# Using Data to Drive Improvement

Interdisciplinary Trauma Network of Canada

BC PATIENT SAFETY & QUALITY COUNCIL

Working Together. Accelerating Improvement.

# Performance Measurement in Health Care

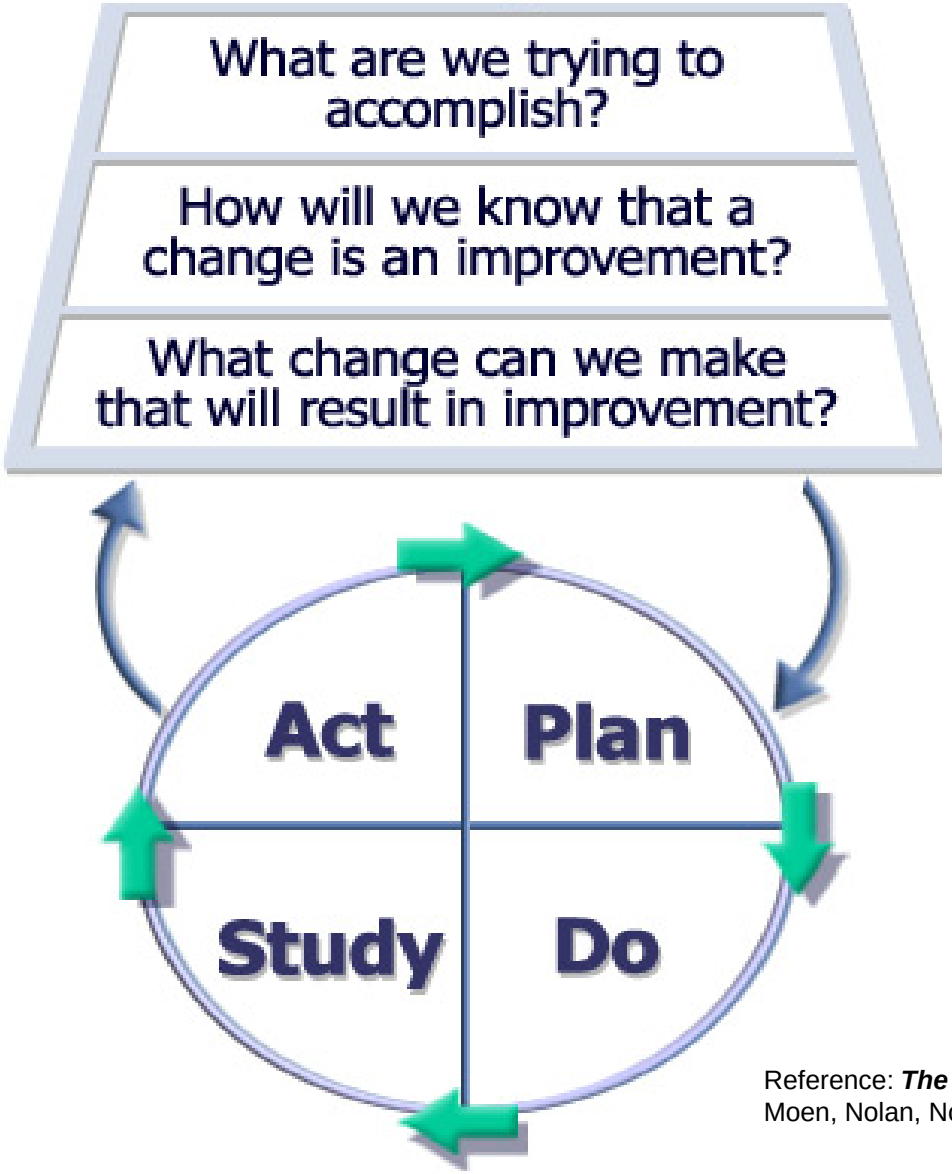
- Accountability:  for judgement, to reassure the public, to decide how much people are paid, to choose between two options.

- Research:  to develop new knowledge, often generalizable

- Improvement: to guide our efforts to change, to monitor our progress, to understand the problem.

| ASPECT | ACCOUNTABILITY | RESEARCH | IMPROVEMENT |
|---|---|---|---|
| Measurement Aim | Comparison, choice, reassurance, spur for change | New knowledge | Improvement of care |
| Measurement Methods | | | |
| Test observability | No test, evaluate current performance | Test blinded or controlled | Test observable |
| Bias | Measure and adjust to reduce bias | Design to eliminate bias | Accept consistent bias |
| Sample size | Obtain 100% of available, relevant data | "Just in case" data | "Just enough" data, small sequential samples |
| Flexibility of hypothesis | No hypothesis | Fixed hypothesis | Hypothesis is flexible; it changes as learning takes place |
| Testing strategy | No tests | One large test | Sequential tests |
| Determining if a change is an improvement | No change focus | Hypothesis, statistical tests (t tests, F tests, Chi square) with p-values | Run charts or Shewhart control charts (use statistical process control methods) |
| Confidentiality of the data | Data available for public consumption and review | Research subjects' identities protected | Data used only by those involved with improvement |

# Model for Improvement




Reference: ***The Improvement Guide***, 2nd ed. Langley, Moen, Nolan, Nolan, Norman & Provost, p. 24

# Purpose of Measurement for Improvement

Data can tell us:

- Where we can get some change ideas
- How we are progressing over time

# Intended and Unintended Variation

- **Intended variation is an important part of effective, patient-centered health care.**

- **Unintended variation is due to changes introduced into healthcare process that are not purposeful, planned or guided.**

- Walter Shewhart focused his work on this unintended variation. He found that reducing unintended variation in a process usually resulted in improved outcomes and lower costs.

(Berwick 1991)

# Understanding Variation: the good and bad

- Unintended:
  - Poor research – Professional uncertainty
  - Poor knowledge – professional ignorance

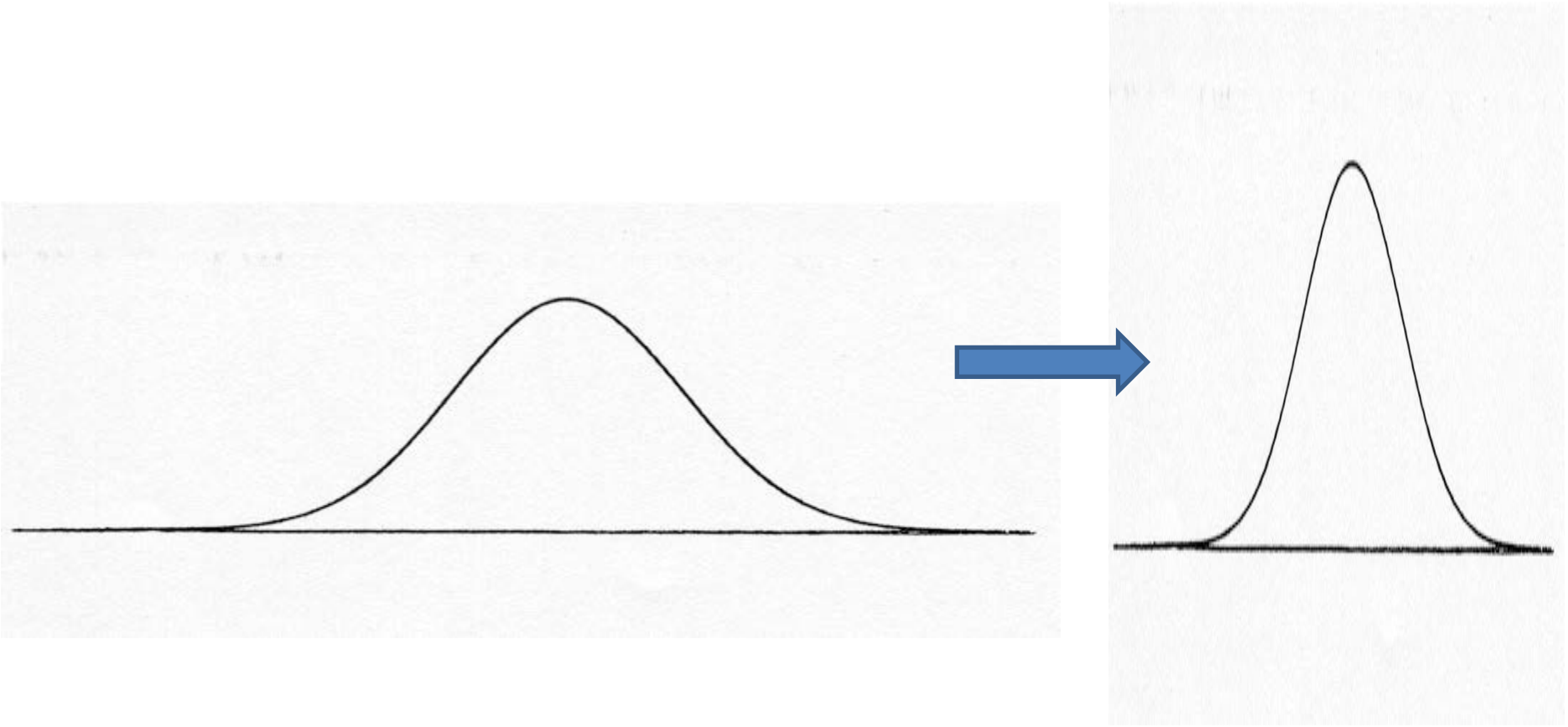
- Intended:
  - Clinical differences among patients
  - Personal differences among patients

# Unintended Variation

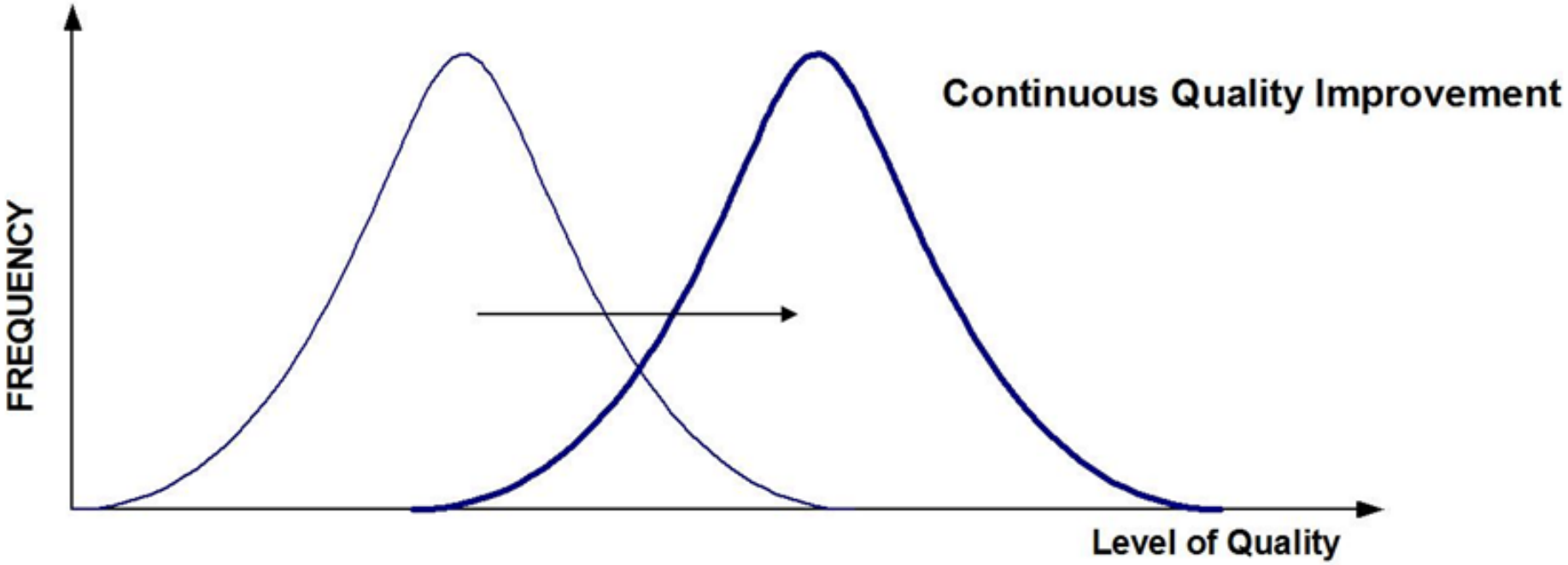
- Most work of improvement is focused on unintended variation

- If all variation was unintended, it would be easy to stop. What is difficult is reducing unintended variation while keeping intended variation

# Reducing Unintended Variation



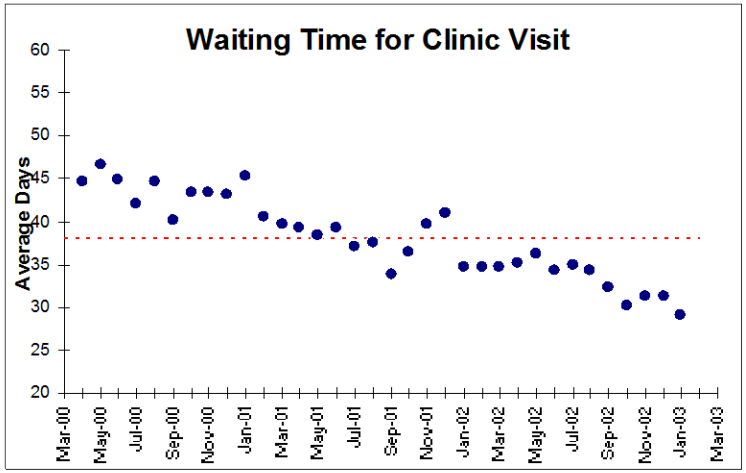
# Shifting Performance



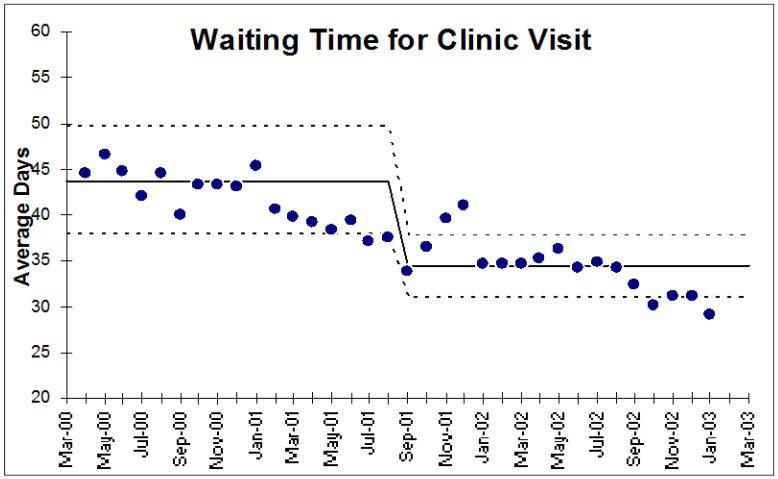
We use a variety of tools to learn about variation.

They rely on visual analysis, and use statistics – but we can’t rely only on the summary statistics alone.

