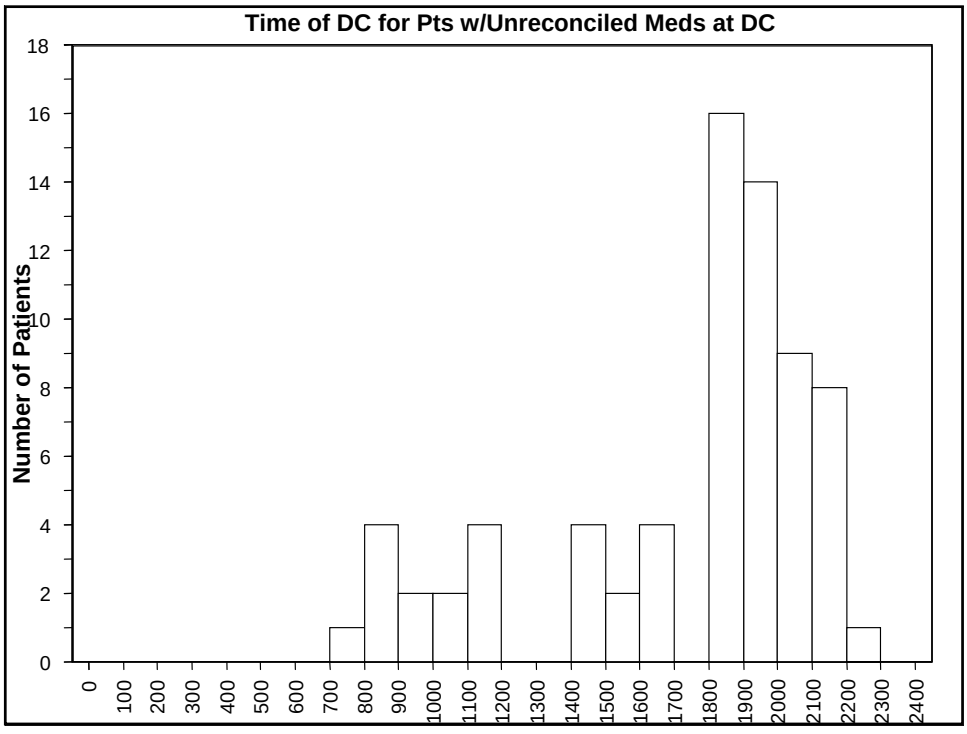
1. Have a data set of related values (i.e. arrival times in ED)
2. Want to see central location, shape, spread of data to learn about system
   - Does all of process fit within needs? (Our standards)
   - Any patterns that bear looking into?

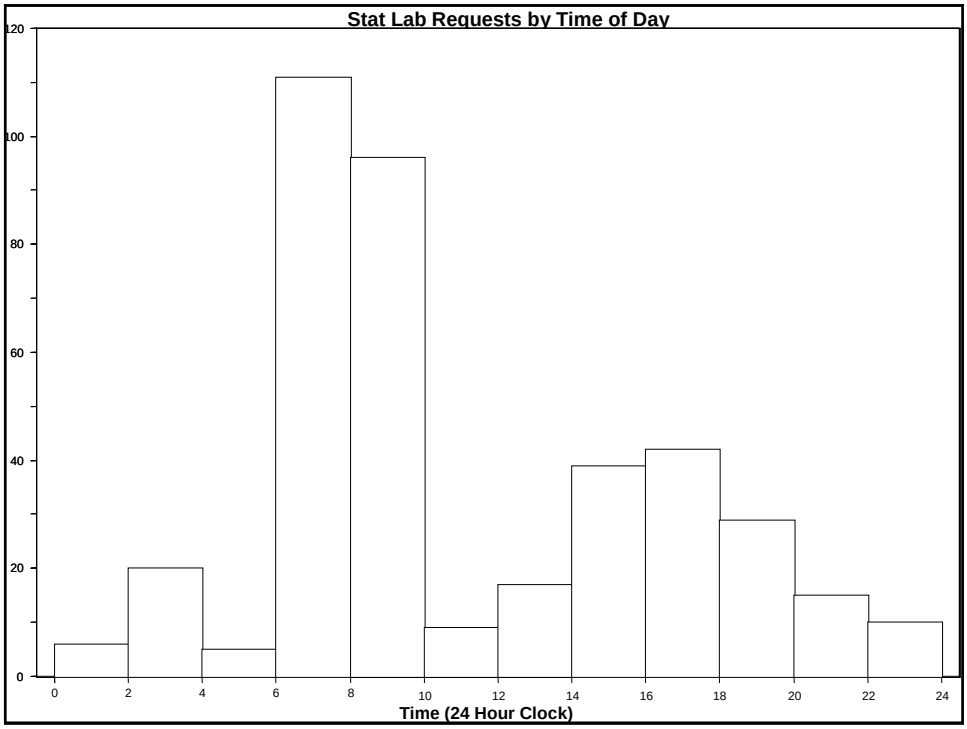
122

How Is It Interpreted?

- Evaluate **central location**
- Evaluate spread
- Learn from shape

123

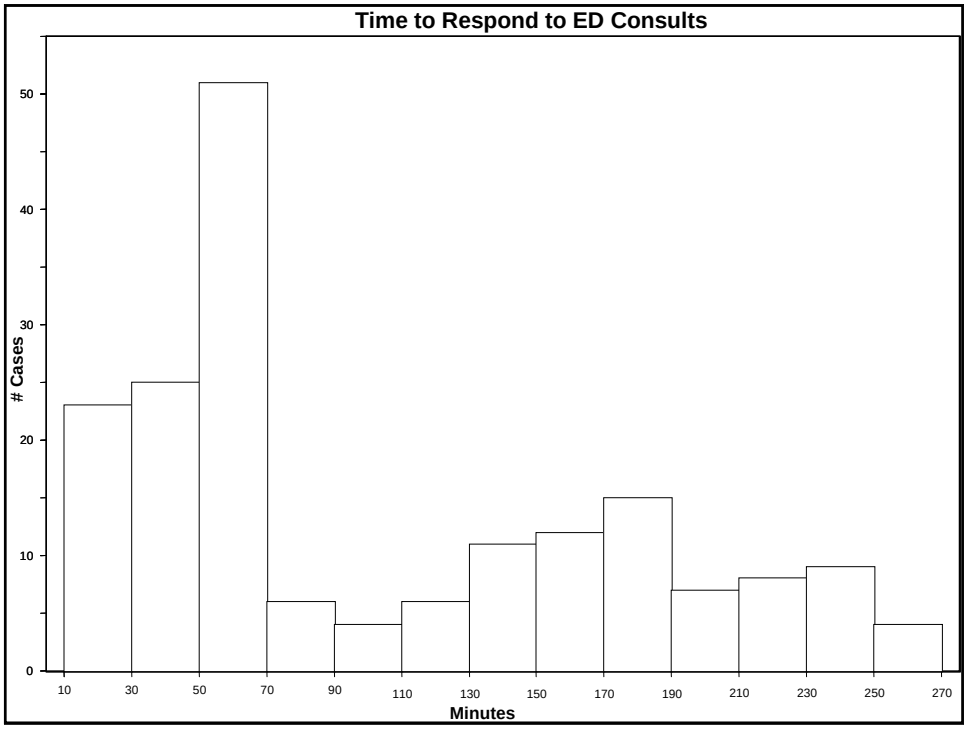




How Is It Interpreted?

- Evaluate central location
- Evaluate **spread**
- Learn from shape

126

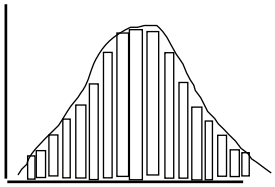


How Is It Interpreted?

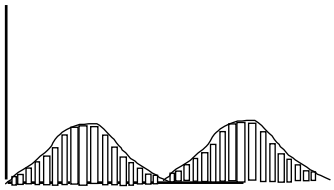
- Evaluate central location
- Evaluate spread
- Learn from **shape**

128

Common Frequency Plot Shapes

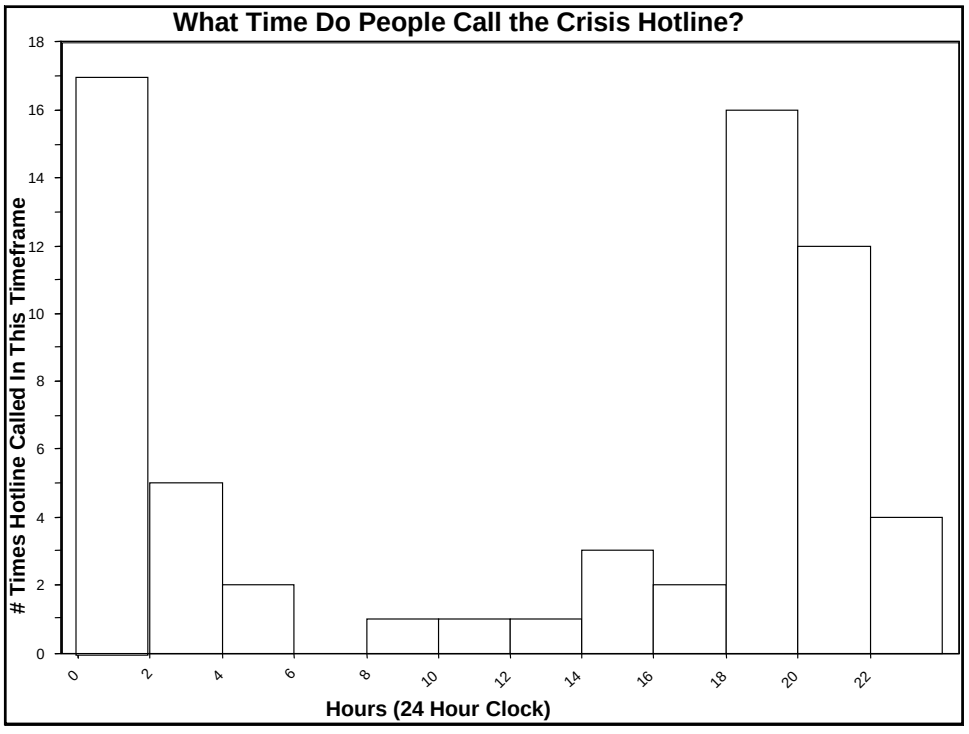


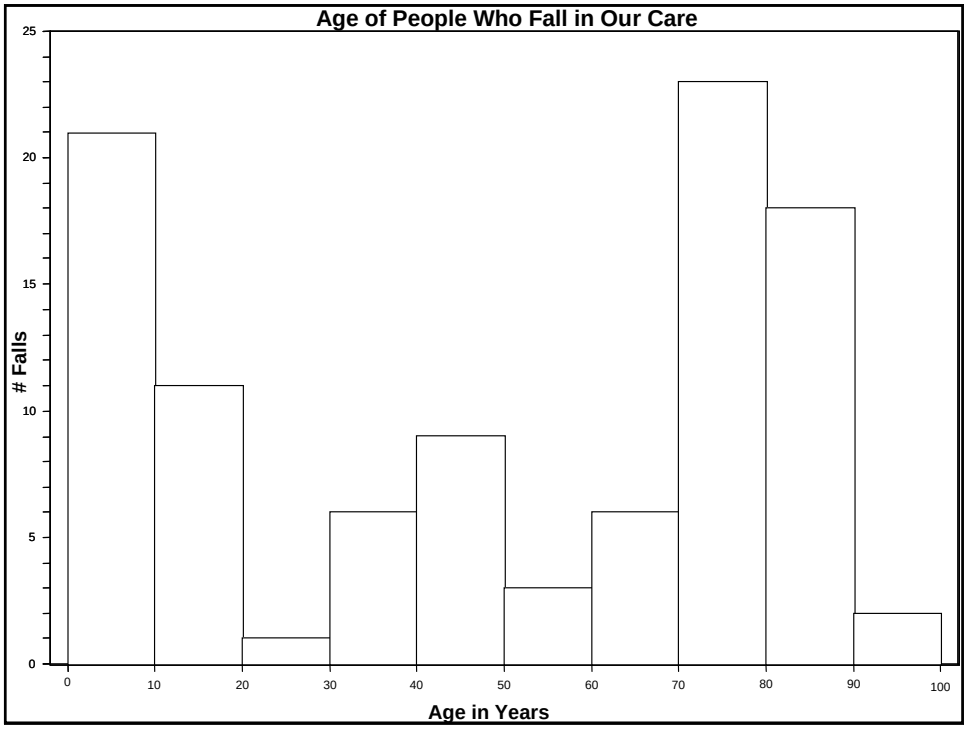
Symmetrical
•normal distribution

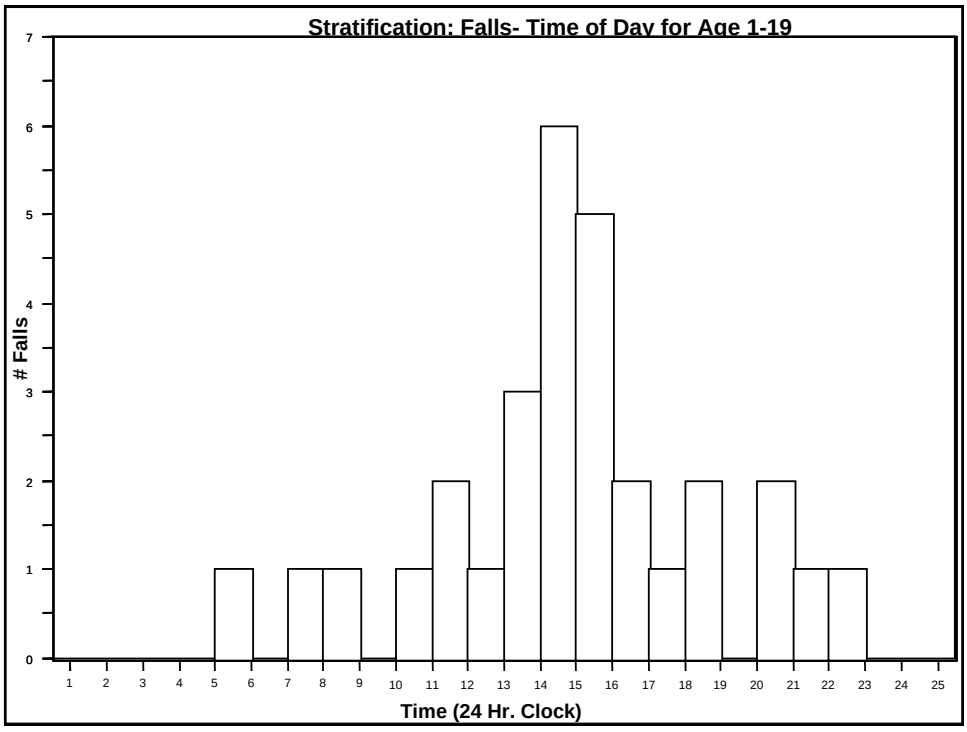


Bimodal
•two peaks
•data from two processes
•separate and analyze each

129




Age of People Who Fall in Our Care
Falls
0
5
10
15
20
25
0
10
20
30
40
50
60
70
80
90
100
Age in Years


