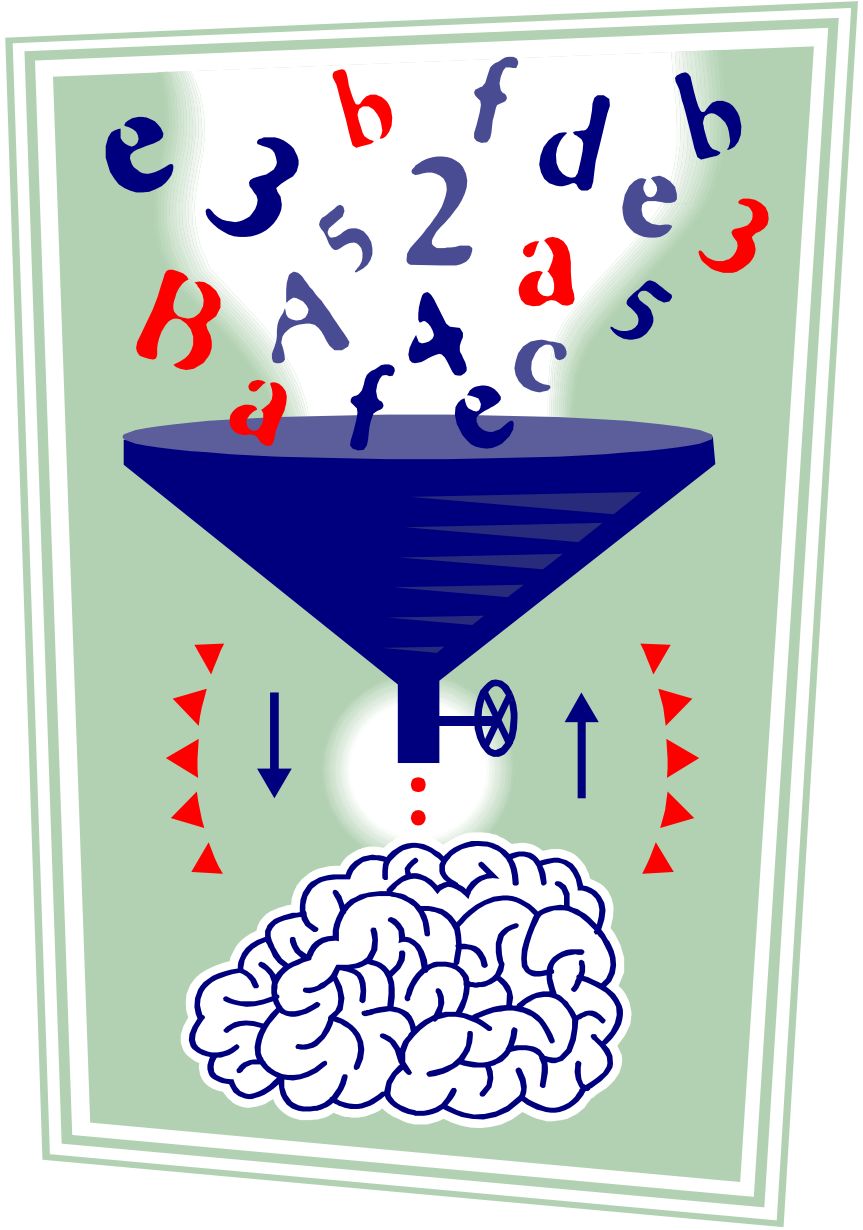


Making ***Sense*** *Out of Data for Improvement in Healthcare*

Sandra K. Murray, April 2017
ctconcept@comcast.net

Objectives

- Select the appropriate tool from a chest of data tools for the question being addressed
- Analyze a run chart
  - Identify signals that indicate statistically significant evidence of change on a run chart
- Analyze a Pareto chart, a Histogram and a Scatter Diagram
- Identify a Shewhart control chart

References

Books:

1. The Health Care Data Guide. Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.
2. The Improvement Guide. Gerald J. Langley, Kevin M. Nolan, Thomas W. Nolan, Clifford L. Norman, Lloyd P. Provost, Jossey-Bass, 2009.

Software Used in This Presentation:

1. ChartRunner. PQ Systems. 1-800-777-3020.
2. Excel
3. QI Charts. API, 512-708-0131

Articles:

1. The run chart: a simple analytical tool for learning from variation in healthcare processes. Rocco J Perla, Lloyd P Provost and Sandra K Murray. BMJ Qual Saf 2011 20: 46-51.
2. Sampling Considerations for Health Care Improvement**.** Rocco J Perla, Lloyd P Provost and Sandra K Murray. Q Manage Health Care. Vol. 22, No. 1, pp. 36-47, 2013.

Internet:

www.ihi.org

Exercise: What Data Do You Use?

- Task: Create a list that looks like the following slide

Name of Measure	Description (e.g.Num/Denom)	How often can you get data	Type of Chart
Average length of stay per pt.	Average days LOS	weekly	
% compliance	# met standard/# records reviewed	monthly	
Type of compliance errors	# compliance errors categorized by type of error	2 months worth of data	
Infection rate per 1000 cases	# infections/[# cases/1000]	monthly	
Age of patients who fell	Age of each patient who fell	Last 6 mo. of data	
Patient Satisfaction	Percent who rated our organization 4 or higher on pt. sat survey	monthly	
Reasons for pt dissatisfaction	Reasons pts say they were not satisfied	From last 3 mo.	

This column will be blank for now

Name of Measure	Description (e.g.Num/Denom)	How often can you get data	Type of Chart

Purpose of Measurement

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

The Three Faces of Performance Measurement: Improvement, Accountability and Research. Journal on Quality Improvement, Volume 23, Number 3, March, 1997.

Data for Improvement, Accountability and Research in Health Care

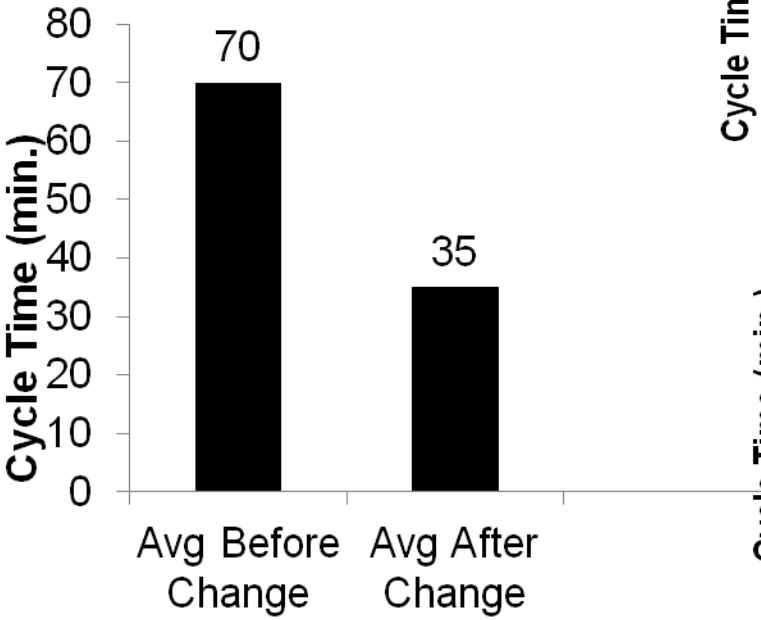
Aspect	Improvement	Accountability or Judgment	Research
Aim:	Improvement of care processes, systems and outcomes	Comparison for judgment, choice, reassurance, spur for change	New generalizable knowledge
Methods:	Test observable	No test, evaluate current performance	Test blinded
Bias:	Accept consistent 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
Determining if a Change is an Improvement:	Run charts or Shewhart control charts	No focus on change	Hypothesis, statistical tests (t-test, F-test, chi square, p-values)
Confidentiality of the Data:	Data used only by those involved with improvement	Data available for public consumption	Research subjects' identities protected
Frequency of Use:	Daily, weekly, monthly	Quarterly, annually	At end of project

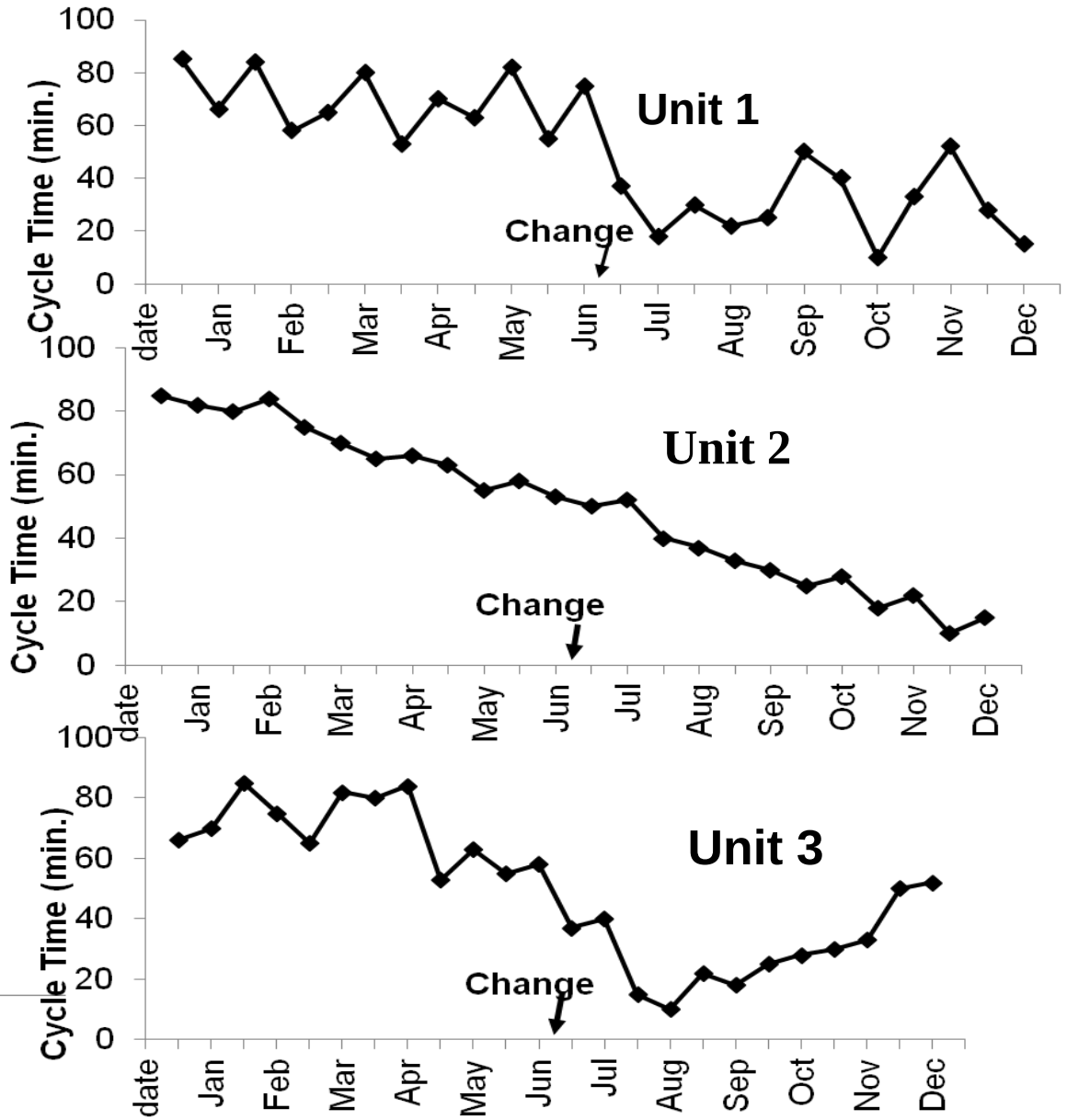
Source: The Data Guide: Learning from Data to Improve Healthcare. Developed from Solberg, Leif I., Mosser, Gordon and McDonald, Susan. "The Three Faces of Performance Measurement: Improvement, Accountability and Research." Journal on Quality Improvement. March 1997, Vol.23, No.

Graphical Display of Data

- Effective visual presentations of data, instead of tabular displays, provide the most opportunity from variation
- Viewing variation over time enhances learning

Cycle Time Results for Units 1, 2 and 3

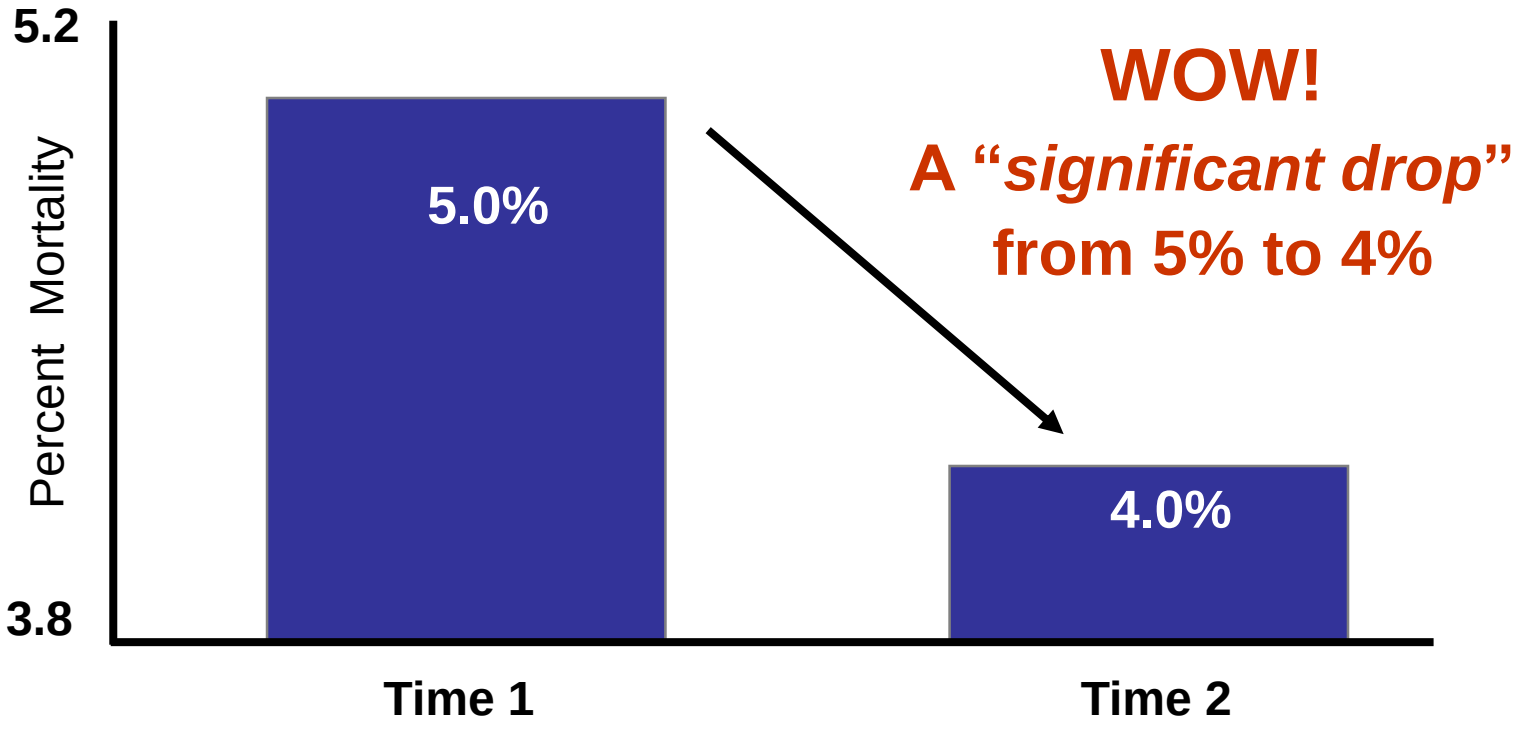




The run chart: a simple analytical tool for learning from variation in healthcare processes.
Rocco J Perla, Lloyd P Provost and Sandra K Murray. BMJ Qual Saf 2011 20: 46-51.

Average CABG Mortality

Before and After the Implementation of a New Protocol

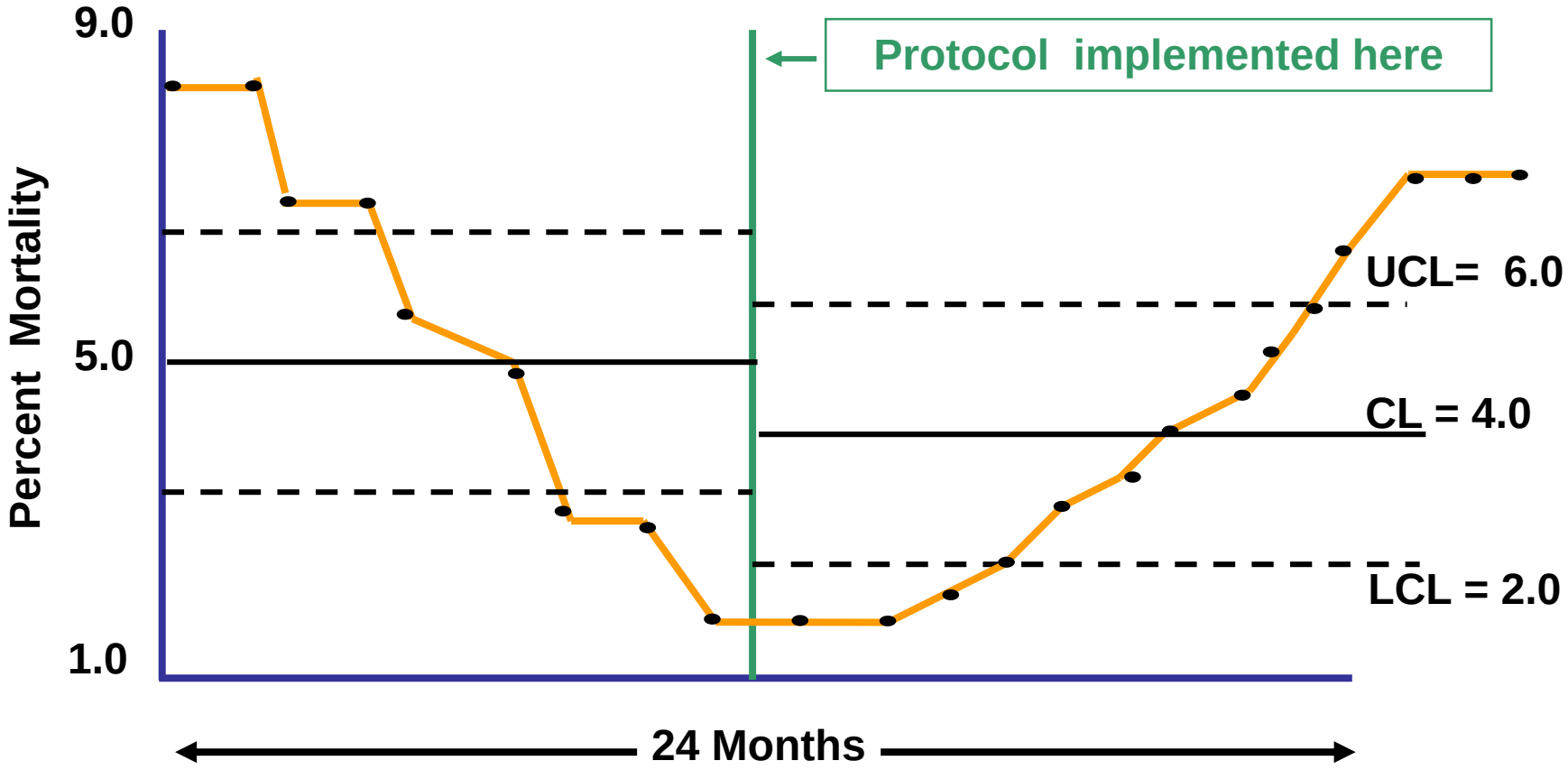


Conclusion -The protocol was a success!
A 20% drop in the average mortality!

Source: R. Lloyd

Average CABG Mortality

Before and After the Implementation of a New Protocol

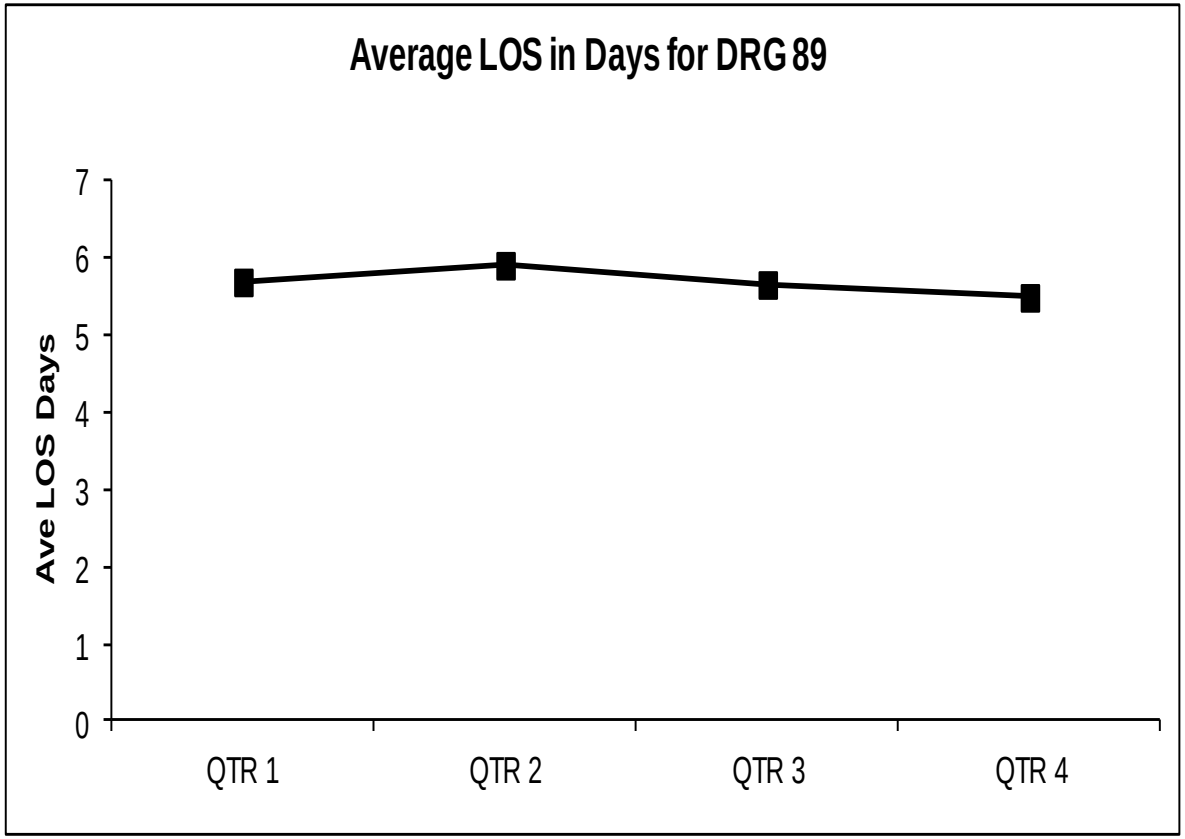


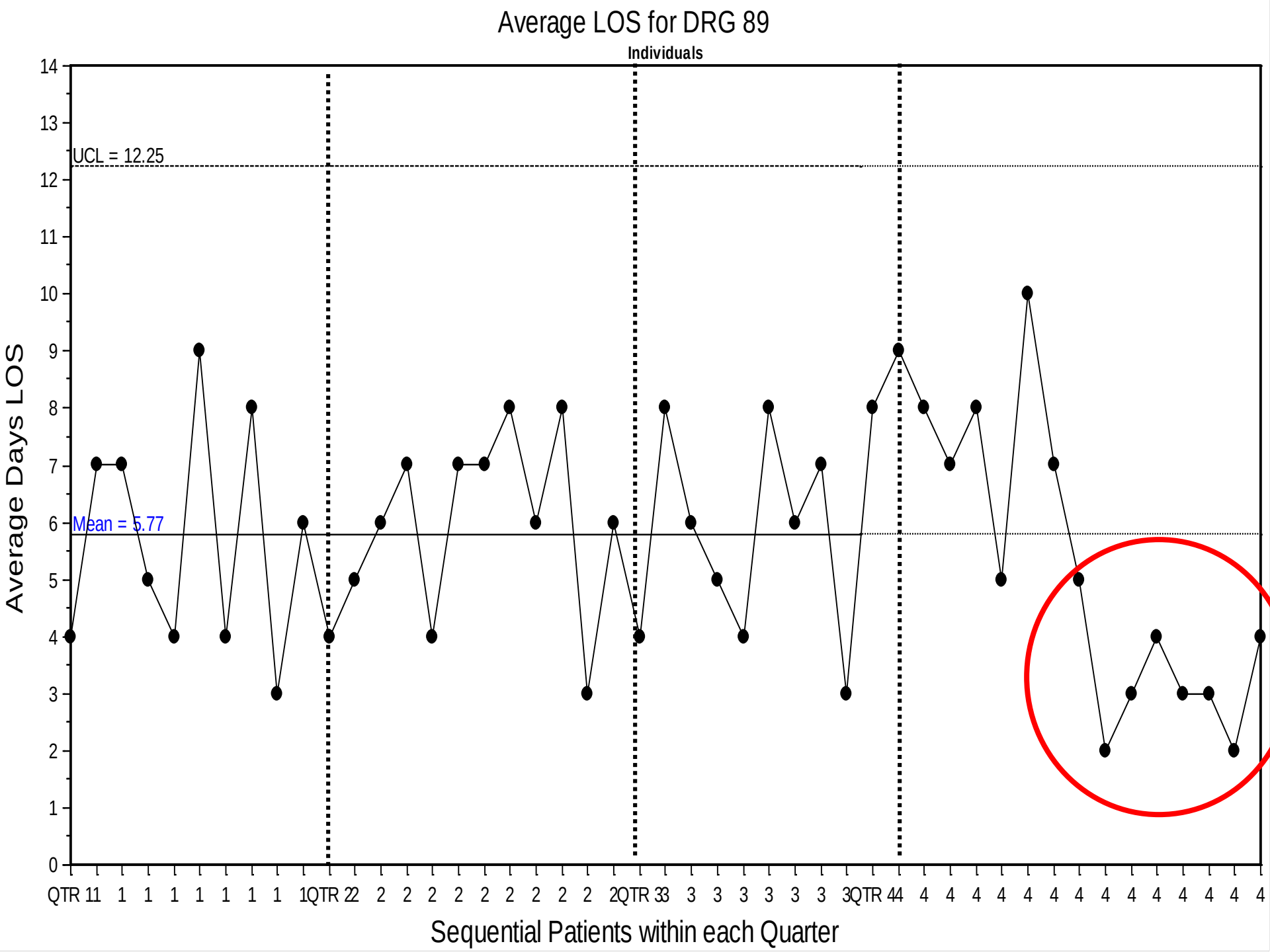
Source: R. Lloyd

Need data more often than annually…

Much better if more frequently than quarterly

Qtr	LOS Days
QTR 1	4
1	7
1	7
1	5
1	4
1	9
1	4
1	8
1	3
1	6
QTR 2	4
2	5
2	6
2	7
2	4
2	7
2	7
2	8
2	6
2	8
2	3
2	6
QTR 3	4
3	8
3	6
3	5
3	4
3	8
3	6
3	7
3	3
QTR 4	8
4	9
4	8
4	7
4	8
4	5
4	10
4	7
4	5
4	2
4	3
4	4
4	3
4	3
4	2
4	4




Average LOS for DRG 89
Individuals
UCL = 12.25
Mean = 5.77
Average Days LOS
Sequential Patients within each Quarter
QTR 1
QTR 2
QTR 3
QTR 4

Enumerative and Analytic Statistics

On Probability as a Basis for Action. W. Edwards Deming. The American Statistician, November 1975, Vol. 29, No. 4, pp. 146-152

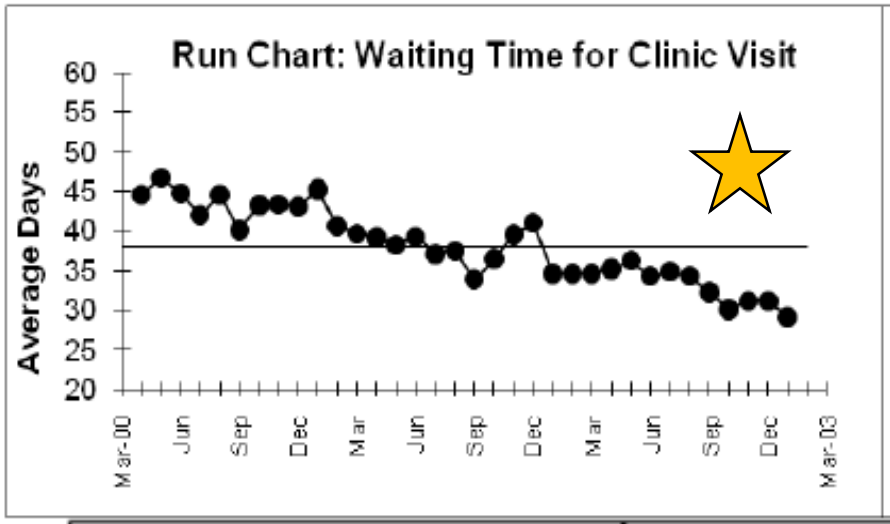
Enumerative: a pond

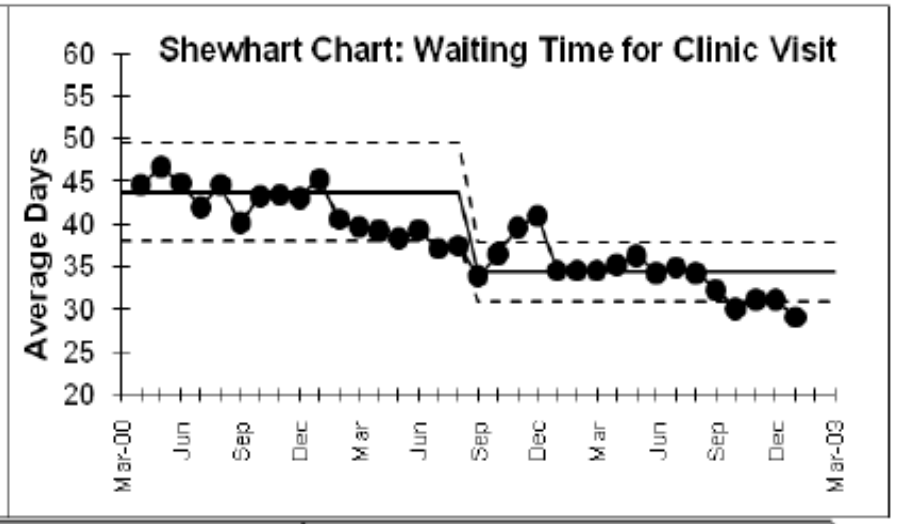
Fixed population- universe, frame, distribution known
Purpose: **Estimation**
-how much variation, significance
-random sampling
-learning applies only to population sampled
-**take action on population studied (e.g. accept or reject sampled population)**

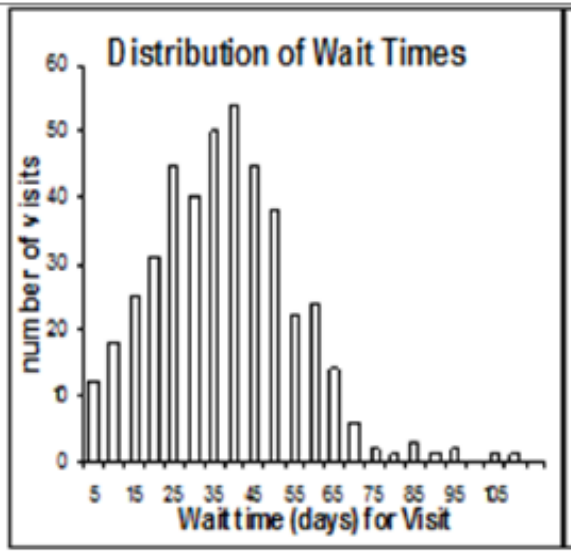
Analytic: a stream

Not fixed population-ongoing “stream” of data, distribution unknown
Purpose: **Prediction of future performance**
-how much variation, what type, why
-judgment sampling
-take action on underlying process to improve future outcome of process

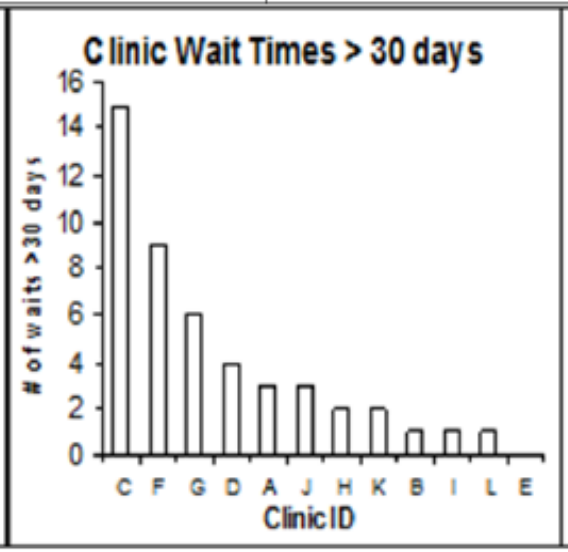
Tools to Learn from Variation in Data



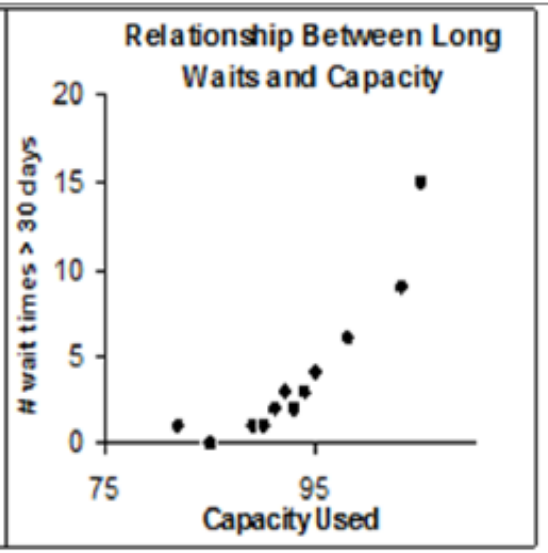




Frequency Plot



Pareto Chart



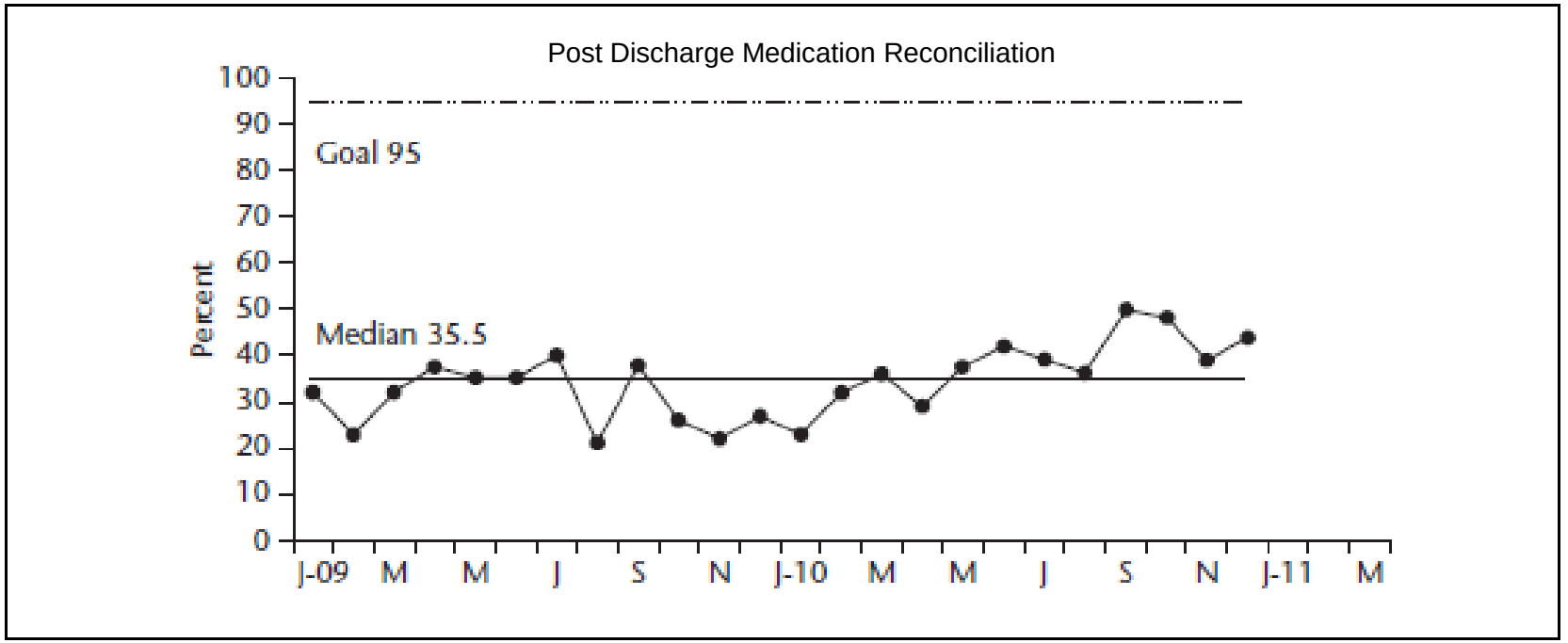
Scatter Plot

The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Run Chart

- Graphical display of data plotted in some type of order. Also has been called a time series, run plot or a trend chart.

FIGURE 3.1 Run Chart Example

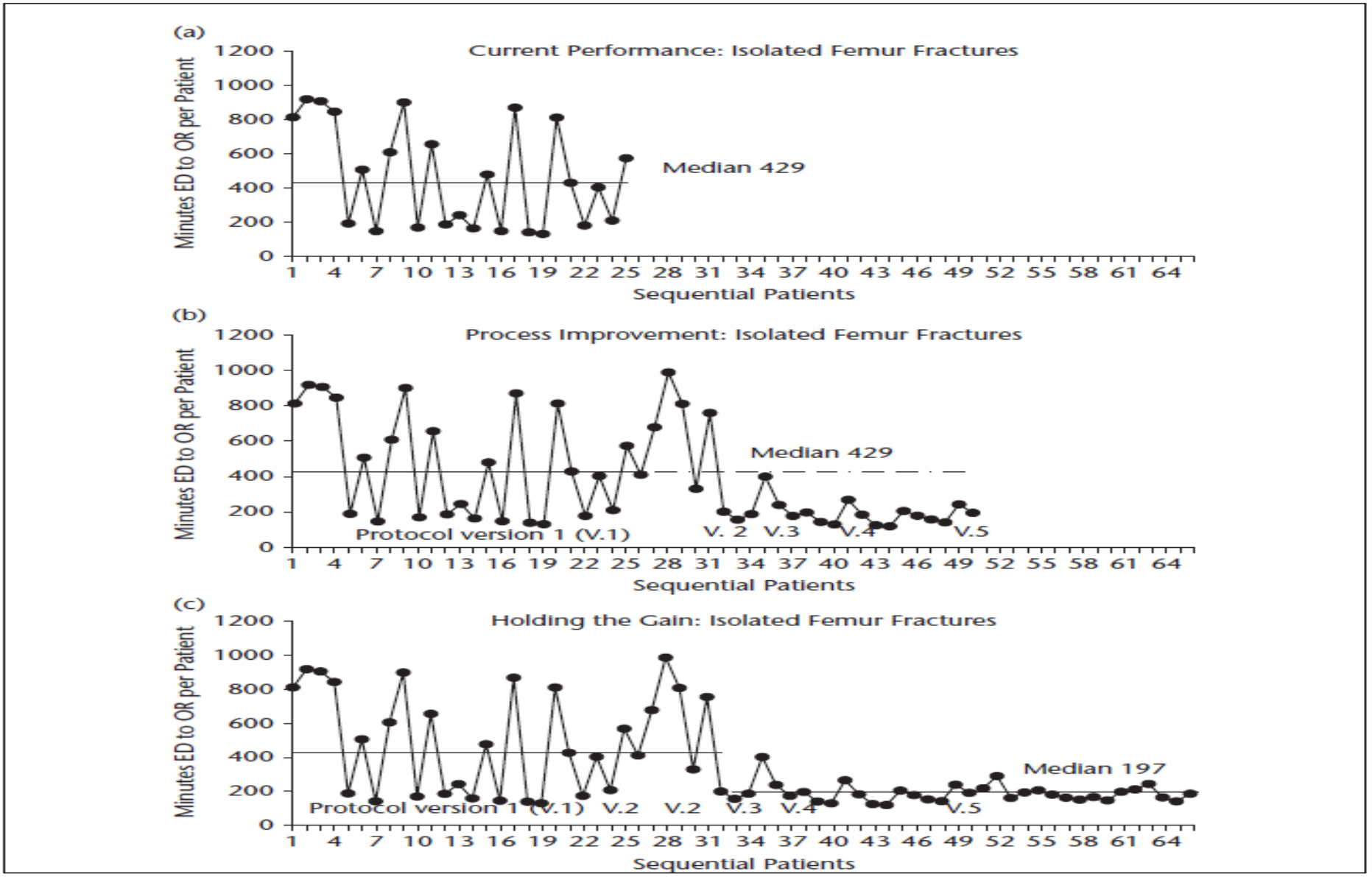


The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Fundamental Uses of Run Charts

- How much variation do we have?
  - Display data to make process performance visible
- Have our changes yielded improvement?
  - Determine whether a change resulted in evidence of improvement
- Are we holding the gains we made?
  - Determine whether we are sustaining gains made by our improvement or seeing them slip away

FIGURE 3.21 Three Key Uses of Run Charts in Improvement Initiatives



The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

How Do We Tell a Change is an Improvement?

- Run charts speak for themselves…or..

- Analyze with probability-based rules

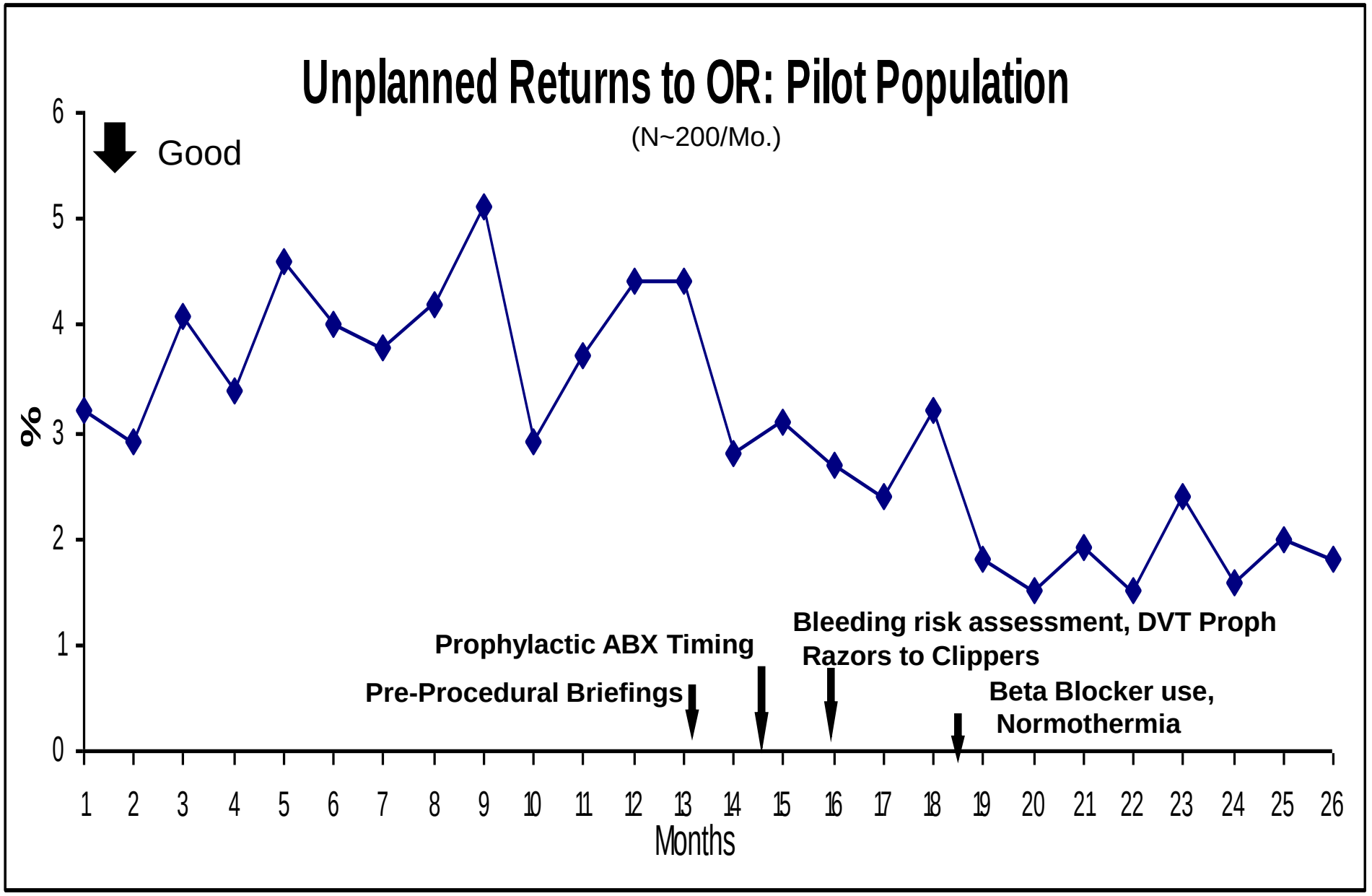
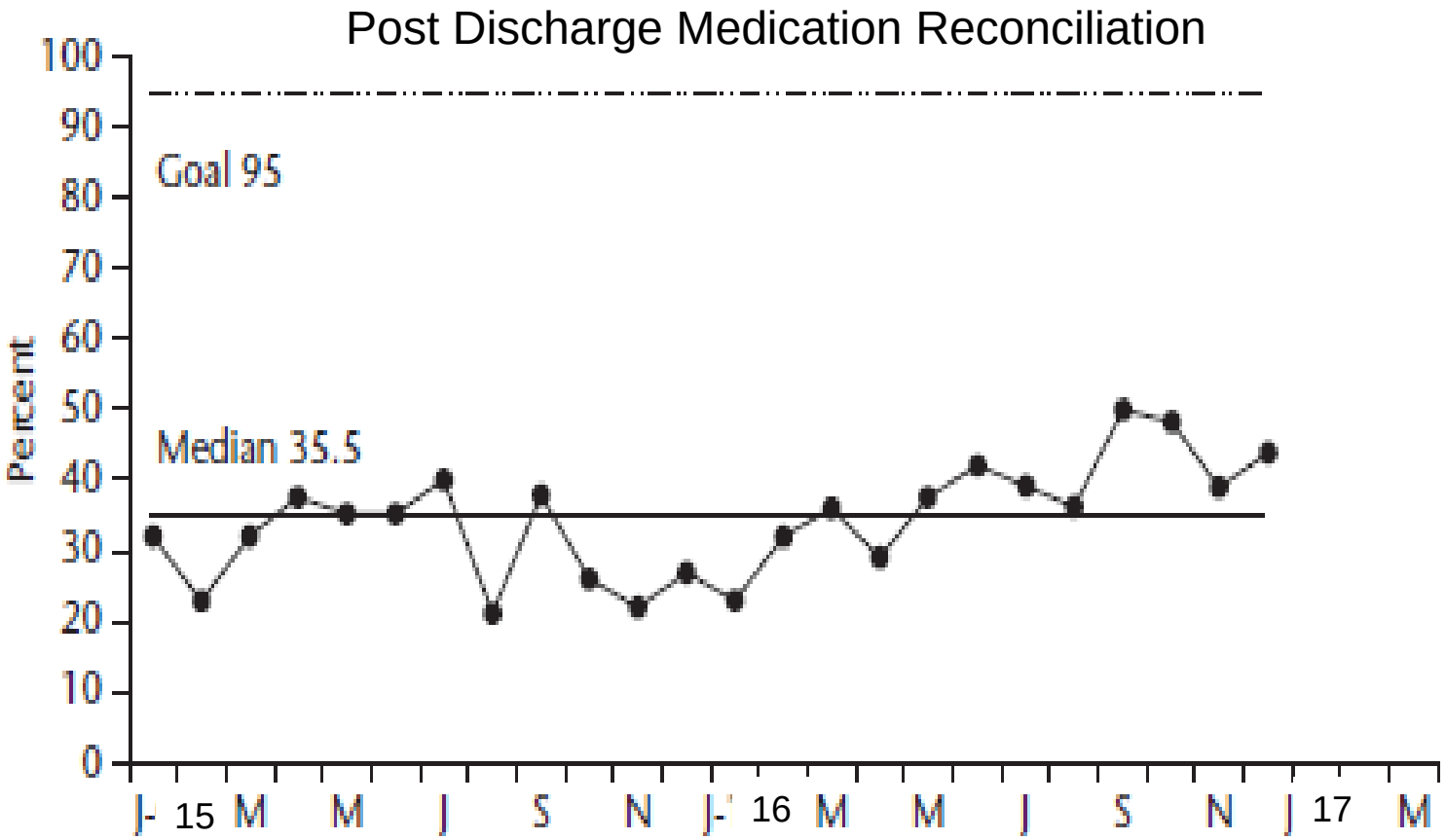

Unplanned Returns to OR: Pilot Population
(N~200/Mo.)
Good
%
0
1
2
3
4
5
6
Prophylactic ABX Timing
Pre-Procedural Briefings
Bleeding risk assessment, DVT Proph
Razors to Clippers
Beta Blocker use,
Normothermia
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26
Months

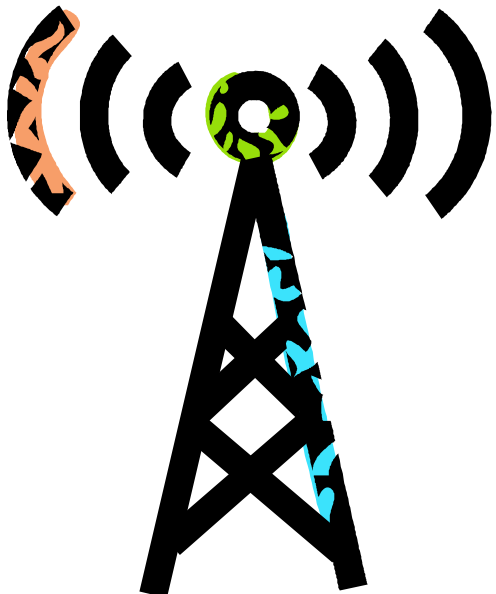
FIGURE 3.1 Run Chart Example



The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

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 probability-based rules
  - Can detect signal of change (a non-random pattern in the data)
  - To do this we must place **median** on the run chart



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

MODE: the most frequently occurring number

Why Median Rather Than Mean?