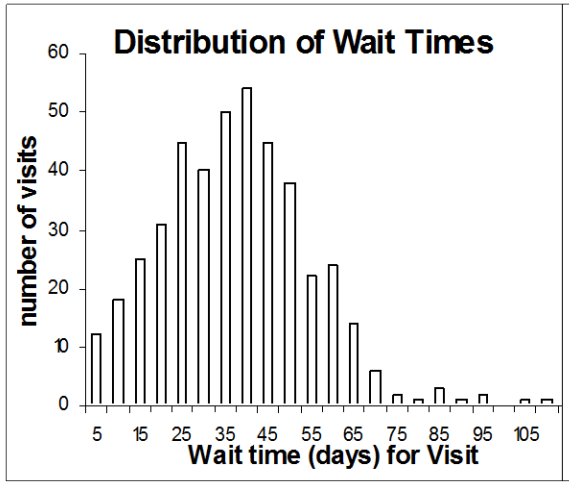
# Tools to Learn from Variation in Data



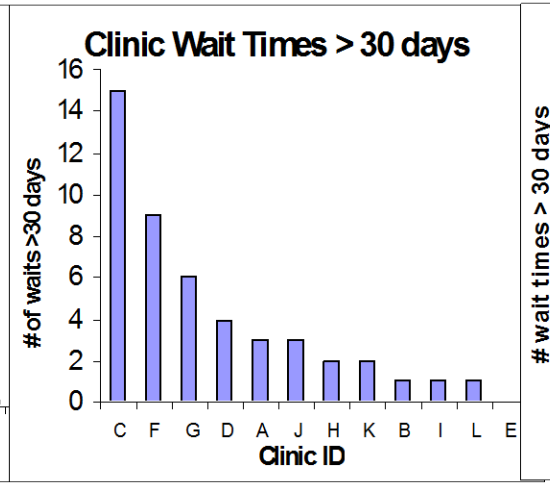

**RUN CHART**



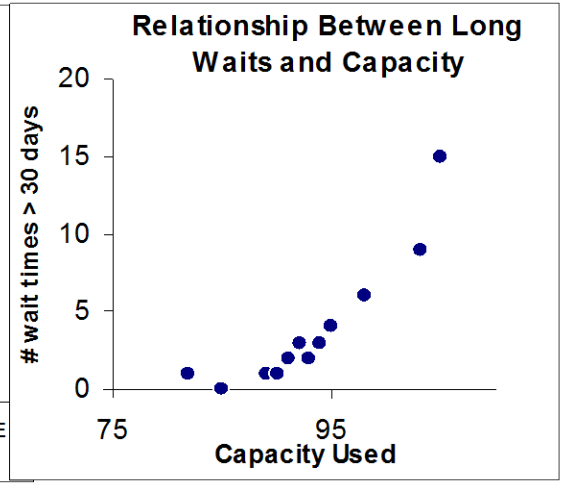

**SHEWHART CHART**




**FREQUENCY PLOT**




**PARETO CHART**




**SCATTER PLOT**

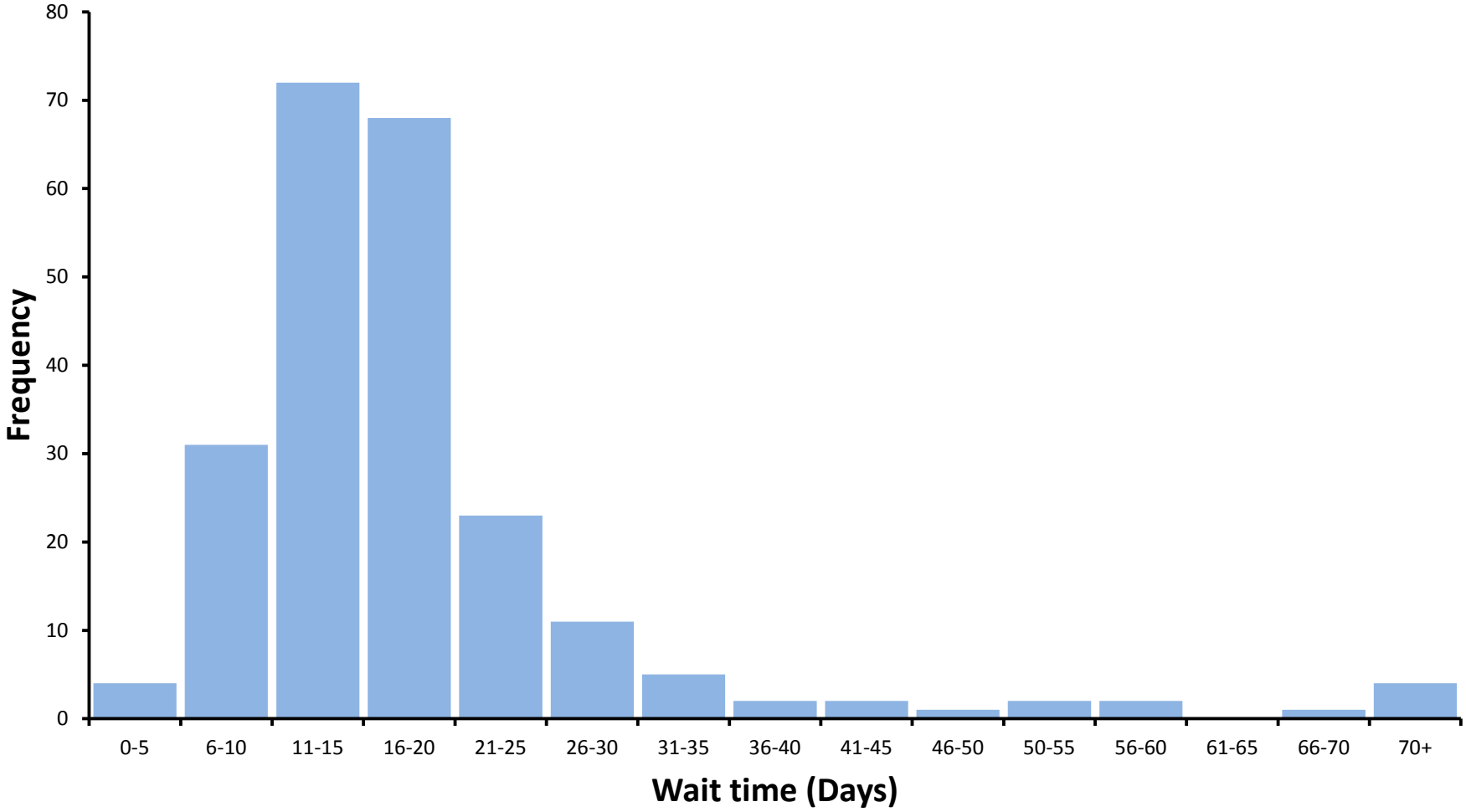
*Health Care Data Guide*, p. 65

# Histogram

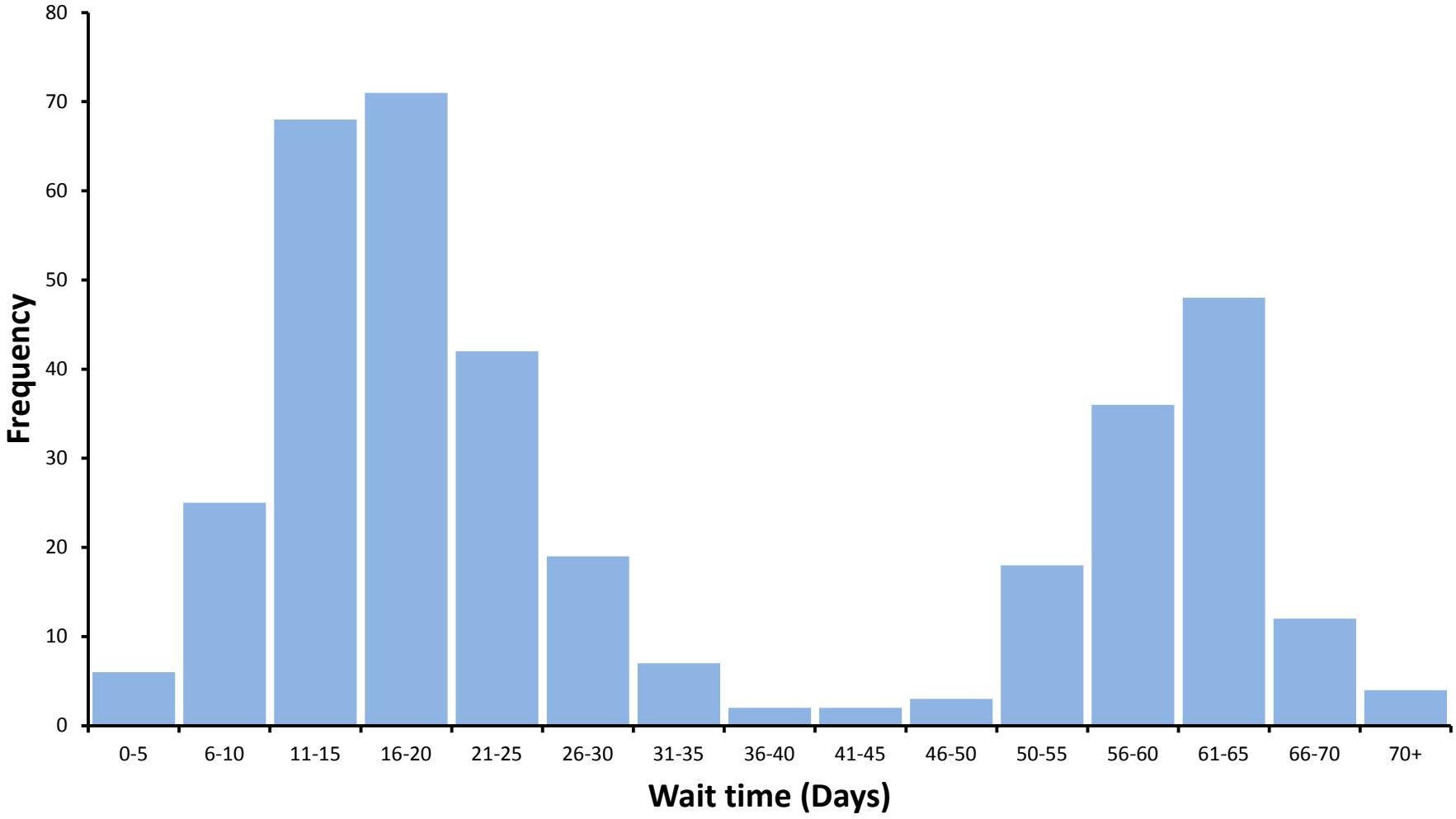
- Graphical display of the distribution of numerical data.

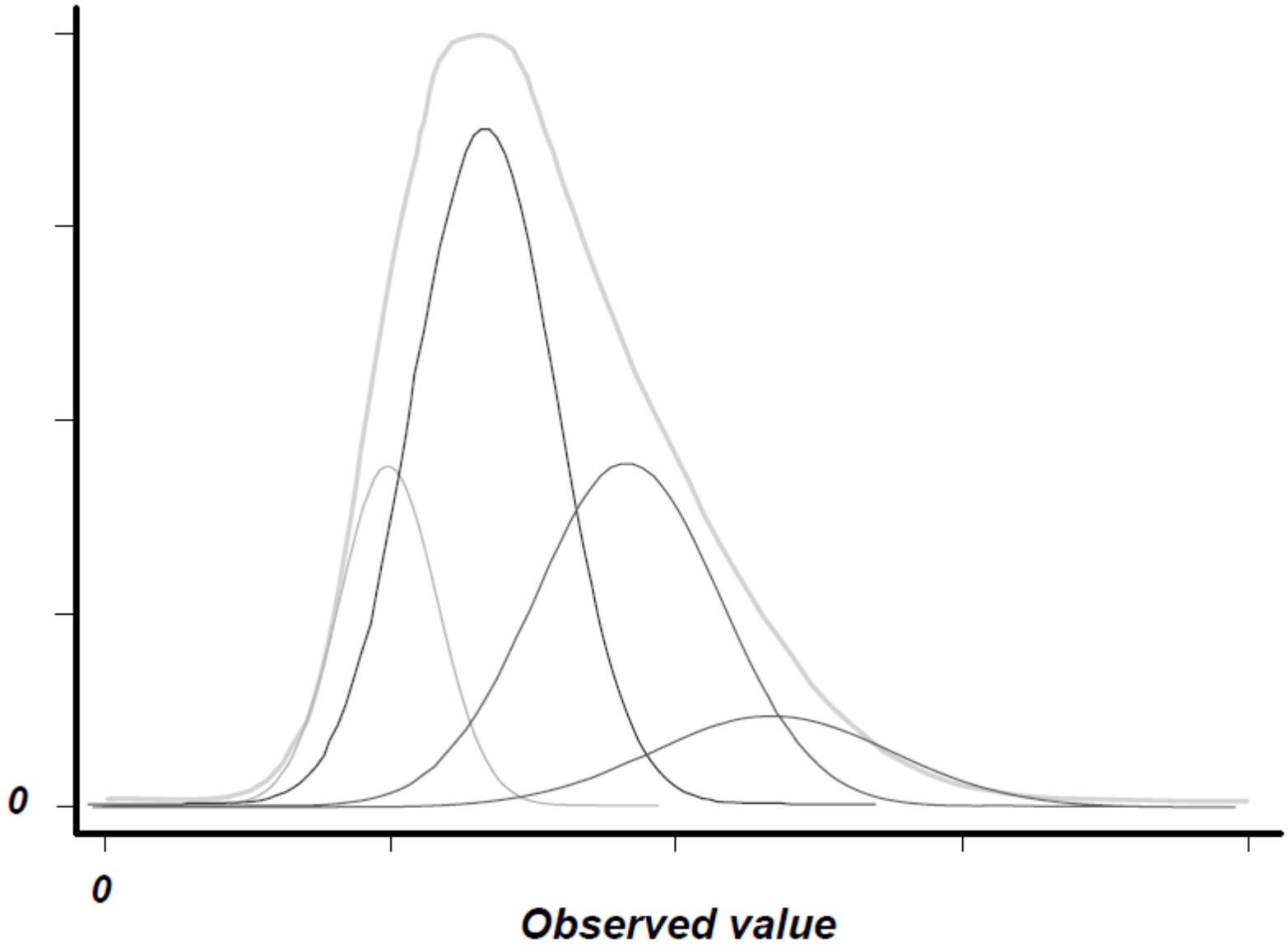
- Provides information about the location, spread and shape of a measure.

# Histogram: Wait time to be seen by a specialist



# Histogram: Wait time to be seen by a specialist



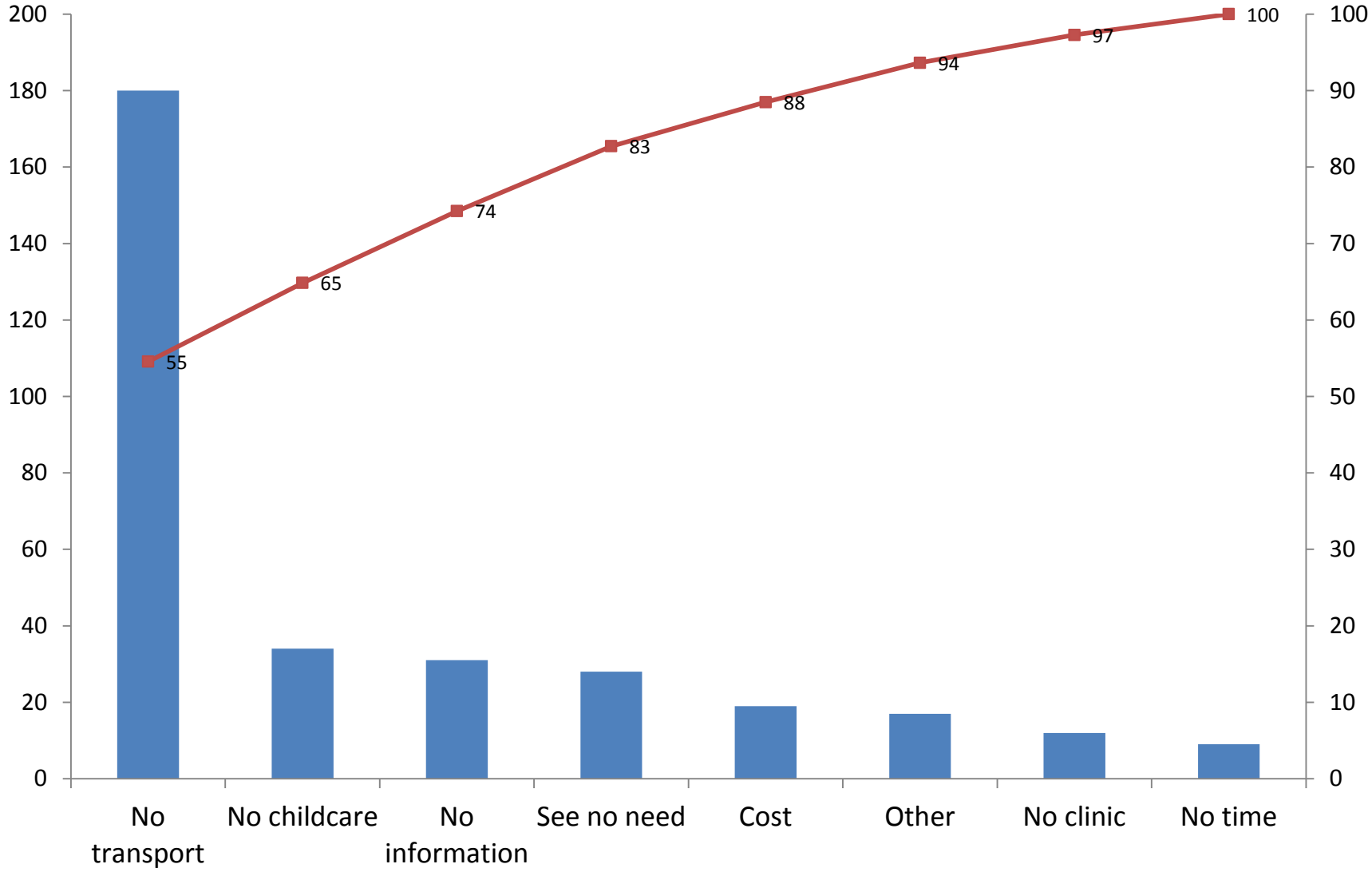

0
0
Observed value

# Pareto Charts

- Application of the Pareto principle
- Helpful for prioritizing action, or finding biggest contributing factors
- Similar to a histogram for categories

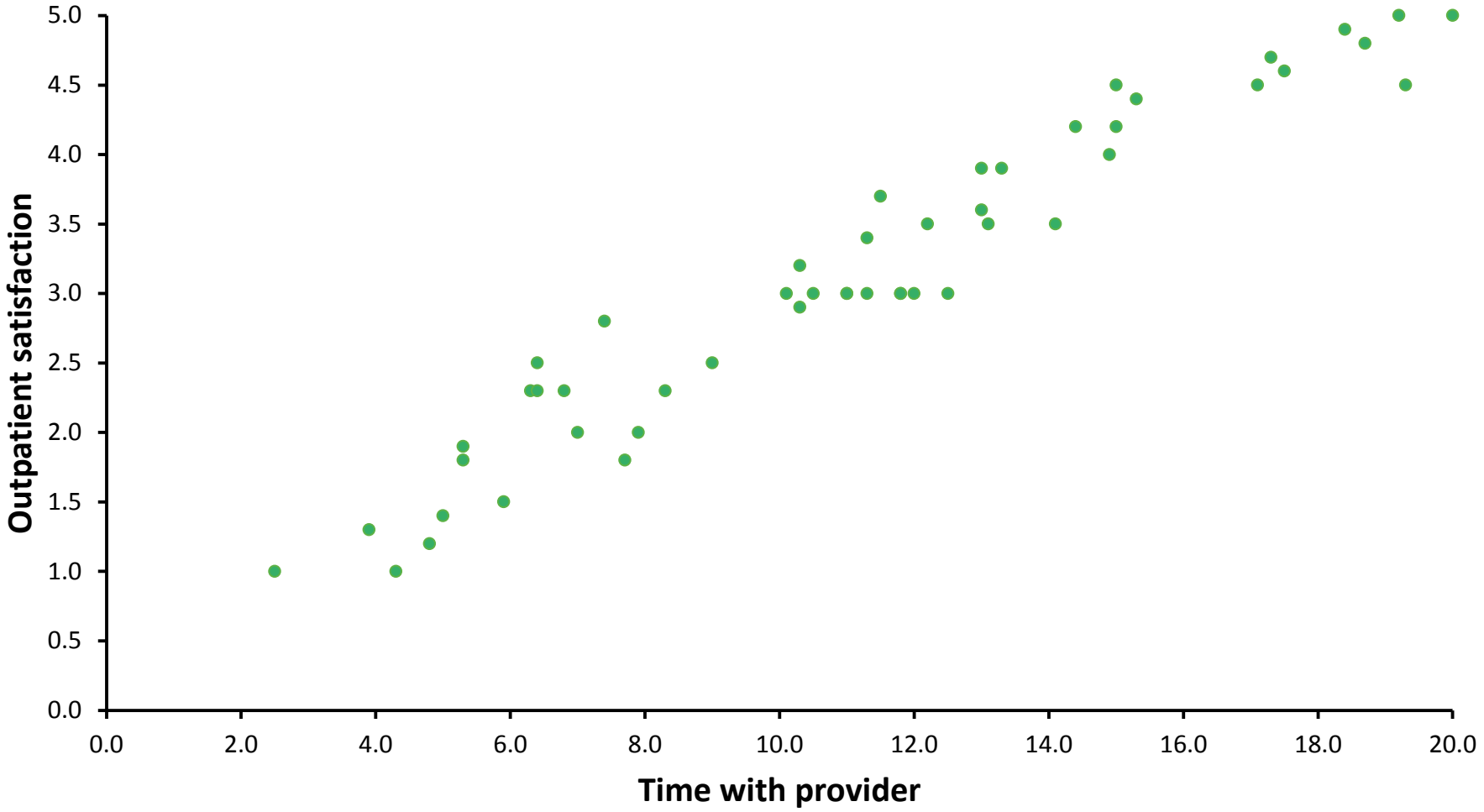
"Separate the vital few from the trivial many"