Stratification: Falls- Time of Day for Age 1-19
Falls
0
1
2
3
4
5
6
7
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
Time (24 Hr. Clock)

Frequency Plot

- Bar Chart
- Distribution of data related to one variable
  - Only one variable across bottom of chart
- Each bar equal width and completely separate

133

- What are the major reasons for delays in claim turn around times?
- How is the age of our primary care providers distributed?
- Has caller satisfaction been increasing since we changed our customer service process?
- What is the abandonment rate for each hour of the day?

134

What Have Others Used Frequency Plots For?

- **Time of day falls occur**
- **Age of patients being readmitted**
- **Days LOS prior to ulcer**
- **Time of arrival in ED**
- **Time of discharge**
- **Age of people calling the crisis intervention hotline**
- **Number of months of fertility treatment prior to conception**

135

The Tool List

- **<u>Run Chart:</u> How much variation do we have? Is our change an improvement? Are we holding it?**
- **<u>Pareto:</u> Which variables out of many are occurring most?**
- **<u>Frequency Plot:</u> How is this one variable distributed (what is the spread of LOS, Cost, etc.)**
- **<u>Scatter Plot:</u> Is variable A possibly related to variable B?**

136

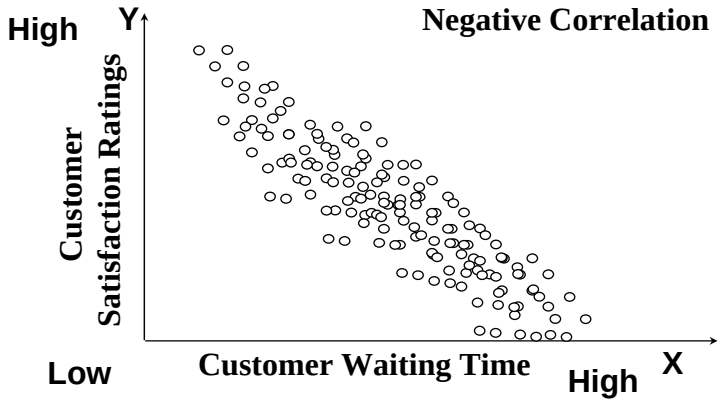
SCATTER PLOT
What Is It?

- **Graph to evaluate possible relationship between one variable and another**
  - Test for <u>possible</u> cause and effect
- Each dot on the chart represents a pair of measures

137

SCATTER PLOT:
What Does It Look Like?

Does Customer Waiting Time Affect Customer Satisfaction?



138

When Is It Used?

When Is It Used?

- Do you want to test whether the performance of one factor is related to performance of another?
- Can you get meaningful paired samples?
  - I.E. Outcome and a variable you suspect is related for the same patient?

140

SCATTER PLOT: How To Make One

- Develop question
- Collect paired samples of data you believe may be related
  - (15 Telephone Orders, Prop. Late Meds. .005)

141

Data for Scatter Plot

(# of phone requests that day, proportion of late medications that day)

(15, .005)	(15, .006)
(43, .016)	(46, .017)
(10, .007)	(50, .029)
(18, .008)	(60, .027)
(63, .036)	(10, .007)
(14, .006)	(23, .005)
(19, .008)	(75, .030)
(70, .028)	(55, .031)
(24, .005)	(27, .013)
(80, .035)	(85, .043)
(32, .011)	(90, .036)
(35, .015)	(100, .042)
(40, .018)	

SCATTER PLOT

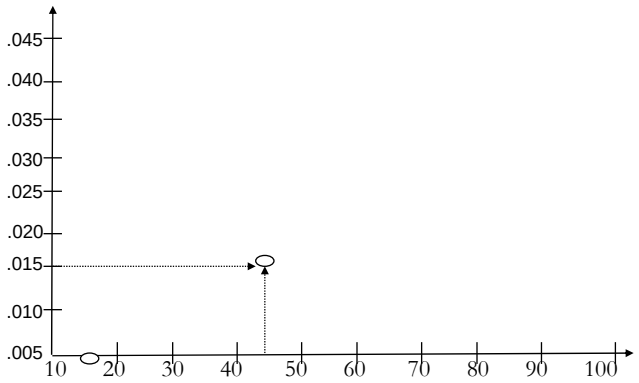
(15, .005)

(43, .016)

High

Y

Dependent Variable

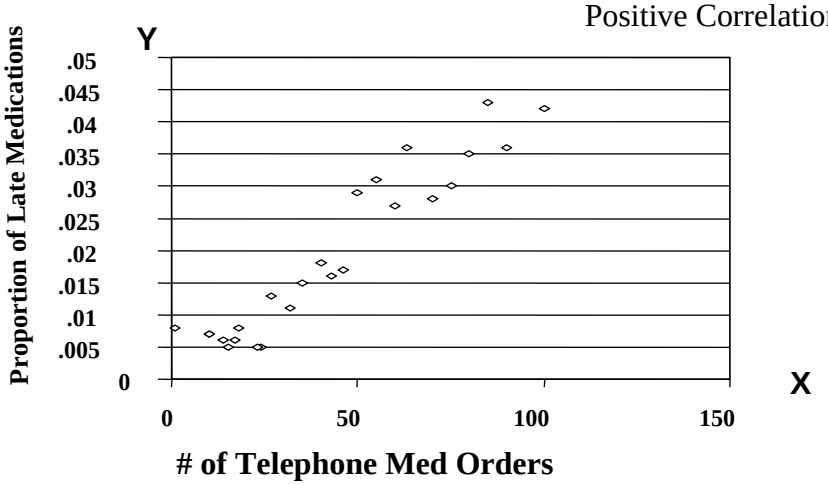


Low **X** Independent Variable (Driver) *High*

143

SCATTER PLOT: EXAMPLES

Positive Correlation



144

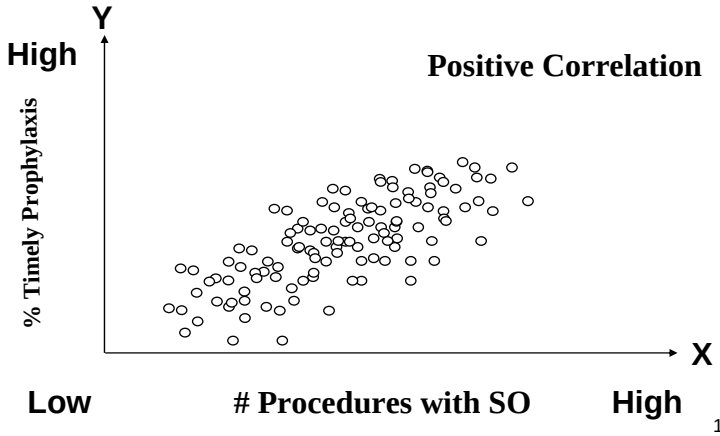
How Is It Interpreted?

- Look for patterns in the scatter plot
  - A narrow band of dots
  - A circular pattern
  - Peaks or troughs
- Look for outliers

145

SCATTER PLOT: EXAMPLES

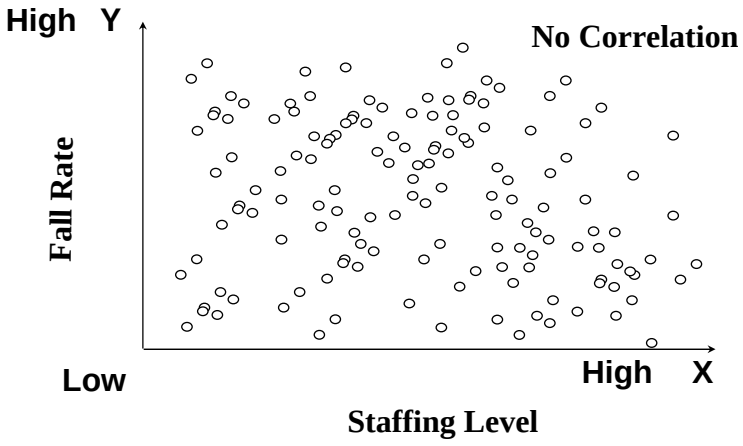
Does the # of Surgical Procedures with Standing Antibiotic Orders Seem to Affect % Timely Prophylactic Antibiotics?



146

SCATTER PLOT: EXAMPLES

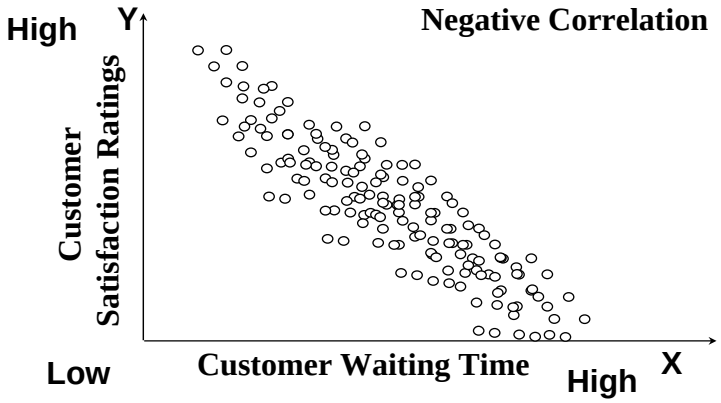
Does Staffing Level Seem to Affect Fall Rate?



147

SCATTER PLOT: EXAMPLES

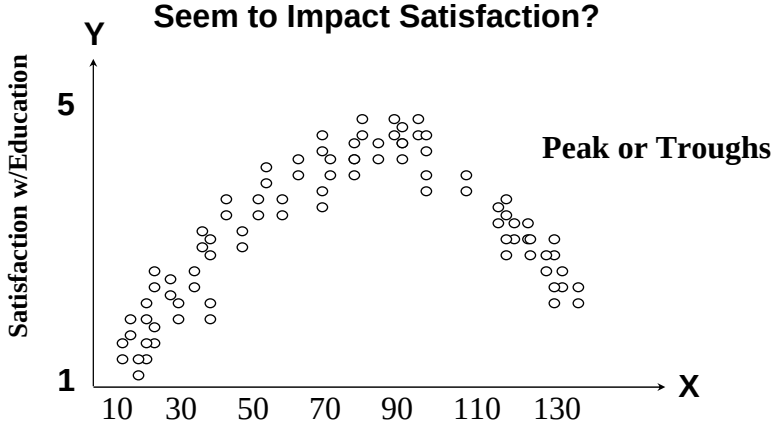
Does Customer Waiting Time Affect Customer Satisfaction?



148

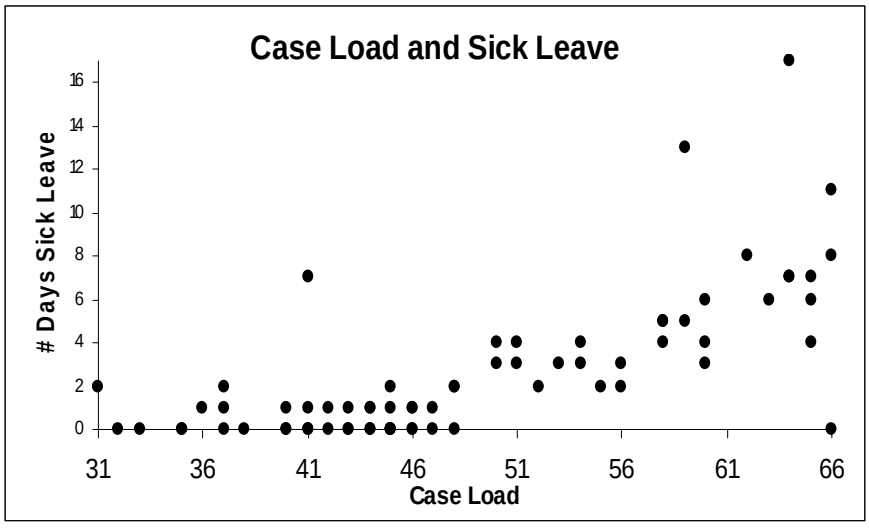
SCATTER PLOT: EXAMPLES

Does Length of Diabetic Education Session Seem to Impact Satisfaction?