- 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

Looking at Post Discharge Medication Reconciliation

Month	% Timely		Month	% Timely
1- 2016	32		1-2017	23
2	23		2	32
3	32		3	36
4	38		4	29
5	35		5	38
6	35		6	42
7	40		7	39
8	21		8	36
9	38		9	50
10	26		10	48
11	22		11	39
12	27		12	44

The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

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

Finding the Median: Reordering the Data

- **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.**
- **Excel: place cursor in blank cell and type=MEDIAN(A2:A21) where A2 is the first cell you want to include and A21 the last)**

The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Making a Run Chart

1. State the question that the run chart will answer and obtain data necessary to answer this question.

2. Develop the horizontal scale for the run chart. This will usually be a time scale, but other alternatives can be used. Appropriate time increments to develop the axis will typically be days, weeks, months, quarters, years, sequential patients, sequential procedures, etc. A useful practice is to label several future time increments even though no data yet exist for that time frame. The scale should cover the time period of interest for the graph, not just the time when data are currently available.

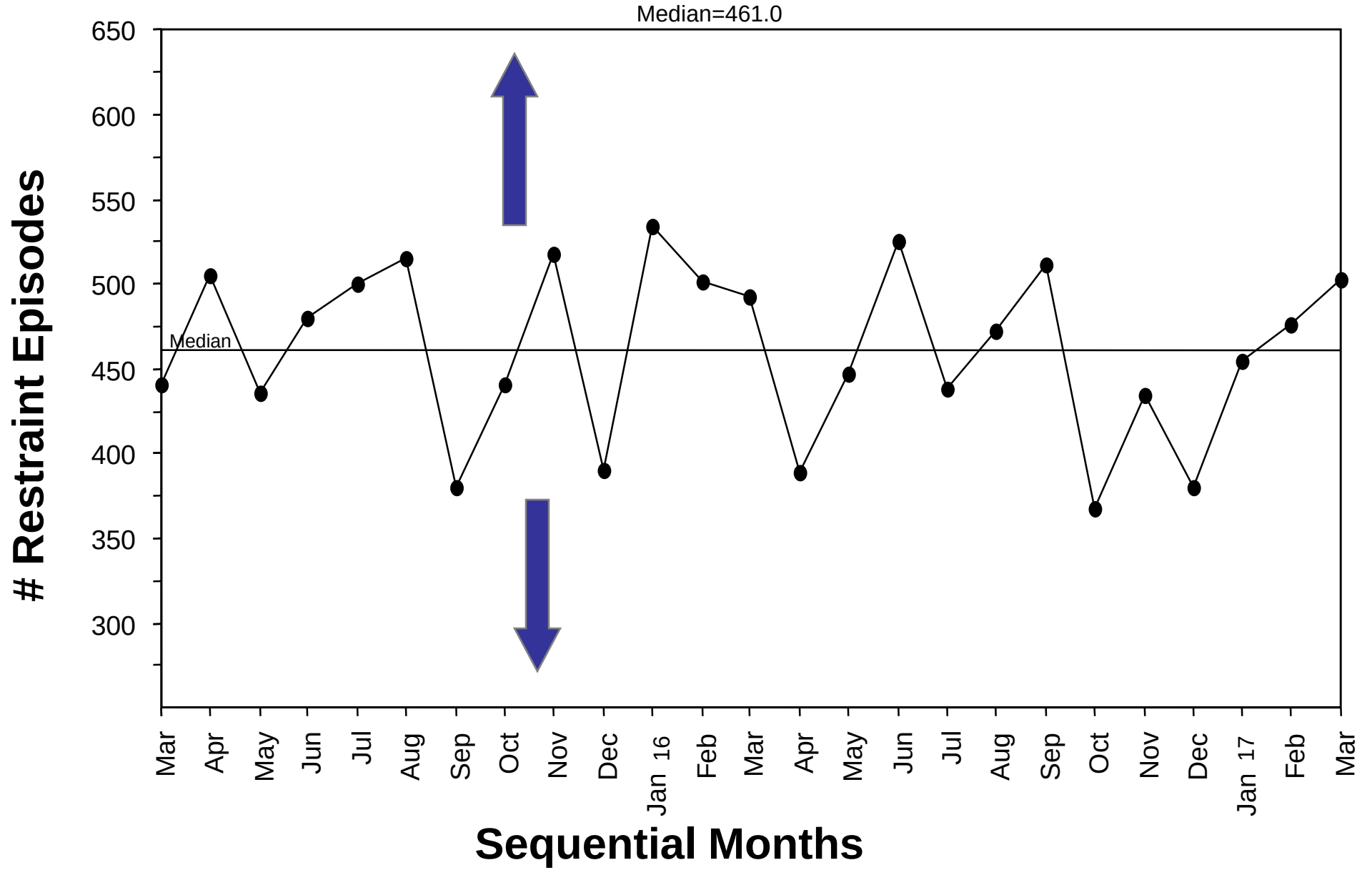
3. Develop the vertical scale for the run chart. A good scale is one that is easy to plot, easy to read, and leaves ample room for future data that might be larger or smaller than the values used to create the initial run chart. Criteria for a good scale include [1]:

   - Most of the data lies in about the middle half of the graph.
   - Labeled values on the axis should be round numbers and should be equally spaced.
   - Unlabeled tic marks should be easily plotted and read. They should be easy to work with and interpolate between.

   The completed chart should be sized with a 2:5 vertical to horizontal ratio. Estimate the range of the data points to be plotted on the vertical scale (the smallest value to the largest value). Then use this range to develop a vertical scale for the run chart. Be sure to construct your vertical scale so that it is high or low enough to encompass variation in future data and reference values such as your goal, a benchmark, or zero if it is meaningful to the chart.

What Does A Run Chart Look Like? How Are Restraint Episodes Varying Over Time?

Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 98	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 99	Feb	Mar
Data	440	505	436	480	499	515	380	440	517	390	533	501	492	389	447	525	438	473	511	367	434	380	454	476	503



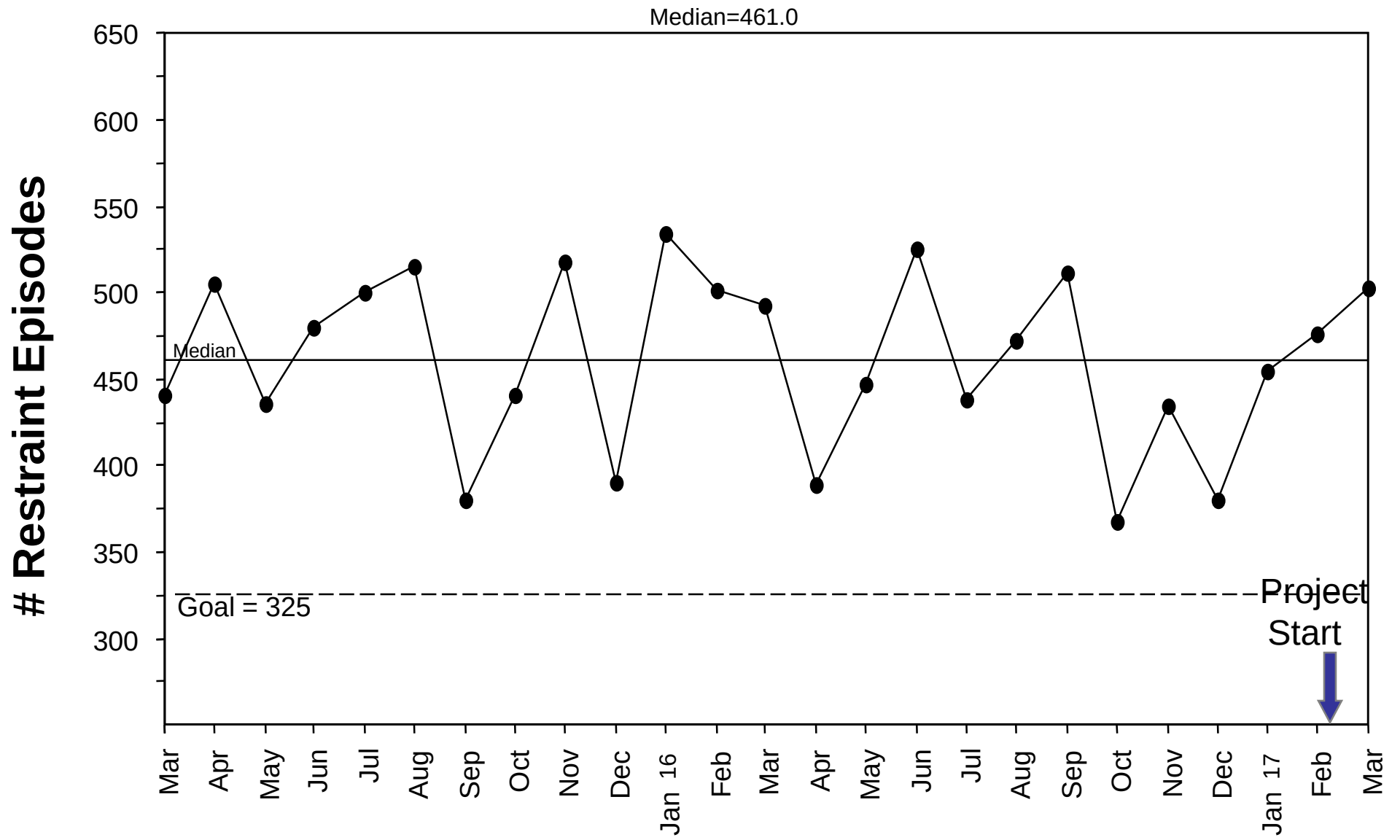
4. Label the graph completely with a useful title. Label the horizontal access with the sequence of the data (i.e. case 1, case 2, case 3, week 1, week 2, week 3, or Jan, Feb, Mar, etc.). Label the vertical access with the name of the measure or characteristic that you are studying.

5. Calculate and place a median of the data on the run chart. The median is the number in the middle of the data set when the data are reordered from the highest to the lowest data. The median is required when applying some of the rules used to interpret a run chart. Placing the median on a run chart with a small number of data points or on a run chart with more than one series of data can add too much complexity to the interpretation of the run chart.

6. Add additional information to the chart. Add a goal or target line if appropriate. Annotate unusual events, changes tested, or other pertinent information on the run chart at an appropriate time location.

What Does A Run Chart Look Like? How Are Restraint Episodes Varying Over Time?

Month	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 98	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan 99	Feb	Mar
Data	440	505	436	480	499	515	380	440	517	390	533	501	492	389	447	525	438	473	511	367	434	380	454	476	503

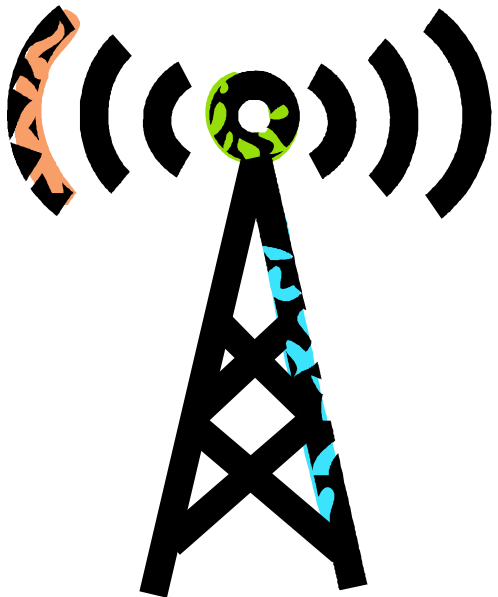


Run Chart Using Excel

- **Highlight columns** containing **labels** (e.g. dates) and your **data**.
- Go to “Insert” tab …by recommended charts select line chart…select one with dots!!
- Make it better!
  - Add median line by clicking in new column and inserting formula: =median(B2:B31)
    - Copy median value and paste into each cell in column as a value. Paste it into as many cells as you have data points on your graph
  - To insert Median onto chart after calculating it:
    - Go to chart and click on plot area
    - Select data…Add new series
    - Create name of series and select data (your median line data)
- To improve graph check out the Format tab
- To improve data lines select data and right click…select format data line and “play”
  - What dots prominent, line rather faint and all black and white

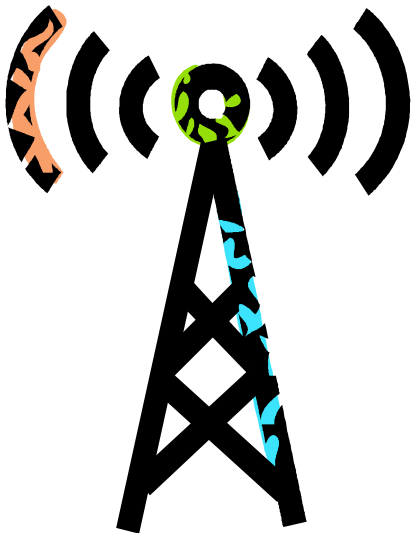
How Do We Tell a Change is an Improvement?

- Run chart may speak for itself
- If run chart does not speak for itself we can analyze it further using probability-based rules
  - Can detect signal of change (a non-random pattern in the data)



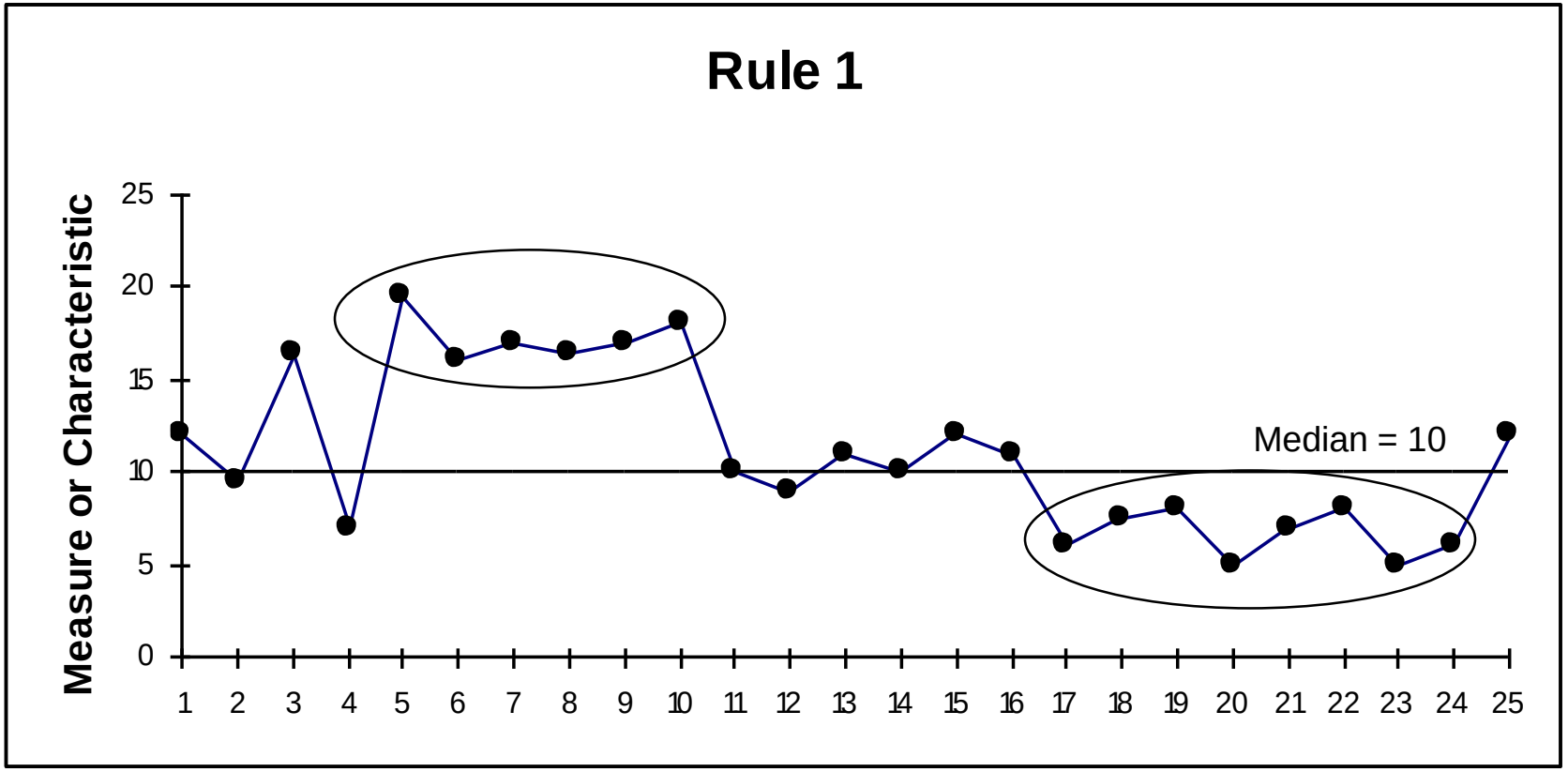
What Are They? What Do We Do With Signal?

- Signals can be evidence of improvement
  - That changes are adding up to improvement
- Signals can be evidence that things got worse
  - Changes caused unexpected degradation of process or outcome
  - Something else entered the process resulting in a signal
- Our job when seeing a signal
  - Go learn from signal and take appropriate action



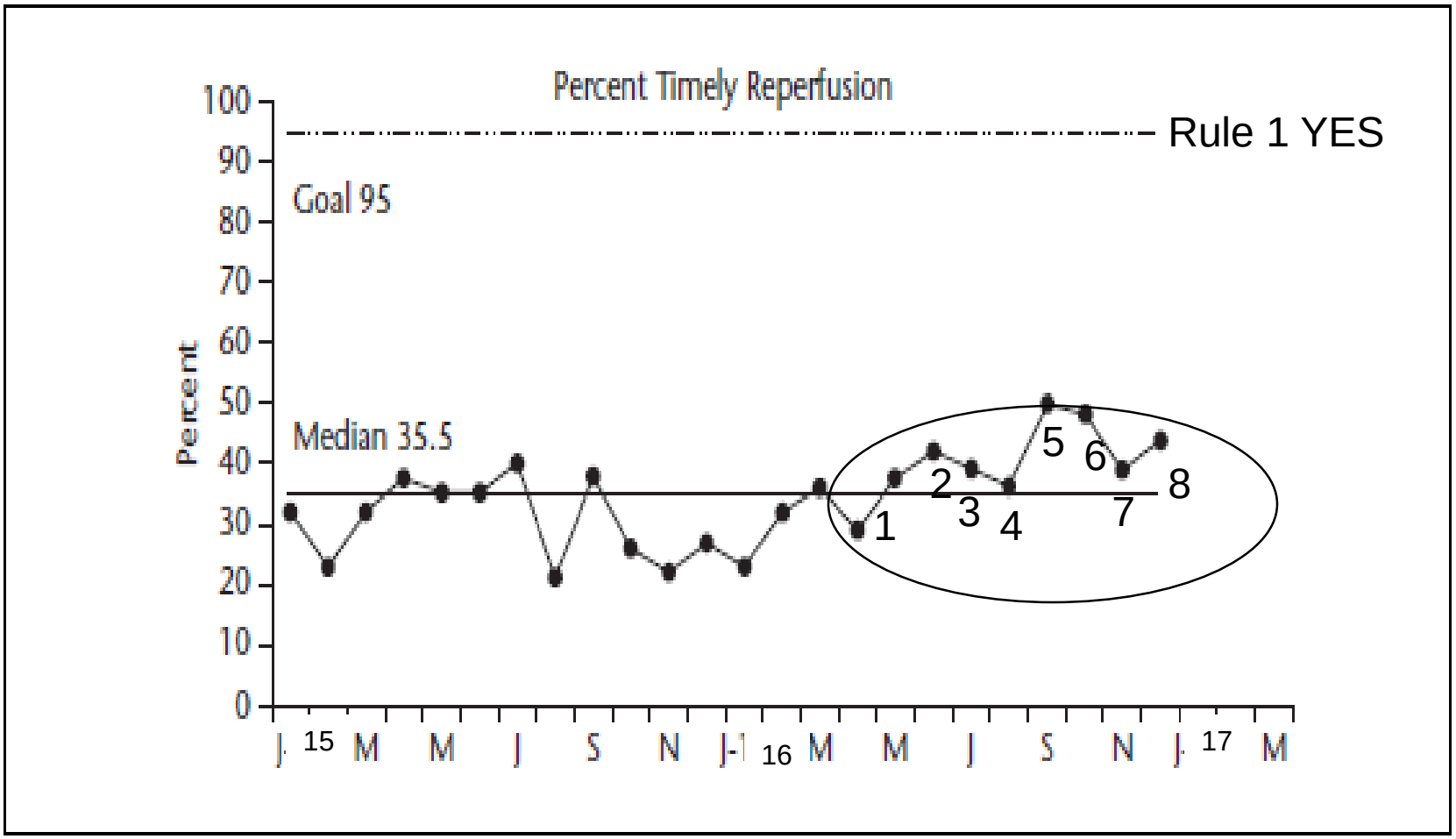
Rule 1: Shift

- **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.**



The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

FIGURE 3.1 Run Chart Example



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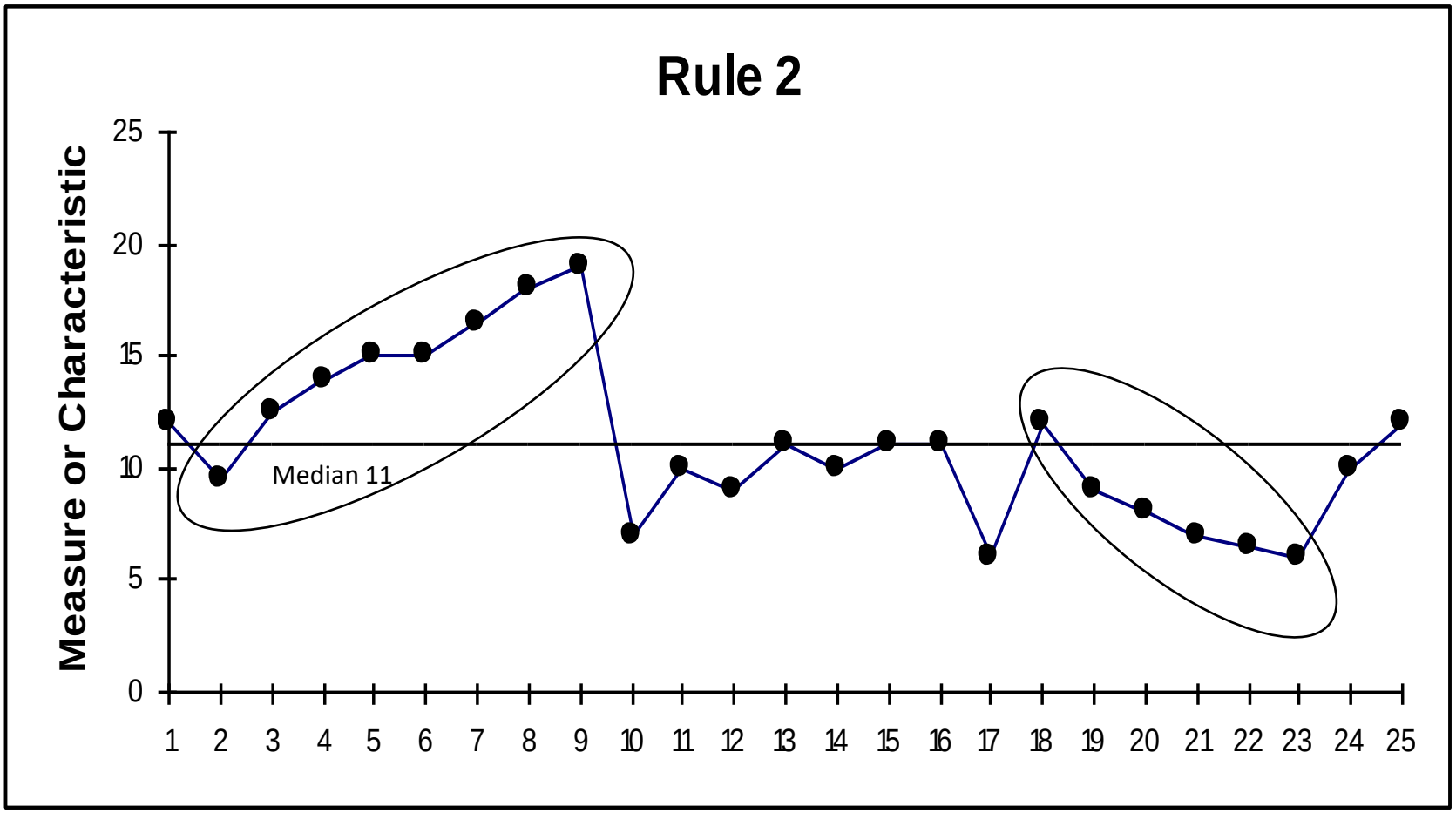
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Rule 2: Trend

- **Five points all going up or all going down. If the value of two or more successive points is the same count the first one then ignore the identical points when counting; like values do not make or break a trend.**



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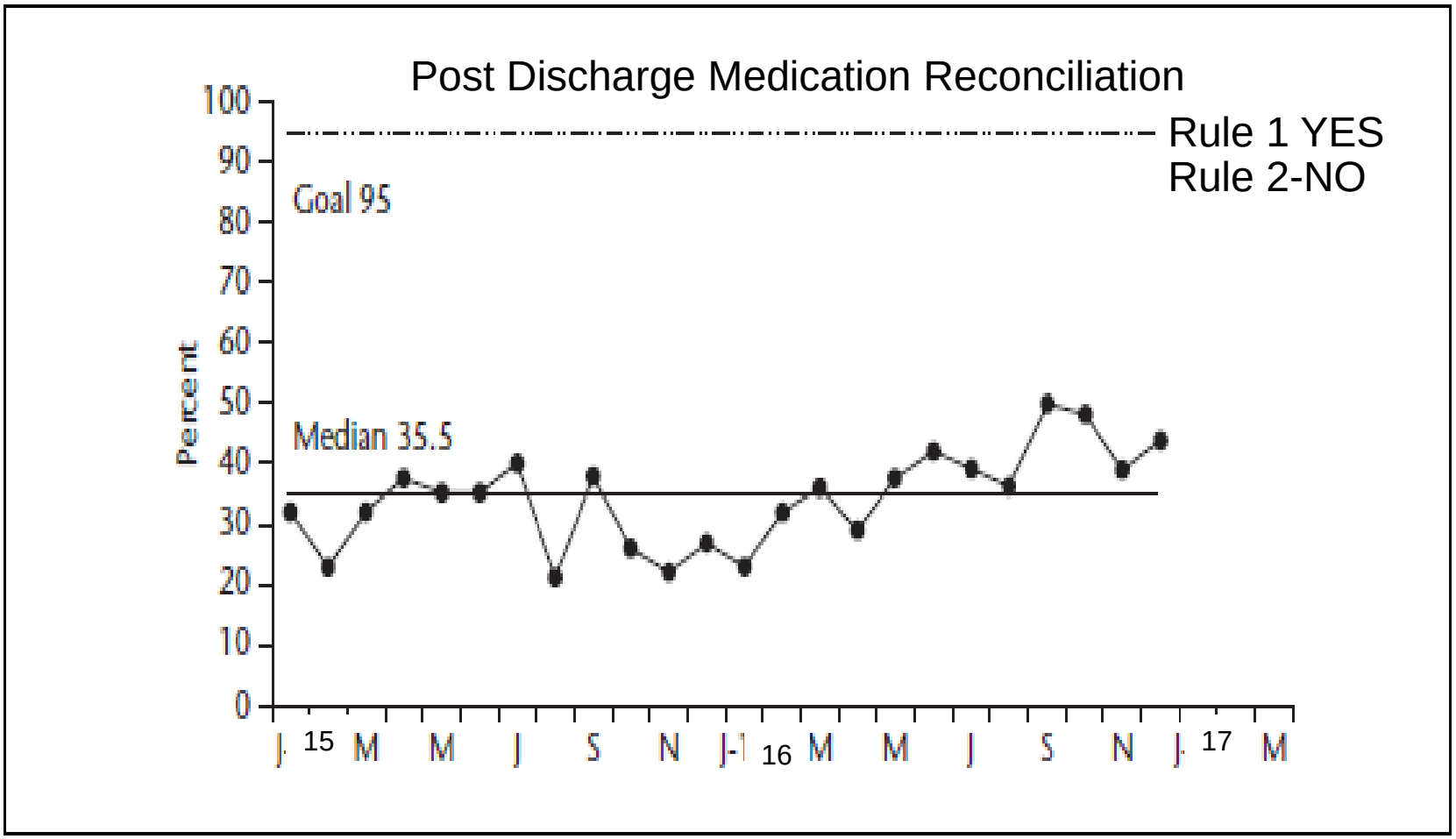
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

FIGURE 3.1 Run Chart Example



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Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Rule 3: Runs

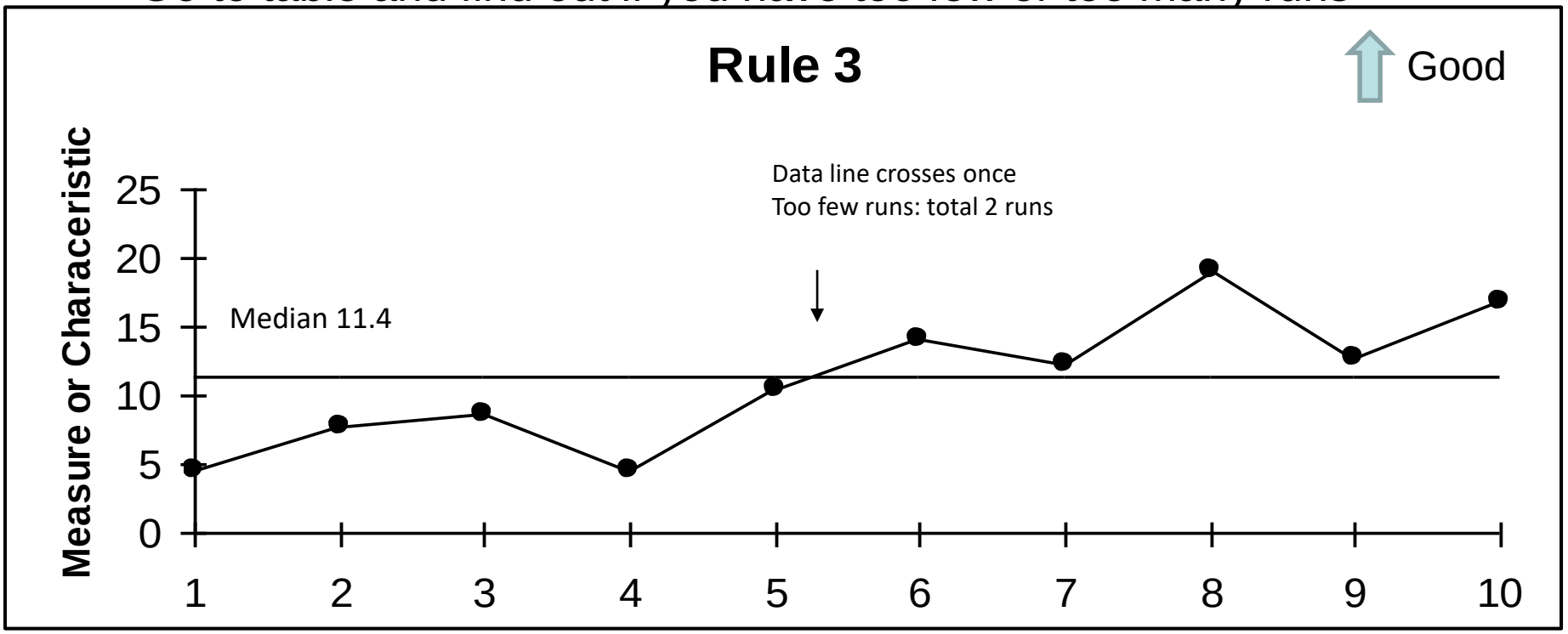
Microsoft Word Document

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.
- 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: NUMBER OF RUNS

- **Steps**
  - Count the # of data points not falling on the median (in this case 10)
  - Count the # of runs (# times data line crosses the median + 1) (in this case 2)
  - Go to table and find out if you have too few or too many runs



The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

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

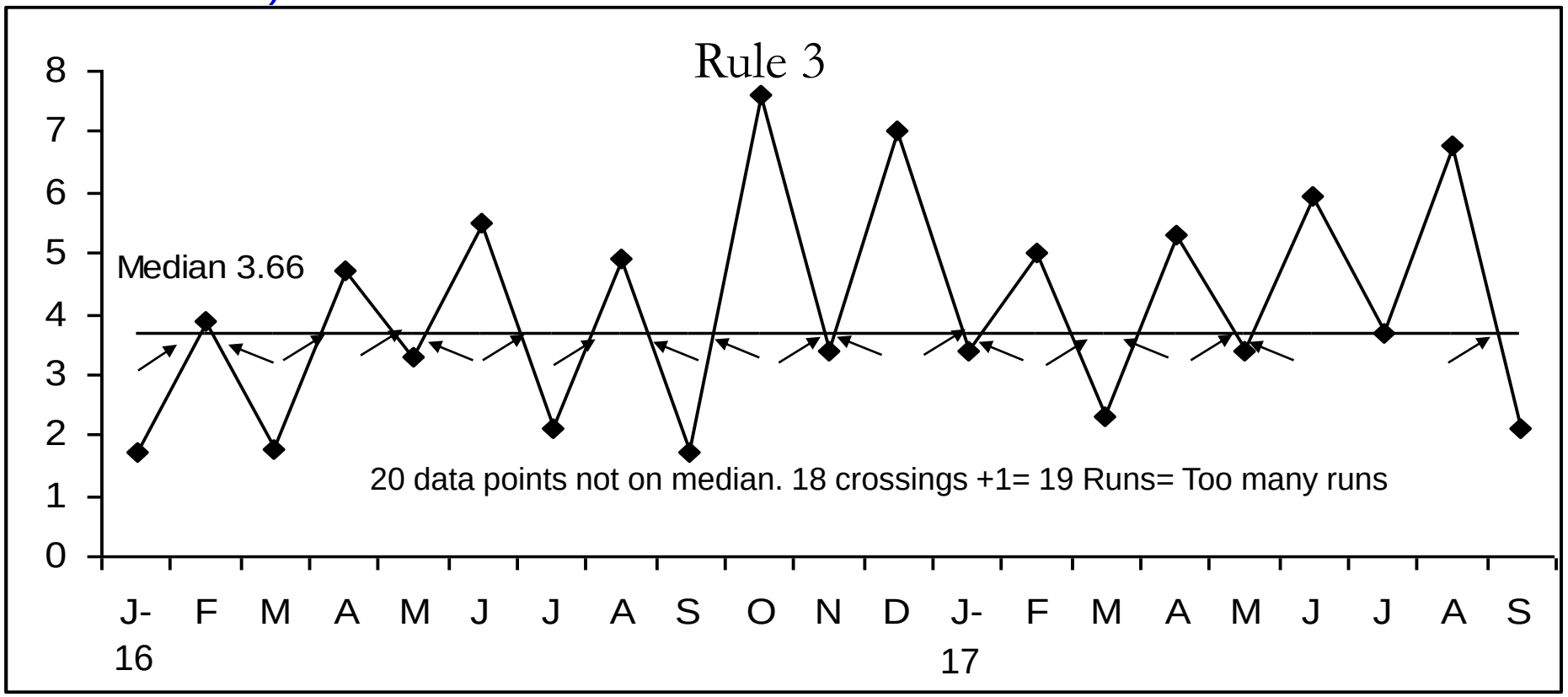
Table is based on about a 5% risk of failing the run test for random patterns of data. Frieda S. Swed and Churchill Eisenhart, (1943). "Tables for Testing Randomness of Grouping in a Sequence of Alternatives. Annals of Mathematical Statistics. Vol. XIV, pp.66 and 87, Tables II and III

Rule 3: NUMBER OF RUNS

- **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.**
  - A signal is evidenced by too few, or too many runs.
- **Steps**
  - Count the # of data points not falling on the median (in this case 10)
  - Count the # of runs (# times data line crosses the median + 1) (in this case 2)
  - Go to table and find out if you have too few or too many runs (in this case should have 3-9 runs. Only have 2, so too few runs.)
- **What does it mean?**
  - Too few runs with data going in our desired direction is signal of improvement
  - Too few runs if data going in undesirable direction is signal of degradation

Rule 3

- **We Can Have Too Many Runs Too:**
- **Steps**
  - Count the # of data points not falling on the median (in this case 20)
  - Count the # of runs (# times data line crosses the median + 1) (in this case 19)



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Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

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. Frieda S. Swed and Churchill Eisenhart, (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

- **What does it mean if too many runs?**
  - It is a signal—an opportunity to learn
  - Not typically improvement
  - Most often has to do with organization of data
    - Day shift, night shift
    - Weekdays, weekends

Looking at Post Discharge Medication Reconciliation

Month	% Timely		Month	% Timely
1- 2016	32		1-2017	23
2	23		2	32
3	32		3	36
4	38		4	29
5	35		5	38
6	35		6	42
7	40		7	39
8	21		8	36
9	38		9	50
10	26		10	48
11	22		11	39
12	27		12	44

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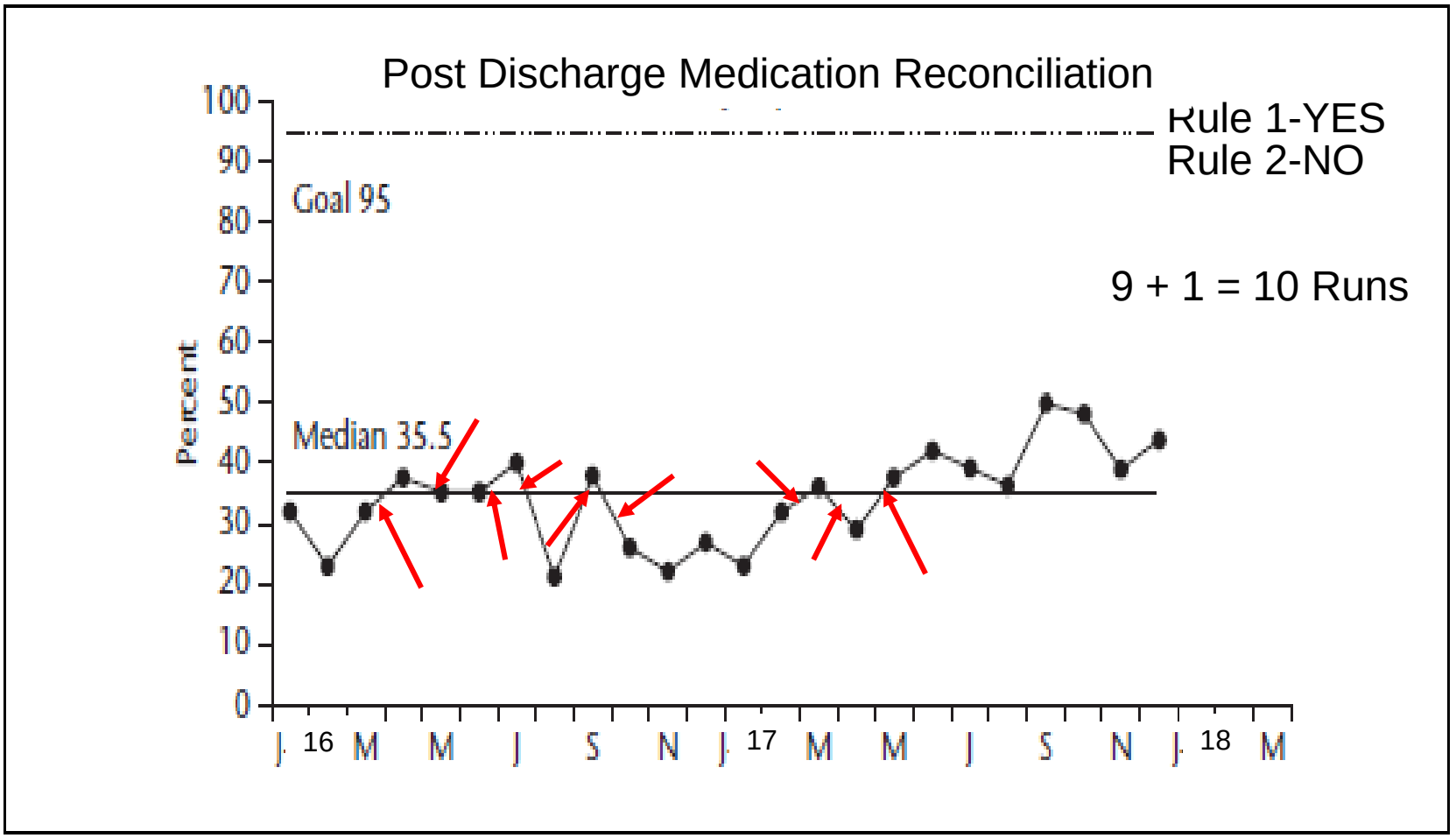
FIGURE 3.1 Run Chart Example



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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. Frieda S. Swed and Churchill Eisenhart, (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

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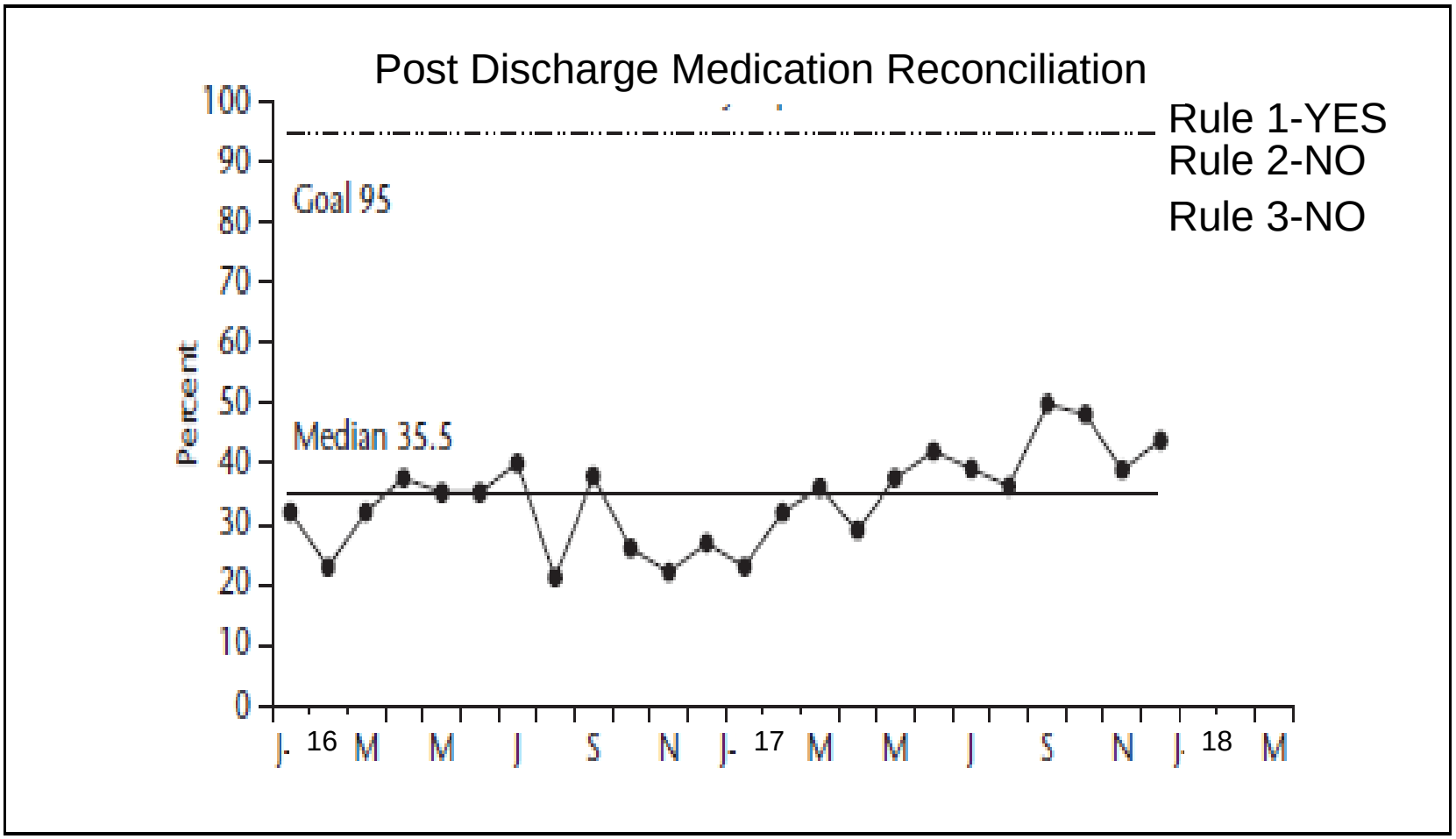

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RULE 4: Astronomical

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

- Data that is Blatantly Obvious as a 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

