MODULE 5: Measurement in Continuous Quality Improvement

Unit 5.1: Performance measurements in quality improvement
Unit Objectives

• Define process performance
• List types of process performance measures
• Explain the different types of performance measures
• Analyse and interpret data for decision making
Content

• Process performance
• Types of performance measures
• Data analysis and interpretation
Where in the System of Profound Knowledge are we measuring?
Measuring change in a system
Overall Project Aim: Improve Body Shape

<table>
<thead>
<tr>
<th>Type</th>
<th>Name of Measure</th>
<th>Definition, how to collect data</th>
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Process performance measurement

- Performance measurement is the use of statistical evidence to determine progress toward specific defined organizational objectives
  - Improvement goal
  - Discern whether interventions are giving desired results
"A process of assessing progress toward achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services (outputs), the quality of those outputs (how well they are delivered to clients and the extent to which clients are satisfied) and outcomes (the results of a program activity compared to its intended purpose), and the effectiveness of government operations in terms of their specific contributions to program objectives."
Why measure?

• Set goals and standards
• Detect and correct problems
• Manage, describe, and improve processes
• Document accomplishments
‘Eureka moment’ when presented with improvement data
- Types of reports include clinical reports, dashboards, project updates, board reports
- People often over-react or under-react to improvement data

Erroneous basis for reaching conclusions
- Reactions often based on a single or most recent data point
Why measure? (Cont.)

• Subjective terminologies
  —Terms like ‘shift’ or ‘trend’ are then used subjectively

• Interpretation of improvement data follows statistical probability-based rules
  —However, these terms have statistical definitions based on probability rules
  —Provide evidence for non-random patterns based on an error of $P < 0.05$
  —$P < 0.05$ level of significance provides objective statistical threshold for whether changes are leading to improvement, or degradation in a process
Components of successful measurement

- Comprises a balanced set of a limited but vital few measures
- Produces timely and useful reports at a reasonable cost
- Displays and makes readily available information that is shared, understood and used by an organization
- Supports the organization's values and the relationship the organization has with customers, suppliers and stakeholders
Types of performance: measures to be aware of

Three types:

• Outcome measures — voice of the customer
• Process measures — voice of the system
• Balance measures — voice of the system
Where do measures come from?

- Data elements – raw information already (or in need of) being collected by your organization or the organizations you work with
- Usually found in registers, summary forms or centralized information systems
- Can you give some examples of raw data your process is currently collecting?
Interpreting data to discern improvement

Understanding & Measuring Variation

The role of run charts in measuring improvement, and their interpretation
FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996†

- 1900: 40 States Have Health Departments
- 1918: Influenza Pandemic
- 1957: First Human-to-Human Transmission of Plague
- 1960: First Continuous Municipal Use of Chlorine in Water in United States³
- 1961: First Use of Penicillin
- 1970: Salk Vaccine Introduced
- 1980: Passage of Vaccination Assistance Act

*Crude Death Rate: The number of deaths per 100,000 population.
†The figure represents data from 1900 to 1996.
³Chlorine use began in 1908 with the first use in New York City.
Advantages of Run Charts

- **Analyse process performance with minimal mathematical complexity**
  - Visual display allows learning about *process performance* with minimal mathematical complexity.
- **Determine non-random signals**
  - Simple method to determine if process is demonstrating non-random patterns (‘signal’).
- **Statistically valid charting to measure compliance**
  - Combine power of statistical significance tests with chronological analysis of graphs to detect process changes and trends earlier.
- **Basis for sophisticated analysis methods**
  - Provide foundation for more sophisticated methods of analysis and learning such as *Shewhart* (Control) charts and planned experimentation.
Summary statistics versus time-ordered data

Group exercise (30 minutes)

Go over aggregate data from Kwale on improving ANC.

a) Plot a graph of the percentage ANC clients with ANC profile done over the given period.

b) Annotate the key events.

c) Did the team improve? How can you tell? How confident are you that the team improved?
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QIT WITs

Change ideas testing, coaching,

Median

Shift 0.002

99.8%!!