149

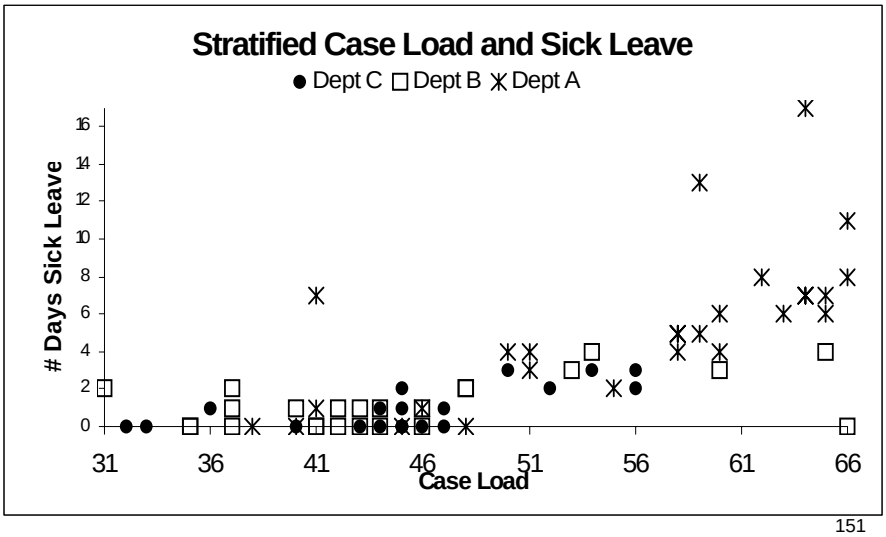
Scatter Plot: Does Case Load Affect Sick Leave Use?



150

Source The Data Guide: Learning from Data to Improve Healthcare. Used with permission.

Stratification: By Department



151

Source The Data Guide: Learning from Data to Improve Healthcare. Used with permission.

Scatter Plot

- A chart searching for possible cause and effect relationship
- Points plotted at intersection of two variables

152

The Tool List

- **<u>Run Chart:</u> How much variation do we have? Is our change an improvement? Are we holding it?**
- **<u>Pareto:</u> Which variables out of many are occurring most?**
- **<u>Frequency Plot:</u> How is this one variable distributed (what is the spread of LOS, Cost, etc.)**
- **<u>Scatter Plot:</u> Is variable A related to variable B?**

153

- What time of day do clients call the dial-a-nurse info line?
- You've made a change to the info line marketing and are sure the volume of calls is much higher as a result.
- You think age and the number of calls made to the info line are related.
- What are the most common questions handled by the health info line?
- Does satisfaction with the info line correlate to satisfaction with the health plan overall?

154

What Have People Used Scatter Diagrams For?

- Following are paired samples (x, y)
- (amount of drug given, pain rating)
- (minutes treatment given, mobility rating)
- (rating on a particular question, overall customer satisfaction rating)
- (age, LOS)
- (volume of work, proportion of errors)

155

The Tool List

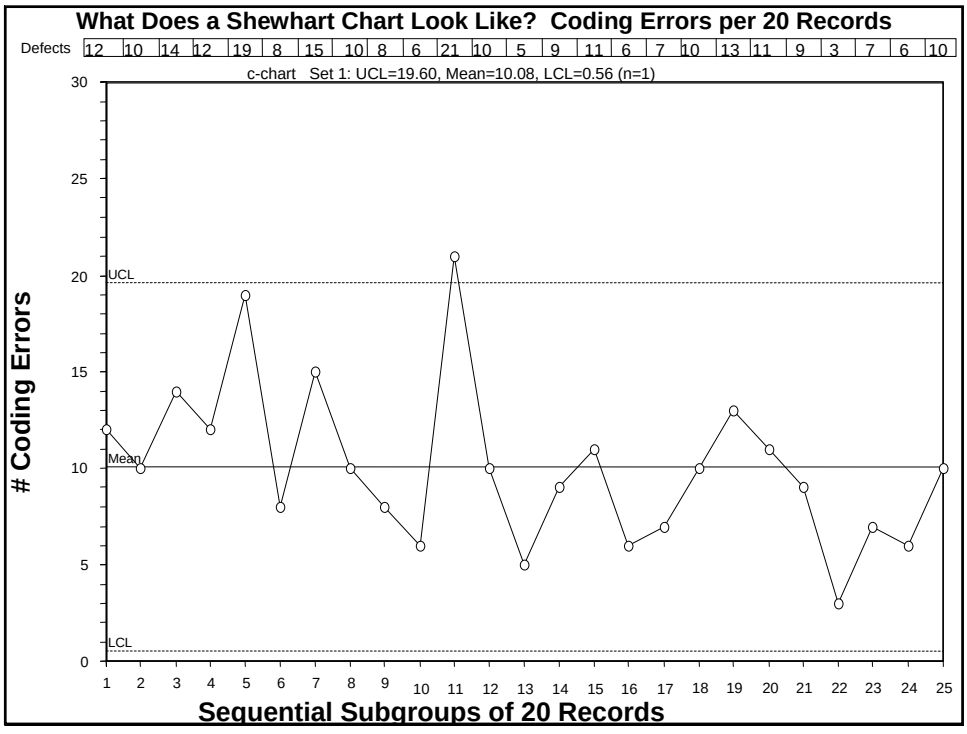
- **Run Chart: How much variation do we have? Is our change an improvement? Are we holding it?**
- **Pareto: Which variables out of many are occurring most?**
- **Frequency Plot: How is this one variable distributed (what is the spread of LOS, Cost, etc.)**
- **Scatter Plot: Is variable A related to variable B?**
- **Shewhart Chart: Is our process stable? Do we have common or special cause variation?**

156

SHEWHART CONTROL CHART:

A Brief Introduction!

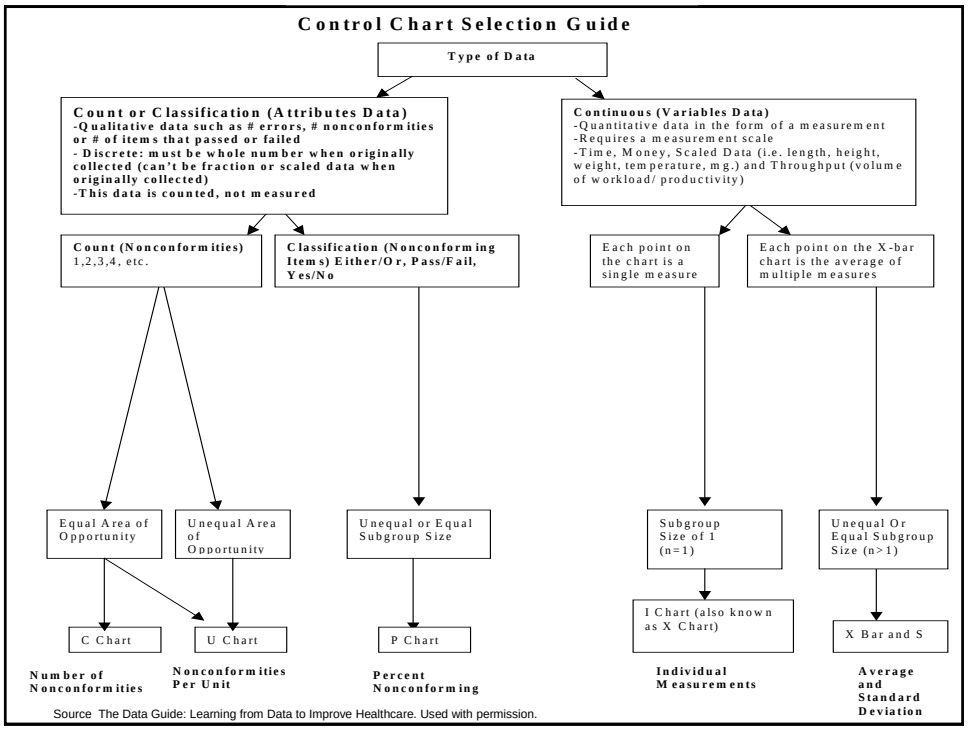
- A statistical tool used to distinguish common from special cause variation in a process
- A display of data **over time** and **most often in time order** with:
  - Mean (most typically)
  - Statistically calculated upper and lower control limits at **3 sigma**



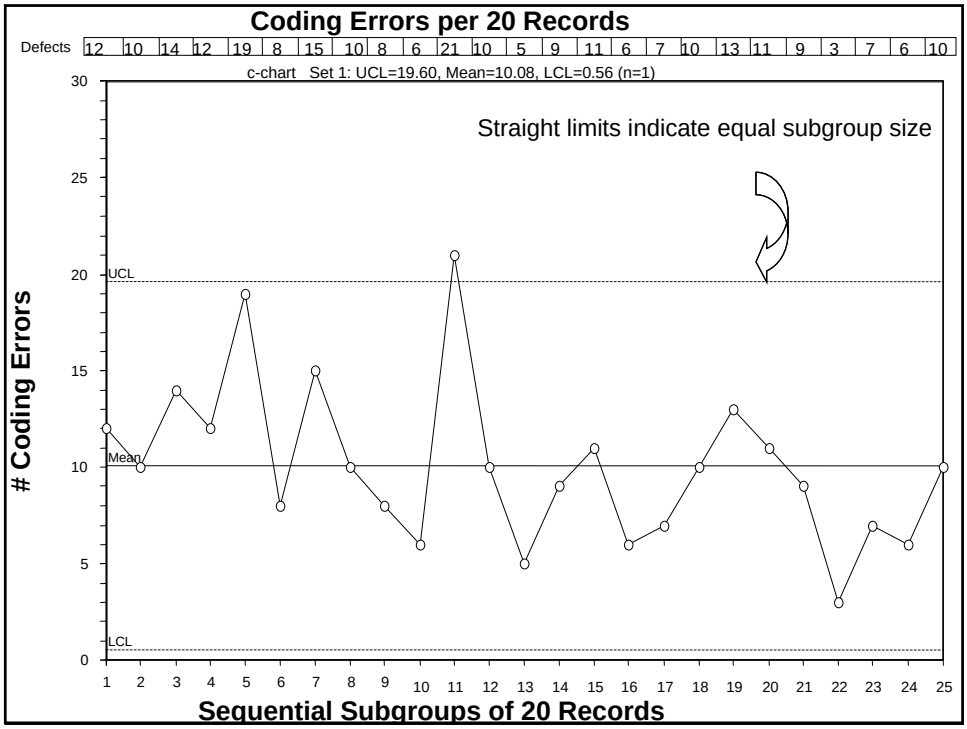
When is it Used?

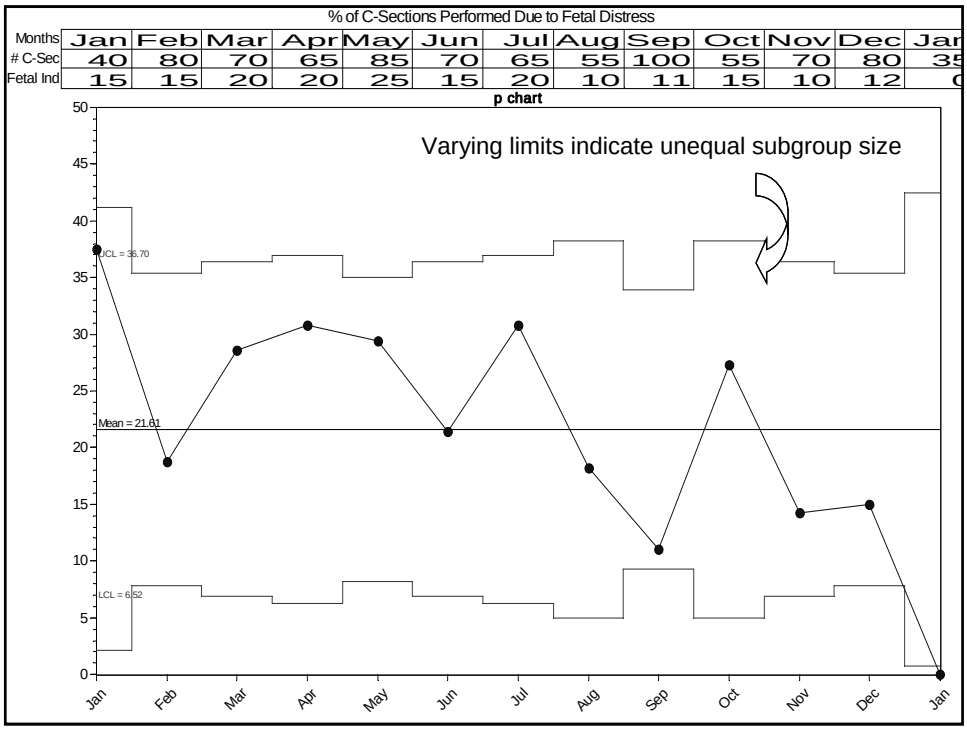
When we need to learn:

- How much variation does process exhibit?
- What kind of variation is present
  - Common cause, special cause
  - Is process predictable?
- Causes of variation
- Is my change an improvement?
- Have I sustained my improvement?