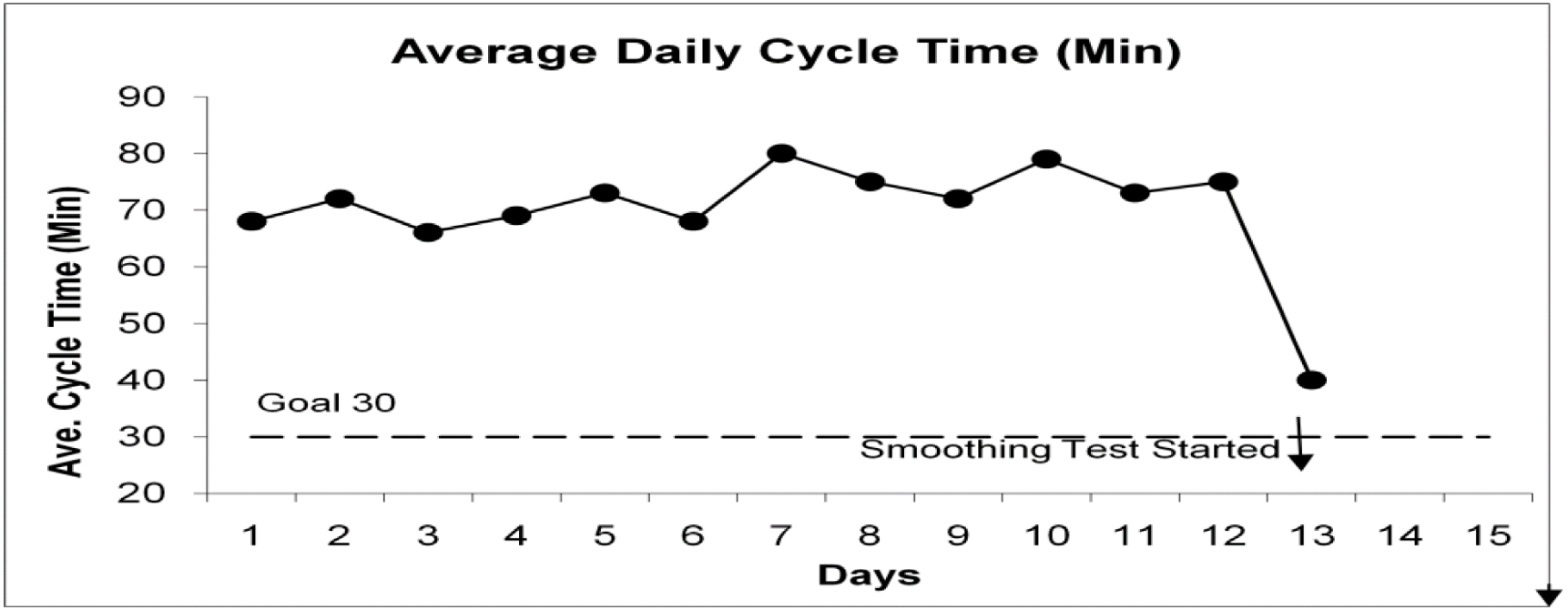

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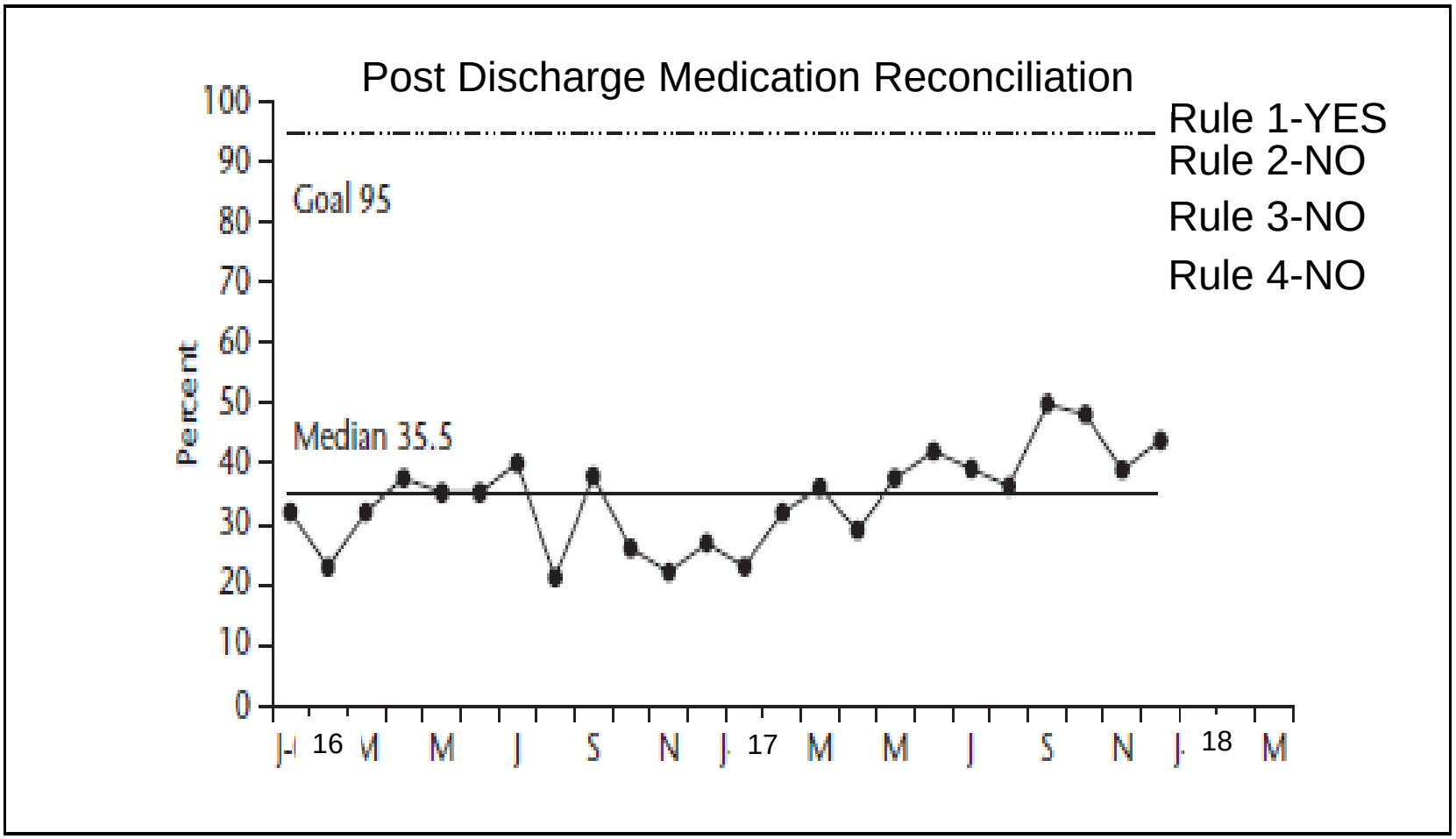
FIGURE 3.1 Run Chart Example



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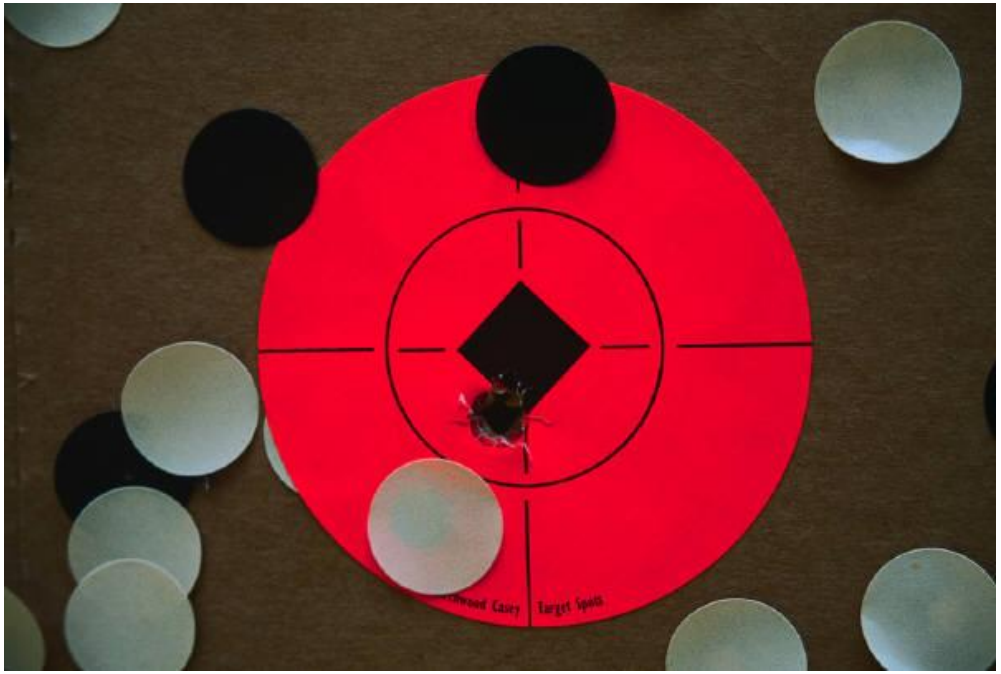
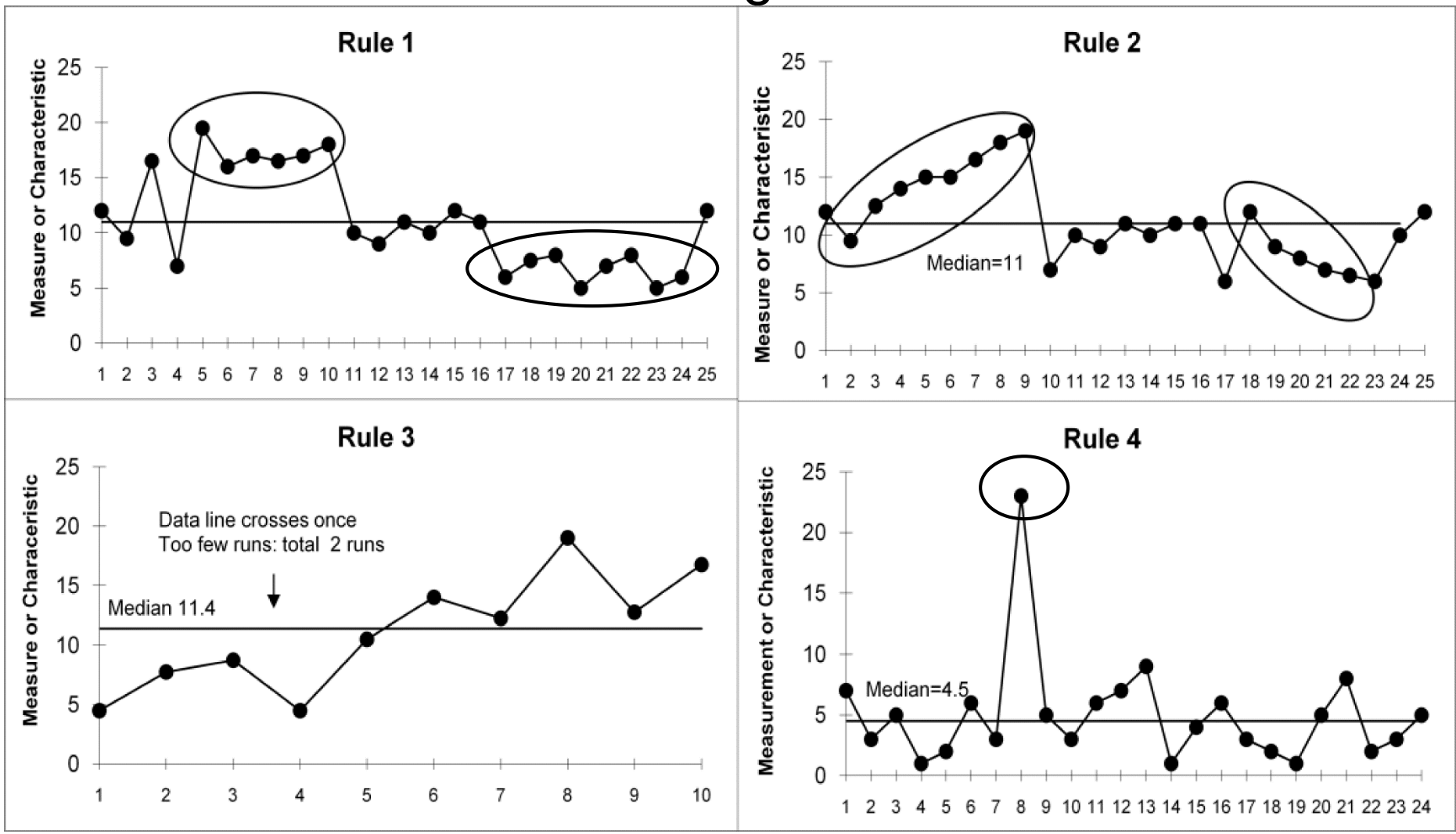
Let's Practice



- **Please work in pairs**
- Evaluate the following run charts to determine :
  - Does the chart show a signal?
  - Use all 4 rules on each chart.
  - If signal noted - **which of the four rules** was "activated"?

Rules for Identifying Non-Random Signals of Change



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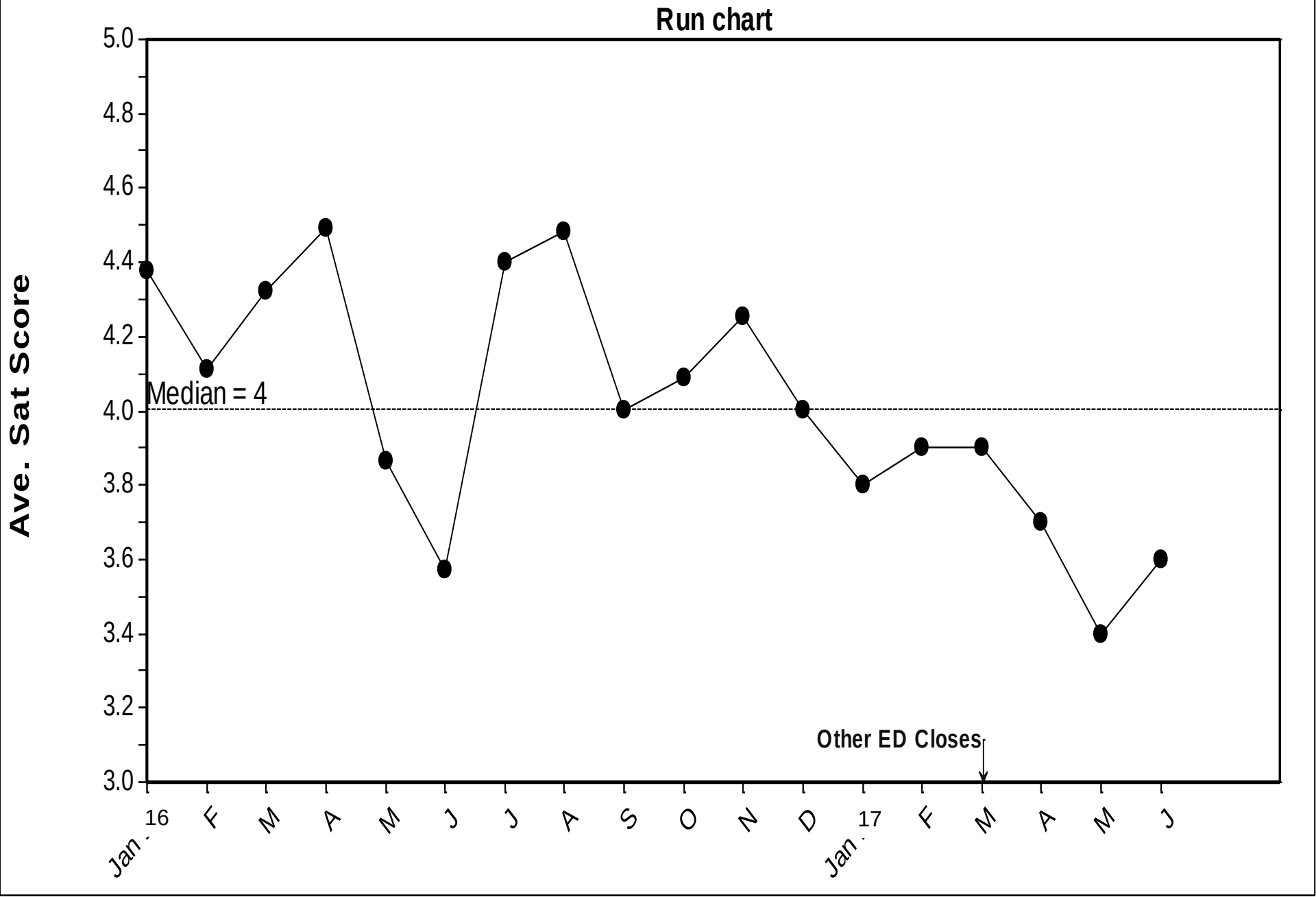
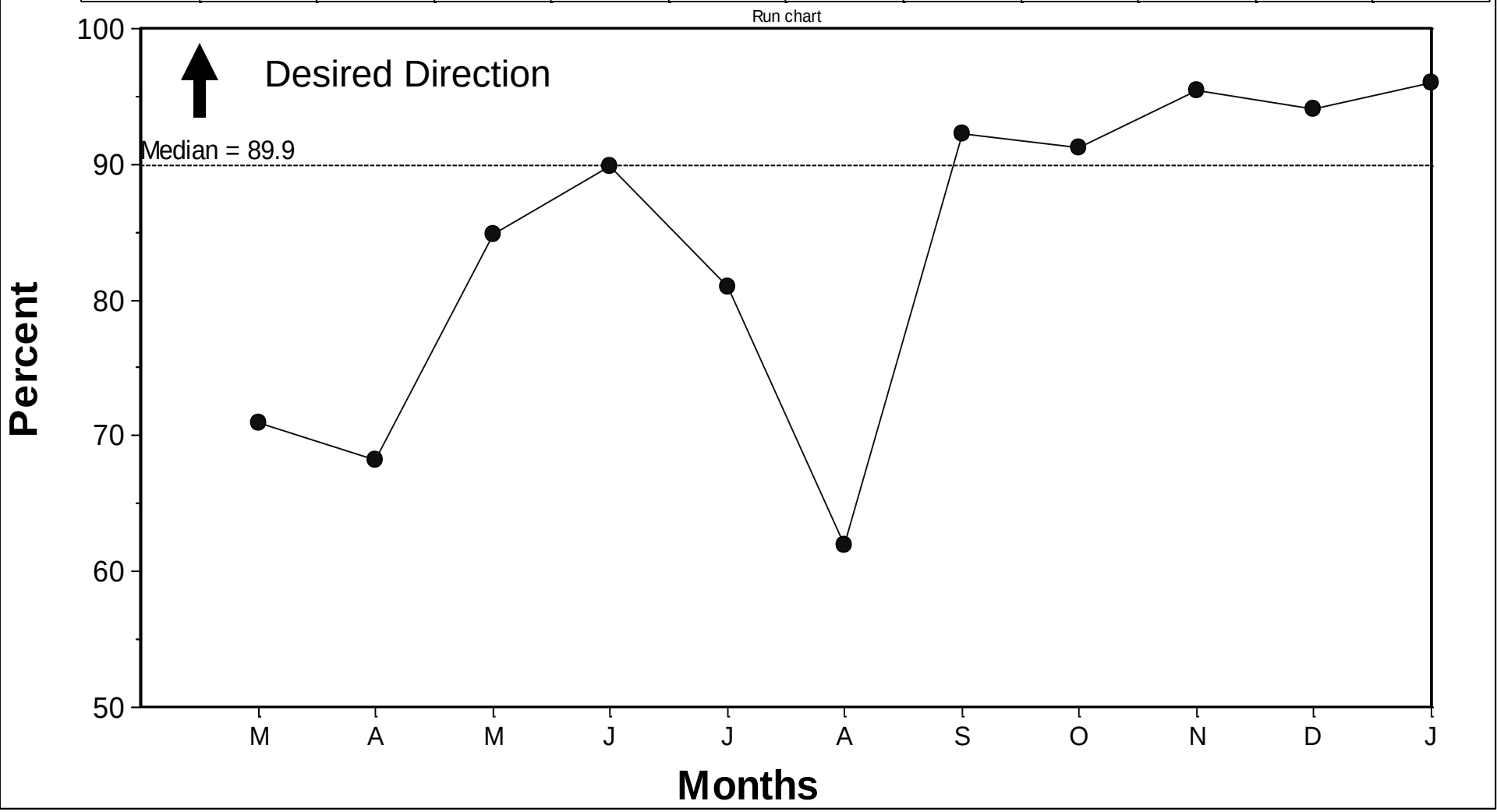
Average ED Patient Satisfaction (1-5 Scale)

Ave Sat	4.37	4.11	4.32	4.49	3.86	3.57	4.40	4.48	4.00	4.08	4.25	4.00	3.80	3.90	3.90	3.70	3.40	3.60



Percent Colorectal Screening

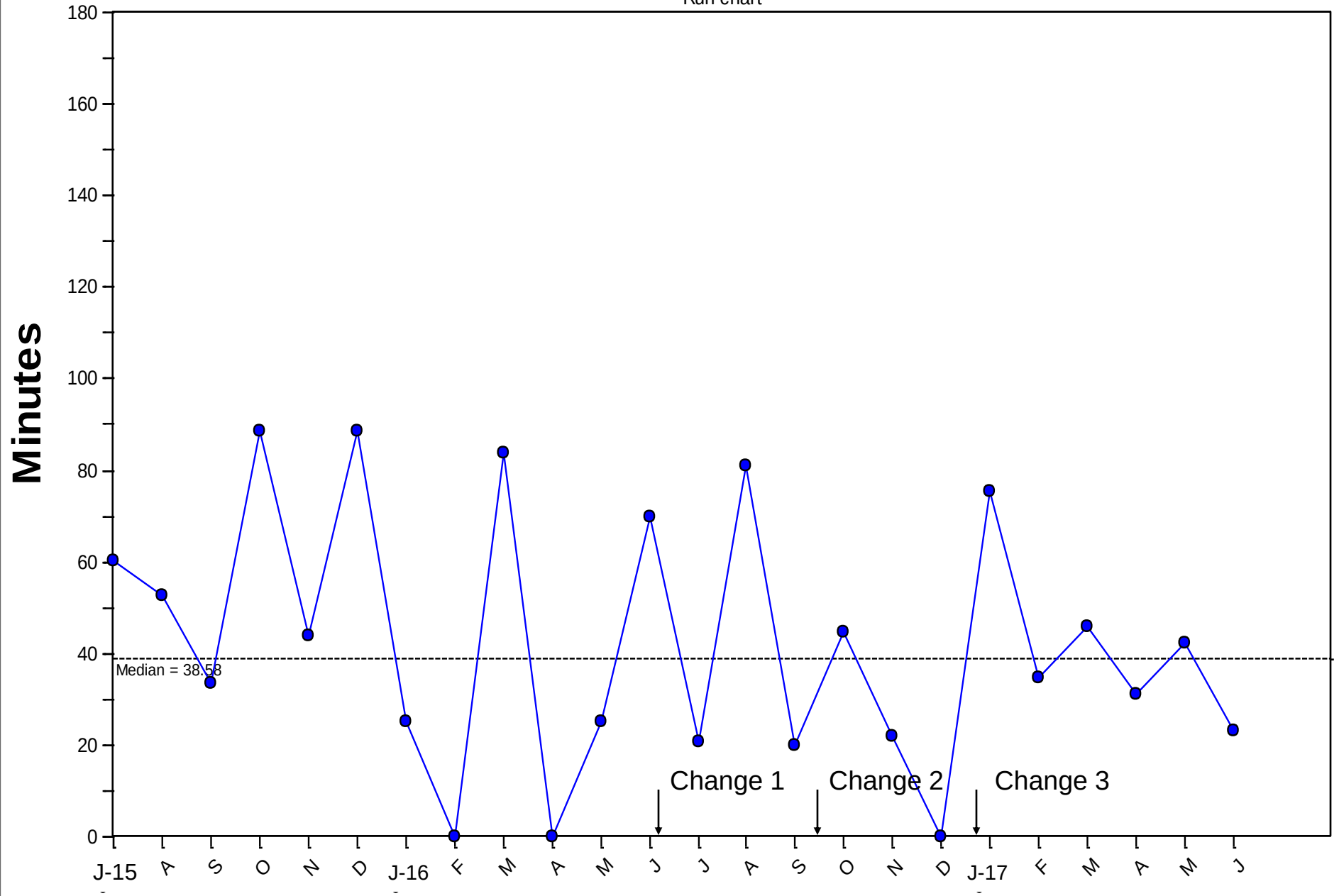
%		71.0	68.2	84.9	89.9	81.0	62.0	92.3	91.2	95.4	94.1	96.0



Average Time to Thrombolysis

1	60.4000	52.6667	33.5000	88.5000	44.0000	88.6667	25.0000	0.0000	84.0000	0.0000	25.3333	70.0000	20.6667	81.1667	20.0000	44.5000	22.0000	0.0000	75.4000	34.6667	46.0000	31.0000	42.5000	23.0000		

Run chart



Why Bother…What Do we Do With A Signal?

- Signals can be evidence of improvement
  - That changes are adding up to improvement
- Signals can be evidence that things got worse
  - Changes caused unexpected degradation of process or outcome
  - Something else entered the process resulting in a signal
- Job when seeing a signal
  - Go learn from signal and take appropriate action
- If testing change and see no signal:
  - Changes not strong enough
  - Changes really made?
  - Testing on such small scale--not impacting system yet
  - Measure not sensitive

Logic for Interpreting Run charts

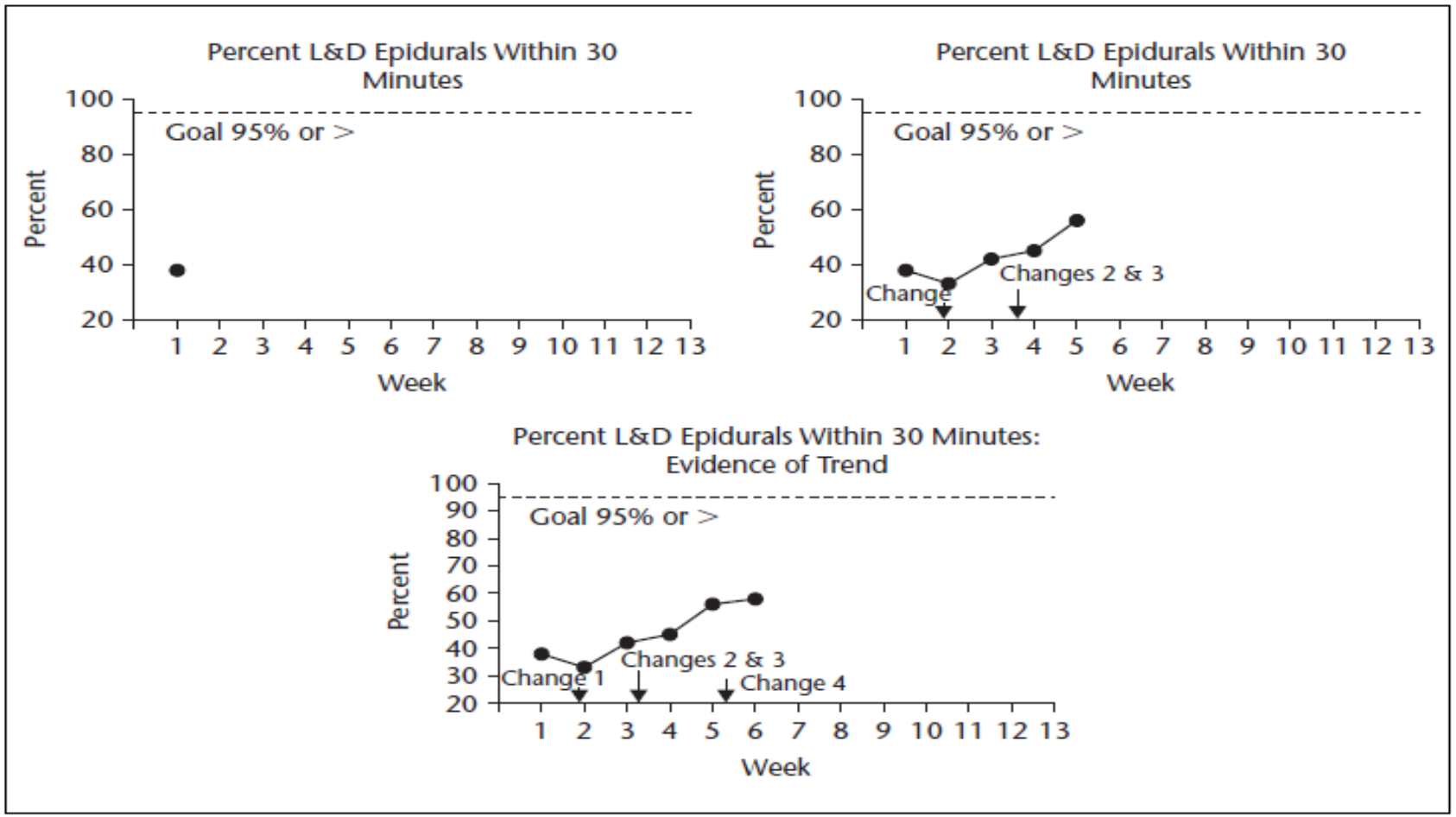
- We selected rules so would have about a 5% probability of occurring by chance
  - Rules for Shewhart charts have historically aimed for <1% probability of occurring by chance
- Annotated run chart used for improvement
  - We are making changes to process so expect, even predict changes will occur in data
  - Small number of data points
  - Do allow us to detect patterns indicative of statistically significant change so can tell if changes resulting in improvement
  - Do not allow us to say process is stable as do not rule out special cause that would be found by Shewhart Chart

Some Keys to Good Graphical Display with Run Charts

- When do we begin a run chart?
  - As soon as we have a data point

When Do We Start a Run Chart?

FIGURE 3.22 Beginning a Run Chart as Soon as the First Data Are Available



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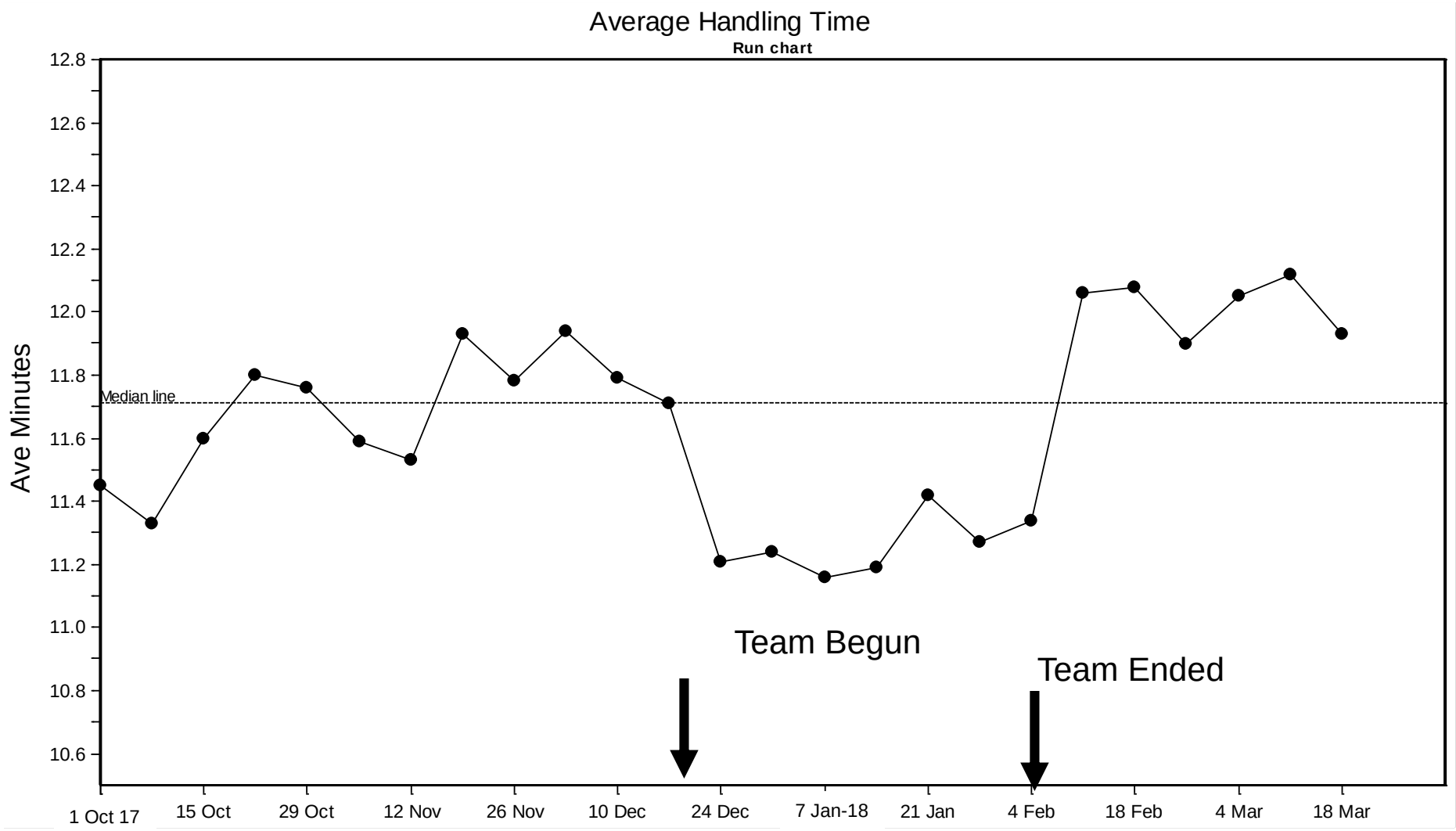
Some Keys to Good Graphical Display with Run Charts

- When do we begin a run chart?
  - As soon as we have a data point
- Shape: 1.5 to 1 (e.g. a rectangle not a square)
- Scale: data should take up half the graph
  - Other half should be “white space” equally divided above and below your data
    - Unless limited by 0 or 100%
    - Don’t scale below 0 or above 100% if data can’t go this low or high
- Annotate the run chart

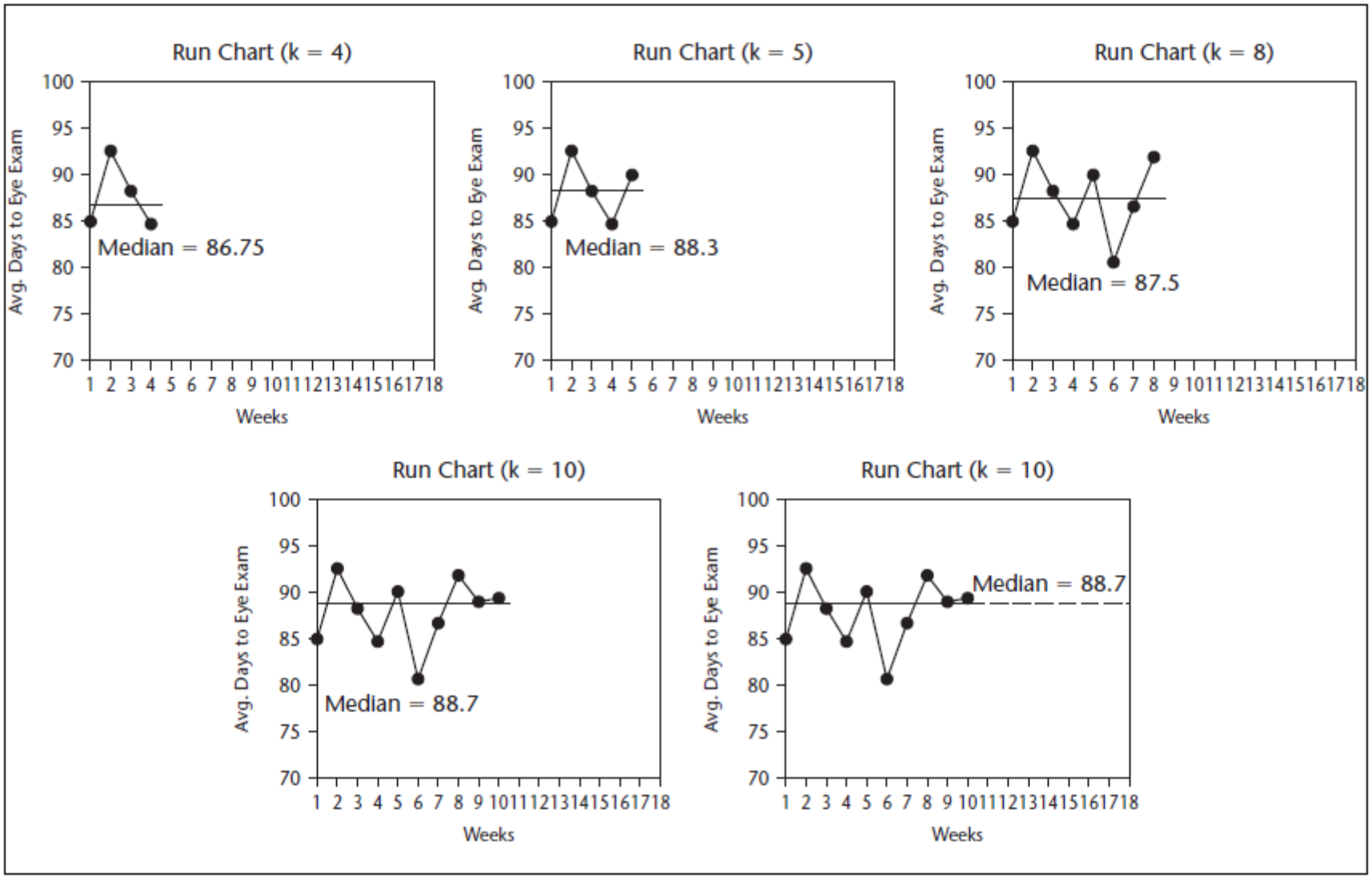
Annotate Graphs



Proper Use of the Median

- When should we apply a median?
  - Will depend on your situation
    - If very little data baseline median may be only a few data points
    - **If want to apply probability-based rules for analysis of run chart prefer 10 or more data points for median**
  - If graph shows no signals (shift, trend, runs astronomical) and median made from 10 or more data points **freeze and extend median** into the future
    - This will result in earliest possible detection of signals

FIGURE 3.23 Run Charts for Waiting Time Data



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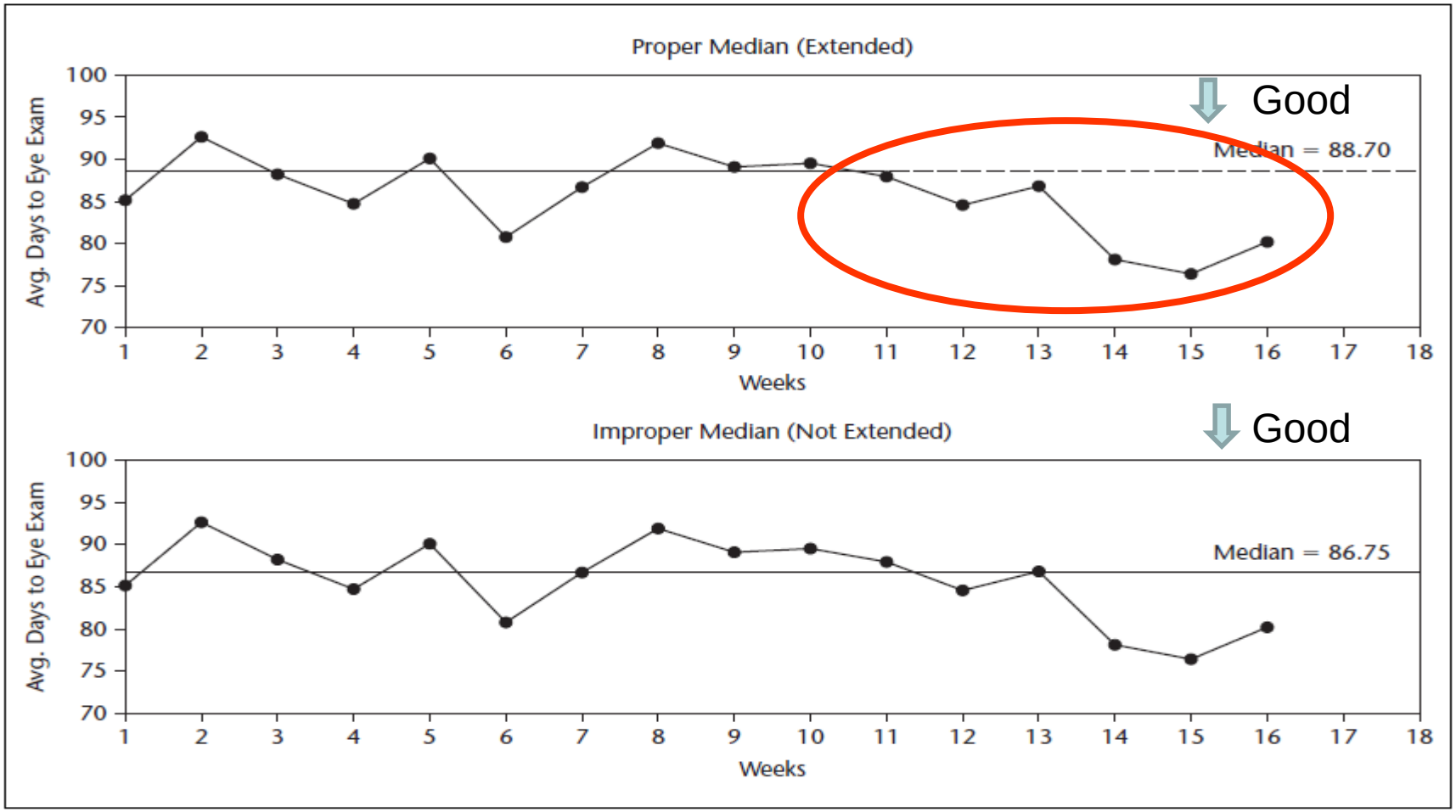
If median not frozen and extended will result in delayed detection of signals

FIGURE 3.24 Delay Detecting Signal with Improper Median Technique



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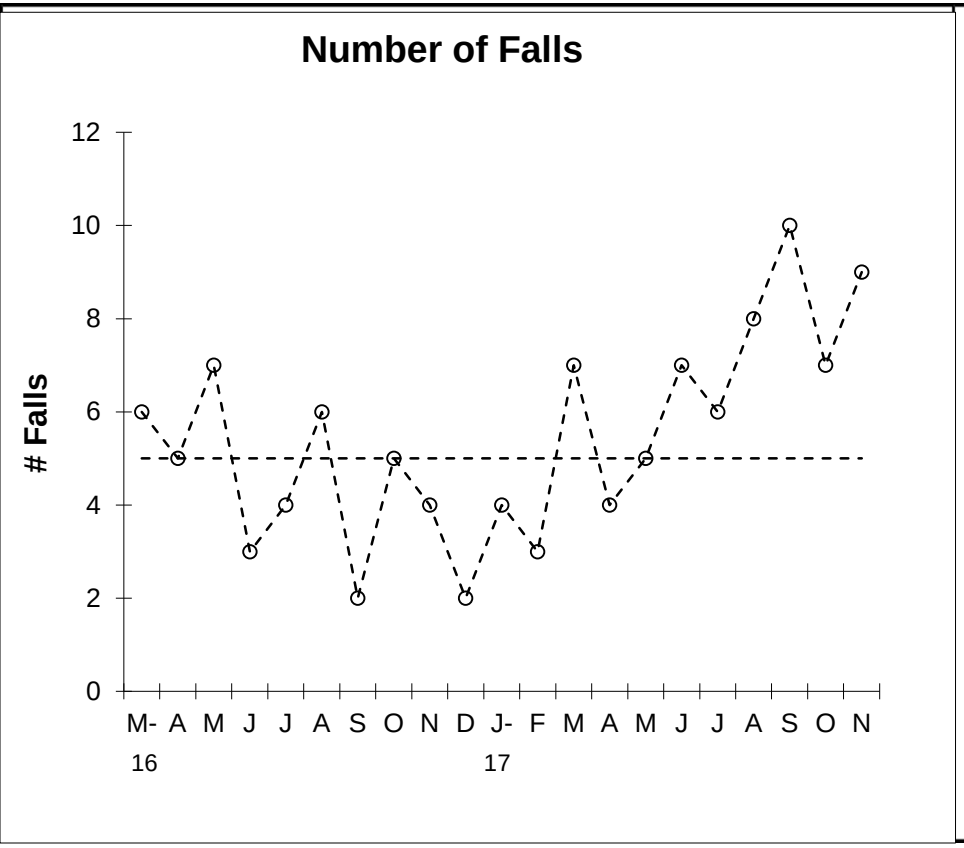
Some Keys to Good Graphical Display with Run Charts

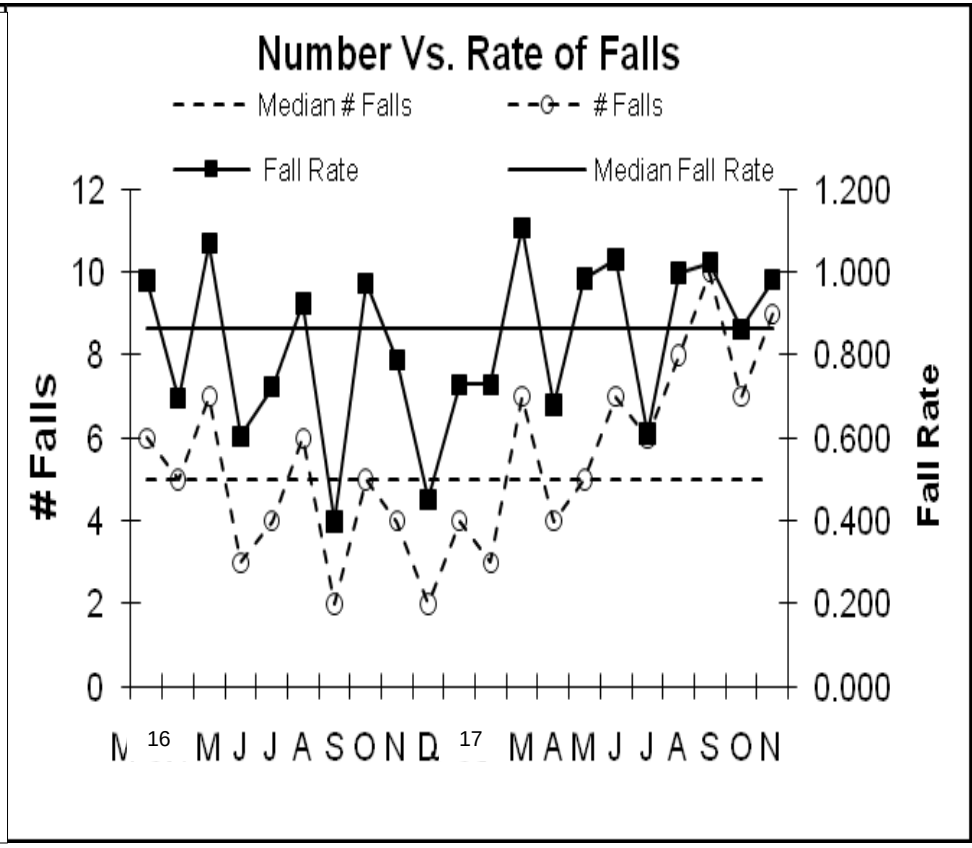
- When do we begin a run chart?
  - As soon as we have a data point
- Shape: a rectangle not a square
- Scale: data should take up half the graph
  - Other half should be “white space” equally divided above and below your data
    - Unless limited by 0 or 100%
    - Don’t scale below 0 or above 100% if data can’t go this low or high
- Annotate the run chart
- Properly use median
- Decide on right statistic (raw data or average, %, or rate??)

