Using Run Charts to Establish Special Cause Variation

Carol Haraden, PhD

This presenter has nothing to disclose.
Coronary Artery Bypass Graft

Mortality Rate (%)

Jan 13: 5.9%
Jan 14: 1.1%
Coronary Artery Bypass Graft

CABG Mortality Rate: Clinic I
Coronary Artery Bypass Graft

CABG Mortality Rate: Clinic II
Coronary Artery Bypass Graft

CABG Mortality Rate: Clinic III
There are two ways to view data

**STATIC VIEW**
- Descriptive Statistics
- Mean, Median & Mode
- Minimum/Maximum/Range
- Standard Deviation
- Bar graphs/Pie charts

**DYNAMIC VIEW**
- Line Chart
- Run Chart
- Control Chart
- Statistical Process Control (SPC)
Improvement uses static and dynamic data

- Static views are suited to assess variation at a point in time
- Dynamic views are best for measuring changes in data variation

© 2014 Kaiser Foundation Health Plan, Inc. For internal use only.
Kaiser Permanente Improvement Institute
Example: Results of New CHF Protocol (static)

90 Day CHF Readmissions

- New CHF Protocol Introduced
- Best Practice Spread to entire Region!

Readmission Reduced from 30% to 24%!
Same data … dynamic view

90 Day CHF Readmissions

New CHF Protocol Introduced

Improvement

© 2014 Kaiser Foundation Health Plan, Inc. For internal use only.

Kaiser Permanente Improvement Institute
How will we know that a change is an improvement?

1. By *understanding the variation* that lives within your data

2. By *making good management decisions* on this variation (i.e. don’t overreact to a special cause and don’t think that random movement of your data up and down is a signal of improvement)
Old Way, New Way

Old Way (Quality Assurance)
- No action taken here
- Reject defectives

New Way (Quality Improvement)
- Action taken on all occurrences

Source: Robert Lloyd, Ph.D.
<table>
<thead>
<tr>
<th></th>
<th>16</th>
<th>15</th>
<th>26</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>17</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>25</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>23</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>9</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>8</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>17</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>X=16.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Graphical Data Display

Frozen Section Turnaround Time Run Chart (minutes)

X = 16.8
Graphical Data Display

Frozen Section Turnaround Time Histogram
(minutes)
Four Dimensions of Data

- Spread
- Shape
- Center
- Sequence
# Types of Variation

<table>
<thead>
<tr>
<th>Common Cause Variation</th>
<th>Special Cause Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Is not ‘good variation’</td>
<td>• Is not ‘bad variation’</td>
</tr>
<tr>
<td>• Is stable and predictable</td>
<td>• Unstable and unpredictable</td>
</tr>
<tr>
<td>• Due to the design of the process</td>
<td>• Due to irregular or unnatural causes- intentional or unintentional</td>
</tr>
<tr>
<td>• Does not mean that the variation is acceptable</td>
<td>• Does not mean that the variation is acceptable</td>
</tr>
</tbody>
</table>
Your Drive to Work....

• How much time does it usually take at 7:30 AM on a Monday morning?

• On Tuesday night at 10:00 PM?

• Is this special or common cause variation?
Common Cause Variation

- Points equally likely above or below center line
- There will be a high data point and a low, but this is expected
- No trends or shifts or other patterns

Courtesy of Richard Scoville, PhD, IHI Improvement Advisor
Two Types of Special Causes

**Unintentional**
When the system is out of control and unstable

**Intentional**
When we’re trying to change the system
Common Cause Variation

Normal Sinus Rhythm (a.k.a. Common Cause Variation)

Special Cause Variation

Atrial Flutter Rhythm (a.k.a. Special Cause Variation)

Holding the Gain: Isolated Femur Fractures

Sequential Patients
### Example of Data for Judgment

*(Perfect Care Bundles – all aspects of a bundle must be met in order to receive credit)*

Does this tabular display of data help us understand how to improve care?