Source The Data Guide: Learning from Data to Improve Healthcare. Used with permission.


Coding Errors per 20 Records
Defects 12 10 14 12 19 8 15 10 8 6 21 10 5 9 11 6 7 10 13 11 9 3 7 6 10
c-chart Set 1: UCL=19.60, Mean=10.08, LCL=0.56 (n=1)
Straight limits indicate equal subgroup size
Coding Errors
UCL
Mean
LCL
Sequential Subgroups of 20 Records


% of C-Sections Performed Due to Fetal Distress
Months Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan
C-Sec 40 80 70 65 85 70 65 55 100 55 70 80 35
Fetal Ind 15 15 20 20 25 15 20 10 11 15 10 12
p chart
Varying limits indicate unequal subgroup size
UCL = 36.70
Mean = 21.61
LCL = 6.52

When Is It Used?

- **When need to find out:**
  - **How much variation does our process exhibit?**
  - **What kind of variation is present (special or common cause)?**
    - **Is process statistically stable?**
  - **Does the variation help me get an idea for a change to test?**
  - **Is my change an improvement?**
  - **Have I sustained my improvement?**

163

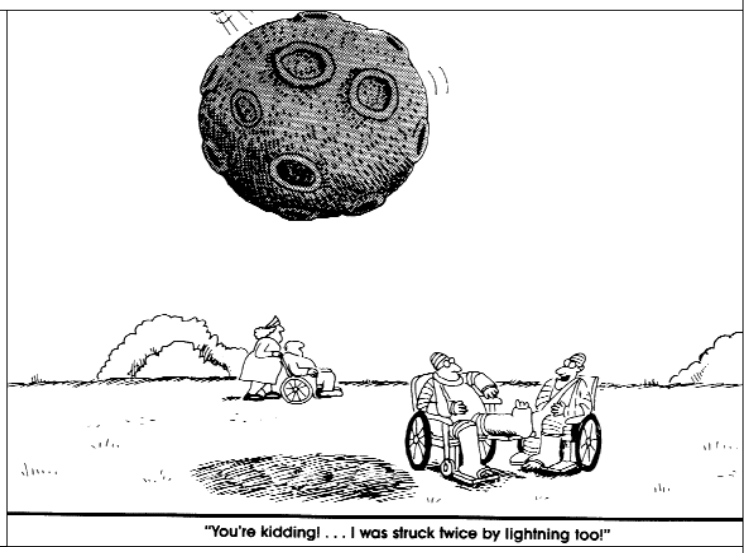
Types of Variation: Common Cause

- The variation is **due to the process or system design**
- It is produced by interactions of **inherent variables** in the process
- The causes **affect** everyone working in the process and **all outcomes** of the process
- Process having only **common cause affecting the outcome is called stable**
  - **Performance is predictable**

Management Strategy: Common Cause System

STRATEGY TO TAKE:

- **Process Study and Redesign!!**
  - Understand that process performance will **not change unless process design is fundamentally altered**
  - **Identify process variables** contributing to common cause variation
  - Determine **which aspect of the process to change**
  - **PDSA** the process change



Types of Variation: Special Cause

- Variation in the process **assignable** to a specific cause or causes - **not part of the usual process**
- This variation **due to specific circumstances**
- Process **not stable**
  - **Is not predictable**

Management Strategy: Special Cause System

IMPROVEMENT STRATEGY:

- **<u>Investigate, learn and standardize the process!!</u>**
  - Immediately **try to understand** when Special Cause occurred
  - **Study what was different** when Special Cause occurred
  - **Identify ways to prevent or use it**, if understandable, to standardize the process
    - either standardize back to where the process was

      or standardize in a new better place

Understanding Variation

- We can make two mistakes
  - **Mistake 1**: thinking an outcome is due to a special cause when it was really due to common causes
  - **Mistake 2**: thinking an outcome is due to common causes when it was really due to a special cause
- Control charts help minimize these two mistakes

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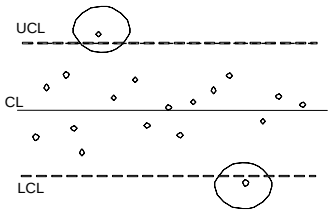
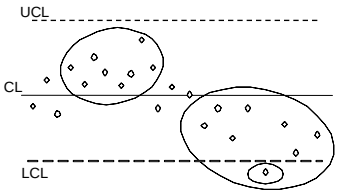
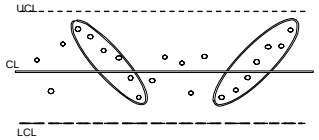
Rules for Determining A Special Cause



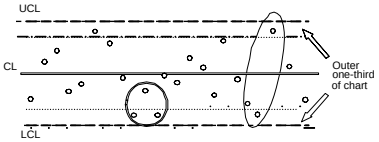
Point outside 3 sigma limits
Note: A point exactly on a control limit is not considered outside the limit



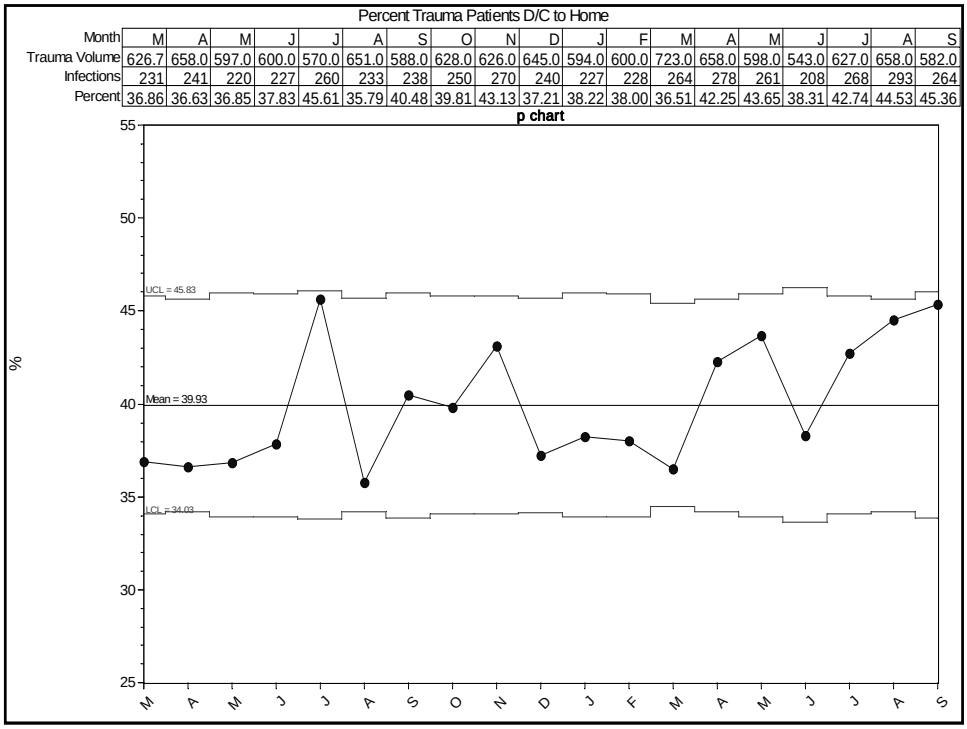
SHIFT: 8 points in row on same side of the mean Note: A point exactly on the centerline does not cancel or count towards a shift

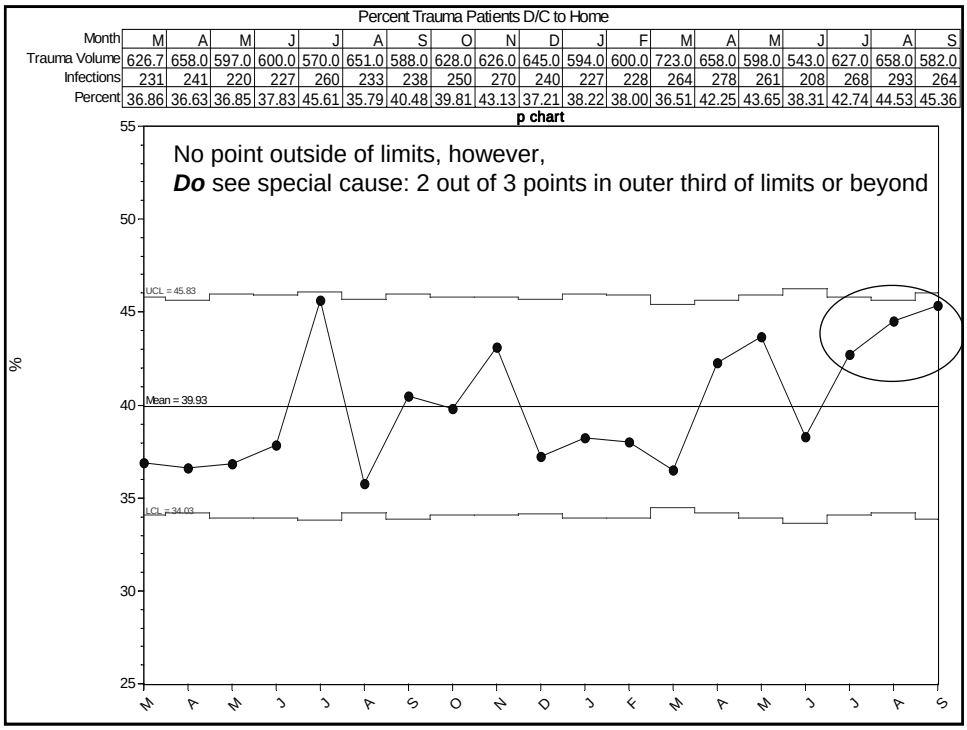


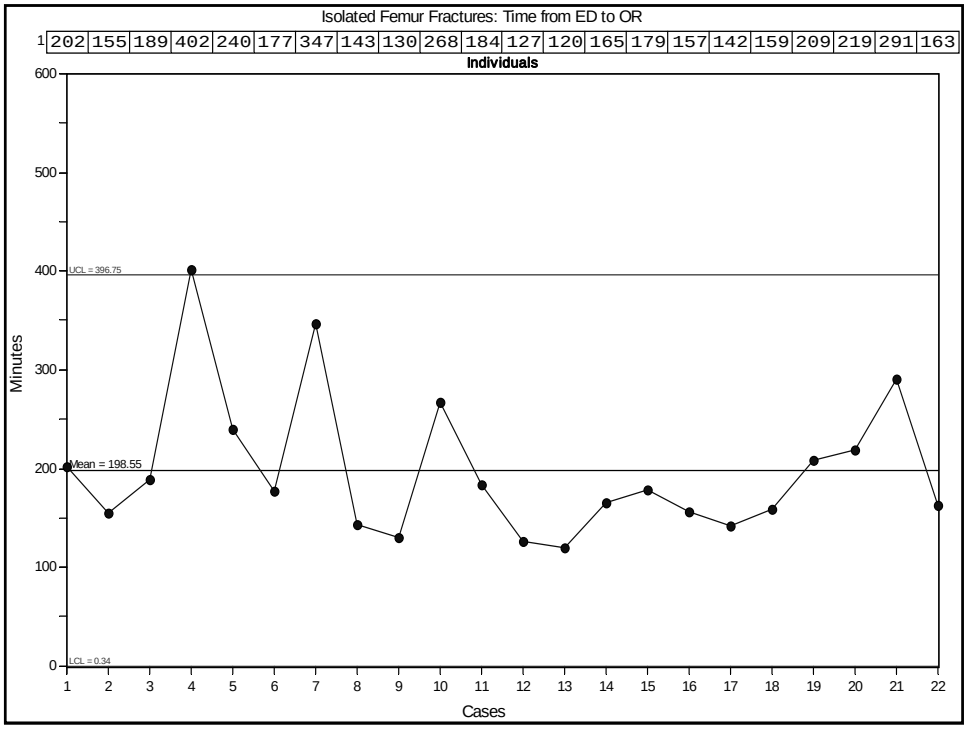
TREND: 6 points in row headed in same direction
Note: Ties between two consecutive points don't cancel or add to a trend

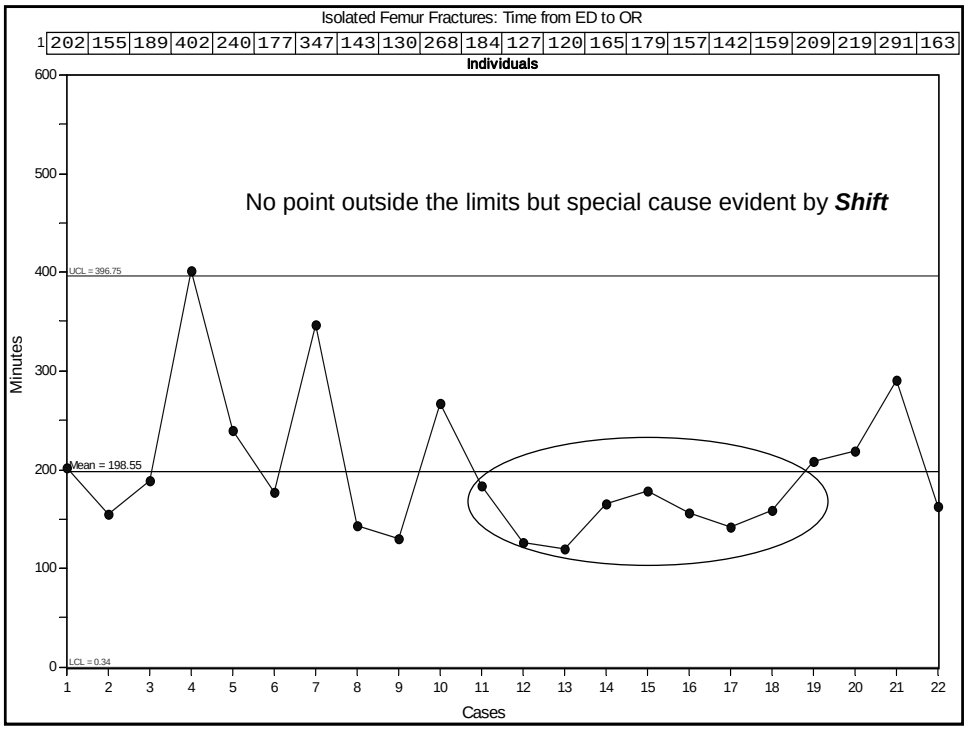


2 out of 3 consecutive points in outer 1/3 of the chart or beyond.
Note: If no lower or no upper limit this rule does not apply to the missing limit


Percent Trauma Patients D/C to Home
Month M A M J J A S O N D J F M A M J J A S
Trauma Volume 626.7 658.0 597.0 600.0 570.0 651.0 588.0 628.0 626.0 645.0 594.0 600.0 723.0 658.0 598.0 543.0 627.0 658.0 582.0
Infections 231 241 220 227 260 233 238 250 270 240 227 228 264 278 261 208 268 293 264
Percent 36.86 36.63 36.85 37.83 45.61 35.79 40.48 39.81 43.13 37.21 38.22 38.00 36.51 42.25 43.65 38.31 42.74 44.53 45.36
p chart
%
UCL = 45.83
Mean = 39.93
LCL = 34.03
55
50
45
40
35
30
25
M A M J J A S O N D J F M A M J J A S


Percent Trauma Patients D/C to Home
Month M A M J J A S O N D J F M A M J J A S
Trauma Volume 626.7 658.0 597.0 600.0 570.0 651.0 588.0 628.0 626.0 645.0 594.0 600.0 723.0 658.0 598.0 543.0 627.0 658.0 582.0
Infections 231 241 220 227 260 233 238 250 270 240 227 228 264 278 261 208 268 293 264
Percent 36.86 36.63 36.85 37.83 45.61 35.79 40.48 39.81 43.13 37.21 38.22 38.00 36.51 42.25 43.65 38.31 42.74 44.53 45.36
p chart
No point outside of limits, however,
Do see special cause: 2 out of 3 points in outer third of limits or beyond
%
UCL = 45.83
Mean = 39.93
LCL = 34.03
55
50
45
40
35
30
25
M A M J J A S O N D J F M A M J J A S


Isolated Femur Fractures: Time from ED to OR
1 202 155 189 402 240 177 347 143 130 268 184 127 120 165 179 157 142 159 209 219 291 163
Individuals
600
500
400
300
200
100
0
UCL = 396.75
Mean = 198.55
LCL = 0.34
Minutes
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Cases


Isolated Femur Fractures: Time from ED to OR
1 202 155 189 402 240 177 347 143 130 268 184 127 120 165 179 157 142 159 209 219 291 163
Individuals
No point outside the limits but special cause evident by ***Shift***
600
500
400
300
200
100
0
UCL = 396.75
Mean = 198.55
LCL = 0.34
Minutes
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Cases

Why Distinguish Special From Common Cause Variation?

- Economic use of our time….Helps us learn with less waste and greater accuracy
  - Special cause
    - Learn from data that is indicating presence of special cause by contrasting it with common cause data
    - ⇨ Ask what was different about the process when this special cause data was obtained
  - Common cause
    - Learn from all of the data
    - ⇨ Ask what is common to the process that impacted all the data

When is it Used?

- When we need to learn:
  - How much variation does process exhibit?
  - What kind of variation is present
    - Common cause, special cause
    - Is process predictable?
  - Causes of variation
  - Is my change an improvement?
  - Have I sustained my improvement?

Some Basics on Building a Shewhart Chart

- Less than 12 data points use run chart

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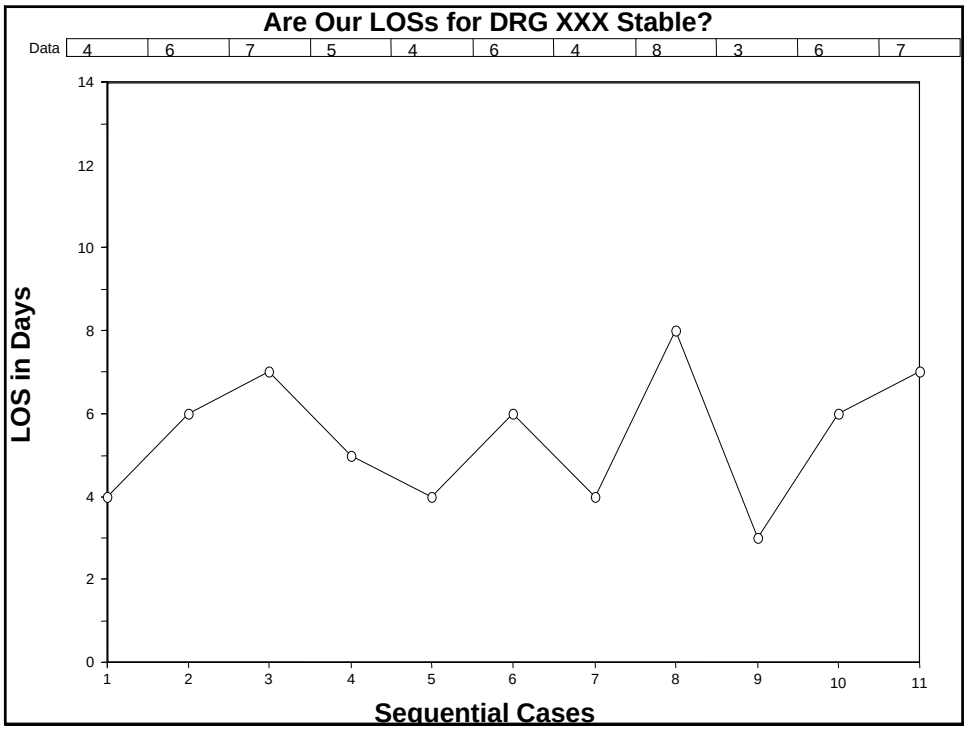
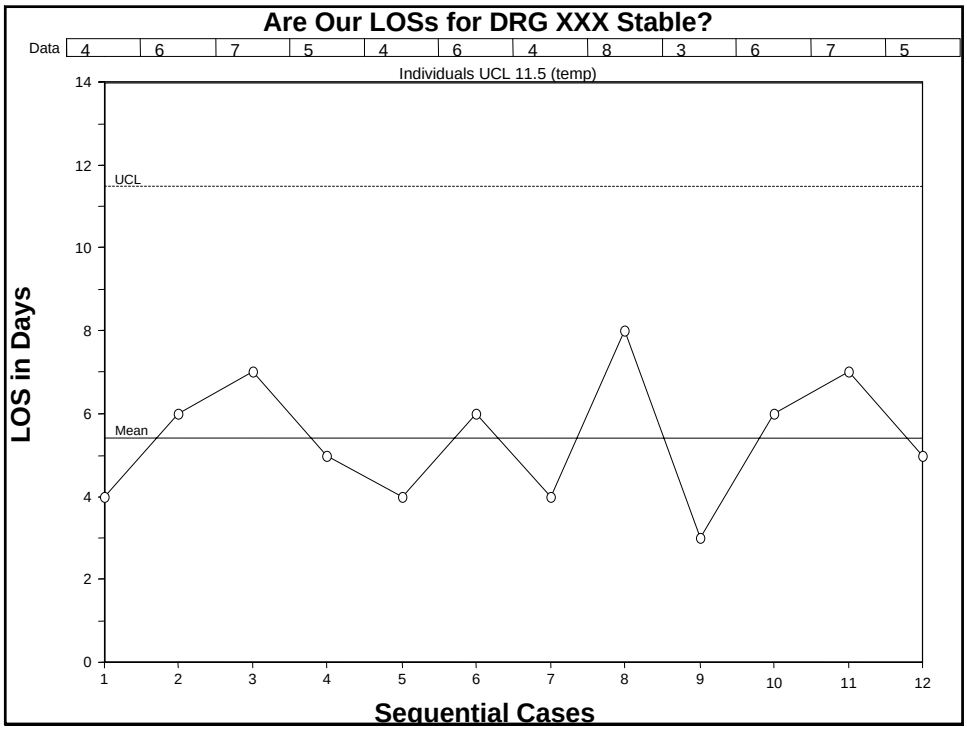


Some Basics on Building a Shewhart Chart

- 12 data points or more I often calculate trial limits

179



Some Basics on Building a Shewhart Chart

- Use trial limits until you reach 20-30 data points
  - Update limits once you have 20-30 data points

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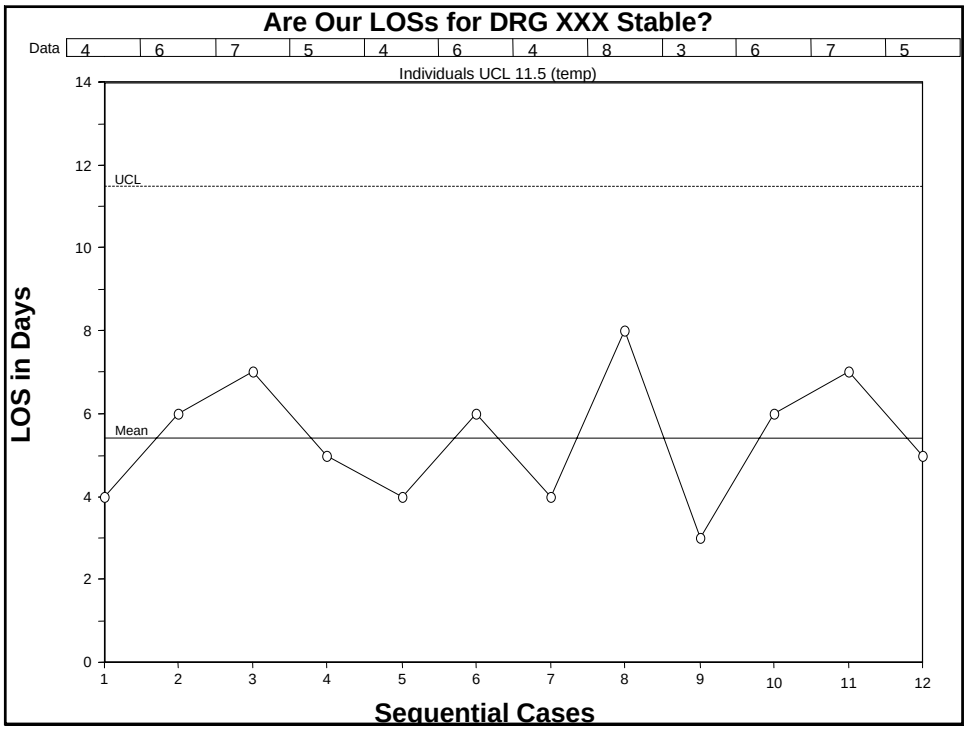
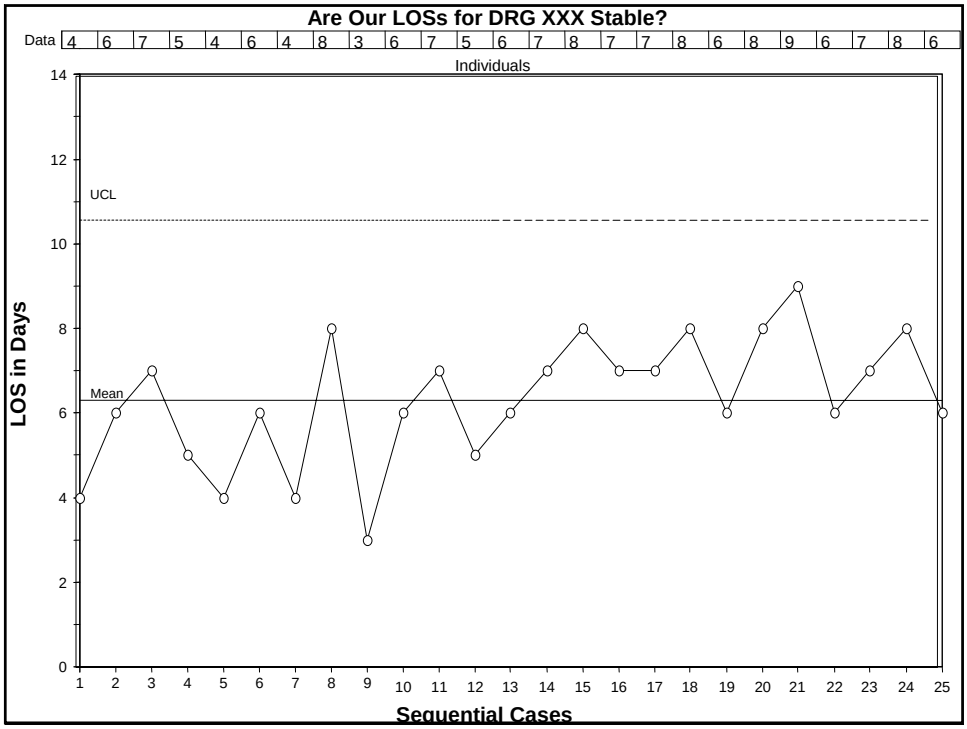
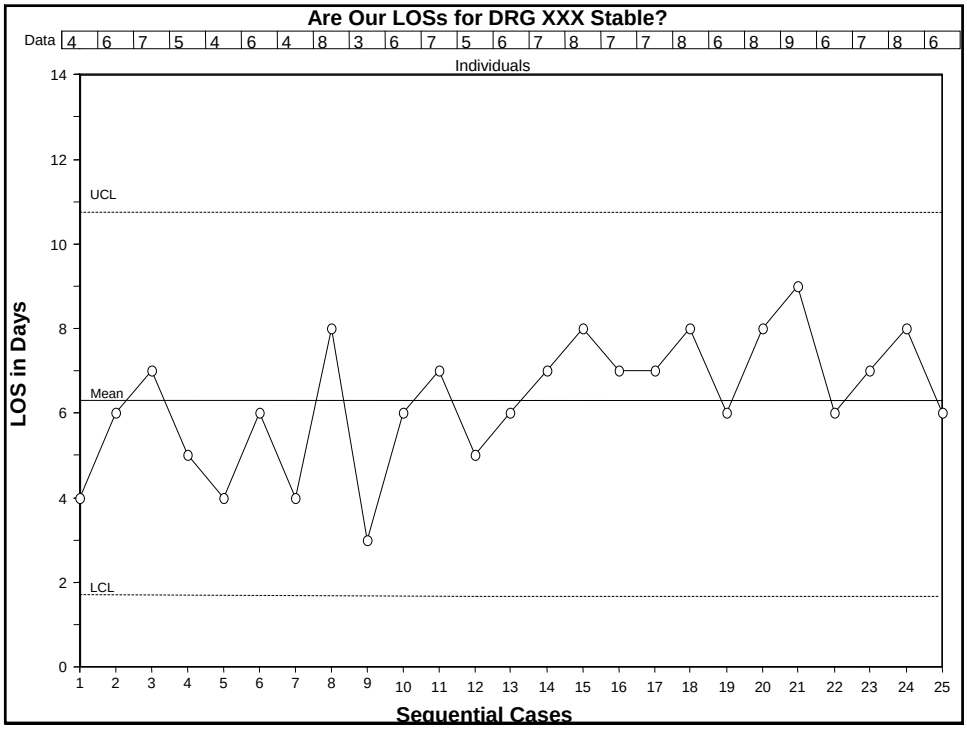