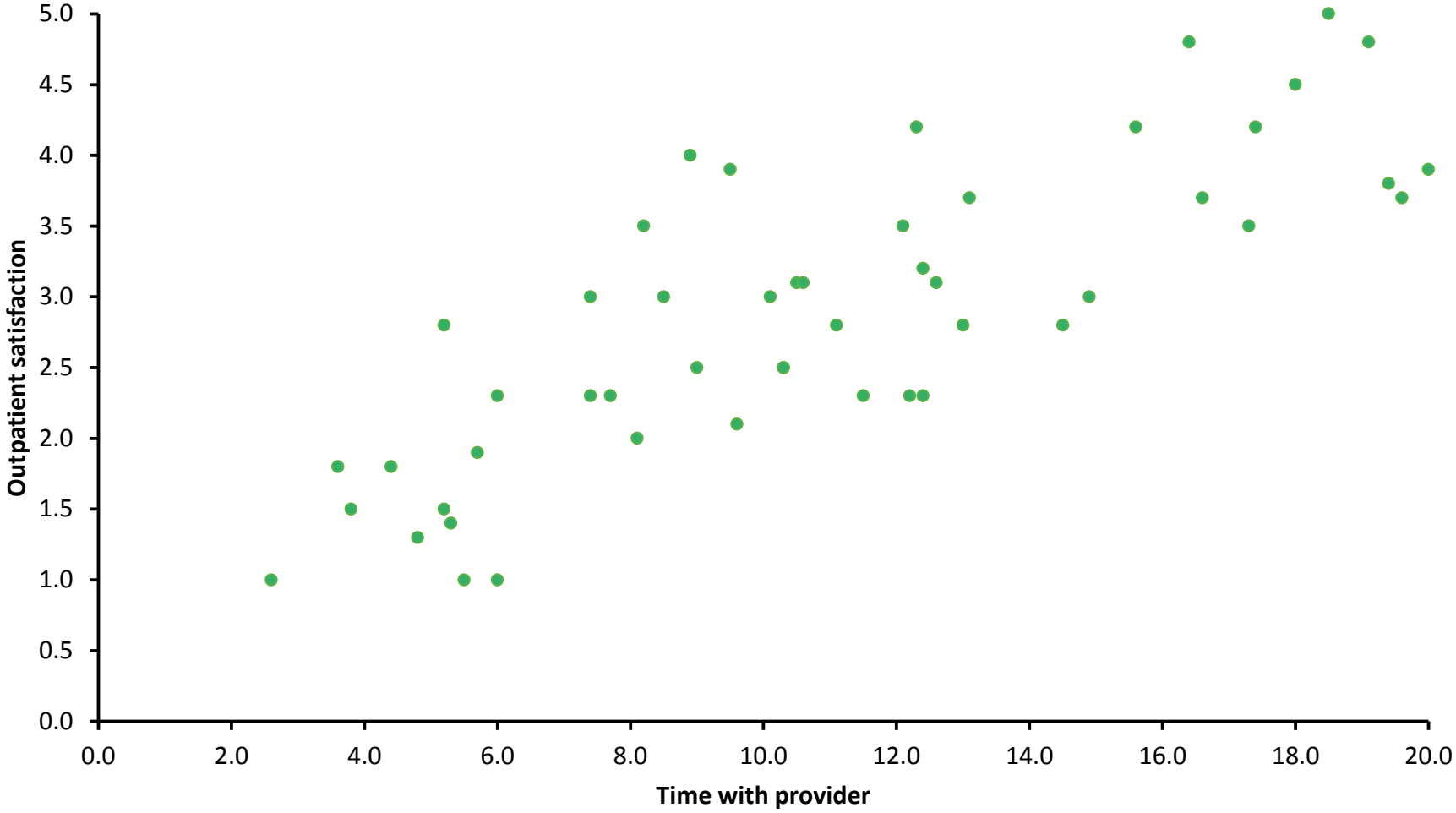
# Pareto: Reasons Cited for Lack of Immunization



# Scatter Plots

- Identify associations or relationships between two numerical variables
- Helpful to test hypotheses of relationships
- Can use statistical measures of relatedness, or visual analysis


Outpatient satisfaction
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Time with provider


Outpatient satisfaction
5.0
4.5
4.0
3.5
3.0
2.5
2.0
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1.0
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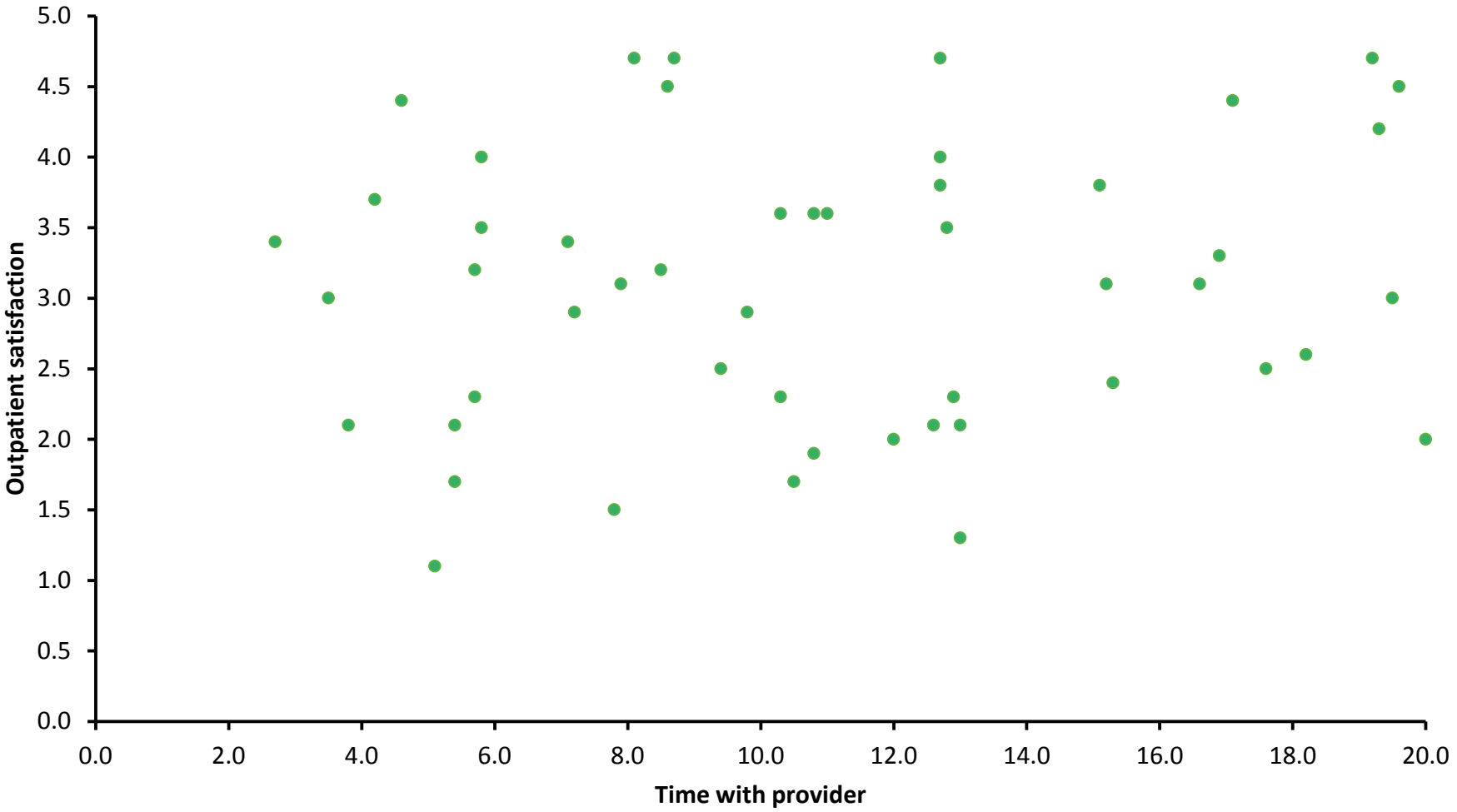
12.0
14.0
16.0
18.0
20.0
Time with provider


Outpatient satisfaction
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
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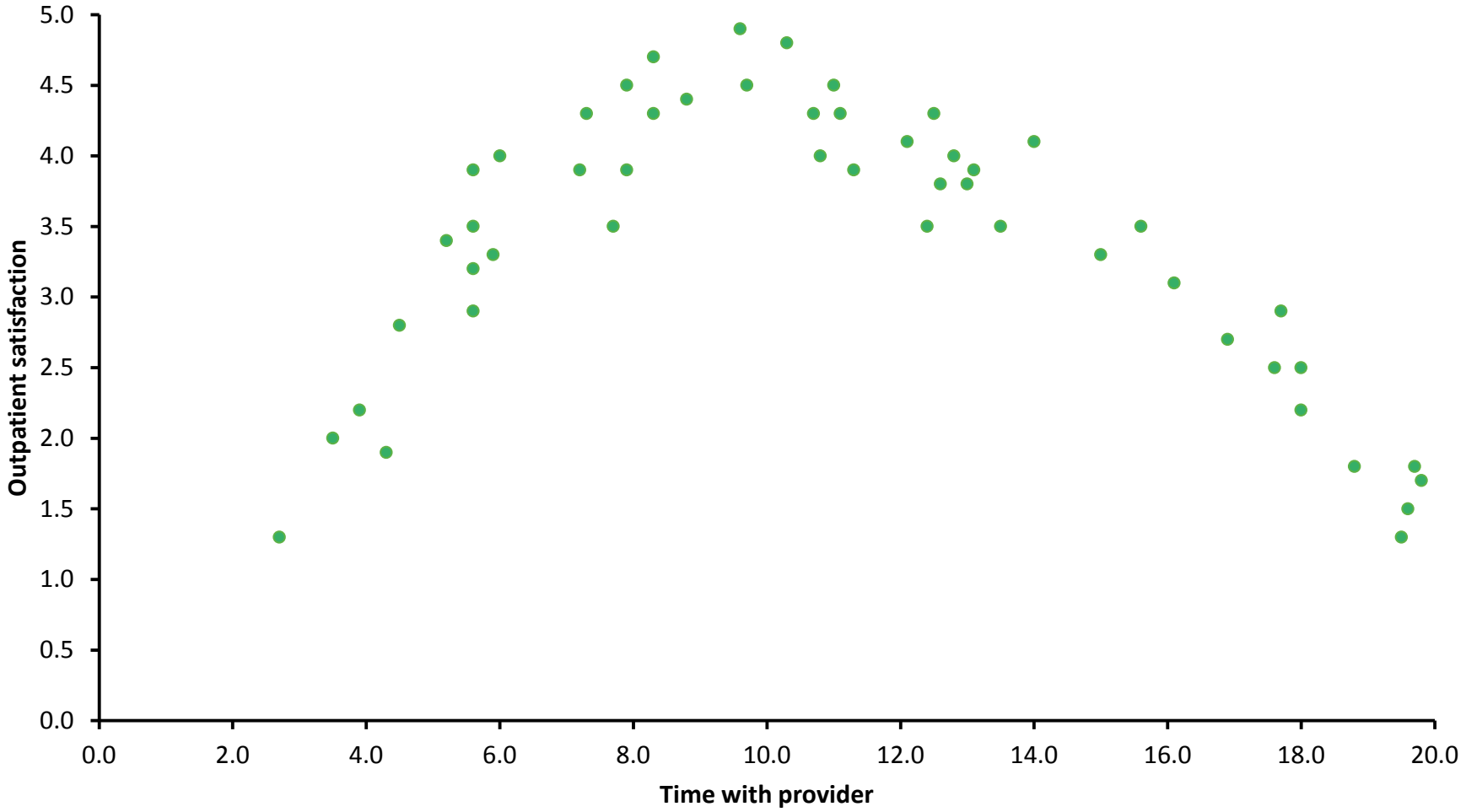
12.0
14.0
16.0
18.0
20.0
Time with provider


Outpatient satisfaction
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
20.0
Time with provider

# Why we look at data over time

| Period | LOS1 (days) | LOS2 (days) | LOS3 (days) | LOS4 (days) | LOS5 (days) |
|---|---|---|---|---|---|
| 1 | 1 | 3.4 | 4.5 | 4.1 | 2.5 |
| 2 | 1.2 | 3.1 | 3 | 3.1 | 2.7 |
| 3 | 1.6 | 3 | 3.6 | 3 | 3 |
| 4 | 1.9 | 3.3 | 1.9 | 2.1 | 2.3 |
| 5 | 2 | 3.2 | 3.7 | 1.4 | 3 |
| 6 | 2.2 | 2.8 | 4 | 2.8 | 7.3 |
| 7 | 2.3 | 2.6 | 3.6 | 2.6 | 3.1 |
| 8 | 2.5 | 3.2 | 3.5 | 3.2 | 3.2 |
| 9 | 2.3 | 3.3 | 2.5 | 3.3 | 2.9 |
| 10 | 2.7 | 3.1 | 4.5 | 3.1 | 3 |
| 11 | 2.9 | 3.4 | 2.5 | 4.2 | 2.5 |
| 12 | 2.8 | 3 | 3.3 | 4.3 | 2.8 |
| 13 | 2.7 | 2.8 | 3.9 | 2.8 | 3.1 |
| 14 | 3 | 3.1 | 2.3 | 3.1 | 2.3 |
| 15 | 2.8 | 2.9 | 3.7 | 2.9 | 3 |
| 16 | 2.9 | 1.9 | 2.6 | 1.9 | 2.6 |
| 17 | 2.9 | 2.5 | 2.7 | 2.5 | 2.7 |
| 18 | 3.1 | 2 | 4.2 | 3.6 | 6.7 |
| 19 | 3.6 | 2.4 | 3 | 3.3 | 3 |
| 20 | 3.8 | 2.2 | 1.2 | 2.2 | 1.9 |
| 21 | 3.6 | 2.6 | 3.3 | 2.6 | 3.3 |
| 22 | 3.4 | 2.4 | 3.1 | 2.4 | 3.1 |
| 23 | 3.6 | 2 | 3.9 | 2 | 3.2 |
| 24 | 4 | 4.3 | 3.3 | 4.3 | 2.9 |
| 25 | 3.9 | 3.8 | 3.2 | 3.8 | 2 |
| 26 | 4.1 | 4 | 2.2 | 4 | 2.5 |
| 27 | 4.1 | 3.8 | 4.2 | 3.8 | 6.8 |
| 28 | 4.6 | 4.2 | 2.7 | 4.2 | 2.6 |
| 29 | 4.5 | 4.1 | 2.7 | 2.3 | 2 |
| 30 | 4.8 | 3.8 | 1 | 2.1 | 2.5 |

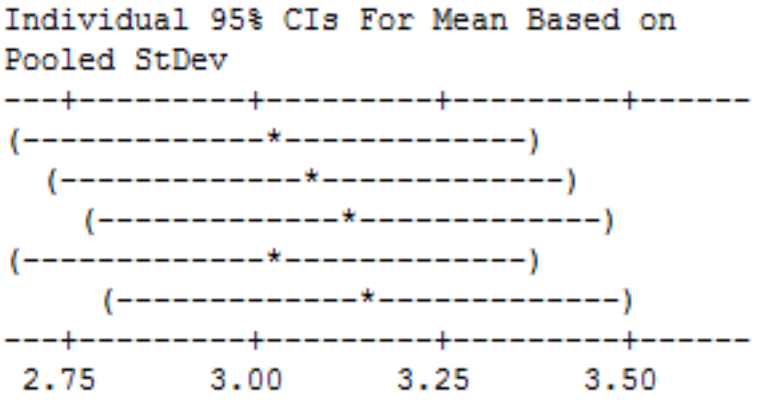
| Period | LOS1 (days) | LOS2 (days) | LOS3 (days) | LOS4 (days) | LOS5 (days) |
|---|---|---|---|---|---|
| Average | 3.027 | 3.073 | 3.127 | 3.033 | 3.15 |
| | | | | | |
| Q1 | 2.3 | 2.575 | 2.575 | 2.375 | 2.5 |
| Median | 2.9 | 3.1 | 3.25 | 3.05 | 2.9 |
| Q3 | 3.825 | 3.5 | 3.75 | 3.8 | 3.1 |

| | Performance Rank | LOS | Comparison to System Average | Target | Comparison to Target |
|---|---|---|---|---|---|
| Hospital 1 | 1 | 3.03 | ↔ | 2.5 | ■ |
| Hospital 2 | 3 | 3.07 | ↔ | 2.5 | ■ |
| Hospital 3 | 4 | 3.12 | ↔ | 2.5 | ■ |
| Hospital 4 | 2 | 3.03 | ↔ | 2.5 | ■ |
| Hospital 5 | 5 | 3.15 | ↔ | 2.5 | ■ |
| | | | | | |
| Overall System Average | | 3.08 | | 2.5 | ■ |
| | | | | | |
| Legend:<br>• Better than expected<br>• Within +/- 5%<br>• Worse than expected | <br>●<br>↔<br>■ | | | | |

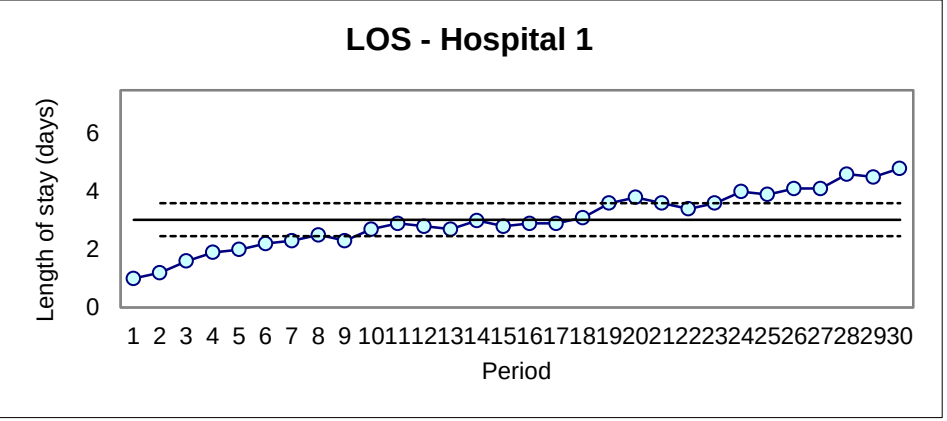
| Source | DF | SS | MS | F | P |
|---|---|---|---|---|---|
| Factor | 4 | 0.364 | 0.091 | 0.10 | 0.983 |
| Error | 145 | 133.718 | 0.922 | | |
| Total | 149 | 134.081 | | | |