Fixed centre line

% of ANC visits with complete

Trend

Median

QIT WITs

Change ideas testing, coaching,

Time in Months

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Key results, Uganda: Coverage, retention, and clinical outcomes

Changes

July–Sept 2012
- Recorded patient self-management progress with a self-management tool and tally sheets
- Introduced a VHT referral form to give to patients when sent to a facility
- Each patient enrolled is introduced to a VHT in catchment area
- Self-management groups formed

Coverage, Retention, and Clinical Outcomes at 5 Sites in Buikwe District
Oct 2010-Aug 2012

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- # with good clinical outcome: 716, 700, 717, 839, 810, 875, 1043, 1298, 1465, 1728, 1813, 1713, 1842, 1777, 1925, 2132, 2325, 2417, 2592, 2771, 3049, 3287, 3349
- # of Sites: 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5, 5
Why is the Median central to interpreting a run chart?

- **Median is the middle most value of a set of data**, that means 50% of the values fall above it and the remaining 50% fall below it.
- While using a run chart we start with the assumption that the data had occurred completely randomly.
- This means that the different values of the variable had occurred independently of one another.
Why is the Median central to interpreting a run chart?

- If the above assumption is true we can argue following statistical theory that the chance that a particular value will fall above the median = ½, that is, 50%. Similarly that it would fall below it is also = ½, that is, 50% each.
- The chance that 2 consecutive values will fall on the same side of the median is ¼ (0.25)
- The chance that 3 consecutive values will fall on the same side of the median is 1/8 (0.125)
- The chance that 4 consecutive values will fall on the same side of the median is 1/16 (0.0625)
Why is the Median central to interpreting a run chart?

- The chance that 5 consecutive values will fall on the same side of the median is 1/32 (0.03125): too small it cannot be a random effect (most likely due to your change idea!!)
- The chance that 9 consecutive values will fall on the same side of the median is 1/512 (0.002). Even more confident it is not by chance but your change idea is the reason!!==shift
Run charts: What are they?

Graphical display of data plotted in some type of order

Key features of run charts

• Time-ordered data
• At least 12 data points
• Median (center line) point at which half of the observations are expected to be above or below
• Story told through careful use of annotation
Designing a run chart

• **Horizontal axis**
  o time, or sequential patients, visits or procedures

• **Vertical line**
  o quality indicator being studied, e.g. infections rates, patient visits

• **Median used as centre line**
  o provides point at which half of the observations are expected to be below, or above centre line
  o not influenced by extreme values in the data

• Includes goal lines and other data annotations
Rules for identifying non-random signals (analysis)

• Trend
• Shift
• Runs
• Astronomical points
Rules for identifying non-random signals with run charts

**Rule 1: Shift**

**Rule 2: Trend**

**Rule 3: Number of Runs**

Data line crosses once
Too few runs: total 2 runs

**Rule 4: Astronomical Data Point**

Limitations of Run charts I

• **Stability of process performance***
  o Cannot determine if a process is stable (common or special-cause variation)

• **Contextual understanding**
  o Require judgment and understanding of context and situation in which data is collected

• **Healthcare worker training**
  o Health professionals are trained in aggregate summary statistics and hypothesis testing paradigms focusing on large datasets collected at distant intervals
  o SPC may represent a new and challenging way of thinking
Limitations of run charts II

• **Statistical distribution of data**
  - Discrete data makes interpretation of run-chart rules complex

• **Frequency of data collection**
  - Requires regular monitoring and data collection to better understand the voice of the process (and patient)
Why do we need statistical process control? I

- Also known as **Statistical Quality Control (SQC)***
- Developed in 1920s (**Dr Walter Shewhart**); popularized by E. Deming
- **Link between changes and improvement**
  - *Improvement* of healthcare requires making *changes in processes* of care and service delivery
- **Measuring impact of changes**
  - To determine if changes are having desired *beneficial effects*, we need to measure *process performance*
Why do we need statistical process control? II

• To determine the impact of natural variation on process performance. Natural variation complicates measurement of process performance because repeated measures yield different values**

• Traditional statistical analysis methods vs Statistical Process Control.
Why do we need statistical process control? III

• Thus, SPC theory envisages 2 types of variations:****
  o **Common cause variation**
  o **Special cause variation**
Understanding Variation Parts III & IV