Cautions with Graphing Raw Data

- Plotting raw data can be misleading if a useful denominator would lead to another conclusion
- Use of ratio minimizes confusion from changes in denominator volume
- Ratio = $\frac{\text{numerator for key measure}}{\text{denominator (for unit of production or volume related to key measures)}}$

Key Measure (Numerator)	Possible Denominator	Ratio
# ADEs	# Doses Dispensed	ADE/Dose
Screening Costs	# Screenings	Total screening cost/# screenings
# with BP in control	# should be in control	# in control/# should be
Patients LWBS	# Patients Registering in ED	Patients LWBS/# Patients Registered
# Falls	# Patient days	Falls/Patient Day





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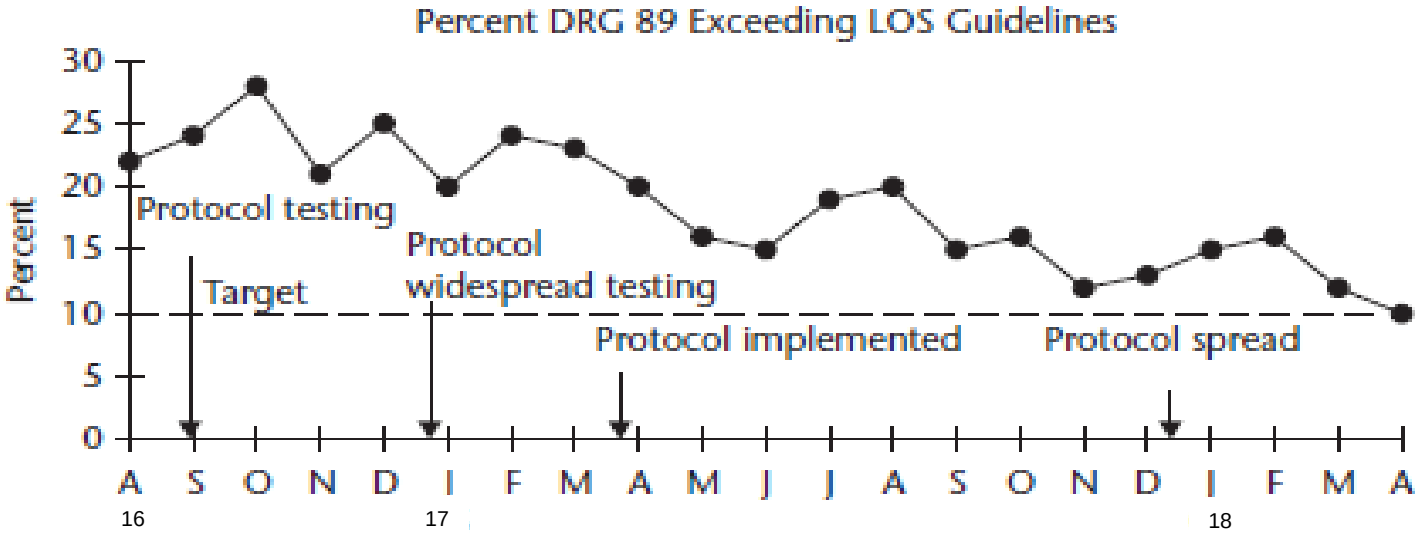
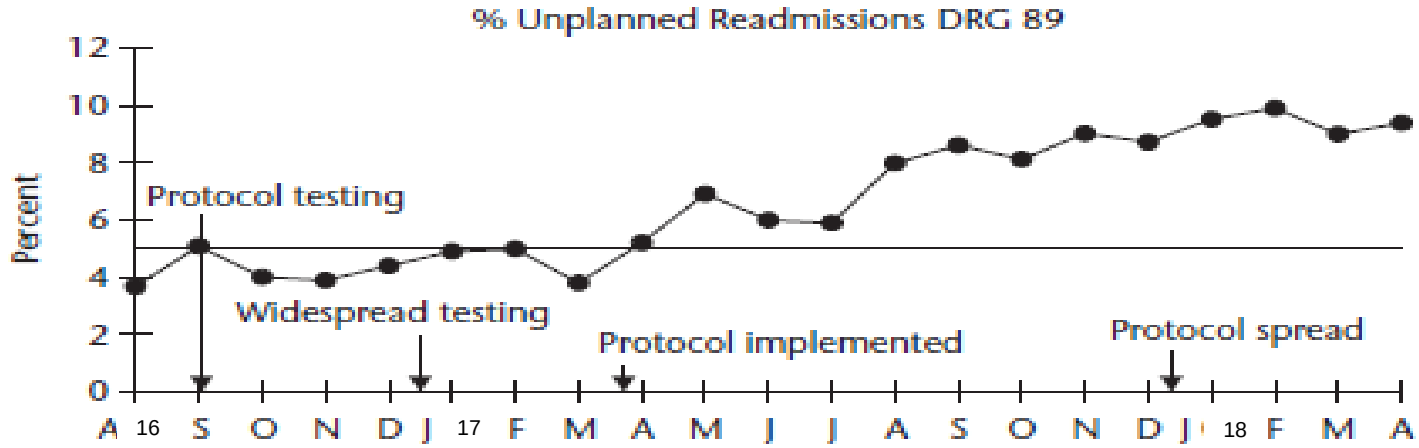
Why Improvement Projects Require a Family of Measures!





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Improvement Projects Require a Family of Measures

- 2-8 measures typically -Each on a graph -All viewed on one page

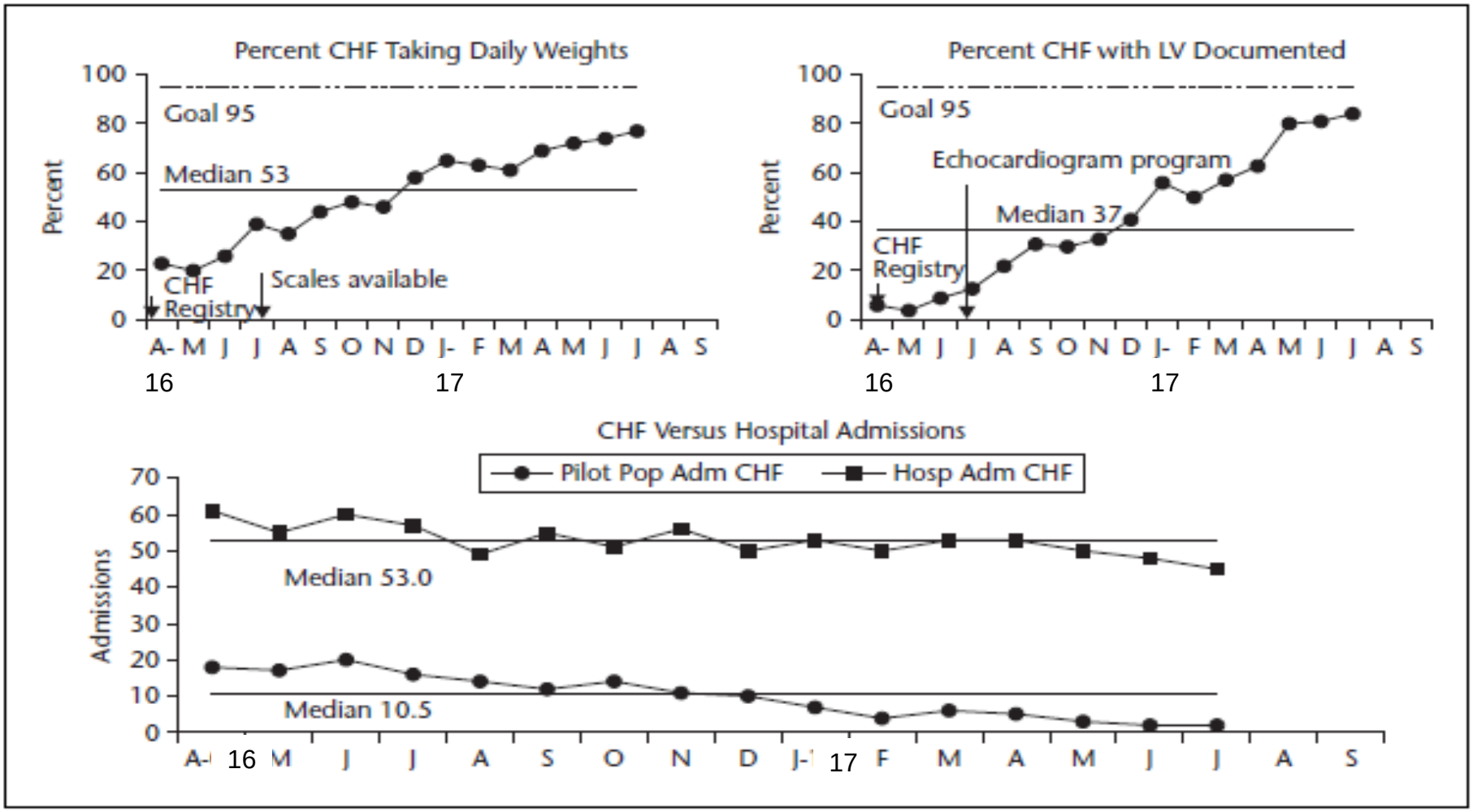

Fig 3.6: Improvement Evident Using a Set of Run Charts Viewed on One Page

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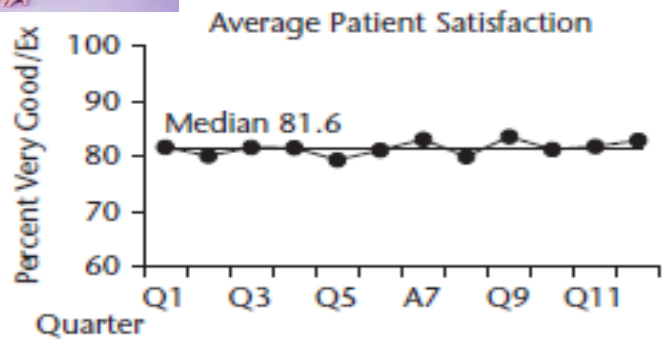
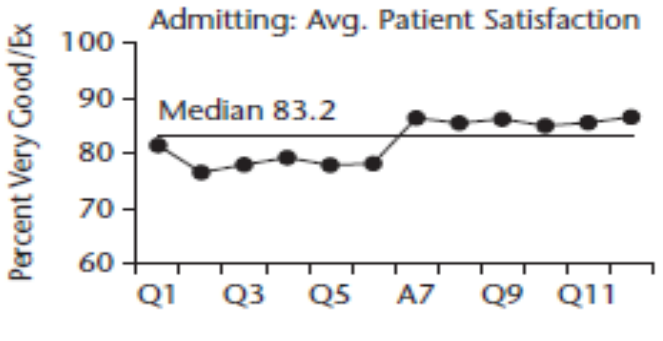
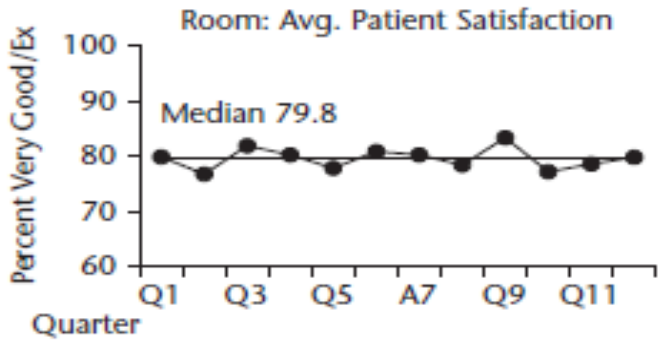
Small Multiples

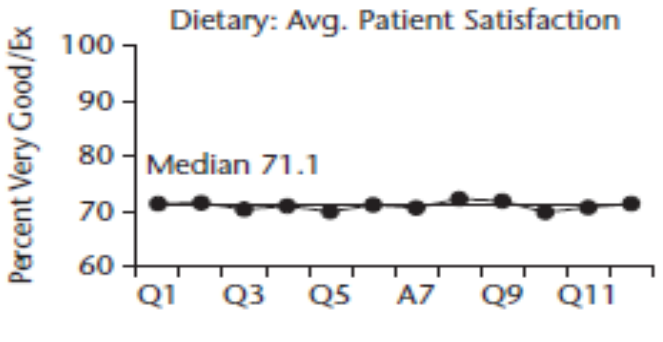
- Multiple run charts viewed on one page
- All these run charts are about the **same measure** but for a different location, provider or segment of the population
- Each has the **same scale vertically and horizontally**
- Allows for rapid comparison

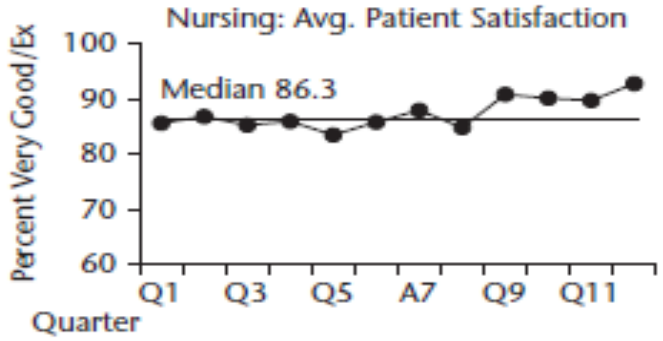
FIGURE 3.7 Run Charts Used as Small Multiples

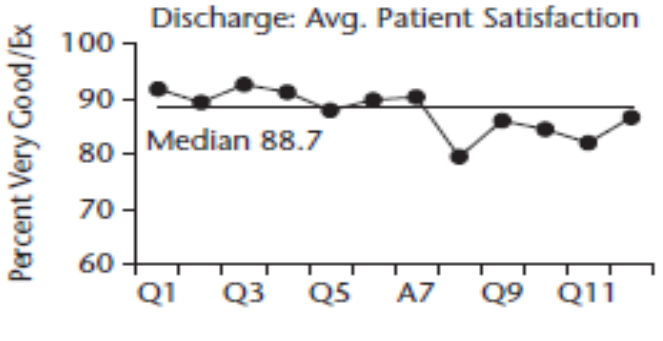












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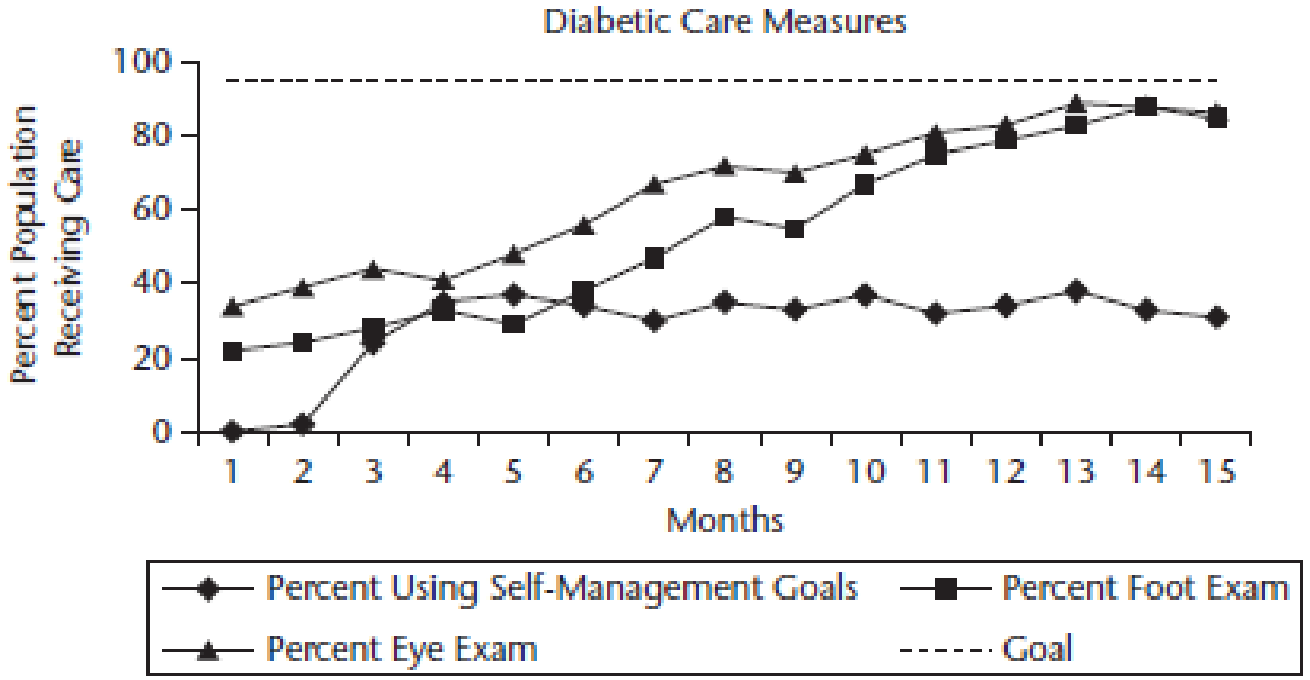
May Display More Than One Measure on a Graph

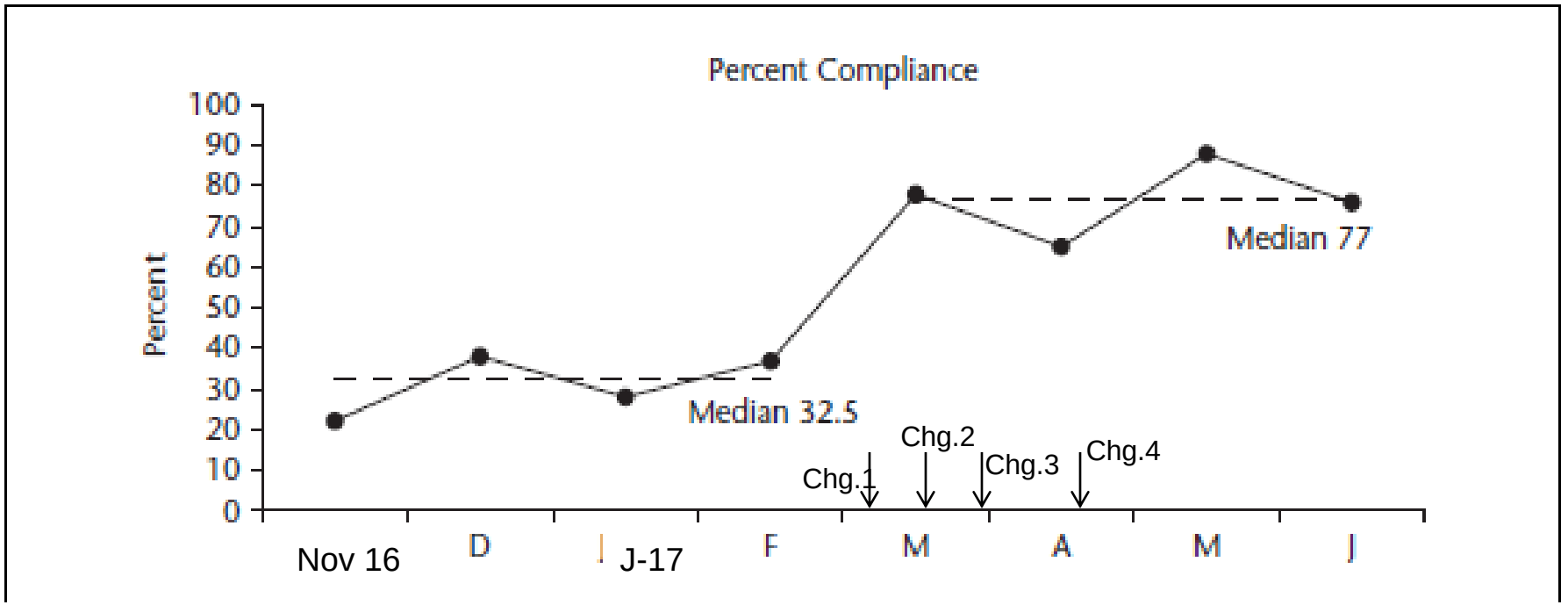
FIGURE 3.8 Run Chart Displaying Multiple Measures



Sometimes We Don't Have Much Data

- May not be rich in data but that data may still lead to a high degree of belief in the change(s) tested
- Characterize the change by describing the before and after medians
- Minimizes point-to-point variation

FIGURE 3.11 Run Chart with Little Data



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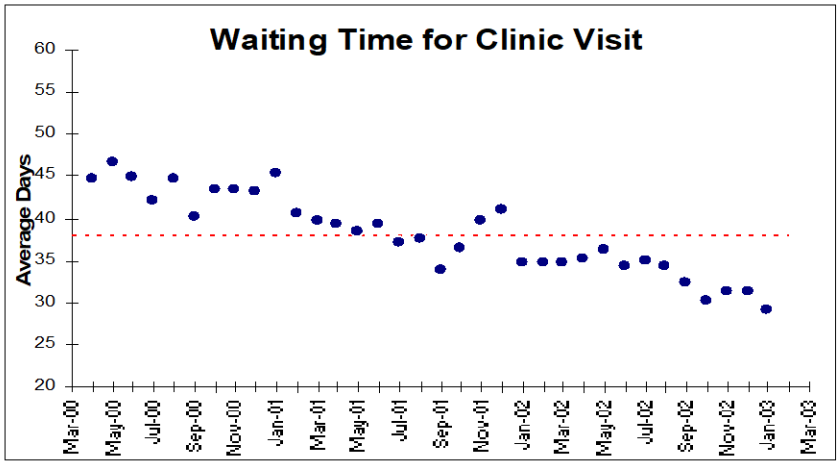
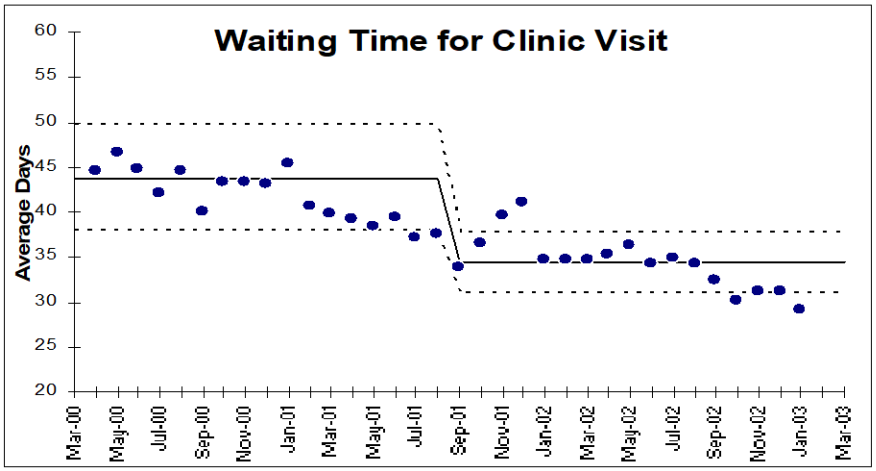
Run Chart

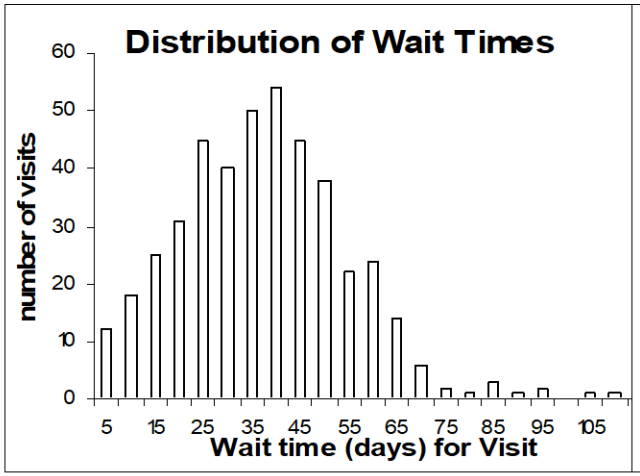
- A line graph of data plotted over time
- Data is kept in time order
- Can see flow of data
- Helps answer questions:
  - **What is our baseline variation?**
  - **How much variation do we have?**
  - **How is process changing over time?**
  - **Has our change resulted in an improvement?**
  - **Did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

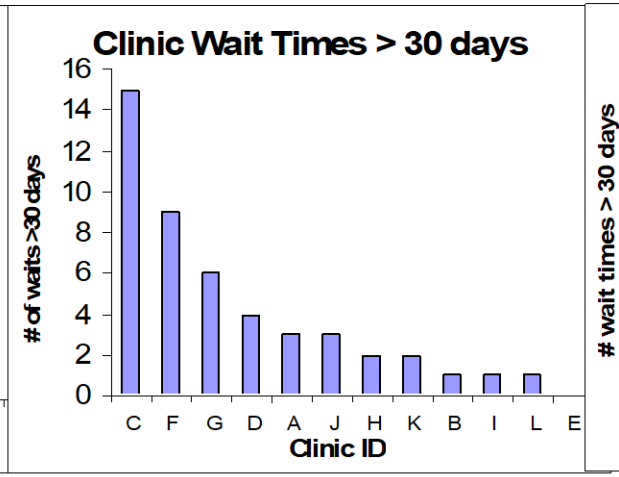
We Use Other Tools Too!

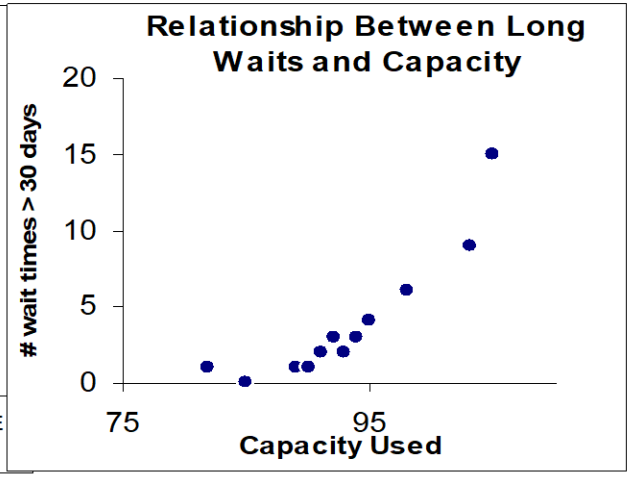
When collect information on # or % of errors typically want to know type of errors or time of day or relationship between errors and some other variable!







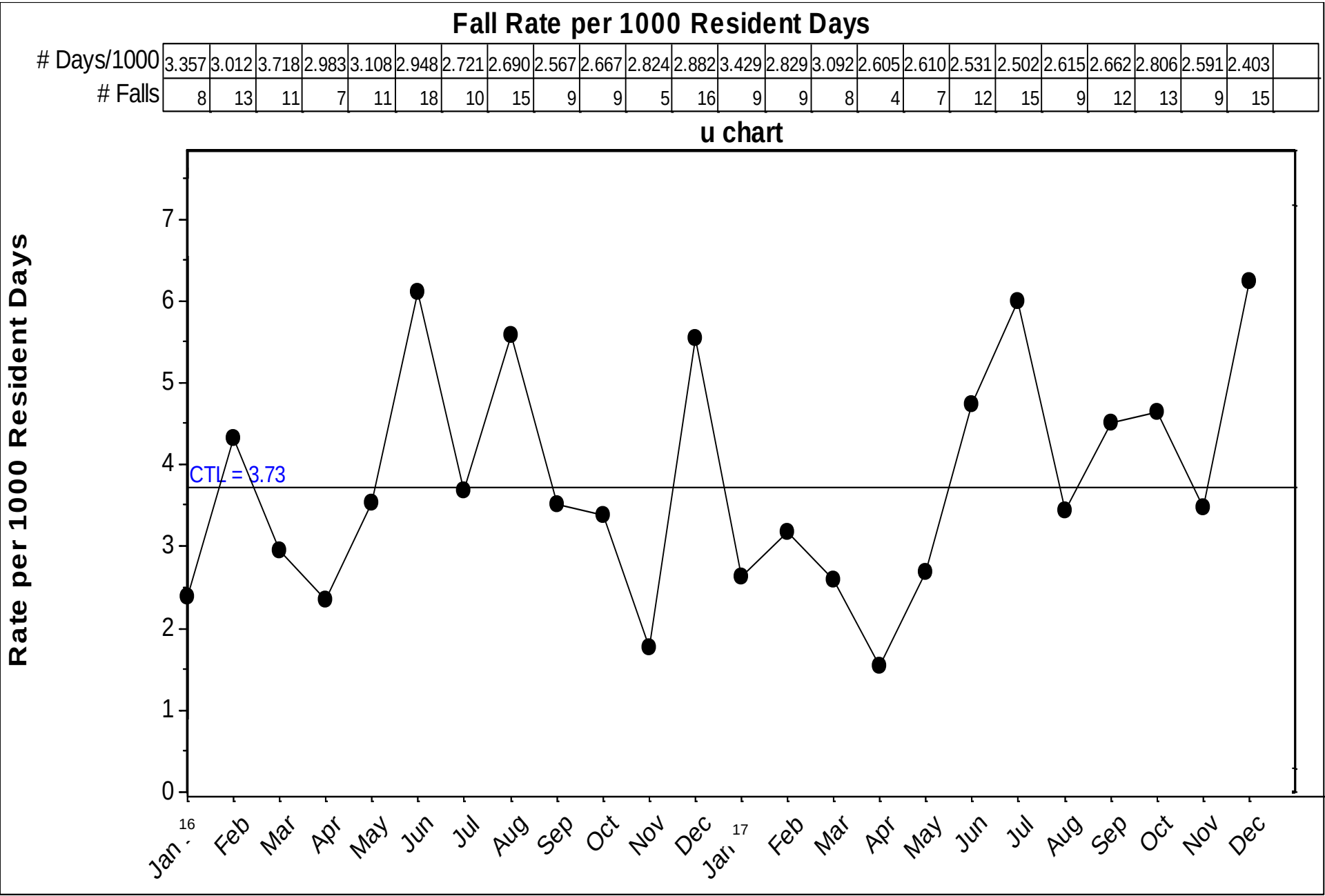




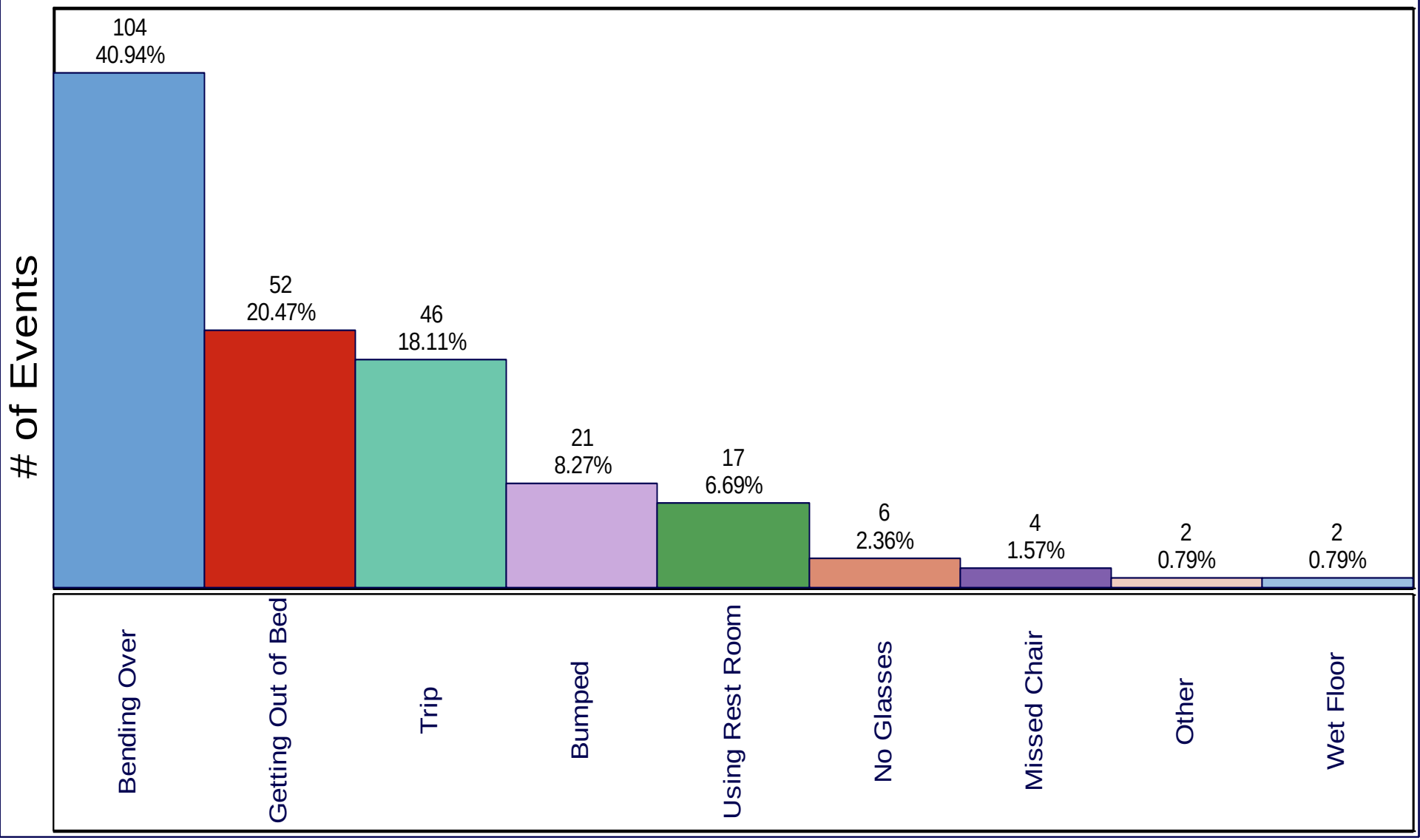
We Use Other Tools Too!

Fall Rate per 1000 Resident Days

# Days/1000	3.357	3.012	3.718	2.983	3.108	2.948	2.721	2.690	2.567	2.667	2.824	2.882	3.429	2.829	3.092	2.605	2.610	2.531	2.502	2.615	2.662	2.806	2.591	2.403
# Falls	8	13	11	7	11	18	10	15	9	9	5	16	9	9	8	4	7	12	15	9	12	13	9	15

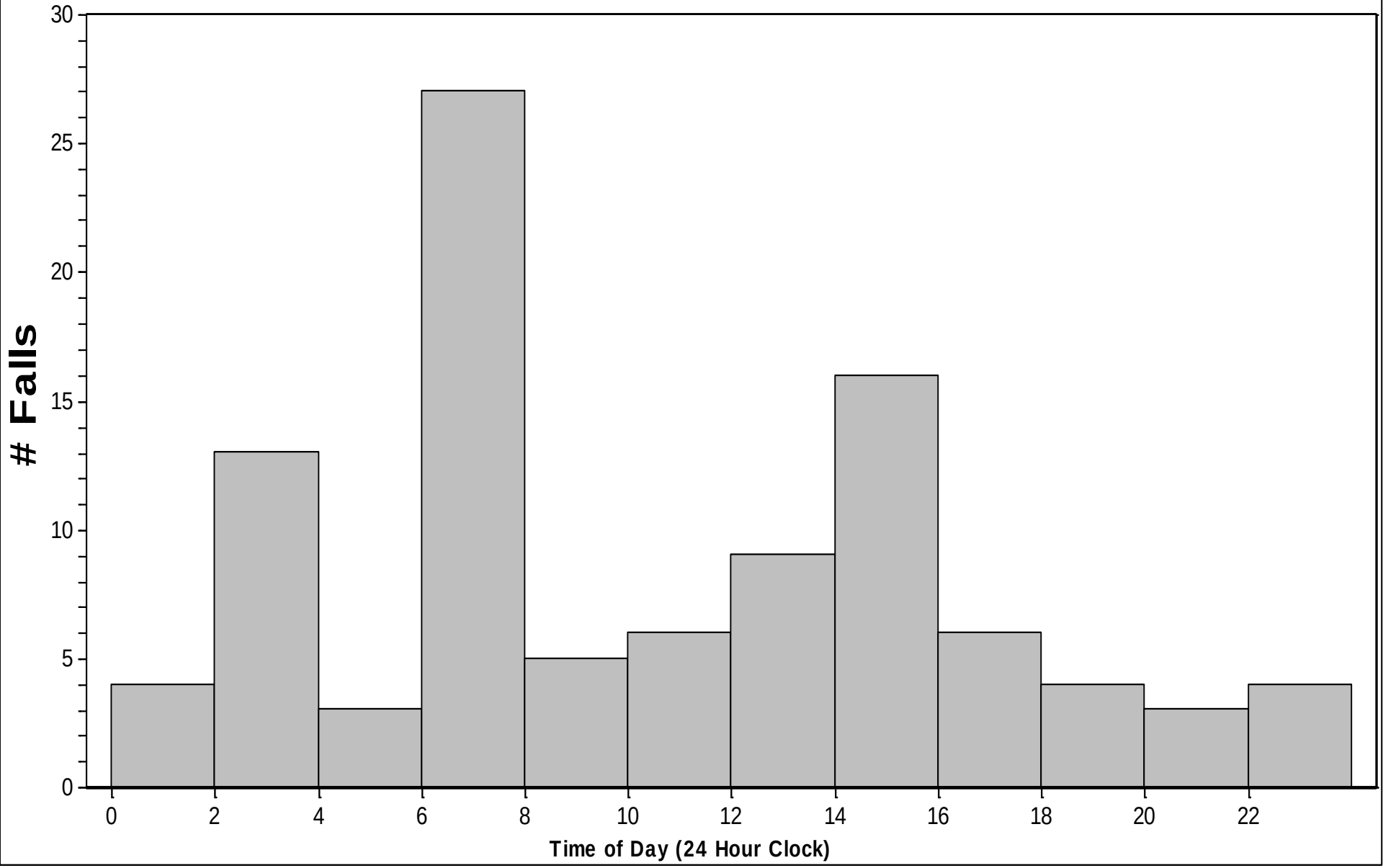


# Factors Associated with Resident Falls
N=254

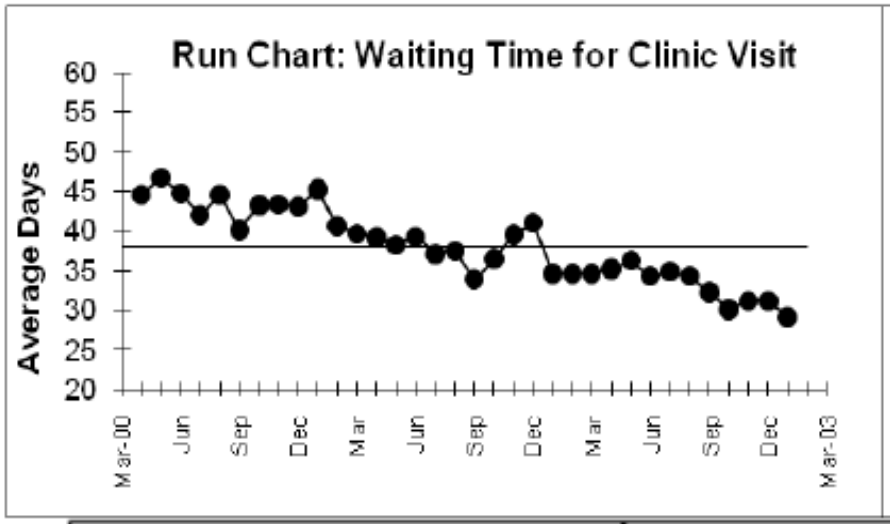


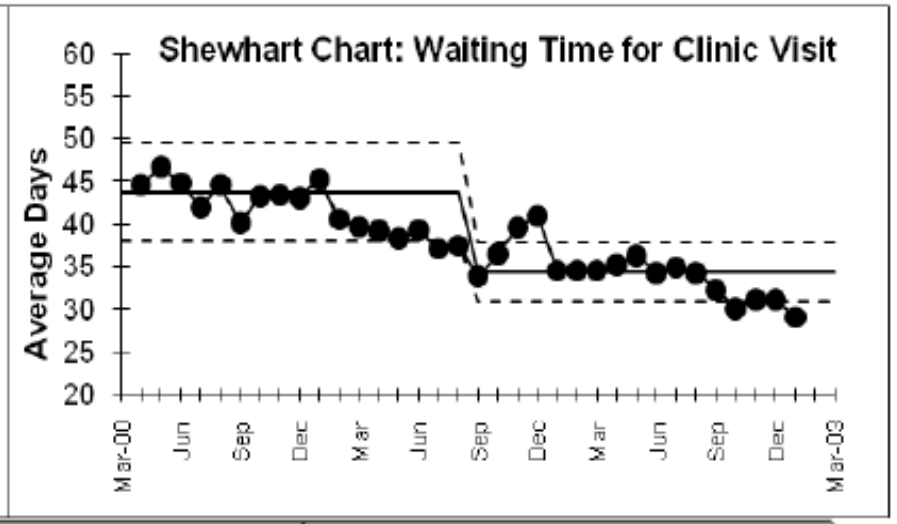
Number of Falls by Time of Day

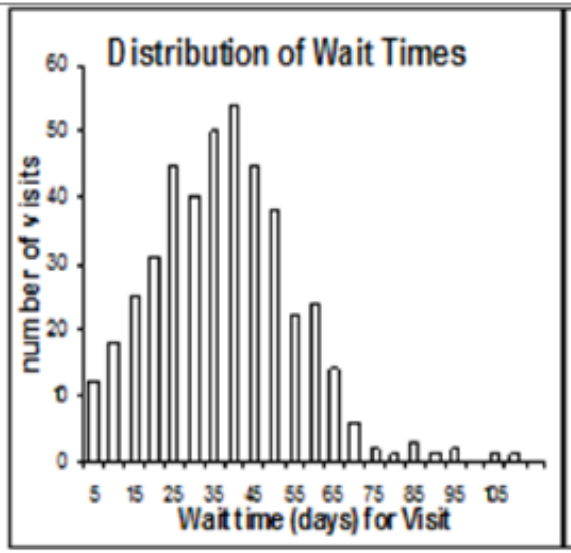
Histogram

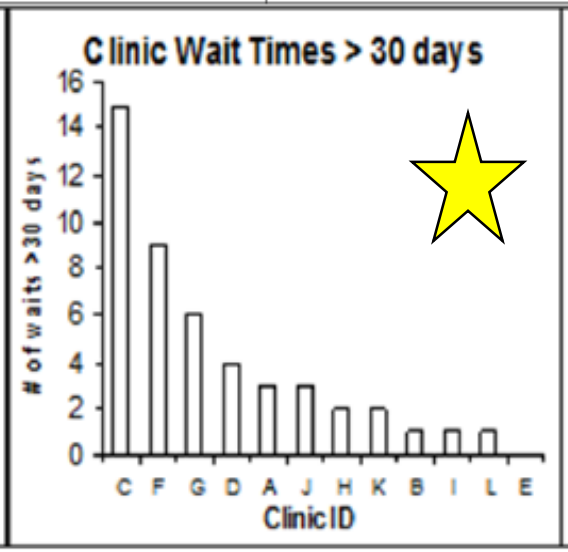


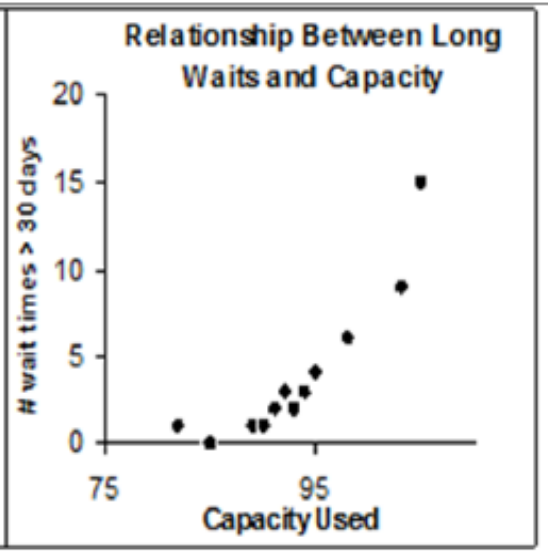
Tools to Learn from Variation in Data











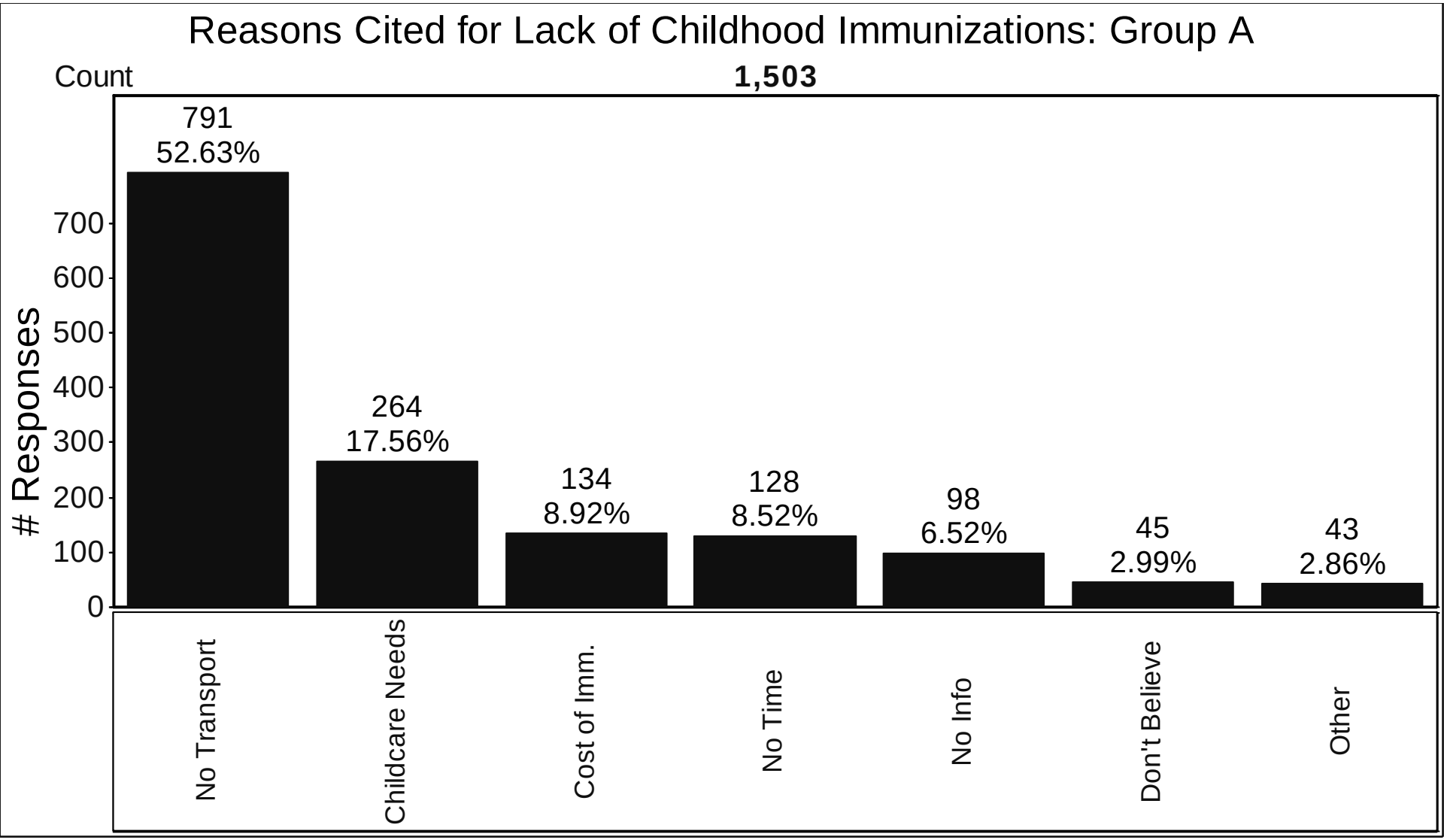
Frequency Plot | Pareto Chart | Scatter Plot

The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Pareto Chart

- Bar chart with bars in rank order
- **Each bar represents a different variable, factor or problem**
- Becomes useful with **30-50 pieces** of data
- Looking for **20% of bars** representing **80% of opportunity**
- Want to know where to **focus our efforts**
  - Which are the vital few areas we should concentrate on?
  - Which variables out of many are occurring most?

Pareto Chart: What Does One Look Like?