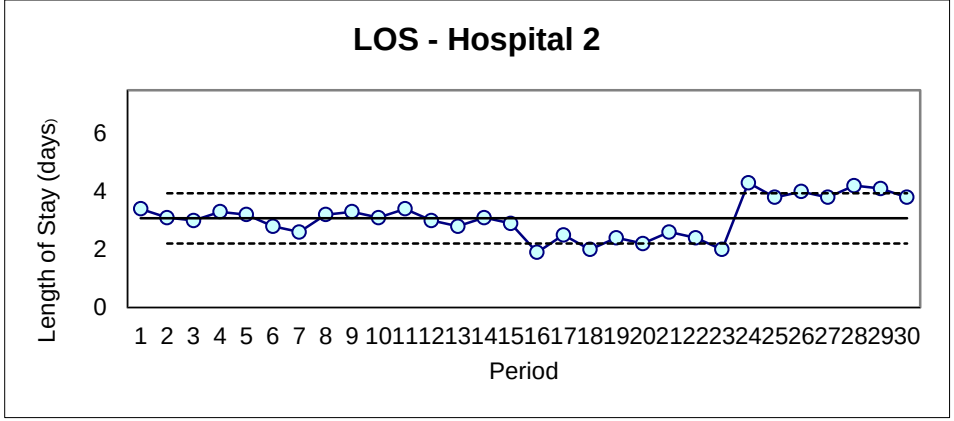
S = 0.9603  R-Sq = 0.27%  R-Sq(adj) = 0.00%

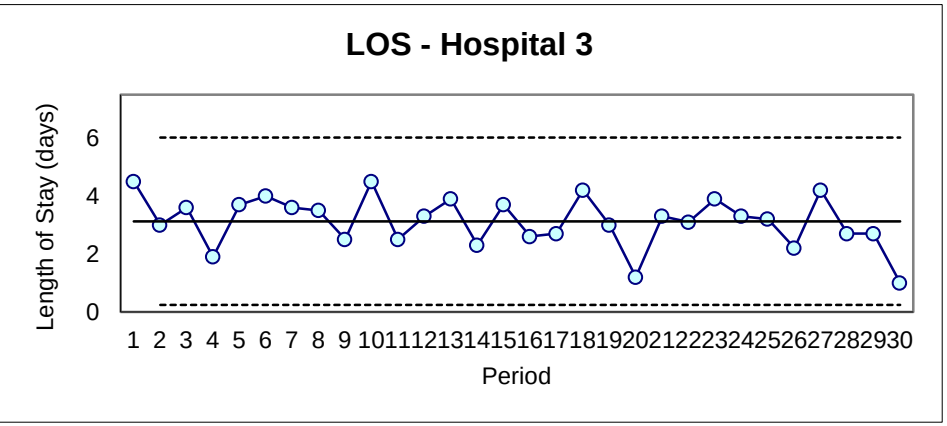
| Level | N | Mean | StDev |
|---|---|---|---|
| LOS1 | 30 | 3.0267 | 0.9777 |
| LOS2 | 30 | 3.0733 | 0.6680 |
| LOS3 | 30 | 3.1267 | 0.8769 |
| LOS 4 | 30 | 3.0333 | 0.8066 |
| LOS 5 | 30 | 3.1500 | 1.3377 |

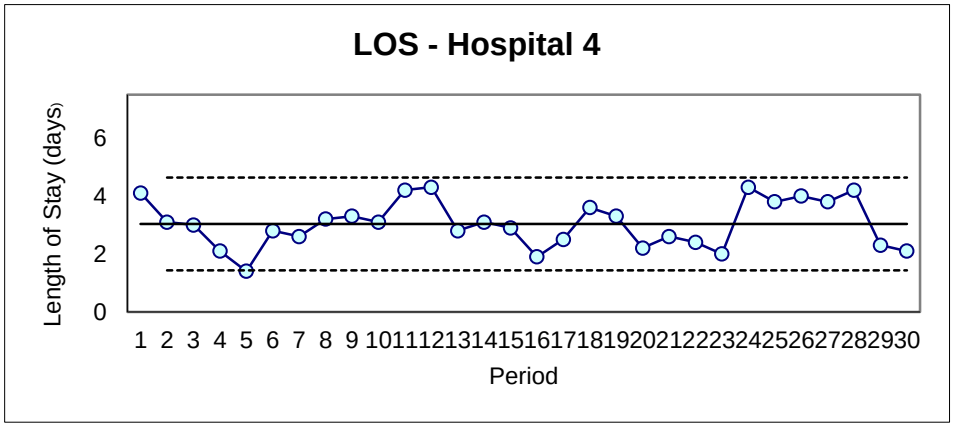


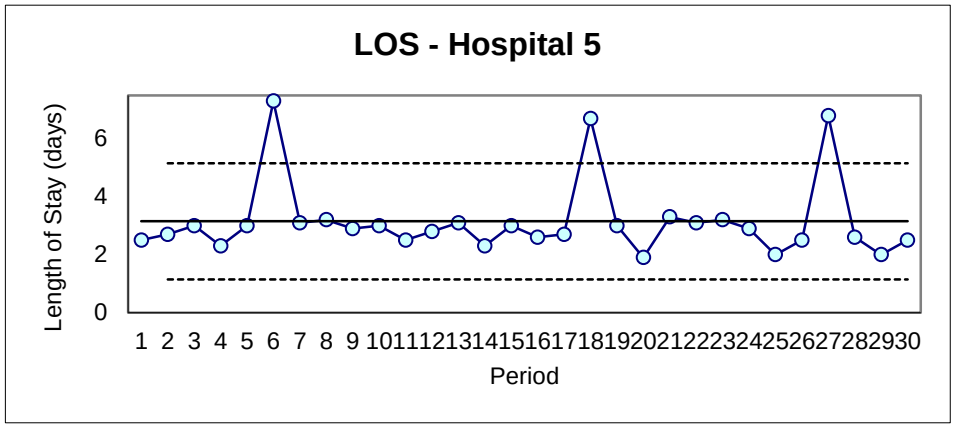

Pooled StDev = 0.9603

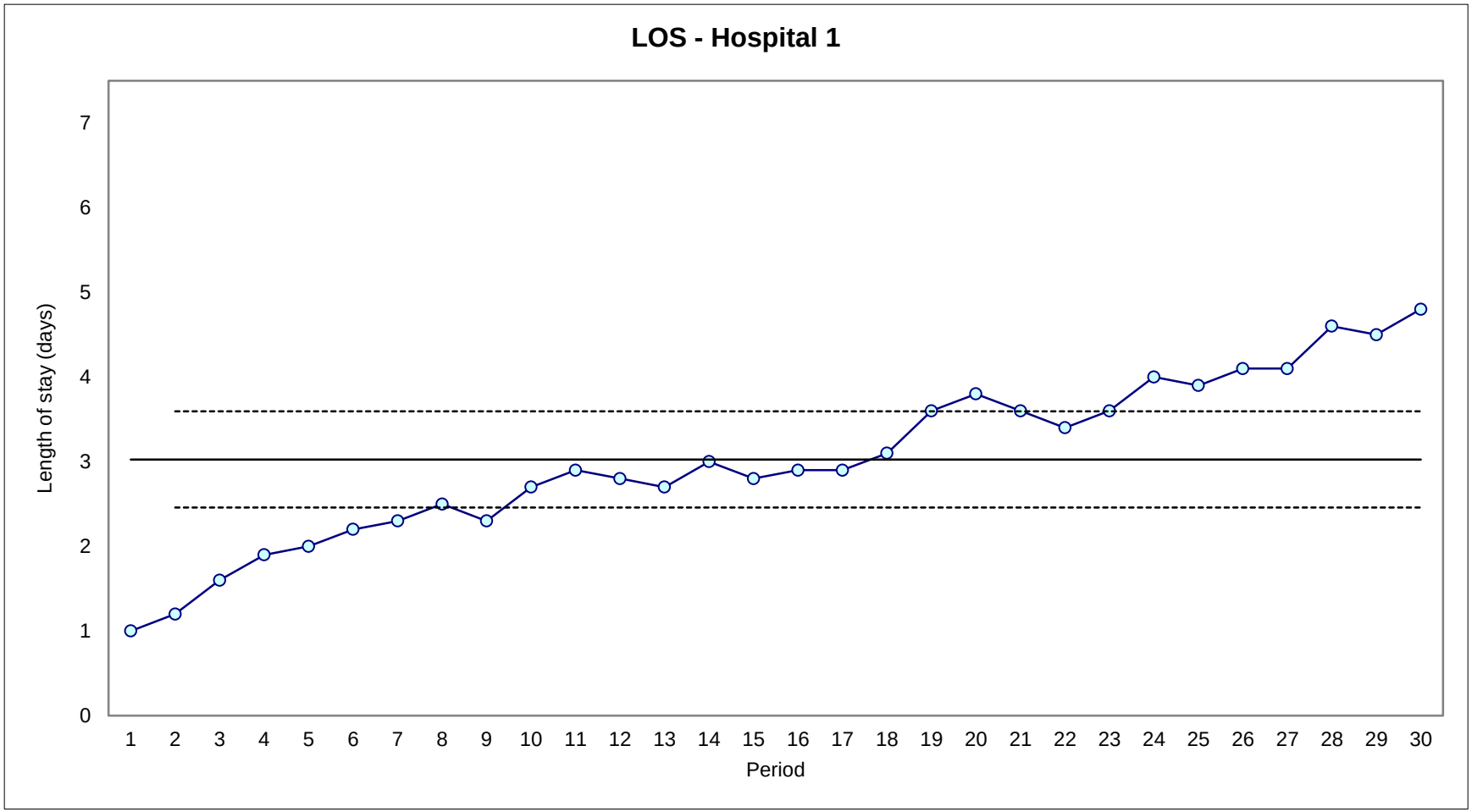

LOS - Hospital 1
Length of stay (days)
0
2
4
6
1 2 3 4 5 6 7 8 9 10111213141516171819202122232425262728293O
Period

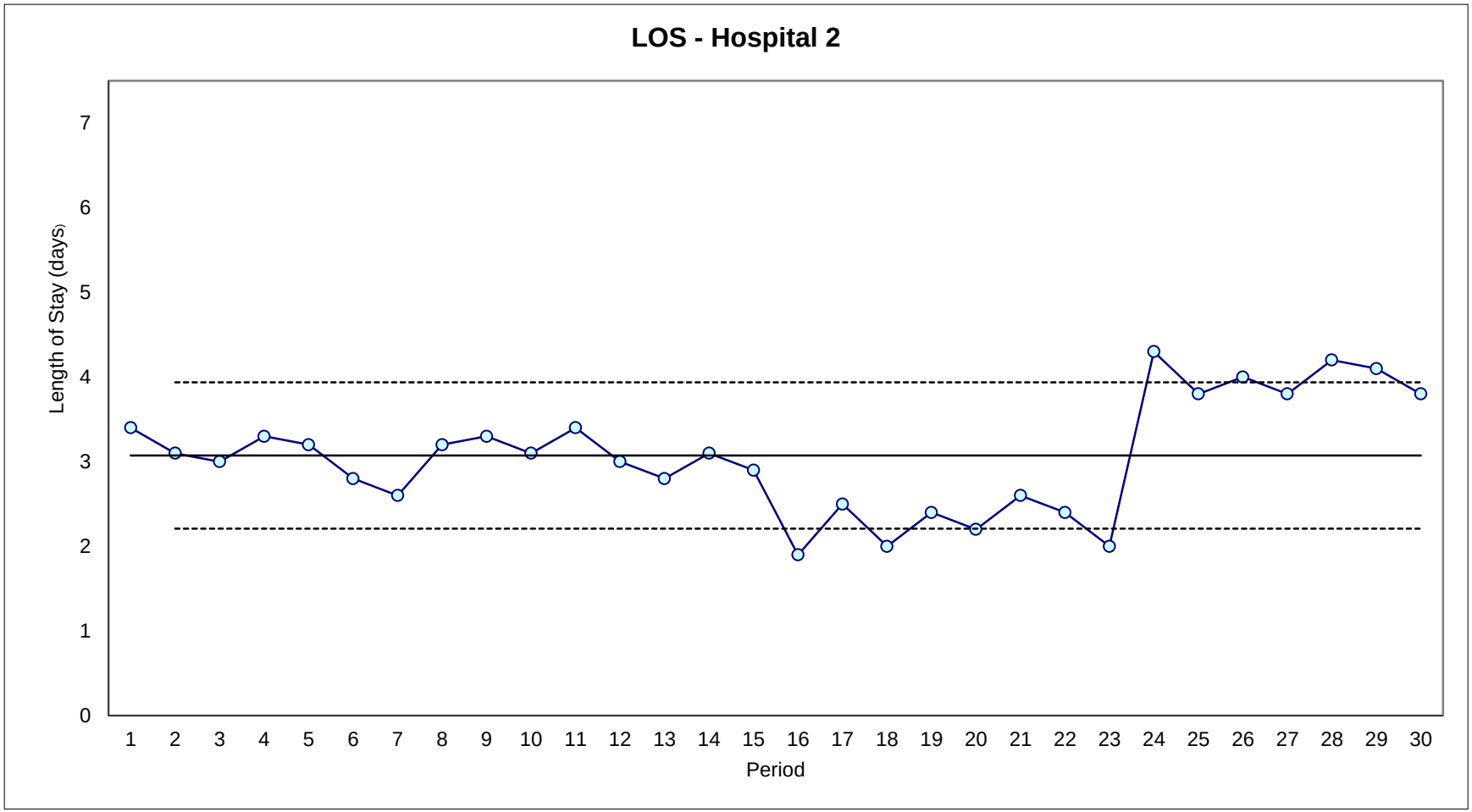

LOS - Hospital 2
Length of Stay (days)
0
2
4
6
1 2 3 4 5 6 7 8 9 10111213141516171819202122232425262728293O
Period

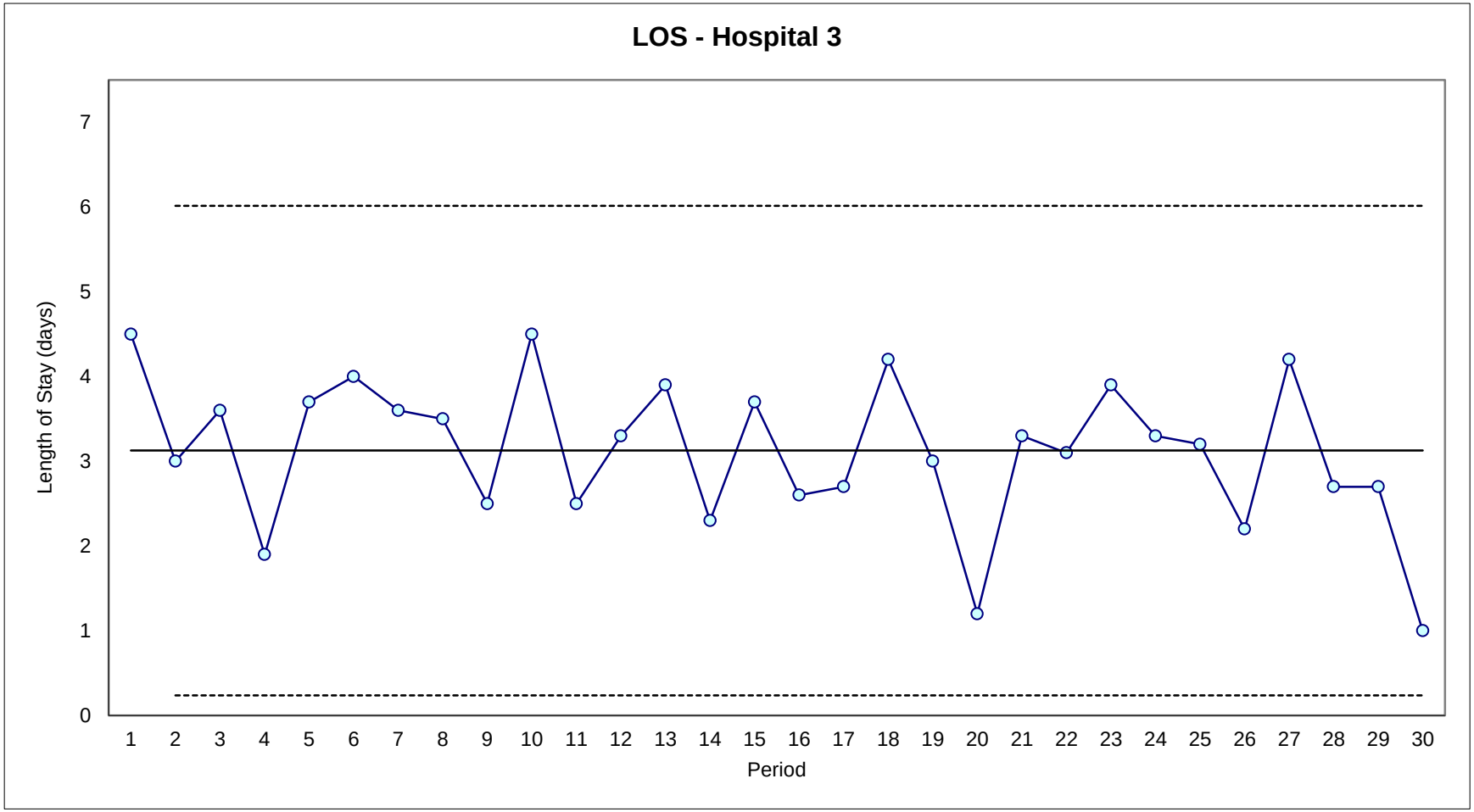

LOS - Hospital 3
Length of Stay (days)
0
2
4
6
1 2 3 4 5 6 7 8 9 10111213141516171819202122232425262728293O
Period