Statistical Process Control
Presentation objectives

• Introduce the concept of Statistical Process Control*
• Test understanding of SPC using case studies
Statistical tools determine if patterns in measurements exhibit special or common cause variations

**Common cause variation**

- Natural variation* inherent in a process on a regular basis
  - e.g. random variation in body temp within a health population; random variation in week-to-week rate of wound infection

**Special cause variation**

- Unnatural variation due to events, changes, or circumstances that have not previously been typical or inherent in the regular process
  - Results from either deliberate events (*change ideas*), or external events outside our control.**
Statistical tools determine if patterns in measurements exhibit special or common cause variations

**Common cause variation**
- Expected to follow underlying statistical distribution if its parameters remain constant over time.
- Processes that only exhibit ‘**common cause variation**’ = Stable, predictable and in ‘statistical control.’

**Special cause variation**
- Similar to statistically significant differences concept although here we are testing for changes graphically, over time and using small samples, e.g. increased demand for A&E services following RTA.
- Processes exhibiting SCV are unstable and unpredictable.
How do we improve processes? I

• **Control chart** defines what a process is capable of producing given its current design and operation.
  - If different performance is needed in future, introduce a change in process (a special cause).
  - To maintain current performance, avoid or eliminate special causes of variation.

• **Processes exhibiting special variation**
  - Improved by first eliminating special causes to bring process ‘into control.’
How do we improve processes? II

Processes that exhibit only common cause variation

• Will continue to produce the same results within statistical limits, unless the process is fundamentally changed or redesigned.

Utility of control charts

• Control charts help detect special cause variation more easily and faster than traditional statistical methods for evaluating effectiveness of a process and sustainability of improvements over time.
The Shewhart (Control) Chart

• Primary tool for Statistical Process Control (SPC)
• Distinguishes between common and special cause variation
• Has 2 parts:
  o Graphed time-ordered measures
  o Template:
    – Centre line / mean
    – Upper control limit (UCL)
    – Lower control limit (LCL)
• UCL and LCL (SD) calculated from inherent variation in data based on standard distributions used for common cause variation
• Major tool for SPC = Statistical Control Chart
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Improving waiting time before consultation

**Before improvement**

- Waiting time
- Data
- UCL
- CL (Mean)
- LCL

**After improvement**

- Waiting time
- Data
- UCL
- CL (Mean)
- LCL
Interpreting a Control chart I

- **Common cause variation**
  - all data on the graph fall randomly between UCL and LCL
- **Special cause variation**
  - data outside of control limits
- Control limits (UCL and LCL) set at +/- 3SD to detect meaningful changes in process performance* and to balance between 2 types of risks:
  - Too narrow limits increases risk of **type I error***/ / **False+.
  - Too wide limits increases risk of **type II error***/ / **False–.
• **Caution:** Traditional statistical techniques in medical literature use 2SD as statistical criteria for decision-making.***
Additional tests for determining SCV*

Determine if data appear randomly distributed between the limits:

• **one point** outside the upper or lower CL
• **two out of three** successive points more than 2SD from the mean on the same side of the centre line
• **four out of five** successive points more than 1SD from the mean on the same side of the centre line
• **eight** successive points on the same side of the centre line
• **six** successive points increasing or decreasing (a trend) or
• obvious cyclic behavior
Calculating SD for Control charts

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<th>SD formulae applied</th>
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<td>SD of binomial distribution</td>
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<tr>
<td>Rate of medication error</td>
<td>SD formulae of a Poisson distribution</td>
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<tr>
<td>Normal distribution data</td>
<td>SD formulae similar to that used for hypothesis tests of means and variances</td>
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Case Studies

- Flash sterilization rate
- Laboratory turnaround time (TAT)
- Surgical site infections
- Appointment access satisfaction
- Infectious waste monitoring
Control chart for flash sterilization rate: baseline compared with period following arrival of new surgical group

Control chart of turn around time (TAT) for day shift routine orders for complete blood counts in the A&E department

Control chart for surgical site infections

Control chart of appointment access satisfaction (percentage of patients very satisfied or higher with delay to see provider)

Control chart for infectious waste

References