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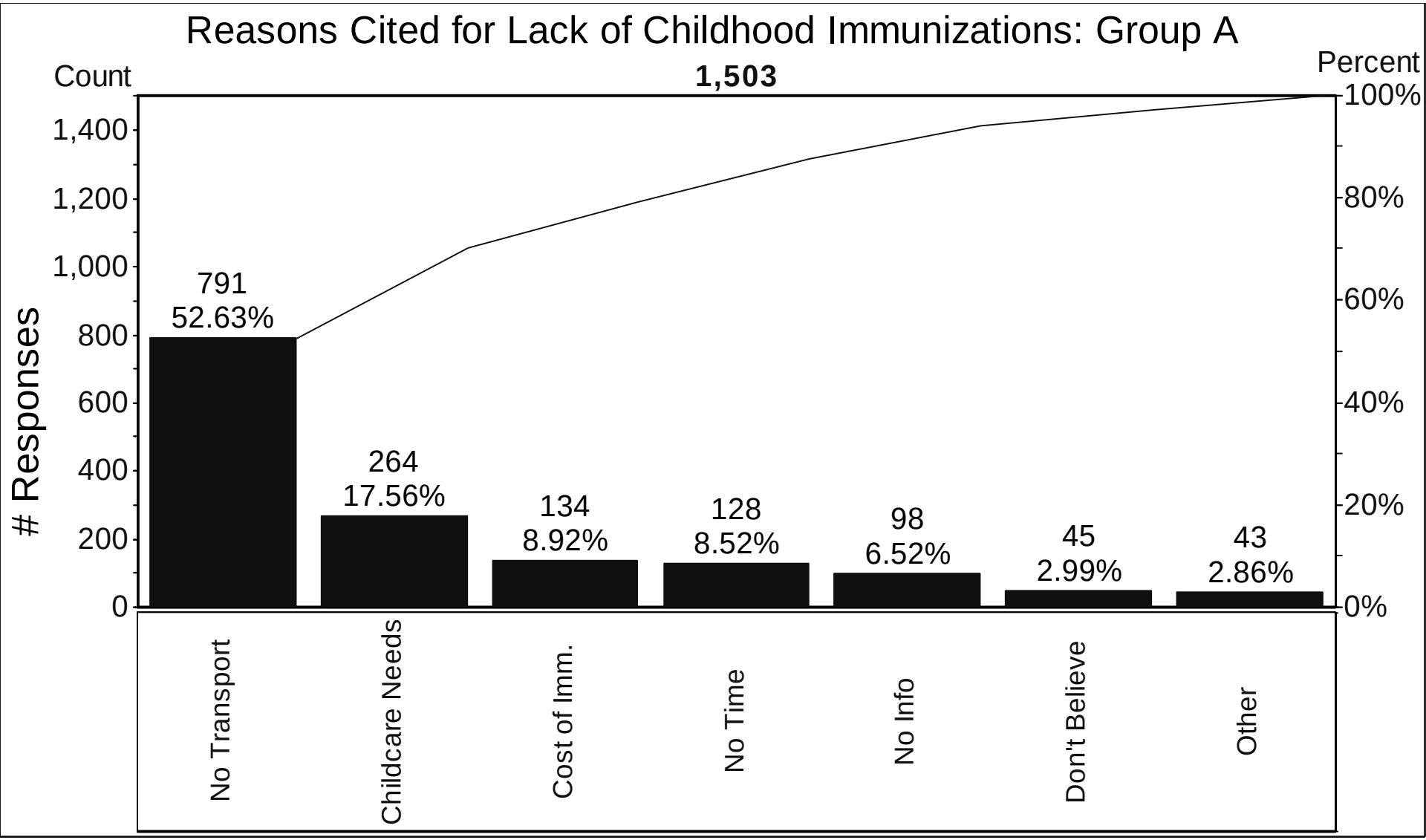
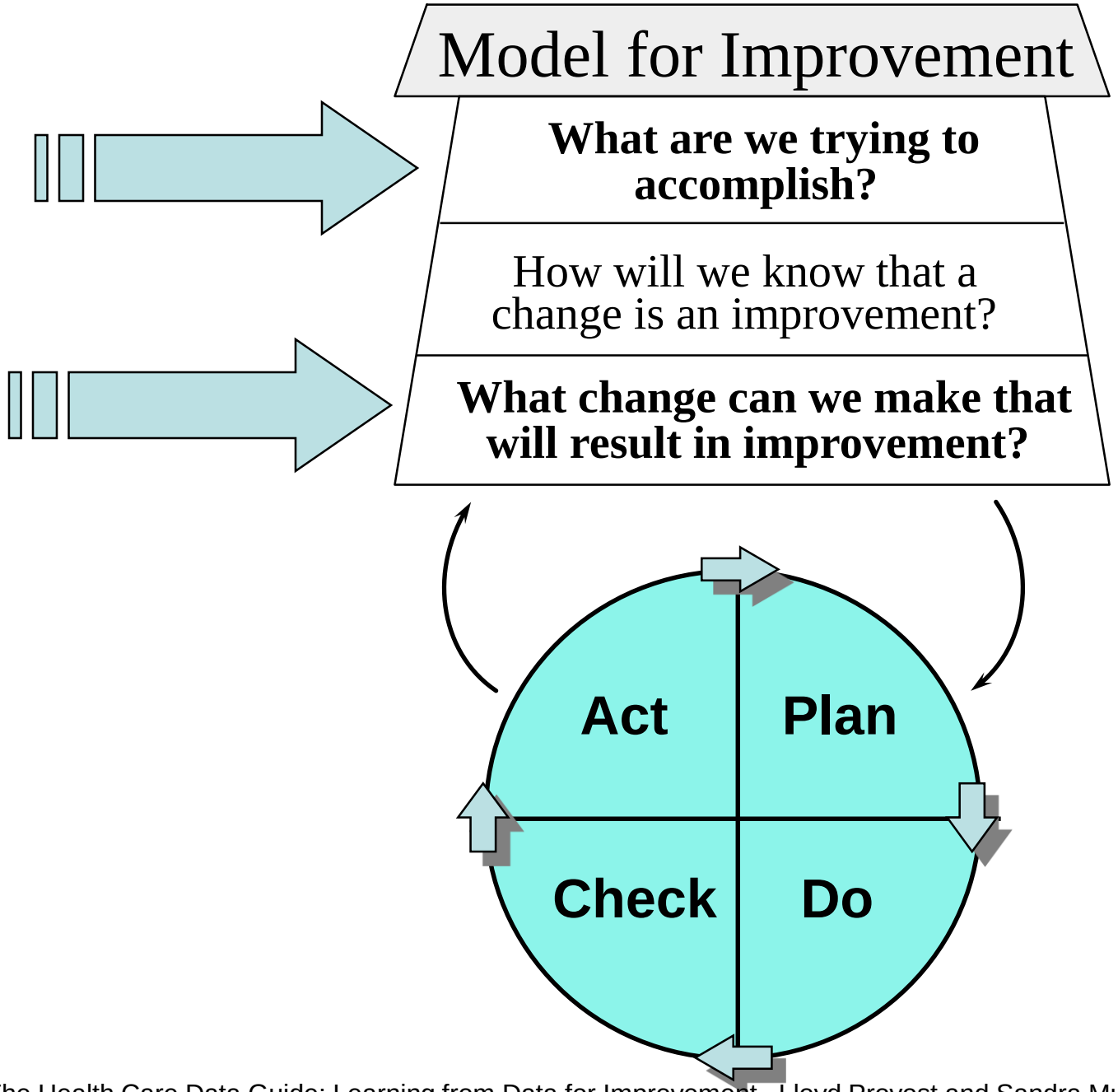
Pareto Chart: What Does One Look Like?



The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

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



The Health Care Data Guide: Learning from Data for Improvement. Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

To Make Pareto Chart

1. Determine question being asked
2. Determine data needed to answer it and collect
3. Summarize data by making a frequency table (how often did things happen in each of your categories?)
4. Draw and scale the horizontal and vertical axis
5. Draw and label the bars for each category (from most to least)
6. Calculate % for each category and annotate on top the respective bar (total for that category divided by grand total X 100)
7. Study the results

What Factors Are Most Related to ED Patient Dissatisfaction?

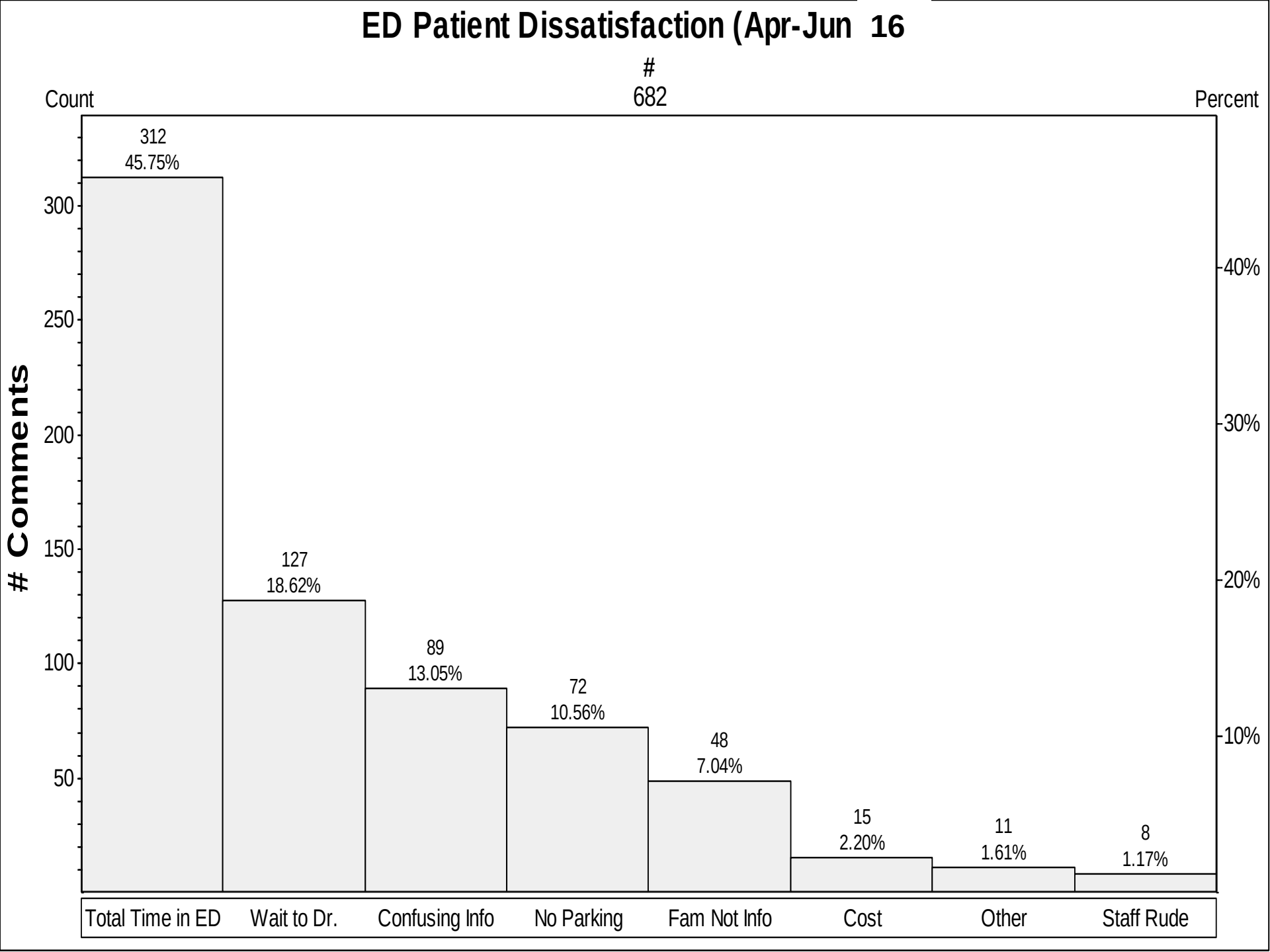
Category related to Pt. Dissatisfaction	#	%
Parking	**72**	
Confusing Info	**89**	
Wait to Dr.	**127**	
Total Time in ED	**312**	
Cost	**15**	
Staff Rude	**8**	
Fam Not Info	**48**	
Other	**11**	
Grand Total	**682**	

What Factors Are Most Related to ED Patient Dissatisfaction?

Category related to Pt. Dissatisfaction	#	%
Parking	**72**	**10.6**
Confusing Info	**89**	
Wait to Dr.	**127**	
Total Time in ED	**312**	
Cost	**15**	
Staff Rude	**8**	
Fam Not Info	**48**	
Other	**11**	
Grand Total	**682**	

What Factors Are Most Related to ED Patient Dissatisfaction?

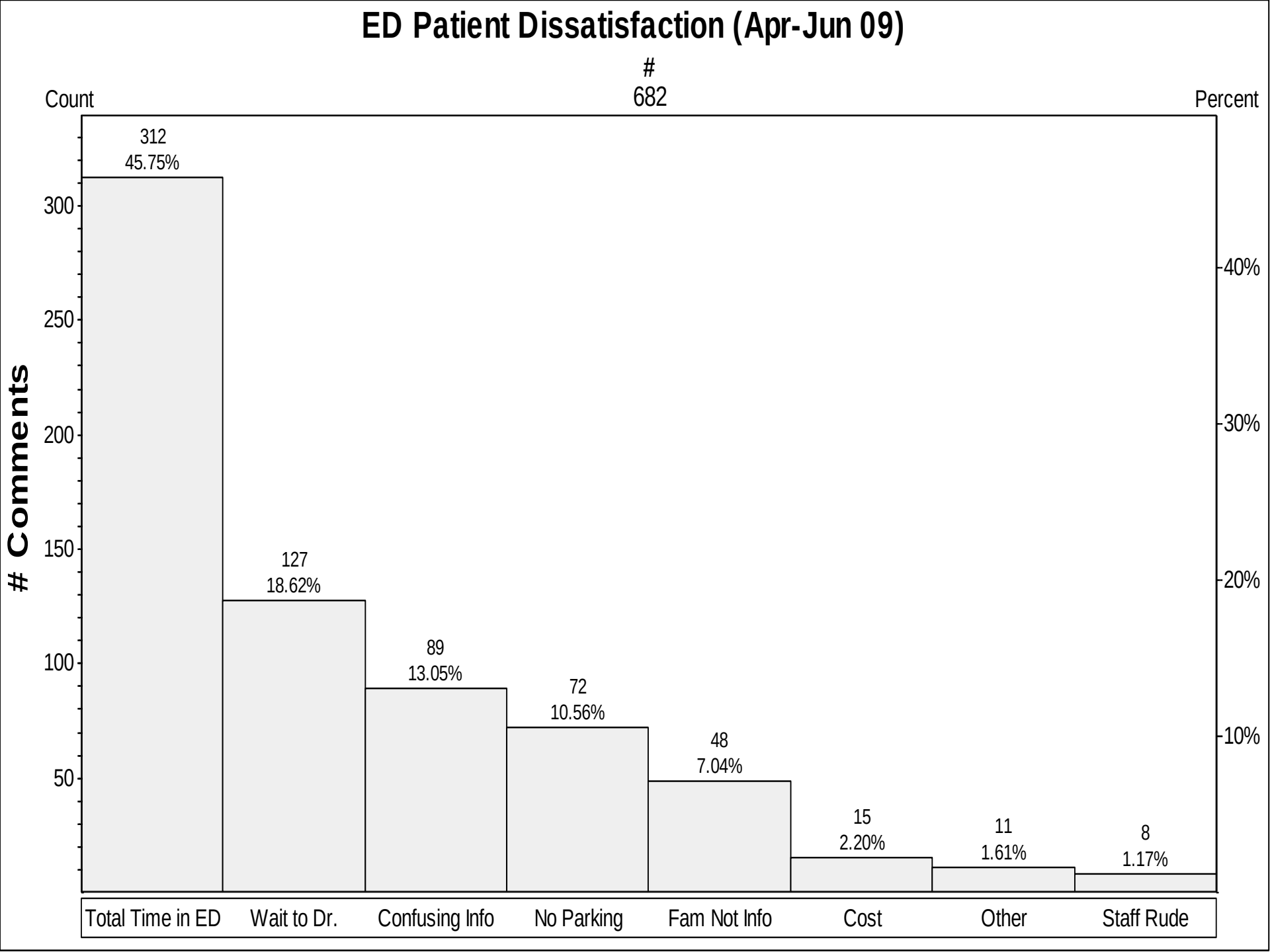
Category related to Pt. Dissatisfaction	#	%
Parking	**72**	**10.6**
Confusing Info	**89**	**13**
Wait to Dr.	**127**	**18.6**
Total Time in ED	**312**	**45.7**
Cost	**15**	**2.2**
Staff Rude	**8**	**1.17**
Fam Not Info	**48**	**7.04**
Other	**11**	**1.61**
Grand Total	**682**	**100**


ED Patient Dissatisfaction (Apr-Jun 16
#
682
Count
Percent
Comments
312
45.75%
127
18.62%
89
13.05%
72
10.56%
48
7.04%
15
2.20%
11
1.61%
8
1.17%
300
250
200
150
100
50
40%
30%
20%
10%
Total Time in ED
Wait to Dr.
Confusing Info
No Parking
Fam Not Info
Cost
Other
Staff Rude

How Is It Interpreted?

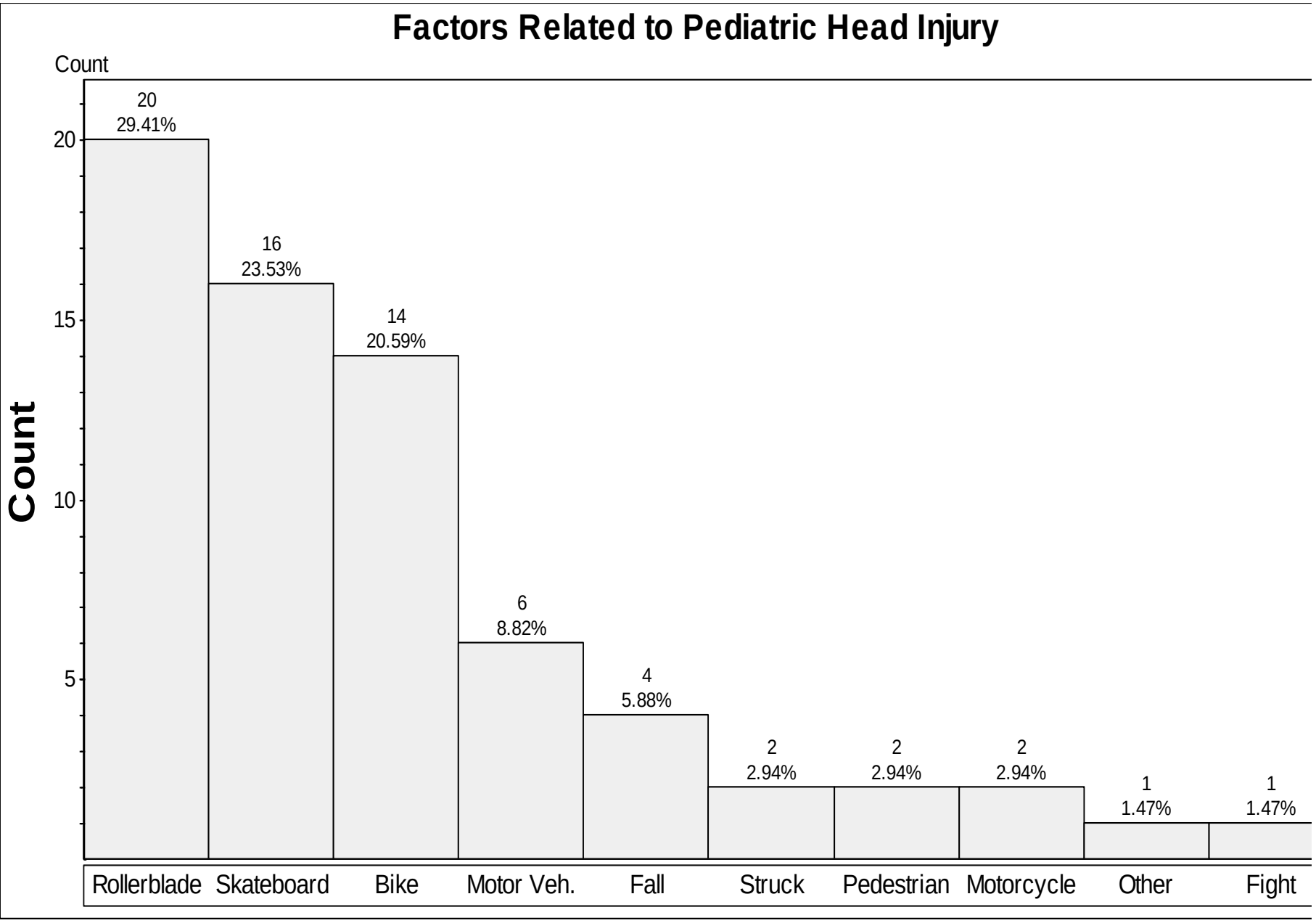
- **Look for the Pareto effect**
  - The 80/20 rule

ED Patient Dissatisfaction (Apr-Jun 09)



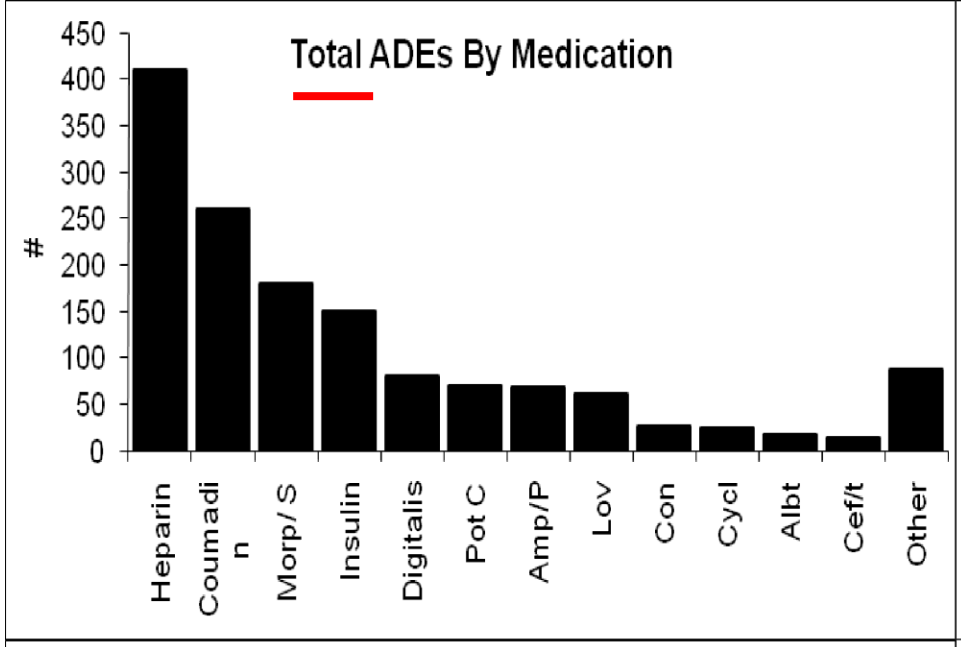
How Is It Interpreted?

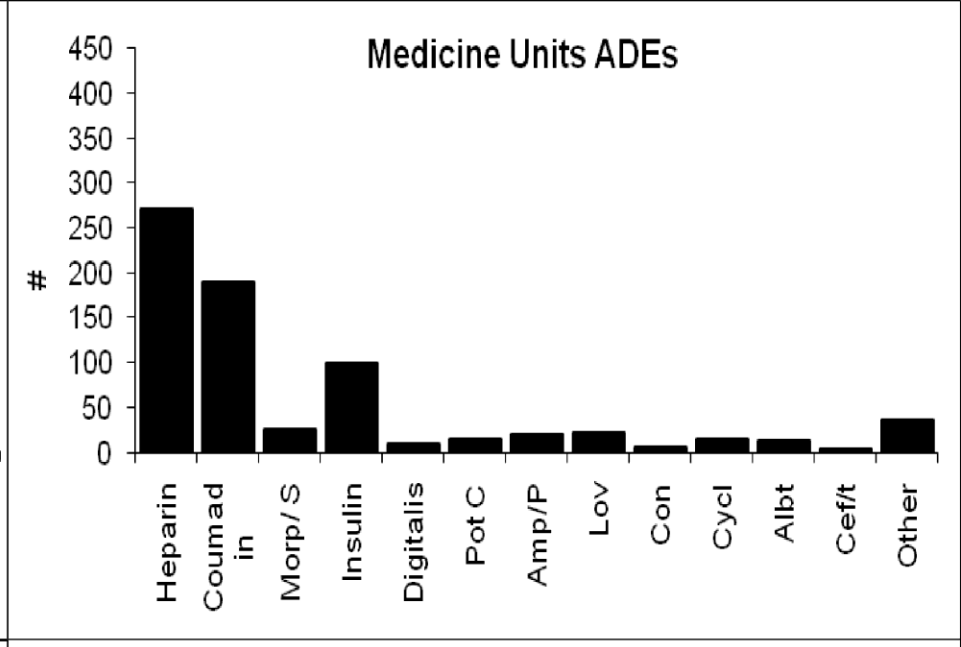
- Look for the Pareto effect
- We won't always find it!
  - Is entire chart speaking to us?

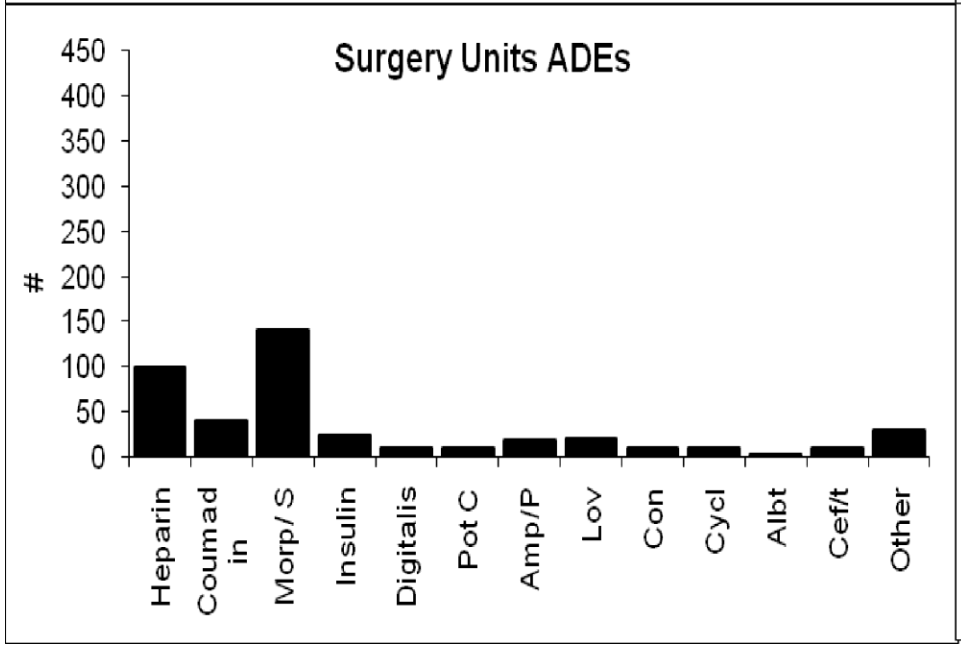

Factors Related to Pediatric Head Injury
Count
Count
20
15
10
5
20
29.41%
16
23.53%
14
20.59%
6
8.82%
4
5.88%
2
2.94%
2
2.94%
2
2.94%
1
1.47%
1
1.47%
Rollerblade
Skateboard
Bike
Motor Veh.
Fall
Struck
Pedestrian
Motorcycle
Other
Fight

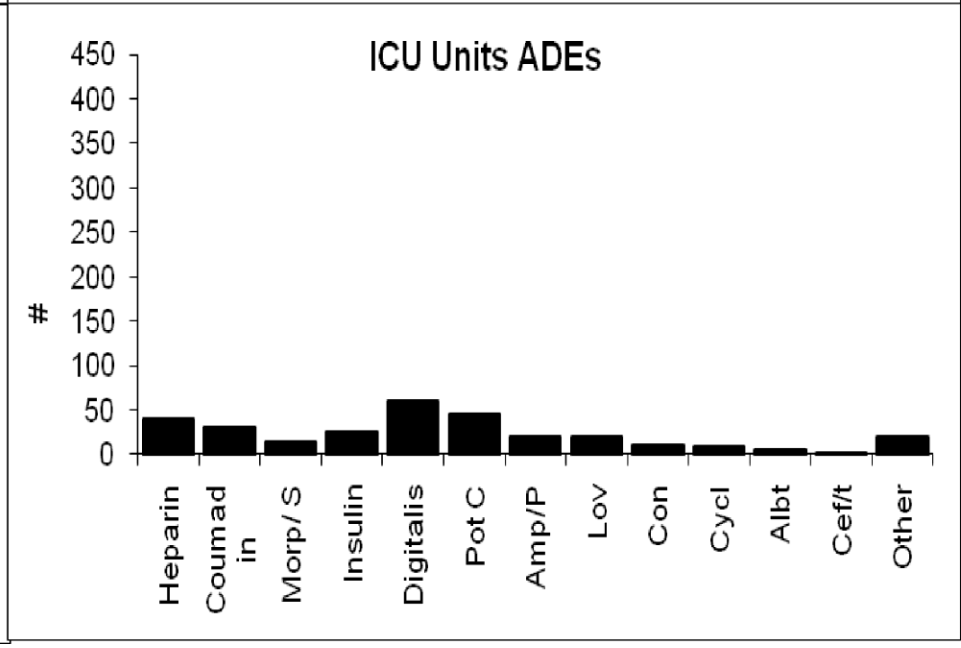
Other Ways To Use Pareto

- Stratification





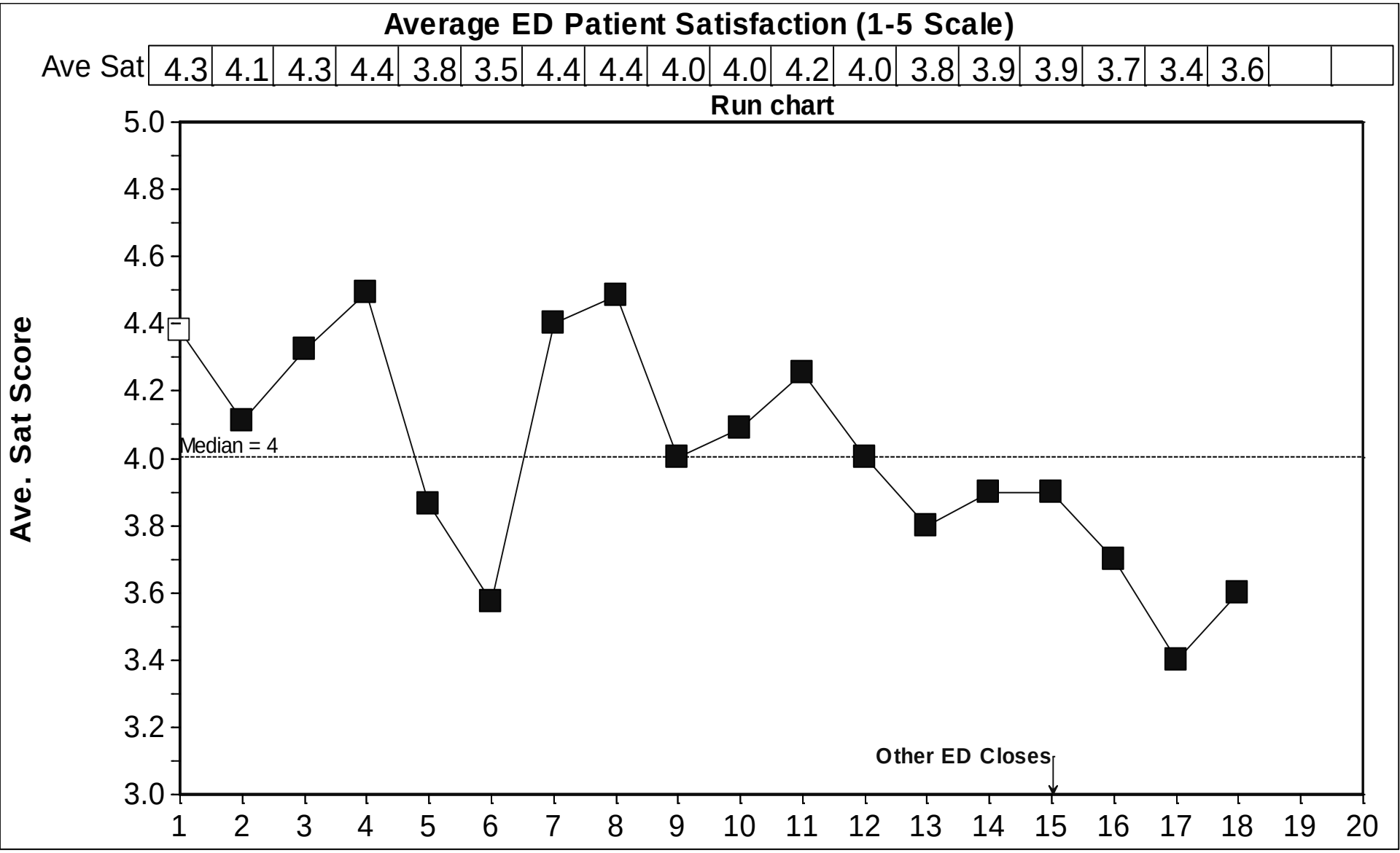




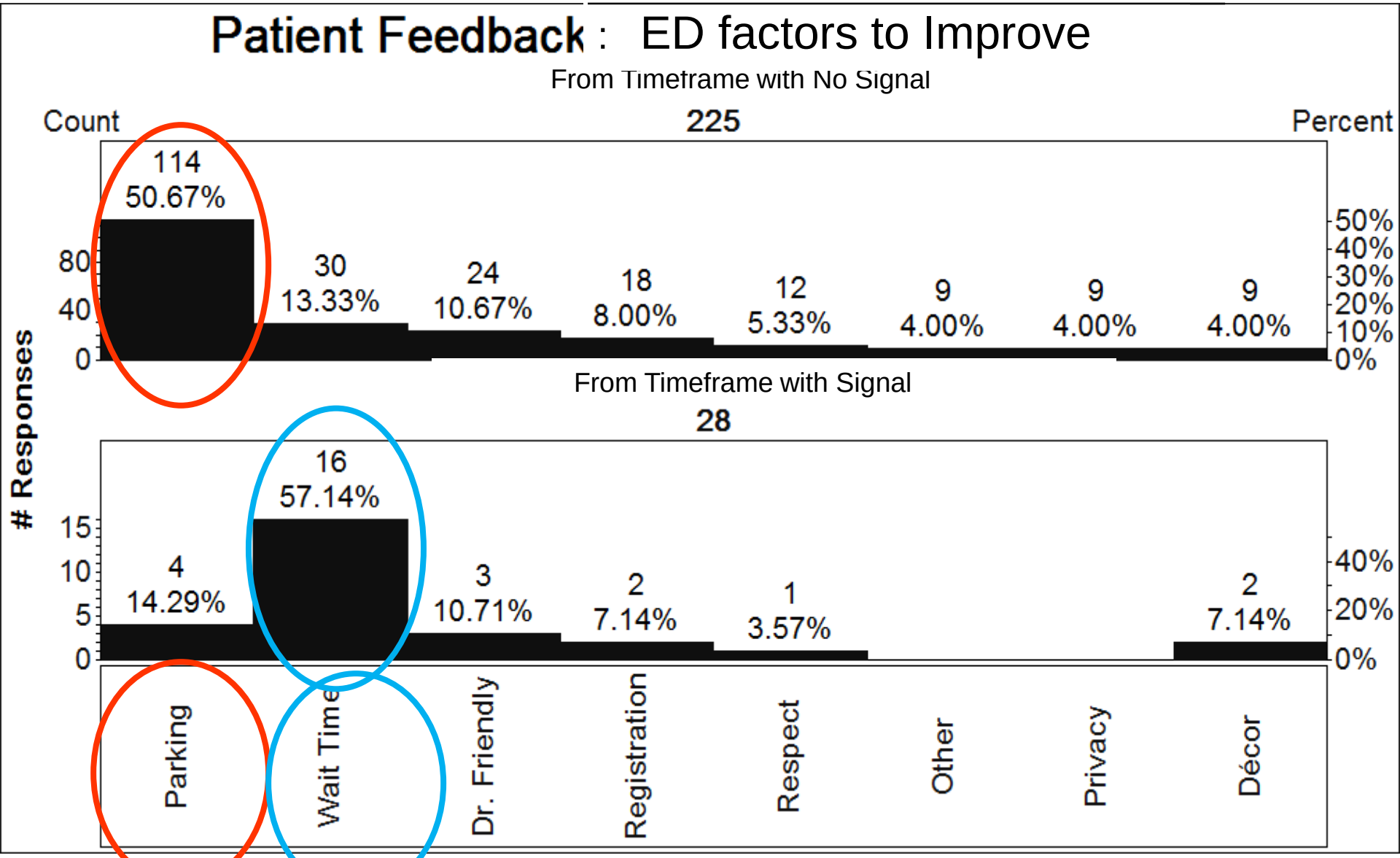
The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

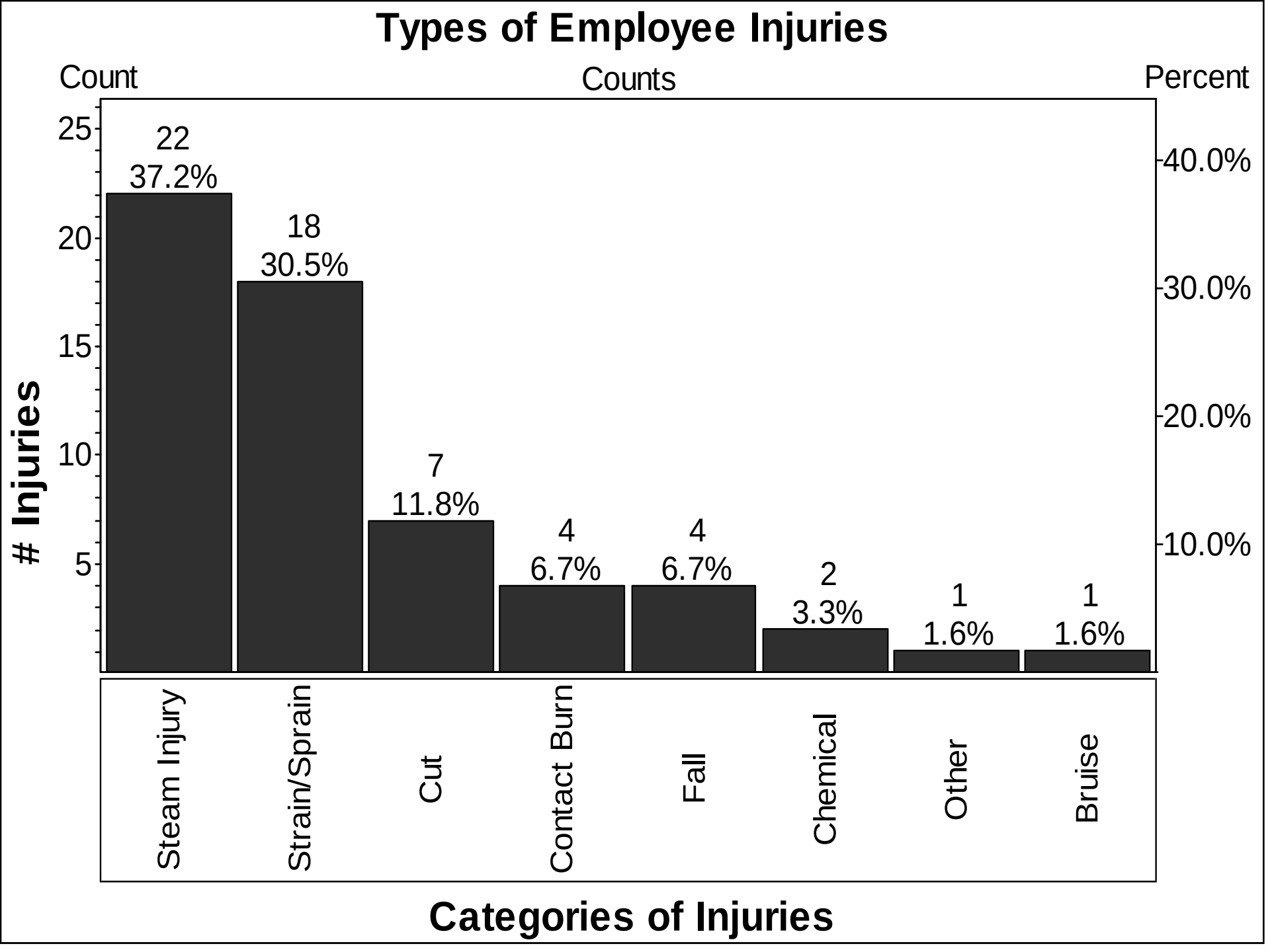
Average ED Patient Satisfaction (1-5 Scale)

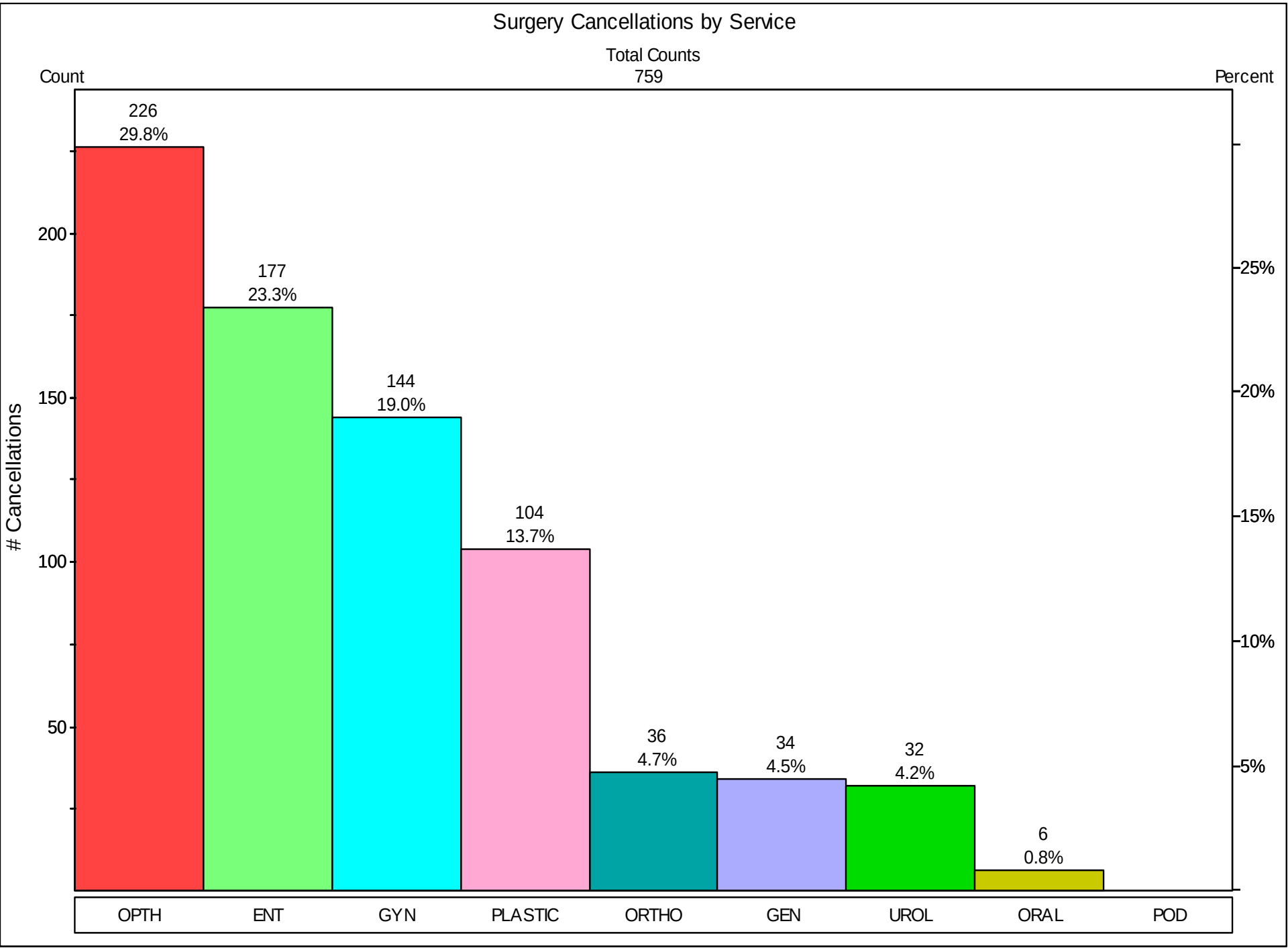
Ave Sat	4.3	4.1	4.3	4.4	3.8	3.5	4.4	4.4	4.0	4.0	4.2	4.0	3.8	3.9	3.9	3.7	3.4	3.6	



Patient Feedback : ED factors to Improve




Types of Employee Injuries
Count
Counts
Percent
25
20
15
10
5
40.0%
30.0%
20.0%
10.0%
Injuries
22
37.2%
18
30.5%
7
11.8%
4
6.7%
4
6.7%
2
3.3%
1
1.6%
1
1.6%
Steam Injury
Strain/Sprain
Cut
Contact Burn
Fall
Chemical
Other
Bruise
Categories of Injuries


Surgery Cancellations by Service
Total Counts
759
Count
Percent
Cancellations
226
29.8%
177
23.3%
144
19.0%
104
13.7%
36
4.7%
34
4.5%
32
4.2%
6
0.8%
200
150
100
50
25%
20%
15%
10%
5%
OPTH
ENT
GYN
PLASTIC
ORTHO
GEN
UROL
ORAL
POD

Pareto Chart

- Bar chart with bars in rank order
- Each bar represents a different variable, factor or problem
- Looking for 20% of bars representing 80% of opportunity
- Want to know where to focus our efforts
  - Which are the vital few areas we should concentrate on?
  - Which variables out of many are occurring most?

