A systems thinking approach for analysing falls data – A discussion

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Alison Eldridge
How do we make sense of data?
How we assess performance #1: Comparing 2 points

Health service complaints

<table>
<thead>
<tr>
<th>Last Quarter</th>
<th>This Quarter</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>96</td>
<td>+20%</td>
</tr>
</tbody>
</table>

Why has the number of complaints gone up? Our service is getting worse. We need to do something! What decision are you going to make?
How we assess performance #2: Comparing to a target number
How we assess performance #2: Comparing to a target number
Three ways to meet a goal

• Improve the system
• Distort the system
• Distort the data

“So, as you can see, customer satisfaction is up considerably since phasing out the complaint forms.”
Why we made a change

FALLS TREND REPORT - ISR 1&2's (2014/2015)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>2014</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>5</td>
</tr>
</tbody>
</table>

Jan | Feb | Mar | Apr | May | Jun
140% | -100% | -100% | -100% | -100% | 200%

Key Performance Indicator

Provide Quality Healthcare

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure Injury Stage 3,4 or unstageable which were avoidable</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Serious Injuries to patients resulting from in-hospital falls (≥ ISR 2)</td>
<td>3.5</td>
<td>5</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Serious harm resulting from an in-hospital medication error (≥ ISR 2)</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>No. of serious reported clinical incidents (ISR 1 and 2)</td>
<td>13</td>
<td>19</td>
<td>8</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>11</td>
<td></td>
</tr>
</tbody>
</table>
What is variation?
The 2 types of variation

Common cause variation (noise)
- Cannot be traced back to root cause
- Stable over time & follows laws of probability and so predictable
- Often referred to as “chance variation”

Special cause variation (signal)
- Variation arising from a single cause not part of the process
- Can potentially be identified and eliminated (or implemented)
- Irregular in time and may be unpredictable
“Data contains both signal and noise. To be able to extract information, one must separate the signal from the noise within the data.”

Walter Shewhart
What is SPC?

Statistical process control charts

- Method of quality control which uses statistical methods
- Developed by Walter Shewhart for use in manufacturing industry
- Used by the NHS
A Statistical Process Control chart

*(SPC chart)*

- Calculate and display mean as a line
- Calculate and display process limits as lines
- Plot data in time order

Analyse chart by studying how values fall around mean and between process limits
1. Plot individual values

% hand hygiene compliance - April to September
2. Calculate Mean & plot it

% hand hygiene compliance - April to September

In Excel use the formula
\[ \text{Mean} = \text{AVERAGE}(\text{range}) \]
Moving Range

- The difference between two consecutive points
- Measures how variations change over time
- **Average moving range** = average of the difference between consecutive points for a set of data
3: Derive moving range

These are required to calculate the control limits.

The first row contains the chart data.

Use the second row to record the difference between successive data values.

The difference is always recorded as a positive value.

<table>
<thead>
<tr>
<th>X Data</th>
<th>50</th>
<th>43</th>
<th>20</th>
<th>45</th>
<th>70</th>
<th>54</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moving Range</td>
<td>7</td>
<td>23</td>
<td>25</td>
<td>25</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>
4: Calculate Average Moving Range

Add up the individual moving range values

$= 7 + 23 + 25 + 25 + \ldots + 18$

Divide by number of values

$= \frac{463}{24}$

Average moving range

$= 19.3$

Now what does this mean?
5: Calculate the control limits

First derive one measure of variation (referred to as 1 sigma)

\[
1 \text{ sigma} = \frac{\text{Average moving range}}{1.128} = \frac{19.3}{1.128} = 17.1
\]

Calculate lower limit as Mean – 3 sigma

Lower limit = \(58 - 3 \times 17.1\)  
Lower limit = 6.7

Calculate upper limit as Mean + 3 sigma

Upper limit = \(58 + 3 \times 17.1\)  
Upper limit = 109.3
5. Plot limits

% hand hygiene compliance - April to September

Weeks

Percentage

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 31 32 33 34 35 36
37 38 39 40 41 42 43 44 45
46 47 48 49 50 51 52 53 54
55 56 57 58 59 60 61 62 63
64 65 66 67 68 69 70 71 72
73 74 75 76 77 78 79 80 81
82 83 84 85 86 87 88 89 90
91 92 93 94 95 96 97 98 99
100 101 102 103 104 105 106 107 108 109

Upper limit = 109

Lower limit = 7
There are 5 steps to constructing your chart:

1. *Plot the individual values*
2. *Calculate the mean and plot it*
3. *Derive the moving range values*
4. *Calculate the average moving range (MR)*
5. *Derive upper and lower limits from this and plot them*
Rule # 1:
Any single point outside the control limits

Source: Lloyd Nelson, Technical Aids: The Shewhart Control Chart – Tests for Special Causes
Rule # 2: A shift
At least 7 points consecutively either above or below the centre line

Source: Lloyd Nelson, Technical Aids: The Shewhart Control Chart – Tests for Special Causes
Rule #3: A drift
At least 7 points consecutively ascending or descending

Note: the points can cross the centre line

Source: Lloyd Nelson, Technical Aids: The Shewhart Control Chart – Tests for Special Causes
Creating your own SPC chart

• Use the SPC handout, ruler and a pencil.
• You will be calculating and drawing the mean and control or process limits
• Finally you get to interpret your chart
Interpreting your SPC chart

Using the 3 rules listed below, see if you have any special causes in your data

Rule #1: Any single point outside either of the control limits
Rule #2: A shift in the process, or too many data points in a run (7 points above or below the mean)
Rule #3: A trend (7 all increasing or decreasing)
What decision do you make?

<table>
<thead>
<tr>
<th>Decision</th>
<th>Because</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do nothing</td>
<td>Performance ok</td>
</tr>
<tr>
<td>Identify cause</td>
<td>Special cause variation</td>
</tr>
<tr>
<td>Eliminate detrimental causes</td>
<td></td>
</tr>
<tr>
<td>Incorporate beneficial causes into process</td>
<td></td>
</tr>
<tr>
<td>Do nothing</td>
<td>Common cause variation</td>
</tr>
<tr>
<td>Process redesign</td>
<td></td>
</tr>
</tbody>
</table>
Want to know more?

A great introduction to variation and SPC

*Understanding variation, Don Wheeler, 1986*

[www.spcpress.com](http://www.spcpress.com)

For information analysts

*Making sense of data, SPC for the service sector, Don Wheeler, 2003*

[www.spcpress.com](http://www.spcpress.com)
Thank you

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