Measurement
in Healthcare

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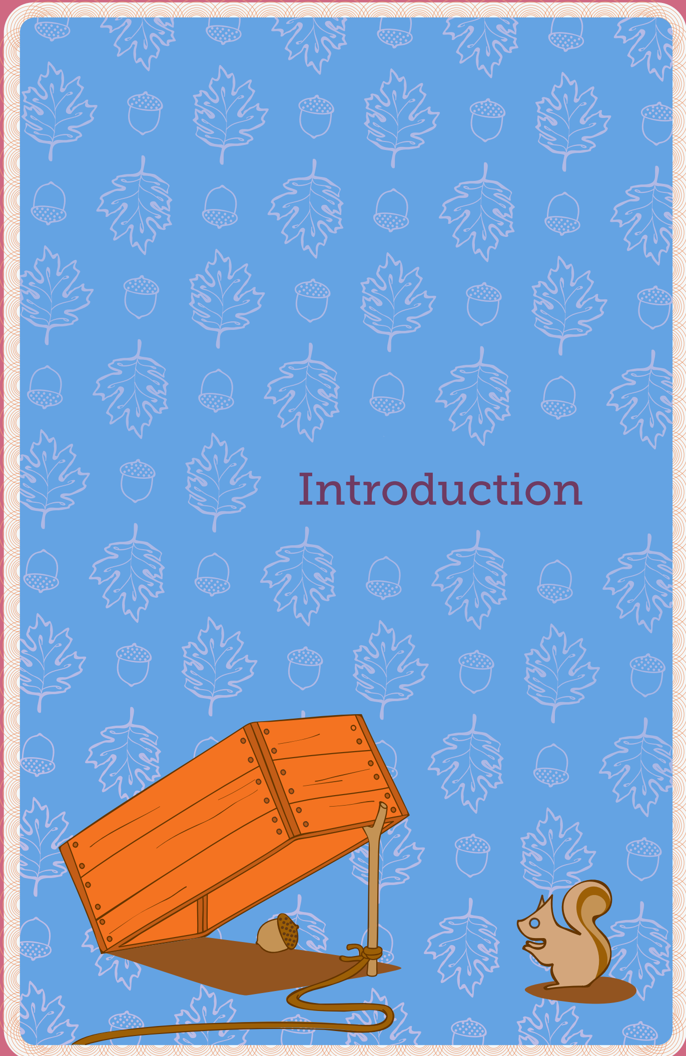
A Guide to Measurement in Healthcare:

"Metrics Matter"



Section 1:

Introduction

A. Why do we need to measure?

Measurement helps us appreciate different perspectives within a system, identify gaps and learn how to close the gaps (see Figure 1).

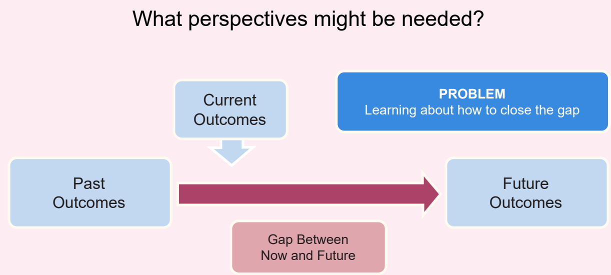


Figure 1: Conceptual Measurement Framework

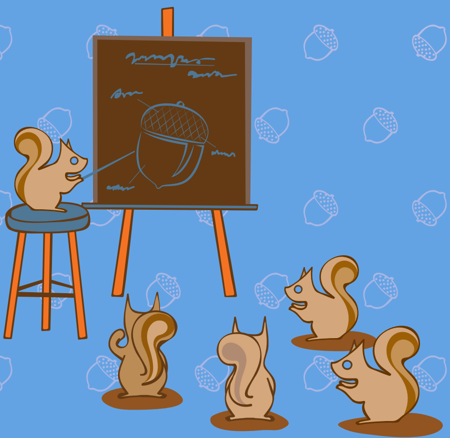
Measurement is applicable in the following areas:

1. Quality Improvement – identify, analyse and track improvements made
2. Patient Safety and Risk Management – identify risks, ensure control measures are instituted
3. Quality Assurance and Accountability – detect issues with compliance and regulatory reporting
4. Research – identify new knowledge to be translated into evidence-based practices
5. Decision making – help management to make informed decisions especially on resource allocation

Data is defined as "documented observations or the results of performing a measurement process". In improvement practice, data incorporates measures and indicators.

Data refers to raw fact, figures or other details collected through recording, observation or measurement. Data can be quantitative (numerical) or qualitative (descriptive).

Concepts behind Data in Healthcare



Section 2:
Concepts behind Data in Healthcare

A. Different types of data

Data can be classified according to its nature and structure and may be quantitative or qualitative.

1. Qualitative Data (Categorical Data)
Description: Non-numerical data that describes qualities or characteristics.

Types:
- **Nominal:** Categories with no natural / specific order (e.g., gender, colours, ethnicity, smokers/ non-smokers).
- **Ordinal:** Categories with a meaningful / natural order but no fixed interval (e.g., rankings, patient satisfaction scales/levels, survey ratings).

2. Quantitative Data (Numerical Data)
Description: Data that represents numerical values and can be measured objectively.

Types:
- **Discrete:** Countable numbers, often integers (e.g., number of students, cars, errors).
- **Continuous:** Measurable and can take any value in a range (e.g., height, weight, temperature).