Pareto Chart in Excel if Data are already Summarized

- Decide on your Pareto Chart data
- **The Pareto Chart will simply be a bar chart of the data sorted from highest to lowest**
- Select **both the category and data column** you are using for your Pareto chart. Copy and paste it elsewhere on your worksheet if you want to protect the source data..
- On the Home tab go to Sort and Filter. Select “Custom Sort”. In the Wizard for “Sort by”… choose the column with your data in it. “Sort on”….values, “Order by”…Largest to smallest. Click OK
- Go to Insert tab in Excel. Highlight the Pareto chart data and categories you just sorted. Insert column chart.
- Select the first 2D column chart option
- Title and label your Pareto chart

Example

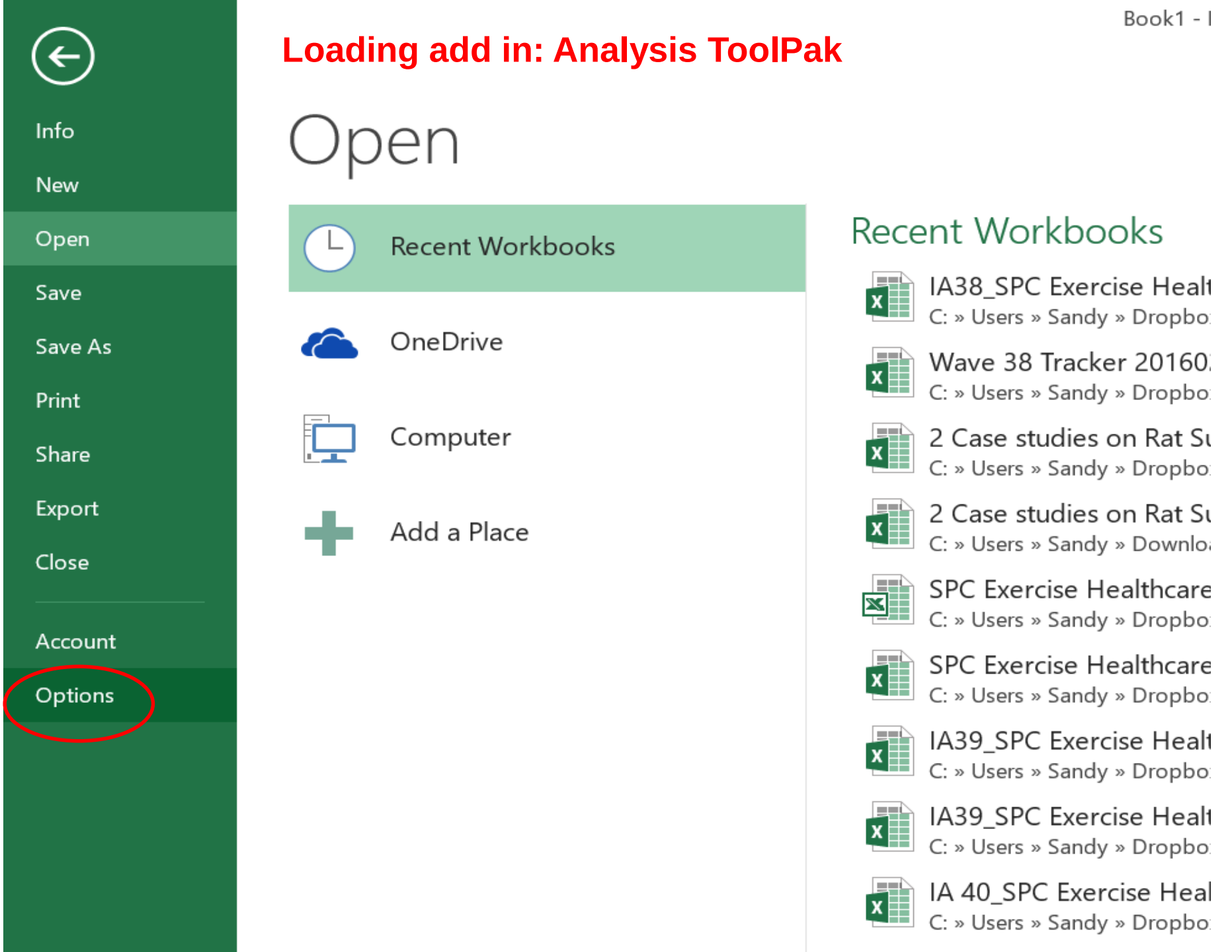
Category: Reasons Given for Not Having Children Immunized	Qtr 1 # Responses
Cost of Imm.	43
Don't Believe In	17
No Time	31
Childcare Needs	89
No Transport	281
No Info	39
Other	18

Pareto Chart in Excel if Data are Coded and not Summarized into a Table Already

- Make certain you have Analysis ToolPak activated in Excel (see following guidance)
- Decide on your Pareto Chart data
- **Title a column "Bins" and Set up bins that correspond to the Code of your categories**
- Go to data tab
- Select Data Analysis
- Select Histogram (yes Histogram!)
- Select data…select bins...select labels…select output and click somewhere on sheet to place chart on that sheet...select Pareto chart, check chart output, may select cumulative percent line if want
- Highlight graph and check out Format tab
  - Label well
  - Change title, check vertical scale

Example

Safety Events (Se) for June 16	SE Code
Fall	1
UTI	7
infection	11
Pressure ulcer S1 or 2	3
misc injury	12
UTI	7
drug dose	10
Fall w. harm	2
foreign object	6
diagnostic error	13
UTI	7
Fall	1


Book1 - I
Loading add in: Analysis ToolPak
Info
New
Open
Save
Save As
Print
Share
Export
Close
Account
Options
Open
Recent Workbooks
OneDrive
Computer
Add a Place
Recent Workbooks
IA38_SPC Exercise Healt
C: » Users » Sandy » Dropbo
Wave 38 Tracker 20160
C: » Users » Sandy » Dropbo
2 Case studies on Rat Su
C: » Users » Sandy » Dropbo
2 Case studies on Rat Su
C: » Users » Sandy » Downlo
SPC Exercise Healthcare
C: » Users » Sandy » Dropbo
SPC Exercise Healthcare
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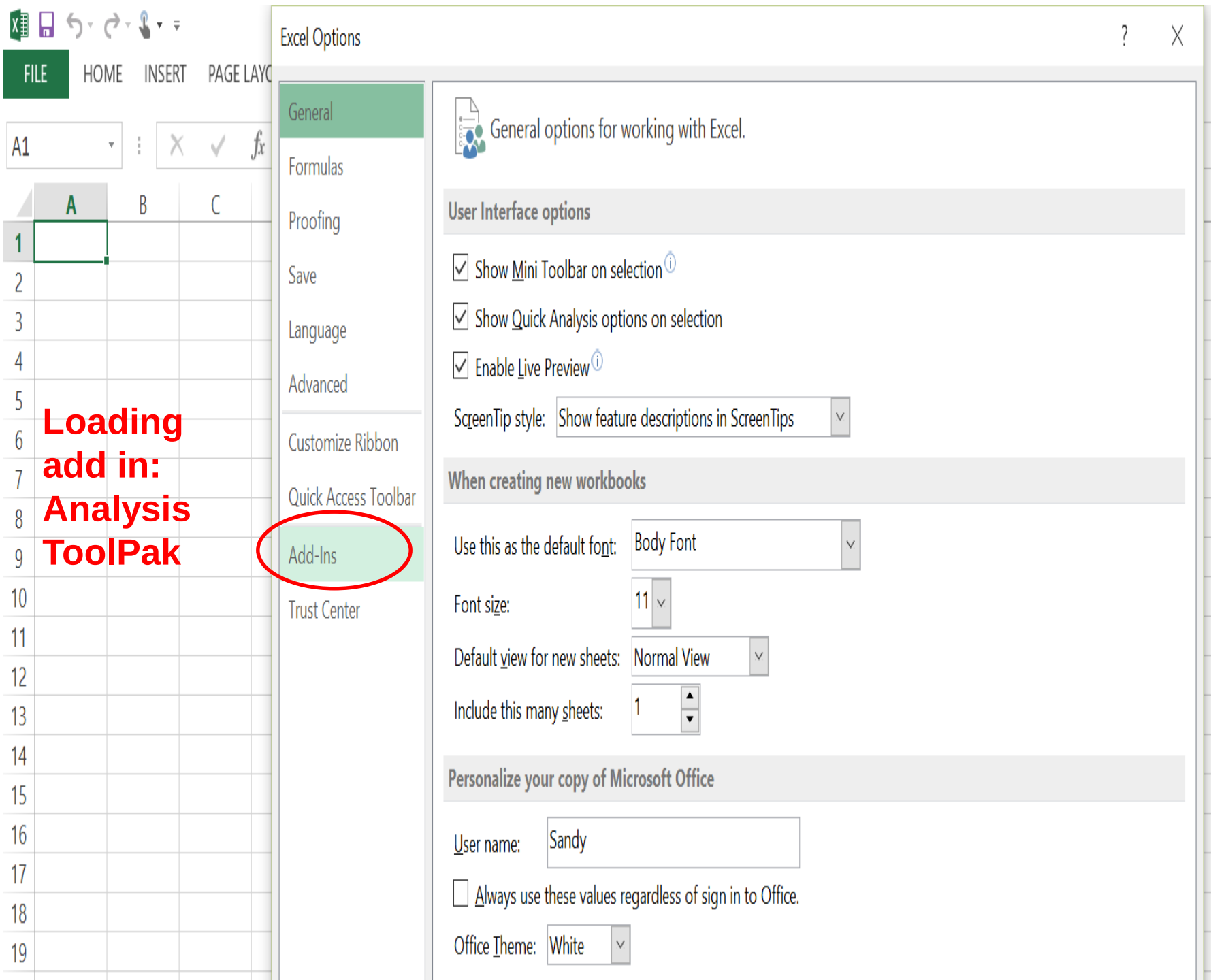
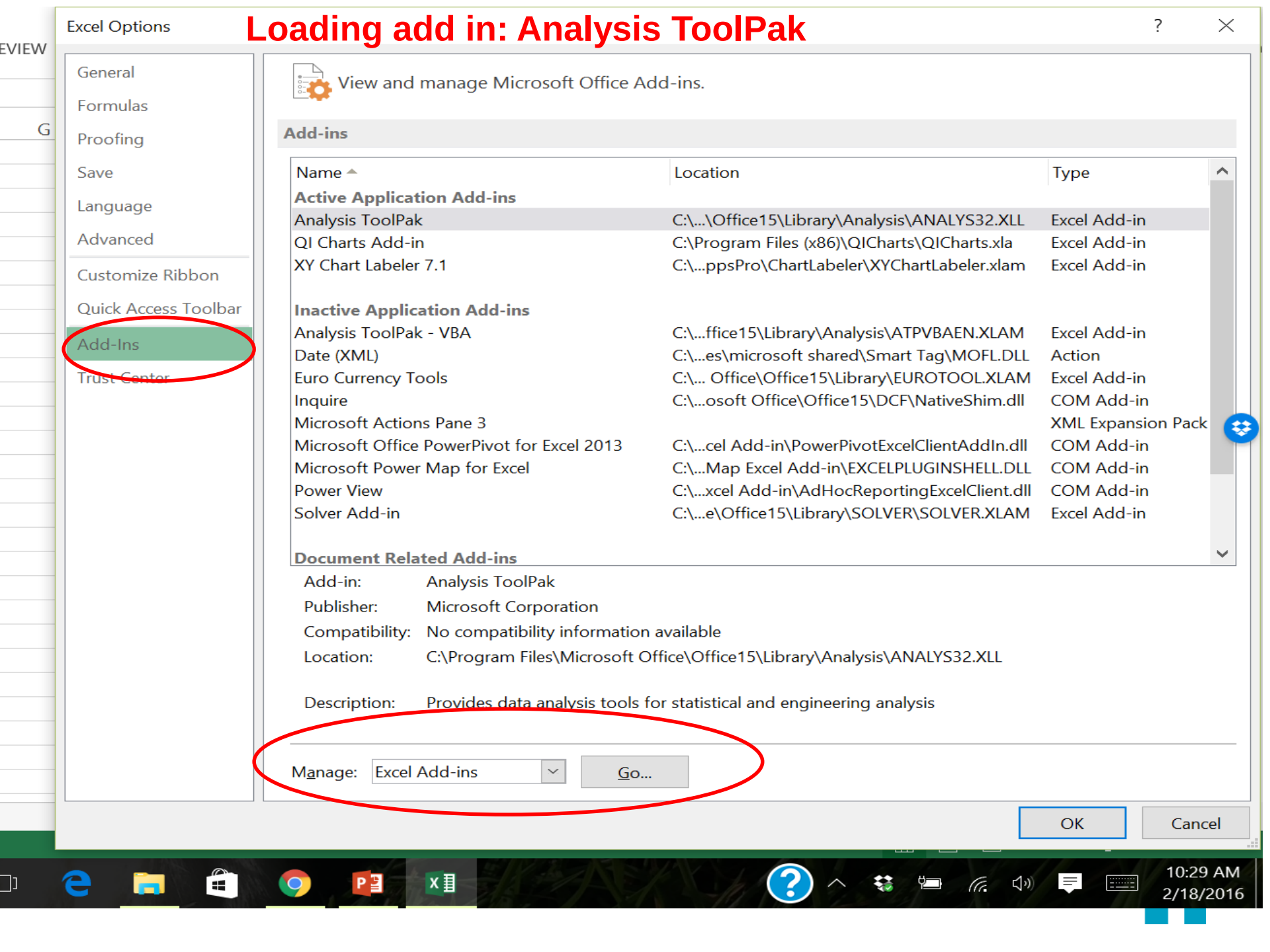
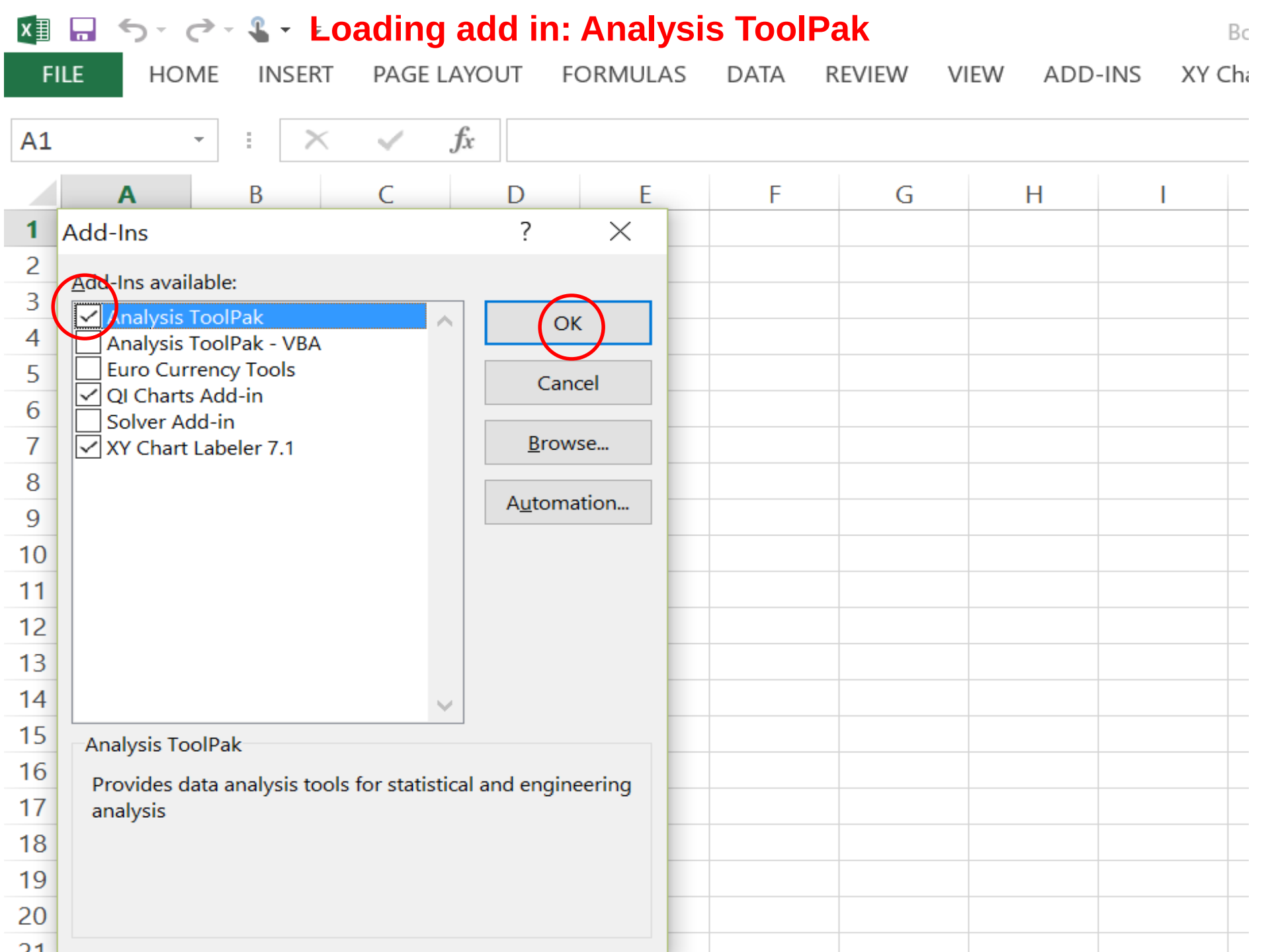

FILE
HOME
INSERT
PAGE LAYO
A1
Loading add in: Analysis ToolPak
Excel Options
General
Formulas
Proofing
Save
Language
Advanced
Customize Ribbon
Quick Access Toolbar
Add-Ins
Trust Center
General options for working with Excel.
User Interface options
Show Mini Toolbar on selection
Show Quick Analysis options on selection
Enable Live Preview
ScreenTip style:
Show feature descriptions in ScreenTips
When creating new workbooks
Use this as the default font:
Body Font
Font size:
11
Default view for new sheets:
Normal View
Include this many sheets:
1
Personalize your copy of Microsoft Office
User name:
Sandy
Always use these values regardless of sign in to Office.
Office Theme:
White


Loading add in: Analysis ToolPak
Excel Options
General
Formulas
Proofing
Save
Language
Advanced
Customize Ribbon
Quick Access Toolbar
Add-Ins
Trust Center
View and manage Microsoft Office Add-ins.
Add-ins
Name
Location
Type
Active Application Add-ins
Analysis ToolPak
C:\...\Office15\Library\Analysis\ANALYS32.XLL
Excel Add-in
QI Charts Add-in
C:\Program Files (x86)\QICharts\QICharts.xla
Excel Add-in
XY Chart Labeler 7.1
C:\...ppsPro\ChartLabeler\XYChartLabeler.xlam
Excel Add-in
Inactive Application Add-ins
Analysis ToolPak - VBA
C:\...ffice15\Library\Analysis\ATPVBAEN.XLAM
Excel Add-in
Date (XML)
C:\...es\microsoft shared\Smart Tag\MOFL.DLL
Action
Euro Currency Tools
C:\... Office\Office15\Library\EUROTOOL.XLAM
Excel Add-in
Inquire
C:\...osoft Office\Office15\DCF\NativeShim.dll
COM Add-in
Microsoft Actions Pane 3
XML Expansion Pack
Microsoft Office PowerPivot for Excel 2013
C:\...cel Add-in\PowerPivotExcelClientAddIn.dll
COM Add-in
Microsoft Power Map for Excel
C:\...Map Excel Add-in\EXCELPLUGINSHELL.DLL
COM Add-in
Power View
C:\...xcel Add-in\AdHocReportingExcelClient.dll
COM Add-in
Solver Add-in
C:\...e\Office15\Library\SOLVER\SOLVER.XLAM
Excel Add-in
Document Related Add-ins
Add-in: Analysis ToolPak
Publisher: Microsoft Corporation
Compatibility: No compatibility information available
Location: C:\Program Files\Microsoft Office\Office15\Library\Analysis\ANALYS32.XLL
Description: Provides data analysis tools for statistical and engineering analysis
Manage: Excel Add-ins
Go...
OK
Cancel
10:29 AM
2/18/2016

Loading add in: Analysis ToolPak



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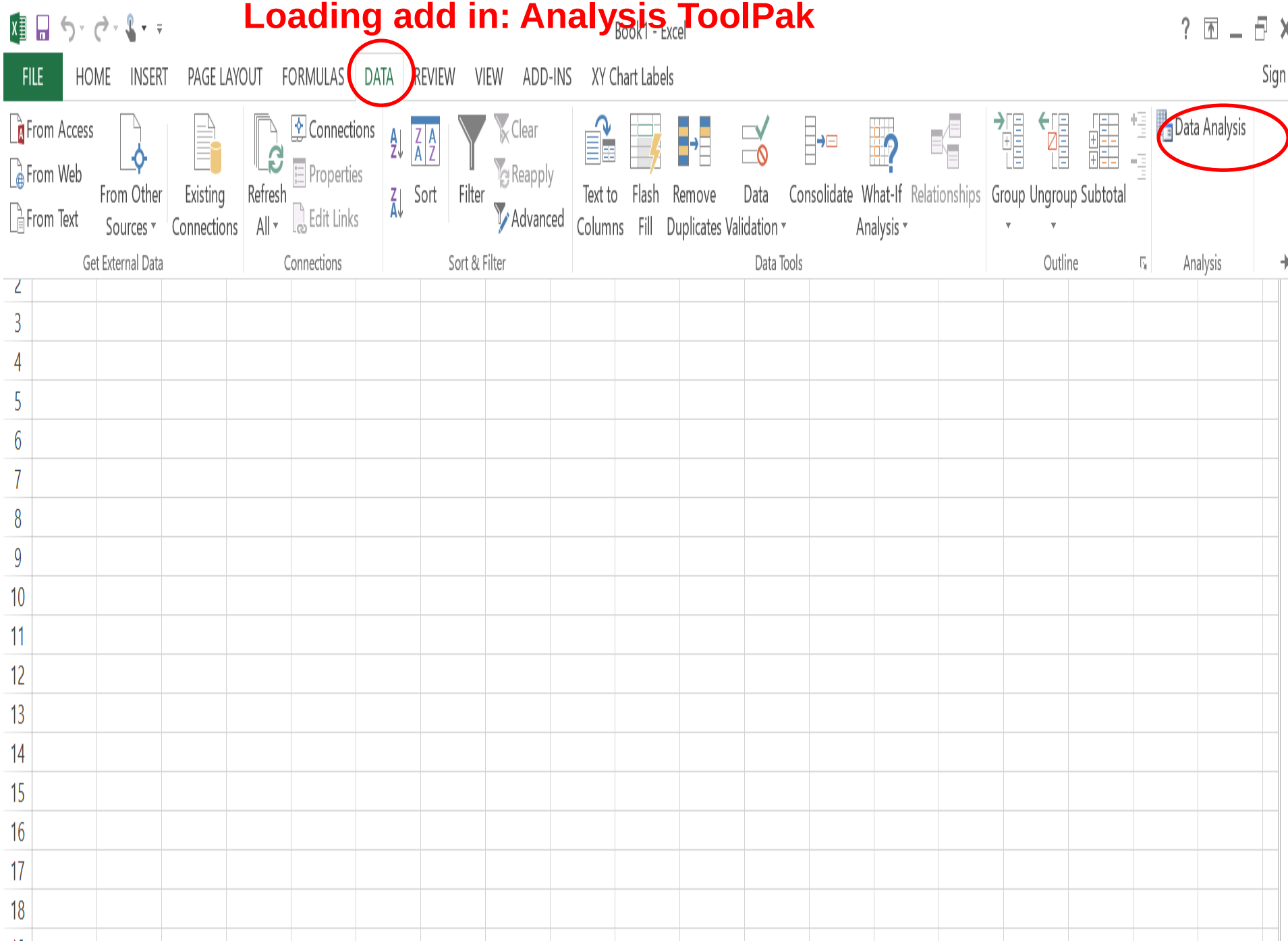
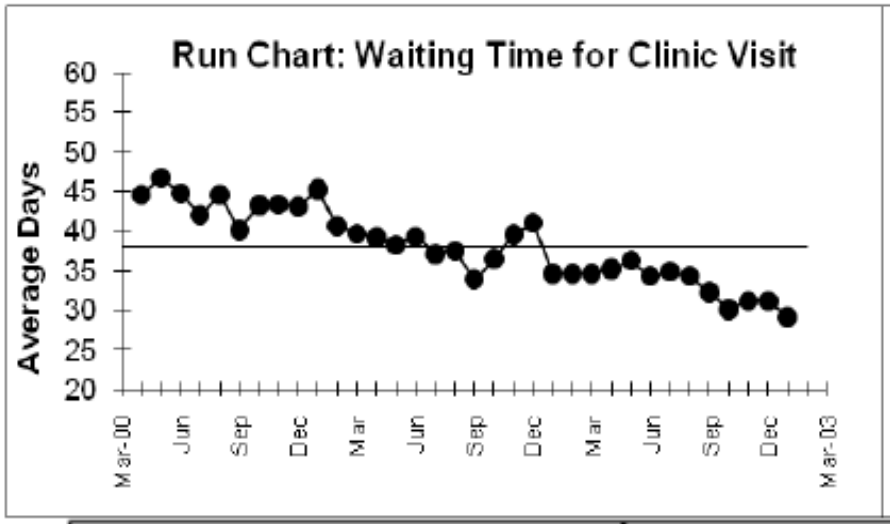
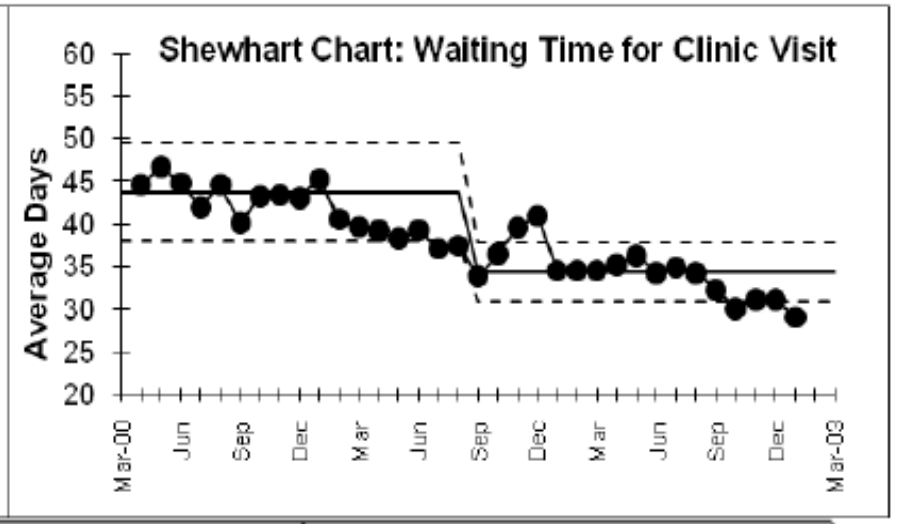
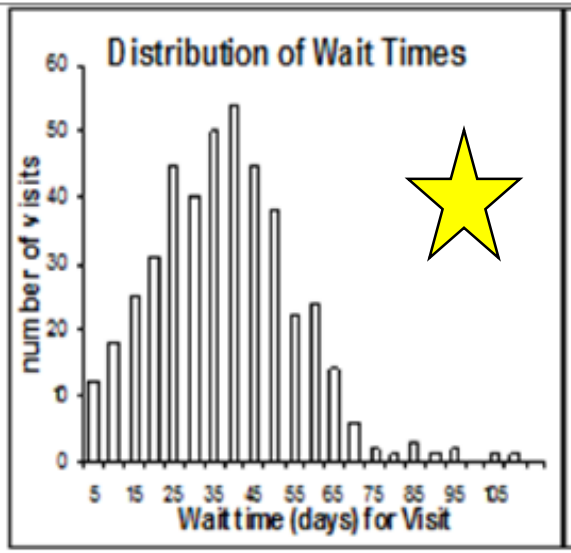


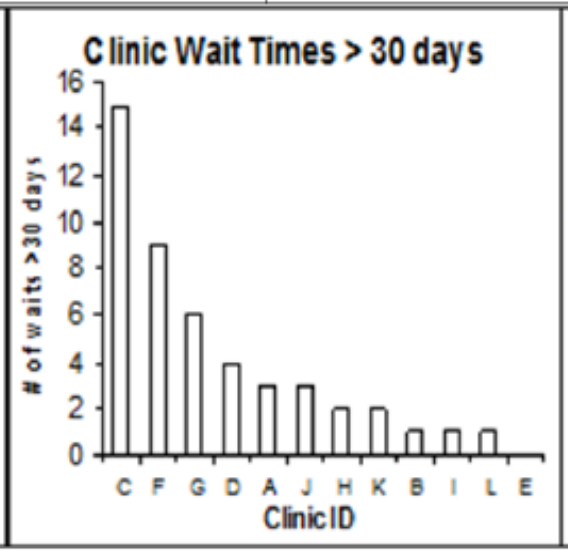
Tools to Learn from Variation in Data



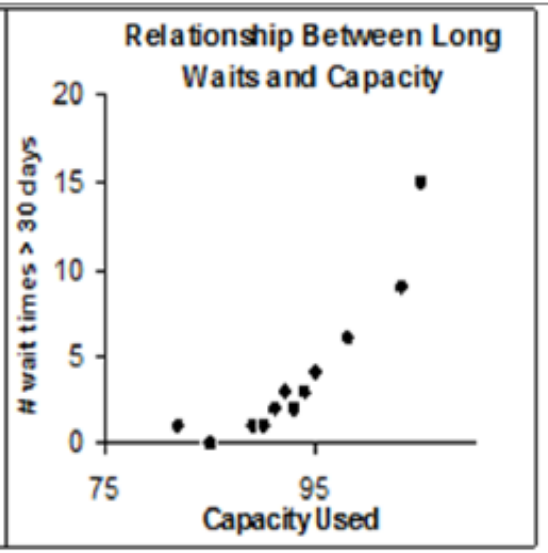




Frequency Plot



Pareto Chart



Scatter Plot

The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

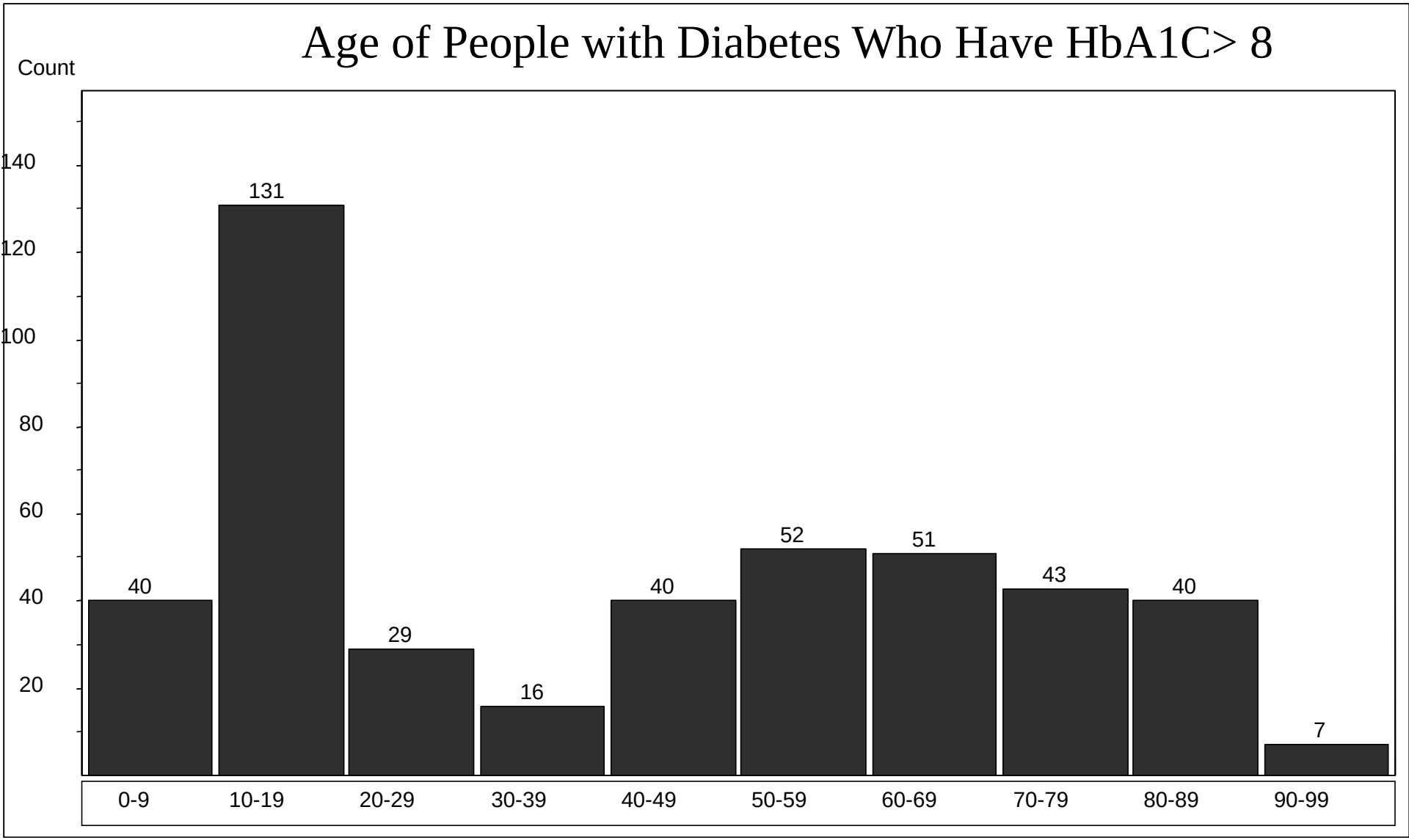
Frequency Plot (Histogram): What Is It?

- A bar chart for **one variable only**
- Each bar **equal**, each **distinct**
- Most often used with time, money, throughput or a scaled measurement (i.e. dollars, weight, age, height)
- Used to visualize central location, shape and spread of the data
- Becomes useful with 30-50 pieces of data
- Like Pareto, frequency Plot does little good for interpretation if process not stable
    - Doesn't show stability

The Tool List

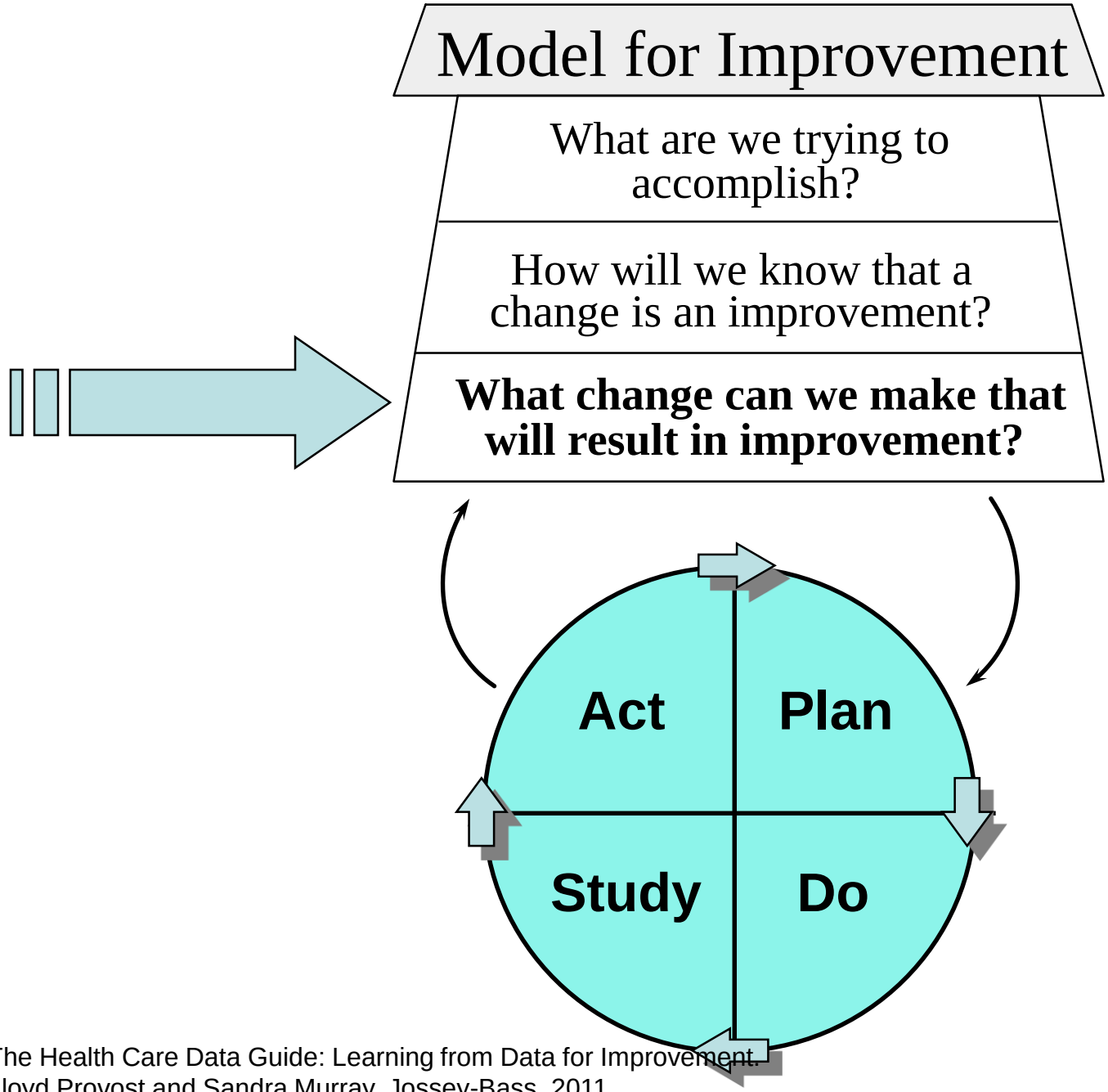
- Frequency Plot:
  - How is this one variable distributed (what is the spread of LOS, Cost, HA1C, etc. in our population)?

What Does a Histogram Look Like?



When Is It Used?

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



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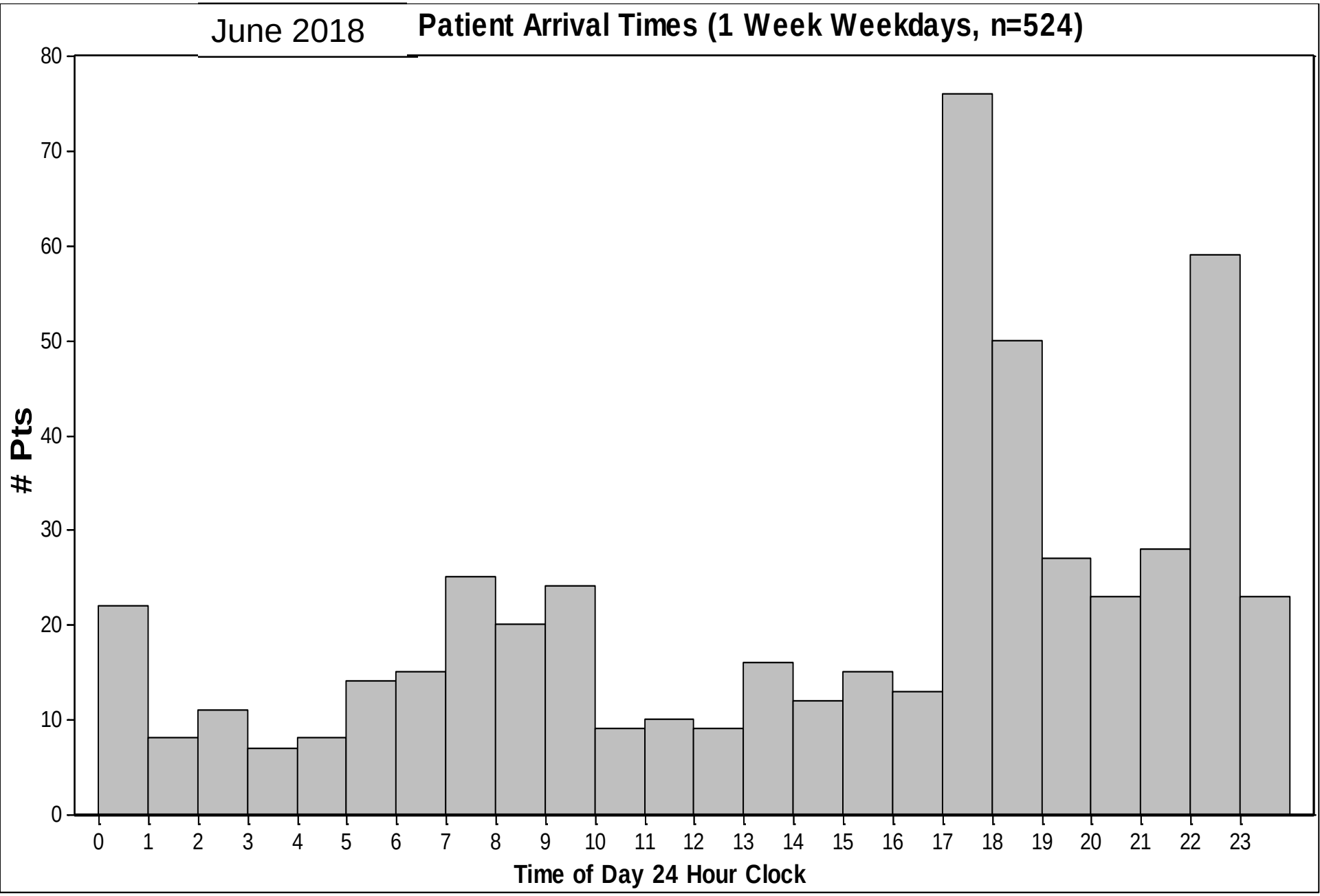

June 2018
Patient Arrival Times (1 Week Weekdays, n=524)
Pts
0
10
20
30
40
50
60
70
80
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time of Day 24 Hour Clock

Frequency Plot: How Is It Made?

1. Get a good, clear question.
2. Get data to answer that question.
3. Decide upon the **number of classes** (bars) and bar size,

6 to 15 bars seems to work best.

Number of Data Points	Number of Bars (classes)
Under 50	5-7
51-100	6-10
101-250	7-12
Over 250	10-20

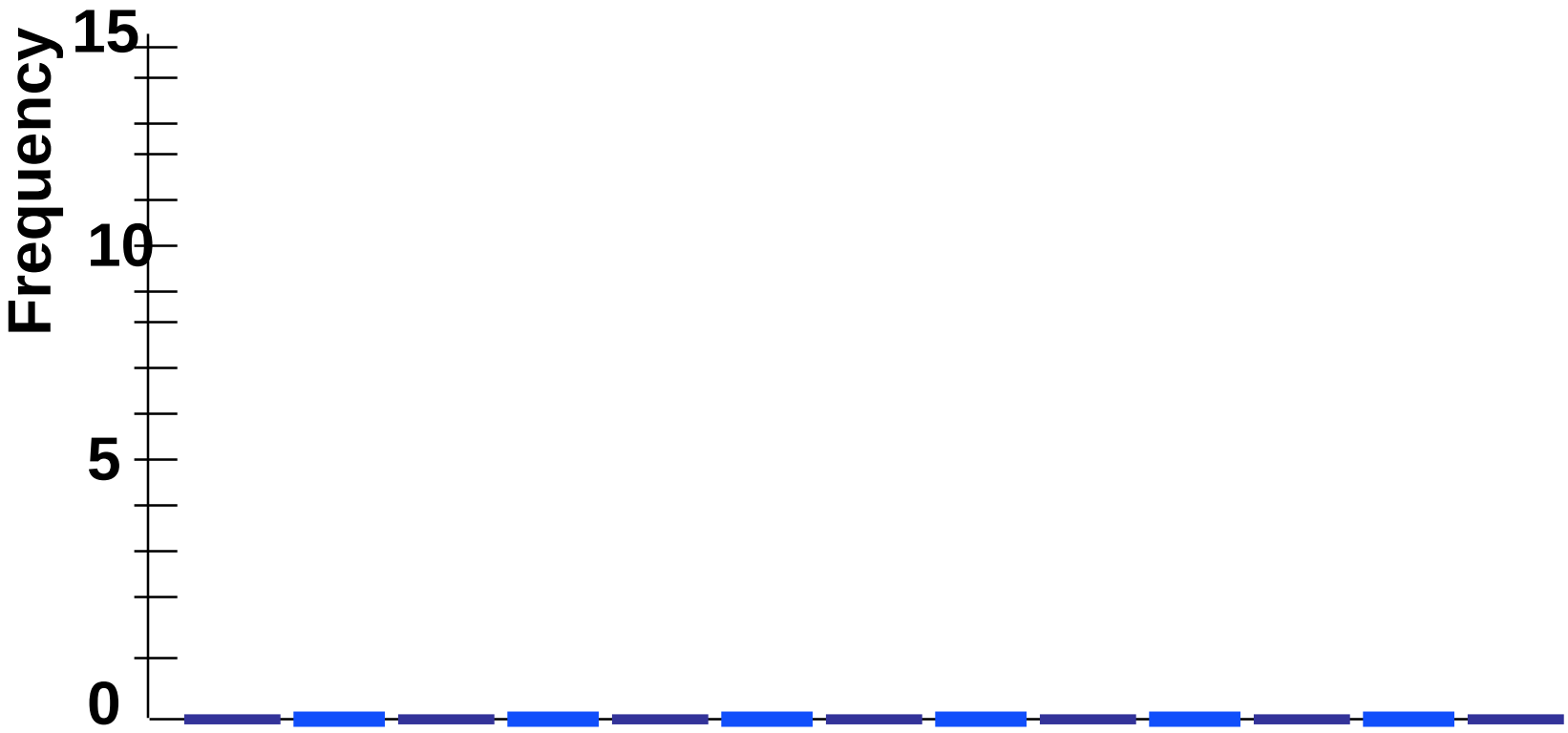
4. Determine bar width; keep bar width equal.
   - Look at range of data. Subtract lowest from highest number in data set.
   - _____ =
   - Divide the range by the number of bars you determined to use.
   - _____ =
   - Round to an easy number to work with.
   - _____

5. Design the bars so that a data point **can not possibly** be in two bars.

6. Create a frequency table to determine which bar will have the most data in it.
7. Set up your graph
   - –Label your graph with frequency on vertical and scale it to go a little higher than your highest bar.
   - –Label what you are measuring (the classes or bars) across the horizontal.

Frequency Plot Example: # M&Ms in a Package

Operational Definition



Bars = # M&Ms

Frequency Plot: How Is It Made?

1. Get a good, clear question.
2. Get data to answer that question.
3. Decide upon the **number of classes** (bars) and bar size,

6 to 15 bars seems to work best.

Number of Data Points	Number of Bars (classes)
Under 50	5-7
51-100	6-10
101-250	7-12
Over 250	10-20

4. Determine bar width; keep bar width equal.
   - Look at range of data. Subtract lowest from highest number in data set.
     - _____ =
   - Divide the range by the number of bars you determined to use.
     - _____ =
   - Round to an easy number to work with.
     - _____

5. Design the bars so that a data point **can not possibly** be in two bars.

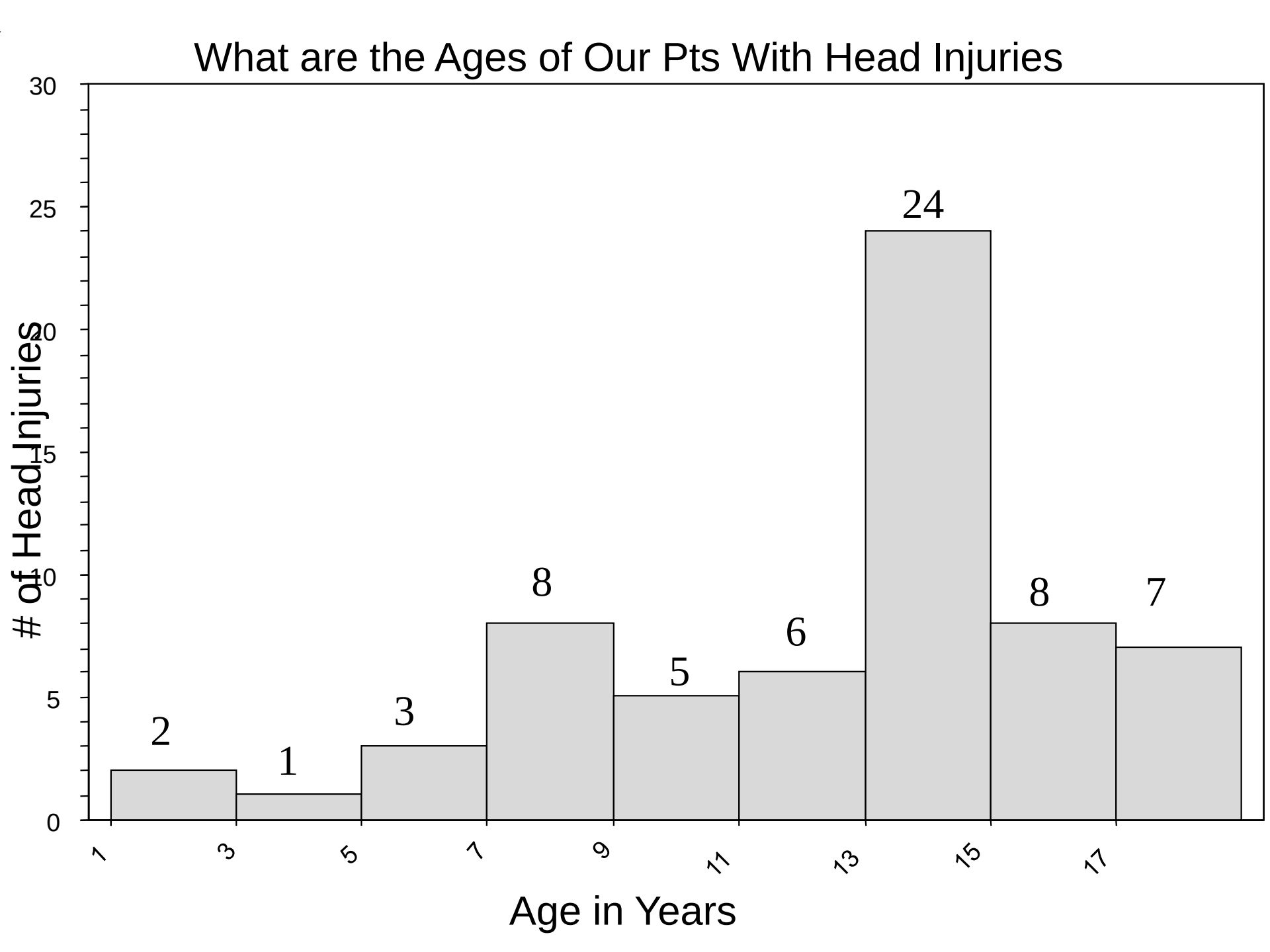
6. Create a frequency table to determine which bar will have the most data in it.
7. Set up your graph
   - –Label your graph with frequency on vertical and scale it to go a little higher than your highest bar.
   - –Label what you are measuring (the classes or bars) across the horizontal.

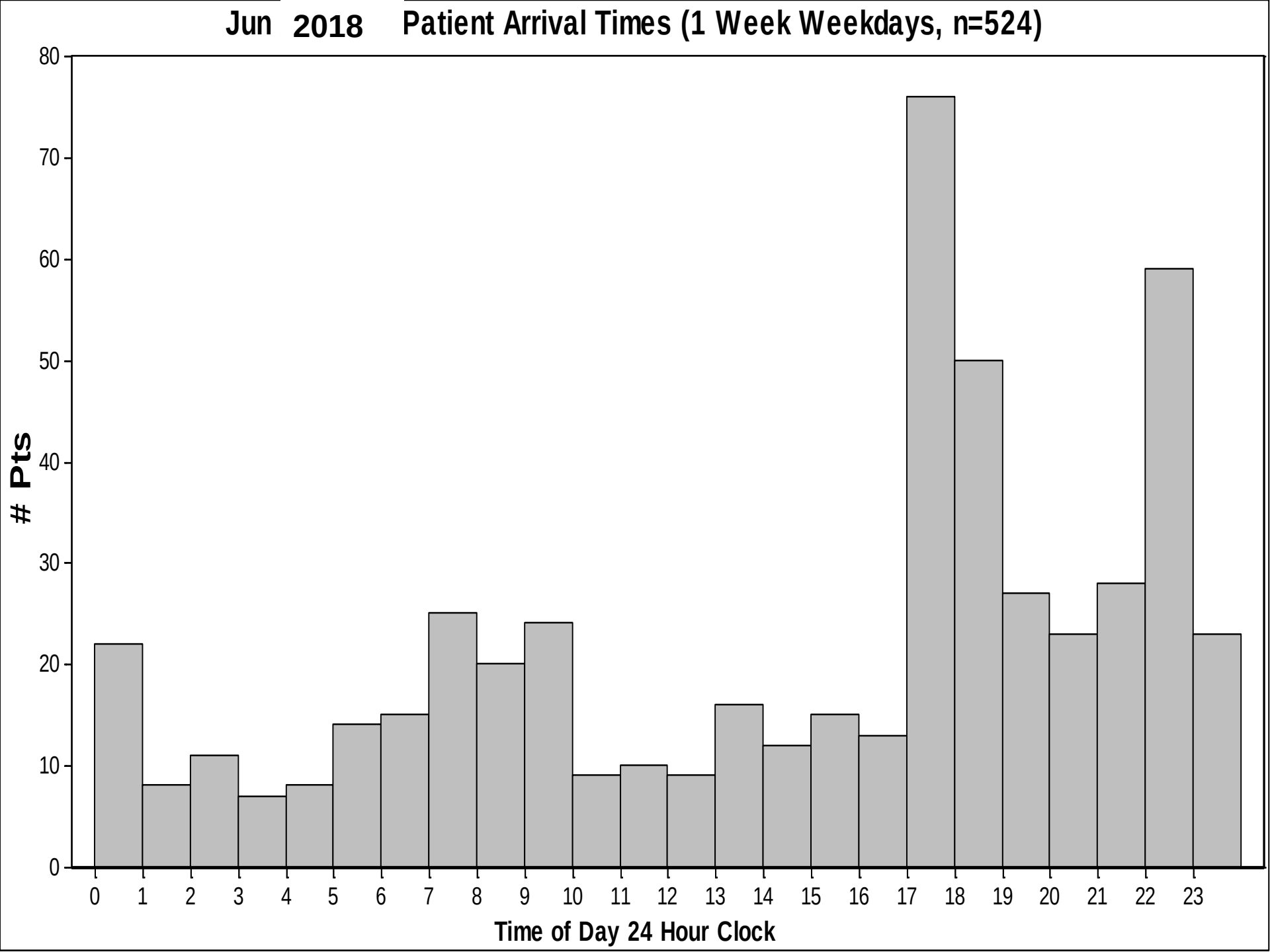
8. Plot the data by drawing a rectangle above the correct bar when that data point occurs. Put any data you need to save inside the rectangle (i.e., provider #).

