## Objectives

- Participants will be able to:
  - Identify fundamental differences between data when used for improvement, accountability and research
  - Appreciate the value of viewing data graphically and over time
  - Learn when to use and how to interpret data on tools fundamental to improvement:
    - Run chart to identify statistically significant signals of change
    - Shewhart Chart (Introduction only)
    - Pareto chart
    - Histogram (Frequency Plot)
    - Scatter Plot
  - Select the appropriate tool for the question being asked

## Purpose of Measurement

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


## Graphical Display of Data

- Effective visual presentations of data, instead of tabular displays, provide the most opportunity from variation

## Data for Improvement, Accountability and Research in Health Care

<table>
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<th>Aspect</th>
<th>Improvement</th>
<th>Accountability on Judgment</th>
<th>Research</th>
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<tr>
<td>Definition</td>
<td>Improvement of care processes, systems and outcomes</td>
<td>Comprehension for judgment</td>
<td>New generalizable knowledge</td>
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<td>No hypothesis</td>
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<td>Test biased</td>
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<td>Accept consistent bias</td>
<td>Measure and adjust to</td>
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<td>Sample Size</td>
<td>Just enough data, and unprejudiced samples</td>
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<td>Statistical Significance</td>
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<td>Fixed hypothesis</td>
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<td>Run charts or Shewhart control charts</td>
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<td>Hypothesis, statistical</td>
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<td>Trend</td>
<td>Data is not always available</td>
<td>Data is not always available</td>
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References


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

Software Used to Produce Charts:
2. QI Charts. API, 1-512-708-0131
3. Minitab, 1-814-238-3280

Articles:

## Purpose of Measurement

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

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

Table 4.1: Wait Time and Satisfaction Data from Four Clinics

<table>
<thead>
<tr>
<th></th>
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<td>4.5</td>
<td>2.8</td>
<td>4.8</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Cycle Time
- Run Chart of Measure
- Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov
- Median = 84
- Goal = 90

What’s the Question You’d Ask Here?

Repeated Use of the PDSA Cycle
- Model for Improvement
- What are we trying to accomplish?
- How will we know that a change is an improvement?
- What change can we make that will result in improvement?

Run or Shewhart Charts
- Pareto Charts
- Run and Shewhart Charts, Pareto charts, Frequency Plots, Scatter Plots

Model for Improvement
- Reduce Per-op harm by 30%
- Pts with Peri-op harm
- Peri-op Harm Rate
- Unplanned returns OR
- DVT Prophylaxis
- Beta Blocker Prophylaxis
- SSI Interventions

Changes That Result in Improvement
- Implementation of Change
- Wide-Scale Tests of Change
- Follow-up Tests
- Very Small Scale Test

What are we trying to accomplish?
- How will we know that a change is an improvement?
- What change can we make that will result in improvement?
Tools for Understanding Variation

- Run Chart: Study variation in data over time; understand the impact of changes, detect signals of improvement.
- Shewhart Chart: Distinguish between special and common causes of variation. Is process stable, predictable?
- Pareto Chart: Where should we focus? Focus improvement on area with greatest potential impact.
- Frequency Plot: Understand distribution of data (e.g., central location, spread, shape, and patterns).
- Scatter Plot: Analyze potential relationship between two variables.

Run Chart
Graphical display of data plotted in some type of order. Also has been called a time series or a trend chart.

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 the gains we made slipping away?
  - Determine whether we are holding the gain made by our improvement

How Do We Tell a Change is an Improvement?
- Run charts speak for themselves…or..
- Analyze with probability-based rules
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)

Looking at Timeliness

<table>
<thead>
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<th>Month</th>
<th>% Timely</th>
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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.

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
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.

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
- 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.

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.
Rule 3: Runs

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

Rule 3: 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

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<th>Total number of data points on the run chart that do not fall on the median</th>
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<th>Upper limit for the number of runs (&gt; than this number of runs is &quot;too many&quot;)</th>
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</tbody>
</table>

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 (how many 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

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**Rule 3: # of Runs**

<table>
<thead>
<tr>
<th>Total number of data points on the run chart that do not fall on the median</th>
<th>Lower limit for the number of runs (when the number (from a tie is too few))</th>
<th>Upper limit for the number of runs (when the number of runs is too many)</th>
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<tr>
<td>25</td>
<td>8</td>
<td>18</td>
</tr>
</tbody>
</table>


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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

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)
  - Signal could be improvement or degradation

Let's Practice

- Please work in pairs
- Evaluate the following run charts to determine:
  - Does the chart show a signal?
  - If signal noted - which of the four rules did you use to find it?