Are Our LOSs for DRG XXX Stable?
Data 4 6 7 5 4 6 4 8 3 6 7 5 6 7 8 7 7 8 6 8 9 6 7 8 6
Individuals
UCL
Mean
LOS in Days
Sequential Cases


Are Our LOSs for DRG XXX Stable?
Data 4 6 7 5 4 6 4 8 3 6 7 5 6 7 8 7 7 8 6 8 9 6 7 8 6
Individuals
UCL
Mean
LCL
LOS in Days
Sequential Cases

Building a Shewhart Chart

- Once you have 20-30 data points and process is stable:
  - Extend center line and limits into future
  - Use these limits until no longer useful

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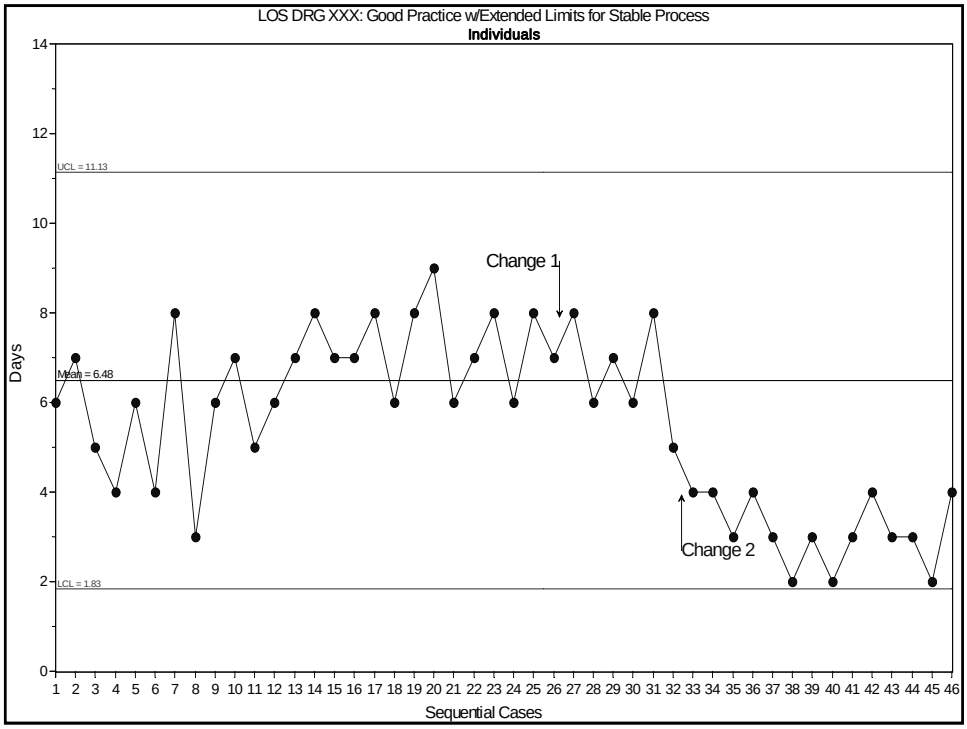
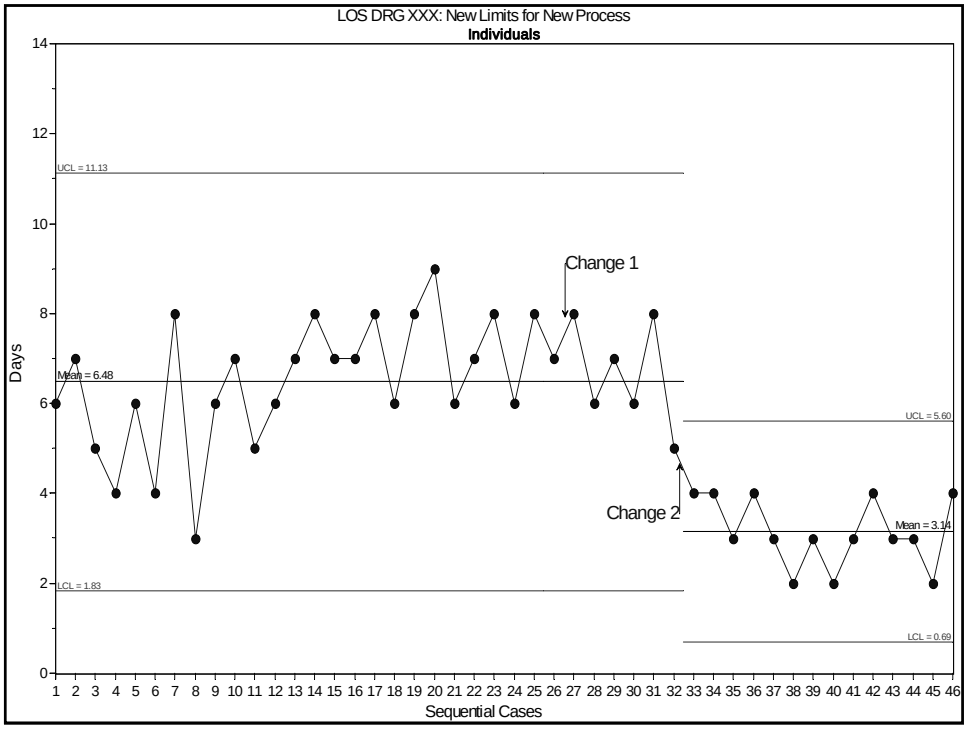
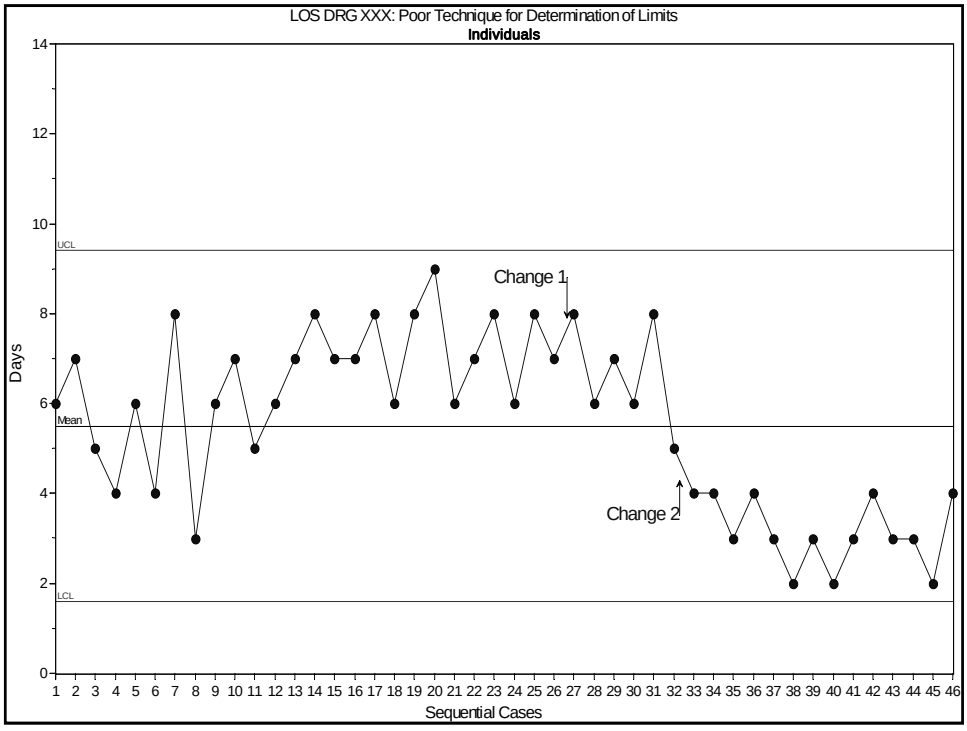



LOS DRG XXX: New Limits for New Process
Individuals
Days
Sequential Cases
UCL = 11.13
Mean = 6.48
LCL = 1.83
Change 1
Change 2
UCL = 5.60
Mean = 3.14
LCL = 0.69


LOS DRG XXX: Poor Technique for Determination of Limits
Individuals
Days
Sequential Cases
UCL
Mean
LCL
Change 1
Change 2

Why Use Shewhart Chart?