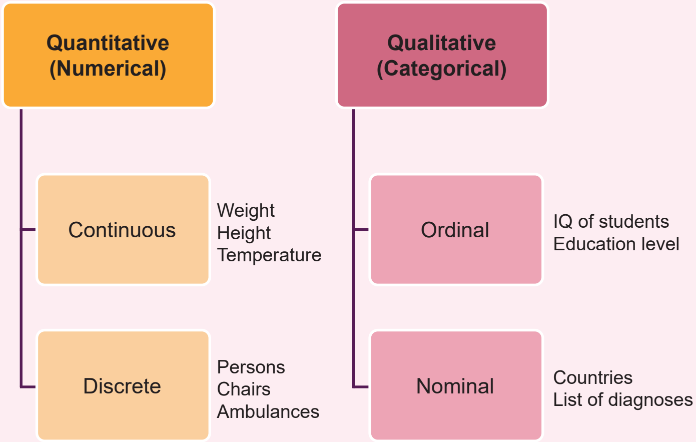


Figure 2: Types of Data

B. Definitions of Measures and Donabedian's Quality Framework

Donabedian's Quality Framework introduces the concept of **Structure, Process and Outcome** measures.

Structure Measures focus on the characteristics of the organisation such as infrastructure and other capabilities e.g. competent professionals to perform a procedure.

Process Measures reflect how care delivery systems and processes work to deliver desired patient outcome. Process measures provide information concerning process steps that are often referenced to evidence-based guidelines to achieve certain clinical outcomes. They often offer faster insights into quality compared to outcome measures.

Outcome Measures: show the results of the healthcare service being delivered to one or more patients. These effects may be physical, mental and/or emotional and may occur in the short-term or long- term. Outcome measures provide information on whether the system/ initiative is effective in meeting the needs of those for whom the service was intended.

In the Donabedian Framework, structure measures influence process measures, which in turn affect outcome measures.

A fourth component, **Balancing Measures**, completes the family of measures.

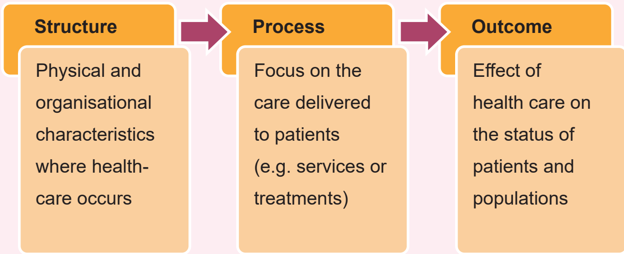


Figure 3: The Donabedian Quality Framework

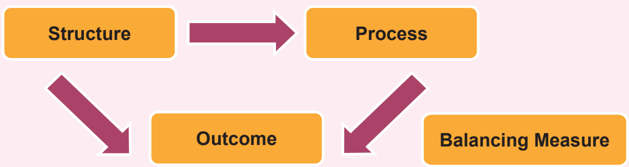


Figure 4: Adapted from the original Donabedian Framework with the addition of Balancing Measure.

Reference: Donabedian, A. (1988). **The quality of care: How can it be assessed?** *JAMA*, 260(12), 1743–1748.

Balancing Measures look from a broader system perspective to detect unintended effects. These effects may be positive or negative. Balancing measures are identified from process or outcome measures, and help to avoid trade-offs that may result from efforts to change the system's overall performance.

Refer to **Annex 1** for Examples of Outcome, Process, and Balancing Measures for a Peri-operative Safety Project.

C. Systems approach to data

The healthcare system is composed of three levels, namely:

- Macrosystem: this is an organisational level perspective that looks at all micro and mesosystems and works to ensure alignment between levels to achieve the overall goal.

- Mesosystem: this is an interrelated set of peer microsystems that provides care to certain patient populations or support the care provided to these populations.

- Microsystem: defined as small interdependent healthcare professionals who work together to achieve a common goal care for a specific population of patients. Common support systems include information, communication and improvement.

Each system level has their own set of aims and data.

Systems Levels

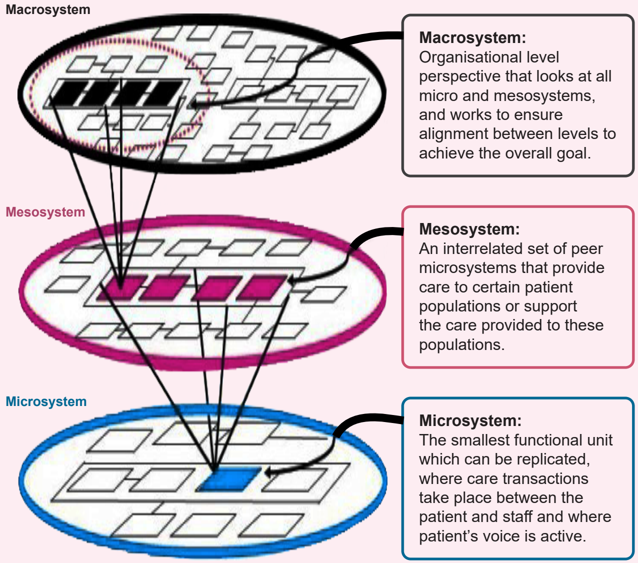


Figure 5: Systems Approach to Data

Reference: Nelson, E. C., Batalden, P. B., & Godfrey, M. M. (2007). **Quality by design: A clinical microsystems approach**. San Francisco, CA: Jossey-Bass Publishers.

Cascading measures refer to the process of aligning, aggregating and disaggregating similar data across different levels of the organisation. This helps to create clear links between individuals, teams, departments, units and organisations in terms of goals and targets for performance measures. (refer Figure 6).

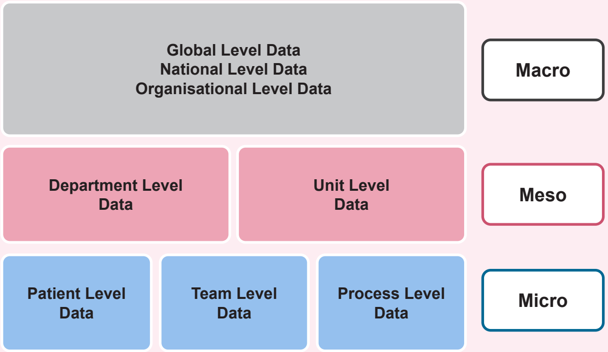


Figure 6: The Cascading System

Please refer to **Annex 2** for an example.

Section 3:
How Measures are Used in Healthcare

A. The 3 'Faces' of Measures

Data can be used in different ways to address the 3 'faces' of performance measurement, namely improvement, judgement (accountability) and research.

This necessitates distinguishing the purpose of each approach to avoid confusion.

It is important to determine the purpose of the data from the outset because the subsequent behaviours and actions of data definitions, collection, analysis, and reporting, are different for the different settings.

A wrong approach, including setting wrong priorities and targets, may cause unintended consequences and/or serious damage.

Aspect	Improvement	Accountability	Research
Aim	Improvement of care	Comparison, choice, reassurance, spur for change	New knowledge
Methods:			
• Test Observability	Test observable	No test, evaluate current performance	Test blinded or controlled
• Bias	Accept consistent bias	Measure and adjust to reduce bias	Design to eliminate bias
• Sample Size	"Just enough" data, small sequential samples	Obtain 100% of available, relevant data	"Just in case" data
• Flexibility of Hypothesis	Hypothesis flexible, changes as learning takes place	No hypothesis	Fixed hypothesis
• Testing Strategy	Sequential tests	No tests	One large test
• Determining if a change is an improvement	Run charts or Shewhart control charts	No change focus	Hypothesis, statistical tests (t-test, F-test, chi square), p-values
• Confidentiality of the data	Data used only by those involved with improvement	Data available for public consumption and review	Research subjects' identities protected

Table 1: Data for Improvement, Accountability and Research in Healthcare

Reference: Solberg, L. I., Mosser, G., & McDonald, S. (1997). **The three faces of performance measurement: Improvement, accountability, and research**. *Journal on Quality Improvement*, 23(3), 135–147.

B. What is a Driver Diagram?

A Driver Diagram is a visual tool to clarify the relationship between different factors within a system that work together to achieve a common outcome for a specific population of patients.

Having a Driver Diagram for an improvement activity helps to provide the theory for change, project planning, communication and tracking of improvement outcomes for accountability.

A Driver Diagram has 3 levels:

1. **AIM** or **OUTCOME** is the high-level goal for the change.

2. **PRIMARY DRIVERS** are the systemic factors/ processes that have a major positive impact towards achieving the Aim. These are usually few in number.

3. **SECONDARY DRIVERS** are systemic components and processes that influence primary drivers.

From these, you can identify specific changes or projects that can be executed.

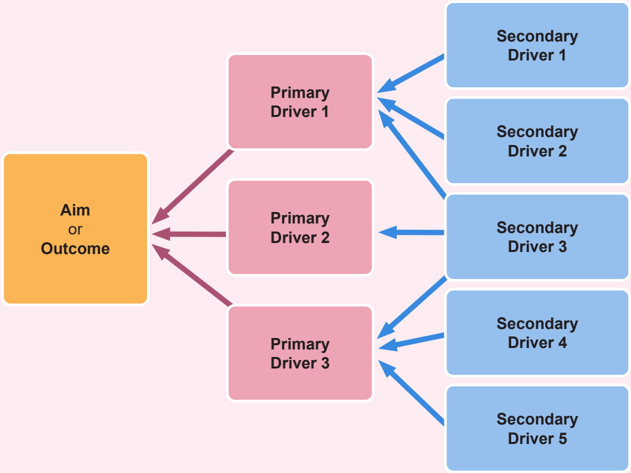


Figure 7: Conceptual View of a Driver Diagram

C. Driver diagrams as a measurement tool

At each level, measures can be developed to enable tracking of the effectiveness of changes that are implemented throughout the system to achieve the overall aim. In determining specific measures for different drivers, it is useful to implement different type of measures from Donabedian's Framework. (Refer to **Annex 3** for an example of a Driver Diagram with Measures)

A cascading set of measures can be built using the Driver Diagram to reflect activities and measures at different levels of the system.

The macro, meso and micro system levels should be considered when selecting measures, whether indicators can be rolled up or drilled down. (refer to Figure 8)

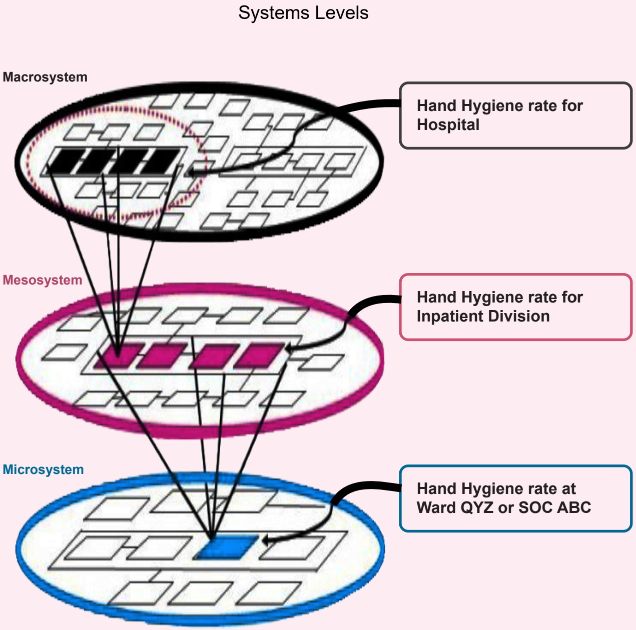


Figure 8: Example of Cascading Measures

Section 4:
Selecting and Defining a Measure

A. Selecting an indicator/measure

The following criteria are useful for selecting a measure.