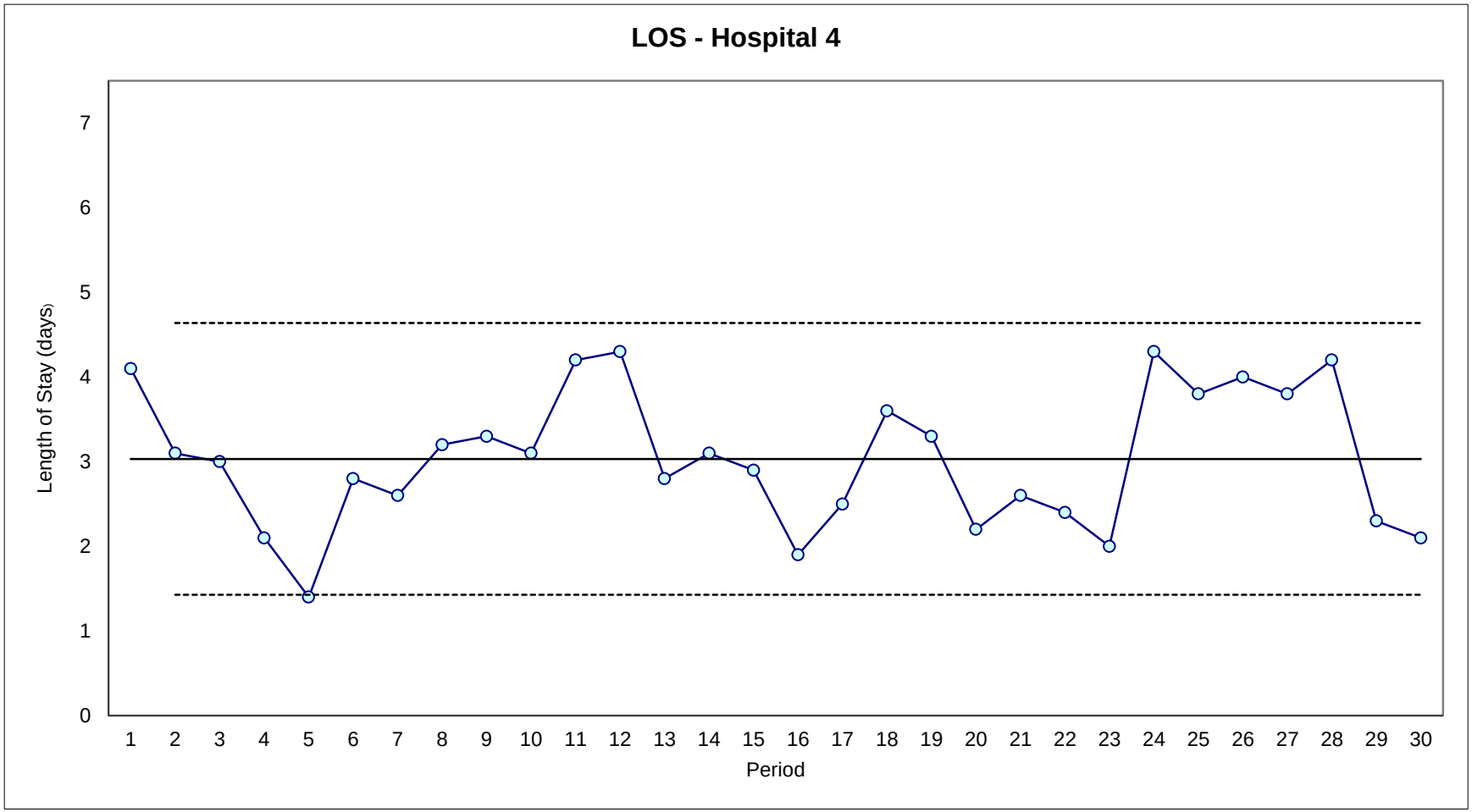

LOS - Hospital 4
Length of Stay (days)
0
2
4
6
1 2 3 4 5 6 7 8 9 10111213141516171819202122232425262728293O
Period

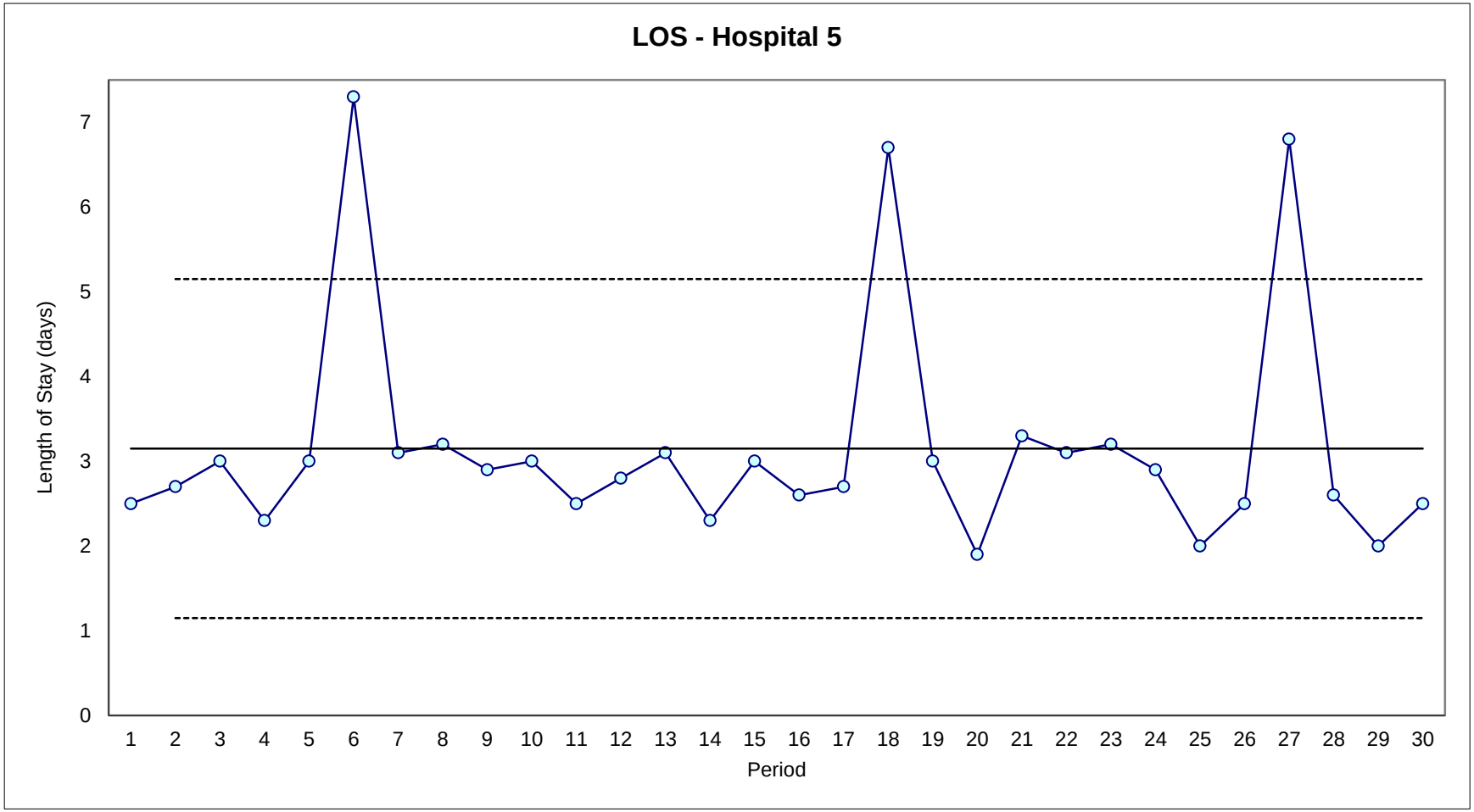

LOS - Hospital 5
Length of Stay (days)
0
2
4
6
1 2 3 4 5 6 7 8 9 10111213141516171819202122232425262728293O
Period


LOS - Hospital 1
Length of stay (days)
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 26 27 28 29 30
Period

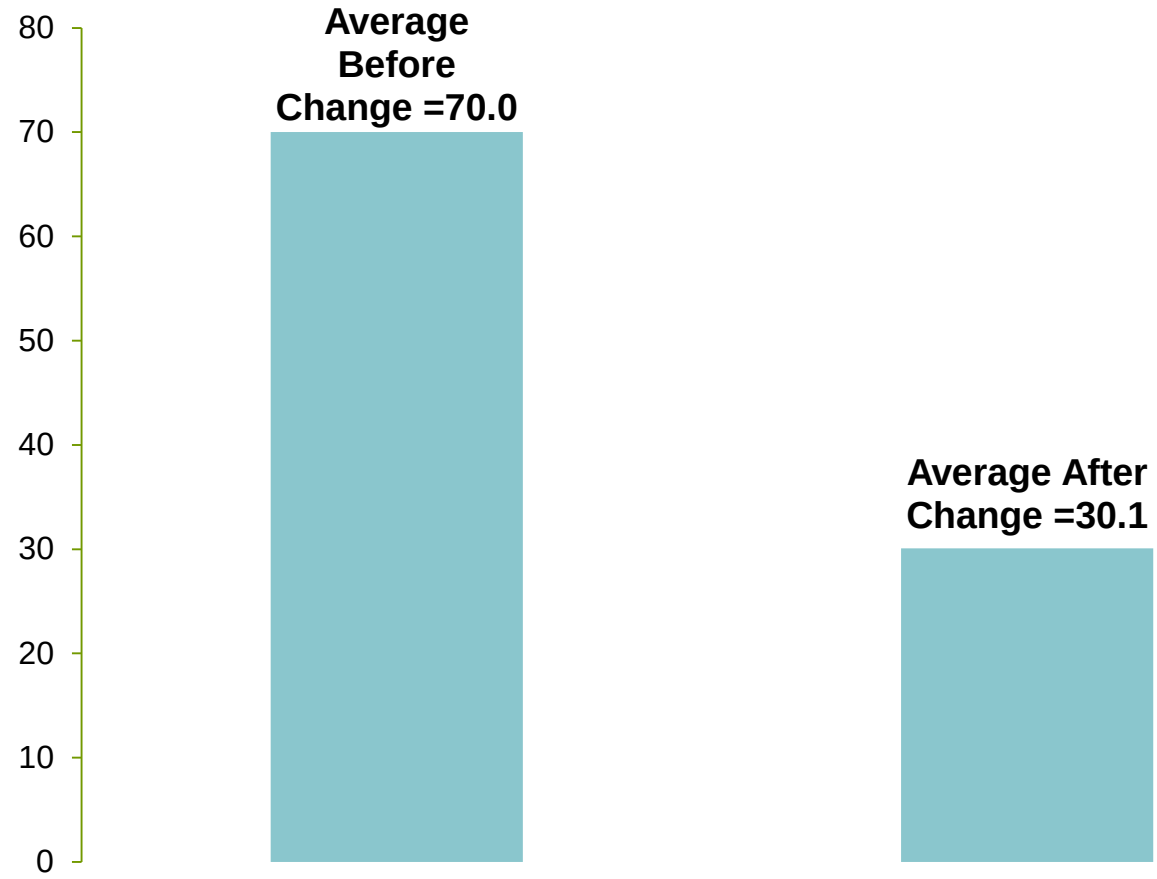

LOS - Hospital 2
Length of Stay (days)
0
1
2
3
4
5
6
7
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Period


LOS - Hospital 3
Length of Stay (days)
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 26 27 28 29 30
Period


LOS - Hospital 4
Length of Stay (days)
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 26 27 28 29 30
Period

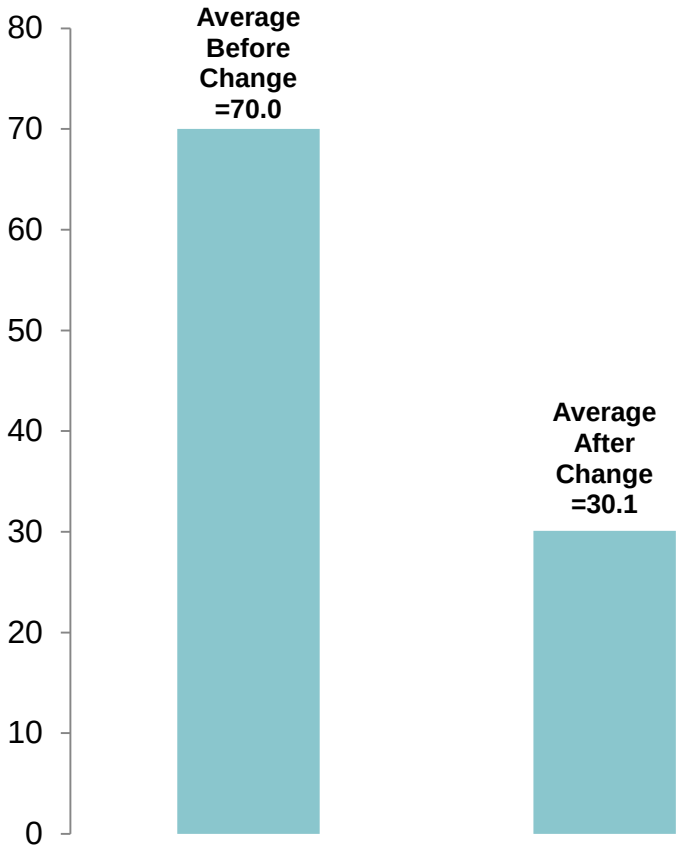

LOS - Hospital 5
Length of Stay (days)
0
1
2
3
4
5
6
7
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Period

# What if we use a t-test?

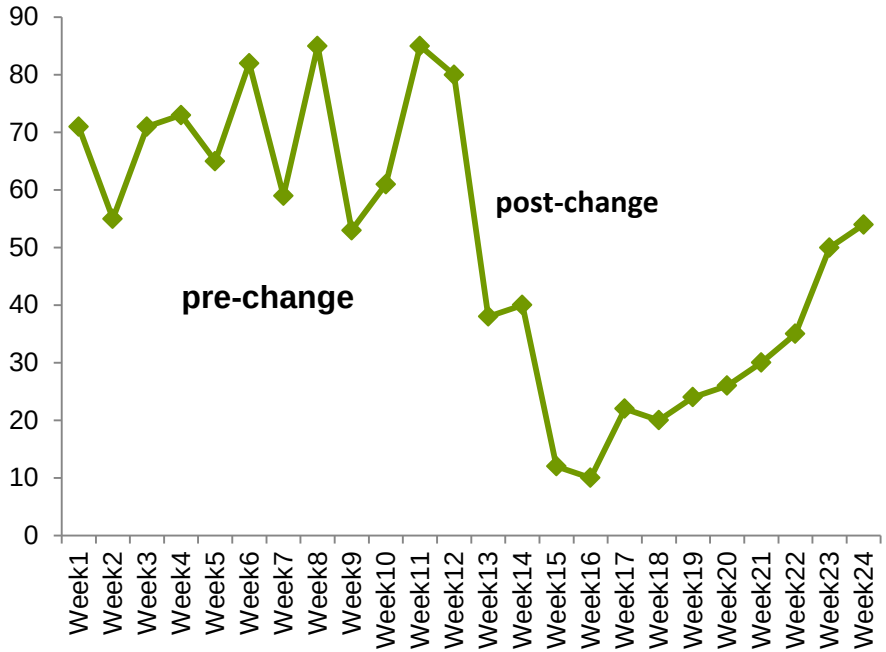



**The t-test shows a significant difference: t(22)=7.6, p<.001**

Adapted from Perla R.J., Provost L.P., & Murray S.K. (2011). The run chart: a simple analytical tool for learning from variation in healthcare processes. BMJ Quality & Safety, 20(1):46-51.




**t(22)=7.6, p<.001**

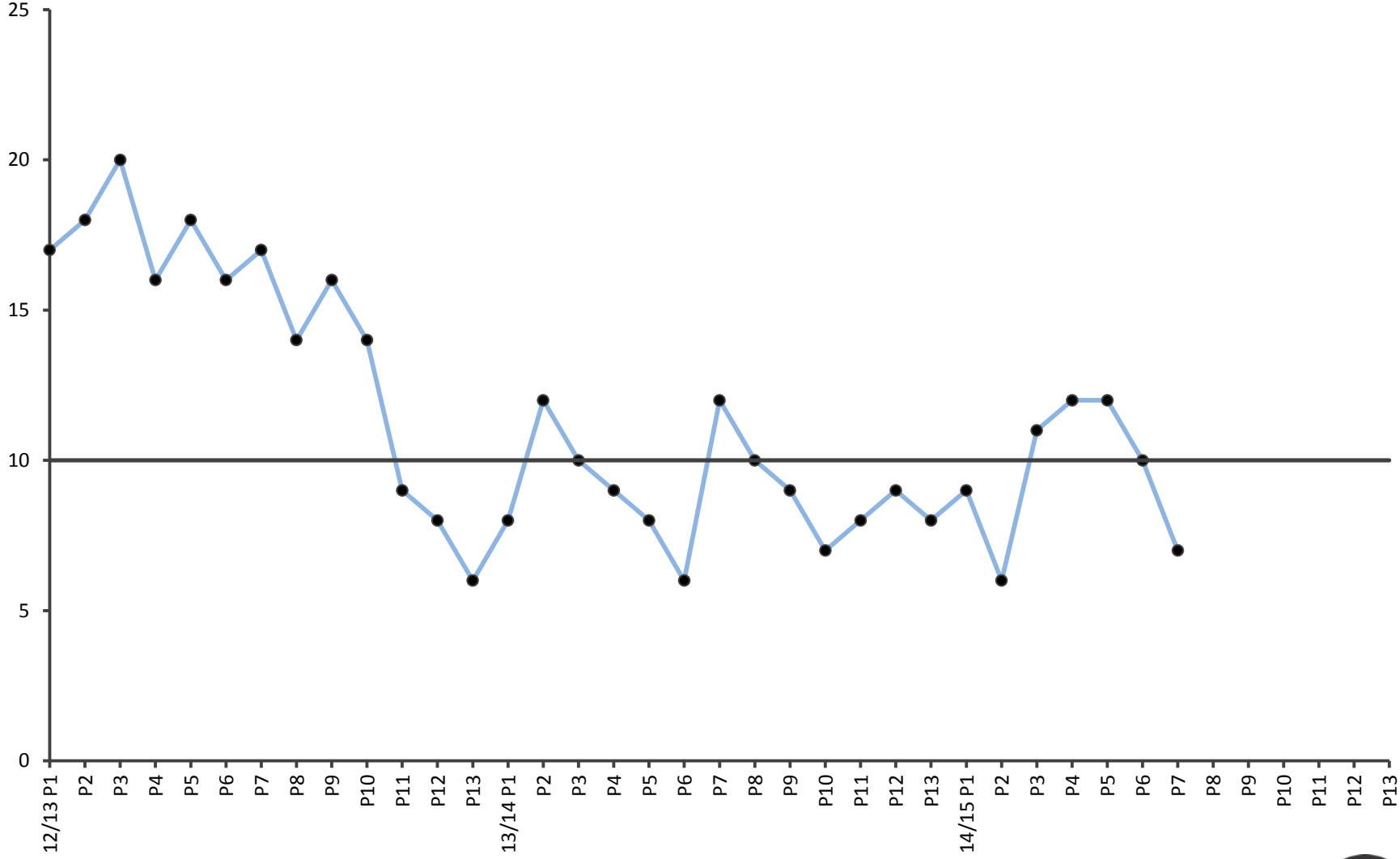



Adapted from Perla R.J., Provost L.P., & Murray S.K. (2011). The run chart: a simple analytical tool for learning from variation in healthcare processes. BMJ Quality & Safety, 20(1):46-51.