9. Study the shape, spread, center.

How Is Histogram Interpreted?

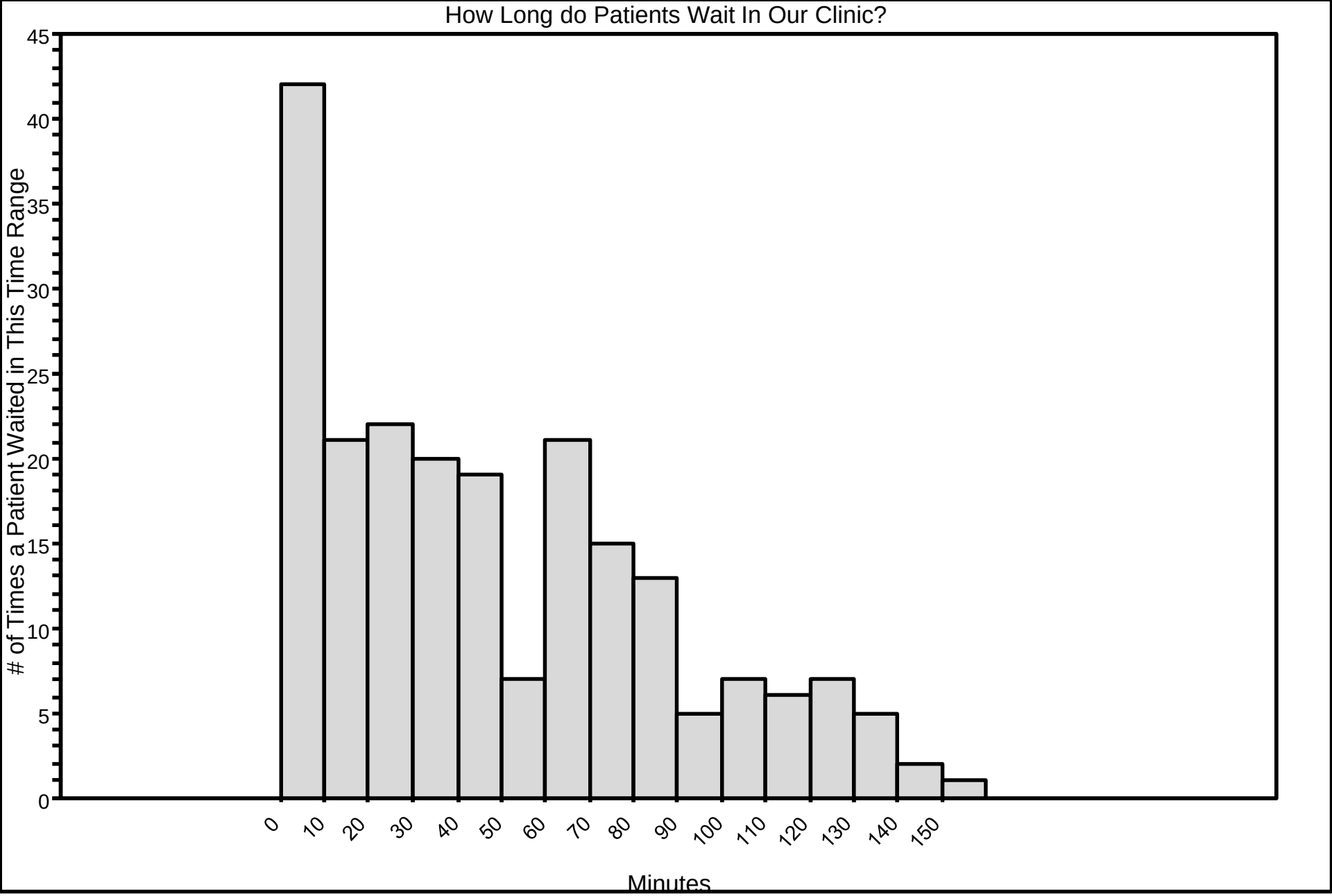
- Evaluate **central location**
- Evaluate spread
- Learn from shape


What are the Ages of Our Pts With Head Injuries
# of Head Injuries
0
5
10
15
20
25
30
2
1
3
8
5
6
24
8
7
1
3
5
7
9
11
13
15
17
Age in Years


Jun 2018 Patient Arrival Times (1 Week Weekdays, n=524)
Pts
0
10
20
30
40
50
60
70
80
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time of Day 24 Hour Clock

How Is It Interpreted?

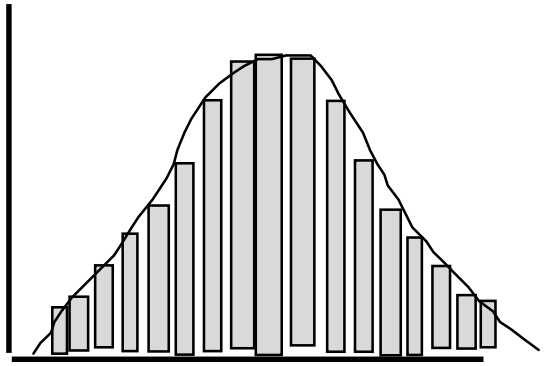
- Evaluate central location
- Evaluate **spread**
- Learn from shape


How Long do Patients Wait In Our Clinic?
# of Times a Patient Waited in This Time Range
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Minutes

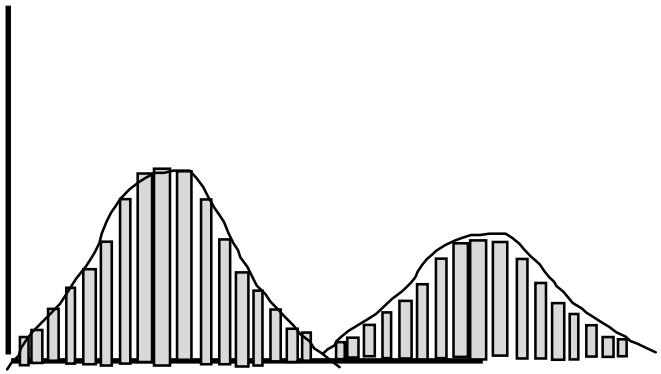
How Is It Interpreted?

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

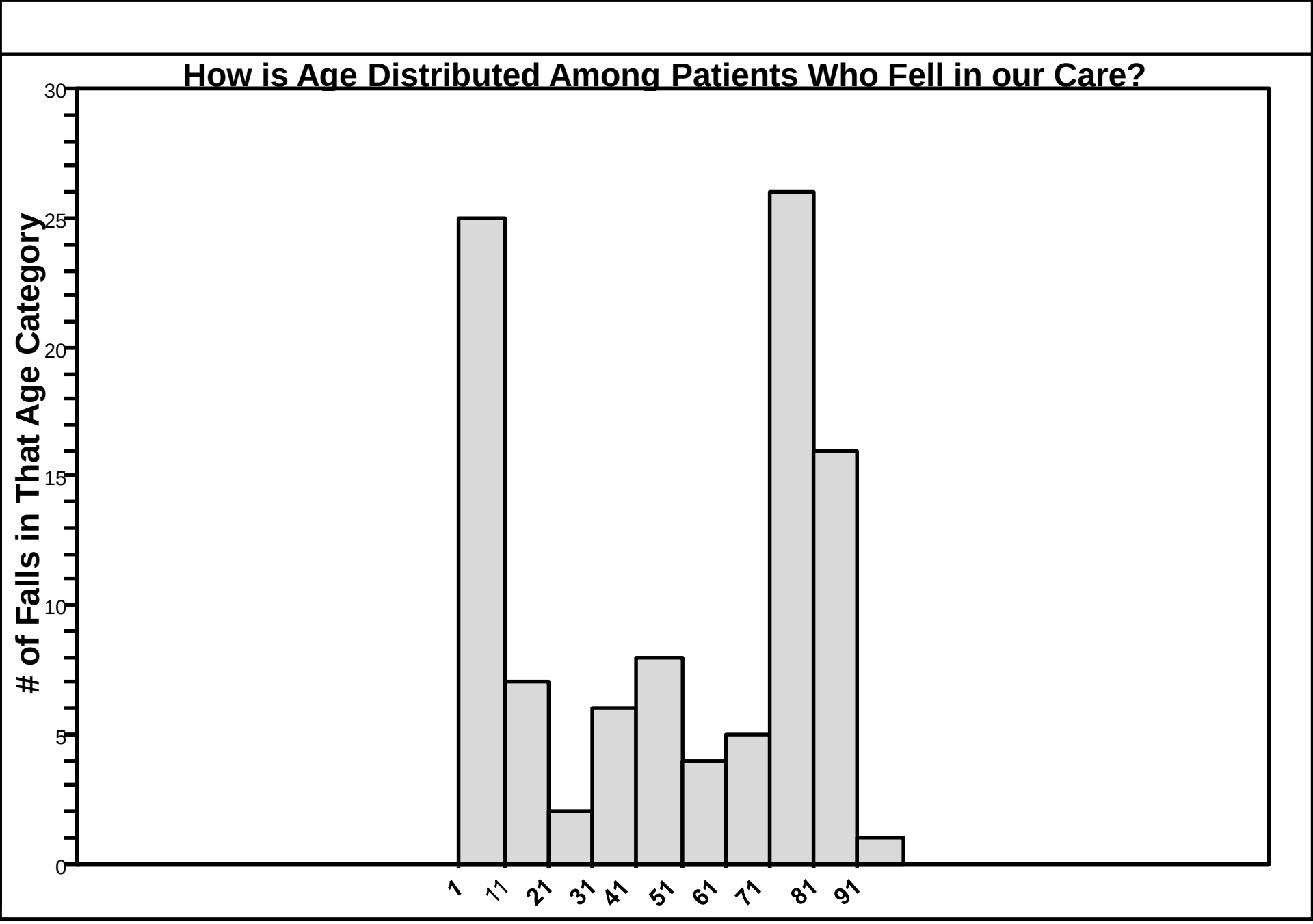
Common Frequency Plot Shapes



Symmetrical
- **normal distribution**



Bimodal
- **two peaks**
- **data from two processes**
- **separate and analyze each**


How is Age Distributed Among Patients Who Fell in our Care?
# of Falls in That Age Category
30
25
20
15
10
5
0
1
11
21
31
41
51
61
71
81
91

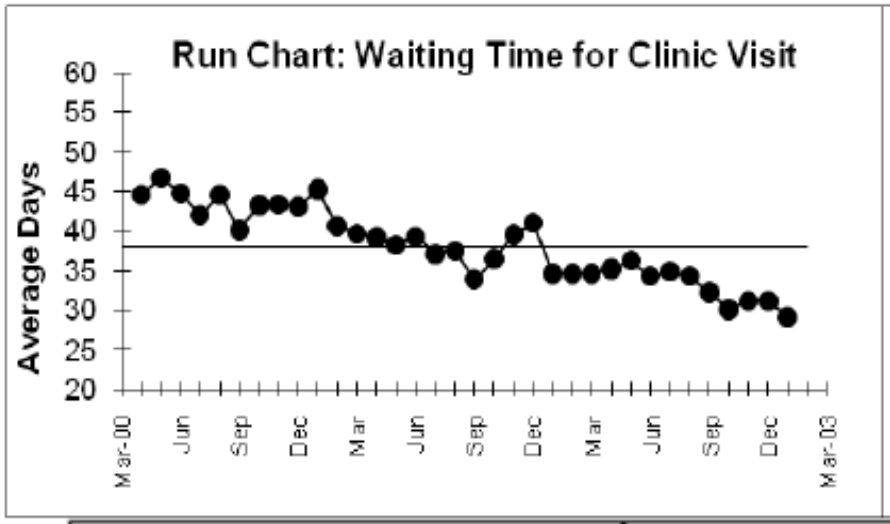
Frequency Plot (Histogram): What Is It?

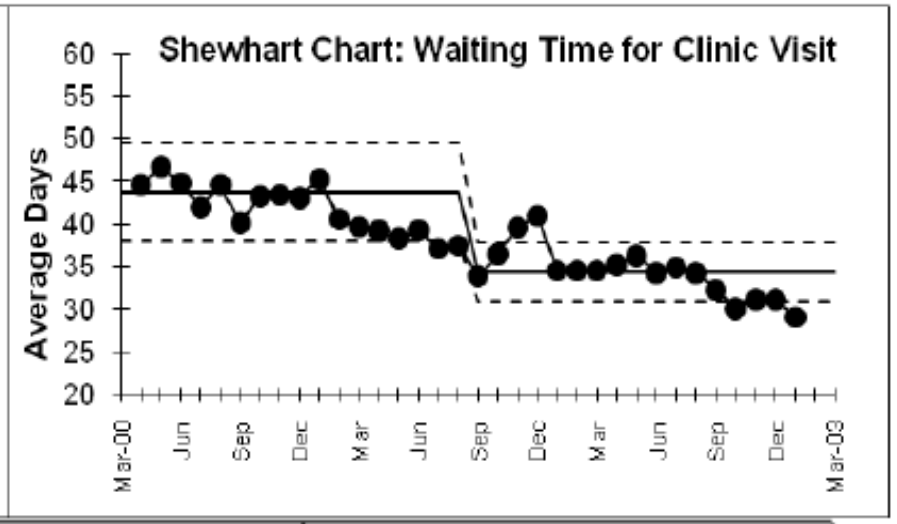
- **A bar chart for <u>one variable</u>**
- **Used to visualize central location, shape and spread of the data**
- **Each bar <u>equal</u>, each <u>distinct</u>**
- **Most often used with time, money, throughput or a scaled measurement (i.e. dollars, weight, age, height,)**
  - Frequency Plot does little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

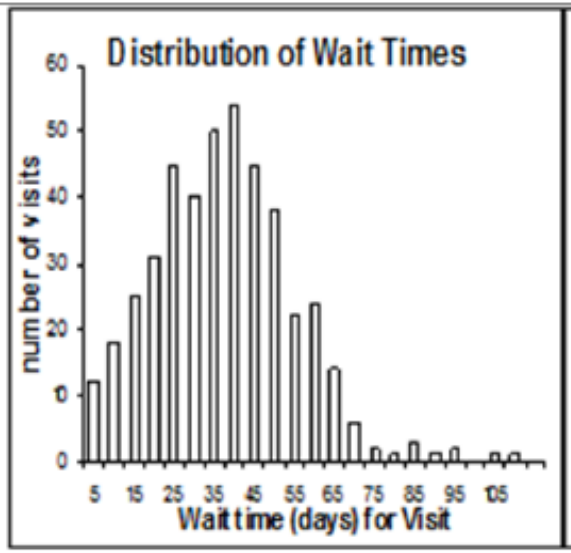
Histogram…Using Excel

- Make sure you have Analysis ToolPak activated in your version of excel
- Decide on your histogram data
- **Decide what you want the cells—Bins—to be and type them in a column you title BINS (must be numeric)**
  - **E.g. 60, 65, 70, 75, 80, 85 etc.**
- Go to Data tab….Select Data Analysis
- Select Histogram
- Select data…select bins…select output by clicking somewhere on excel worksheet…check chart output
- Highlight graph and check out Format tab
  - Label well

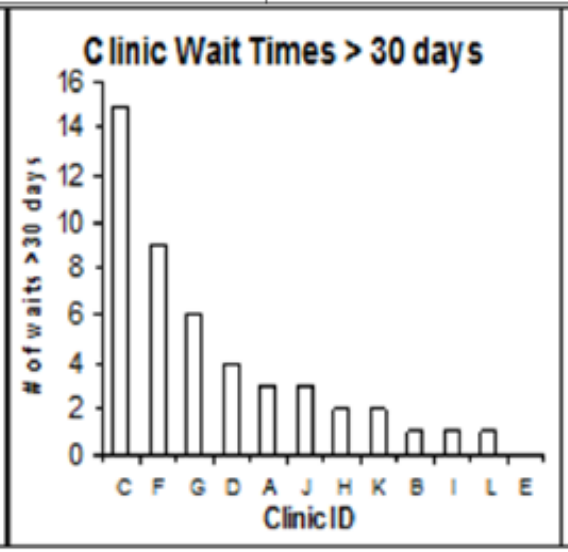
Tools to Learn from Variation in Data



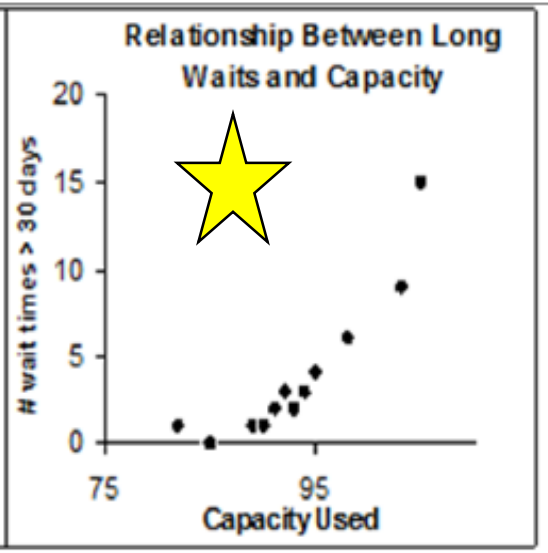




Frequency Plot



Pareto Chart



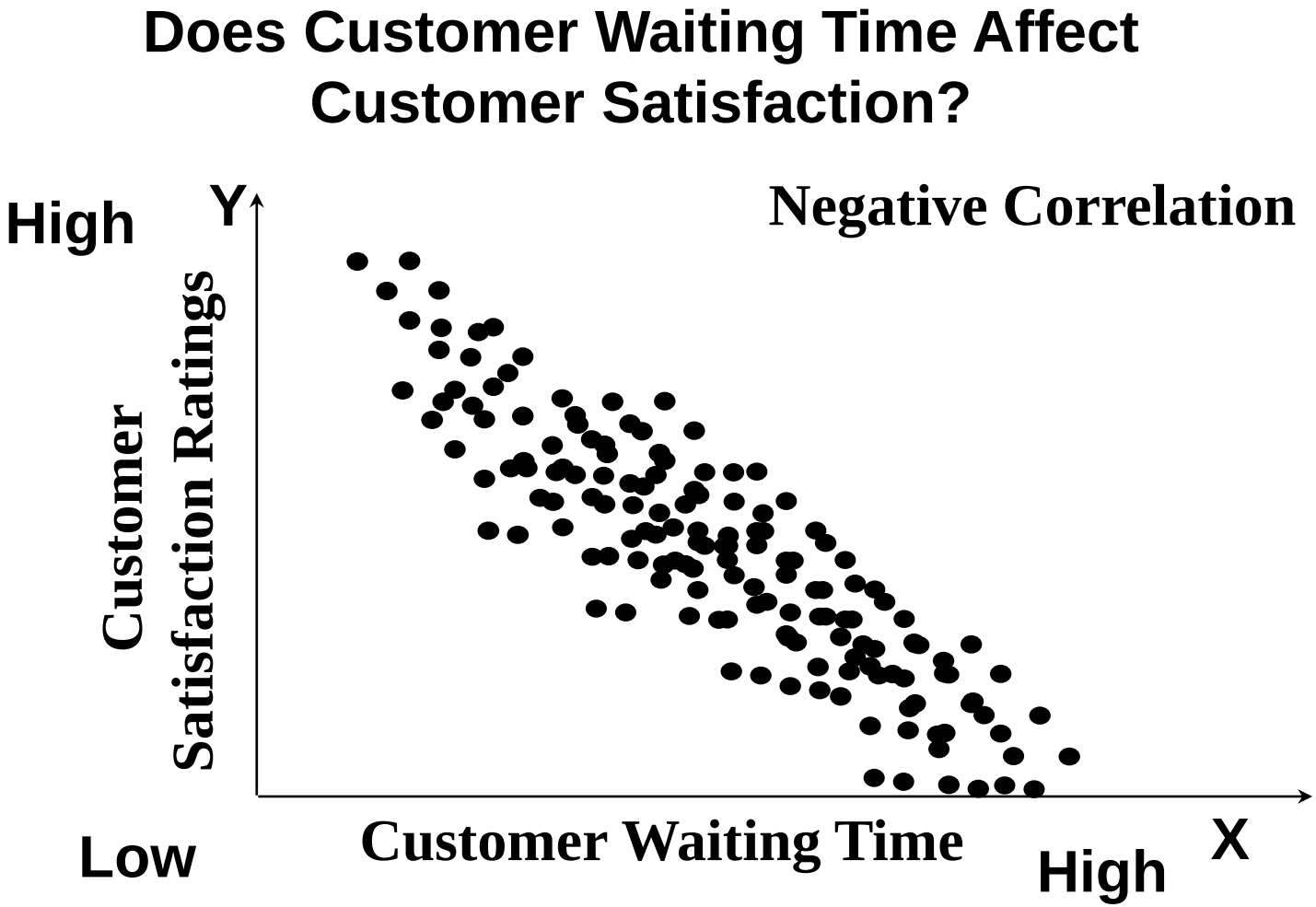
Scatter Plot

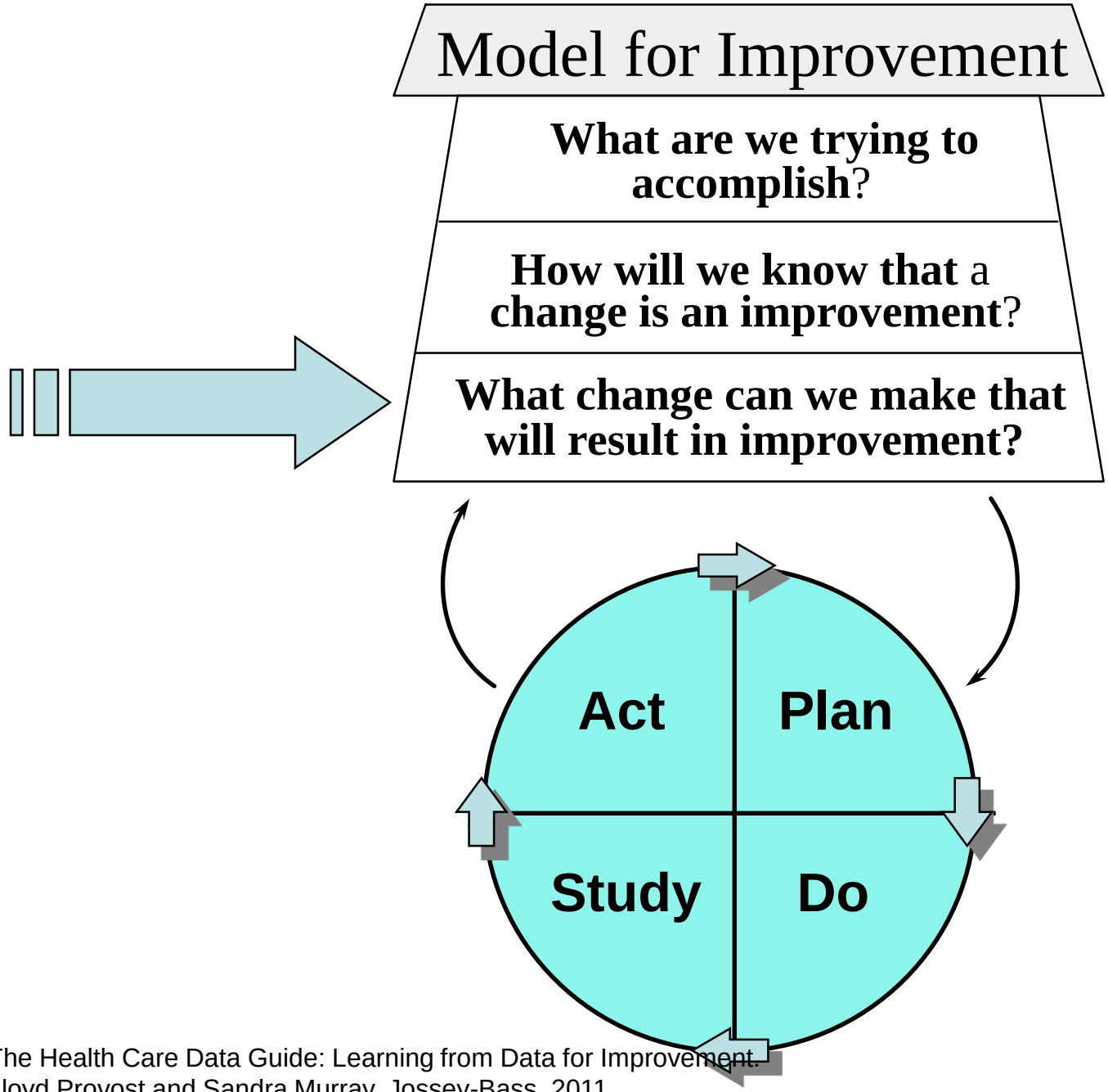
The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

SCATTER PLOT: What Is It?

- **Graph to evaluate theory about relationship between one variable and another**
  - Test for **possible** cause and effect
  - Does not **prove** a C & E relationship exists
  - A cause and effect relationship will be verified only when the improvement is tested and results studied using a control chart
- Each dot on the chart represents a pair of measures
- Becomes useful between 30-50 data points

SCATTER PLOT: What Does It Look Like?





The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

SCATTER PLOT: How To Make One

- Develop question
- Collect paired samples of data you believe related
  - (Min wait time for the patient, Satisfaction score from that patient)

Data for Scatter Plot : Does wait time impact satisfaction with clinic?

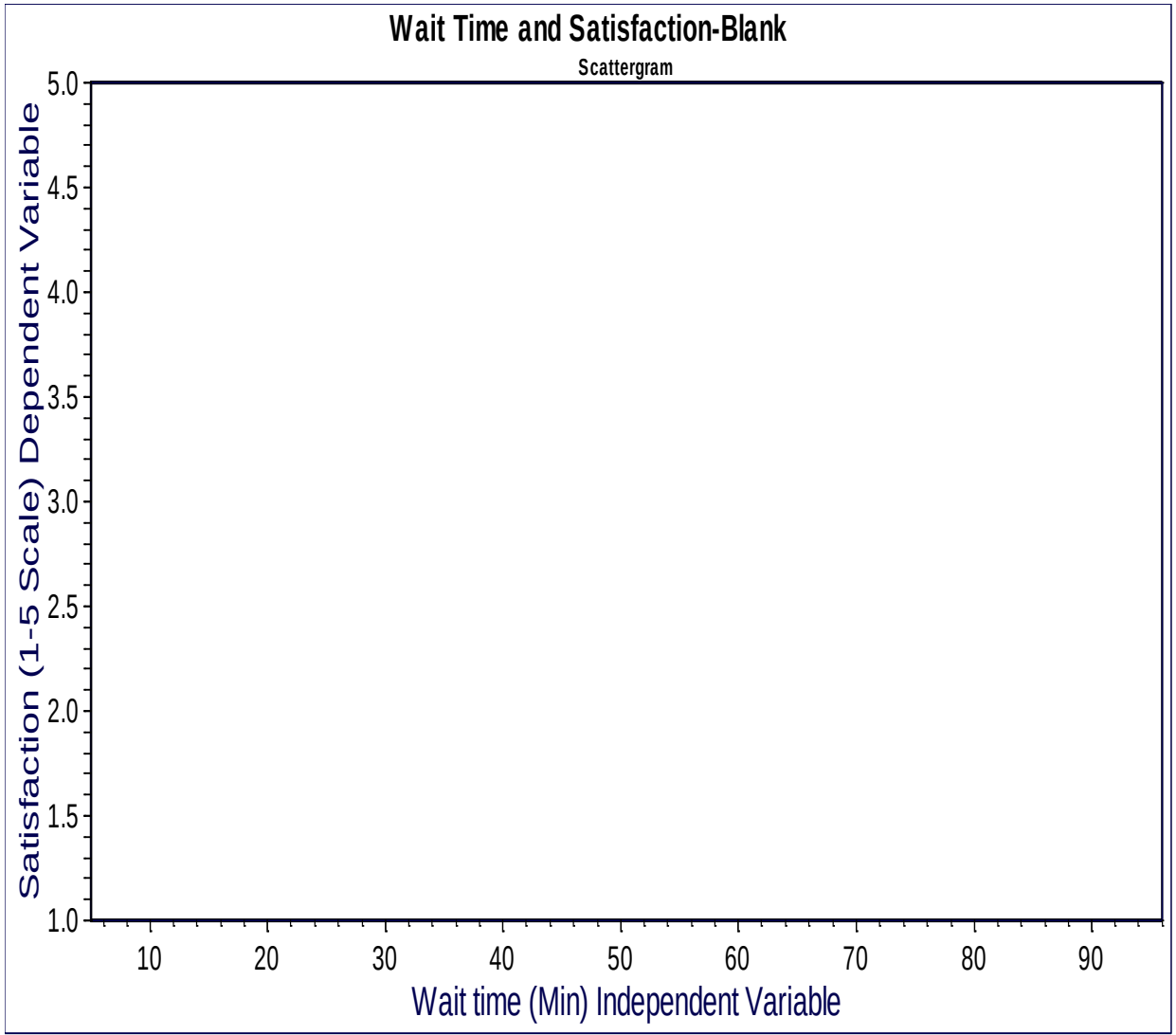
Min Wait	Sat Score		Min Wait	Sat Score		Min Wait	Sat Score
49	3.5		42	4		74	2
78	1		51	3.5		72	1.5
3	5		76	3		15	5
55	2.5		46	5		64	3.5
15	4		83	2		17	4
28	3		31	5		91	2
96	1.5		60	2		10	4.5
47	3		85	2.5		5	5
15	3.5		70	1.5		9	4
82	1		5	5		71	1.5
24	4		50	3		7	5
68	3		74	2		55	3
64	1		21	4.5		74	2.5

SCATTER PLOT: How To Make One

- Develop question
- Collect paired samples of data you believe related
  - (15 Telephone Orders, Prop. Late Meds. .005)
- Draw Graph
  - **Independent** Variable on **X Axis** (Horizontal)
  - **Dependent** Variable on **Y Axis** (Vertical)
    - Values higher as go up on graph
    - Start with actual lowest value in your data set

Draw Graph

- **Independen**t Variable on X Axis (Horizontal)
- **Dependen**t Variable on Y Axis (Vertical)
  - Values higher as go up on graph
  - Start scale with actual lowest value in your data set

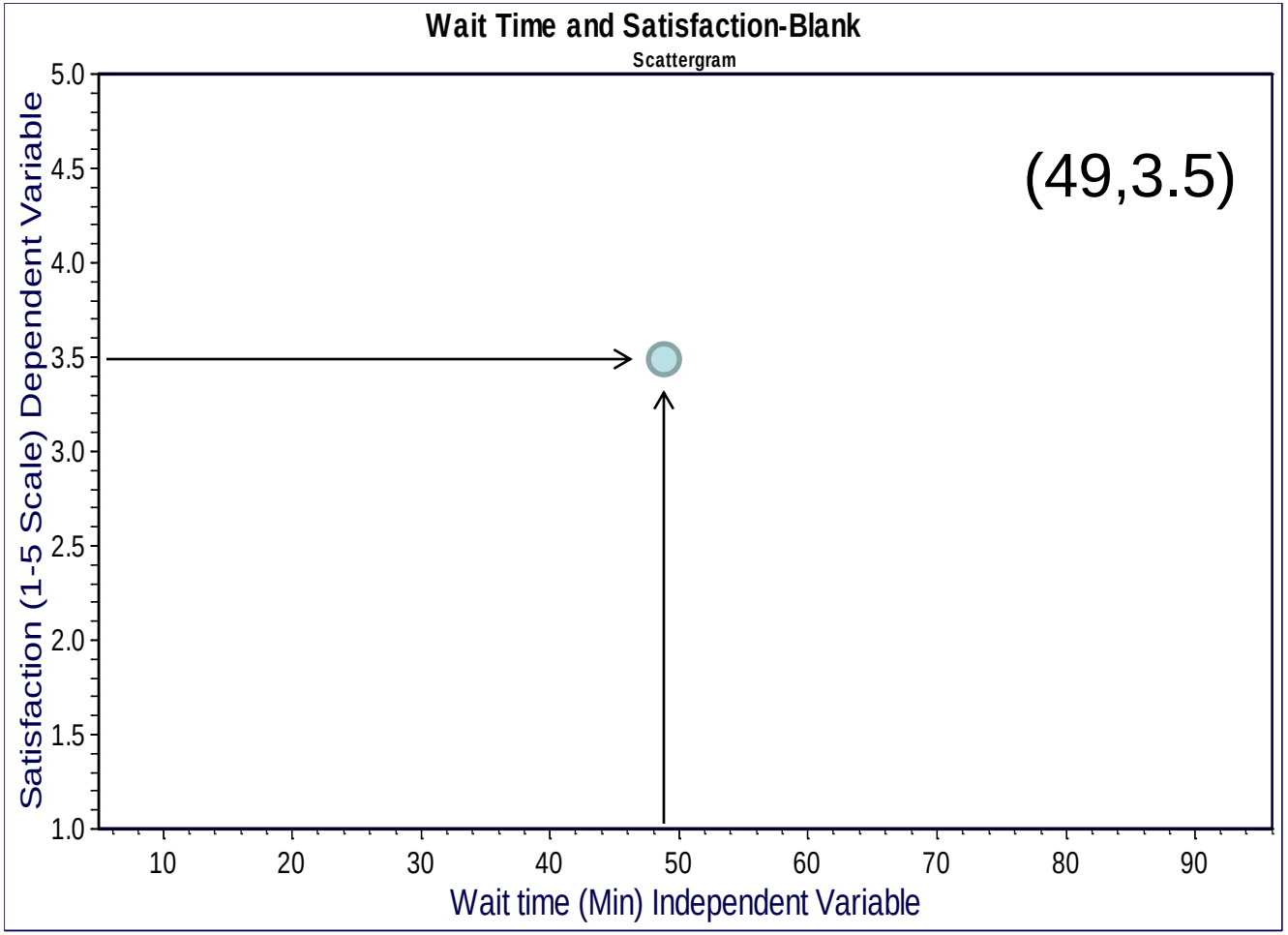


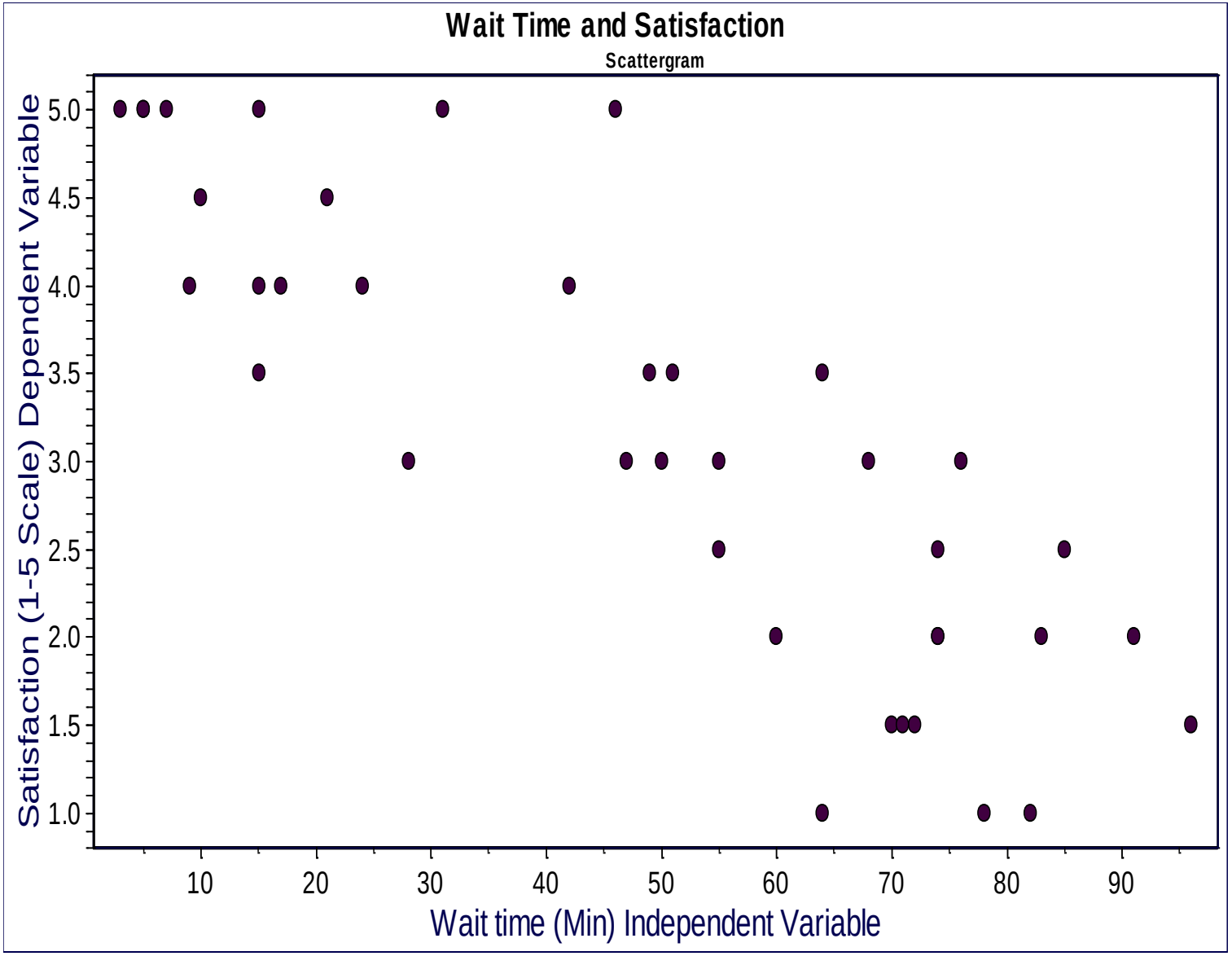
SCATTER PLOT: How To Make One

- Develop question
- Collect paired samples of data you believe related
  - (49 min wait time, satisfaction score)
- Draw Graph
  - Independent Variable on X Axis (Horizontal)
  - Dependent Variable on Y Axis (Vertical)
    - Values higher as go up on graph
    - Start with actual lowest value in your data set
- Plot Data on Graph
  - Go over on X axis until find value for X
  - Then go up on Y axis until find value for Y
  - Draw dot where two values meet
- Analyze Graph

Draw Graph

- **Independen**t Variable on X Axis (Horizontal)
- **Dependen**t Variable on Y Axis (Vertical)
  - Values higher as go up on graph
  - Start scale with actual lowest value in your data set

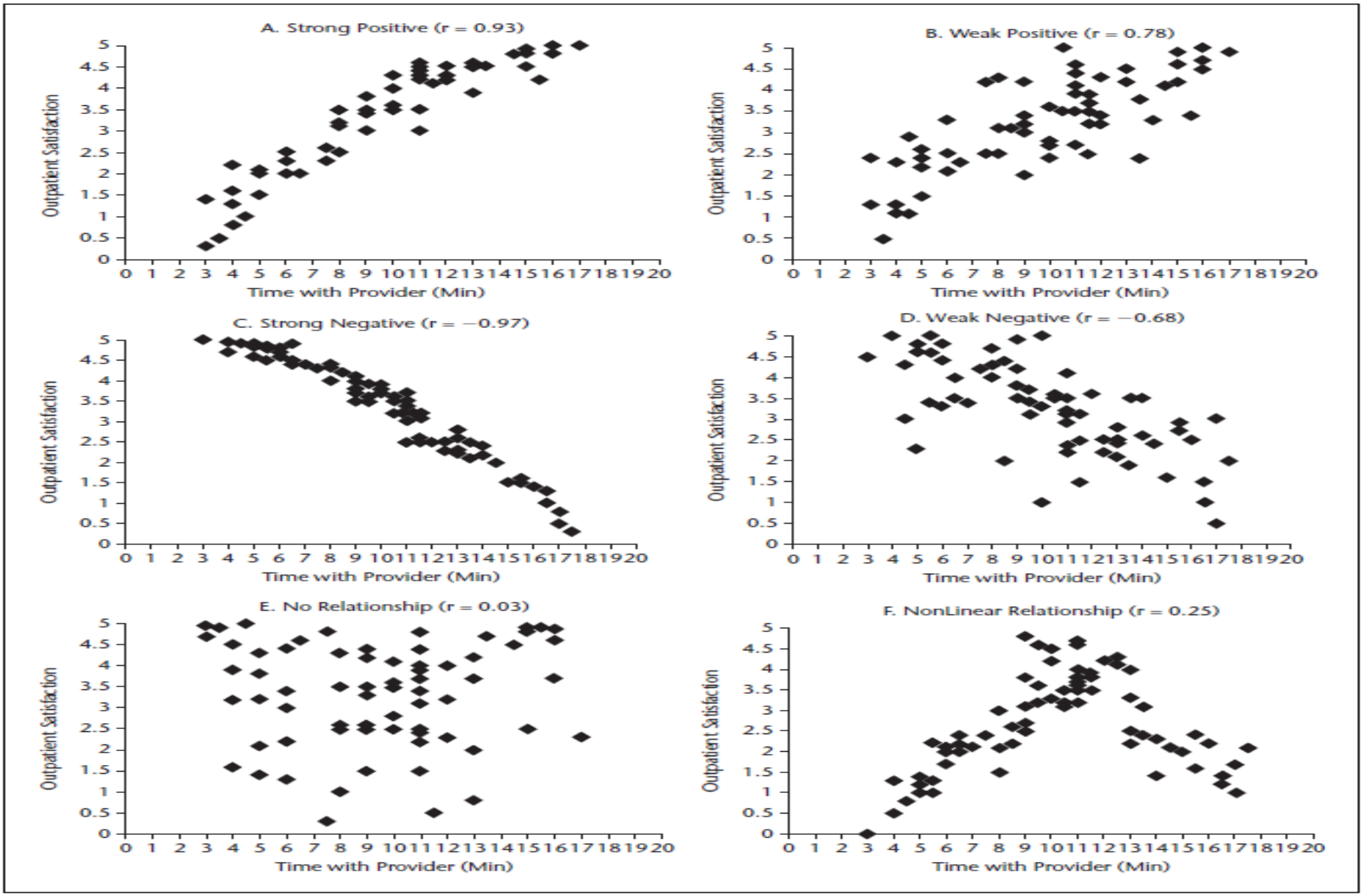



Wait Time and Satisfaction
Scattergram
Satisfaction (1-5 Scale) Dependent Variable
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
10
20
30
40
50
60
70
80
90
Wait time (Min) Independent Variable

How Is It Interpreted?

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

FIGURE 4.40 Interpreting Patterns on the Scatter Plot

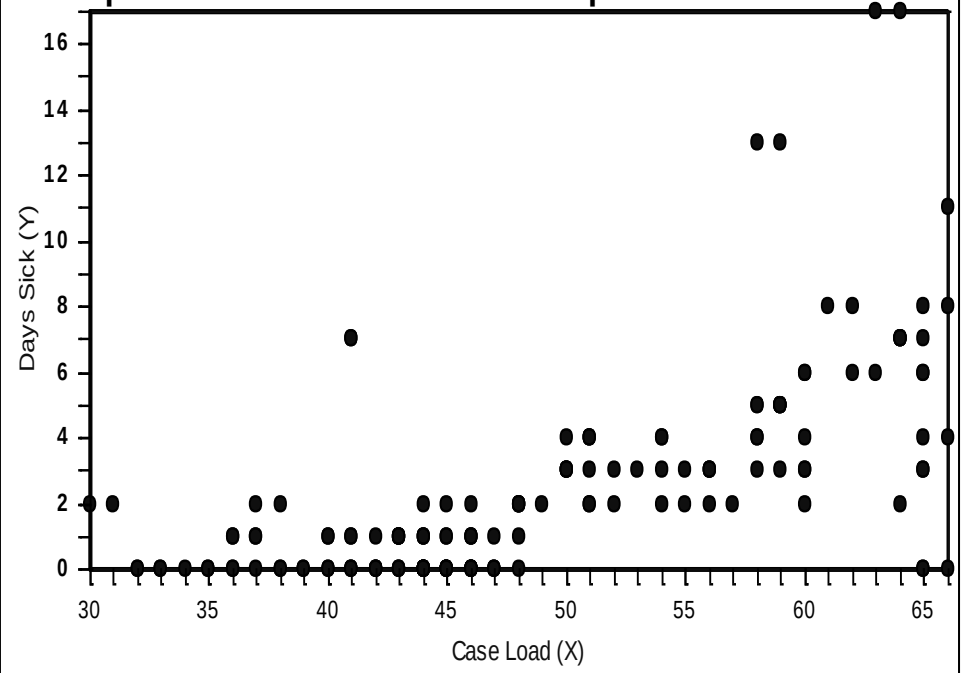


The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

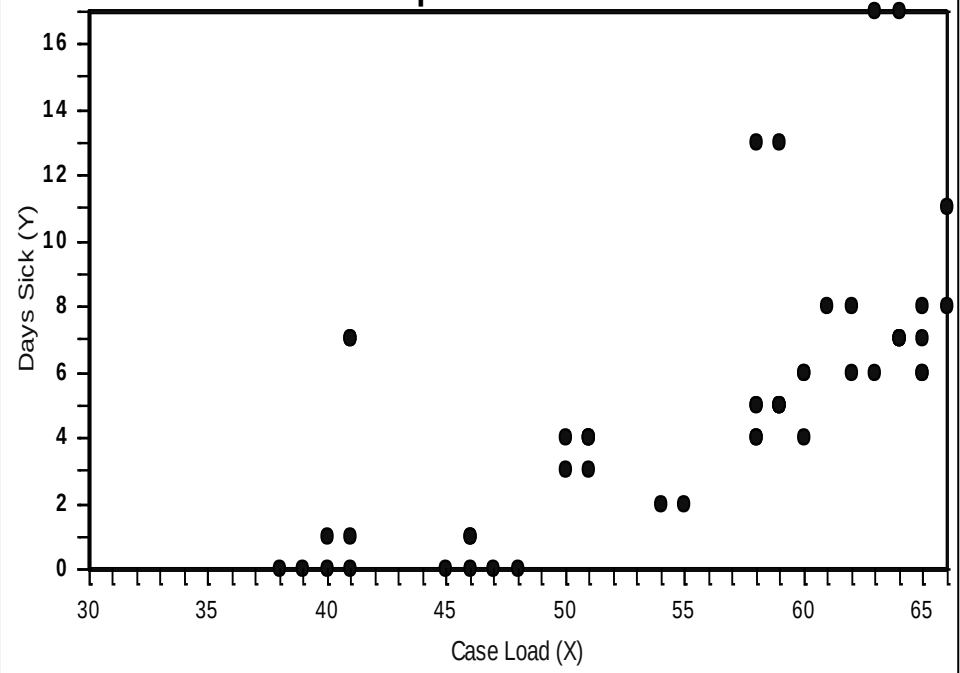
How Is It Interpreted?

- Outliers
  - Points that do not fall into the pattern of the others
  - Do not cluster with other points
    - Should investigate why appear
    - May be a measurement error
    - Possible may be a signal of a process change
    - Possible may be change in relationship between the factors

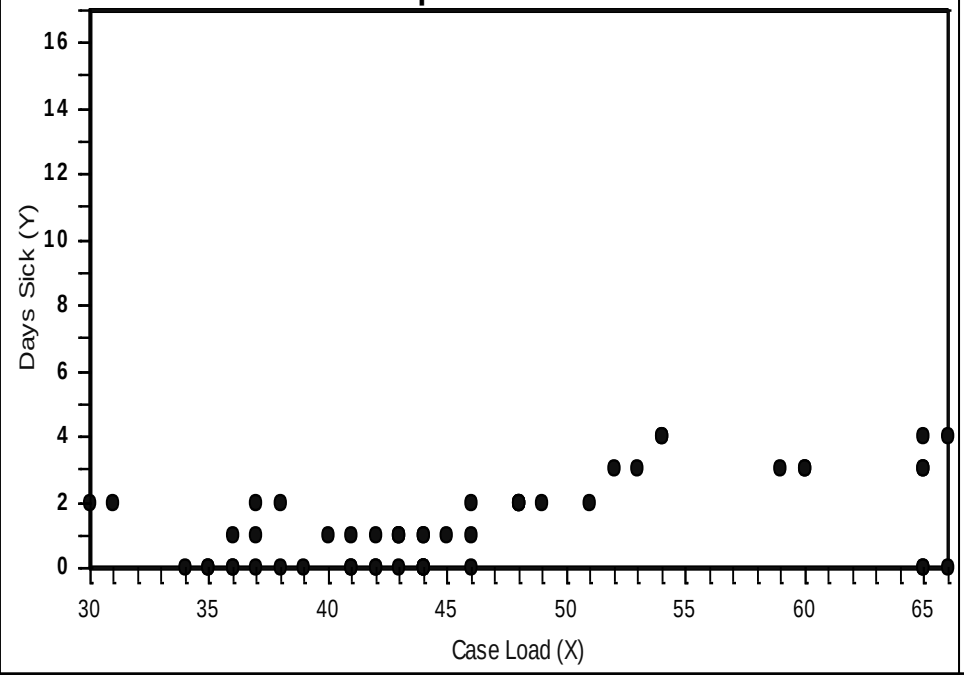
All Departments: Does Case Load Impact Sick Leave Use?