Criteria	Description
Direct	Should be linked to the result that you are trying to achieve
Objective	Should be objective with no ambiguity about what is measured, and should be operationally precise
Adequate	Should have a balance between resources to collect data and information needs for a given result
Quantitative	A preferred attribute as numbers allow for better interpretation
Disaggregated	This may be needed for drilling down data to sub-populations/specific groups
Practical	Should be practical so that data can be obtained in a timely manner and at reasonable cost
Reliable	Should be reliable for which data of sufficient quality needs to be collected over time for informed decision-making

Table 2: Selection Criteria of a Measure

Reference: USAID. (2010). **Performance monitoring & evaluation tips: Selecting performance indicators** (Issue No. 6, 2nd ed.). United States Agency for International Development. (Supplemental reference to the Automated Directive System [ADS] Chapter 203).

B. Defining an indicator/measure

Once an indicator is selected, it is essential to define the indicator.

Defining an indicator provides a unique identity for the measure, which allows both users and stakeholders to establish a common reference or understanding of the indicator.

C. Importance of a measure definition

If data are collected differently by different people or differently each time, it will be difficult to determine if any change in the data is due to changes implemented or from inconsistencies in data collection.

Measure definitions are useful in standardising how data will be collected, thereby ensuring consistency in data collection.

- The definition of an indicator explains how a specific concept or variable will be measured or observed in practical terms, often including the tools, procedures, or criteria used.

- This facilitates "like-for-like" comparability for the indicators in the performance report across organisations and supports benchmarking.

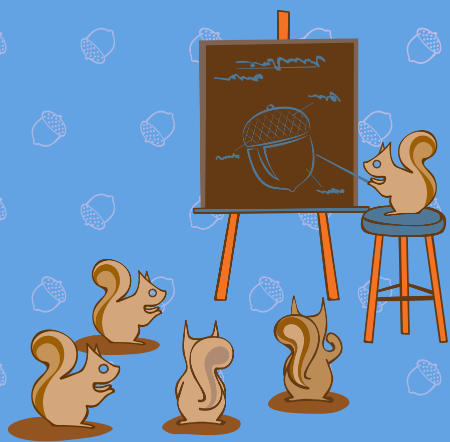
A definition should include the following key components:

Component	Description
a) Title	Brief description of the focus of the measure
b) Purpose	What this measure is for
c) Definition	Clear and concise description of the measure
d) Method of Measurement	Specific sequence of how to collect the data
e) Numerator	Top number of a common fraction for calculation of the indicator
f) Denominator	Bottom number of a common fraction
g) Calculation	Specific steps to derive the indicator value
h) Data Collection Method & Tools	Specific sequence of actions and tools to collect data
i) Data Collection Frequency	Intervals at which the data is collected
j) Data Collection Sample Size	How many observations make up each interval
k) Data Disaggregation	Relevant sub-groups that data can be divided into
l) References	Sources of information relating to the indicator

Table 3: Components of a Measure Definition

Data Collection:

Constructing an Effective Data Collection Plan



Section 5:

Data Collection: Constructing an Effective Data Collection Plan

A. Importance of good data collection

Good data collection is important because this:

- Standardises and reduces practice variation
- Provides clarity for data staff and facilitates training
- Supports deployment of resources
- Ensures good quality data for decision making

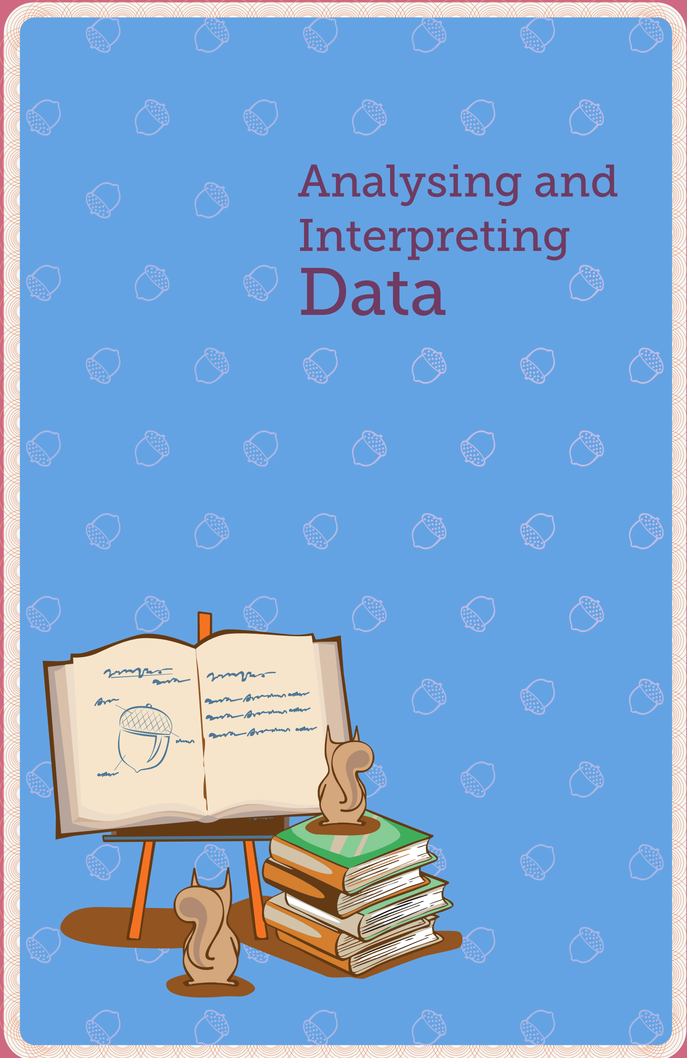
B. Steps in the data collection plan

1. Define objectives: is there a clear measure definition?
2. Choose methods. (Refer to **Annex 4** for details)
3. Check data types and sources. Ensure data sources are available, accessible and reliable.
4. Develop detailed process/subprocess for data collection (and develop collection tools, if appropriate):
    a. Get necessary approvals
    b. Determine frequency
    c. Define sample size
    d. Ensure documentation/storage of collected data
    e. Obtain informed consent if required
    f. Ensure confidentiality of data
5. Train staff. Ensure consistency and accuracy in data collection.
6. Validate data.
7. Store and secure data. Ensure privacy and data integrity.

C. Data validation

Validating data quality is essential for ensuring accuracy and securing stakeholder buy-in, especially when any of the following conditions are noted:

- A new measure is implemented
- The data source has changed
- New staff are trained
- The data resulting from an existing measure has changed in an unexplainable way



Section 6:
Analysing and Interpreting Data

A. Why the need to interpret data?

Data can be used to provide the basis for action.

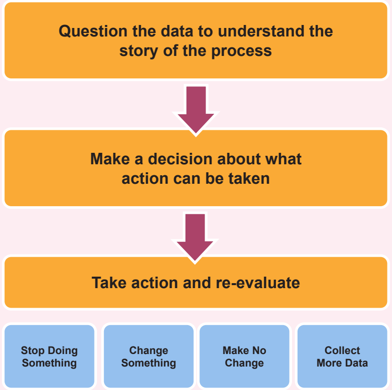
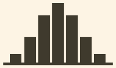
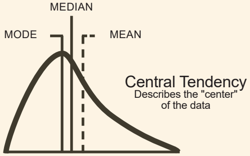


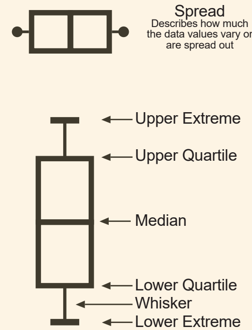
Figure 9. Translating Data Interpretation into Action

B. The 4 dimensions of data and its use in interpretation

Understanding the **4 characteristics** of data, also known as the **4 Dimensions of Data**, is instrumental for understanding a population or condition.

Table 4: The 4 Dimensions of Data

#	Dimension	What it is	What it describes	Figure
1	**Shape or Distribution**	Describes how data points are distributed across values (distribution of values) to create a shape	The shape can be normal (bell curve), skewed (left or right), bimodal, uniform, etc.	Histogram / Probability Density Curve 
2	**Measures of Central Tendency**	A central measure of tendency refers to a single number that represents the centre point or value of a dataset.	Measures include mean, median and mode. **Mean** • Known as "average" and the most commonly used measure of central tendency. • Defined as the average value of a set of observations, if the dataset has a normal distribution. • Particularly susceptible to the influence of outliers. **Median** • Defined as the number present in the middle when the numbers in a set of data are arranged in ascending or descending order. The data must be ranked (sorted in ascending/descending order) first, to identify the middle number. • If the number in a dataset is even, then the median is the mean of the two middle numbers. • The median is the preferred measure of central location, when a dataset has extreme values. **Mode** • Defined as the value that occurs most frequently in a set of data. • A dataset may have more than one mode; bimodal, or multimodal or there can be no mode. • Often used for discrete data and cannot be used with continuous data. • Mode varies and can be unstable.	A skewed distribution curve with vertical lines showing markers of mean, median, and mode 

#	Dimension	What it is	What it describes	Figure
3	**Spread or Dispersion**	Describes how much the data values vary or are spread out (data distribution around the central value).	Measures include range, variance (inter-quartile range, percentile, outliers) and standard deviation. **Range** • The simplest measure of variability. • Measures dispersion or difference between the highest and lowest result (number) in a dataset. • Very sensitive to the smallest and largest value in the dataset. **Inter-Quartile Range (IQR)** • Used to exclude extreme scores in a dataset. • Scores are lined up in the order of their magnitude and divided into quarters and the focus is on the middle 50% of cases. 25% | 25% | 25% | 25% **Standard Deviation** • Most commonly used statistic for measuring degree of variability of data points around the mean. • Measures the spread or dispersion of data around the mean: - Standard = average spread of scores around the mean - Deviation = how much each score is scattered from the mean • Symbol to denote standard deviation is called sigma (α). • The spread is also dependent on the sample size.	A box-and-whisker plot 
4	**Sequence (or Time Dependence)**	Refers to the order of the data points, especially important in time series data. Trends, seasonality, and cycles are part of this.	How the data behaves over a time span or over consecutive measurements.	A line graph over time showing trends and fluctuations (Time series) 

In a dataset with normal distribution:

- The greater the spread of distribution, the greater is the dispersion or variability from the mean
- The more the values cluster around the mean, the smaller the variability or deviation from the mean