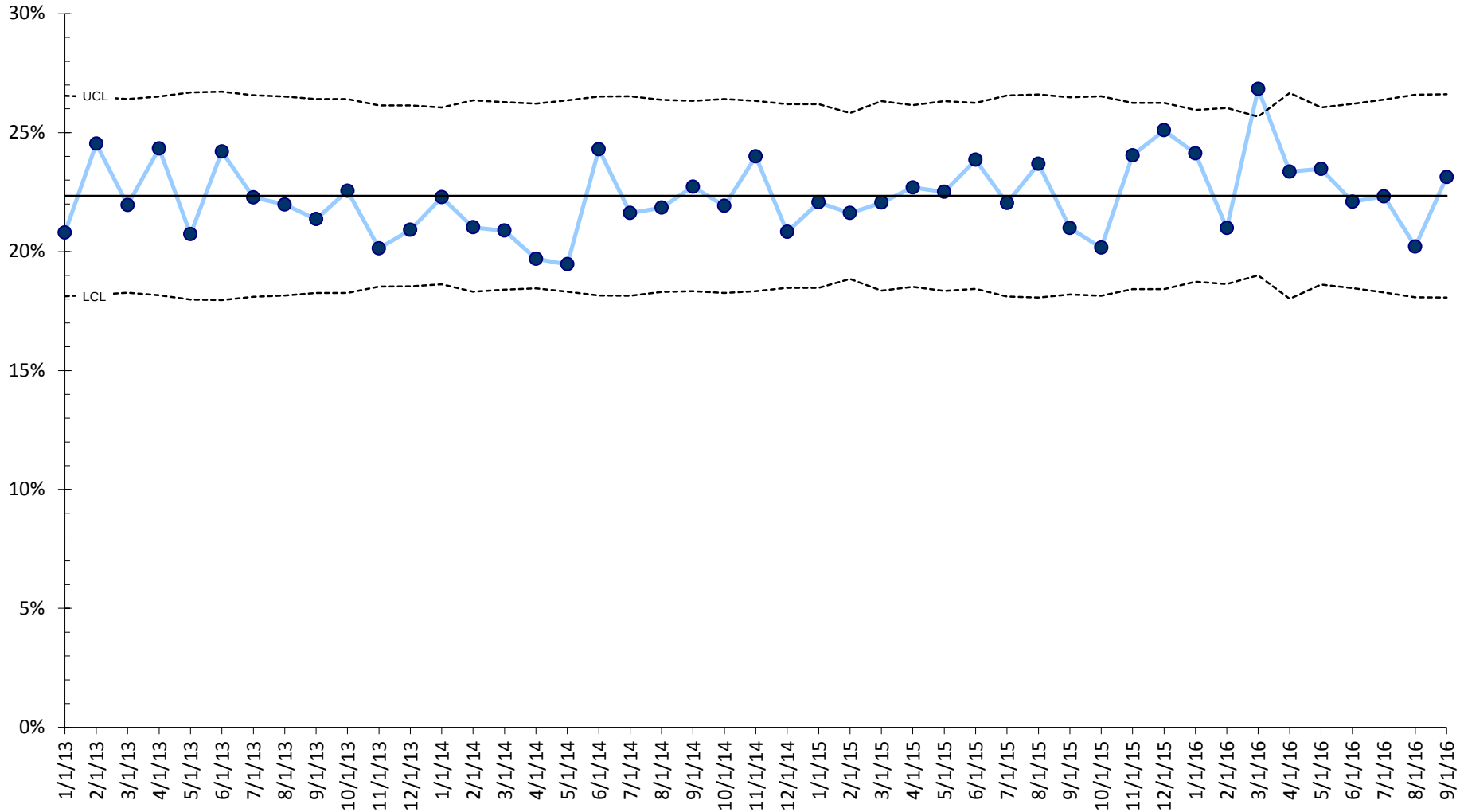
# Data in real-time

- Data in real time allows us to track progress of the work
- Tells us if we getting better or worse
- Tells us if the changes we are testing are working
  - The longer the lag, the slower the learning cycle

# Number of incidents



# Control Chart: Rate of All Cause Readmission of Indexed Heart Failure Episode



# Shewhart's Theory of Variation

**Common Causes**—those causes inherent in the system over time, affect everyone working in the system, and affect all outcomes of the system

- Common cause of variation
- Chance cause
- Stable process
- Process in statistical control

**Special Causes**—those causes ***not*** part of the system all the time or do not affect everyone, but arise because of specific circumstances

- Special cause of variation
- Assignable cause
- Unstable process
- Process not in statistical control

# Common and Special Causes of variation

**Write the letter “a” five times in a column**

## Stable Process –

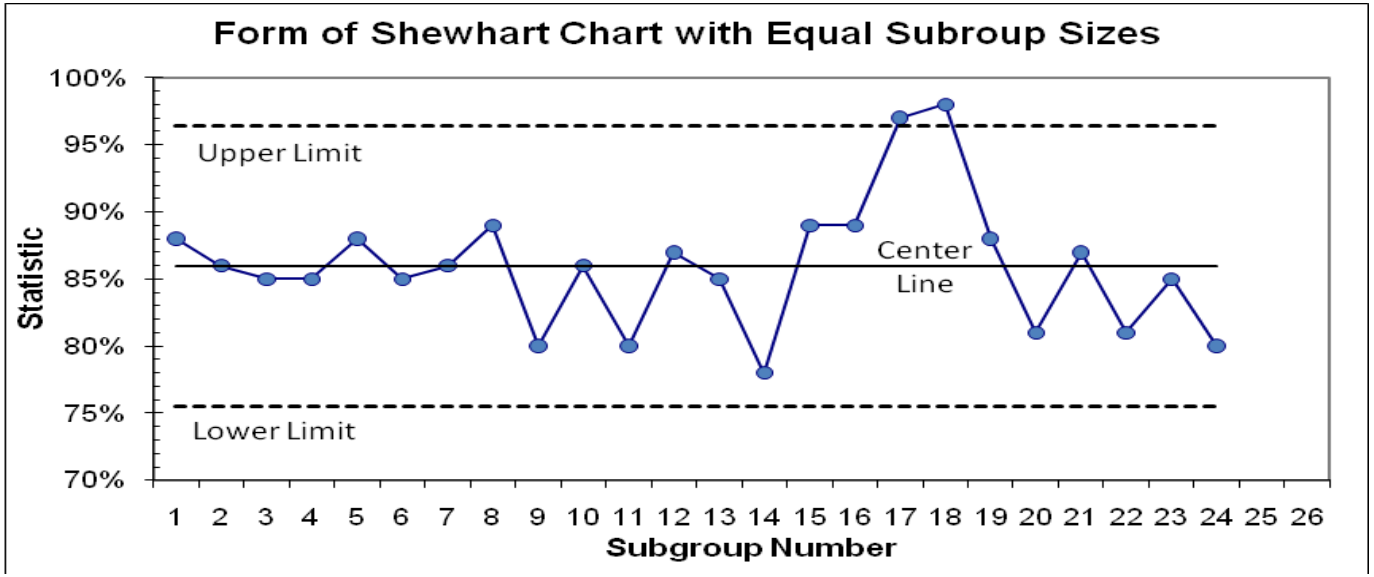
Implies that the variation is predictable within common bounds – only common cause variation.

## Unstable Process –

A process that is affected by both special cause variation and common cause variation. The variation from one time period to the next is unpredictable.

# Control Chart aka Shewhart Chart

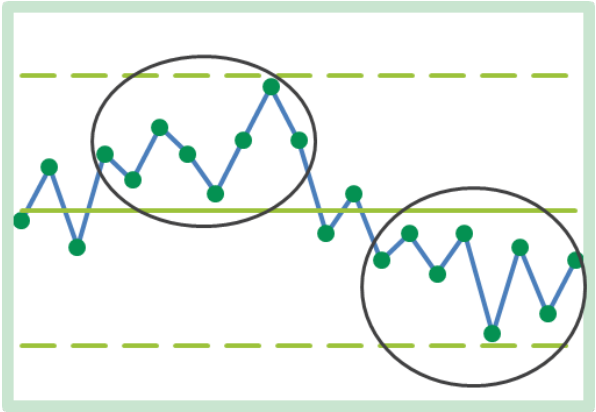
- The Shewhart chart is a statistical tool used to distinguish between variation in a measure due to common causes and variation due to special causes



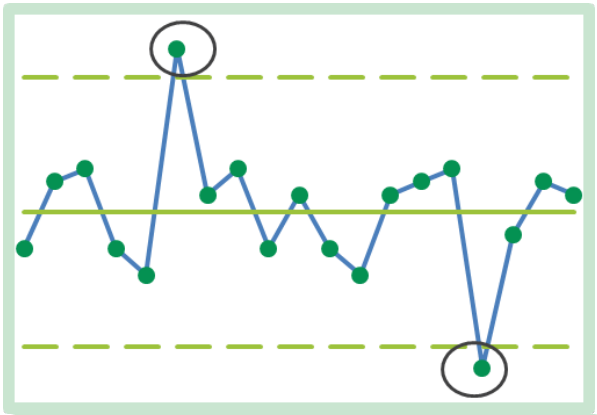

*(Most common name is a control chart, more descriptive would be learning charts or system performance charts)*

# Rules for determining Special Cause

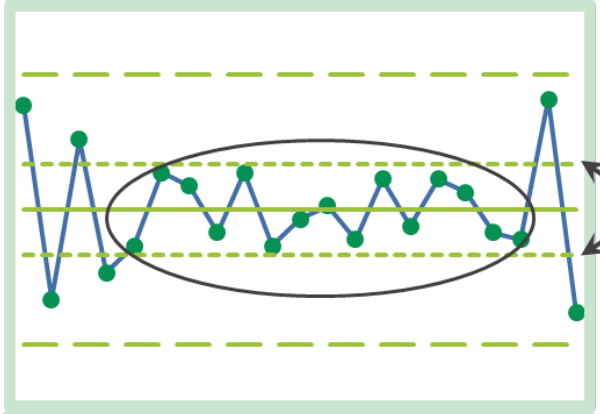
Eight or more on same side of the mean



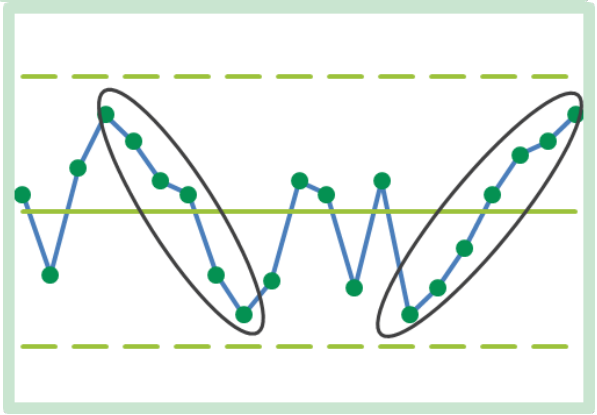
Point outside the control limits



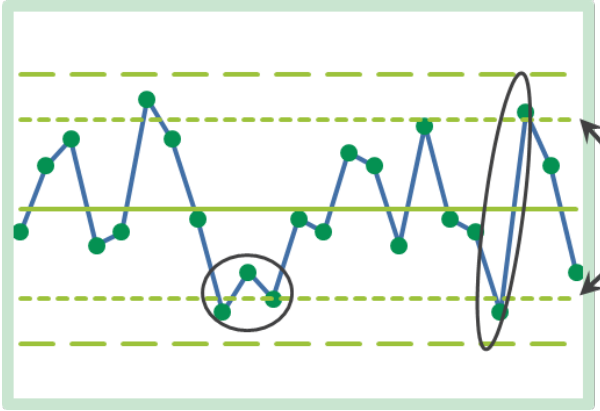
15 consecutive within 1 sigma



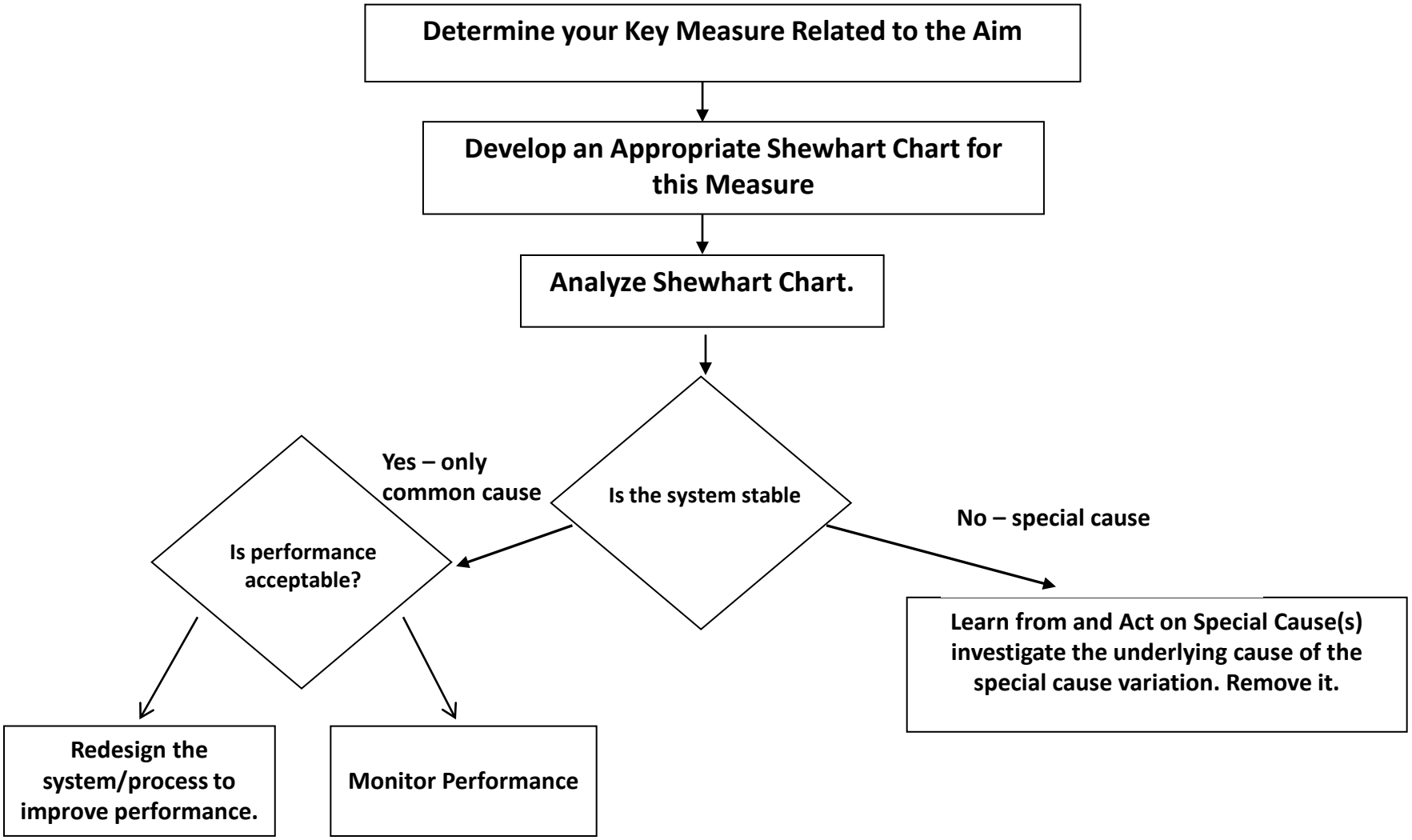

6 consecutive points up or down



2 out of 3 in the outer third



# How Understanding Variation Guides Improvement Work



# Reacting to Common and Special Cause Variation

| ACTION | No Special Cause, Only Common Cause | Special Cause |
|---|---|---|
| **Take action on individual points** | **Mistake1: costs money and time** | **Good approach** |
| **Try to change the whole system to improve it** | **Good approach** | **Mistake2: costs money and time** |

# Improvement efforts need a few key indicators…

- Monitor them over time
- Frequently collected
- As close to real time as possible
- Visually displayed
- Shared with the team

# A Few key indicators to track project progress

Guideline:  between 3-8 measures per project

- at least one outcome measure
- at least one process measure

# Family of Measures

| OUTCOME | PROCESS | BALANCING |
| --- | --- | --- |
| • Based on your Aim Statement (usually)<br>• What is better for the patient/customer?<br>• What is the result of the new process/procedure?<br>• What, ultimately, will be better? (not what are you trying to "do") | • Voice of the system<br>• What is being done differently that we want to capture?<br>• What is now being done consistently? | • What unintended consequences might occur?<br>• What are we worried about – that we can do something about? |
| Example 1: Median wait time from referral to seen by specialist | Example 1: Percent of referrals to the specialist that have complete information | Example 1: Median wait time from specialist appointment to date of surgery |
| Example 2: Percent of patients with a Surgical Site Infection | Example 2: Percent of patients with appropriate hair removal according to best practice | Example 2: Staff satisfaction with new forms for Surgical Site Infection guidelines |

# Operational Definitions

- Full description of a measure:
  - What is the measure
  - Inclusion/exclusion criteria
  - Calculation
  - Sample size
  - Sampling strategy
  - Subgroup frequency
  - Data collection strategy
  - By whom
  - Etc.

# Measurement Plan Worksheet

| Measure | Operational Definition | Outcome, Process or Balancing | Data Collection Strategy | Frequency of Data Collection | How will measure be displayed | Baseline result | Target result |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

# Operational Definitions

- Option 1
  - Number of people who fell
  - All patients over 5yrs
  - Number of patients with a fall/total number of patients
  - Complete enumeration
  - Monthly
  - Data source: DAD
- Option 2
  - Number of falls
  - Patients 70+
  - Count of all falls in the facility
  - Complete enumeration
  - Reports to PSLS
  - Monthly
- Option 3
  - Number of falls with an injury
  - All patients
  - Count of all falls in the facility that caused harm
  - Sample of 50 charts
  - Audit by quality department staff
  - Quarterly

# Sampling?

- Complete enumeration is best

- Sampling saves resources – usually recommended – use judgment samples

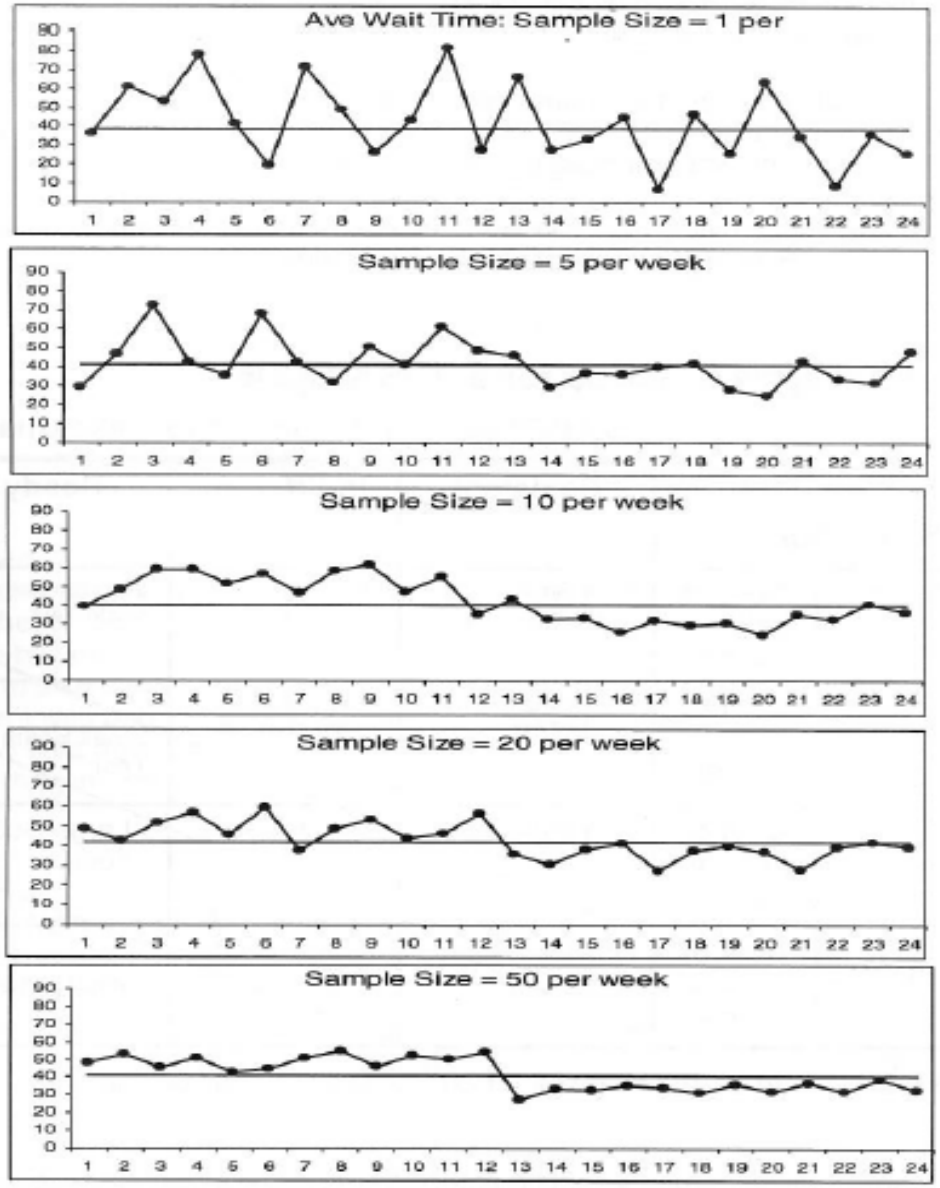



**Figure 2.10: Sample Size and Ability to Detect Change**

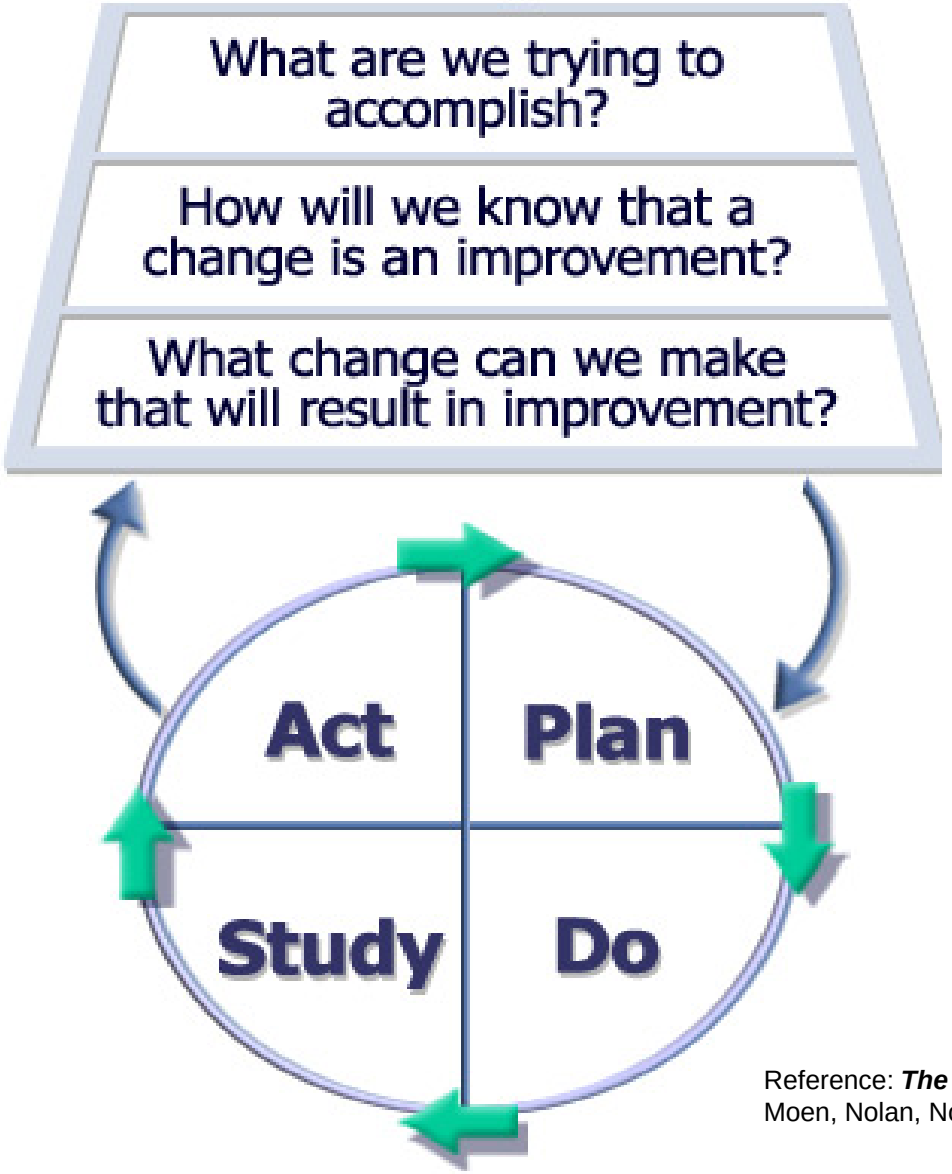
# DATA COLLECTION

- Start right away
- Small, frequent measures
- Integrate into workload
- Timely

“Measurement should be used to speed things up, not to slow them down”

- - IHI Breakthrough Series Guide

# Model for Improvement




Reference: ***The Improvement Guide***, 2nd ed. Langley, Moen, Nolan, Nolan, Norman & Provost, p. 24

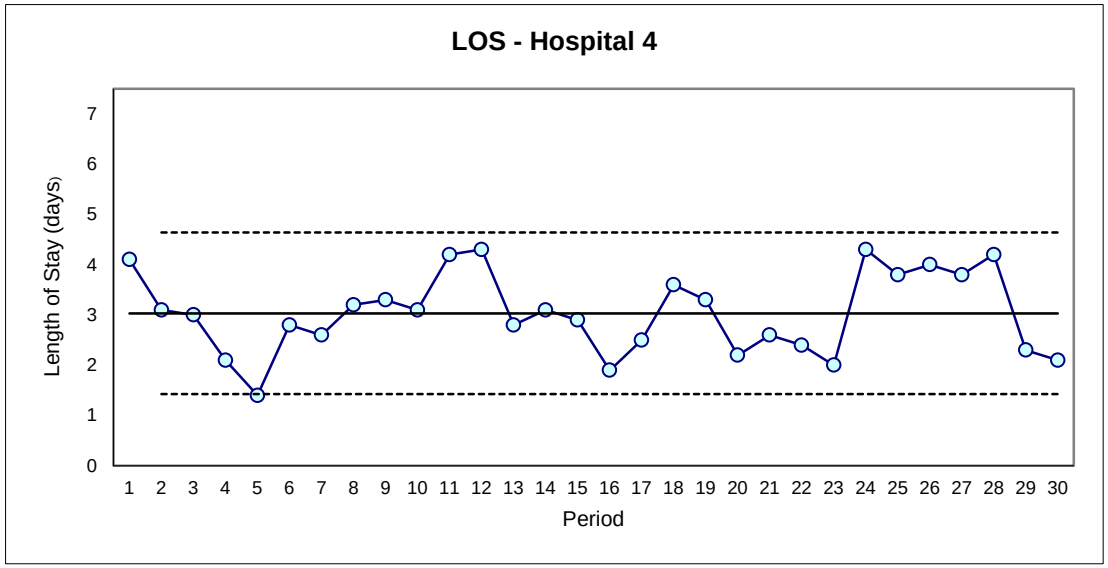
# Generate light, not heat, with data

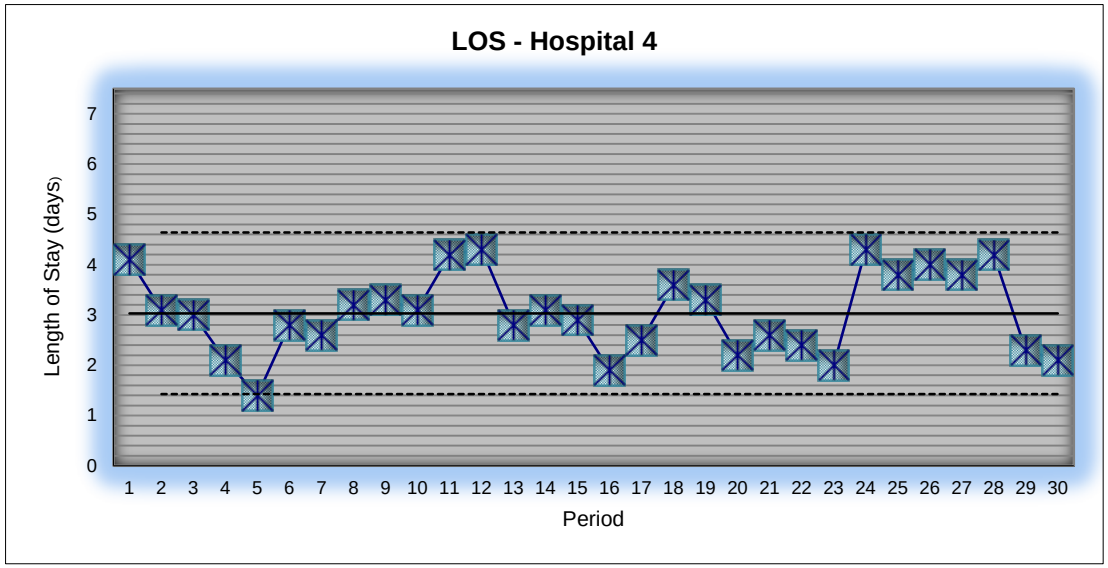

- Reinertsen JL, Gosfield AG, Rupp W, Whittington JW. *Engaging Physicians in a Shared Quality Agenda. IHI Innovation Series white paper. Cambridge, Massachusetts: Institute for Healthcare* Improvement; 2007

# Displaying Data Principles

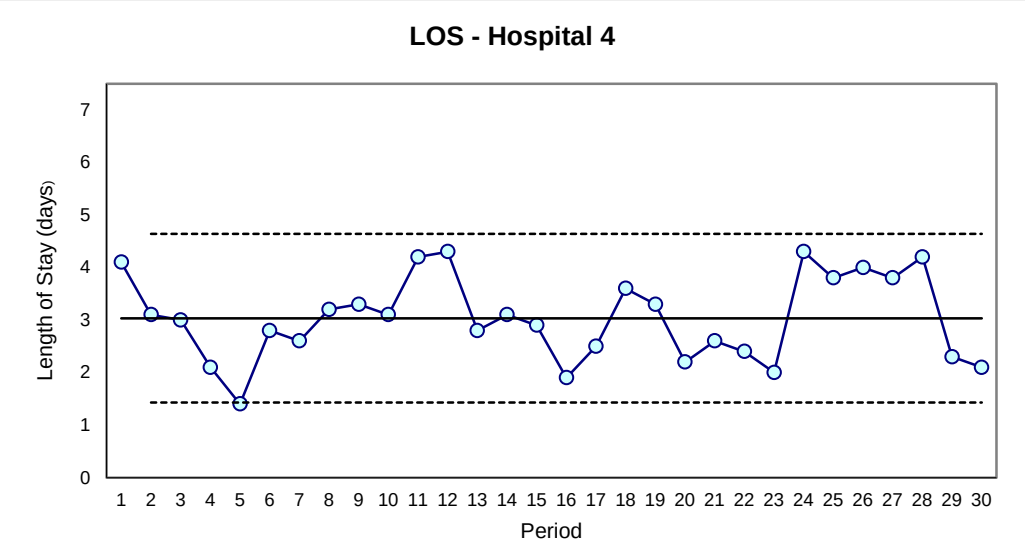
## Some Heuristics

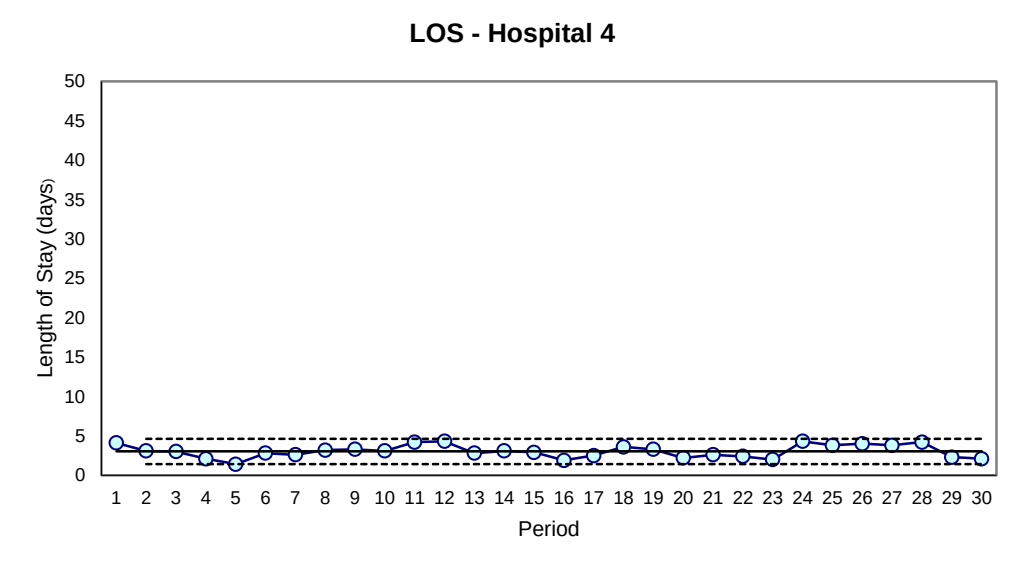
# Least Ink


LOS - Hospital 4
Length of Stay (days)
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 26 27 28 29 30
Period

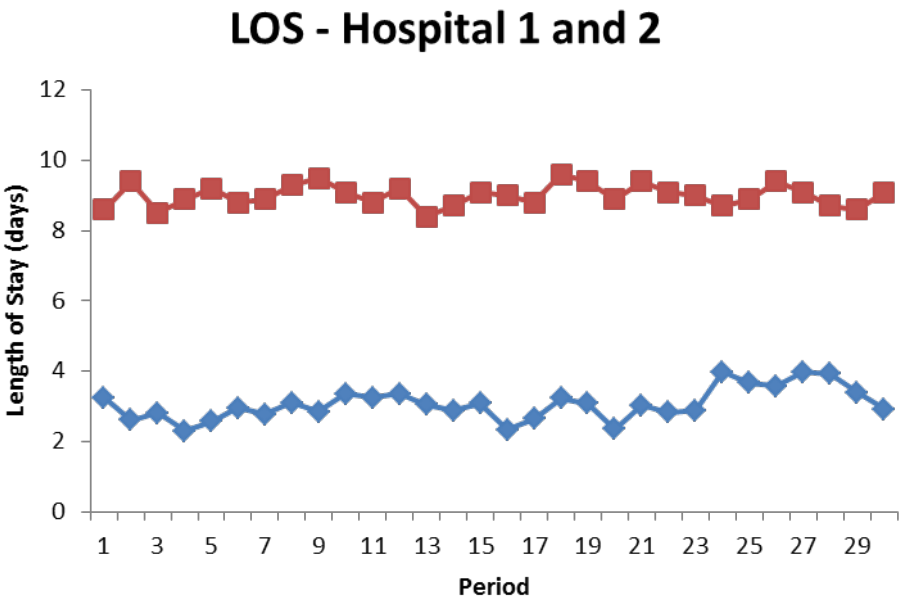

LOS - Hospital 4
Length of Stay (days)
0
1
2
3
4
5
6
7
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Period

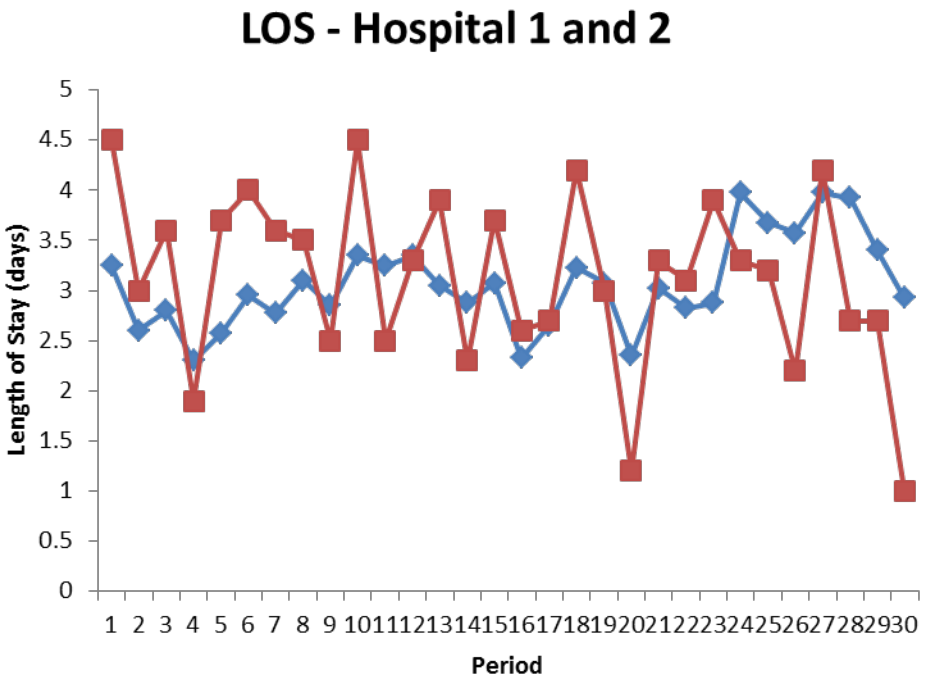
# Half White


LOS - Hospital 4
Length of Stay (days)
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 26 27 28 29 30
Period