- Greater ability to detect statistically significant change than a run chart

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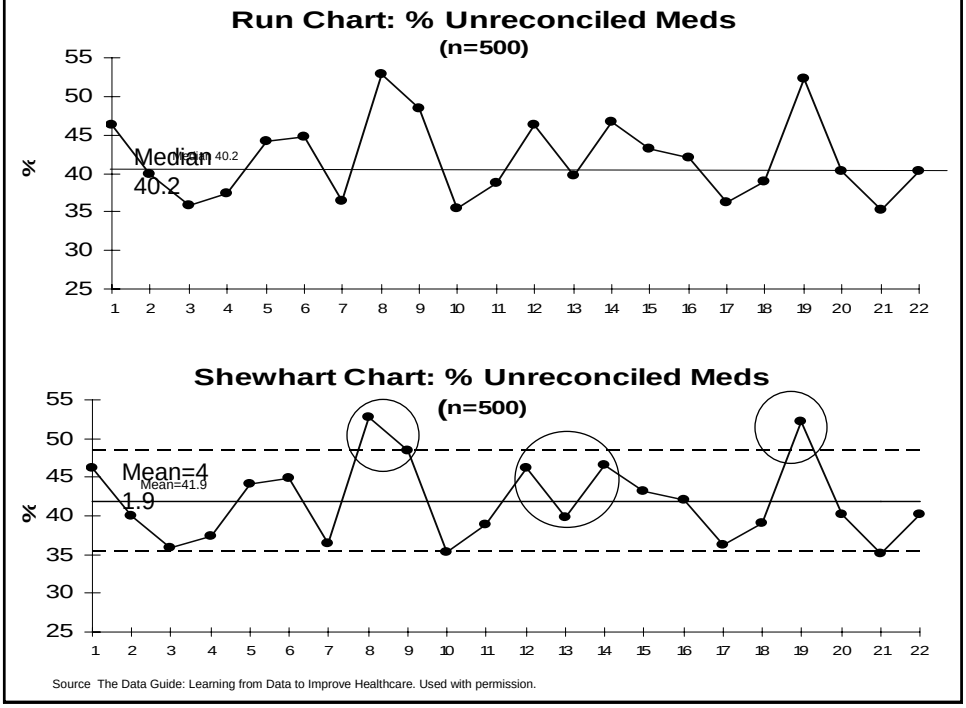
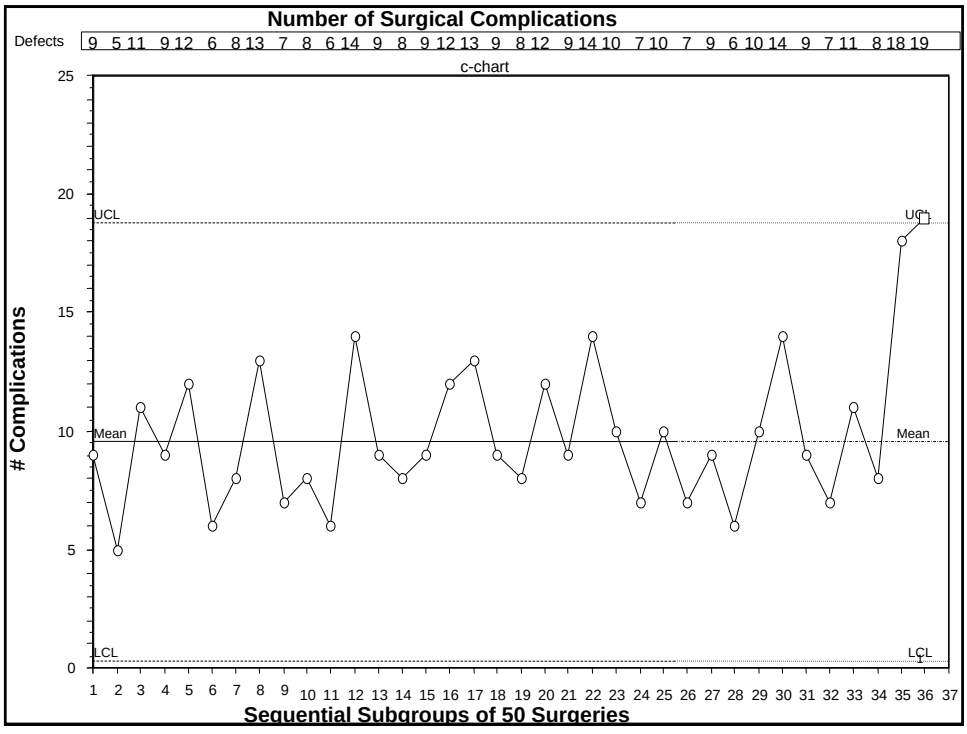


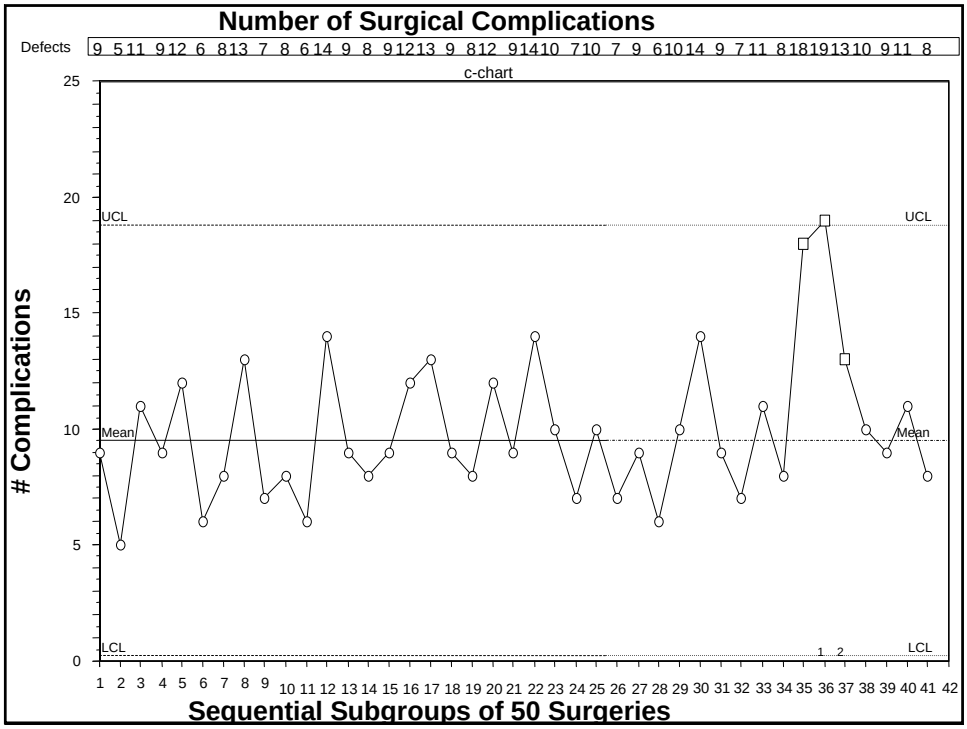
Source The Data Guide: Learning from Data to Improve Healthcare. Used with permission.

Using a Shewhart Chart

- Assess stability and determine improvement strategy (common or special cause strategy)
- **<u>Monitor performance and correct as needed</u>**
- Find and evaluate causes of variation
- Tell if our changes yielded improvements
- See if improvements are “sticking”

191





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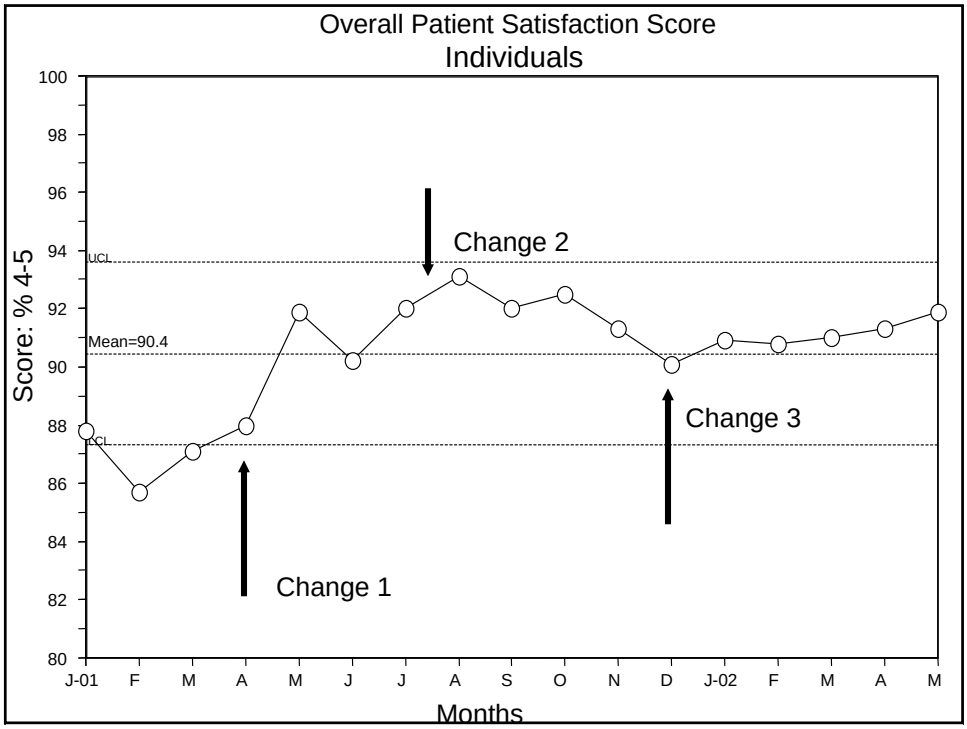
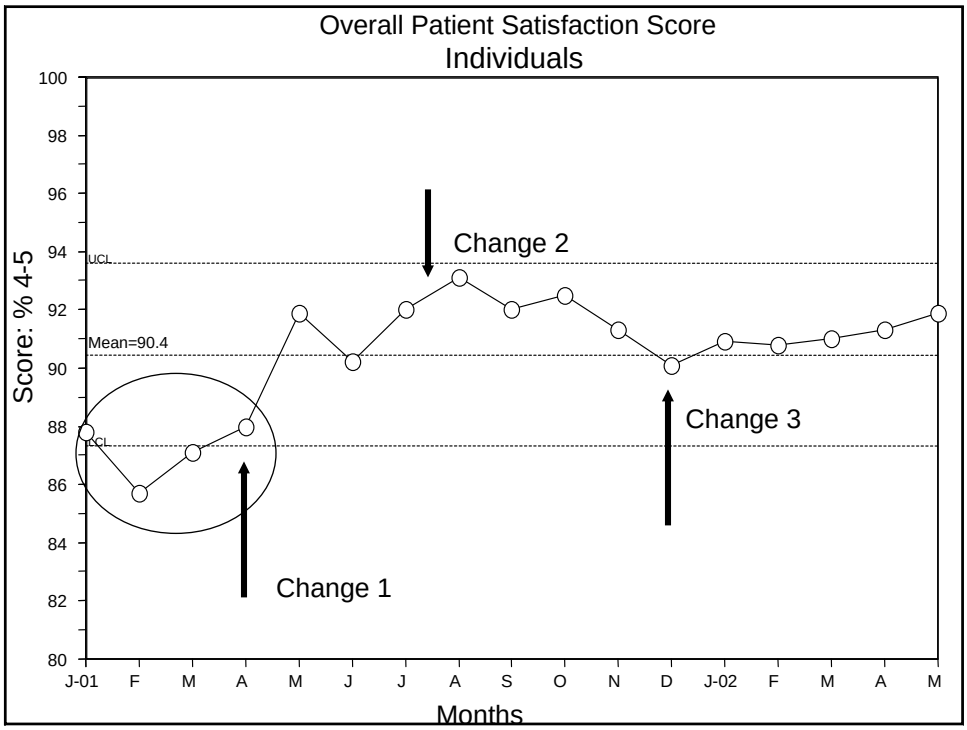

Overall Patient Satisfaction Score
Individuals
Score: % 4-5
100
98
96
94
92
90
88
86
84
82
80
UCL
Mean=90.4
LCL
Change 1
Change 2
Change 3
J-01
F
M
A
M
J
J
A
S
O
N
D
J-02
F
M
A
M
Months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Score: % 4-5
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96
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92
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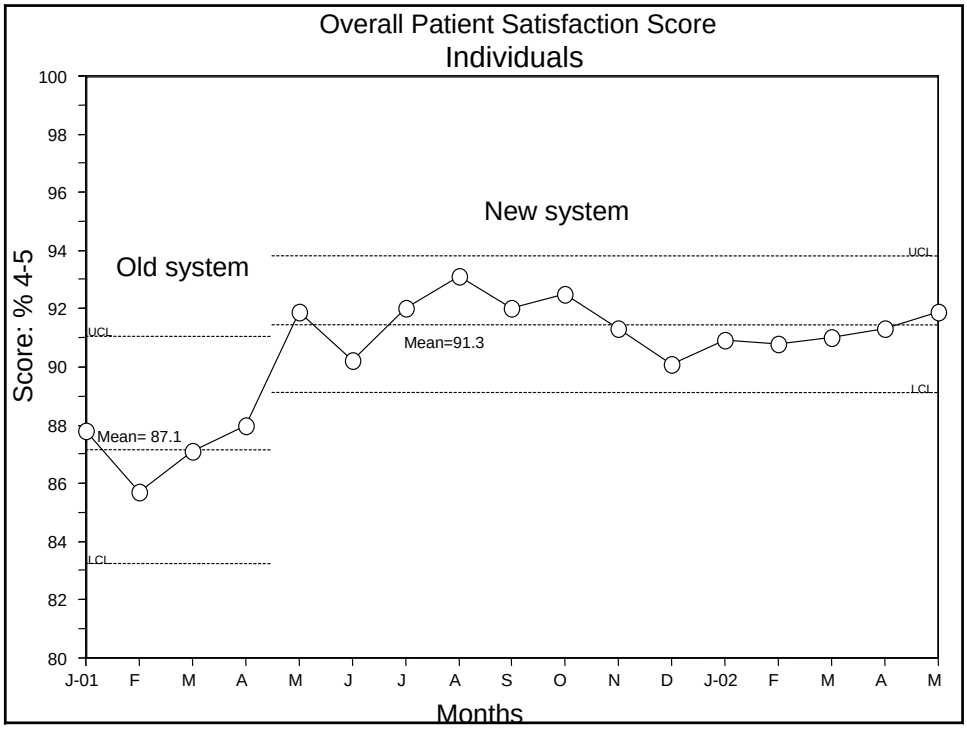
Mean=90.4
LCL
Change 1
Change 2
Change 3
J-01
F
M
A
M
J
J
A
S
O
N
D
J-02
F
M
A
M
Months