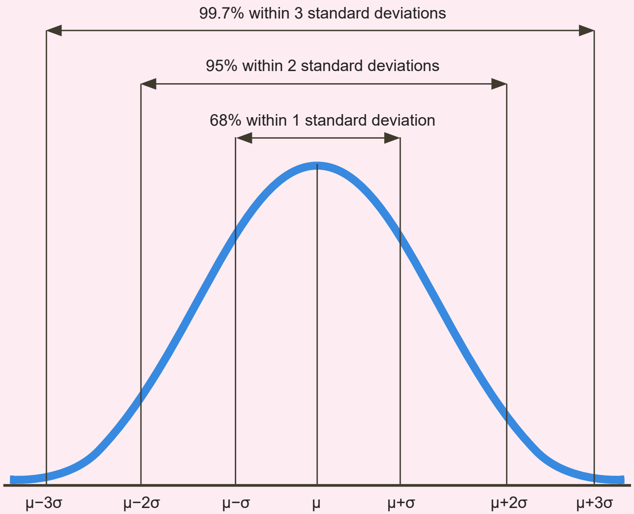


Figure 10: Normal Distribution (Bell Curve) with Standard Deviations

C. Understanding variation

Understanding variation is important because it allows appropriate and correct interpretation of past performance, to make predictions or significant improvements to your process.

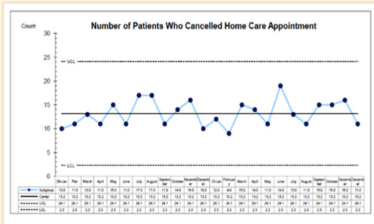
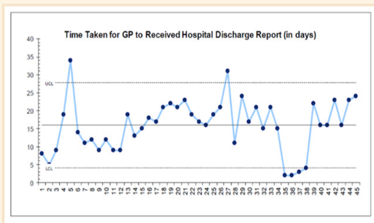
Not understanding variation creates two problems: seeing patterns in random noise, and attributing chance occurrences to other factors.

D. Types of variation

There are 2 types of variation: Common Cause Variation, and Special Cause Variation.

E. Responding to variation

How we respond depends on the type of variation we observe.

Type of Variation	Example	Response to variation
Common Cause Variation: (or Random Change) These are small variations that occur all the time and are an inherent part of the process/ system. It is part of the way that the system is built e.g., errors, defects, wastes in the system.		• Do not react to high or low individual values. Instead, work to identify causes of common variation. • The process/system needs to be fundamentally changed or re-designed to remove/eliminate these causes.
Special Cause Variation: This variation happens due to a unique event occurring outside of the process/system. It may not be possible to eliminate but it can be controlled.		• If the cause is negative, work to remove the cause; if the cause is positive, work to build it into process. • Do not change the whole process in response to a special cause, as the change may be temporary.

F. Analysis rules for Run charts and Statistical Process Control (SPC) charts

These rules provide insights into the stability and performance of the process being studied and helps to make decisions for action based on common or special cause variation or if a certain observed pattern is of significance.

Run Chart	SPC Chart
Any number of points (minimum 6 – 10)	≥ 25 data points
Centre line reflects median	Centre line reflects mean
No control limits	Control limits
Interpretation rules	**Interpretation rules**
• Astronomical point: a data point that is obviously, and unusually different from all or most other values in the set	• Single point out of control limit
• Shift: ≥ 6 points above or below the central line	• ≥ 8 points above/below
• Trend: ≥ 5 consecutive points up or down	• ≥ 6 consecutive points in same direction
• Number of runs: too many or too few runs in a dataset when compared to run count table	• 2/3 consecutive points in outer third • 15 consecutive points hugging the centre line
Less sensitive, but good to give an overview	More sensitive in detecting special causes

Table 5: Run Charts versus SPC Charts: Differences and Interpretation Rules

Reporting Data

Section 7: Reporting Data

A. Why use charts and graphs for reporting data?

Data is one of the most powerful mechanisms for telling stories.

Use of numerical tables can be tiresome and difficult to perceive, while graphs or charts provide the visuals to data presentations, which helps:

- To simplify complicated relations that may be difficult to observe.
- To provide a visual shortcut to the essence of statistical information and allow people to quickly grasp patterns, trends, and outliers that might be buried in raw numbers.

A graphic method attracts and challenges the mind, assisting in both quicker perception and understanding of the structures and relations.

B. Common charts and graphs for reporting data

Table 6 illustrates the charts and graphs used for reporting data.

For quality improvement projects, line/run charts and SPC charts are most commonly used for reporting data.

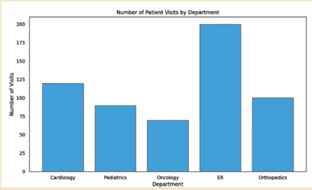
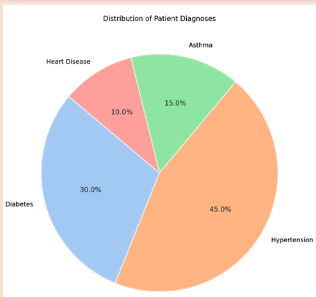
Chart Type	What it is	Example
Bar Chart	Compares values across different categories	Number of patient visits by department 
Pie Chart	Shows the proportions or percentages within a whole dataset (best for 3–5 segments)	Percentage of patients with various diagnoses 