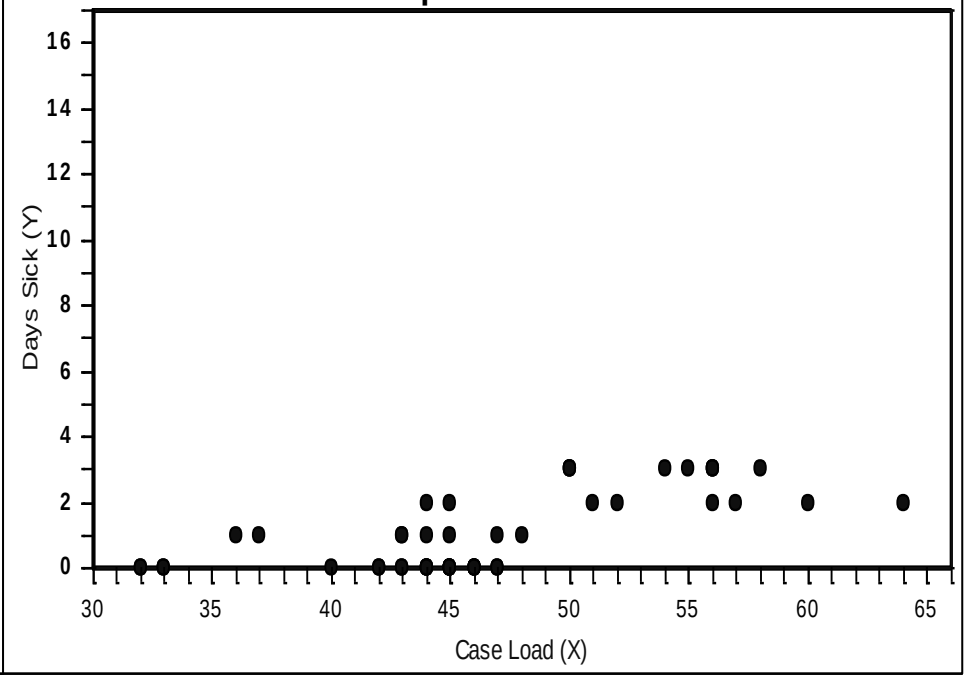
Department A



Department B



Department C



SCATTER PLOT: What Is It?

- **Graph to evaluate theory about relationship between one variable and another**
  - Test for **possible** cause and effect
  - Does not prove a C & E relationship exists
  - A cause and effect relationship will be verified only when the improvement is tested and results studied using a control chart
- Each dot on the chart represents a pair of measures
- Becomes useful between 30-50 data points

Scatter Plot…Using Excel

- Select and highlight two columns of data you believe may have relationship
  - **Tip: have data you believe is Independent variable (on X axis) in first column. Dependent Variable data (Y axis data) in second column**
- Go to Insert tab and select scatter plot
- Check to see if X axis is Independent Variable you intended!
  - If not highlight chart and chose “select data” to edit the data you want on the X and y axis—or rebuild
- Highlight graph and check out Format tab
  - Label well so people know what the X and the Y axis represent

What is a Shewhart Chart

- A **statistical tool used to distinguish between variation in a measure due to common causes and variation due to special causes**
  - Plots a stream of data
  - Most often in time order
  - Includes center line
  - Uses formula to determine upper and lower 3 sigma limits

What does one look like??

Parts of a Shewhart Chart

FIGURE 4.3 Example of Shewhart Chart for Equal Subgroup Size

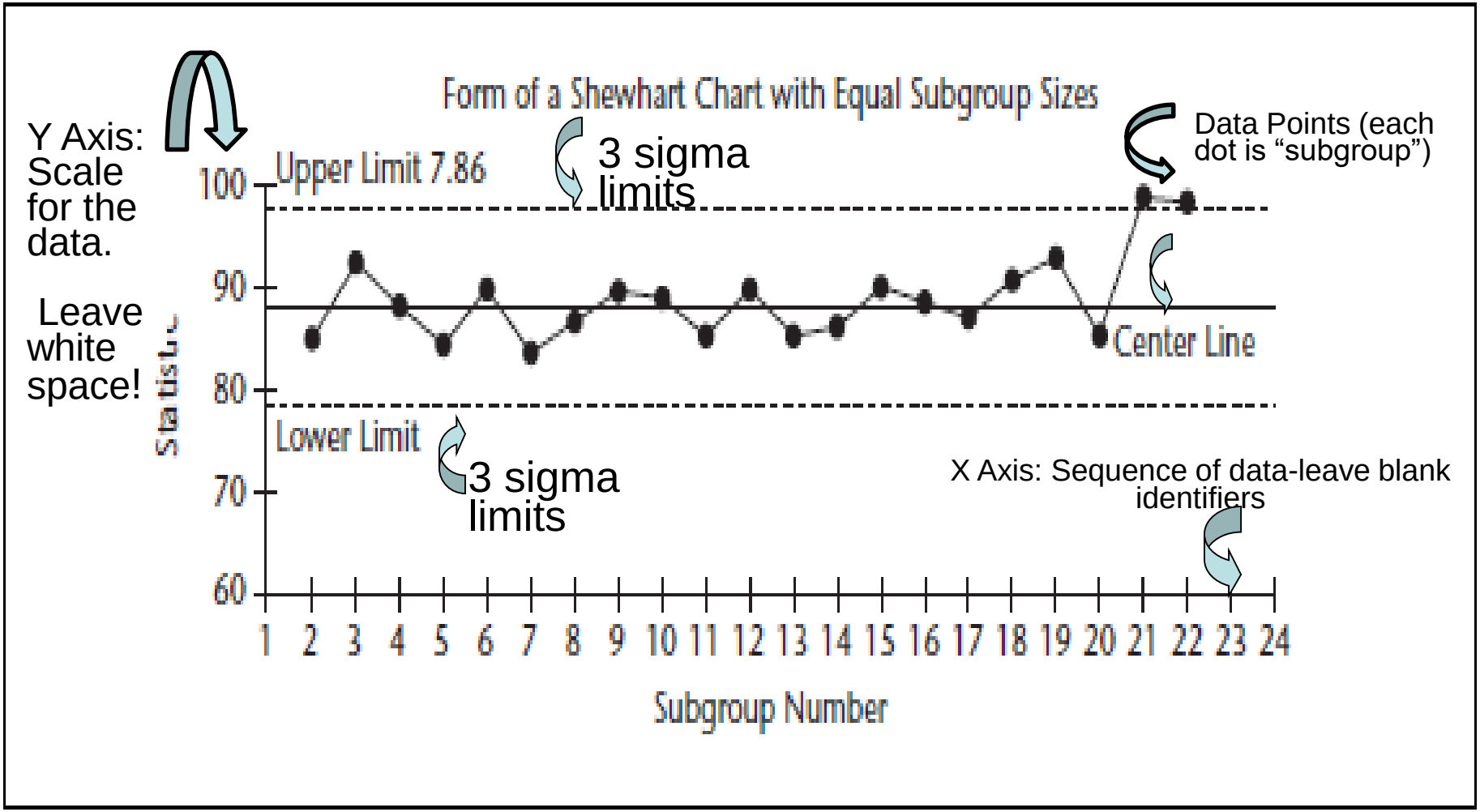
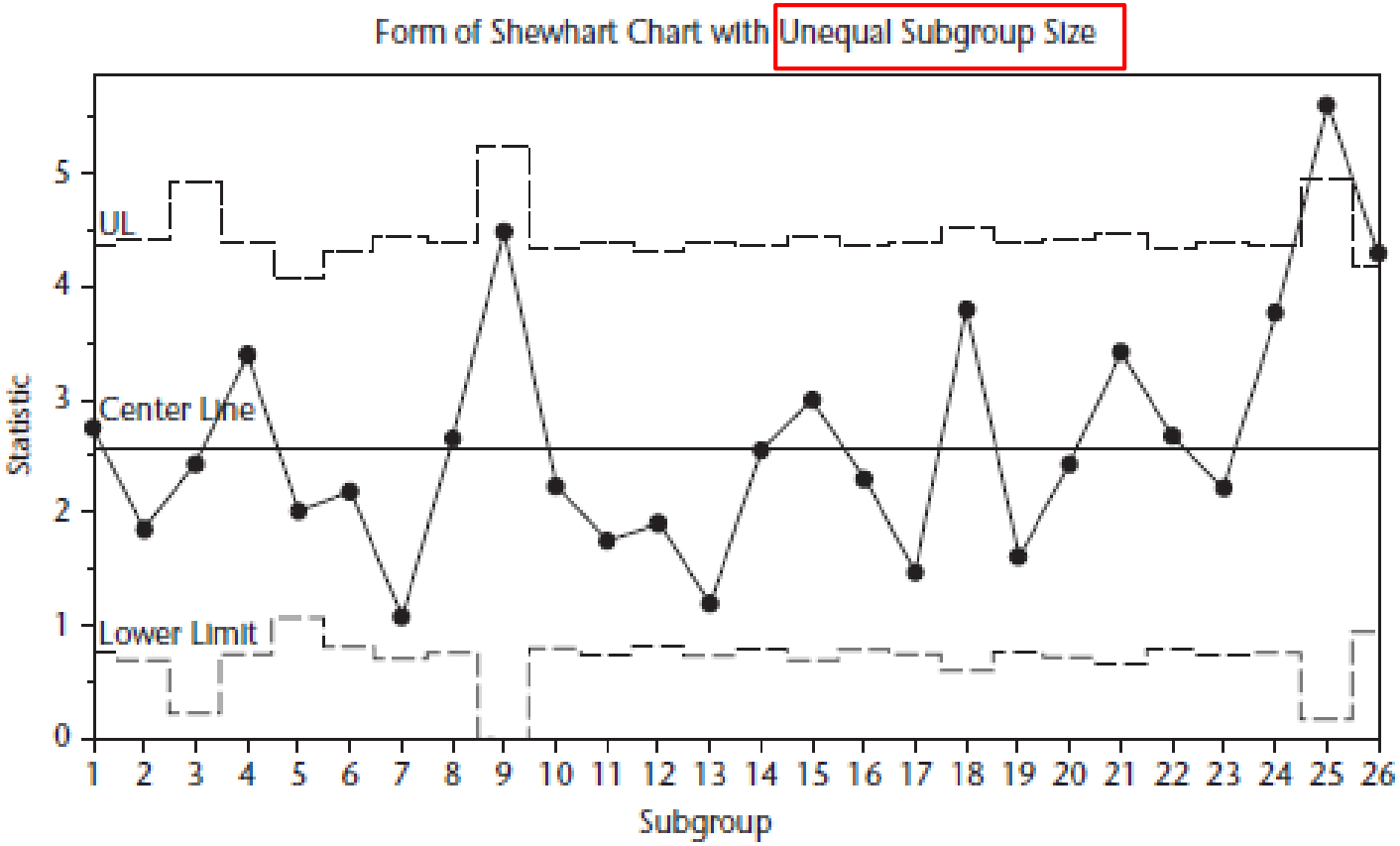


FIGURE 4.4 Example of Shewhart Chart for Unequal Subgroup Size



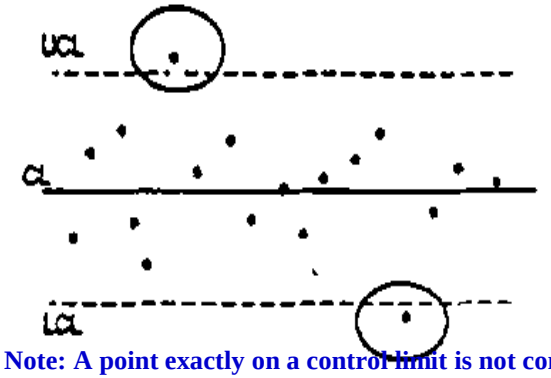
Shewhart Chart Allows us to Distinguish Types of Variation

- **Common Cause:** causes that are inherent in the process, over time affect everyone working in the process, and affect all outcomes of the process
  - *Process stable, predictable*
  - ***Action:*** *if in need of improvement must redesign process(es)*
  - ***If we are testing changes and see only common cause it means our changes have not yet resulted in improvement***

- **Special cause:** causes that are not part of the process all the time, or do not affect everyone, but arise because of special circumstances
  - *Process unstable, not predictable*
  - ***Action:*** *go learn from special cause and take appropriate action*
  - ***May be evidence of improvement (change(s) we tested working) or evidence of degradation of process/outcome***

Rules or detecting a special cause

1. A single point outside the control limits.

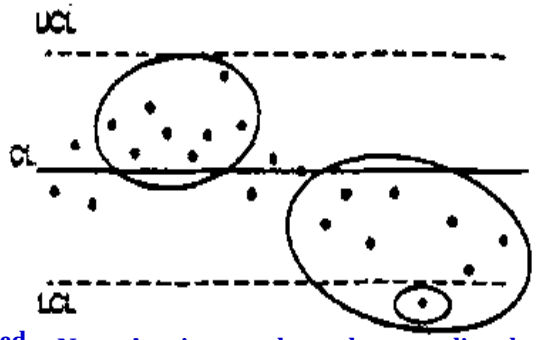


Note: A point exactly on a control limit is not considered outside the limit

When there is not a lower or upper control limit

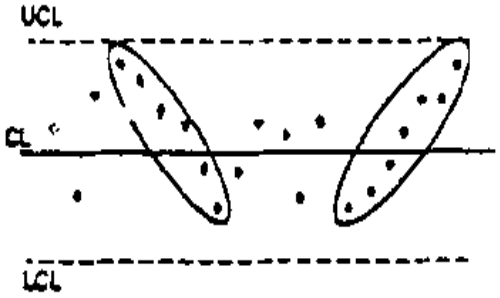
Rule 1 does not apply to the side missing limit

2. A run of eight or more points in a row above (or below) the centerline.



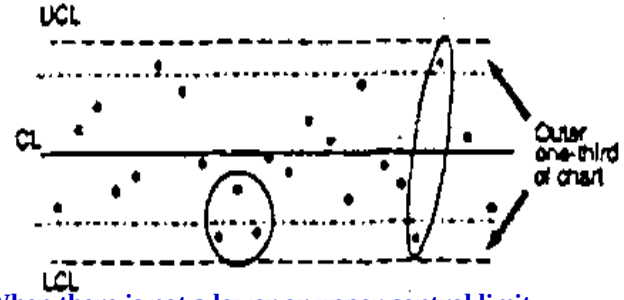
Note: A point exactly on the centerline does not cancel or count towards a shift

3. Six consecutive points increasing (trend up) or decreasing (trend down).



Note: Ties between two consecutive points do not cancel or add to a trend.

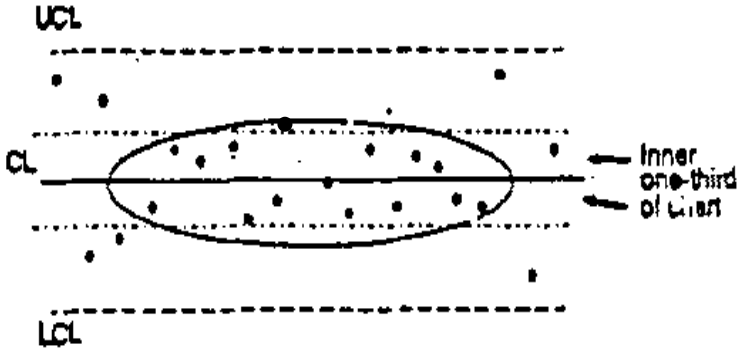
4. Two out of three consecutive points near (outer one-third) a control limit.



When there is not a lower or upper control limit

Rule 4 does not apply to the side missing limit

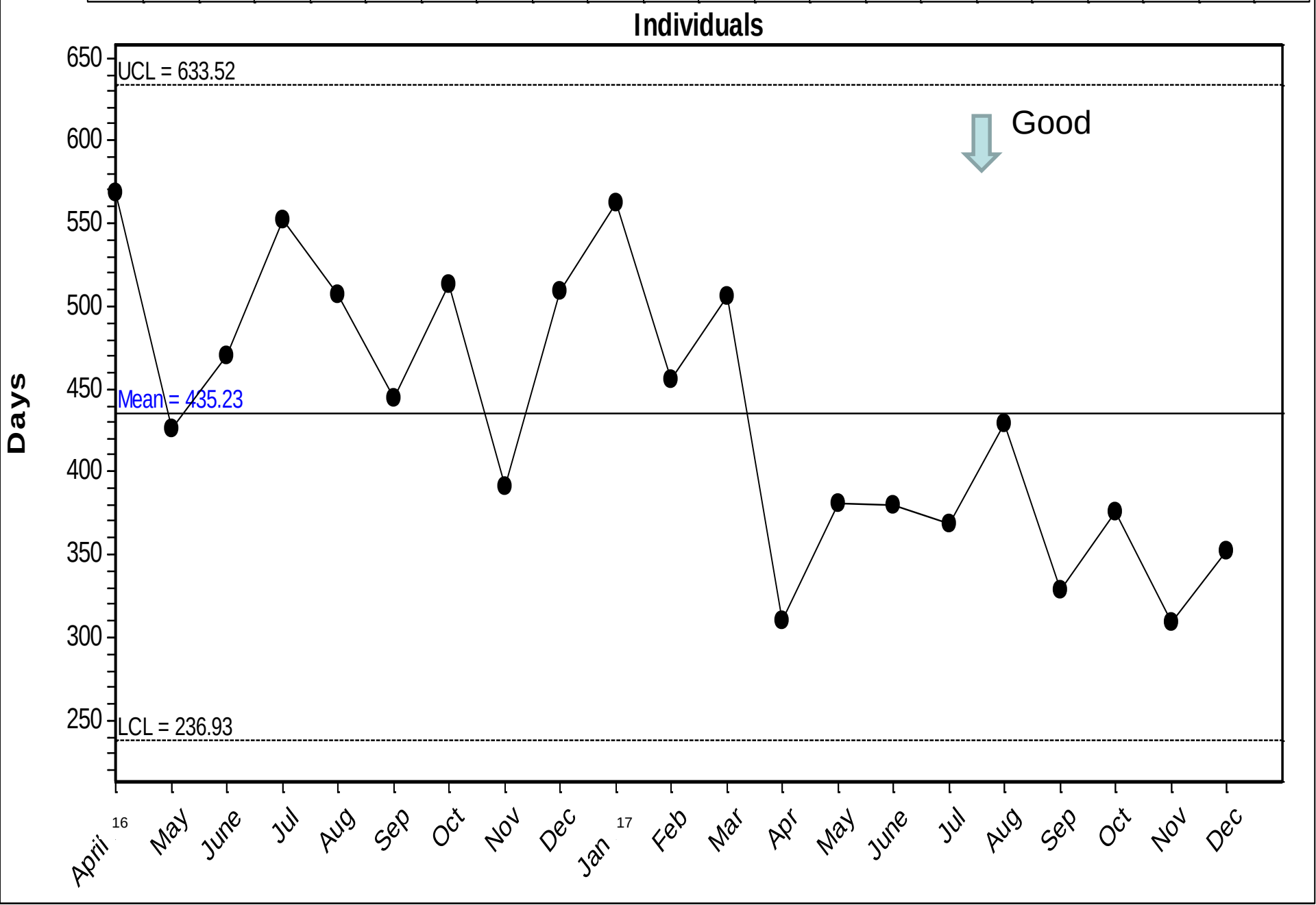
5. Fifteen consecutive points close (inner one-third of the chart) to the centerline.

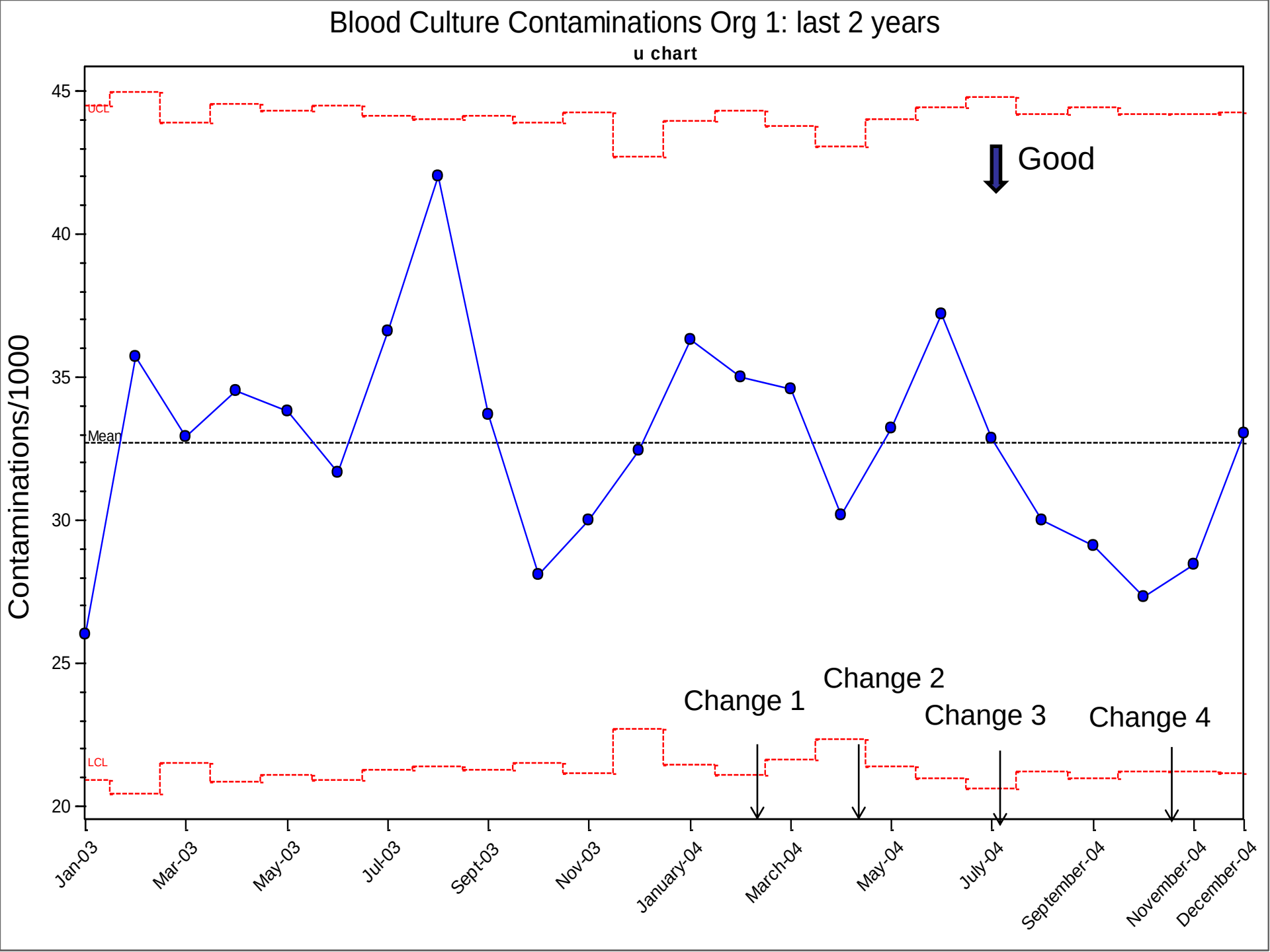


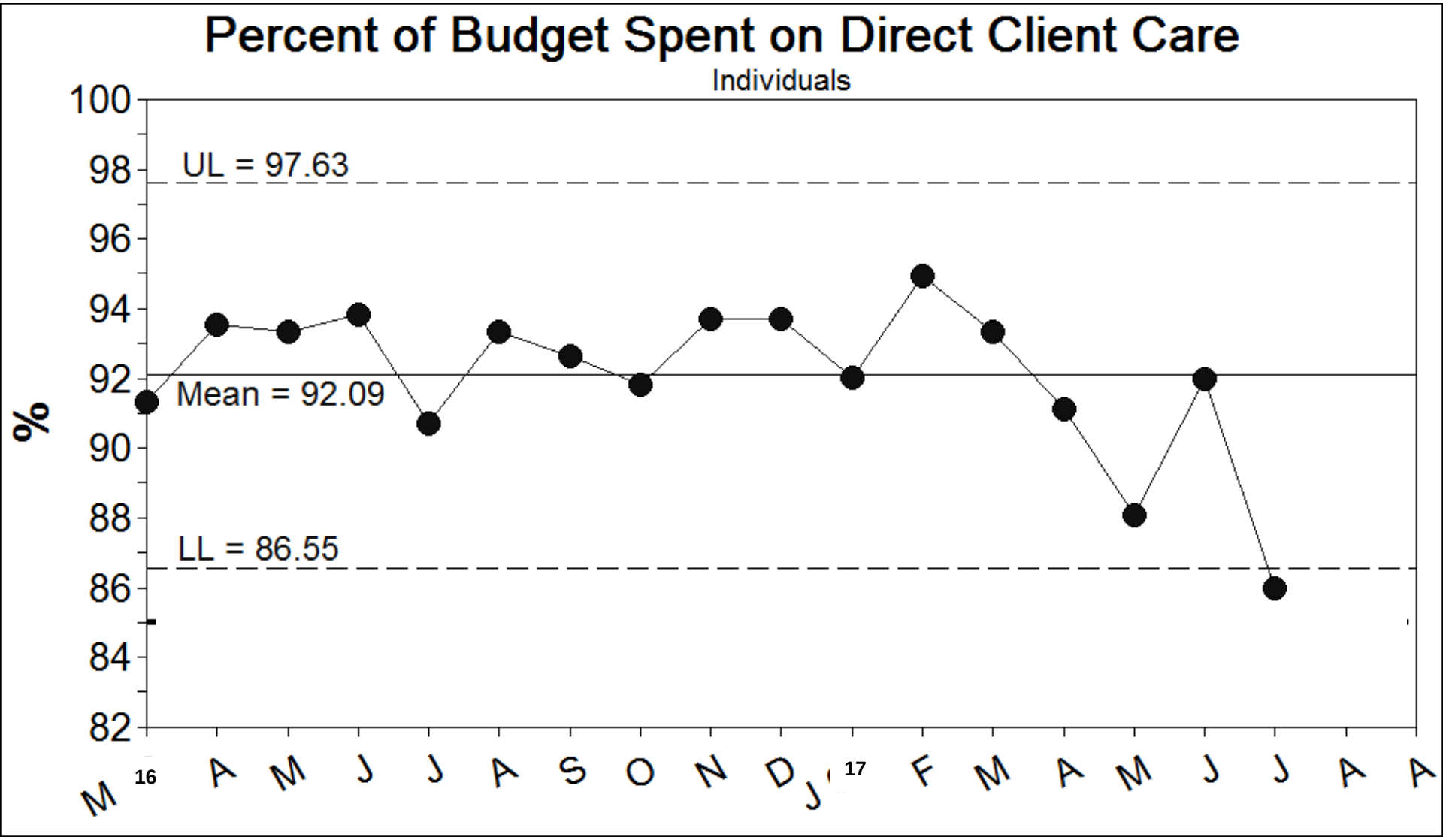
The Health Care Data Guide: Learning from Data for Improvement.
Lloyd Provost and Sandra Murray, Jossey-Bass, 2011.

Long Stay Low Average LOS

Days	568.2	426.0	470.2	551.8	506.9	444.0	513.0	391.2	509.4	562.2	456.1	506.1	309.9	381.0	380.1	368.1	429.1	328.5	375.6	309.4	351.7



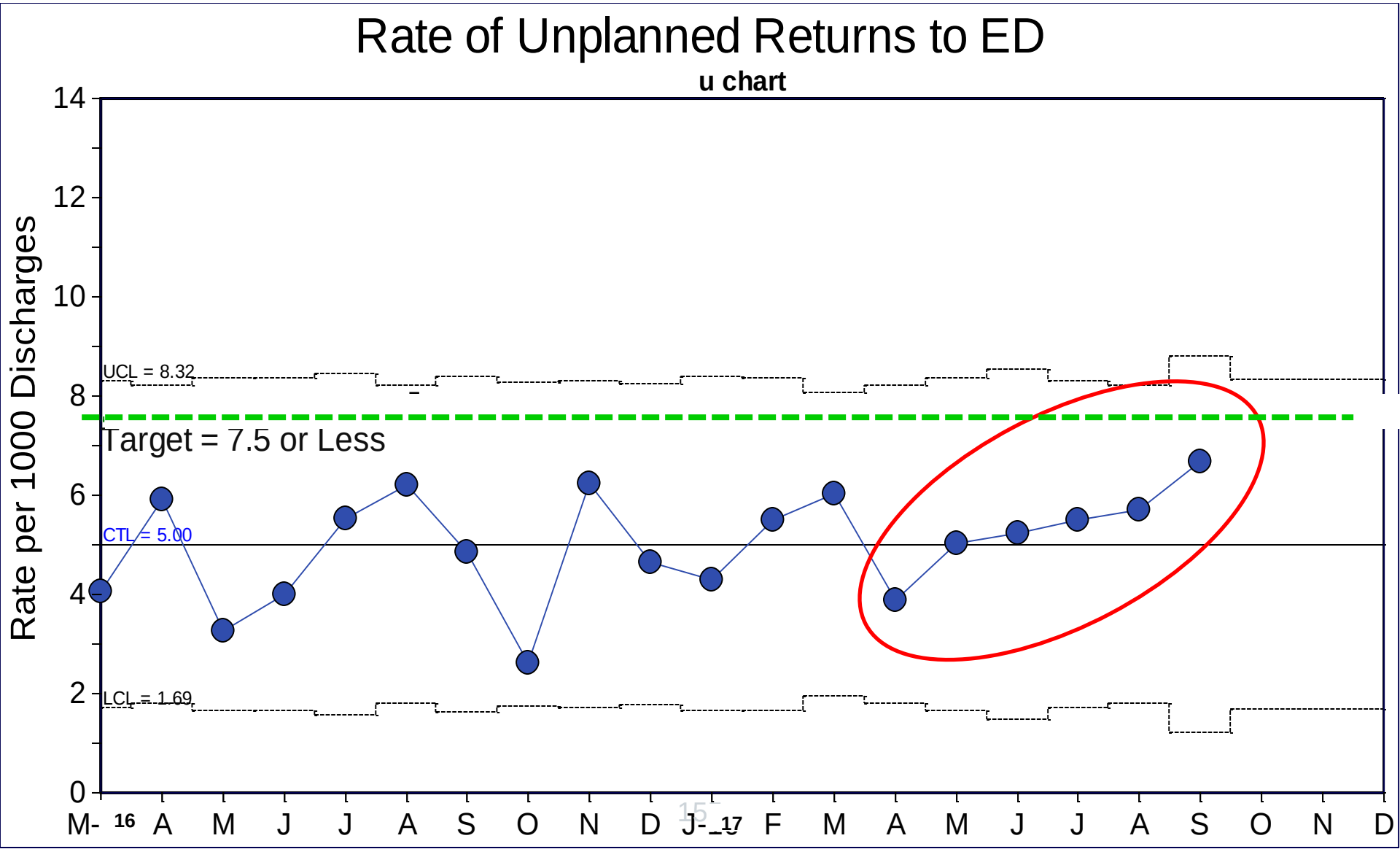

Blood Culture Contaminations Org 1: last 2 years
u chart
Contaminations/1000
45
40
35
30
25
20
UCL
Mean
LCL
Good
Change 1
Change 2
Change 3
Change 4
Jan-03
Mar-03
May-03
Jul-03
Sept-03
Nov-03
January-04
March-04
May-04
July-04
September-04
November-04
December-04


Percent of Budget Spent on Direct Client Care
Individuals
100
98
96
94
92
90
88
86
84
82
%
UL = 97.63
Mean = 92.09
LL = 86.55
M
A
M
J
J
A
S
O
N
D
J
F
M
A
M
J
J
A
A
16
17

Using a Shewhart Chart

- Learn how much variation exists in process
- Assess stability and determine improvement strategy (common or special cause strategy)
  - When sponsoring improvement effort it's helpful, if data readily available, to determine if process has only common cause or if special cause also present
- Monitor performance and correct as needed
- Find and evaluate causes of variation
- Tell if our changes yielded improvements
- See if improvements are "sticking"

Performance Better Than Target…but is all OK?



Legend for Status of Goals (Based on Annual Goal)

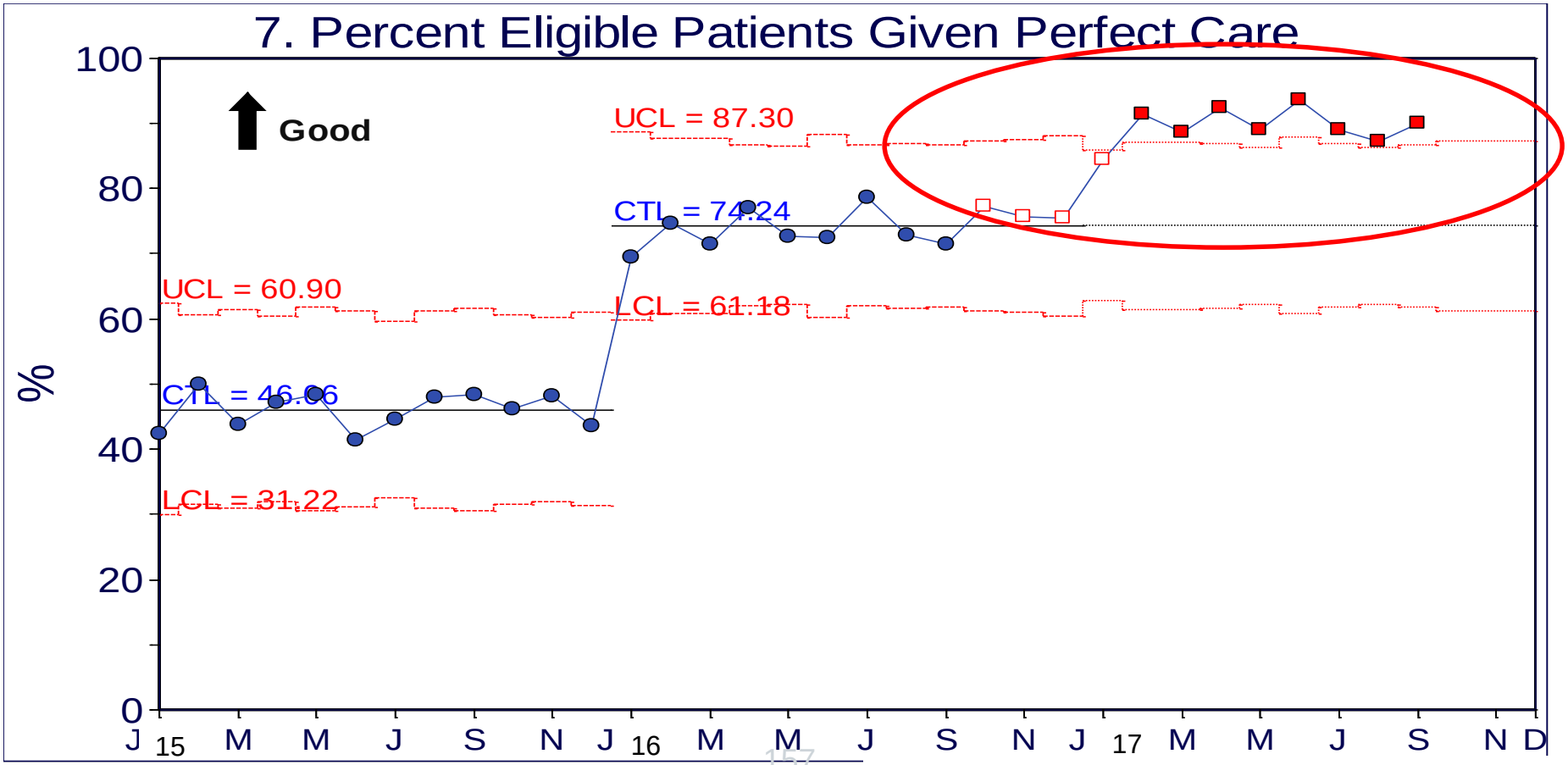
- Goal Met (GREEN)
- Goal 75% Met (YELLOW)
- Goal Not Met (RED)

FY 2017 Hospital System-Level Measures

	Good	Goals FY 17 Goal	Goals Long Term Goal	FY 2015	FY 2016	FY 2017 Q1	FY 2017 Q2	FY 2017 Q3
Patient Perspective								
1. Overall Satisfaction Rating: Percent Who Would Recommend (Includes inpatient, outpatient, ED, and Home Health)		60%	80%	37.98%	48.98%	57.19%	56.25%	51.69%
2. Wait for 3rd Next Available Appointment: Percent of Areas with appointment available in less than or equal to 7 business days (n=43)		65%	100%	53.5%	51.2%	54.3%	61.20%	65.1%
Patient Safety								
3. Safety Events per 10,000 Adjusted Patient Days	↓	0.28	0.20	0.35	0.31	0.31	0.30	0.28
4. Percent Mortality	↓	3.50	3.00	4.00	4.00	3.48	3.50	3.42
5.Total Infections per 1000 Patient Days	↓	2	0	3.37	4.33	4.39	2.56	1.95
Clinical								
6. Percent Unplanned Readmissions	↓	3.5%	1.5%	6.1%	4.8%	4.6%	4.1%	3.5%
7. Percent of Eligible Patients Receiving Perfect Care--Evidence Based Care (Inpatient and ED)		95%	100%	46%	74.1%	88.0%	91.7%	88.7%
Employee Perspective								
8. Percent Voluntary Employee Turnover	↓	5.80%	5.20%	5.20%	6.38%	6.10%	6.33%	6.30%
9. Employee Satisfaction: Average Rating Using 1-5 Scale (5 Best Possible)		4.00	4.25	3.90	3.80	3.96	3.95	3.95
Operational Performance								
10. Percent Occupancy		88.0%	90.0%	81.3%	84.0%	91.3%	85.6%	87.2%
11. Average Length of Stay	↓	4.30	3.80	5.20	4.90	4.60	4.70	4.30
12. Physician Satisfaction: Average Rating Using 1-5 Scale (5 Best Possible)		4.00	4.25	3.80	3.84	3.96	3.80	3.87
Community Perspective								
13. Percent of Budget Allocated to Non-recompensed Care		7.00%	7.00%	5.91	7.00%	6.90%	6.93%	7.00%
14. Percent of Budget Spent on Community Health Promotion Programs		0.30%	0.30%	0.32%	0.29%	0.28%	0.31%	0.29%
Financial Perspective								
15. Operating Margin-Percent		1.2%	1.5%	-0.5%	0.7%	0.9%	0.4%	0.7%
16. Monthly Revenue (Million)-change so shows red--but sp cause good related to occupancy		20.0	20.6	17.6	16.9	17.5	18.3	19.2

How is Percent Perfect Care Doing?…

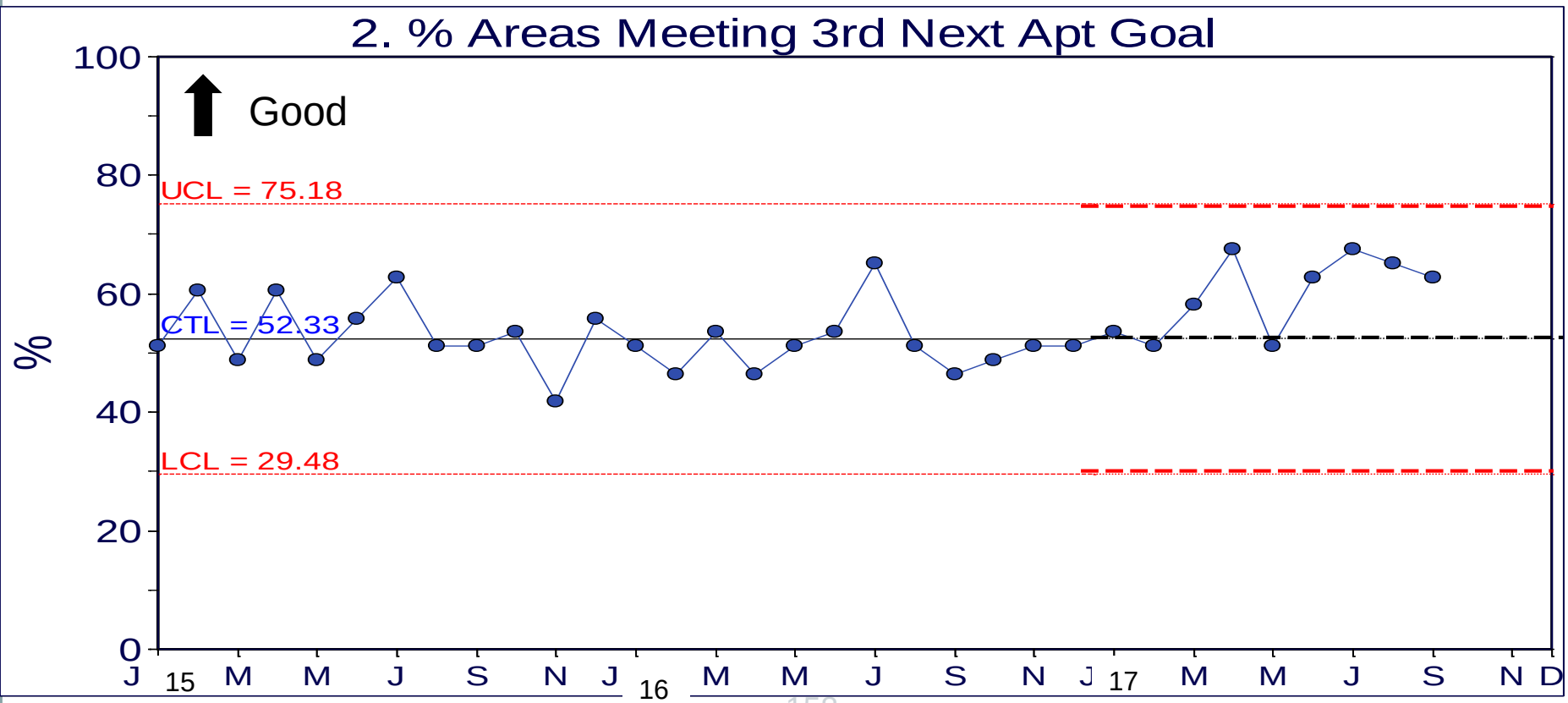
		Goals		FY 2015	FY 2016	FY 2017 Q1	FY 2017 Q2	FY 2017 Q3
		FY 17 Goal	Long Term Goal					
7. Percent of Eligible Patients Receiving Perfect Care--Evidence Based Care (Inpatient and ED)	↑	95%	100%	46%	74.1%	88.0%	91.7%	88.7%



Source: The Health Care Data Guide. Provost and Murray 2011

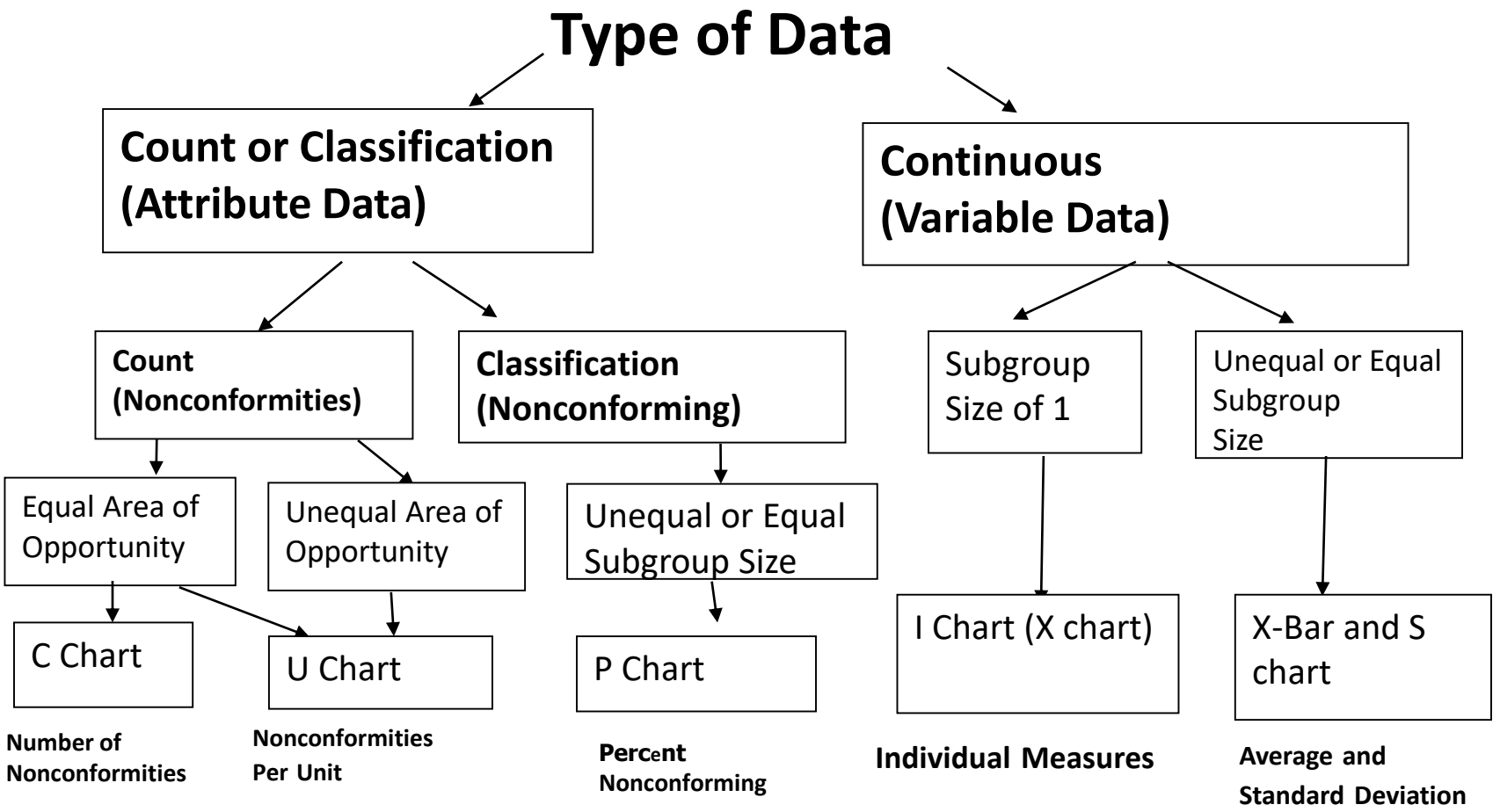
How is 3rd Next Available Appointment Doing?…

		Goals		FY 2015	FY 2016	FY 2017 Q1	FY 2017 Q2	FY 2017 Q3
		FY 17 Goal	Long Term Goal					
2. Wait for 3rd Next Available Appointment: Percent of Areas with appointment available in less than or equal to 7 business days (n=43)	↑	65%	100%	53.5%	51.2%	54.3%	61.2%	65.1%



Source: The Health Care Data Guide. Provost and Murray 2011

Selecting the Appropriate Shewhart Chart



Other types of control charts for attribute data:

1. NP (for classification data)
2. T-chart [time between rare events]
3. Cumulative sum (CUSUM)
4. Exponentially weighted moving average (EWMA)
5 G chart (number of opportunities between rare events)
6. Standardized control chart

Other types of control charts for continuous data:

7. X-bar and Range
8. Moving average
9. Median and range
10. Cumulative sum (CUSUM)
11. Exponentially weighted moving average (EWMA)
12. Standardized control chart

Objectives

- Select the appropriate tool from a chest of data tools for the question being addressed
- Analyze a run chart
  - Identify signals that indicate statistically significant evidence of change on a run chart
- Analyze a Pareto chart, a Histogram and a Scatter Diagram
- Identify a Shewhart control chart