Using a Shewhart Chart

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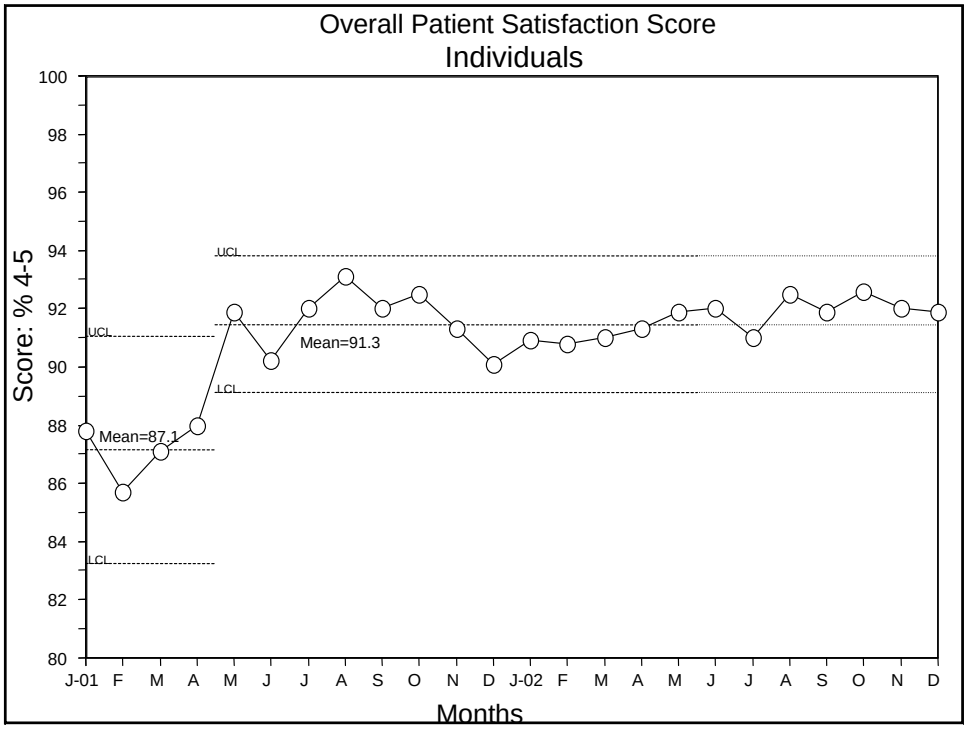
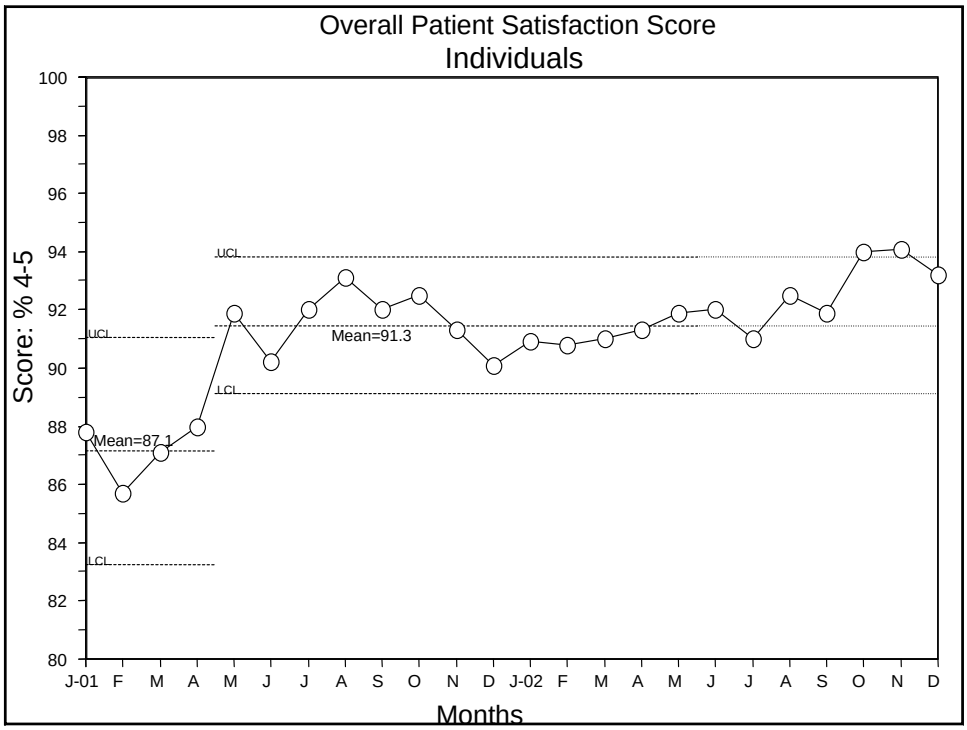
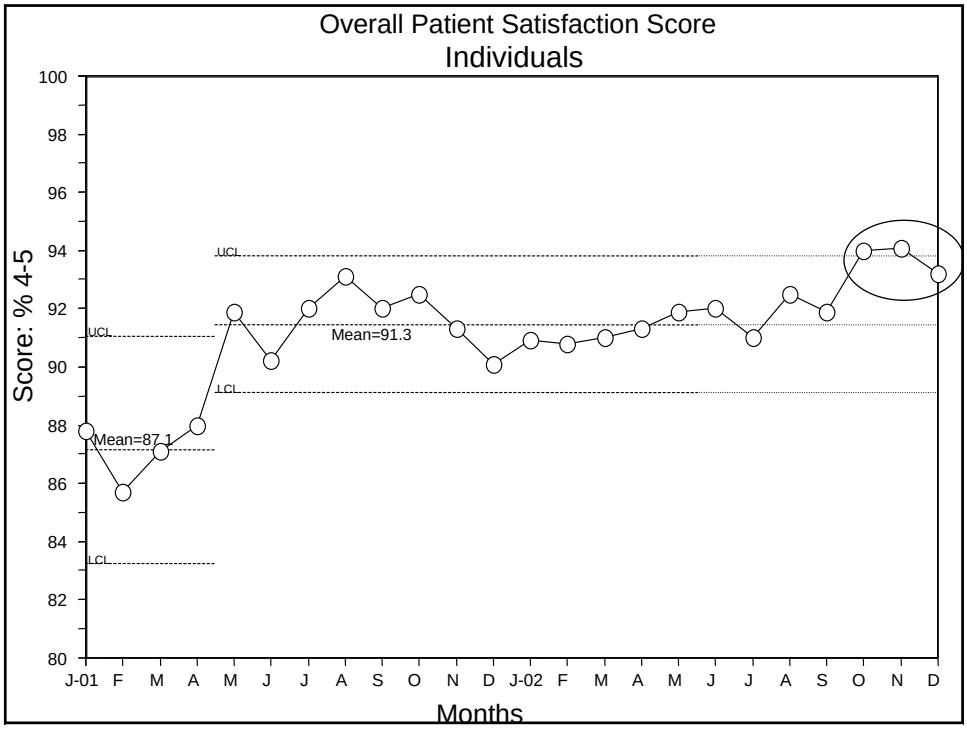
198


Overall Patient Satisfaction Score
Individuals
Score: % 4-5
100
98
96
94
92
90
88
86
84
82
80
UCL
UCL
Mean=91.3
LCL
Mean=87.1
LCL
J-01 F M A M J J A S O N D J-02 F M A M J J A S O N D
Months


Overall Patient Satisfaction Score
Individuals
Score: % 4-5
100
98
96
94
92
90
88
86
84
82
80
UCL
UCL
Mean=91.3
LCL
Mean=87.1
LCL
J-01 F M A M J J A S O N D J-02 F M A M J J A S O N D
Months


Overall Patient Satisfaction Score
Individuals
Score: % 4-5
100
98
96
94
92
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84
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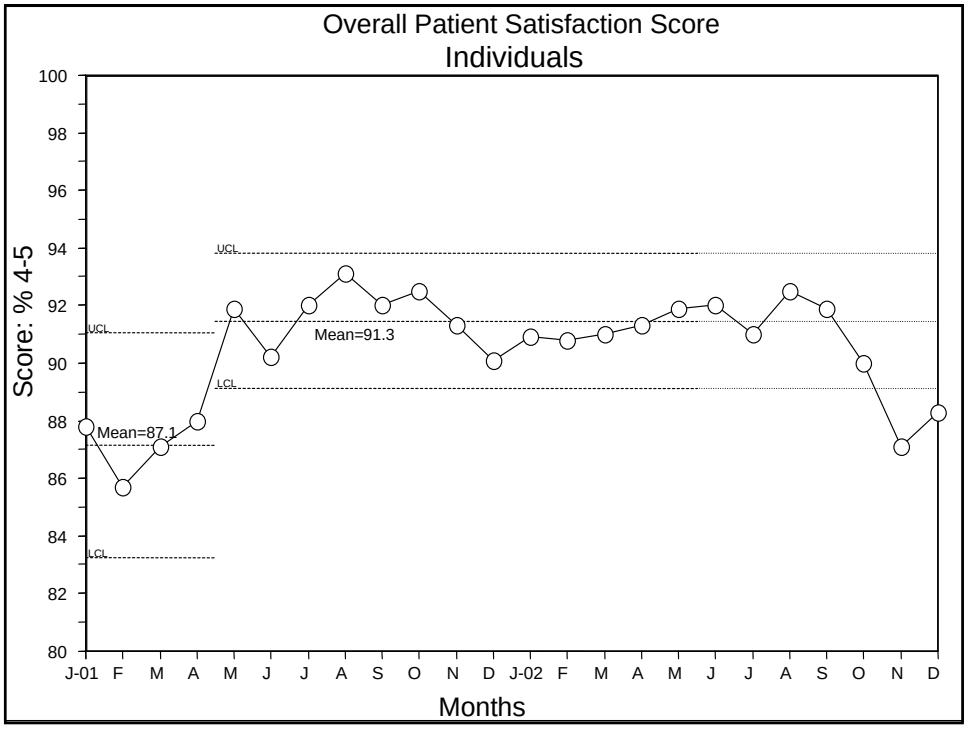
UCL
Mean=91.3
LCL
UCL
Mean=87.1
LCL
J-01 F M A M J J A S O N D J-02 F M A M J J A S O N D
Months


Overall Patient Satisfaction Score
Individuals
Score: % 4-5
100
98
96
94
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90
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84
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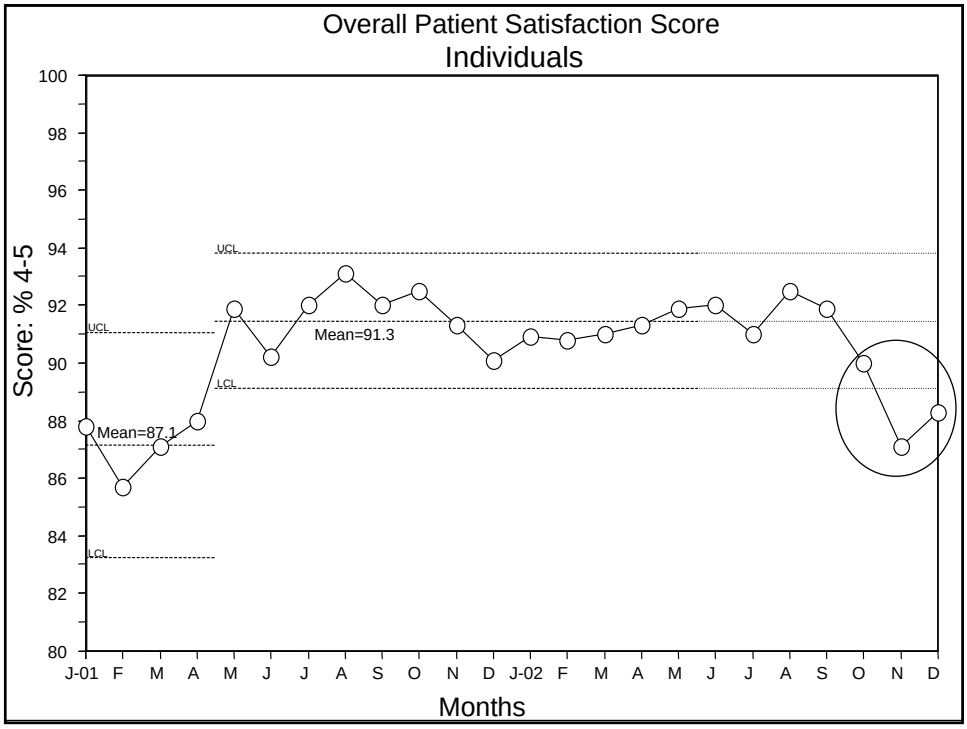
80
UCL
Mean=91.3
LCL
UCL
Mean=87.1
LCL
J-01 F M A M J J A S O N D J-02 F M A M J J A S O N D
Months



Pop Quiz

- What are the biggest reasons for reperfusion delays?
- Does the number of staff on duty appear to drive the reperfusion time?
- We've made a lot of safety changes. Is our percent of Adverse Drug Events improving?
- What is the age at which kids say they smoked their first cigarette?

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Objectives

- **Identify fundamental differences in data used for improvement, accountability, research**
- **Interpret data on a :**
  - **Run chart**
  - **Pareto chart**
  - **Frequency Plot**
  - **Scatter Plot**
  - **Shewhart (Control) Chart (introduction only)**
- **Recognize the most appropriate tool for the measurement question you are posing**

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