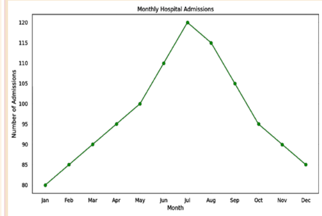
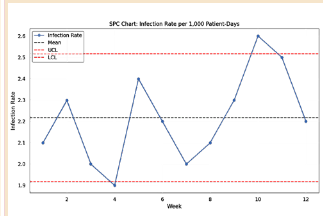
Chart Type	What it is	Example
Line Chart	Tracks changes and shows trends over time	Monthly number of hospital admissions 
Statistical Process Control (SPC) Chart	Studies how a process changes over time, showing special and common cause variations A control chart always has a central line for the average. In addition, it has an upper line for the upper control limit, and a lower line for the lower control limit each representing 3 sigmas (the equivalent of Standard Deviation (SD)	Infection rate per 1000 patient days 

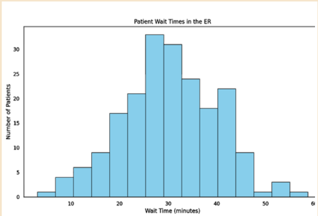
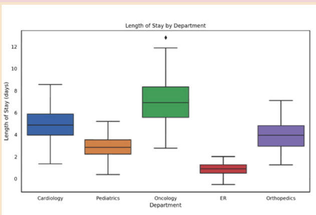
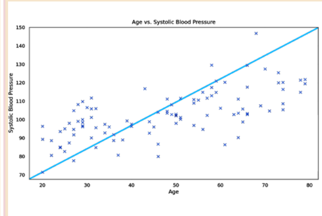
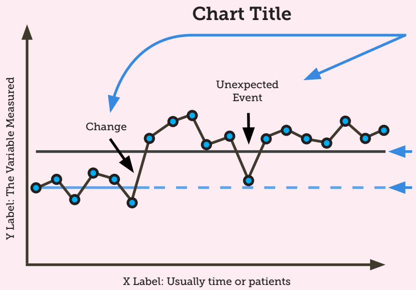
Chart Type	What it is	Example
Histogram	Shows the distribution of a dataset	Distribution of patient wait times in the Emergency Room (ER) 
Boxplot	Shows the distribution of numerical data and skewness through displaying the data in quartiles/ percentiles and averages	Length of stay by department 
Scatter Plot	Identifies and shows the correlation or relationships between two variables	Relationship between age and systolic blood pressure 

Table 6: Common charts and graphs in reporting data

C. Understanding Run charts and Statistical Process Control (SPC) charts

Anatomy of a Run Chart



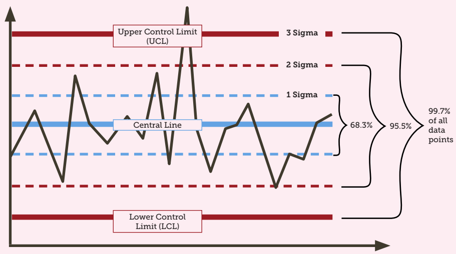
Annotations - specific changes or noteworthy events. Adds a layer of qualitative data and helps tell a story about what is happening to the process.

Goal Line - the result you are aiming for.

Median/Baseline - performance before interventions started. You need at least 5 data points to create this. It should run across the chart.

Source: The Complete Medic
https://thecompletemedic.com/improvement/run-charts

Anatomy of a SPC Chart



Y-axis: Key Quality Characteristic

X-axis: Time sequence

Centre line: Mean

Control limits: represent 3 Sigmas, (the equivalent of 3 SD - 99.7%) on either side of the h line (the upper control (UCL) and the lower control limits (LCL)

Source: QI Macros
https://www.qimacros.com/lean-six-sigma-articles/stability-analysis-vs-capability-analysis/

D. Role of benchmarking in healthcare

Benchmarking is the comparison of an organisation's or an individual practitioner's results with a reference point. Ideally, the reference point should be a demonstrated best practice.

The process involves the following steps:

- Select the object of the benchmarking (the service or activity to be improved).
- Identify benchmarking partners (reference points). Ensure the data definitions are aligned.
- Identify the competitive gap by comparing against external data.
- Develop action plans.
- Take concrete action (project management).

E. Best practices when reporting data

The goal is effective communication through data to relevant stakeholders.

- Choose the right chart for data under consideration and for the audience (do not force it into a pie chart just because it looks nice).
- Keep it simple, clear and concise.
- Ensure the design and contents are culturally appropriate.
- Label everything clearly e.g., axis, title, legends, annotations, units.
- Use colour purposefully.
- Test the draft report on a small group to seek feedback before disseminating or presenting to a larger group.

Click to Download

Data Reporting Template

Conclusion: Connecting the Dots

Conclusion: Connecting the Dots

In healthcare, data provides the "what" (facts about performance), change management provides the "how" (structured methods to implement improvements), and communication provides the "why" and "who" (motivation, clarity, and engagement) (refer to Figure 11).

All three must work together for successful and sustained change.

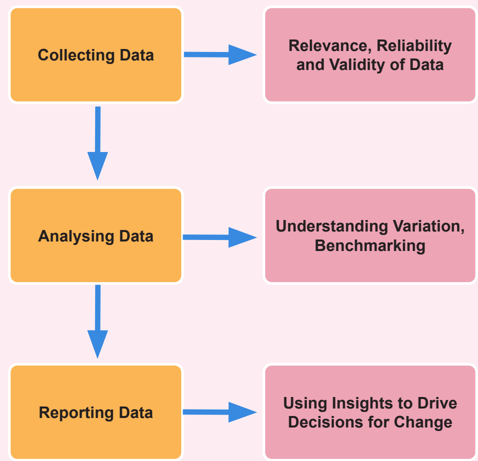


Figure 11: Steps in Data Management

Acknowledgement and References

Section 9:
Acknowledgement and References

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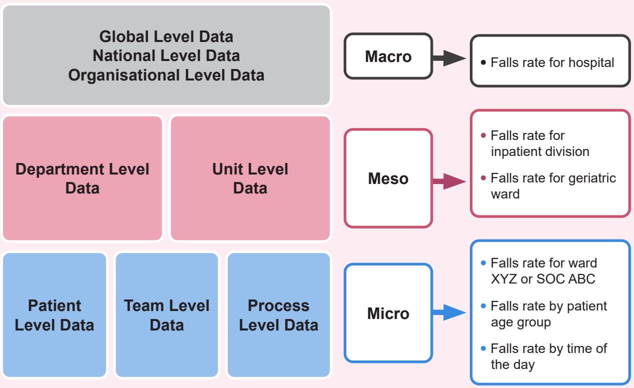
Section 10:
Annexes

Annex 1. Examples of Outcome, Process, and Balancing Measures for a Peri-operative Safety Project

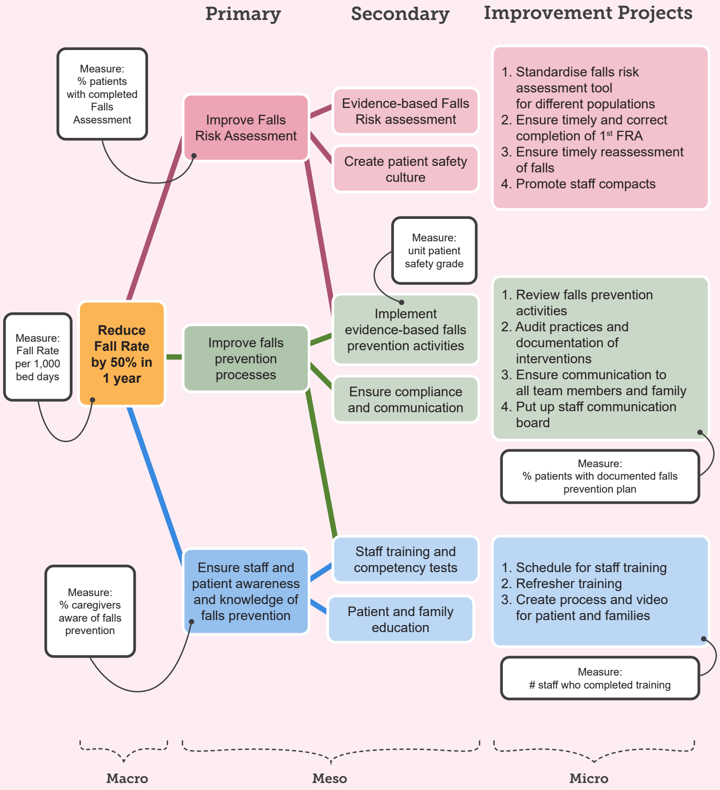
Type of Measure	What it is	Examples
Outcome	• The voice of the customer or patient. • How is the system performing? • What is the result?	• Percentage of patients harmed • Percentage of unplanned returns to the operating room • Percentage of unplanned surgical readmissions
Process	• The 'voice' of the workings of the process. • Logically linked to attaining the outcomes. • Address how key parts or steps of the system are performing.	• Percentage of patients with on-time antibiotic administration • Percentage of patients with appropriate DVT prophylaxis • Percentage of patients with appropriate Beta Blocker use
Balancing	• The 'voice' of the workings of the process. • Logically linked to attaining the outcomes. • Address how key parts or steps of the system are performing.	• Look at a system from different directions or dimensions. • Is concerned with "What happened to the system as we improved the outcome and process measures?" • Could relate to unintended consequences or competing explanations for project success.

Reference: Provost, L. P., & Murray, S. K. (2011). **The healthcare data guide: Learning from data for improvement**. San Francisco, CA: Jossey-Bass Publishers.

Annex 2. Example of Cascading Measures



Annex 3. Driver Diagram with Measurement Indicators



Annex 4. Common Data Collection Methods

Patient-Reported & Qualitative Methods	
Surveys & Questionnaires:	Standardized forms (paper/online) for demographics, history, lifestyle, knowledge (self- or interviewer-administered).
Interviews:	In-depth, one-on-one conversations for rich qualitative data on experiences/perceptions
Focus Groups:	Guided discussions with small groups to explore attitudes, beliefs, and shared experiences.
Observation:	Watching and recording behaviors in natural settings (e.g., physical activity, dietary habits).
Electronic & Technological Methods	
Electronic Health Records (EHRs/EMRs):	Comprehensive digital patient histories for clinical decision-making.
Wearable Devices / Telehealth:	Real-time monitoring via devices (smartwatches, sensors) and remote consultations.
Administrative Data:	Using existing data from claims, billing, or public health databases.

Clinical & Biological Methods	
Biological Samples:	Blood, urine, tissue collection for lab analysis, genetics, biomarkers.
Direct Measurement:	Using instruments for vital signs, lab tests, or imaging.
Secondary & Archival Methods	
Secondary Data Analysis:	Leveraging existing datasets (hospital records, national databases).
Document Review:	Analyzing medical records, charts, or other archived documents.
Research-Specific Methods	
Controlled Experiments:	Evaluating new treatments with strict protocols.
Disease Registries:	Structured databases tracking specific diseases over time.

These methods are often combined to build a complete picture of patient health, from individual experiences to population-level trends.

Annex 5. Templates for constructing Run and SPC charts

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Run Chart Template developed by Richard Scoville, PhD | Version 2.0 | May 30, 2016 | Contact: richard@rscoville.net

Click to Download

SPC Template developed by Gloucestershire Hospitals NHS Foundation Trust | https://gloshospitals.nhs.uk | Accessed: 23 Dec 2025

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