<table>
<thead>
<tr>
<th>Care Bundle</th>
<th>Region Average</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>TYD Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMI</td>
<td>79</td>
<td>79</td>
<td>79</td>
<td>81</td>
<td>80</td>
<td>79</td>
</tr>
<tr>
<td>CHF</td>
<td>61</td>
<td>56</td>
<td>58</td>
<td>63</td>
<td>62</td>
<td>60</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>46</td>
<td>16</td>
<td>16</td>
<td>20</td>
<td>31</td>
<td>20</td>
</tr>
<tr>
<td>SSI</td>
<td>52</td>
<td>41</td>
<td>43</td>
<td>54</td>
<td>49</td>
<td>47</td>
</tr>
</tbody>
</table>

**Legend**

<table>
<thead>
<tr>
<th>Better than or equal to the Region</th>
<th>Worse than Region Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Red</td>
</tr>
</tbody>
</table>
CHF: Special Cause or Common Cause?
SSI: Special Cause or Common Cause?

Bundle Reliability

Quarters
What is wrong with this chart?

- Comparison is region average - is the color assigned based on best practice or best performance by region even when not best practice?
- Is there enough data to make any decision?
- No goal stated - is the goal green or best practice?
- What is rewarded? Special cause or common cause?
### Appropriate Management Response to Common & Special Causes of Variation

<table>
<thead>
<tr>
<th>Type of variation</th>
<th>Is the process stable?</th>
<th>Consequences of making the wrong choice</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>YES</td>
<td>Increased variation!</td>
</tr>
<tr>
<td></td>
<td>NO</td>
<td>Wasted resources! (time, effort, morale, money)</td>
</tr>
<tr>
<td>Only Common</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special + Common</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Right Choice**
- **Is the process stable?**
  - YES: Change the process
  - NO: Investigate the origin of the special cause

**Wrong Choice**
- **Is the process stable?**
  - YES: Treat normal variation as a special cause (tampering)
  - NO: Change the process

Attributes of a Leader Who Understands Variation

Leaders understand the different ways that variation is viewed.

They explain changes in terms of common causes and special causes.

They use graphical methods to learn from data and expect others to consider variation in their decisions and actions.

They understand the concept of stable and unstable processes and the potential losses due to tampering.

Capability of a process or system is understood before changes are attempted.
Understanding Variation with Run Charts
How many data points do I need?

Ideally you should have between 10 – 15 data points before constructing a run chart.

- 10 – 15 patients
- 10 – 15 days
- 10 – 15 weeks
- 10 – 15 months
- 10 – 15 quarters...

- If you are just starting to measure, plot the dots and make a line graph.
- Once you have 8-10 data points make a run chart.
Elements of a Run Chart

Four simple run rules are used to determine if special cause variation is present.
Normal Distribution with Standard Deviations
Every process displays variation:
- **Controlled variation**
  - stable, consistent pattern of variation
  - “chance”, constant causes
- **Special cause variation**
  - “assignable”
  - pattern changes over time
Analysis of Run Charts

Special Cause Rule Number 1: Shifts

Eight or more consecutive points either above or below the center line (mean or median). Values on the center line are ignored, they do not break a run, nor are they counted as points in the run.

SERUM GENTAMICIN LEVELS - TROUGH

Mean = 2.0
Analysis of Run Charts

Special Cause Rule Number 2: Trends
Five or more consecutive points all going up or all going down. If the value of two or more consecutive points is the same, only count the first point and ignore the repeating values; like values do not make or break a trend.

ADVERSE DRUG REACTIONS

Mean = 3.0
Analysis of Run Charts

Special Cause Rule Number 3: Patterns
Any non-random pattern may be an indication of a special cause variation. A general rule is to investigate any non-random pattern that recurs eight or more consecutive times.

DIALOSTIC BLOOD PRESSURE

Mean = 94.32
Analysis of Run Charts

Special Cause Rule Number 4: Points Outside Limits
A point or points outside control limits is/are evidence of special cause. Control limits are calculated based on data from the process.

ABNORMAL PAP TEST FOLLOW-UP PROCESS

Mean = 35
Medication Administration Process

![Chart showing the elapsed time to administer medication in minutes for each medication sequence. The chart indicates a mean time of 22.5 minutes.]

SHIFT DOWN

Mean = 22.5
Abnormal Pap Test Follow-up Process

**Median = 35**
Process for Obtaining a Stat Consult

SHIFT UP

Median = 3.75
Process for Admitting from Outpatient Clinic

- **Patient: Admissions**
- **Time in Hours**
- **Median = 3.0**

**TREND**

**PATTERN**
Number of Days Between Falls

SHIFT DOWN
TREND
Abnormal Pap Test Follow-up Process

RANDOM VARIATION

Median = 35
Take a moment to reflect on your own work. What will you incorporate from this session into your plans?