Rules for Identifying Non-Random Signals of Change

Behavioral Health: Crisis Hours Provided In-Network

Percent Ventilator Associated Pneumonia Bundle Compliance

Average Time to Thrombolysis
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
  - Action 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

Some Keys to Good Graphical Display with Run Charts

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

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 need 10 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

If median not frozen and extended will result in delayed detection of signals
A signal is detected utilizing both original and extended median

**FIGURE 3.25 Detecting Signal with Proper Median Technique**

![Signal Detected Using Baseline and Extended Median](image)

If a signal is detected and sustained a new median may be created for the new process performance

- **FIGURE 3.26 Detecting Signal of Improvement with Two Medians**

Plotting Rare Events

- Results in too many zeros
- Makes interpretation difficult and chart of little value
- Useful alternative is to chart time or workload *between* undesirable events
  - Up is always good for these charts

**FIGURE 3.28 Run Chart Resulting in Too Many Zeros**

**FIGURE 3.29 Run Chart of Cases Between Undesirable Events**

**FIGURE 3.30 Mature Run Chart Tracking Cases Between Rare Events**

**FIGURE 3.31 Days Between MRSA Run Chart**
Judgment Vs. Improvement

Nifty Things You Can Do With Run Charts

Improvement Projects Require a Family of Measures

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
May Display More Than One Measure on a Graph

**FIGURE 3.8 Run Chart Displaying Multiple Measures**

- Diabetic Care Measures
- Percent of Time with Self-Management Goals
- Percent of Time with Pneumonia
- Percent of Time with Diabetic Foot Examination

May Use Different Measure for Each Axis

**FIGURE 3.9 Run Chart Displaying a Different Measure For Each Axis**

- Wait Time
- Pattern Vitals

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**

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 = numerator for key measure / denominator (for unit of production or volume related to key measures)

<table>
<thead>
<tr>
<th>Key Measure (Numerator)</th>
<th>Possible Denominator</th>
<th>Ratio</th>
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<tr>
<td>ADEs</td>
<td>Doses Dispensed</td>
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<td>OR Costs</td>
<td>Surgeries</td>
<td>OR Cost/Surgery</td>
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<td>Admissions</td>
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<td>Patients LWBS</td>
<td>Patients Registering in ED</td>
<td>Patients LWBS/Patients Registered</td>
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<tr>
<td>Falls</td>
<td>Patient days</td>
<td>Falls/Patient Day</td>
</tr>
</tbody>
</table>

Number of Falls

Number vs. Rate of Falls

**FIGURE 3.12 Stratification Displaying a Run Chart**

- Total Tunes: March 2000 - May 2001
- Weekly Loping: Monday - Friday
- Day Shift: Morning - Evening
- Night Shift: 10 PM - 6 AM

Key
- M: Monday
- T: Tuesday
- W: Wednesday
- J: Thursday
- F: Friday
- S: Saturday
- S: Sunday
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?

Tools for Understanding Variation

- **Run Chart:** Study variation in data over time; understand the impact of changes.
- **Shewhart Chart:** Is my process stable; predictable? Distinguish between special and common causes of variation.
- **Pareto Chart:** Focus improvement on with greatest potential impact.
- **Frequency Plot:** Understand distribution of data (e.g., central location, spread, shape, and patterns).
- **Scatter Plot:** Analyze potential relationship between two variables.

Shewhart Control Charts: What Am I Looking At and Why Bother!

- What is Shewhart chart?
- Special and common cause variation
- How to interpret one
- Uses of Shewhart charts
- Why bother?
- There are different kinds of Shewhart charts

Introduction to Shewhart Chart

- Statistical tool used to distinguish special from common cause variation

**FIGURE 4.1 Example of Shewhart Chart for Equal Subgroup Size**
Types of Variation: Common Cause

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

Management Strategy: Common Cause System

STRATEGY TO TAKE:

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

ACTIONS TO AVOID:

- Doing nothing at all!
- Tampering
- Trying to attach specific meaning to fluctuations in the data (i.e. explain the difference between points that are high vs... low)

Types of Variation: Special Cause

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

Management Strategy: Special Cause System

IMPROVEMENT STRATEGY:

- **Investigate, learn and standardize the process!!**  
  - Immediately try to understand when Special Cause occurred  
  - Study what was different when Special Cause occurred  
  - Identify ways to prevent or use it, if understandable, to standardize the process  
  - either standardize back to where the process was  
  - or standardize in a new better place

ACTIONS TO AVOID:

- Doing nothing at all
- Failing to involve the people who work in the process in identifying special causes

Distinguishing Special from Common Cause Variation

FIGURE 4.8: Shewhart Charts Common Cause and Special Cause Systems
Understanding Variation

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

Let's Analyze One Together

- We always apply all 5 rules to each chart
  - Any one rule "activated" indicates special cause in that area
  - Common cause is determined by "ruling out" special cause (none of 5 rules activated)
- Let's consider appropriate action based on your analysis
  - Special cause action?
  - Common cause action?

Let's Practice

- Please analyze one of these charts
- Apply all 5 rules to each chart
- Circle special cause if you find it
- What action would you take based on your analysis?
  - Special cause action?
  - What would you do if it is solely common cause?
**Using a Control Chart**

- Learn how much variation exists in process
  - If stable are predictable. Can use info in planning, communicate with staff, patients, family
- Assess stability and determine improvement strategy (common or special cause strategy)
- Monitor performance and correct as needed
- Find and evaluate causes of variation
- Tell if our changes yielded improvements
- See if improvements are “sticking”

**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”
Using a Shewhart Chart

- Learn how much variation exists in process
- Assess stability and determine improvement strategy (common or special cause strategy)
- **Monitor performance and correct as needed**
- Find and evaluate causes of variation
- Tell if our changes yielded improvements
- See if improvements are "sticking"

Using a Shewhart Chart

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

Using a Shewhart Chart

- Learn how much variation exists in process
- Assess stability and determine improvement strategy (common or special cause strategy)
- Monitor performance and correct as needed
- Find and evaluate causes of variation
- **Tell if our changes yielded improvements**
  - When you **intend** to improve process you are on the lookout for special cause indicative of improvement
  - See if improvements are “sticking”
Using a Shewhart Chart

- Learn how much variation exists in process
- Assess stability and determine improvement strategy (common or special cause strategy)
- Monitor performance and correct as needed
- Find and evaluate causes of variation
- Tell if our changes yielded improvements
- See if improvements are “sticking”
Selecting the Appropriate Shewhart Chart

**Type of Data**

- Count or Classification (Attribute Data)
- Continous (Variable Data)

**Other types of control charts for attribute data:**
1. NP (for classification data)
2. C (above-baseline, or events)
3. U (above-baseline, or defects)
4. Exponentially weighted moving average (EWMA)
5. G chart (number of opportunities between rare events)
6. Standardized control chart

**Factors Associated with Resident Falls**

- Bending Over: 40.94% (104)
- Getting Out of Bed: 20.47% (52)
- Using Rest Room: 18.11% (47)
- Other: 10.26% (27)
- No Glasses: 8.27% (22)
- Missed Chair: 6.69% (17)
- Wet Floor: 6.19% (16)
- Bumped: 2.36% (6)
- Trip: 2.36% (6)
- No Glasses: 1.57% (4)
- Wet Floor: 0.89% (2)
- Other: 0.79% (2)

**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?
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

Frequency Table: Where Are Needlesticks Occurring?

<table>
<thead>
<tr>
<th>Variable</th>
<th>Wk 1</th>
<th>Wk 2</th>
<th>Wk 3</th>
<th>Wk 4</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3W</td>
<td>17</td>
<td>14</td>
<td>16</td>
<td>12</td>
<td>50</td>
<td>26.34</td>
</tr>
<tr>
<td>ED</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>17</td>
<td>7.59</td>
</tr>
<tr>
<td>ICU</td>
<td>4</td>
<td>7</td>
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<td>3</td>
<td>16</td>
<td>7.14</td>
</tr>
<tr>
<td>2N</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>12</td>
<td>5.36</td>
</tr>
<tr>
<td>3N</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>17</td>
<td>7.59</td>
</tr>
<tr>
<td>2W</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>20</td>
<td>8.93</td>
</tr>
<tr>
<td>Allergy/Imm</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>14</td>
<td>6.25</td>
</tr>
<tr>
<td>2S</td>
<td>10</td>
<td>13</td>
<td>12</td>
<td>13</td>
<td>48</td>
<td>21.43</td>
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<tr>
<td>Lab</td>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>12</td>
<td>5.36</td>
</tr>
<tr>
<td>Other</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>9</td>
<td>4.02</td>
</tr>
<tr>
<td>Grand Total</td>
<td>224</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 %</td>
</tr>
</tbody>
</table>

Needlessticks By Location (n=224)
How Is It Interpreted?