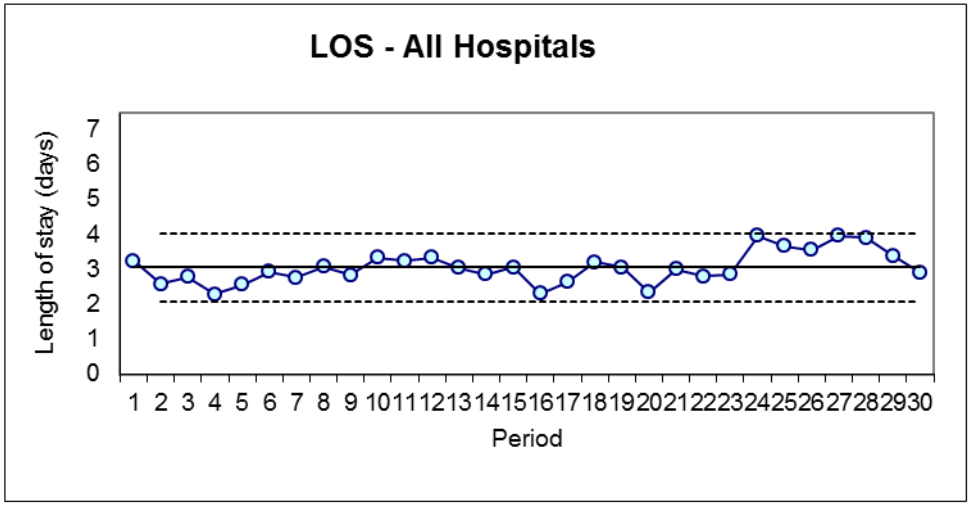

LOS - Hospital 4
Length of Stay (days)
0
5
10
15
20
25
30
35
40
45
50
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Period

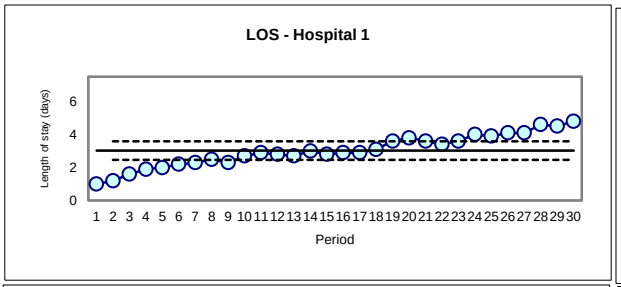
# Multiple indicators/sites

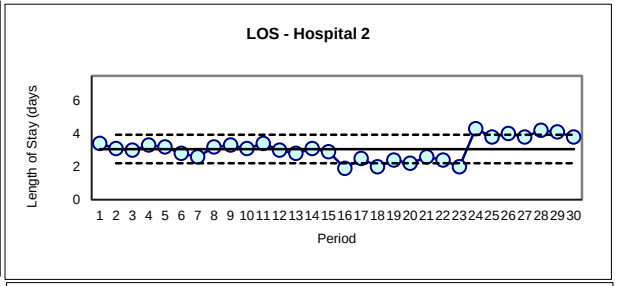


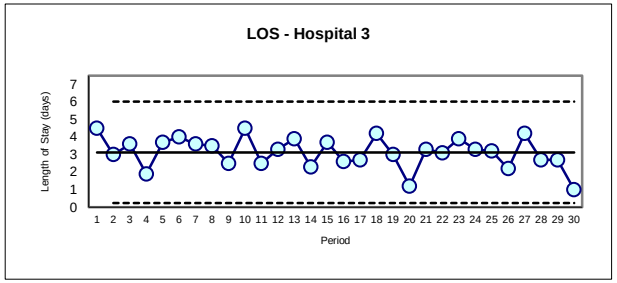



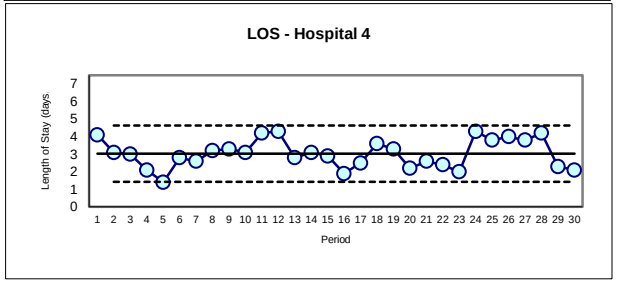
# Small Multiples



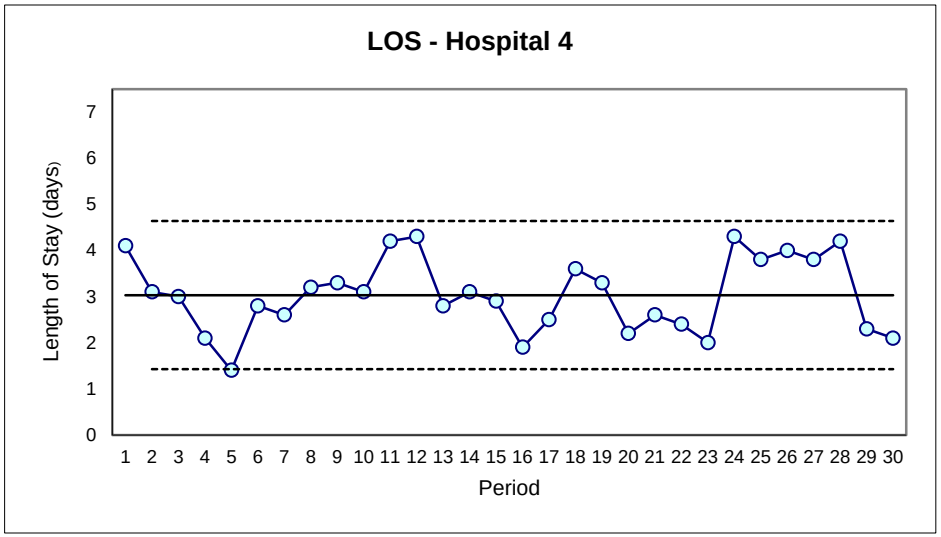



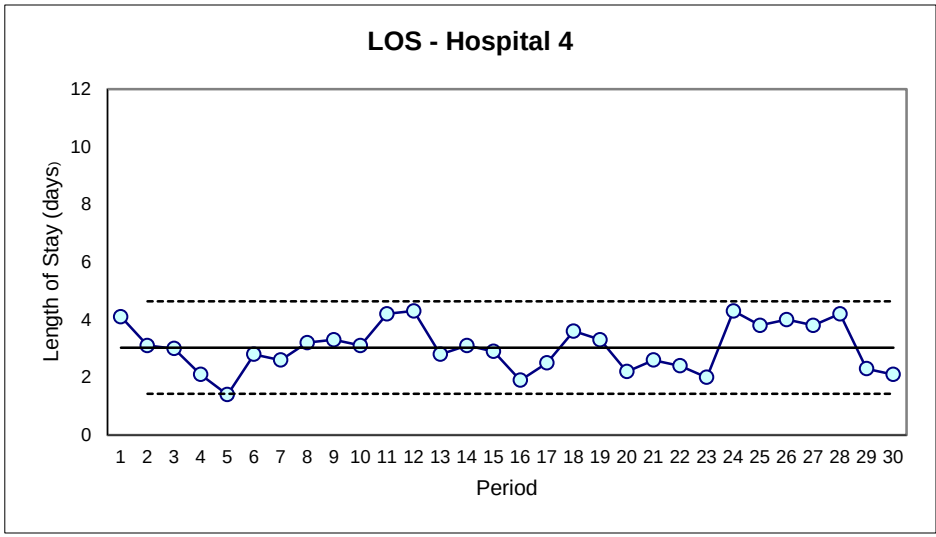



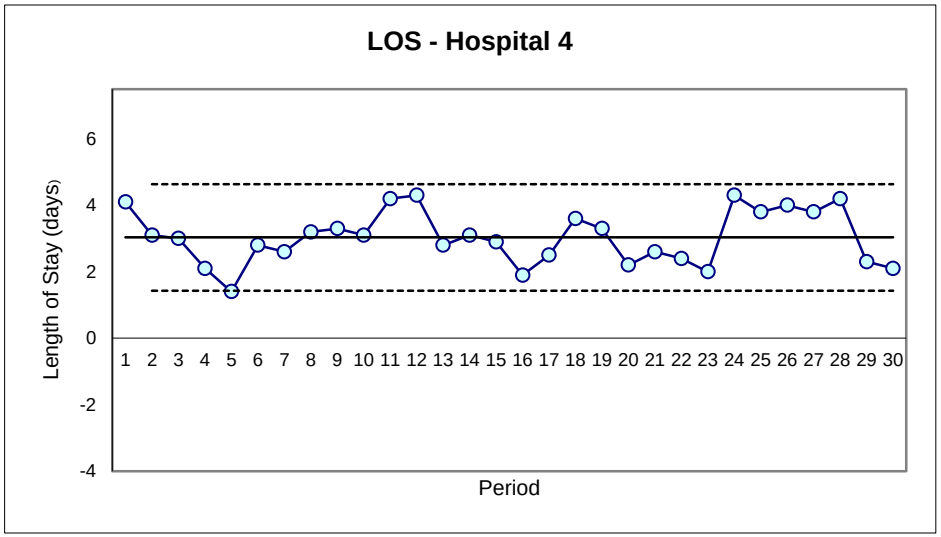



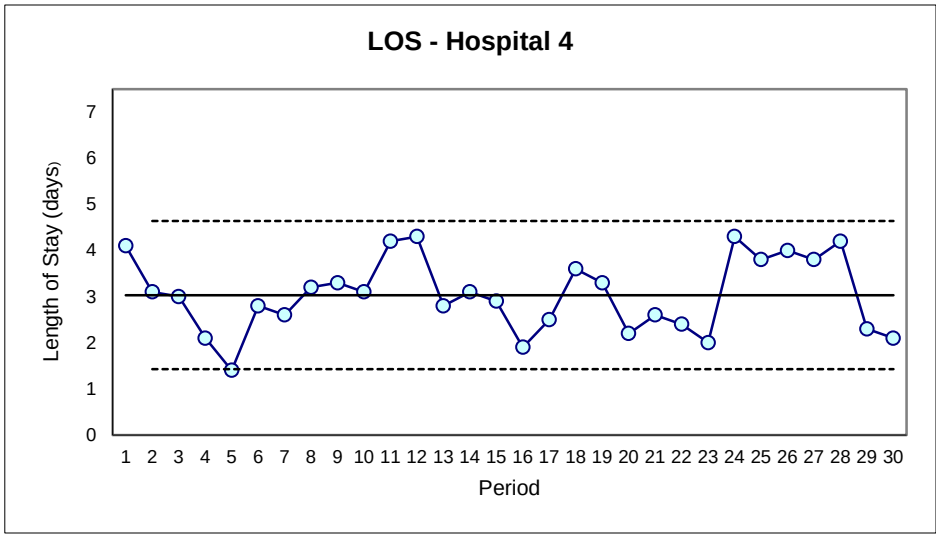
# Common Scales



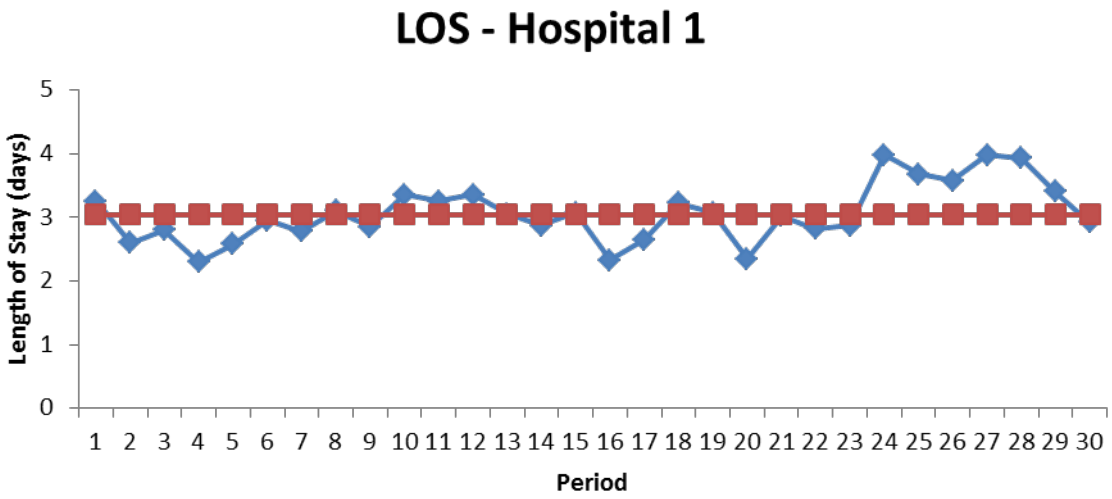



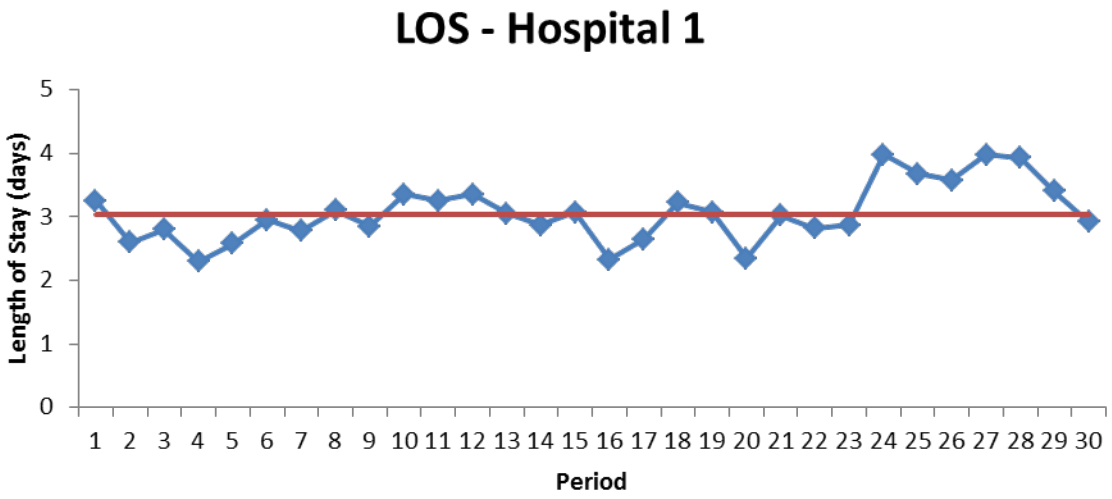
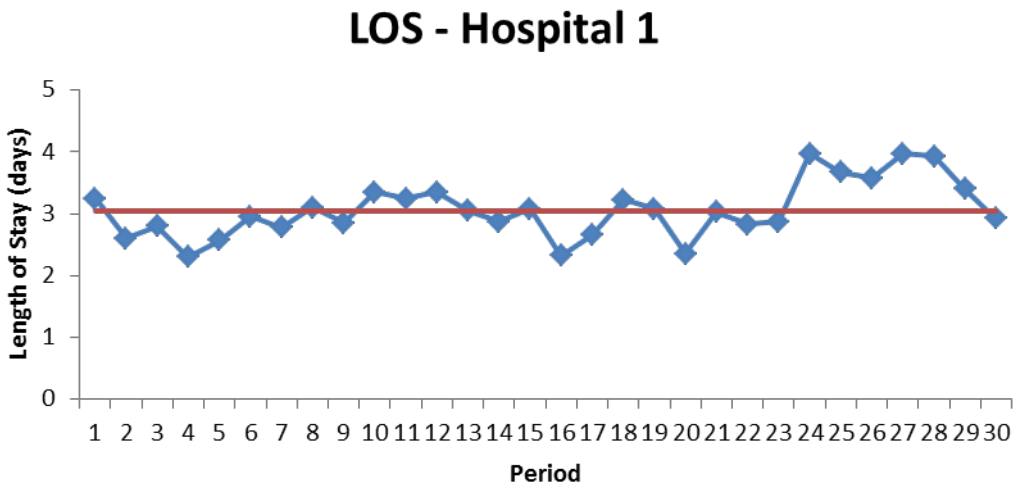
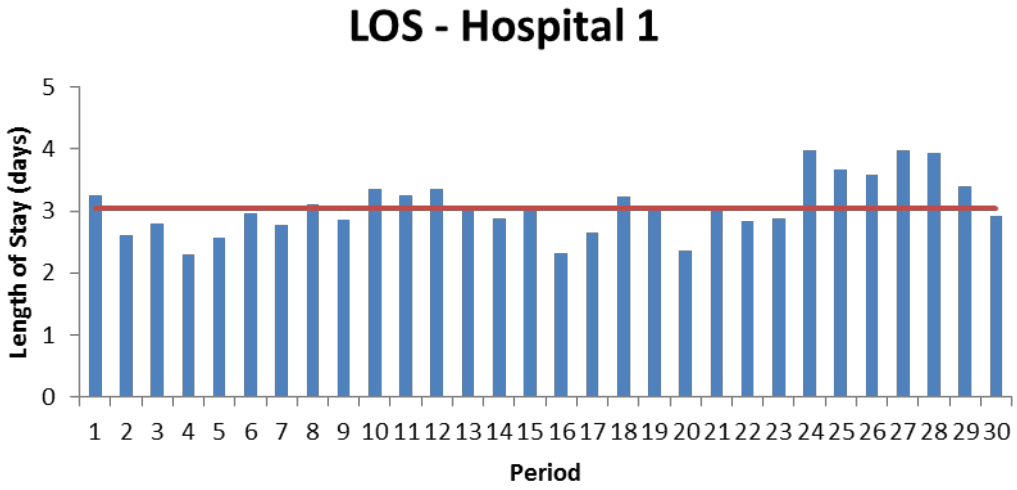
# Real Scales


LOS - Hospital 4
Length of Stay (days)
6
4
2
0
-2
-4
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 27 28 29 30
Period


LOS - Hospital 4
Length of Stay (days)
7
6
5
4
3
2
1
0
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 27 28 29 30
Period

# Data point or statistic?






# Bars over time?