Using Tools for Quality Improvement

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What’s wrong with this picture?

CAUTION
THIS SIGN HAS
SHARP EDGES
DO NOT TOUCH THE EDGES OF THIS SIGN
ALSO, THE BRIDGE IS OUT AHEAD
Lessons Learned

• There is too much data…
• Don’t get distracted from all the noise – focus on the core findings
• Set priorities – you can not do everything!
• Communicate clearly – tell folks what is important!
• Slow down… understand before you act
Why Do We Use Data?

• **Standard LD.03.02.01**
  
  • *The hospital uses data and information to guide decisions and to understand variation in the performance of processes supporting safety and quality.*

• **Elements of Performance for LD.03.02.01**
  
  1. Leaders set expectations for using **data** and information to improve the safety and quality of care, treatment, and services.
  
  2. Leaders are able to describe how **data** and information are used to create a culture of safety and quality.
  
  3. The hospital uses processes to support systematic **data** and information use.
  
  4. Leaders provide the resources needed for **data** and information use, including staff, equipment, and information systems.
  
  5. The hospital uses **data** and information in decision making that supports the safety and quality of care, treatment, and services. (See also NR.02.01.01, EPs 3 and 6; PI.02.01.01, EP 8)
  
  6. The hospital uses **data** and information to identify and respond to internal and external changes in the environment.
  
  7. Leaders evaluate how effectively **data** and information are used throughout the hospital.
Why Do We Use Data?

• Regulatory Standards & Expectations
  ▪ Have a well-developed question BEFORE data collection.
  ▪ Data needs to be STABLE and (statistically) PREDICTABLE.
  ▪ To Identify Opportunities for Improvement.
  ▪ Identify Changes that lead to Improvement.
  ▪ Sustain Improvement once we have made it.
Barriers To Putting Data Into Action

• Don’t even know where to get data / info
• Collecting the wrong data
• No one is interested in it
• Paralysis by analysis
• Incorrect interpretation of data
• Too complex to understand
• Defensiveness
Incorrect Interpretation of Data
Too Complex to Understand

The more you know, the harder it is to take decisive action.

Once you become informed, you start seeing complexities and shades of gray.

You realize that nothing is as clear and simple as it first appears. Ultimately, knowledge is paralyzing.

Being a man of action, I can’t afford to take that risk.

You’re ignorant, but at least you act on it.
Comparison Chart: Low Acuity Pediatric Asthma ALOS Measure

TCH Asthma Care Initiative in 2005
Stages of Coping with Data

• *Stage I:* “The data are wrong....”
TCH Asthma Care Initiative in 2005

- Over 200 Asthma Action Plans
  - 25% of inpatients received AAP
- Oxygen weaning strategies ranging from 5 minutes to 24 hours prior to discharge
- Beta agonists:
  - No weaning protocol or dose delivery protocol
  - 20% of patients received MDI treatments
Stages of Coping with Data

• **Stage I**: “The data are wrong….”

• **Stage II**: “The data are right, but it’s not a problem…”

• **Stage III**: “The data are right, it’s a problem, but it’s not my problem…”

• **Stage IV**: “The data are right, it’s a problem, it’s my problem…”

- IHI – Take the Journey to “Jiseki”
Value Data

In God We Trust,

All Others Bring Data.

W. Edwards Deming
How Do We Make Sense of Data?
Quality Improvement Tools

"And that, as you can see, explains nothing."
What do you see?

**Pessimist:** Glass is half empty!

**Optimist:** Glass is half full!

**Know-it-all:**
Glass is FULL!
Half Air & Half Water!

**Quality Improvement Practitioner:**
VOC: Customer only needs this much water. Our capacity is larger than it needs to be!
Purpose of QI Tools

“If the only tool you have is a hammer, you will see every problem as a nail.”

Abraham Maslow, 1966
Purpose of QI Tools

• Describe and improve processes
• Evaluate process or output variation
• Assist with decision-making
• Analyze data in a variety of ways
• Display information
## Types of QI Tools

### Quality Improvement Tool Selection Matrix

| NOTE: | Tool                                      | E/F | 1 Charter & Plans | 2 Customer Needs | 3 Current State | 4 Opportunities | 5 Root Causes | 6 Changes | 7 Do it | 8 Monitor | 9 Standardize | 10 Learnings |
|-------|-------------------------------------------|-----|-------------------|------------------|----------------|----------------|---------------|------------|--------|----------|-----------|-------------|--------------|
|       | ACORN test                                | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Arrow Diagram                             | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Balanced Scorecard                        | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Barriers & Benefits Exercise              | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Check List (generic)                      | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Contingency Diagram                       | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Continu num of Team Goals                 | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Flowchart (generic)                       | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Force-Field Analysis                      | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Gantt Chart                               | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Matrix Diagram (generic)                  | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Meeting Evaluation                        | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Mind Map                                  | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Operational Definitions                   | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Plan-Do-Study-Act Cycle                   | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Plan-Results Chart                        | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Potential Problem Analysis                | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Presentation                              | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Process Decision Program Chart            | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Project Charter                           | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Project Charter Checklist                 | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Relations Diagram                         | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Stakeholder Analysis                      | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Storyboard                                | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Table (generic)                           | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Tree Diagram                              | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Two-dimensional chart (generic)           | F   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Wordsmithing                              | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Affinity Diagram                          | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Benchmarking                              | E/F | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |
|       | Brainstorming                             | E   | ●                 | ●                | ●              | ●              | ●             | ●          |        |          |            |             |              |

### Divergent & Convergent Tools

- ACORN test
- Arrow Diagram
- Balanced Scorecard
- Barriers & Benefits Exercise
- Check List (generic)
- Continu num of Team Goals
- Flowchart (generic)
- Force-Field Analysis
- Gantt Chart
- Matrix Diagram (generic)
- Meeting Evaluation
- Mind Map
- Operational Definitions
- Plan-Do-Study-Act Cycle
- Plan-Results Chart
- Potential Problem Analysis
- Presentation
- Process Decision Program Chart
- Project Charter
- Project Charter Checklist
- Relations Diagram
- Stakeholder Analysis
- Storyboard
- Table (generic)
- Tree Diagram
- Two-dimensional chart (generic)
- Wordsmithing

- Affinity Diagram
- Benchmarking
- Brainstorming
Purpose of QI Tools

However, you don’t have to use EVERY tool for every problem.
Basic Decision Making Toolbox

Histogram
Pareto Chart
Scatter Diagram
Run Chart
Control Chart
Definitions

**Distribution** - Tendency of large numbers of observations to group themselves around some central value with a certain amount of variation or "scatter" on either side

**Variation** - Any quantifiable difference between individual measurements; such differences can be classified as being due to common causes (random) or special causes (assignable)
Definitions

Discrete Data – (Attribute) Data that is qualitative, rather than quantitative. (i.e. Color, Type, Characteristic, yes/no, location, etc.)

Continuous Data – (Variable) Data that is quantitative, rather than qualitative. (i.e. length, time, age, weight, volume, etc.)
Definitions

Measures of Central Tendency - relates to the way in which one dimensional quantitative data tend to cluster around some value

Arithmetic mean, Median, Mode, Geometric mean, Harmonic mean, Weighted mean, Truncated mean, Midrange, Midhinge, Trimean, Winsorized mean.

Average - a measure of the "middle" or "typical" value of a data set
Measures of Central Tendency

“The Average”

Average Length of Stay
Average Age
Average Cost
Average Throughput Time
Average Turnover Time
Average Time to Admission
Etc.
What Constitutes an “Average”?

**Mean** – The mathematical average of a group of measurement values.

**Median** – The middle of a group of measurement values when arranged in numerical order.

**Mode** – The most frequently occurring value in a group of measurements.
“If I stick my right foot in a bucket of boiling hot water and my left foot in a bucket of freezing ice water, on the average, I’m pretty comfortable.”

Author Unknown
Definition of “Average”

Age of Patients Treated in the EC for Syncope

- **Mean** – The mathematical average of a group of measurement values.
Definition of “Average”

Age of Patients Treated in the EC for Syncope

- **Median** – The middle of a group of measurement values when arranged in numerical order.

![Bar chart showing age distribution of patients treated in the EC for syncope with median and mean indicated.](chart.png)
Definition of “Average”

Average Age of Patients with Falls

- **Mode** – The most frequently occurring value in a group of measurements.
Welcome to Quality Medical Center

- The Quality Medical Center (QMC) Management Team is proud of their system of metrics.

- They monitor a wide variety of indicators and carefully compare the averages for these indicators to performance targets on a regular basis.

- They are confident that this process provides them with accurate information of the status of key processes and enables them to make effective management decisions.
But, is this confidence founded?

Let’s look at several scenarios.

• QMC has an innovative new treatment plan for a chronic medical condition with one therapeutic session per day.

• The QMC target for inpatient therapeutic sessions is 8.

• The upper and lower thresholds for this indicator are 9 sessions and 7 sessions respectively.
What are the Consequences?

Based on agreements with the third party payors:

- If inpatient days exceed 9 the hospital reimbursement for those days will be denied.

- If therapeutic sessions are less than 7 there is a greater chance of unplanned readmission, which again will lead to decreased reimbursement.
But, is this confidence founded?

- Their monthly reports to the hospital executives consistently report an average of 8 sessions.

So they are consistently on target…. Right?
Scenario #1: Best Case Scenario
“See, I told you so!”

OP Avg Sessions Histogram

Average: 8.0
Percent Within Standard: 83%
Scenario #2: What happens when the distribution “widens-out”?

**Average Sessions Histogram**

- **Average:** 8.0
- **Percent Within Standard:** 45%
Scenario #3: A Skewed Distribution

OP Avg Sessions Histogram

Average: 8.0
Percent Within Standard: 21%
Scenario #4: “What do you mean we missed the target altogether?”

OP Avg Sessions Histogram

Average: 8.0
Percent Within Standard: 0%
With only the average, there’s no way to determine “what really happened.”
“Do not put your faith in what statistics say until you have carefully considered what they do not say.”

William W. Watt
What does the data tell you?
“There are three kinds of lies: lies, damned lies, and statistics.”

Mark Twain
Basic Decision Making Tools

• Bar Charts
Basic Decision Making Tools

Histogram
What is a Histogram?

- A bar graph that shows the distribution of CONTINUOUS data
- A snapshot of data taken from a process
When are Histograms used?

- Summarize large data sets graphically
- Compare process results to specification
- Communicate information to the team
- Assist in decision making
Descriptive Statistics should be included with Histograms to help with their understanding.
# Descriptive Statistics

<table>
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<tr>
<th>Wait Time (Hours)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>5.39</td>
</tr>
<tr>
<td>Standard Error</td>
<td>0.06</td>
</tr>
<tr>
<td>Median</td>
<td>5.45</td>
</tr>
<tr>
<td>Mode</td>
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</tr>
<tr>
<td>Standard Deviation</td>
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<tr>
<td>Sample Variance</td>
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<tr>
<td>Kurtosis</td>
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<tr>
<td>Skewness</td>
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</tr>
<tr>
<td>Range</td>
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</tr>
<tr>
<td>Minimum</td>
<td>2.95</td>
</tr>
<tr>
<td>Maximum</td>
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</tr>
<tr>
<td>Sum</td>
<td>808.4</td>
</tr>
<tr>
<td>Count</td>
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</tbody>
</table>
Distribution

Histogram of Time To Thrombolitics

Normal

Frequency

Time To Thrombolitics (Minutes)

Mean 35.09
StDev 24.87
N   55
Distribution

Histogram of Radiology Report Turnaround Time

Normal

Mean 16.03
StDev 9.978
N 300

Radiology Report Turnaround Time (Hours)

Frequency

0 5 10 15 20 25
-8 0 8 16 24 32 40
Distribution

Hemoglobin A1C

<table>
<thead>
<tr>
<th>LSL</th>
<th>USL</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>n</th>
<th>Shape</th>
<th>Scale</th>
<th>Intercept</th>
<th>Location</th>
<th>R-squared</th>
<th>Pp</th>
<th>Ppk</th>
<th>PpU</th>
<th>PpL</th>
<th>Skewness</th>
<th>Stdev</th>
<th>Min</th>
<th>Max</th>
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<tbody>
<tr>
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<td>6.40</td>
<td>8.05</td>
<td>7.50</td>
<td>7.5, 9.6, 11.6, 8.7, 6.4, 7.2, 6.8, 4.8, 5.4</td>
<td>43</td>
<td>3.10</td>
<td>9.02</td>
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<td>0.00</td>
<td>0.98</td>
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<td>-0.19</td>
<td>0.47</td>
<td>0.33</td>
<td>2.87</td>
<td>3.20</td>
<td>14.10</td>
</tr>
</tbody>
</table>
Histogram Analysis

- Histograms are a snapshot in time and show “distribution”.

- They do NOT show trends over time.
Histogram

What Have People Used Histograms For?

- Time to complete a type of lab test.
- Minutes waiting time.
- Cost per case
- Length of Stay
- Age of all unplanned readmits
- Length of time to respond to STAT Requests from ED for radiology
- Number of sessions of therapy attended before premature termination of therapy.
Basic Decision Making Tools

Pareto Chart
What is a Pareto Chart?

- Bar chart arranged in descending order of height from left to right
- Bars on left relatively more important than those on right
- Separates the "vital few" from the "useful many" (Pareto Principle)
- 80/20 Rule
  - 80% of the gain from 20% of the categories

![Budget Allocation Chart](chart.png)
Why use a Pareto Chart?

• Breaks big problems into smaller pieces
• Displays causes or problems in priority order
• Identifies most significant factors
• Shows where to focus efforts
• Allows better use of limited resources
Why use a Pareto Chart?

Most people trying to start an improvement try to tackle ALL of the problems at one time rather than breaking it down into manageable pieces.

“If we pull this off, we’ll eat like kings.”
Pareto Chart Construction

N = 122

Break Point

Count of Complaints

Complaint Categories

Patient Satisfaction Complaints - January 1 - June 30, 2004
Pareto Chart

Obstetrical Complications

- Other Obstetrical: 364 cases (65%)
- Advanced Perineal: 115 cases (85%)
- Delivery Wound: 39 cases (92%)
- Major Puerperal: 22 cases (96%)
- Camp. of: 7 cases (97%)
- Major Puerperal: 6 cases (98%)
- Rupture of Uterus: 4 cases (99%)
- Pulmonary embolism: 2 cases (99%)
- Camp. of: 2 cases (100%)
- Deep: 1 case (100%)
Pareto Chart

Causes For Medications Not Being Delivered On-Time

- Generic Versus Manufactured Label
- Drug Out Of Stock
- Cannot Read Order
- Physician Revised Medications
- Complete Medication
Pareto Chart

CANCELLATION REASONS

Count

DR REQUEST  NO REASON GIVEN  PARENT CANCEL  PATIENT SICK  TRANSPORTATION  PAPERWORK NOT CLEARED  SCHED ERROR  RESCHEDULE  INSURANCE ISSUES  Other

Count:
21  9  9  5  4  3  3  2  1  2
Percent:
35.6  15.3  15.3  8.5  6.8  5.1  5.1  3.4  1.7  3.4
Cum %:
35.6  50.8  66.1  74.6  81.4  86.4  91.5  94.9  96.6  100.0
Pareto Chart

CY 14 Top 10 MDC by Average Billed Charges

CY 14 Top 10 MDC by Total Billed Charges

CY 14 Top 10 MDC by Volume

Texas Children's Hospital
Pareto Chart

What Have Others Used Pareto For?

- Sources of referrals to home care
- Reasons for same day surgery cancellations
- What customers called most about in Managed Care Organizations (what benefits)
- Causes of readmission
- Reasons for patients switching physicians
- Hospitals with most unplanned C-sections
- Causes of falls, needlesticks, med errors
- Reasons for Monday phone calls
- Reasons for delays (Discharge, etc)
Basic Decision Making Tools

Scatter Diagram
What is a Scatter Diagram?

A graph of paired data points plotted on a table that helps identify the possible relationship between the changes observed in two different sets of variables.
Why use Scatter Diagrams?

• Supplies the data to confirm a hypothesis that two variables are related.

• Provides both a visual and statistical means to test the strength of a potential relationship.

• Provides a good follow-up to a Cause and Effect Diagram to find out if there is more than just a consensus connection between causes and the effect.
Why use Scatter Diagrams?

“Watch what happens when I do this.”
Interpreting Scatter Diagrams

• **Strong Positive Correlation**: An increase in y may depend on an increase in x.

• **Moderate Positive Correlation**: If x is increased, y may increase somewhat.

• **No Correlation**: There is no demonstrated connection between training experience and session ratings.

• **Moderate Negative Correlation**: As x is increased, y may decrease somewhat.

• **Strong Negative Correlation**: A decrease in y may depend on an increase in x.

• **Non-Linear or Curvilinear**: May increase or decrease alternately to create an arch or sigmoid curve
Scatter Diagram Correlation

- Strong positive correlation
- Moderate positive correlation
- No correlation
- Moderate negative correlation
- Strong negative correlation
- Curvilinear relationship
Do Calories Consumed Affect Weight Gained?

- **R² = 0.9403**

![Scatter Diagram Example](image-url)
Does Gestational Age Affect Birth Weight?

Birth Weight (gm)

Gestational Age (weeks)

R² = 0.6683
Scatter Diagram Example

Is there a correlation?
Scatter Diagram Example

Beware of False Correlation
Scatter Diagram

What Have People Used Scatter Diagrams For?

- Following are paired samples \((X, Y)\)
  - (amount of Pitosin given, length of labor)
  - (amount of drug given, pain rating)
  - (minutes treatment given, mobility rating)
  - (rating on a particular question, overall customer satisfaction rating)
  - (age, length of stay)
  - (# phone orders, rate of late prescription fills)
  - (volume of work, proportion of errors)
Basic Decision Making Tools

Understanding Variation
Basic Decision Making Tools

Variation

Variation - Any quantifiable difference between individual measurements; such differences can be classified as being due to common causes (random) or special causes (assignable).

Variation: A change in data, characteristic or function caused by one of four factors: common causes, special causes, tampering or structural variation.

- American Society for Quality
# Common vs Special Causes of Variation

## Common Causes
- Also called Chance causes of variation.
- Inherent in the process, affect all data points.
- Must focus on improving the process to decrease common cause variation.
- The “background noise” of the process.
- All processes manifest some degree of Common Cause variation.

## Special Causes
- Also called Assignable causes of variation.
- Result from some factor unique to a data point.
- Focus on removing special causes to bring process into statistical control.
Neither type of variation is “good” or “bad” in itself!

COMMON CAUSE

• Only tells you that a process is stable and predictable within certain limits

• However, it may be functioning at an unacceptable level!

SPECIAL CAUSE

• Usually undesirable when you did not plan for it.

• Can also be a “signal” that a planned change was effective.
Using Data Over time

In 1854, Dr. John Snow (father of modern epidemiology) plotted the location of the deaths from a Cholera epidemic on a map of London, and observed that most deaths occurred among those who lived near the Broad Street water pump. He came to the conclusion that they were sharing a contaminated water source. He had an idea to take the handle off of the pump so no one could use it. After he had the handle removed, the epidemic ended.
Using Data Over time

If you do a t-Test, you are going to find a significant difference before and after his intervention.

London Cholera Outbreak 1985

- With Pump Handle: 500 Cholera Deaths
- Without Pump Handle: 100 Cholera Deaths
Using Data Over time

But what happens if we look at the data over time with what we know today? There are very few deaths before September first, then we see a dramatic leap once the epidemic begins. But then they begin tapering off. Now after looking at the data over time, how sure are we that removing the pump handle REALLY made the critical difference?
Basic Decision Making Tools

Run Charts
What is a Run Chart?

A line graph of data points plotted in chronological order that helps detect special causes of variation.
What is a Run Chart?

• A running record of process behavior over time.
• Requires no statistical calculations.
• Shows process behavior at a glance.
• Can detect some special causes.
• Time sequence is plotted on horizontal axis.
• Measure of interest is always plotted on the vertical axis.
• Center Line is the mean or median score.
Why use Run Charts?

• Communicate process performance
• Analyze data for patterns
• Assess process stability
• Understand process variation
• Monitor process performance
Signals of Special Cause Variation

Shift: 8 or more consecutive data points on the same side of the centerline

Trend: 6 or more consecutive ascending or descending points

Repeating Patterns
Interpreting Run Charts: Shift

Number Of Deliveries

Week 1
Week 2
Week 3
Week 4

Mean
Interpreting Run Charts: Trend

Number of Patients Waiting

Day 1
Day 2

Mean
Run Chart Drawbacks
Run Chart Drawbacks

Pneumonia and Influenza Mortality

Week Ending 01/08/2011
Understanding Data

"Now stay calm... Let's hear what they said to Bill."
Basic Decision Making Tools

Control Chart
What is a Control Chart?

A statistical tool used to distinguish between process variation resulting from common causes and variation resulting from special causes.
When people do not understand variation

• See trends where there are no trends

• Blame and give credit to others for things over which they have little or no control

• Build barriers, decrease morale, and create an atmosphere of fear

• Never be able to fully understand past performance, make predictions about the future and make significant improvements in processes
Control Chart

Elements of a Control Chart

Medication Errors

Number of Medication Errors


Upper Control Limit 12.23

Lower Control Limit 5.23

- Medication Errors
- UCL
- Average
- LCL

Texas Children's Hospital
Why use Control Charts?

- Monitor process variation over time
- Differentiate between special cause and common cause variation
- Assess effectiveness of changes
- Establish the basis for determining process capability
- Communicate process performance
Why use Control Charts?

- **Stability**: A process's ability to produce predictable results consistently. Usually resulting in a relatively constant mean and variance.

- **Capability**: A process's ability to remain within the parameters or standards set forth by the customer.
Why use Control Charts?
Standard Normal Distribution
Mean or Average

Half are below average and half are above average.
1 Standard Deviation

68.26% of data will fall within 1 standard deviation of the mean.
2 Standard Deviations

95.46% of data will fall within 2 standard deviations of the mean.
3 Standard Deviations

99.73% of data will fall within 3 standard deviations of the mean.
Tests for Special Causes

**RULE 1**
Point beyond the control limit.

**RULE 2**
2 out of 3 in Zone A or beyond.

**RULE 3**
4 out of 5 Zone B or beyond.

**RULE 4**
Eight or more on one side of centerline without crossing.

**RULE 5**
Six or more in a row increasing or decreasing.
QMC ED Throughput Study
Patient Arrival to MD Exam

Goal <60
Avg = 59

N=250
QMC ED Throughput Study
Patient Arrival to MD Exam

Consecutive Patients

N=250
QMC ED Throughput Study
Patient Arrival to MD Exam

N=250

Goal = <60
Mean = 59
Std Dev = 55
UCL = 224
LCL = 0

Consecutive Patients
QMC ED Throughput Study
Patient Arrival to MD Exam

N=250
Goal = <60
Mean = 59
Std Dev = 12
UCL = 95
LCL = 23
Control Chart Application (actual study)

Average Time from Arrival to MD Evaluation

Subgroups = 15
Subgroup Size = 450
GOAL: < 45
Control Chart Application (actual study)

![Control Chart](attachment:control_chart.png)

- **Average Time from Arrival to MD Evaluation**

  - **UCL = 73.88**
  - **LCL = 14.12**
  - **Overall Mean = 44**
  - **GOAL: < 45**

- **Subgroups = 15**
- **Subgroup Size = 450**

- **Time in Minutes**

  - **Month**
    - Mar-02, Apr-02, May-02, Jun-02, Jul-02, Aug-02, Sep-02, Oct-02, Nov-02, Dec-02, Jan-03, Feb-03, Mar-03, Apr-03, May-03
Control Chart Application (actual study)

Average Time from Arrival to MD Evaluation

Subgroups = 15
Subgroup Size = 450
GOAL: < 45

Monthly Mean
UCL
LCL

Time in Minutes

GOAL: < 45

Mar-02 Apr-02 May-02 Jun-02 Jul-02 Aug-02 Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 May-03

Month

Subgroups = 15
Subgroup Size = 450
GOAL: < 45

Average Time from Arrival to MD Evaluation

Subgroups = 15
Subgroup Size = 450
GOAL: < 45

Monthly Mean
UCL
LCL

Time in Minutes

GOAL: < 45

Mar-02 Apr-02 May-02 Jun-02 Jul-02 Aug-02 Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 May-03

Month

Subgroups = 15
Subgroup Size = 450
GOAL: < 45

Average Time from Arrival to MD Evaluation

Subgroups = 15
Subgroup Size = 450
GOAL: < 45

Monthly Mean
UCL
LCL

Time in Minutes

GOAL: < 45

Mar-02 Apr-02 May-02 Jun-02 Jul-02 Aug-02 Sep-02 Oct-02 Nov-02 Dec-02 Jan-03 Feb-03 Mar-03 Apr-03 May-03

Month
Where are Control Charts Used?

• In the beginning of a Quality Improvement Project during the Measure or Analyze Phase of a project to determine current process capability and benchmarking.

• In the middle during the Improve Phase of a project to determine effectiveness of an intervention.

• At the end in the Control Phase of a project to help sustain the gains.
Data Display Tips

• Begin analyses with questions / hypotheses before ‘digging’ through data
• Plan data display with key stakeholders early in the process
• Limit the display to the points you need to make
• If possible, show benchmark data (internal / external)
• Publicize the results; post graphic displays in hallways and waiting rooms for staff / patients
• Compare outcomes to established targets / goals
• When appropriate, compare results grouped by demographics or other characteristics
Baseline (Not in Control)
Improve (Making Progress)

Emergency Room Throughput

- Throughput
- UCL
- Average
- LCL

Process Change
Control (In Control)

Emergency Room Throughput

- Throughput
- UCL
- Average
- LCL

Hours

Cases: Case 1, Case 5, Case 9, Case 13, Case 17, Case 21, Case 25, Case 29, Case 33, Case 37, Case 41, Case 45, Case 49, Case 53, Case 57, Case 61, Case 65, Case 69, Case 73, Case 77, Case 81, Case 85, Case 89, Case 93, Case 97
Identifying Process Changes

X-Bar Chart

Outpatient Clinic Cycle Time

Measure: Average Time in Department

UCL

LCL
Identifying Process Changes

X-Bar Chart
Control Charts

What Have People Used Control Charts For?

- Rates of infections, occurrences, falls, needle sticks
- Satisfaction rates
- HMO Enrollment, initial or repeat
- HMO Disenrollment
- Waiting times in reception
- Cost per member per month
- Time to treatment
- Cost per lab, cost per procedure
- Days between a “bad” occurrence (fall, infection, death, etc.)
Improve a common cause system by changing the process

- Identify and prioritize options to improve:
  - Pareto charts will identify the “vital few”

- Use your “PI methodology” (i.e., PDCA, DMAIC)

- Identify the Key Process Variables (KPVs)
  - KPVs are those aspects of a process that have a major impact on the measure of interest.
  - Get moving! Don’t wait for “perfect” plan.
How will you know your intervention is a success?

- A **Special** cause in the **desired** direction will signal that the old process is changed for the better.

- A **Special** cause in the **wrong** direction will indicate that your intervention was counterproductive.

- **Continued common cause** variation will indicate that your intervention did not help – but did not hurt either.
Cycle for Learning and Improvement

Four Questions/Phases that Must be Addressed

1. **What are we trying to accomplish?**
   a. Pareto Charts (what problem do we want to tackle)

2. **How will we know that a change is an improvement? (all improvement comes from change, but not all change leads to improvement)**
   a. Run Charts
   b. Control Charts
Cycle for Learning and Improvement

Four Questions/Phases that Must be Addressed

3. *What changes can we make that will lead to improvement?*
   a. Pareto Charts
   b. Run Charts
   c. Histograms
   d. Scatter Diagrams
   e. Control Charts

4. *P.D.S.A.*
   a. Run Charts
   b. Control Charts
Summary

1. Explain the purpose and uses of various quality data displays
2. Interpret basic data quality charts
3. Describe measures of central tendency and other terms commonly used in the interpretation and communication of quality data
4. Understand common misconceptions and limitations that arise from reporting “averages”.
5. Understand the concepts Special Cause and Common Cause when interpreting data.
6. Identify tests used to determine special causes.
7. Interpret basic Run charts and Control Charts.
8. Explain the use of data throughout the PDSA process as described in select AQI projects
Resources

- The Memory Jogger 2
  - Goal QPC

- The Quality Toolbox
  - Nancy Tague
References


Using Tools for Quality Improvement

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