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

How Is It Interpreted?

• Look for the Pareto effect
• We won’t always find it!
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How Is It Interpreted?

• Look for the Pareto effect
• We won’t always find it!
  - Is entire chart speaking to us?
  - Can we re-stratify?
Factors Associated with Resident Falls
N=254

Other Ways To Use Pareto

• Stratification

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?
Tools to Learn from Variation in Data

Frequency Plot               Pareto Chart                           Scatter Plot

Tools to Learn from Variation in Data

Frequency Plot (Histogram): What Is It?

• A bar chart for one variable only
• 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
• Each bar equal, each distinct
• Becomes useful with 30-50 pieces of data
• 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?

Age of People with Diabetes Who Have HbA1C> 8

When Is It Used?

1. Have a set of values related to your question (i.e. arrival times in ED)
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)
How Is It Interpreted?

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

Common Frequency Plot Shapes

Uniform
• provides little info
• check to see if multiple sources variation combined
• if so, re-stratify and graph
• may mean not enough bars
• if so, change bar width and graph

Random
• provides little info
• check to see if multiple sources variation combined
• if so, re-stratify and graph
• May mean too many bars
• if so, change bar width and graph

What Time Do People Call the Crisis Hotline?

Common Frequency Plot Shapes

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NAHQ
Shewhart's Rules

- When average, range or histogram used to summarize data:
  - Summary should not mislead user into taking any action user would not take if data were presented in a time series (graph)
  - Averages, etc. are useful, but seeing the sequence and variation in data is most meaningful

<table>
<thead>
<tr>
<th>Clinic</th>
<th>Avg. Annual Sat</th>
<th>Capitated Cost Annual</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.9</td>
<td>$980</td>
</tr>
<tr>
<td>B</td>
<td>3.9</td>
<td>$940</td>
</tr>
<tr>
<td>C</td>
<td>3.9</td>
<td>$945</td>
</tr>
</tbody>
</table>
**Frequency Plot (Histogram): What Is It?**

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

**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?**

Does Customer Waiting Time Affect Customer Satisfaction?

- **High** Y
- **Low** X
- **Negative Correlation**

**Tools to Learn from Variation in Data**

- **Frequency Plot**
- **Pareto Chart**
- **Scatter Plot**
What are we trying to accomplish?

How will we know that a change is an improvement?

What change can we make that will result in improvement?

**Model for Improvement**

**Act**

**Plan**

**Study**

**Do**

---

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

<table>
<thead>
<tr>
<th>Min Wait</th>
<th>Sat Score</th>
<th>Min Wait</th>
<th>Sat Score</th>
<th>Min Wait</th>
<th>Sat Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>3.5</td>
<td>42</td>
<td>4</td>
<td>74</td>
<td>2</td>
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<tr>
<td>78</td>
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<td>72</td>
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<td>1</td>
<td>21</td>
<td>4.5</td>
<td>74</td>
<td>2.5</td>
</tr>
</tbody>
</table>

---

**How Is It Interpreted?**

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

---

**Draw Graph**

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

---

**Data for Scatter Plot**

- Scattergram
- Wait Time vs. Satisfaction
- Scattergram
- Wait Time vs. Satisfaction
- Negative Correlation

---

**The Health Care Data Guide: Learning from Data for Improvement.**
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

Outliers

Case Load Related to Sick Leave

Stratification Using Symbols to Distinguish Each Department

What Did We Address?

- The value of displaying data graphically vs. table of numbers or summary statistics
- The differences between data used for improvement, accountability and research
- The value of displaying data over time:
  - when working to determine impact of changes being tested
  - To see if are sustaining gains
- The Model for Improvement
What Did We Address?

- Run charts: what they are, when used, how interpreted
  - Median vs. mean: median used as center line
  - Rules for analysis to detect signals of improvement or degradation
- Ways to use
  - Family of measures for improvement project
  - Small multiples
  - Stratification with
- Importance of good technique with median

References

Books:

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

Software Used:
2. QI Charts. API. 1-512-708-0131
3. Minitab, 1-814-238-3280

Articles: