Acquiring and Using Data to Drive Change

Institute for Healthcare Quality, Safety and Efficiency

SCHOOL OF MEDICINE

UNIVERSITY OF COLORADO **ANSCHUTZ MEDICAL CAMPUS**

Disclosures

None

Agenda

1. Data for QI, Accountability and Research
2. Data Use, Management, and Sources
3. Epic as a data source

BREAK

4. Analyzing Data

YOU ARE HERE

Session	2025-2026 Dates & Times* (All sessions are 1-4 p.m. MT)
Quality Improvement & Change Management	August 14, 2025 August 27, 2025 January 8, 2026 January 14, 2026
Applied Patient Safety	August 21, 2025 January 22, 2026
Acquiring Data to Drive Change	September 11, 2025 February 5, 2026
Designing for Change	September 25, 2025 February 12, 2026
Spreading Change Locally and Nationally	October 1, 2025 February 26, 2026
Coaching and Managing Quality Improvement	October 9, 2025 March 5, 2026

**ALL sessions held virtually on Zoom*


zoom

Data and Measurement Differences

Not all are created equal

Photo credit: Office 365 Stock Images

Learning Objectives

1. Describe the differences between data used for
   a) Quality Improvement
   b) Accountability
   c) Research

2. Recall the 4 main types of quality measures

3. Give an example of why a Quality Improvement project might not want to use an Accountability Measure

3 uses

Photo credit: Photo by Pixabay: https://www.pexels.com/photo/white-baby-mouse-159483/ Other photos: Office 365 stock

What are we measuring?

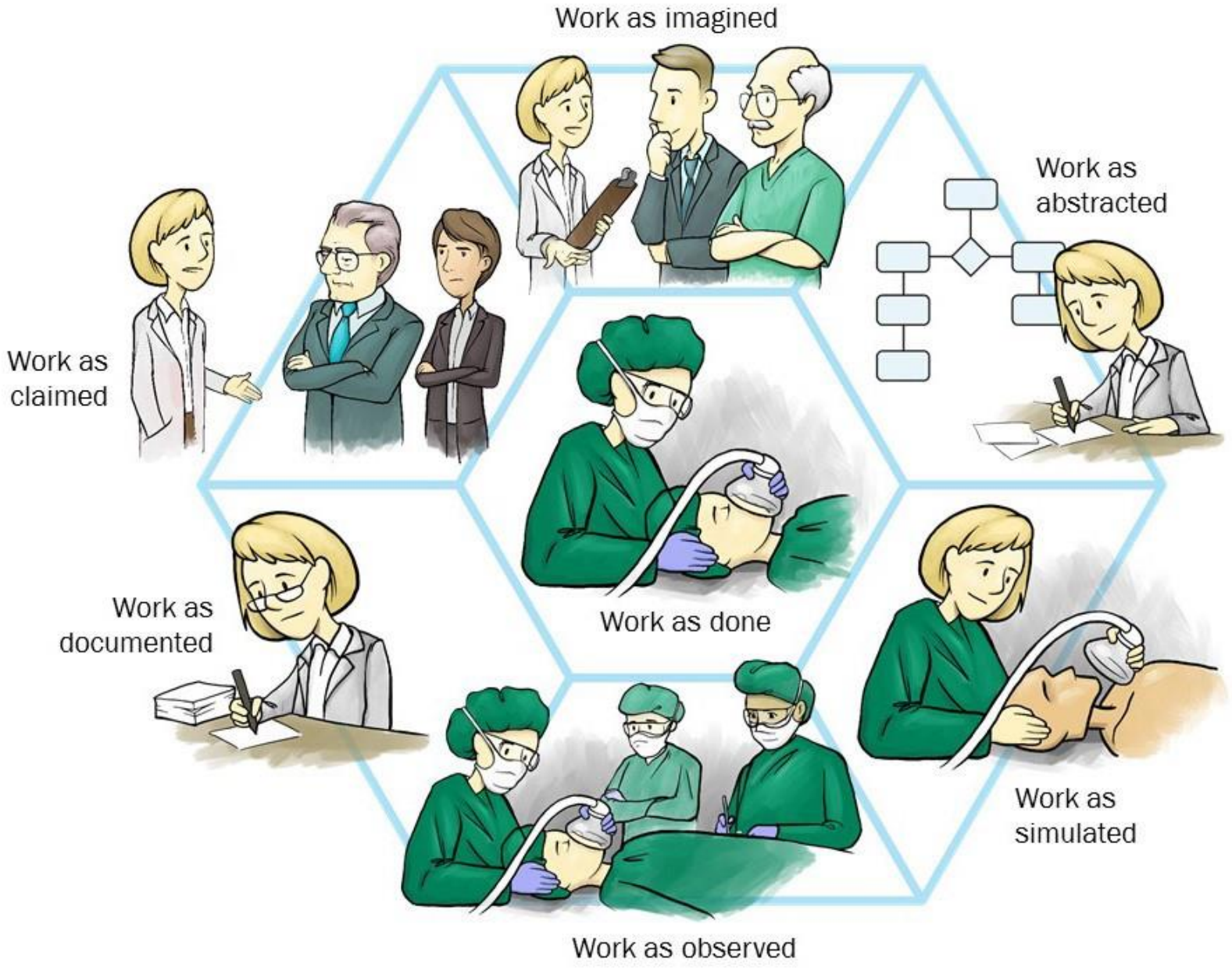


Image credit: Deutsch E. 2017. Bridging the gap between work-as-imagined and work-as-done. Pennsylvania Patient Safety Advisory. https://collections.nlm.nih.gov/master/borndig/101711396/201706_80.pdf

Types of Measures – Sepsis QI Example

Measure Type	Example
Structure	- % Weekly shifts with adequate staffing, by discipline (nurse, lab, pharm)
Process	- Time elapsed between: - Stat lab order (with lactate) placed; Arrival of test tube to lab (nurse) - Arrival of test tube to lab; Lactate lab result in EMR (lab) - Lactate lab result in EMR; Antibiotic order placed (provider) - Antibiotic order placed; Antibiotic start time (pharm, nurse)
Outcome	- % patients with septic shock receiving antibiotics within 2 hours of stat lactate order - % of patients with septic shock surviving to hospital discharge
Balancing	- Time between non-stat, additional lab order placed; Arrival of test tube to the lab - % patients with septic shock receiving antibiotics before blood cultures drawn - % patients with septic shock ordered antibiotics before lactate result available

“Wait, aren’t we already collecting data for CMS?”

- A CMS quality measure: “Percentage of patients who received appropriate care for severe sepsis and/or septic shock”
- Requires collection of 34 data points
- Why not use ‘that data?’

Data for QI and data for Accountability, can they be the same?

Image credit: Office 365 Stock Images

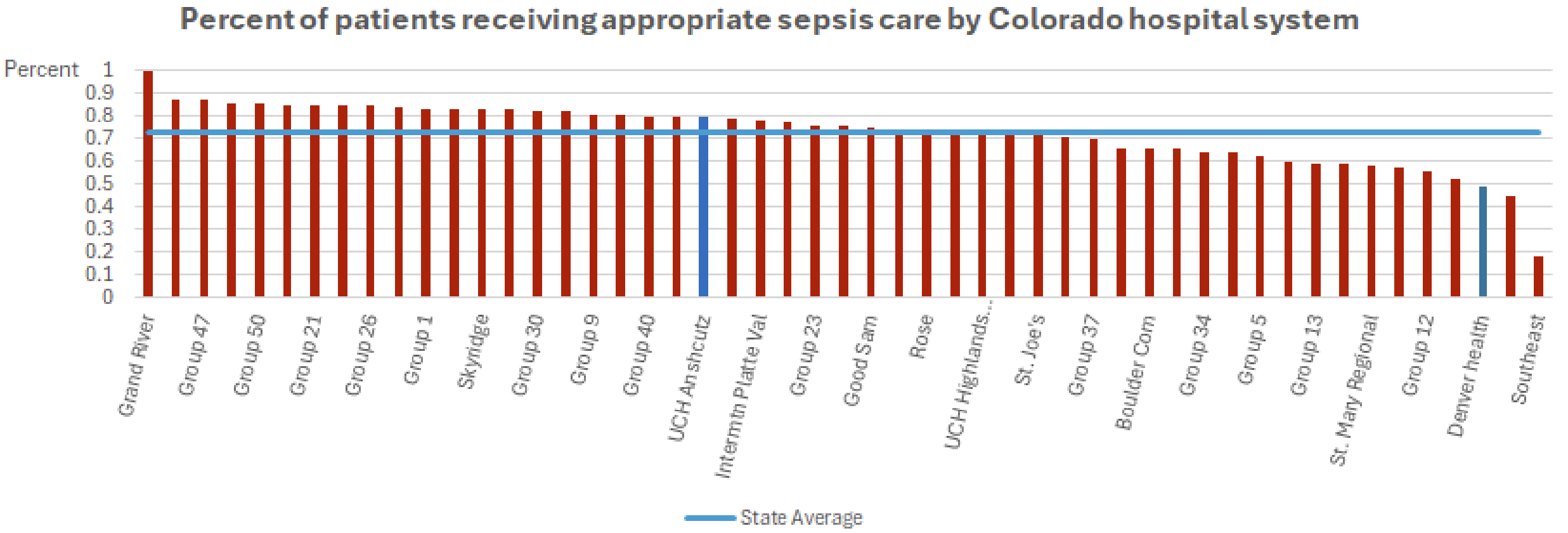
Accountability Measures – Big Comparison

Image credit: Office 365 Stock Images

- For leadership and individuals outside of the system
- Compare system level measures of performance
  - No test of change, no hypothesis
  - Detect outliers
  - Bragging rights
  - Payment bonus/penalty
- Measures have ‘strategic importance’ to maximize public health
- Measures addresses known ‘gap in care’ based on existing evidence
- General, easy to understand, applicable and measurable in all systems/settings

- **More likely to be ‘ideal work’ concepts**

Accountability - Example



Accountability Data

Image credit: Office 365 Stock Images

- Useful variation in data
  - Actual data cannot be all 0s or 100%
    - To ‘drive improvement’ there must be something to improve
    - **NOTE:** Exception to this rule is monitoring for safety
- However, ‘report card’ style reporting often uses 0s or 100% for easy interpretation
- May also be displayed as a ranking or percentiles
  - Someone always is at the top and at the bottom
  - Good for comparing to others, less helpful for quality improvement
    - Is ↑ score from your improvement or others decline?

Accountability Data – Big, Simple, Slow

Image credit: Office 365 Stock Images

- Large sample size, ‘feasible’ data collection (often claims, EMR)
  - Collected infrequently, missing data = rejection (↑feasibility)
  - Time lag between data generation, collection, and public reporting
- Aim for 100% data collection (↑accuracy, ↑cost), unless sampling allowed
- Confounders – important to describe, try to adjust for
  - Data used for judgement and comparison across different groups
  - Severity/risk adjustment ↑ cost and complexity of data collection and reporting
  - Consider stratifying rather than ‘adjusting away’ important disparities (SDOH)
    - Recommended by experts, but complicates reporting, calculation of ‘performance bonus

Quality Improvement: Explore local needs

- Understand current, local process, “real work”
  - Process map, flow diagram, cause/effect diagram
- Understand attitudes of participants in the process (patients, providers, staff)
  - (Dis)Satisfaction with current process
  - Ideas for change
  - Barriers/facilitators for change

- Motivate team/clinic to want to change
- Provide a current baseline
- **Rapidly** track effects of changes in the process
- Learn how participants feel about the changes

Image credit: Office 365 Stock Images

Measures for QI projects - Local

Photo credit: Office 365 Stock Images

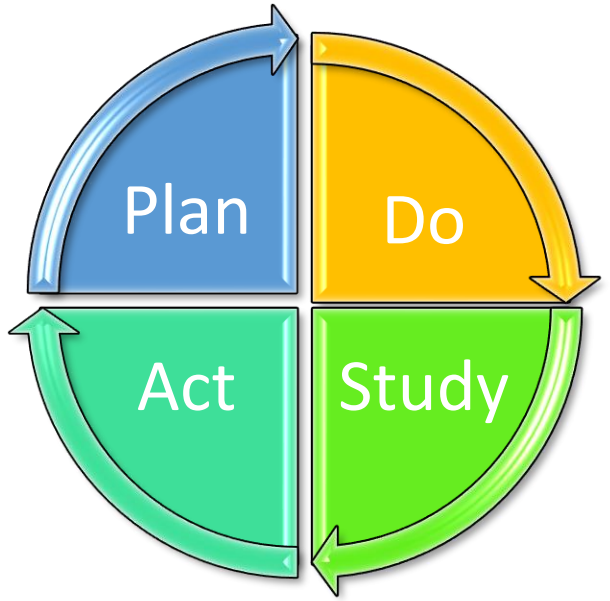
- Need to be specific to the local project and process being improved

- Often include ‘process’ measures to see if desired steps are occurring

- Need to be specific to a site or clinic, as other groups in the same larger system may be slightly different
  - Multiple groups (medical floors, clinics) can work to improve a shared process, but need to be able to stratify by group or area

Data for QI projects – Local, Frequent

- Collect only what is needed to establish baseline, monitor project
- Small, sequential samples
- Minimal time and cost of data collection
- Data often only useful in local context



- Testing strategy – small sequential tests

- Hypothesis is flexible, it changes as learning takes place (each PDSA cycle)

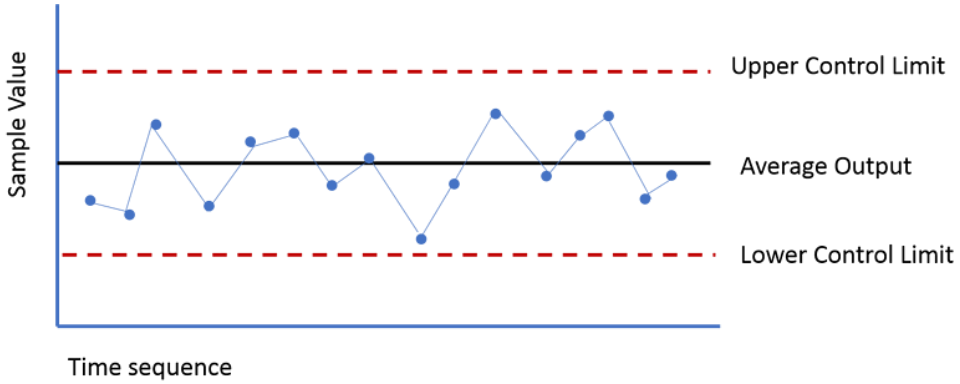
Image credit: Office 365 Stock Images

Data for QI projects

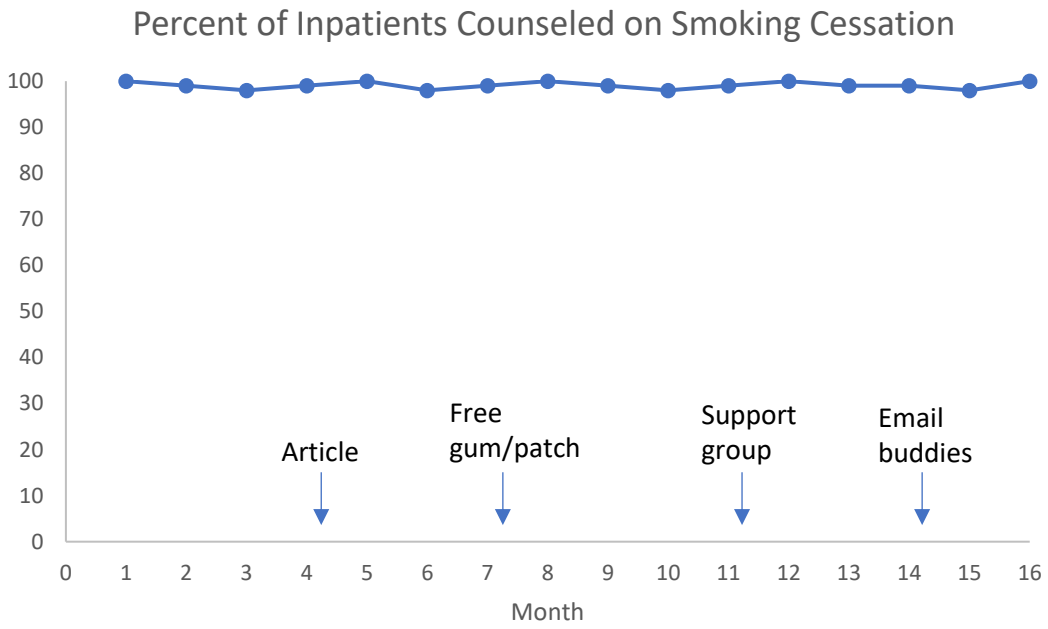
Image credit: Office 365 Stock Images

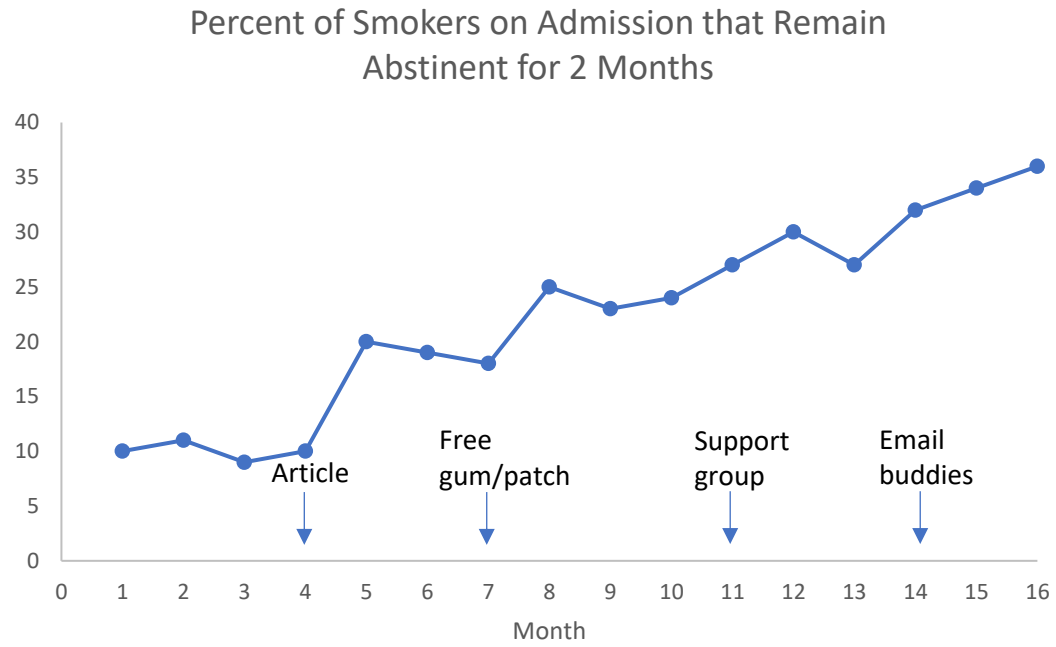
- Confounders may be considered, but rarely measured
- Accept consistent bias within current system
  - Improvements occur despite or 'in the face of' bias
  - Subgroup analysis/stratification could demonstrate local process biases

- Measured <u>over time</u>
  - Demonstrate temporal/seasonal influence
  - Detect whether an intervention made a difference



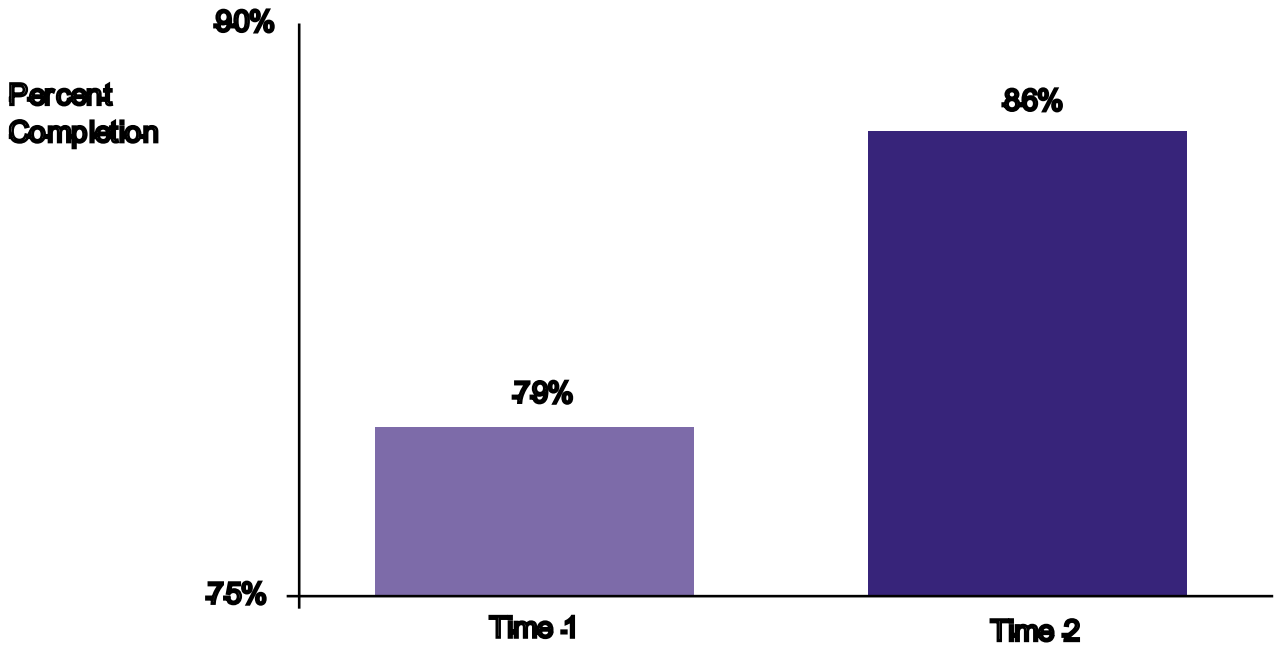
Accountability vs QI – Smoking cessation





Examples based on Provost and Murray, 2022. The Health Care Data Guide Learning From Data for Improvement, 2nd ed. Chapter 2, Figure 2.3, p. 33.

Limits of before/after studies in QI



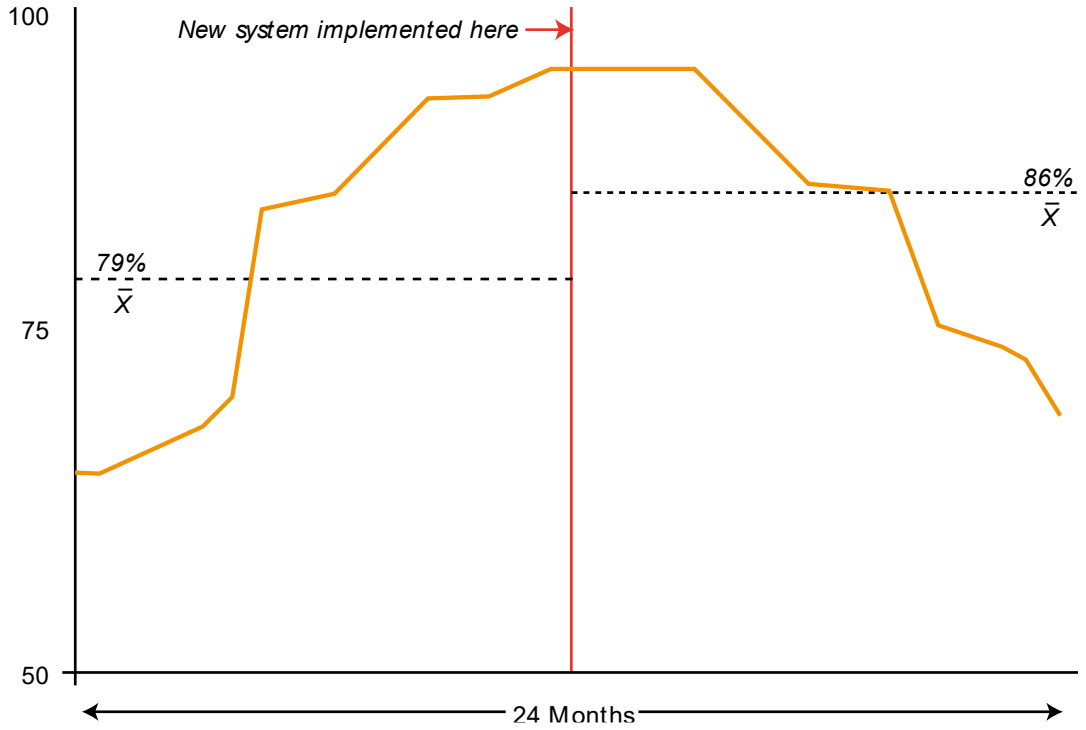


Image credit: https://www.england.nhs.uk/improvement-hub/wp-content/uploads/sites/44/2017/11/A-guide-to-creating-and-interpreting-

Research – Definitive Testing

Photo by Pixabay: https://www.pexels.com/photo/white-baby-mouse-159483/

- Goal is for universally applicable results
- Need to collect data on as many identifiable confounders as possible
- Control or remove sources of bias
- Focus on characteristics of participants and outcomes
- Less focus on process, unless evaluating feasibility or reliability

Research Data – Large, Detailed

Photo by Pixabay: https://www.pexels.com/photo/white-baby-mouse-159483/

- Sample size - often large
  - Need to be able to detect a certain, prespecified amount of change in the primary outcome
- Intervention - often blinded to minimize bias
- Hypothesis is fixed, one large test
- **How do we know if there has been an improvement?**
  - Hypothesis testing: t-tests, Chi-square, p-value, confidence intervals, etc.

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Data Use, Management, and Sources

data noun

da·ta ˈdā-tə ˈda- *also* ˈdä-

factual information (such as measurements or statistics) used as a basis for reasoning, discussion, or calculation

“In God we trust. All others must bring data.”

- W. Edwards Deming

“The goal is to turn data into information, and information into insight.”

- Carly Fiorina, former executive, president, and chair of Hewlett-Packard Co.

Uses for Data in QI

- Problem identification/demonstrate need or buy-in
- Understand WHY
- Reveal solutions
- Track interventions
- Visualize change

Six Steps for a Successful QI Project

1. Define the problem.
2. Identify areas that can be improved.
3. Decide how you will measure progress.
4. Explicitly state your goals (SMART)
5. Implement and measure small tests of change.
6. Build upon success and sustain the process.

Data in every step!

Uses for Data in QI

- **Problem identification/demonstrate need or buy-in**
- Understand WHY
- Reveal solutions
- Track interventions
- Visualize change

Define the problem

Is it a problem?

How do you know?

Who is affected?

By how much?

Are there best practices to refer to?

PROVE IT.

(ahem, with data ☺)

Red Blood Cell (pRBC) Transfusion Recommendations
pRBCs are most likely APPROPRIATE in the following clinical scenarios:
• Hgb < 7 g/dL OR Hgb < 8 with CV disease AND symptoms
• Hemodynamically unstable patient with an acute bleed
• Perioperative acute blood loss anemia with expected Hgb < 7
• Cytotoxic chemotherapy with expected Hgb < 7
• Anemia with symptoms that are intolerable without transfusion
Transfuse 1 unit at a time unless Hgb <6.0 or bleeding out

COST = **~$700**
Per Unit

>50% of non-OR, non-MTP, inpatient transfusions DO NOT meet guidelines

1783 units transfused outside guidelines x $700/unit = $1,248,100.00

New Orders

Haptoglobin S

Add to spec

Routine, ON

New collection

Accept | Cancel

AM LC, SPEP, IFE

Outcome of Add-On Requests

from 1/1/2018 to 9/18/2019

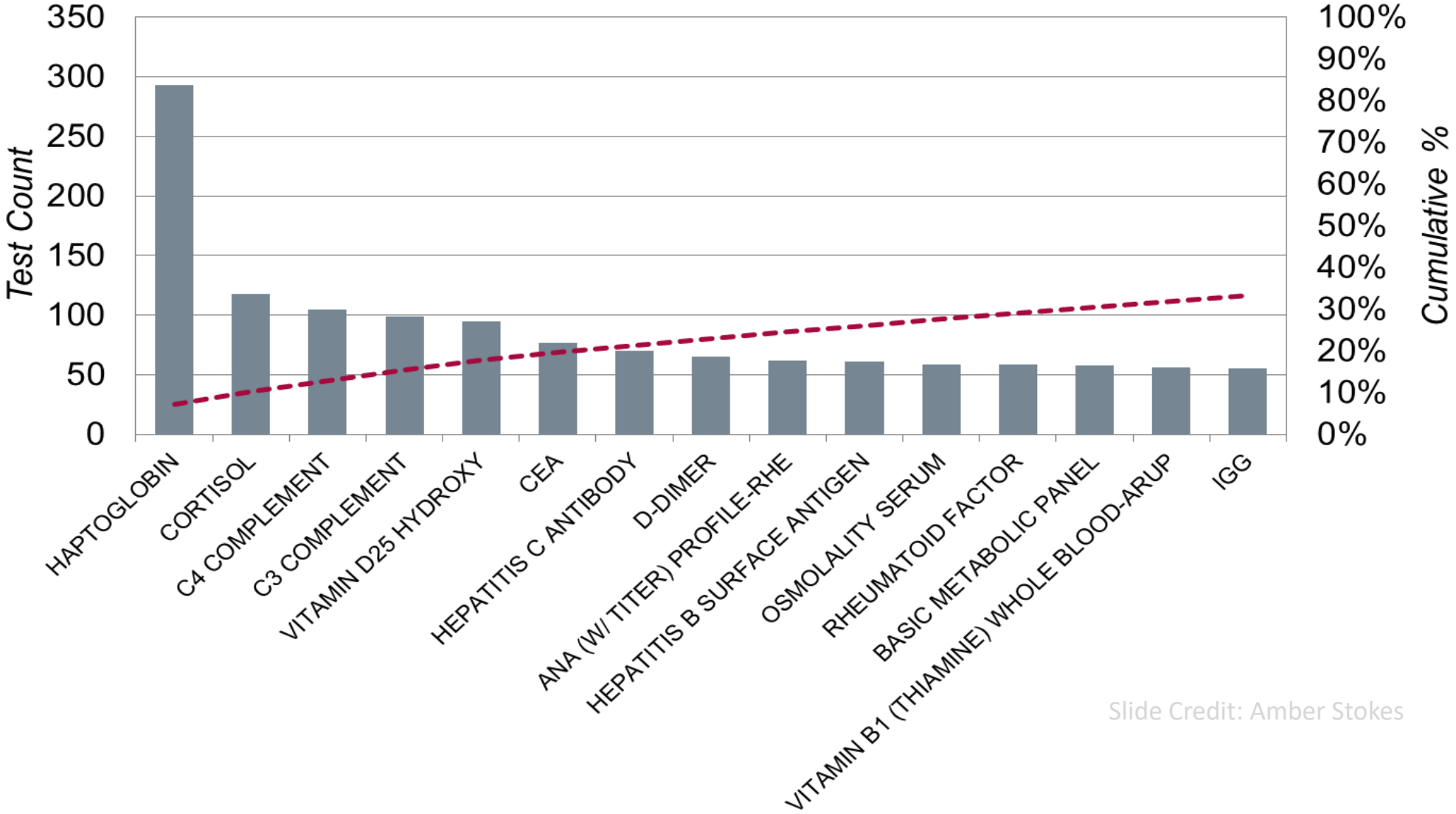
Slide Credit: Amber Stokes

Next Required | Link Order | Accept | Cancel

Uses for Data in QI

- Problem identification/demonstrate need or buy-in
- **Understand WHY**
- **REVEAL solutions**
- Track interventions
- Visualize change

Top 15 Add-On Failures: UCH Inpatient January – August 2017



Slide Credit: Amber Stokes

New Orders

Haptoglobin Serum

Add to specimen collected 2d ago?

Routine, ONCE, First occurrence today at 1924

New collection

University (Anschutz) Hospital

Poudre Valley Hospital

Memorial Hospital

New Orders

Haptoglobin Serum

Add to specimen collected 2d ago?

Routine, ONCE, First occurrence today at 1924

New collection

University (Anschutz) Hospital

Poudre Valley Hospital

Memorial Hospital

Uses for Data

- Problem identification/demonstrate need or buy-in
- Understand WHY
- Reveal solutions
- **Track interventions**
- **Visualize change**

New Orders

Haptoglobin Serum

Routine, ONCE, First occurrence today at 1924

New collection

9/19/2019

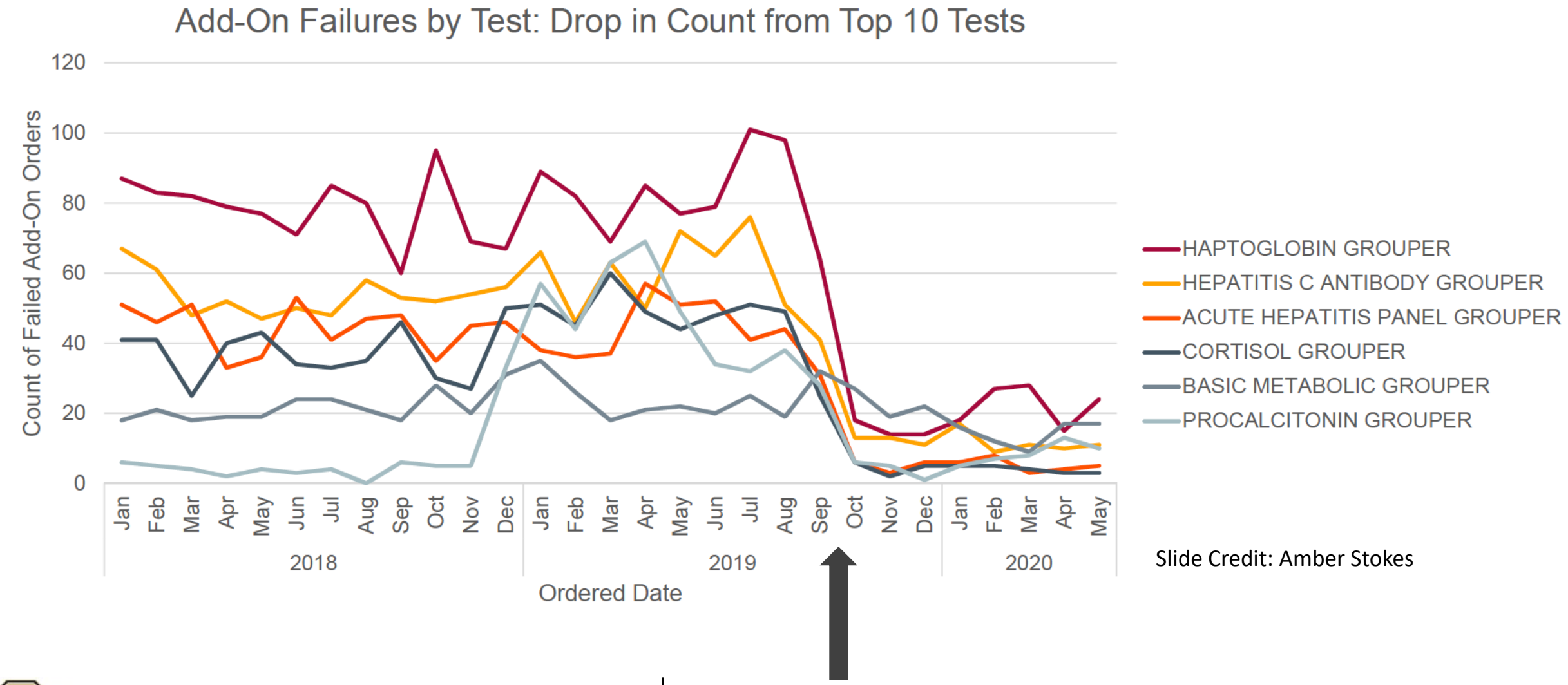
University (Anschutz) Hospital

STOP

Poudre Valley Hospital

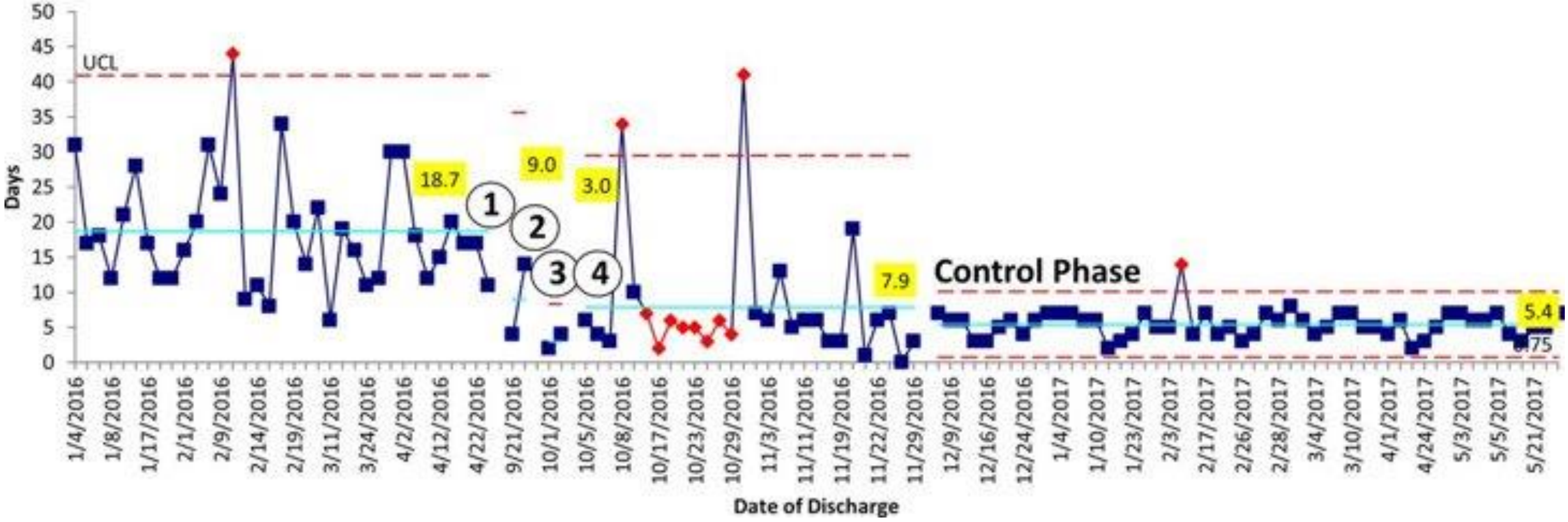
Memorial Hospital

Add-On Failures By Test Over Time



Slide Credit: Amber Stokes

Days from Hospital Discharge to First Scheduled Outpatient Cardiac Rehabilitation Appointment



QI Metrics

OUTCOME

PROCESS

STRUCTURAL

BALANCE

QI Metrics = DATA!

OUTCOME

Your (ultimate) measure of success.

PROCESS

STRUCTURE

The things that lead to your outcomes **AND** are your interventions happening.

BALANCE

What you don't want to change.

Inpatient DVT Prophylaxis

OUTCOME

Inpatient DVT rate per 1000 patients

PROCESS

STRUCTURE

- % of patients receiving appropriate prophylaxis
- SCDs and pumps in room
  - and applied to patient?

Intervention = EHR guidance based on risk

- Risk score completion in EHR

BALANCE

Bleeding rates.

Pediatric Vaccination Schedules

OUTCOME

Percentage of patients (in a clinic) vaccinated
(NOTE: actual outcome is disease)

PROCESS

STRUCTURE

% of patients offered vaccine
% of patients declined

Intervention = pop-up reminder

- % of alerts ignored / followed

BALANCE

Provider alert fatigue
Lower well-child exams for lower SES with a mistrust of vaccines.

Post-Surgical Infections

OUTCOME

Absolute number of post-op wound infections

PROCESS

STRUCTURE

% compliance with pre-anesthesia antibiotics

Intervention: chlorhexidine only in all ORs

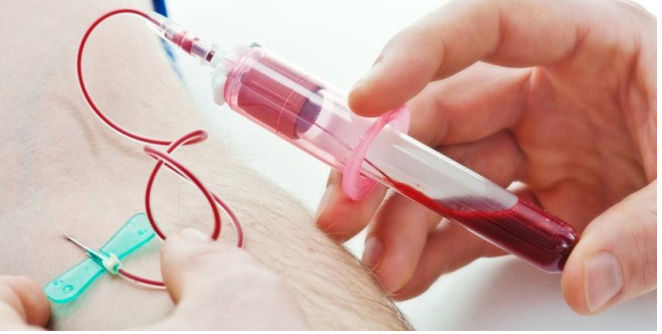
- Stock of chlorhexidine

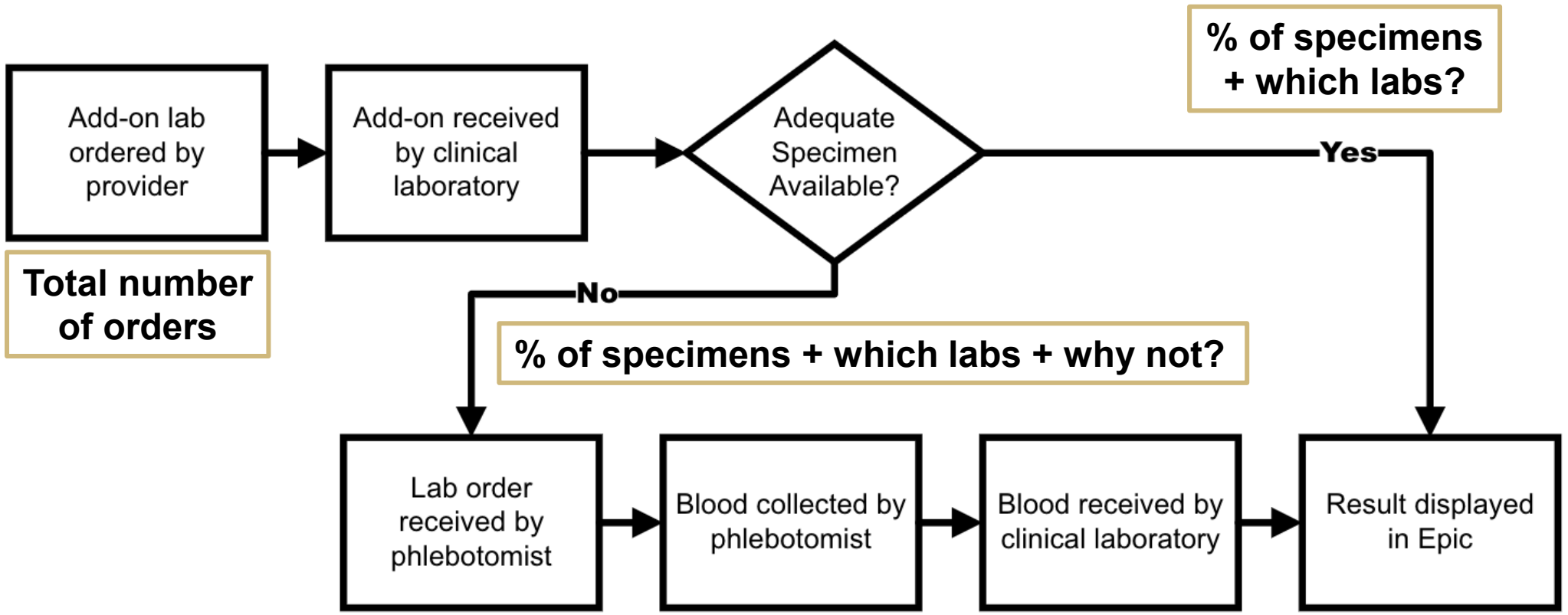
Intervention: chlorhexidine scrub education

- % of techs who attended sessions
- Demonstration of proper scrub technique

BALANCE

Allergic reactions to antibiotics or skin prep




Add-on lab ordered by provider
Add-on received by clinical laboratory
Adequate Specimen Available?
% of specimens + which labs?
Yes
No
Total number of orders
% of specimens + which labs + why not?
Lab order received by phlebotomist
Blood collected by phlebotomist
Blood received by clinical laboratory
Result displayed in Epic

Break-Out

10 mins

1. **Introductions:** you and your project (or a problem you want to fix)

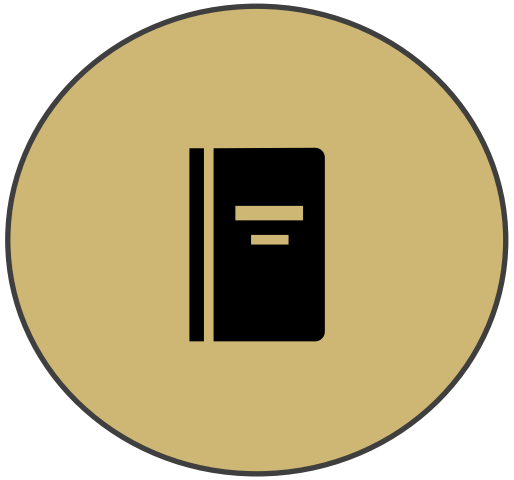
2. Define your: **Outcome Metric(s)**

That lead to…

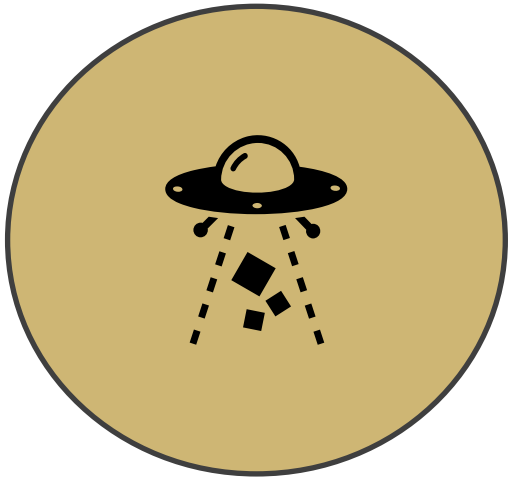
Process Metric(s)

Structural Metric(s)

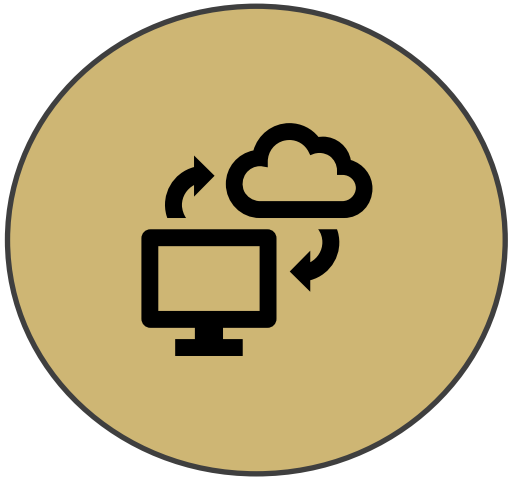
Where to find, how to find, and how to collect data.



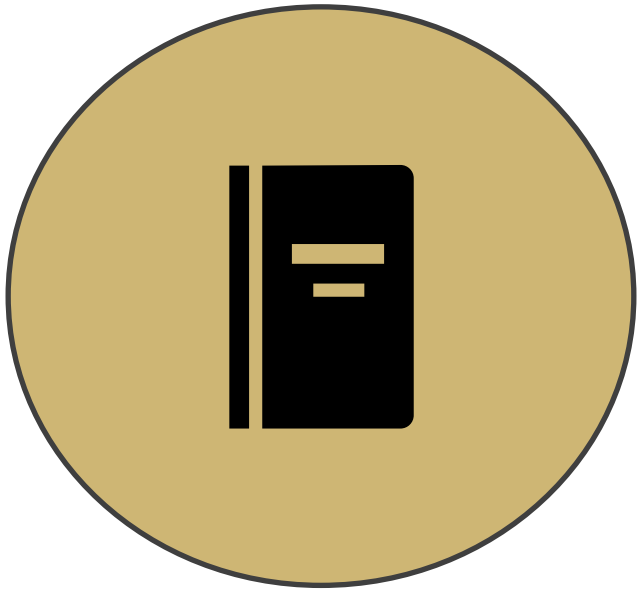
Data Sources



Data Collection



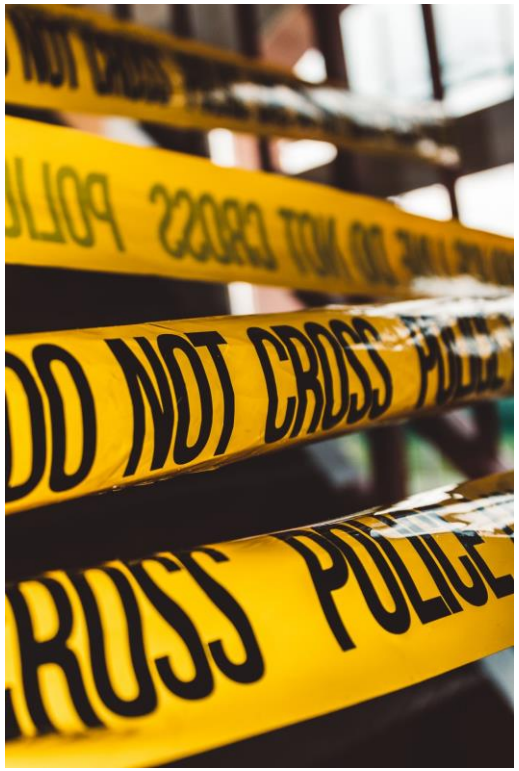
Data from Epic



Data
Sources

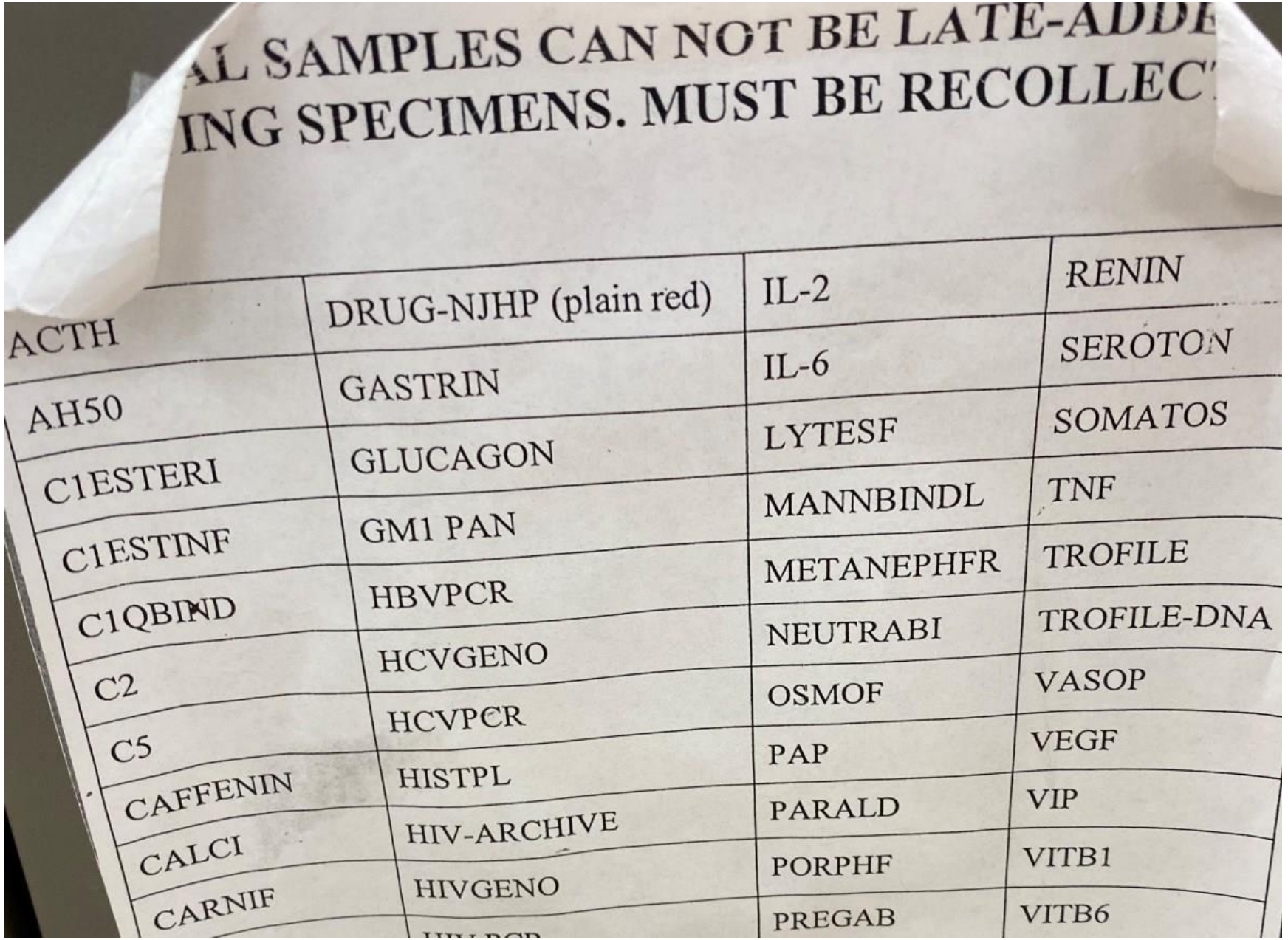
Get it yourself		Manual Chart Review EHR reports
Division/Unit	EHR Reports Data experts	National registries
Department	EHR Reports Data experts	National registries
Institution	EHR Reports Data experts	National rankings
State-Wide		State-death registry All-payer claims database

Get it yourself

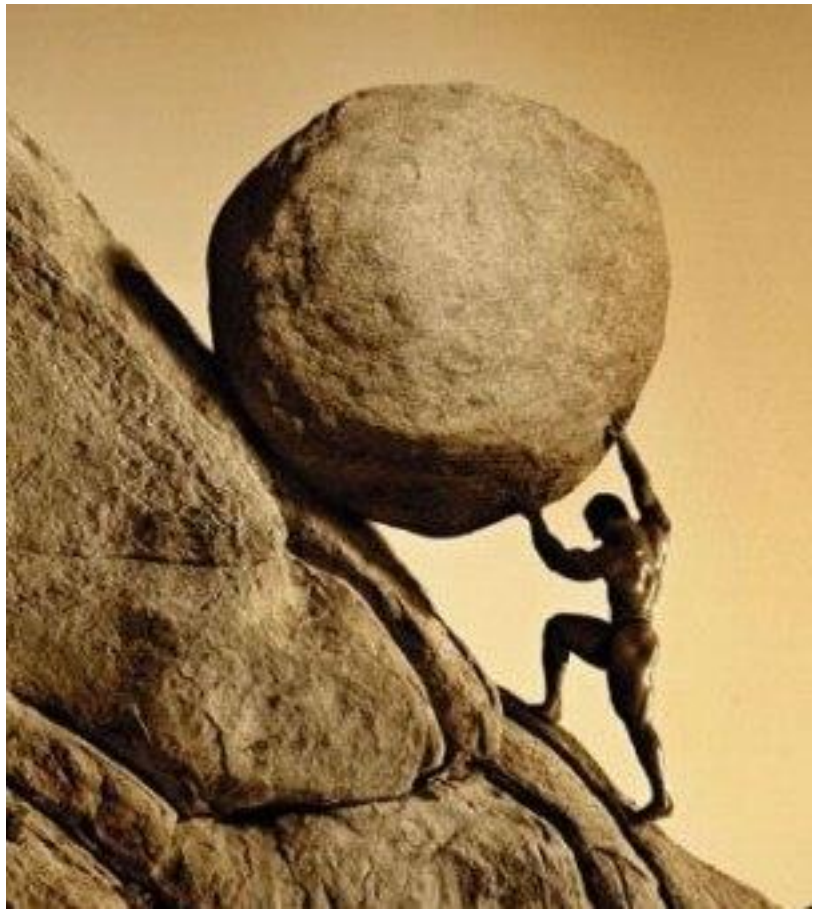


現場 Gemba

NOTE: your data may not presently exist!


AL SAMPLES CAN NOT BE LATE-ADDE
ING SPECIMENS. MUST BE RECOLLEC
ACTH
DRUG-NJHP (plain red)
IL-2
RENIN
AH50
GASTRIN
IL-6
SEROTON
C1ESTERI
GLUCAGON
LYTESF
SOMATOS
C1ESTINF
GM1 PAN
MANNBINDL
TNF
C1QBIND
HBVPCR
METANEPHFR
TROFILE
C2
HCVGENO
NEUTRABI
TROFILE-DNA
C5
HCVPCR
OSMOF
VASOP
CAFFENIN
HISTPL
PAP
VEGF
CALCI
HIV-ARCHIVE
PARALD
VIP
CARNIF
HIVGENO
PORPHF
VITB1
PREGAB
VITB6

Get it yourself



Manual chart review is ONLY for identifying data sources and validation.

Measuring Gait Speed in Seniors Clinic

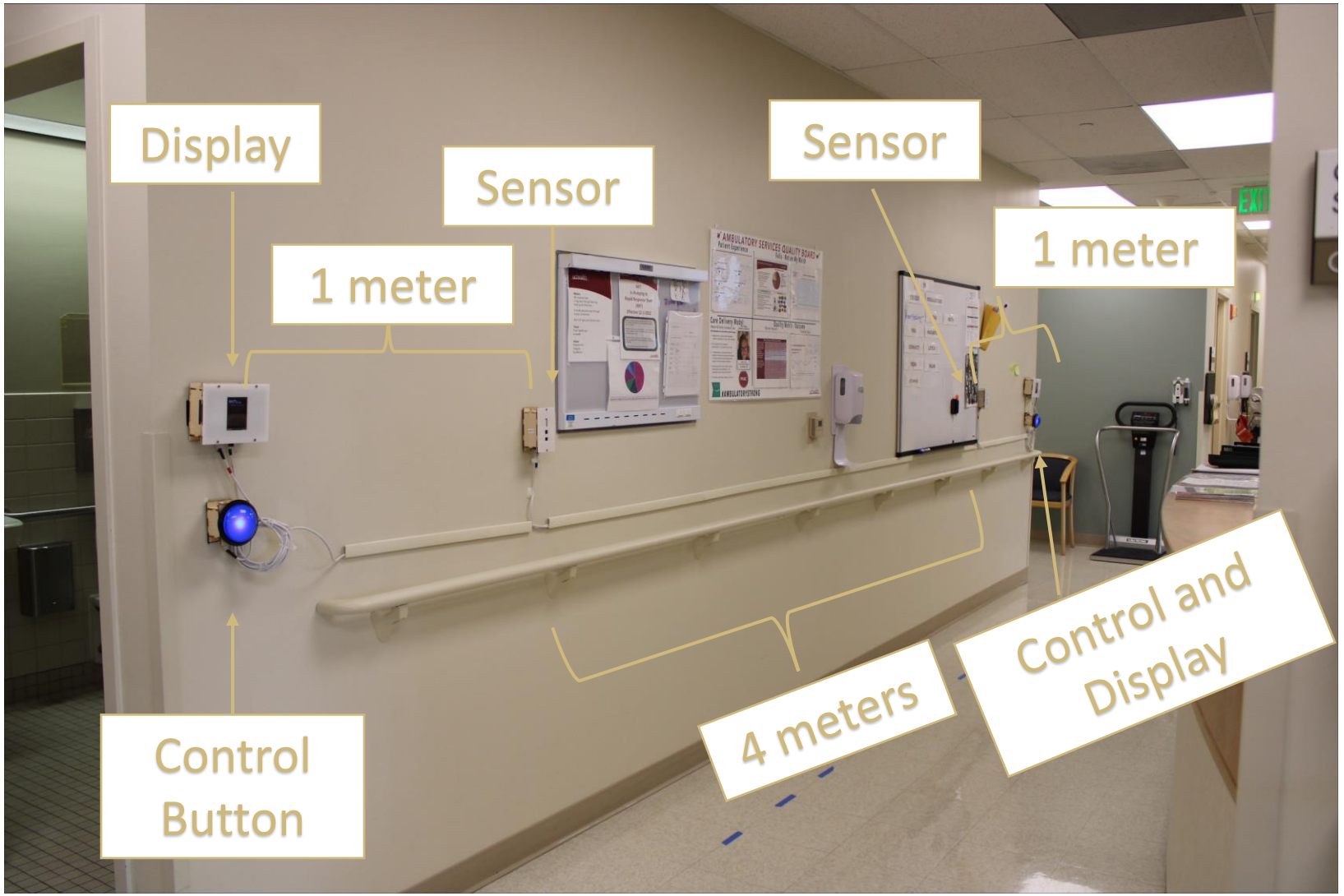


Image Courtesy of Thomas Johnson, MD

Division/Unit

Department

STS/ACC TVT Registry™

Institution

vizient®

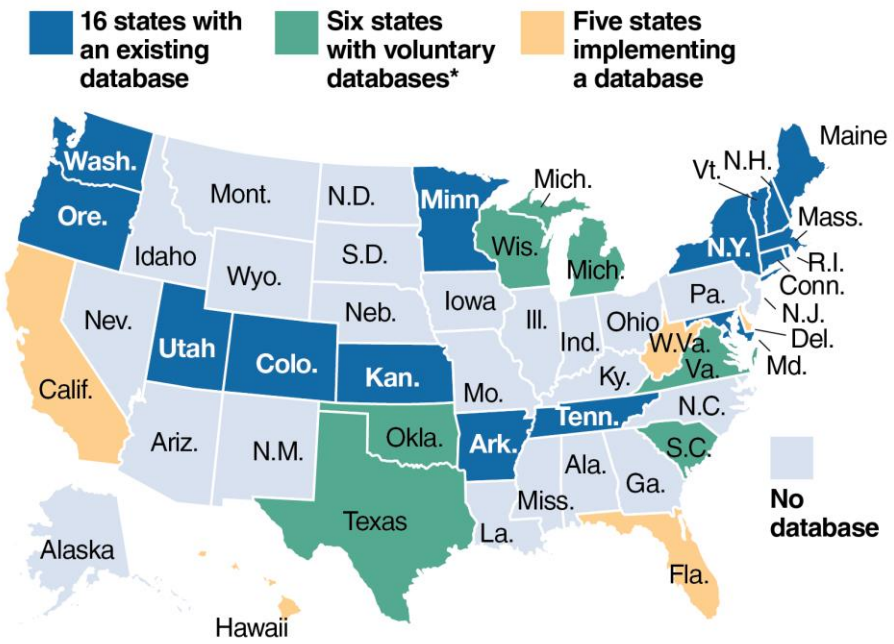
NOTE: Accountability data – USE CAUTION!

State-Wide

State-death registry
All-payer claims database

State of databases

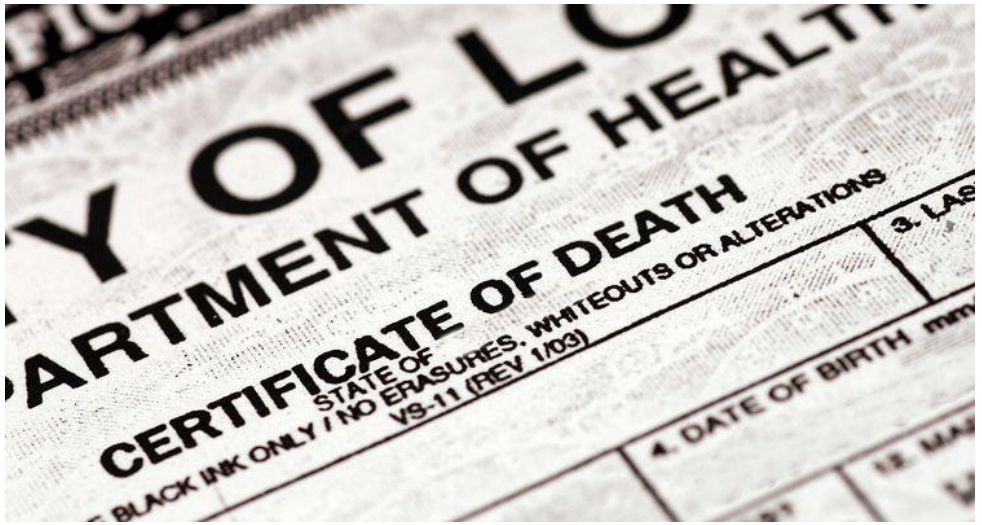
All-payer claims databases have yet to catch on at the state level



Notes: California also has a voluntary database. West Virginia's implementation is currently on hold.

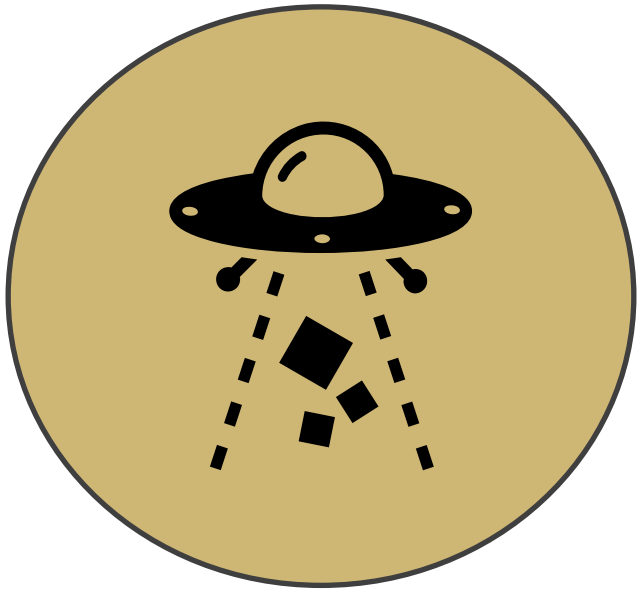
* States where submissions are voluntary or the datase is maintained through voluntary effort

Source: APCD Council interactive state report map



What is **ONE critical piece** of data you need for your project? Where might you find it?

WRITE IT DOWN!



Data Collection

Conceptual vs Operational definitions

- Conceptual is *what* you are going to measure
- Operational is *how*

Average time to appointment

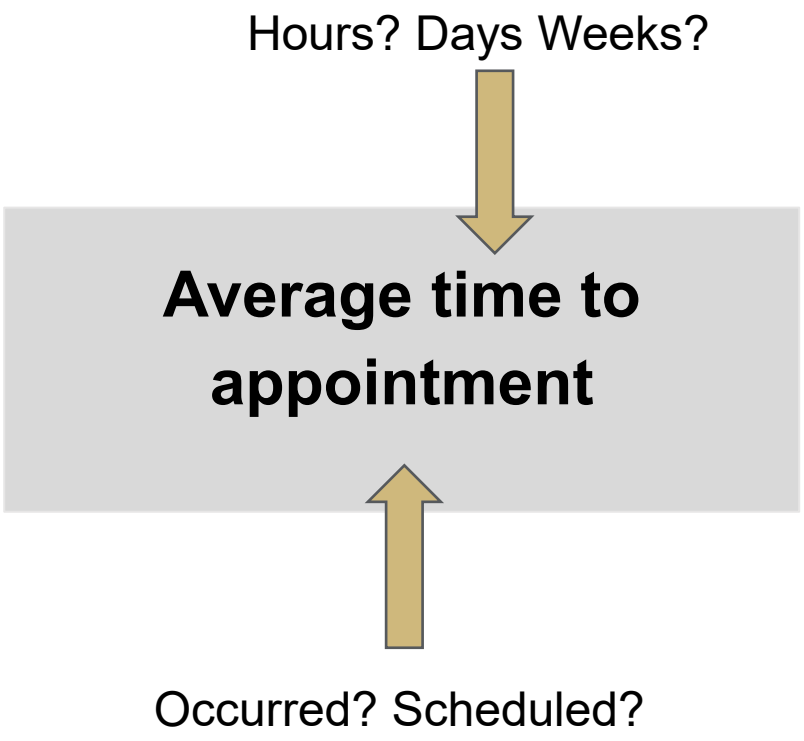
Date/Time appointment occurred

–

Date/Time appointment requested

Total number of appointments requested

Conceptual vs Operational definitions



Date/Time appointment occurred

Encounter Closed?

–

Date/Time appointment requested

Order? Call?

Total number of appointments requested

Conceptual vs Operational definitions

Daily order of CBCs and BMPs on inpatients ordered by day team residents

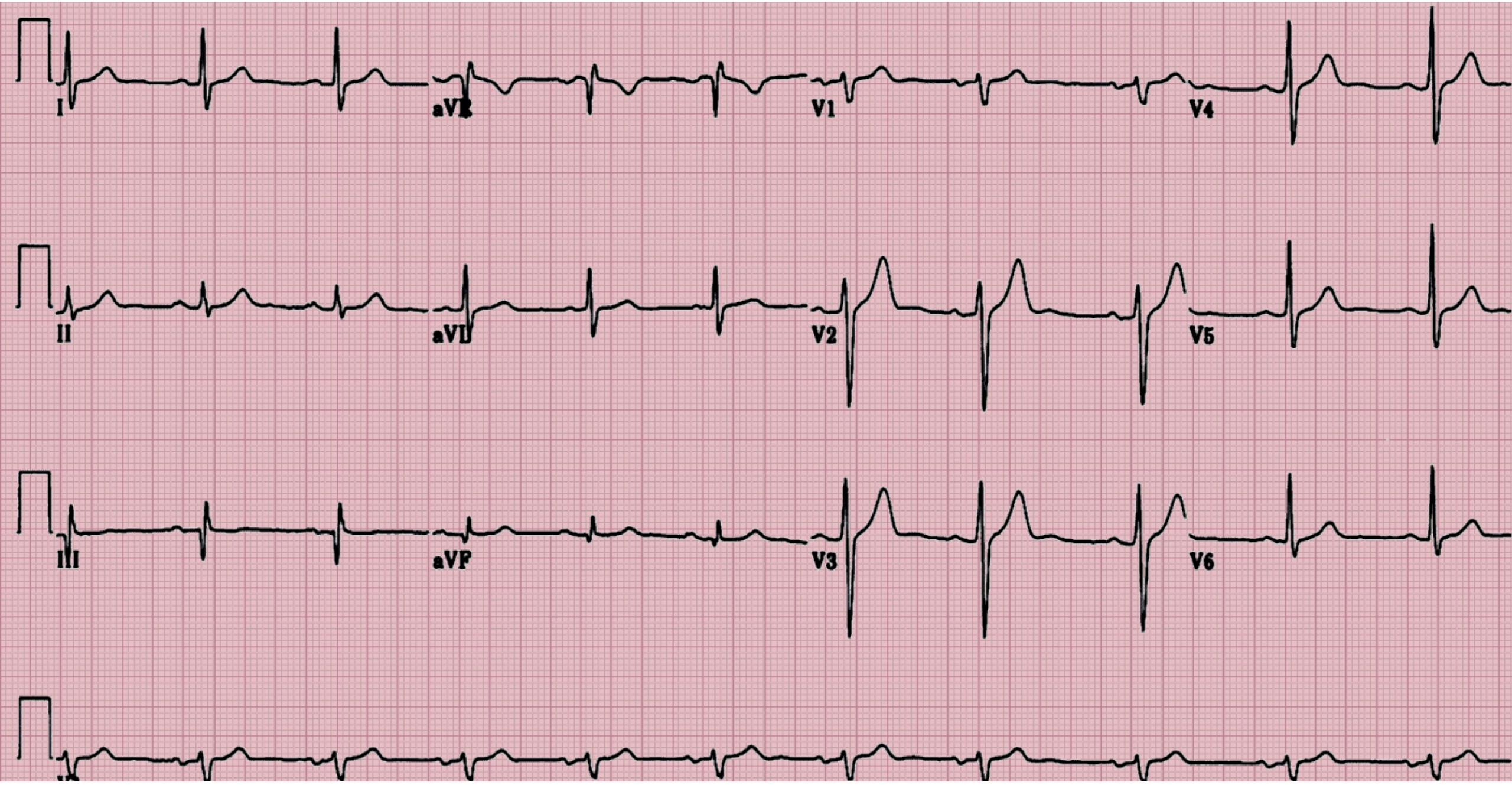
Number of CBCs

+

Number BMPs on inpatients ordered by day team residents between 1200am – 1159pm

---

Total medicine team census per day


I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6

ECG (Electrocardiogram) 12 Lead (Order 397966448)

ECG

Date and Time: 5/10/2018 2:09 PM Department: UCHealth Heart and Vascular Care - Anschutz Medical Campus

Ordering User/Authorizing: Benton, Emily M, NP (auto-released)

Ordered On 5/10/2018 2:09 PM

Ordering Provider	Authorizing Provider	Ordering User	Ordering Department
Benton, Emily M, NP 720-848-5300 303-266-4610	Benton, Emily M, NP 720-848-5300 303-266-4610	Benton, Emily M, NP	AMC CARD PROGCARE UNIT

Order Information

Order Date/Time	Release Date/Time	Start Date/Time	End Date/Time
05/10/18 02:09 PM	05/10/18 02:09 PM	05/10/18 02:10 PM	05/10/18 02:10 PM

Order Details

Frequency	Duration	Priority	Order Class
ONCE	1 occurrence	STAT	Hospital Performed

Order Questions

Question	Answer	Comment
Indication for test:	Tachycardia	

“Happiness is there when expectations meet the reality.”

Dr. Debasish Mridha, MD


Tip

Create a data dictionary

- Repository of all your data points
- Provides a detailed description of each data point including:
  - Definition
  - Source
  - Other notes
- Built over-time as you get more data
- Especially helpful for EHR data

Key Question	Data Element Name	Operational Definition	Parameters	Source	Who	Frequency
What is the length of stay?	Length of stay (LOS)	LOS = Admit time to Discharge time	• Date range: 1/1/2020 - 12/31/2020 • One listed for every patient by CSN • Format: time in hours	EHR -- ADT	Which team member is in charge of collecting?	Monthly data pull, 1st of month

Data Organization

	A	B	C	D	E	F
1	**Date**	**Item**	**Sales Rep**	**Quantity**	**Price**	**Commission**
2	01-07-2018	Projector	Bob	13	150	11%
3	01-07-2018	White Board	Mark	8	40	9%
4	02-07-2018	White Board	Stacey	7	40	7%
5	03-07-2018	White Board	Mark	18	40	8%
6	05-07-2018	Office Chair	Stacey	19	230	6%
7	05-07-2018	Projector	John	4	150	10%
8	08-07-2018	Printer	Bob	9	80	6%
9	10-07-2018	Printer	Laura	16	80	2%
10	10-07-2018	Office Chair	Mark	15	230	9%
11	10-07-2018	Diary	Bob	15	16	1%
12	10-07-2018	Office Chair	John	7	230	2%
13	13-07-2018	Diary	Laura	23	16	11%
14	17-07-2018	White Board	Bob	20	40	5%
15	17-07-2018	Office Chair	Mark	9	230	3%
16	20-07-2018	White Board	Stacey	23	40	6%
17	20-07-2018	White Board	Stacey	4	40	5%

1. ORGANIZE by columns
2. DON’T use color coding
3. Set up BEFORE you start collecting data

Characteristic	UCH	Non-UCH Metro	North	South	All sites Combined
Transfusion order date/time					
Pre-transfusion order Hgb level					
Number of units ordered to be transfused					
Indication for transfusion selected					

	Non-Alert	Alert	
Characteristic	**Arm 1**	**Arm 2 (non-interruptive)**	**Arm 3 (interruptive)**
Age_in_Years			
Sex			
Female			
Male			
missing			
Race			
American Indian or Alaska Native			
Asian			
Black or African American			
Native Hawaiian and Other Pacific Islander			
White or Caucasian			
Other			
More than one race			
Ethnicity			
Hispanic, Latino/a, or Spanish Origin			
Non-Hispanic			
missing			
Language			
English			
Spanish			
Other			
Financial_Classification			
Commercial			
Indigent Care			
Medicaid			
Medicare			
Other			
Self-Pay			

“Doveryai, no proveryai.” (Trust, but verify)

Ronald Reagan, United States President 1981 – 1989

“A minimum put to good use is enough for anything.”

Jules Verne, Around the World in Eighty Days

Getting Data Steps

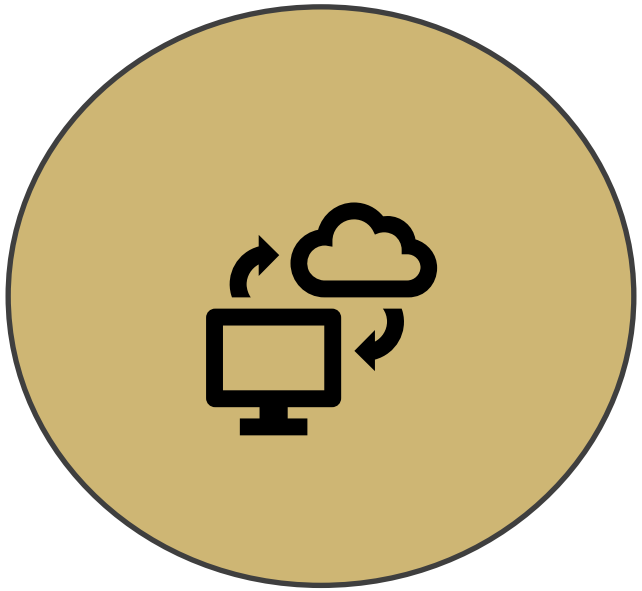
1. Define base population – inclusion/exclusion criteria

2. Request data as best you can, but recognize this will be a conversation between you and who will be pulling data

    - GOAL = pulling ice cream, maybe not specific flavor

3. Validate your data

Don’t let perfect be the enemy of good enough!



Getting Data from Epic

Learning Objectives

1. Identify which data types are most helpful to use in your project

2. Determine which data reporting tools you should use

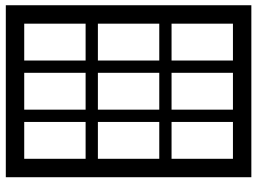
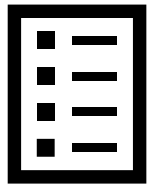
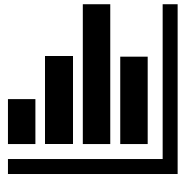
3. Discuss how you'll get your "critical piece of data?"

Outline

1. Structured versus unstructured data in the EMR
2. Epic Specific Structural Overview
3. Data Collection from Epic

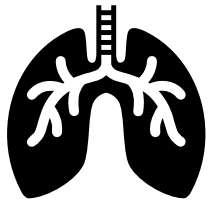
Types of Data in the EMR

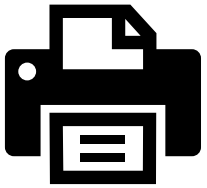
Structured Data Elements


- Data that can be stored in pre-defined fields
- Examples: Orders, Medications, Labs, Flowsheets, SmartLists, Smart Forms, Coded data (CPT, ICD-10, Snomed, smartdata elements…)
- Easier to obtain in automated way

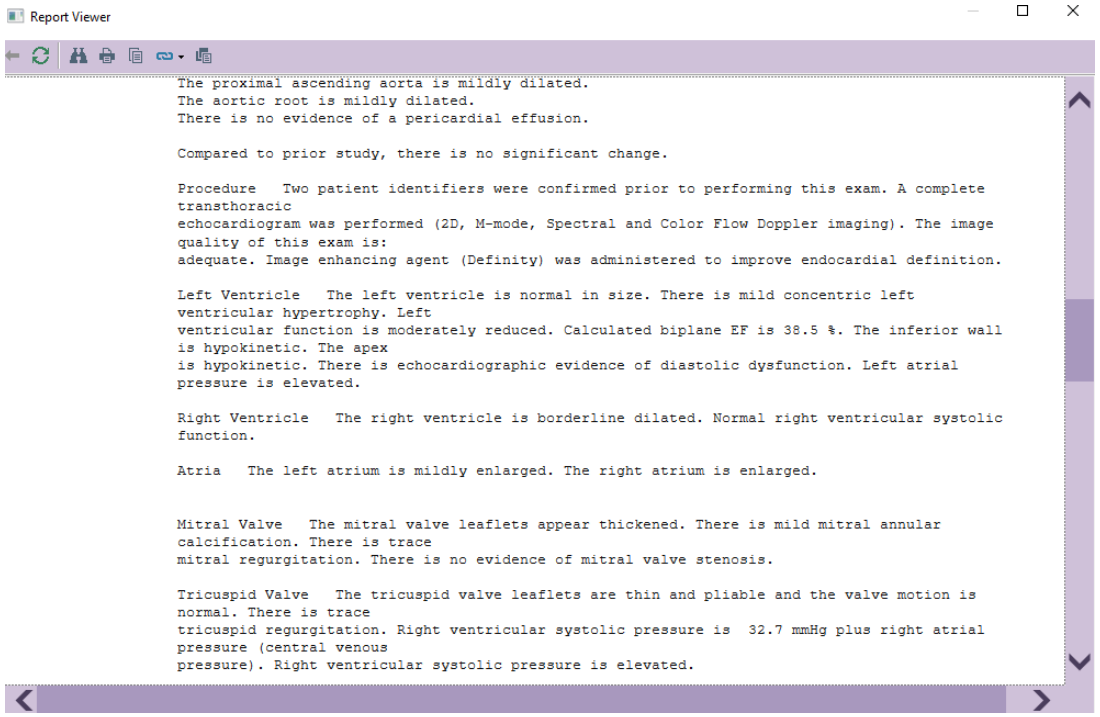
Unstructured Data Elements

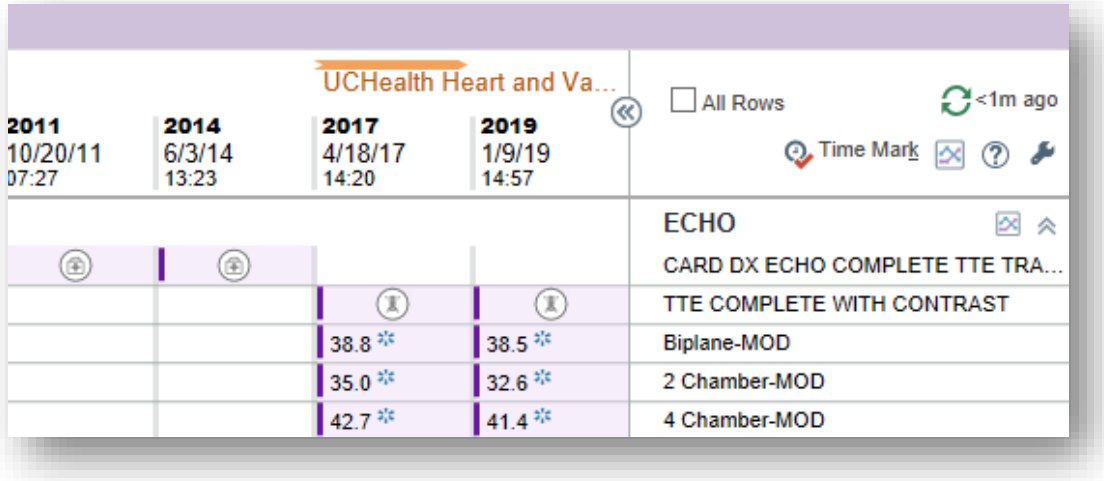


- Data that cannot be put into row-column organization
- Examples: Free text (i.e. notes), curated data (i.e. imaging, pathology, procedural reports), scanned documents, images
- Generally, not linked to data elements = Hard to search for
- Rarely can automate = manual chart review to obtain

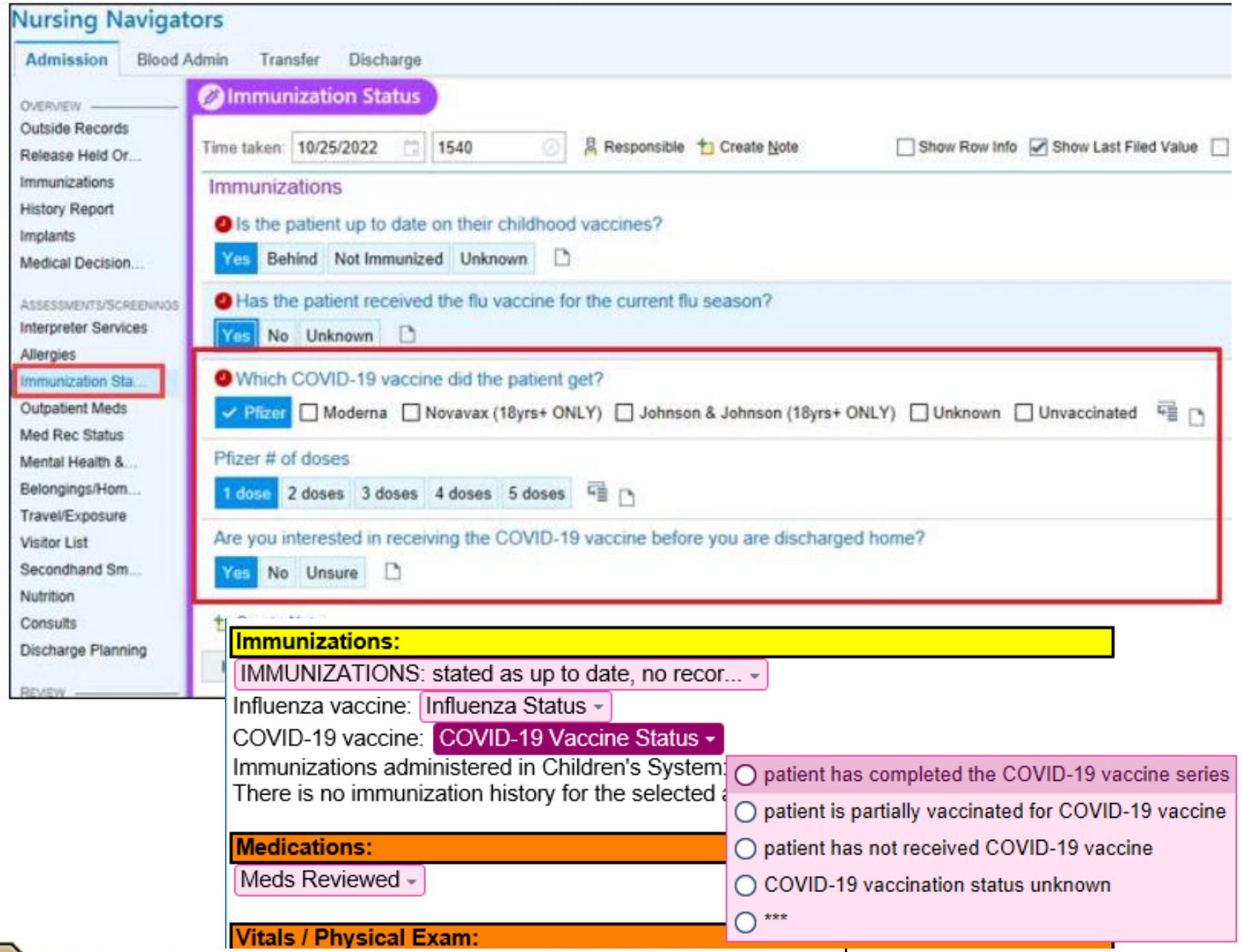
Echocardiogram Report (unstructured)

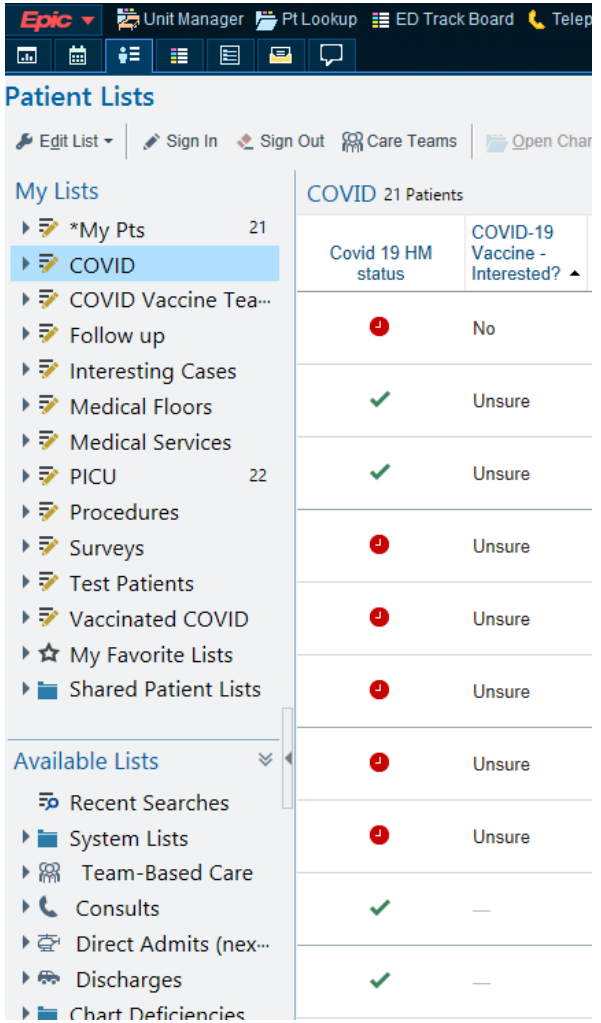


Echocardiogram Results (structured)



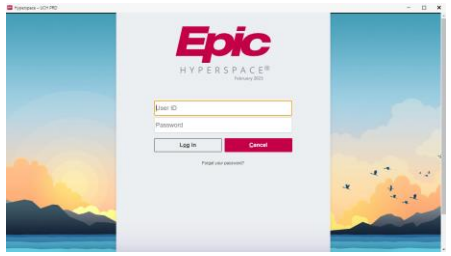
SmartTools (structured)





Epic: A Structural Overview

Epic Data Structure



Epic ASAP
Epic Ambulatory
Epic ClinDoc
Epic Orders
Epic Beaker
Epic Willow
Epic Cadence
Epic OpTime
Epic…

Chronicles

- Operational database
- Real-time data

- Tool: Reporting Workbench
- Benefits: Real-time
- Negatives: SLOW

Clarity

- Storage database
- Updated Nightly

- Tool: Crystal reports
- Benefits: close to real time, full data set
- Negative: Requires SQL coding and other tools

Caboodle

- Data warehouse
- Updated Nightly

- Tool: SlicerDicer, Dashboards
- Benefit: fast, self-service
- Negative: Loses context/detail

Choosing the Right Tool

Questions to ask?

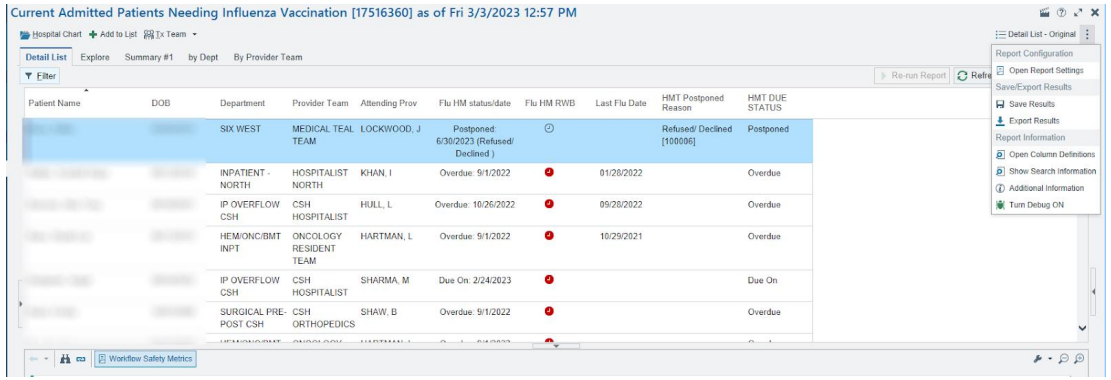
- Does the data need to be in real time?
- Does the report need to be automated?
- Does it need to be interactive/visual?
- Will this require large amounts of data to sift through or display?
- What will the data be used for? Monitoring trends? Care Team Communication

Epic: Data Collection Tools

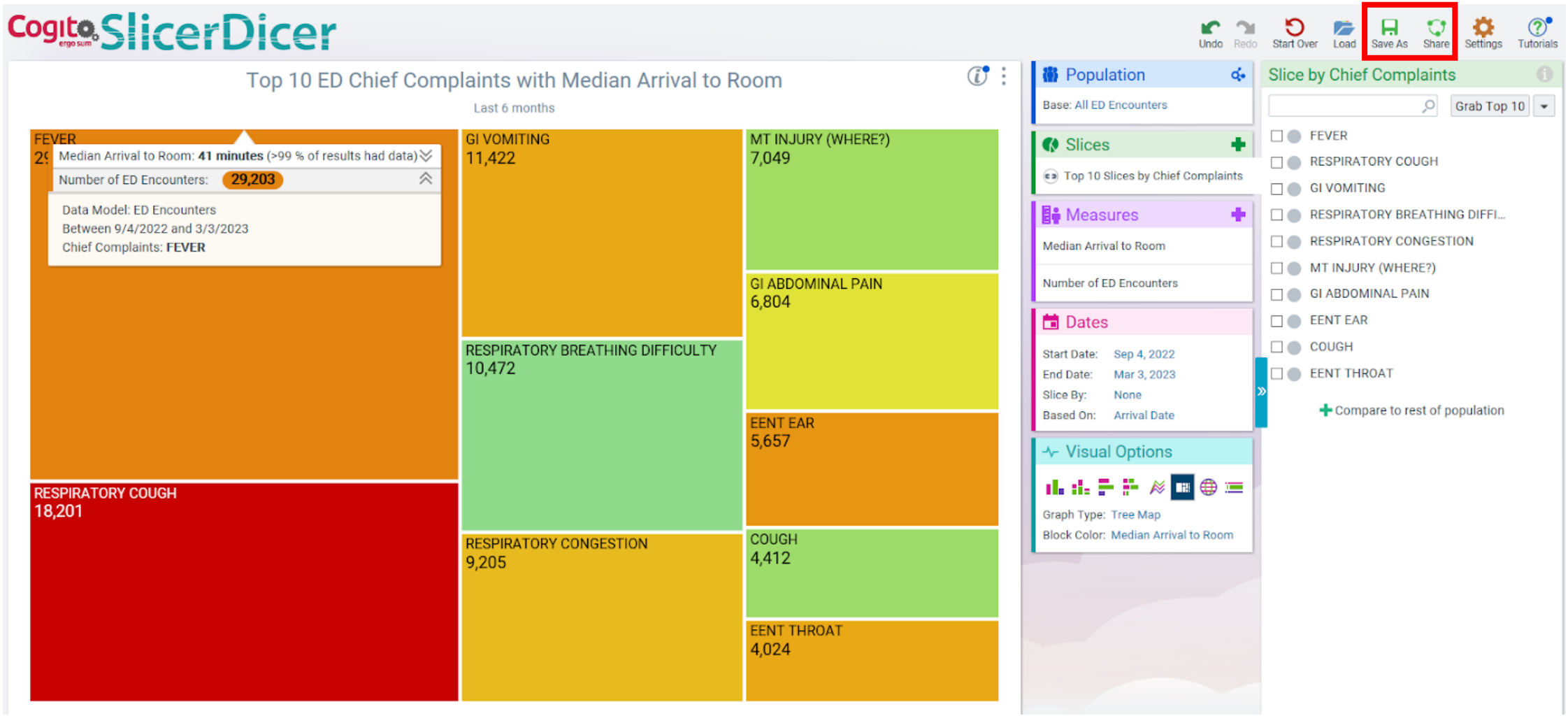
Epic’s Built-In Self-Service Tools

SlicerDicer

Reporting Workbench



SlicerDicer



Cogito ergo sum SlicerDicer

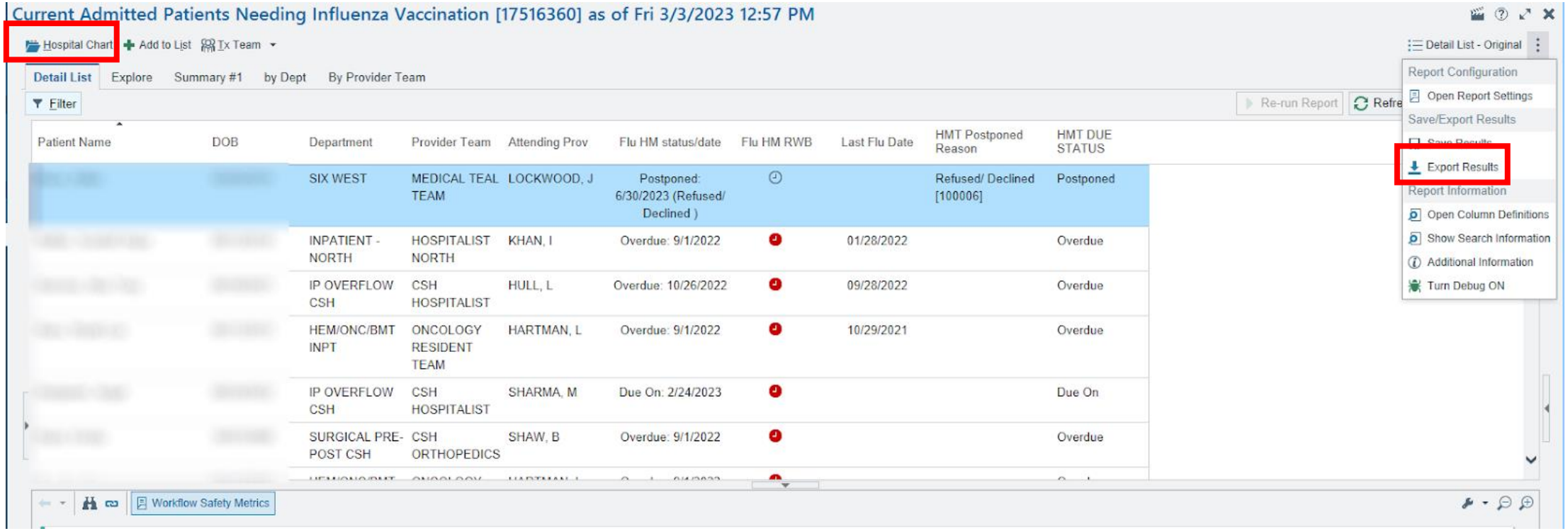
Pros

- Accessible to all providers
- Great visual tool and for following trends
- Great for large or old data
- Can be aggregated and exported using additional Epic tools (ie Dashboards)
- Run analytics and test basic hypotheses without needing IRB approval (no patient identifiers)

Cons

- Not real-time data (1 day behind)
- Newer tool, currently w/ limited data models and “slices”, but is growing with more and more models being added
- Data storage varies institution to institution and sometimes difficult to find the information you want

Reporting Workbench



Reporting Workbench

Pros	Cons
• Accessible to all providers • Provides real-time, actionable data • Easy connection to patient information • More complete data models available • More customizable options • Can be exported and used in additional Epic tools (ie Dashboards)	• Very slow to pull larger/older data • Higher learning curve • Often need data analyst support to build custom reports • PHI has data export/storage rules that vary by institution and sometimes providers are limited on what they can export

Data Collection Tools

Institution specific

- Does your institution have a data request process?
- Do you have departmental leads that can give you support?
- Do you have data analysts or physician builders that can help you?

Break-Out

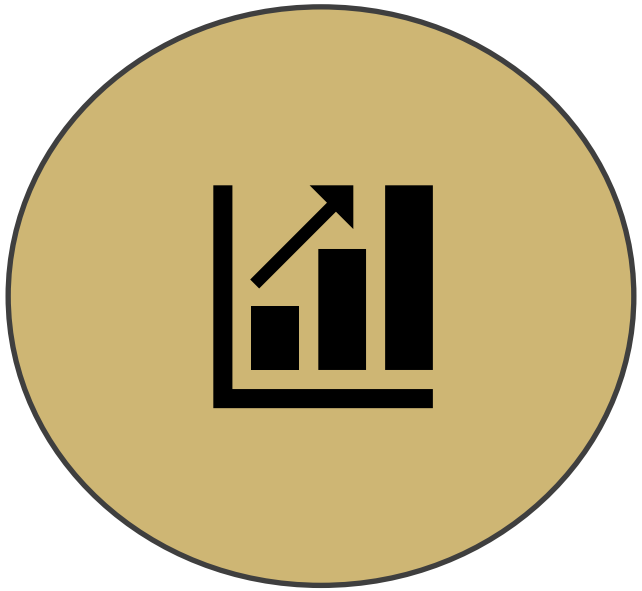
7 mins

Thinking again about that critical piece of data you need:

1. **How can you make it a structured data element?**
2. **How will you plan to get this data?**

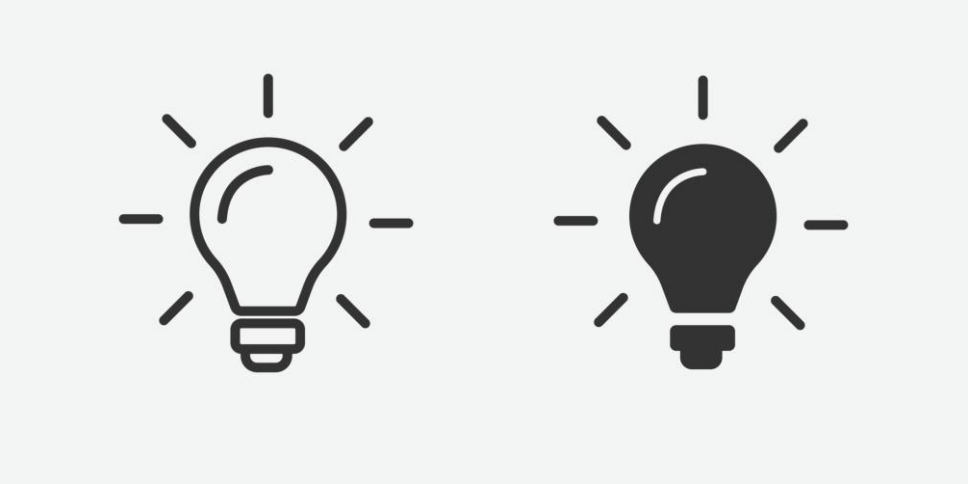
BREAK-TIME

Come back at 3:05PM MT



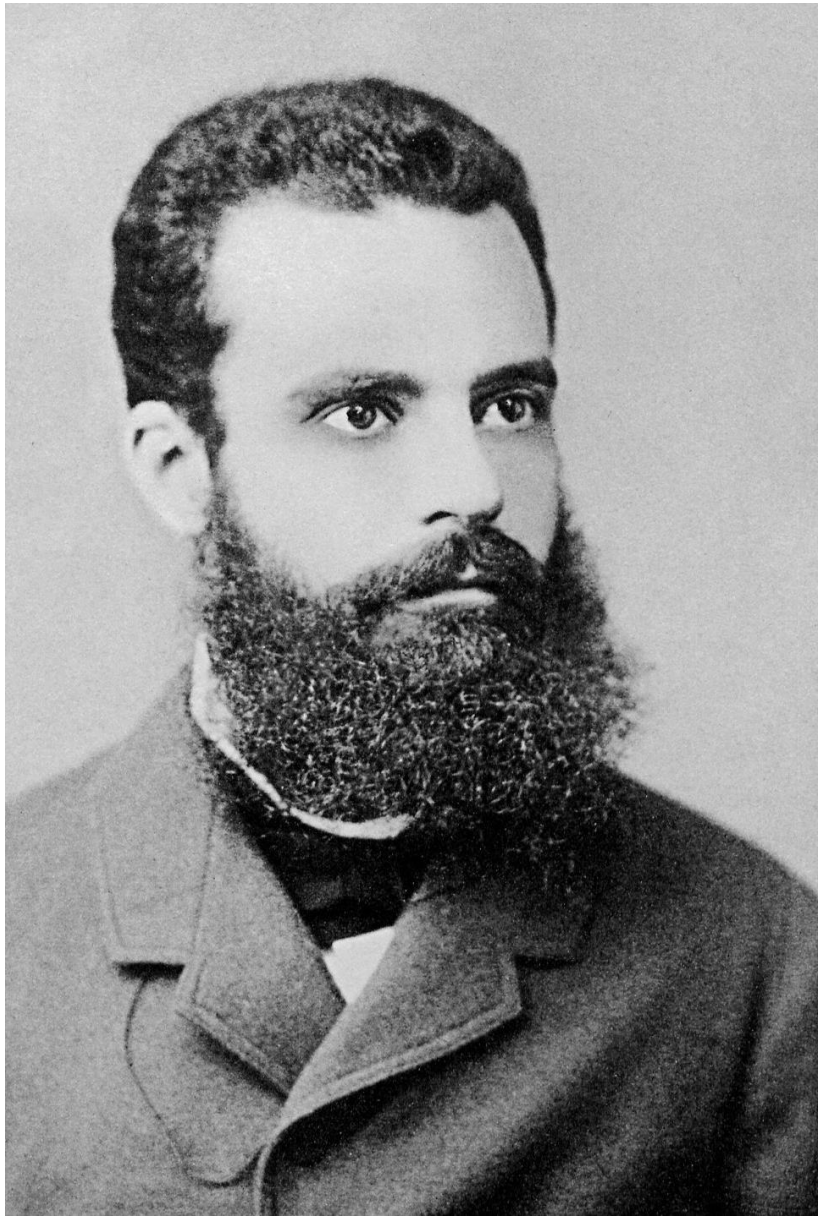
Using Data to Understand and Make Decisions

Data for Understanding

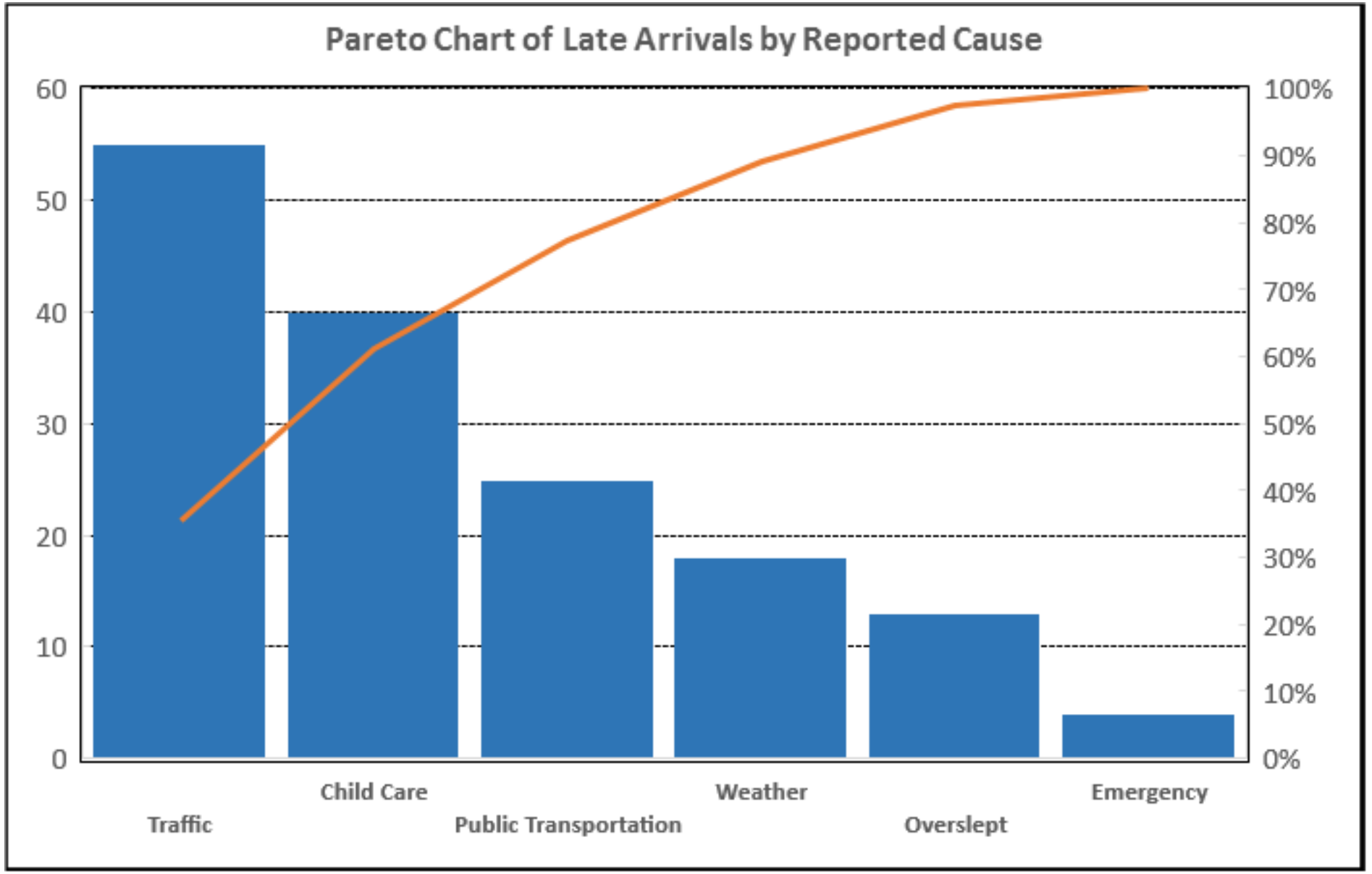


Data for Making Decisions

How much do you trust the results?



The Pareto Rule

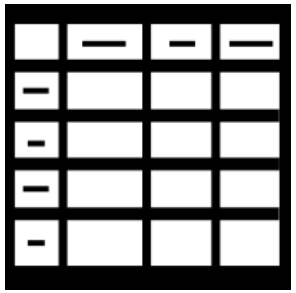

Pareto Chart of Late Arrivals by Reported Cause
60
50
40
30
20
10
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Traffic
Child Care
Public Transportation
Weather
Overslept
Emergency

Pareto Chart

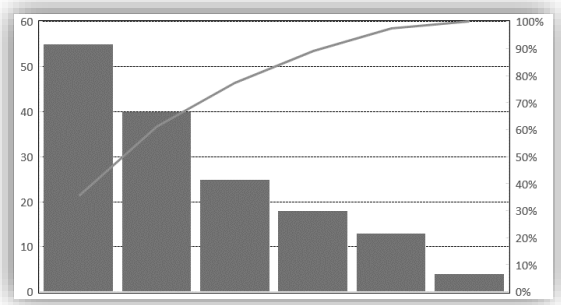
List of Reasons for Problem

- …
- …
- …
- …

Gather frequency data on these reasons

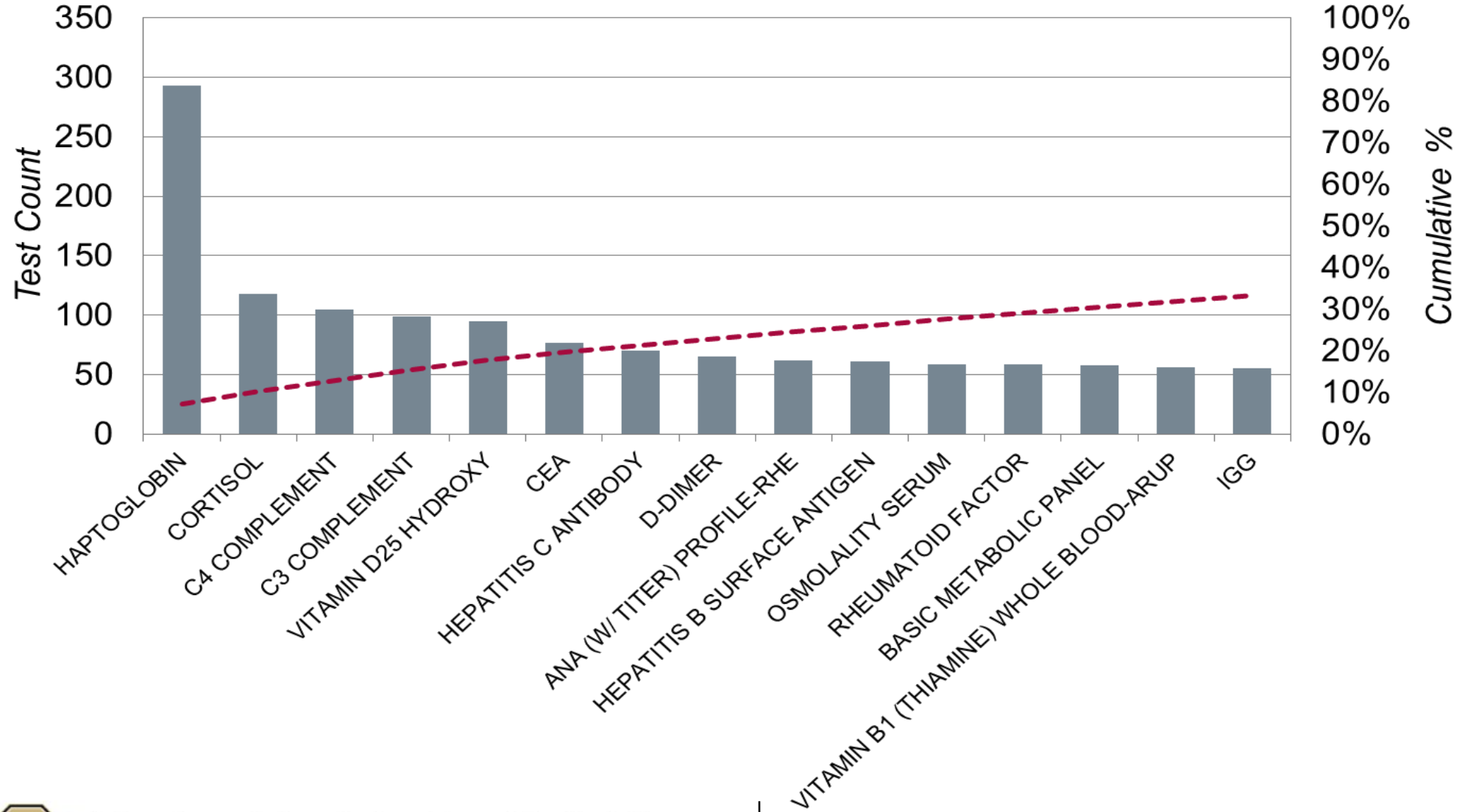


Create **Pareto Chart**



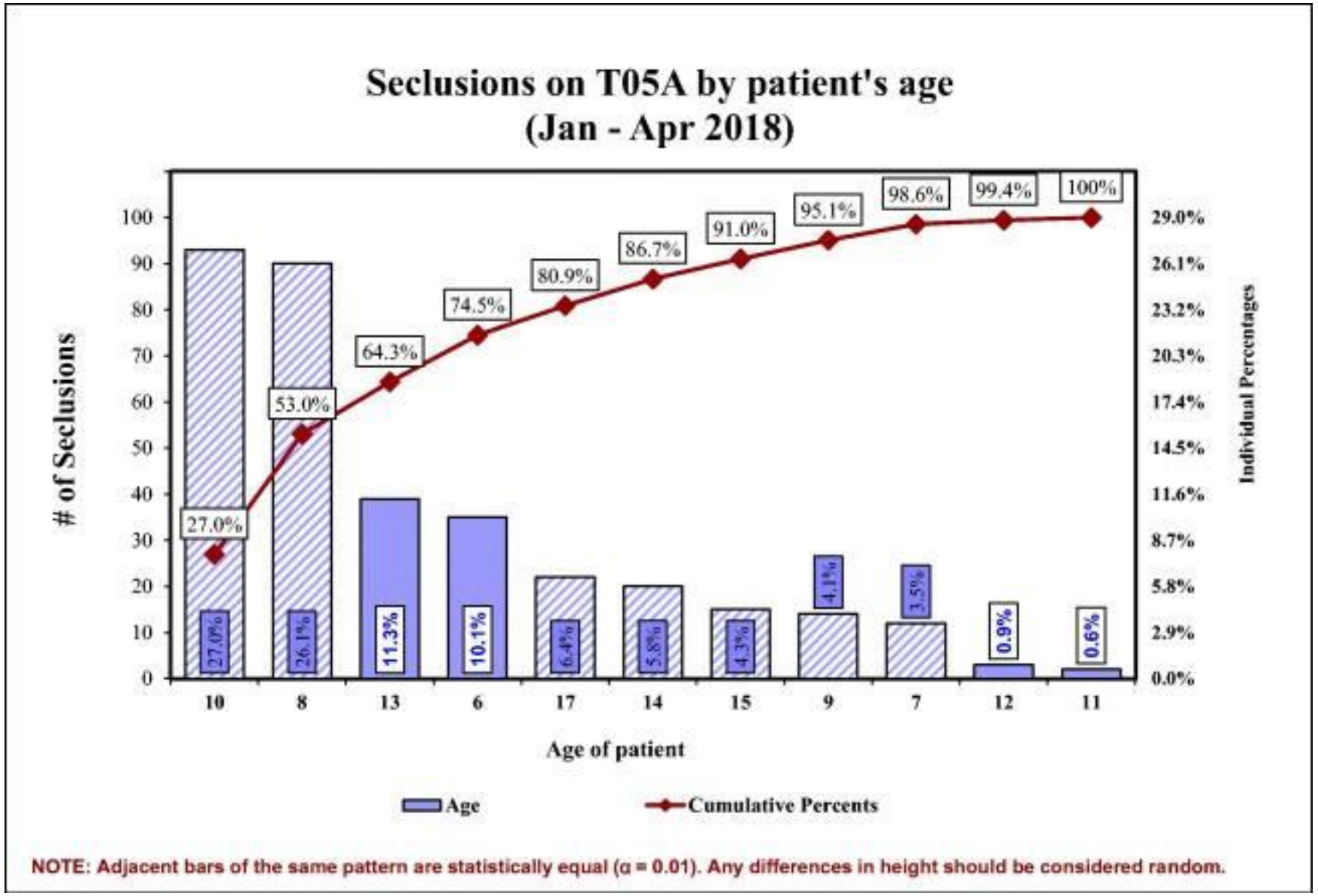
Use to **understand the problem and/or target** Interventions

Top 15 Add-On Failures: UCH Inpatient January – August 2017



Haptoglobin is the most failed add-on labs

Investigate haptoglobin (ask WHY?)

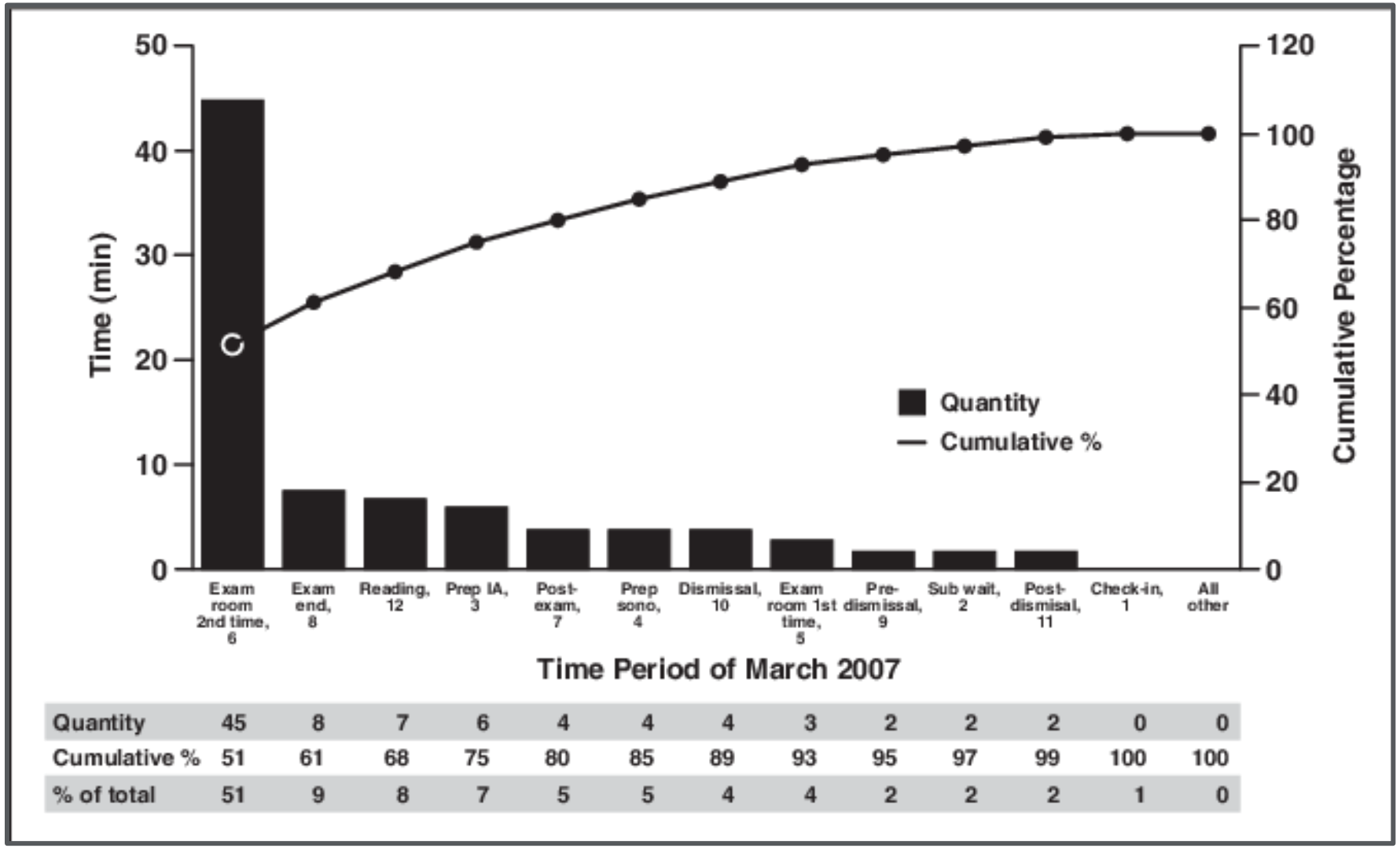


53% of seclusions happen in 8- and 10-year-olds

Targeted intervention ?

Powell NM, Valentino AL, Valleru J, Krishna R. Quality Improvement and Behavior Analysis: A Dynamic Duo. Behav Anal Pract. 2019 Sep 16;13(1):232-239. PMID: 32231985;

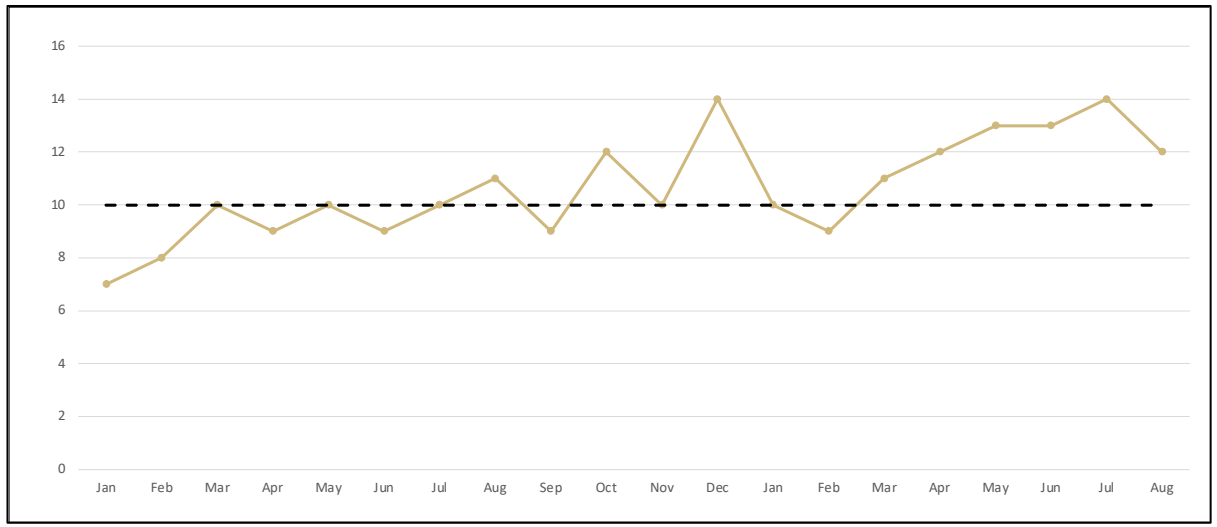
Duration of ultrasound appointment



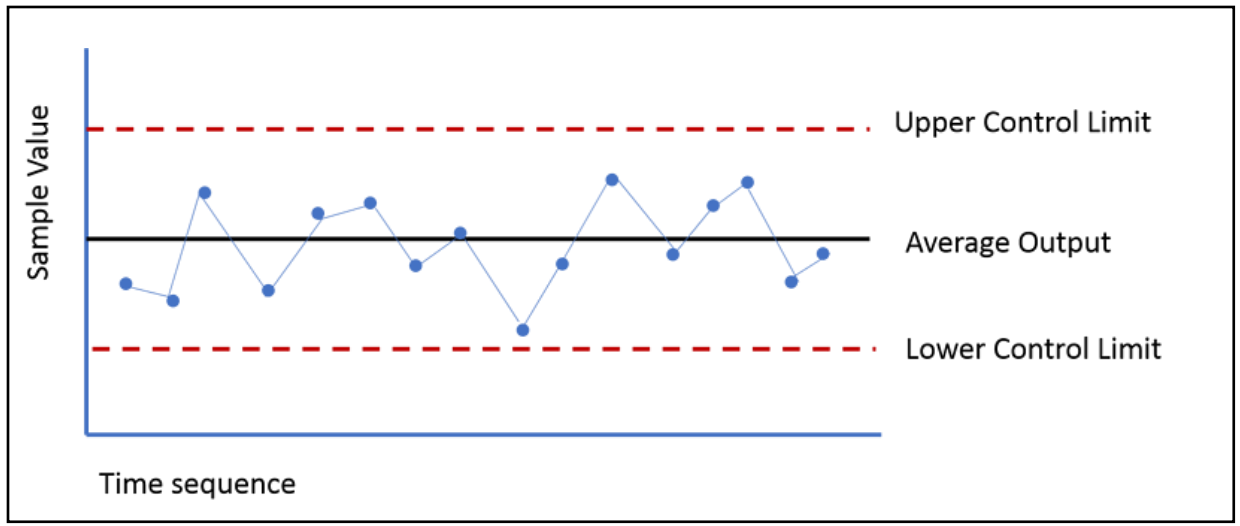
Quantity	45	8	7	6	4	4	4	3	2	2	2	0	0
Cumulative %	51	61	68	75	80	85	89	93	95	97	99	100	100
% of total	51	9	8	7	5	5	4	4	2	2	2	1	0

Measuring that a change has occurred
(IE: data over time)

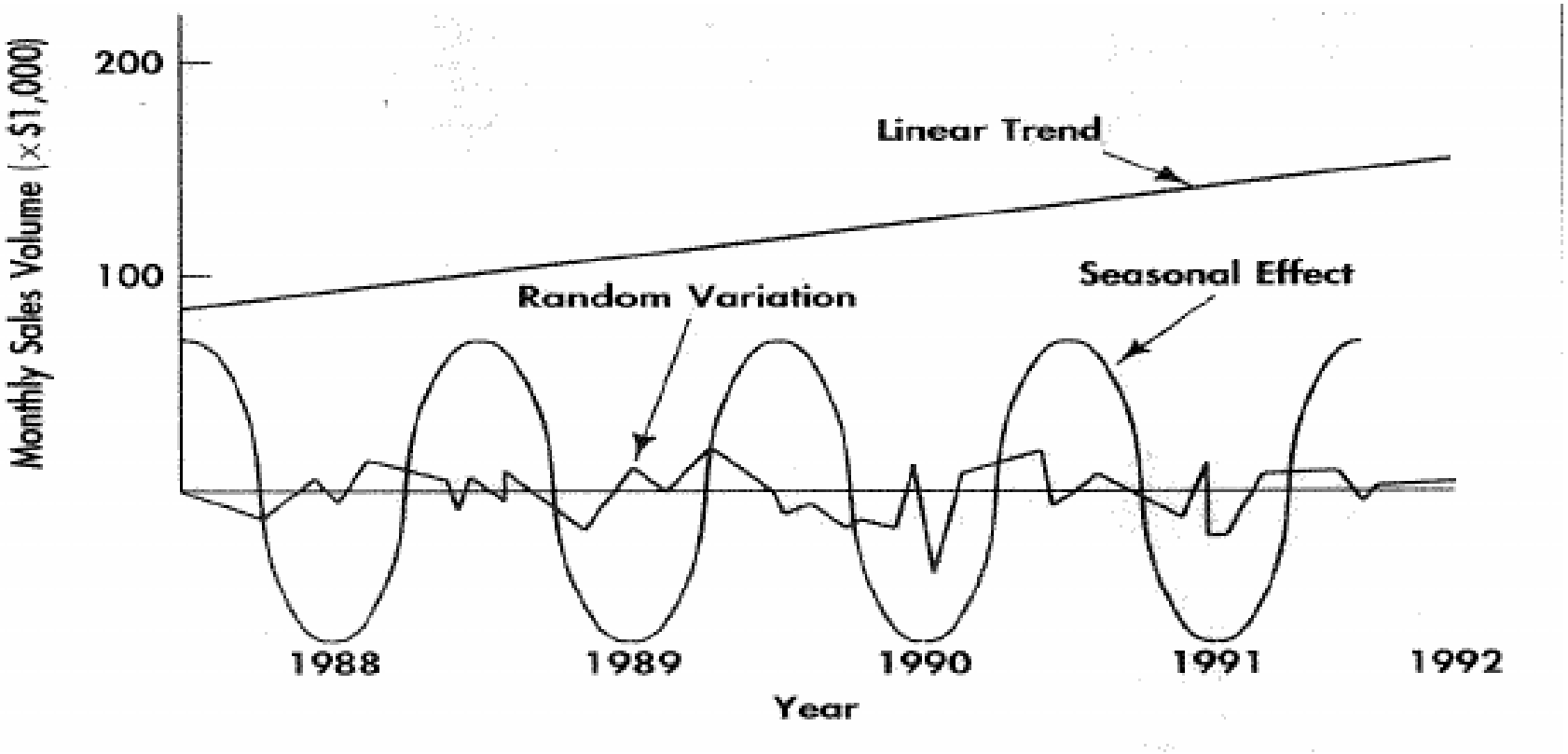
Run Chart

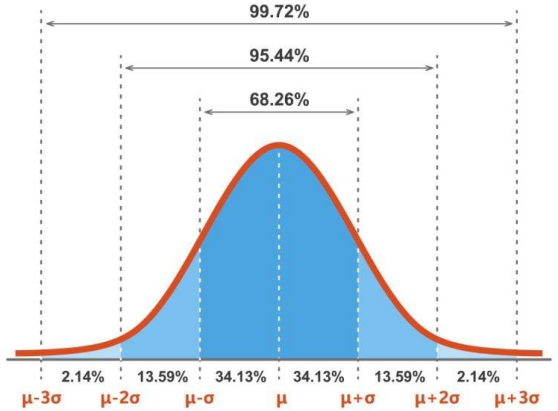


SPC Chart



Detecting and Determining Non-Random Change





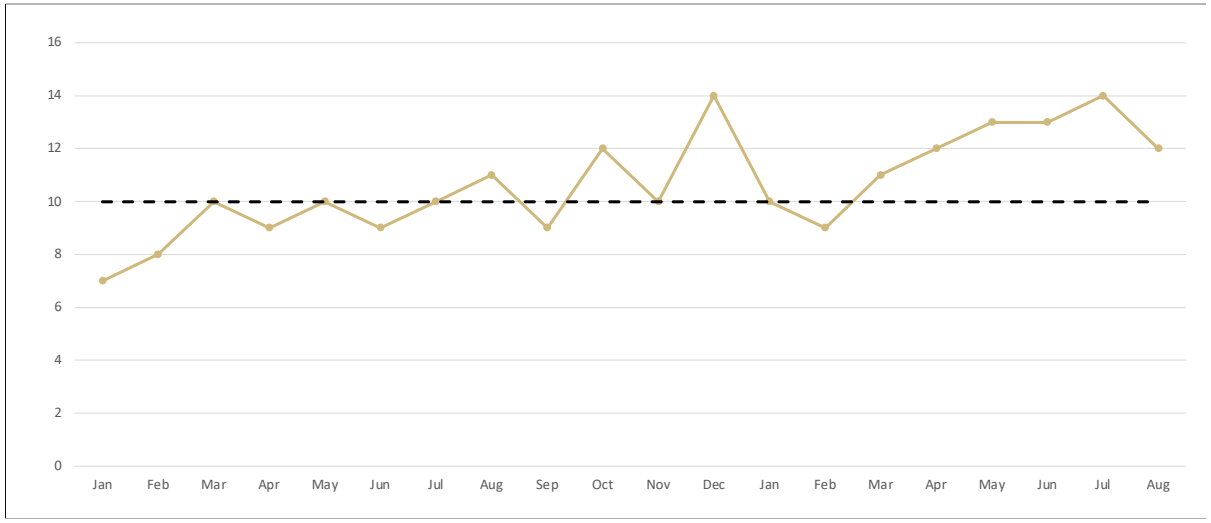
https://www.researchgate.net/figure/An-example-of-a-time-series-with-a-long-term-trend-a-seasonal-e-ect-with-superimposed_fig6_2797556

https://www.simplypsychology.org/normal-distribution.html

Uses of Detecting Non-Random Change

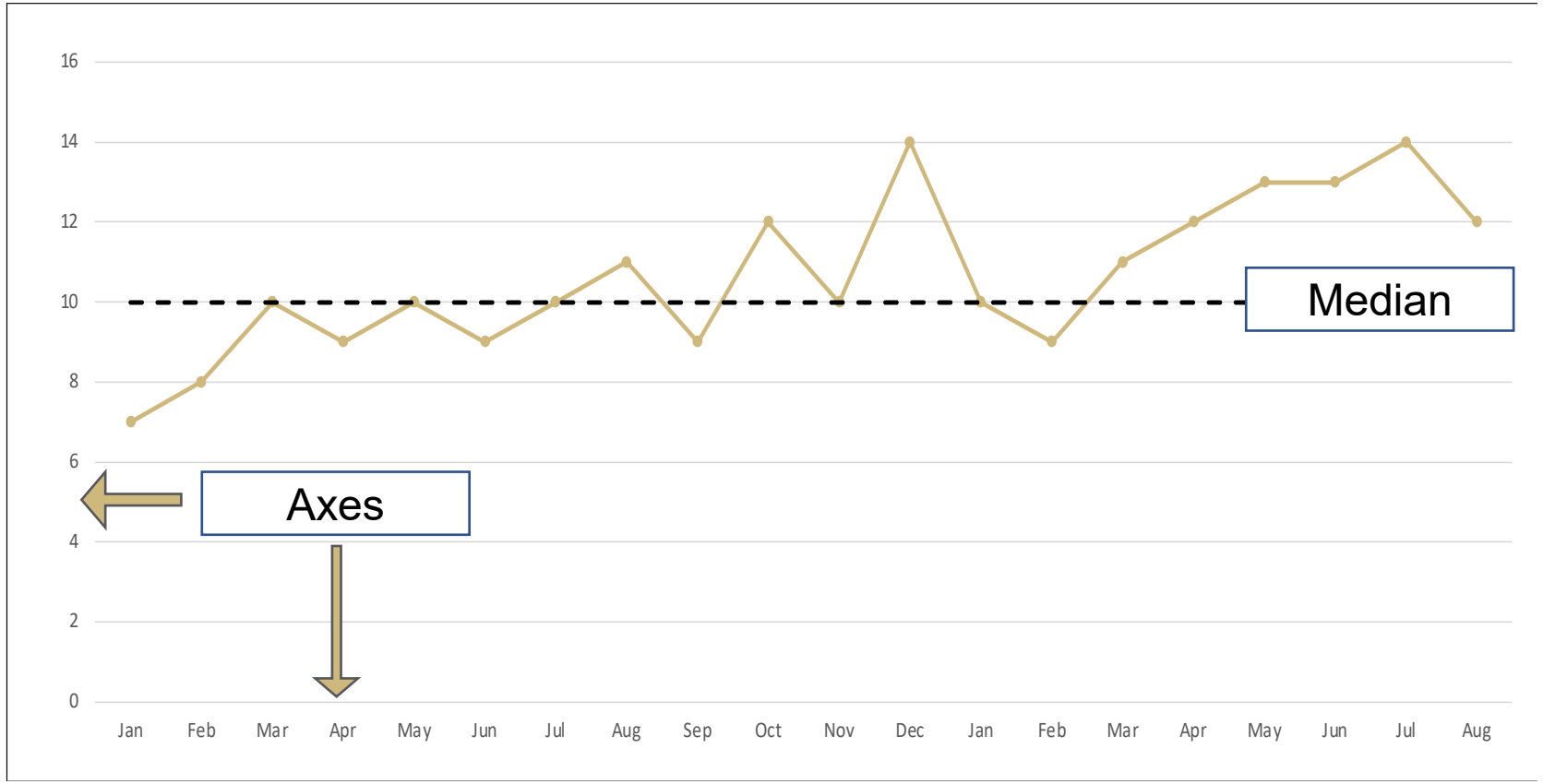
- Visualize the performance of your process for easier communication
- Determine whether changes you made to your process resulted in an improvement
- Determine whether improvements introduced to your process are sustained
- Determine what course of action to take

Run Chart



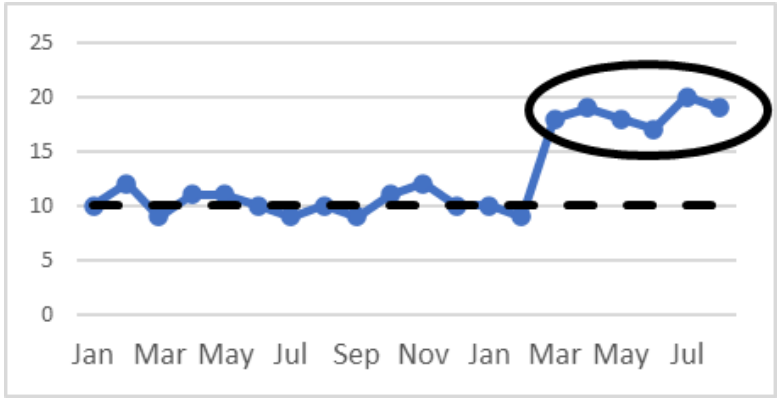
- ☑ Easy to construct
- ☑ Easy to interpret
  (no advanced stats required)
- ☑ Understand the inherent variation within data (10-15 data points)
- ☑ Assess the impact of process changes
  (AKA something happened)

Run Chart - Anatomy

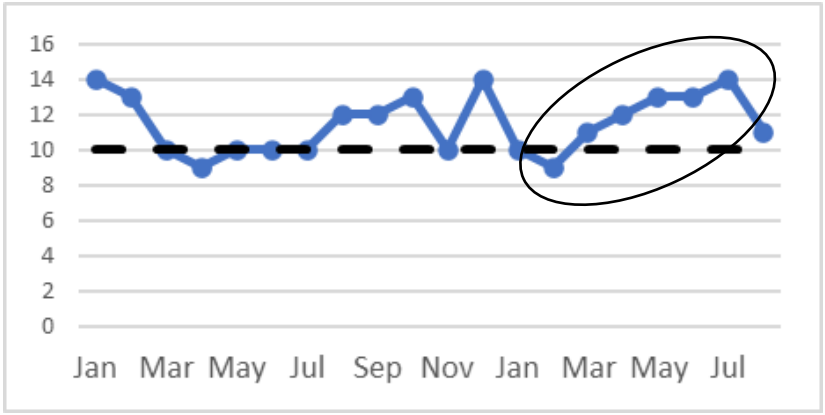


Detect “non-random” change

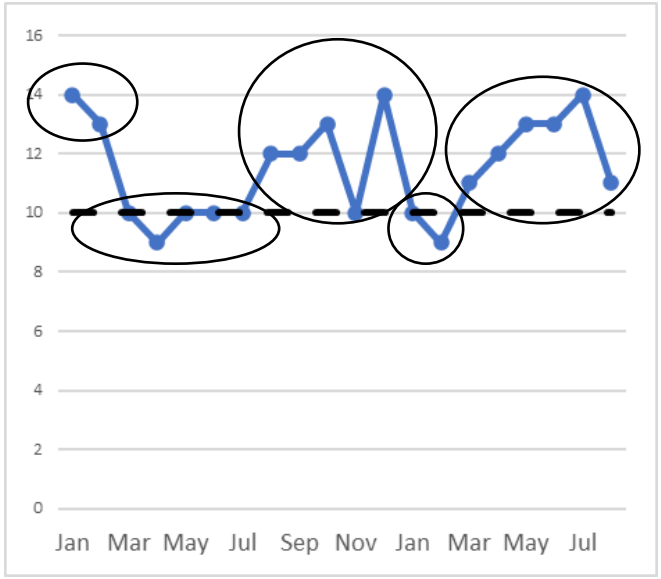
Shifts



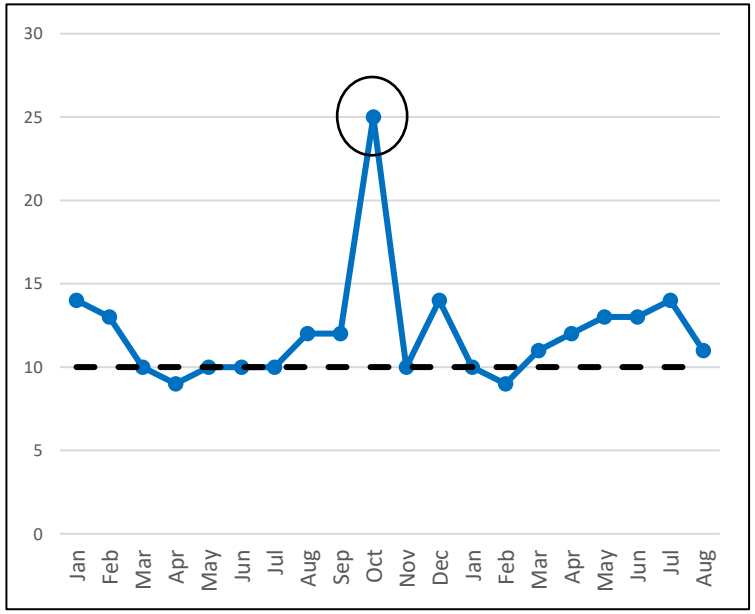
Trends



Runs (too many or too few)

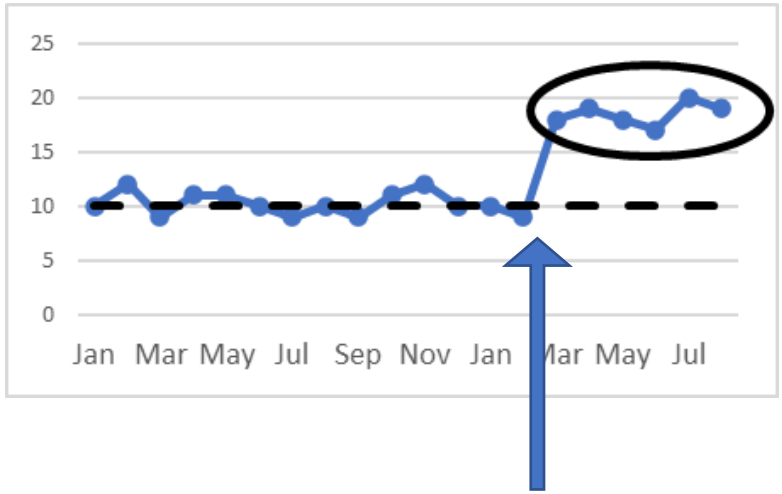


Astronomical Data Points



Run Chart – Interpretation (Non-Random Change)

Shift



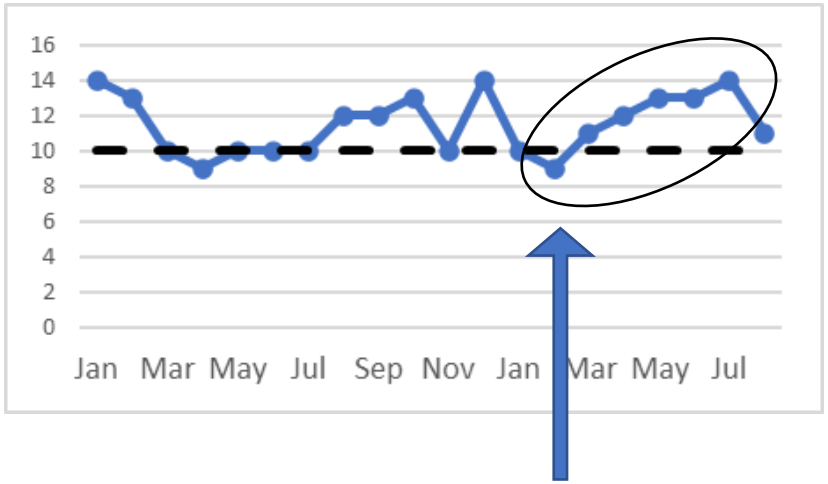
Intervention

Six or more consecutive points all above or all below the median.

(p = 0.03 for 6 points)

Run Chart – Interpretation (Non-Random Change)

Trend



Intervention

Five or more consecutive points all increasing or decreasing.

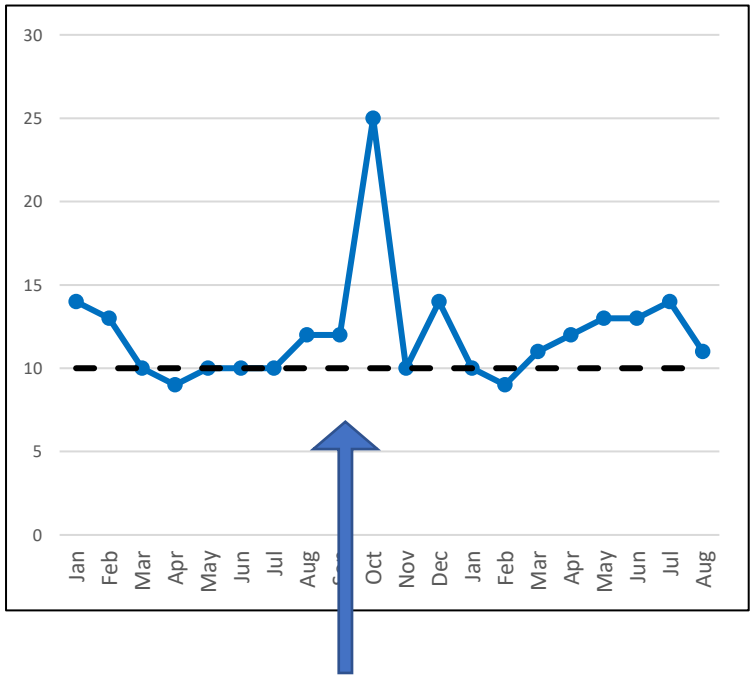
p = 0.031

NOTE:

- can include points ON the median
- count equal points as ONE

Run Chart – Interpretation (Non-Random Change)

Astronomical Data Point



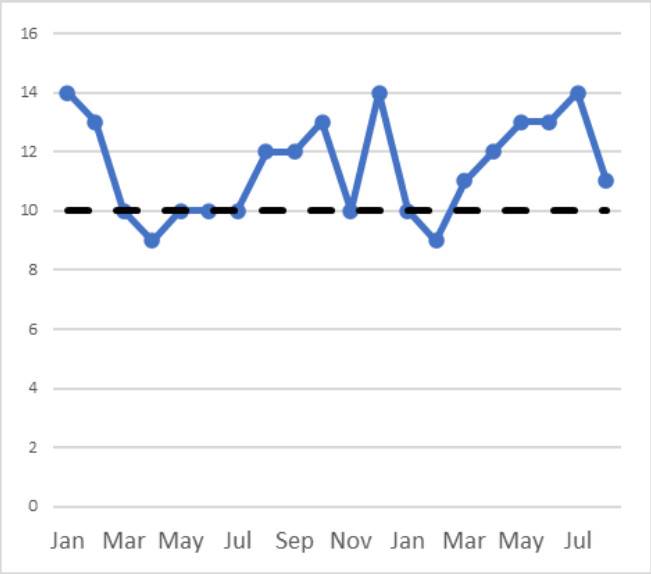
Intervention

Data points that are obviously outside of normal variation.

Seek consensus from the team to determine whether a point is “astronomical” or just the high or low point in the data set.

Run Chart – Interpretation (Non-Random Change)

Number of Runs

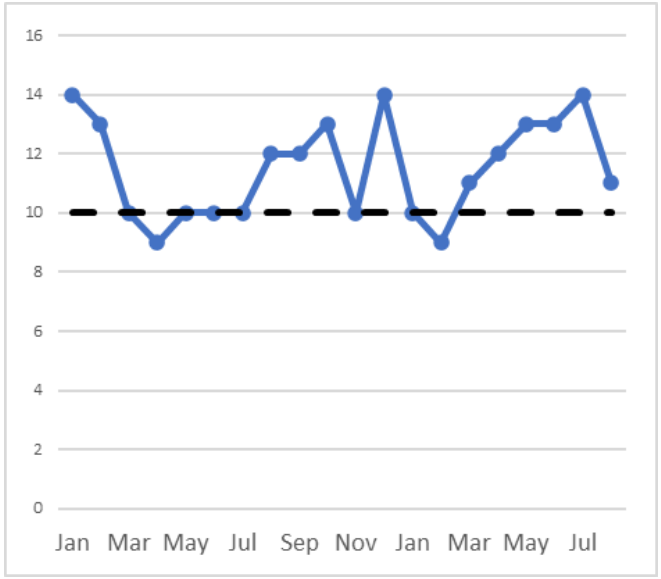


A run is a series of points on one side of the median. The trendline must cross the median before a new run begins. You can quickly calculate the number of runs by counting the number of times the trendline crosses the median and adding one.

The number of runs in a series should be between a lower and upper limit determined by the number of data points in the data set. Anymore, or any fewer, and the series is likely to be non-random.

Run Chart – Interpretation (Non-Random Change)

Number of Runs

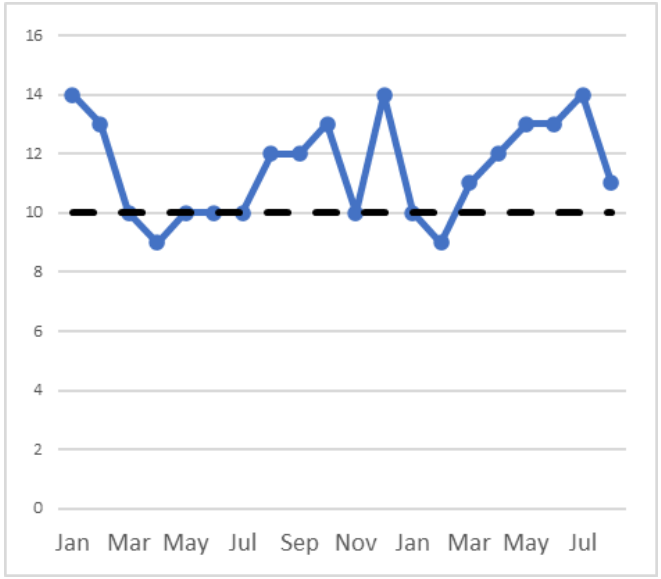


Number of Useful Observations	Lower Number of Expected Runs	Upper Number of Expected Runs
10	3	9
11	3	10
12	3	11
13	4	11
14	4	12
15	5	12
16	5	13
17	5	13
18	6	14
19	6	15
20	6	16
21	7	16
22	7	17
23	7	17
24	8	18
25	8	18
26	9	19
27	10	19
28	10	20
29	10	20

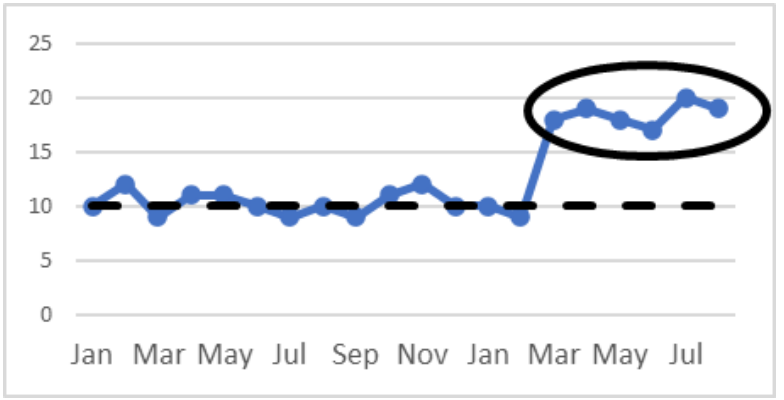
Reference Table

Run Chart – Interpretation (Non-Random Change)

Number of Runs

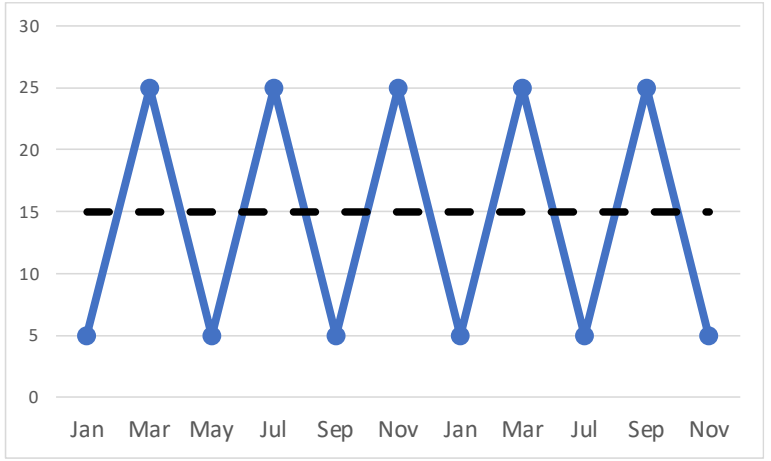


Too few



Too many

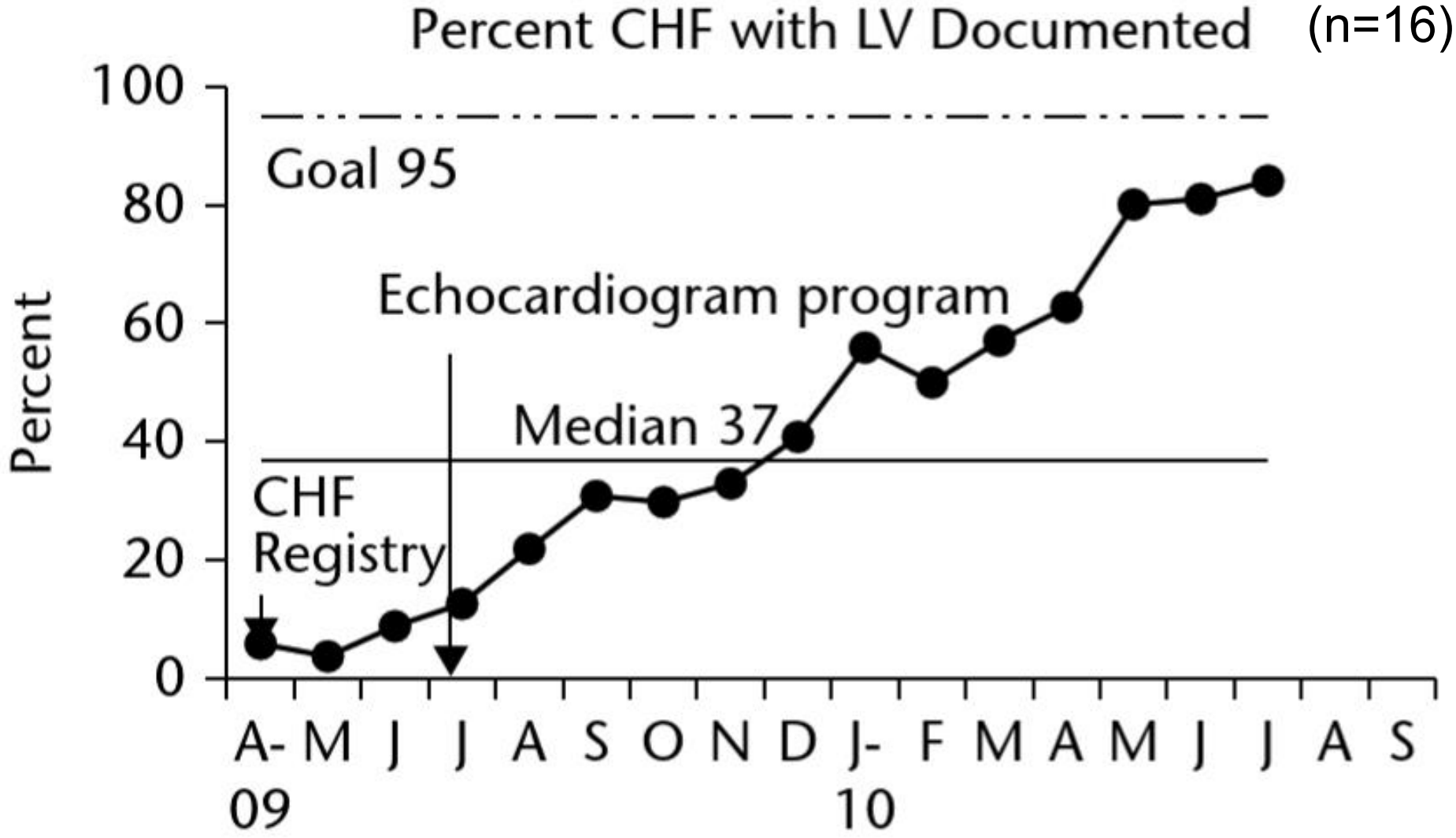
(10 runs)



EXERCISE 1

Number of Runs

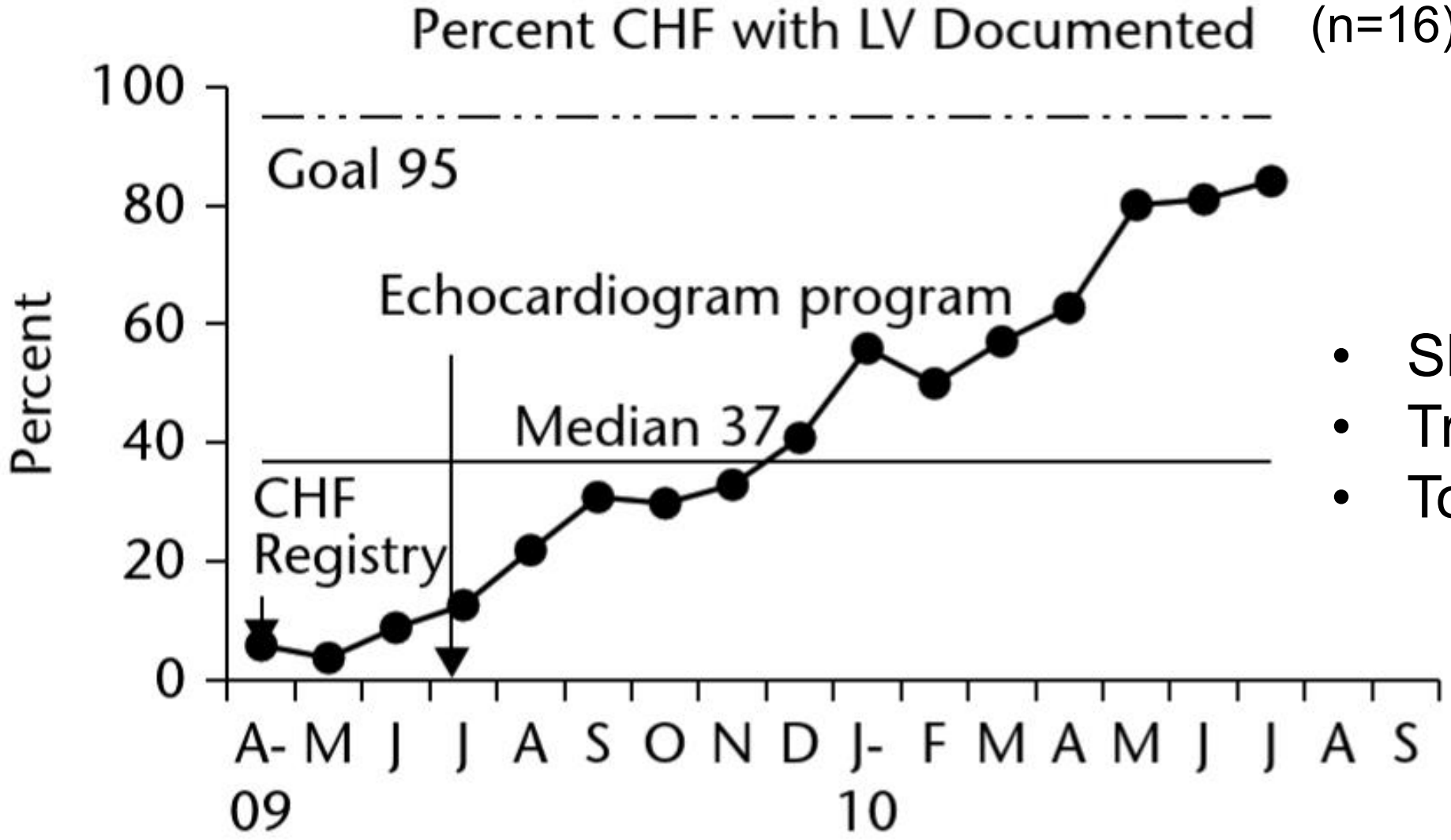
Lower limit: 5
Upper Limit: 13



EXERCISE 1

Number of Runs

Lower limit: 5
Upper Limit: 13

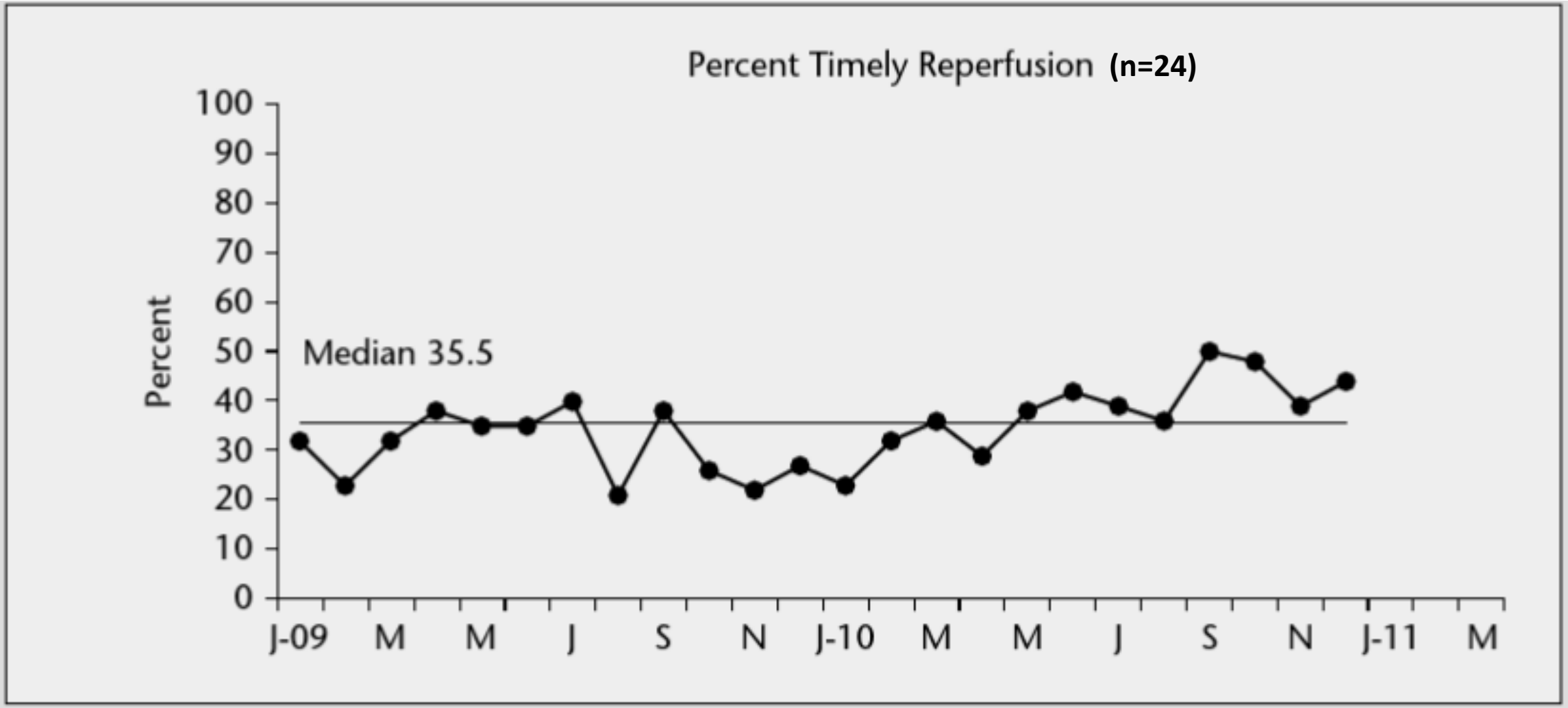


- Shift
- Trend
- Too few runs

EXERCISE 2

Number of Runs

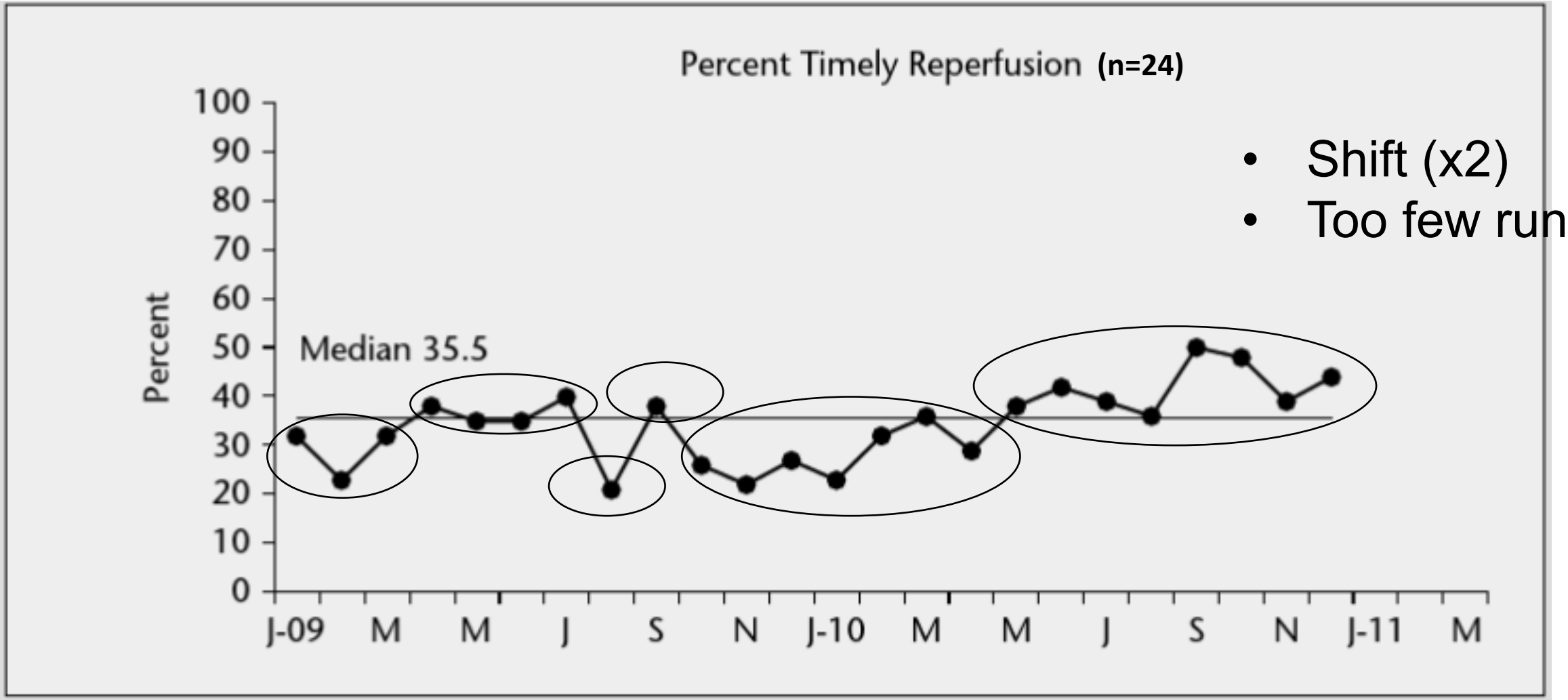
Lower limit: 8
Upper Limit: 18



EXERCISE 2

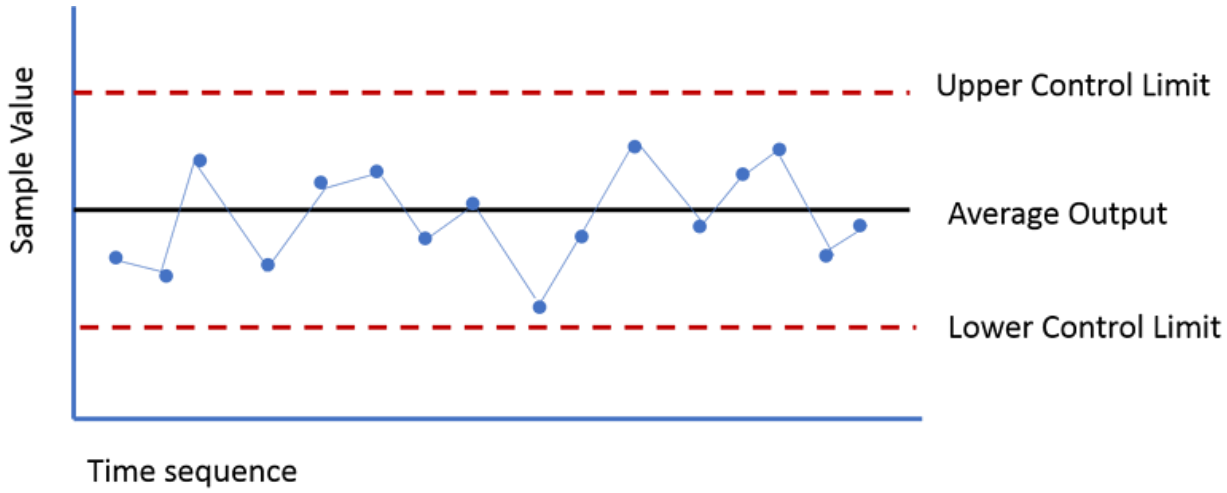
Number of Runs

Lower limit: 8
Upper Limit: 18



- Shift (x2)
- Too few runs

Statistical Process Control (SPC) Chart

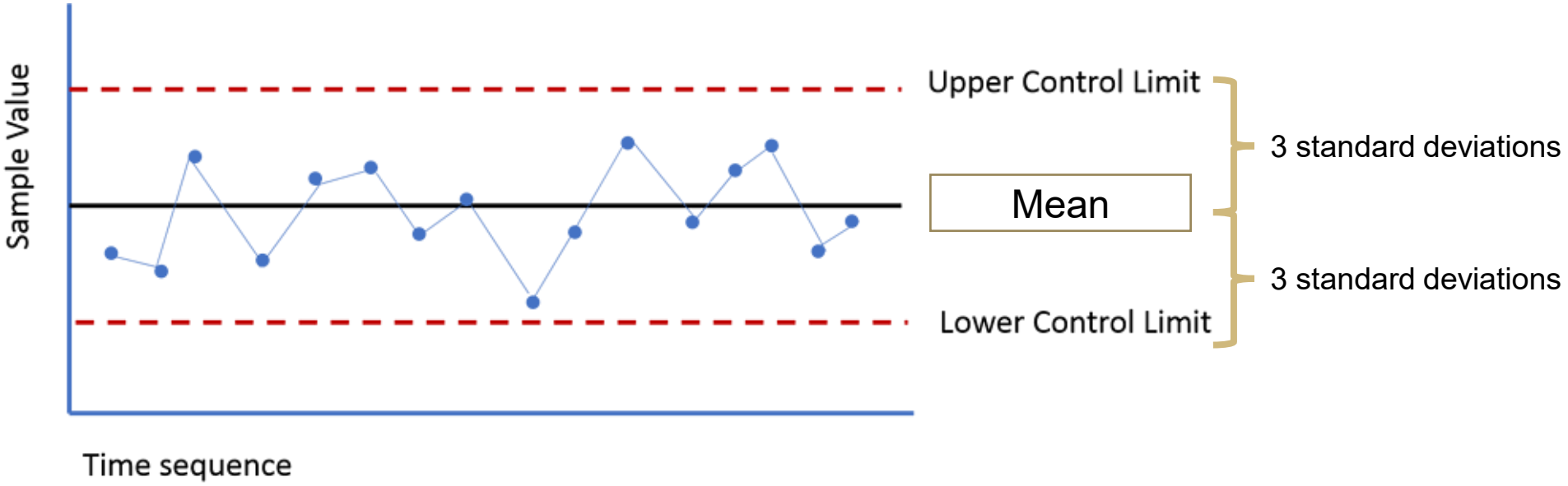


☑ Make informed decisions about which processes to leave alone and which to subject to an improvement cycle.

☑ Predict future performance if the system is stable and in control.

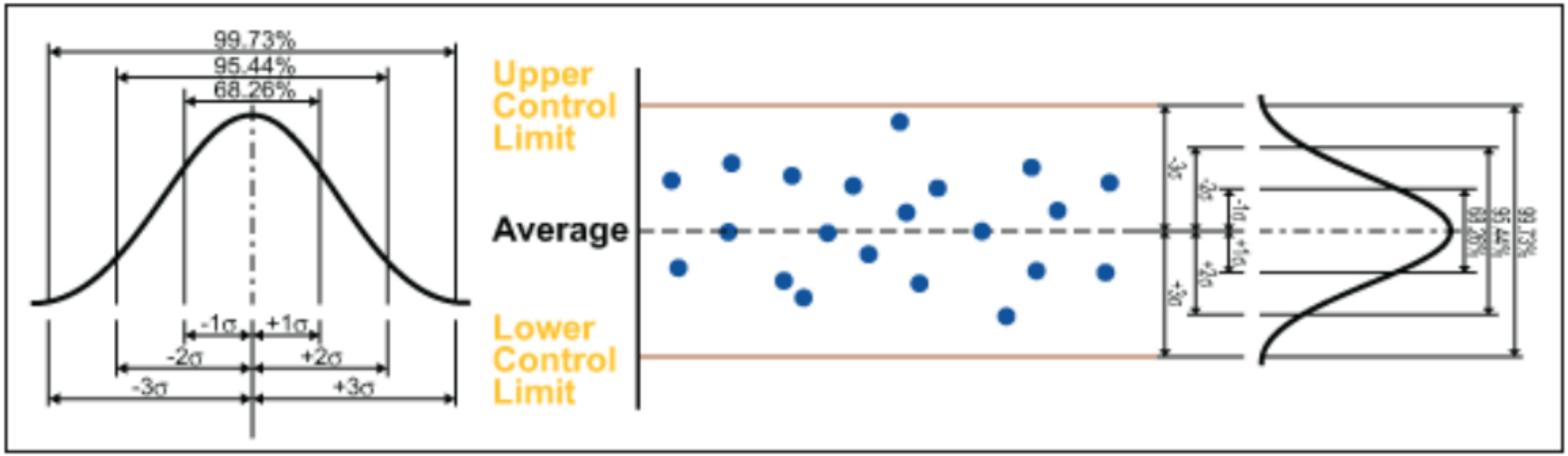
☒ Easy to construct

Statistical Process Control (SPC) Chart - Anatomy



Detect “special vs. common cause variation”

Statistical Process Control (SPC) Chart



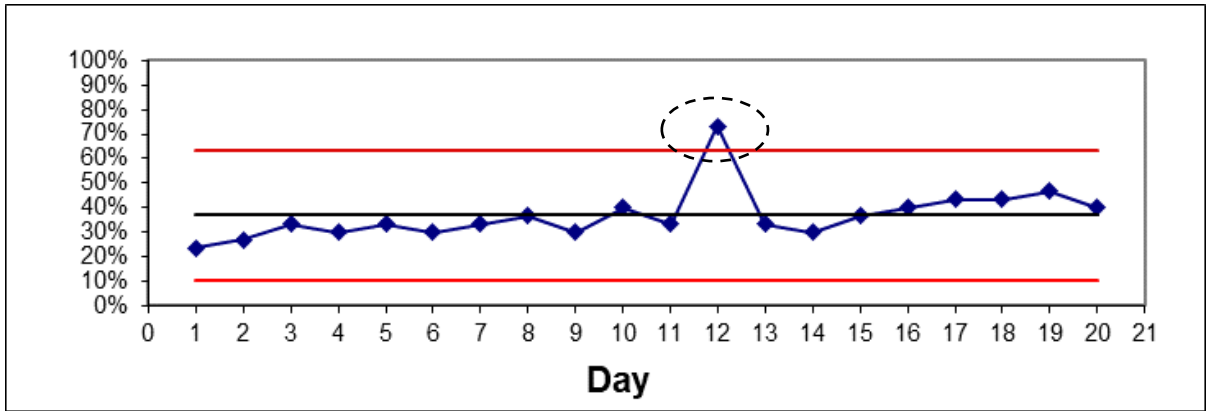
Statistical Process Control (SPC) Chart

But…there are many types

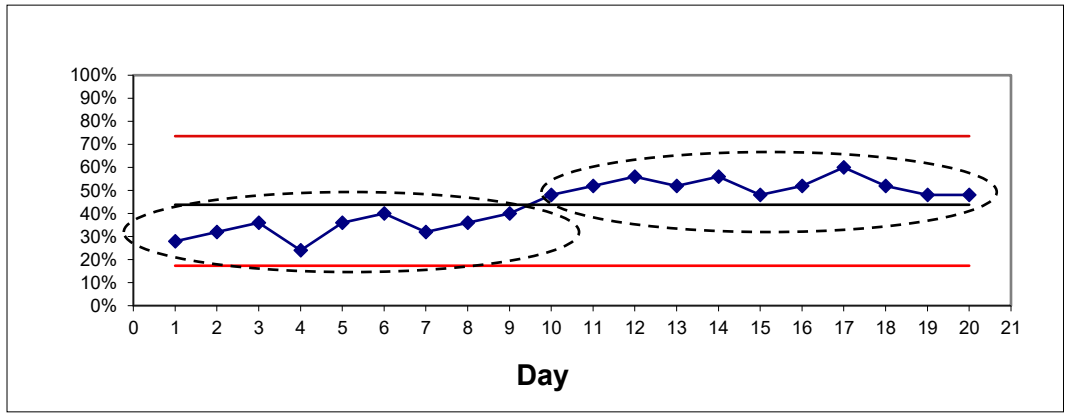
Data Type	Defect Definition	Subgroup Size	Chart Type
Attribute Data Counted as Discrete Events	Defect Data -Number of defects, not number of defective units	Constant Subgroup Size	c Chart Number of Defects
		Variable Subgroup Size	u Chart Defects per Unit
	Defective Unit Data	Constant Subgroup Size, Usually >= 50	np Chart Number of Defective Units
		Variable Subgroup Size, Usually >= 50	p Chart Fraction of Defective Units
Variable Data Measured on a Continuous Scale		Subgroup Size = 1	X and R_m Moving Range
		Subgroup Size < 10	$\bar{X}$ and R
		Subgroup Size >= 10	$\bar{X}$ and s

https://www.moresteam.com/toolbox/statistical-process-control

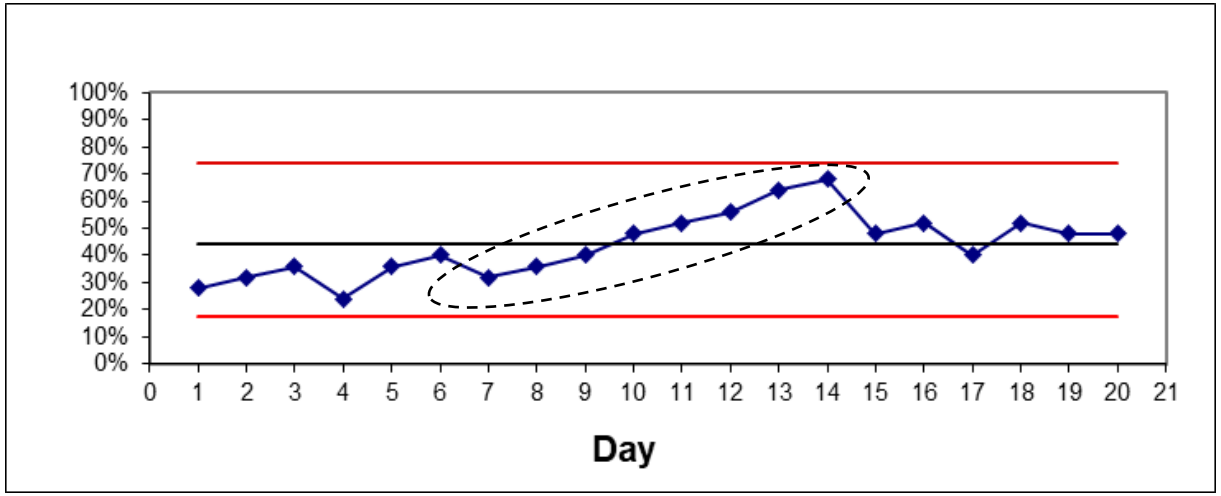
Rule 1: A single point falling outside of the control limits.



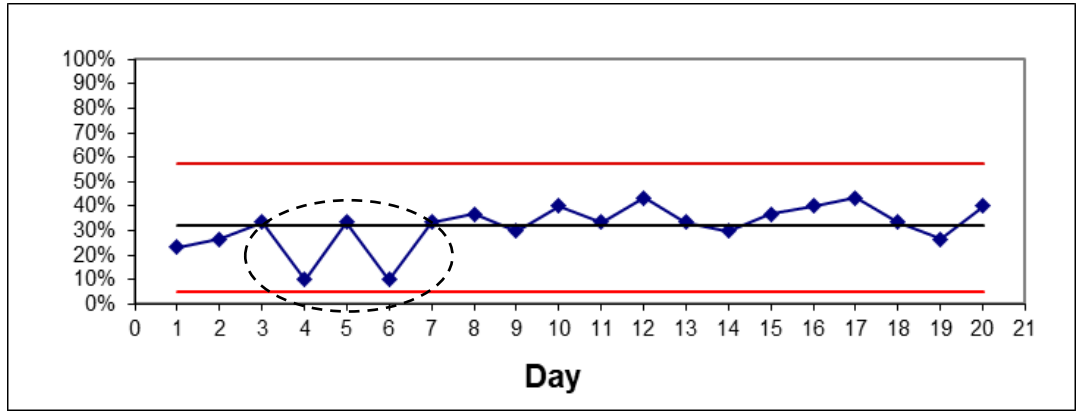
Rule 2: A shift of 8 or more consecutive points above or below the center line



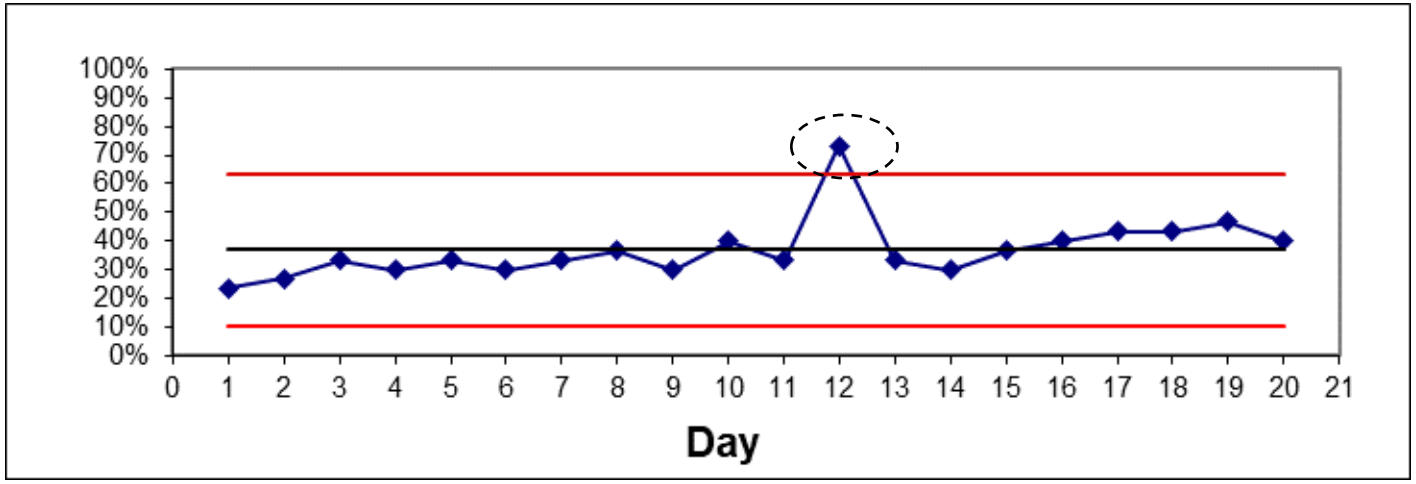
Rule 3: A trend of 6 or more points in one direction, up or down (two consecutive points of equal value count as one).



Rule 4: Two out of any three consecutive points falling in the outer one third of the control limit.

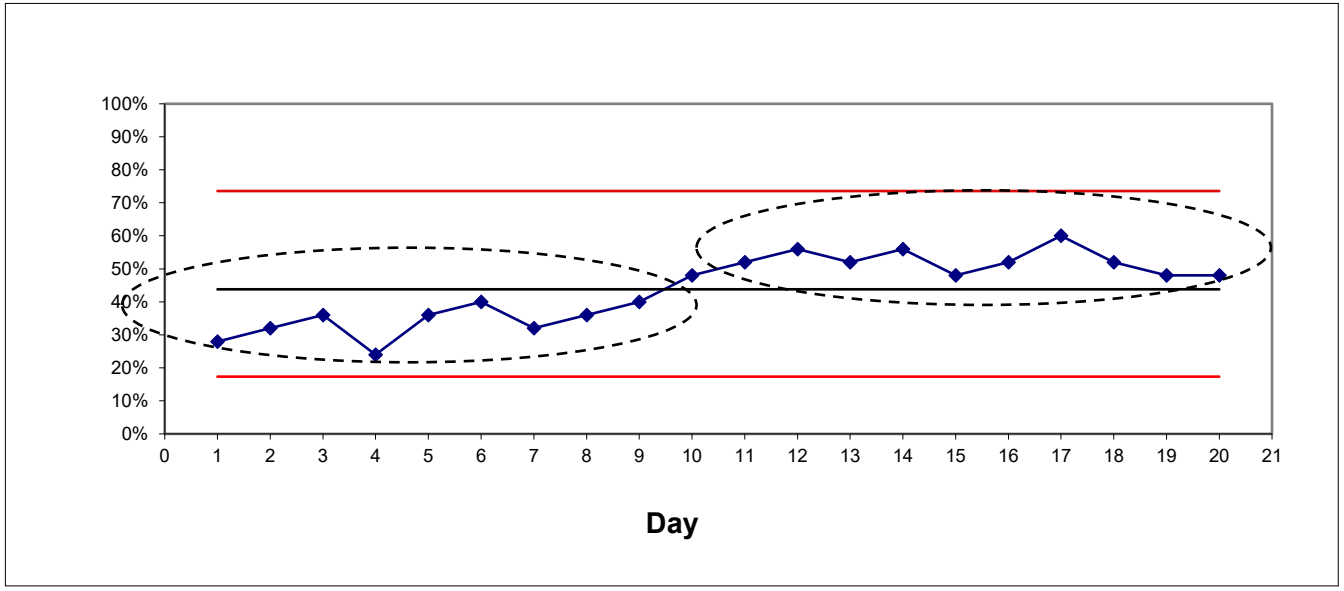


SPC Chart – Interpretation (Special Cause Variation)



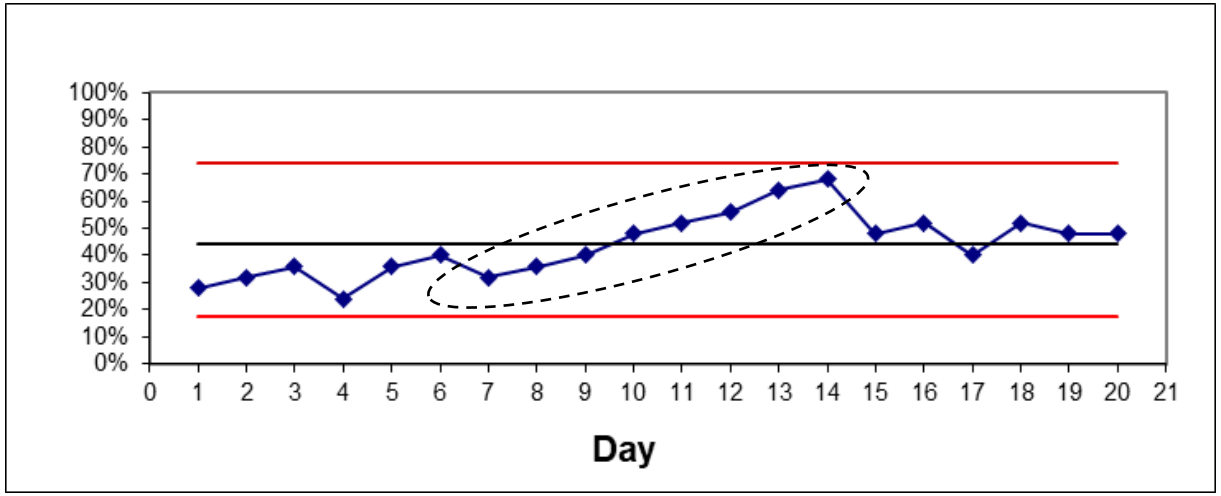
A **single point** falling outside of the control limits.

SPC Chart – Interpretation (Special Cause Variation)



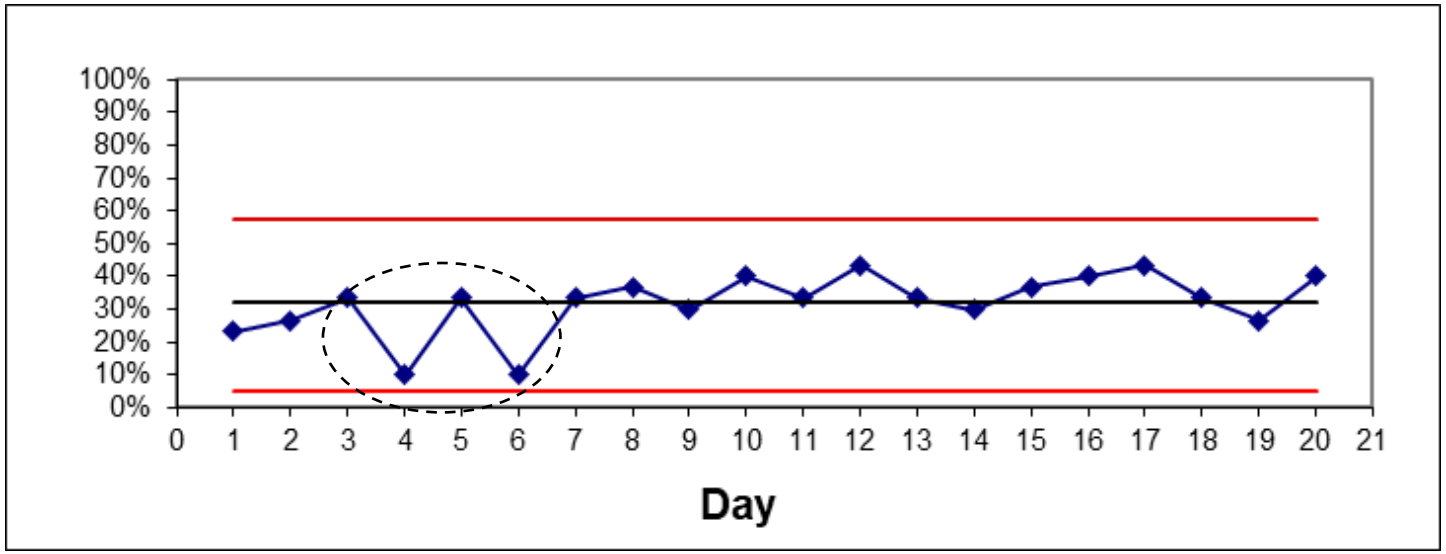
A **shift** of 8 or more consecutive points above or below the center line.

SPC Chart – Interpretation (Special Cause Variation)



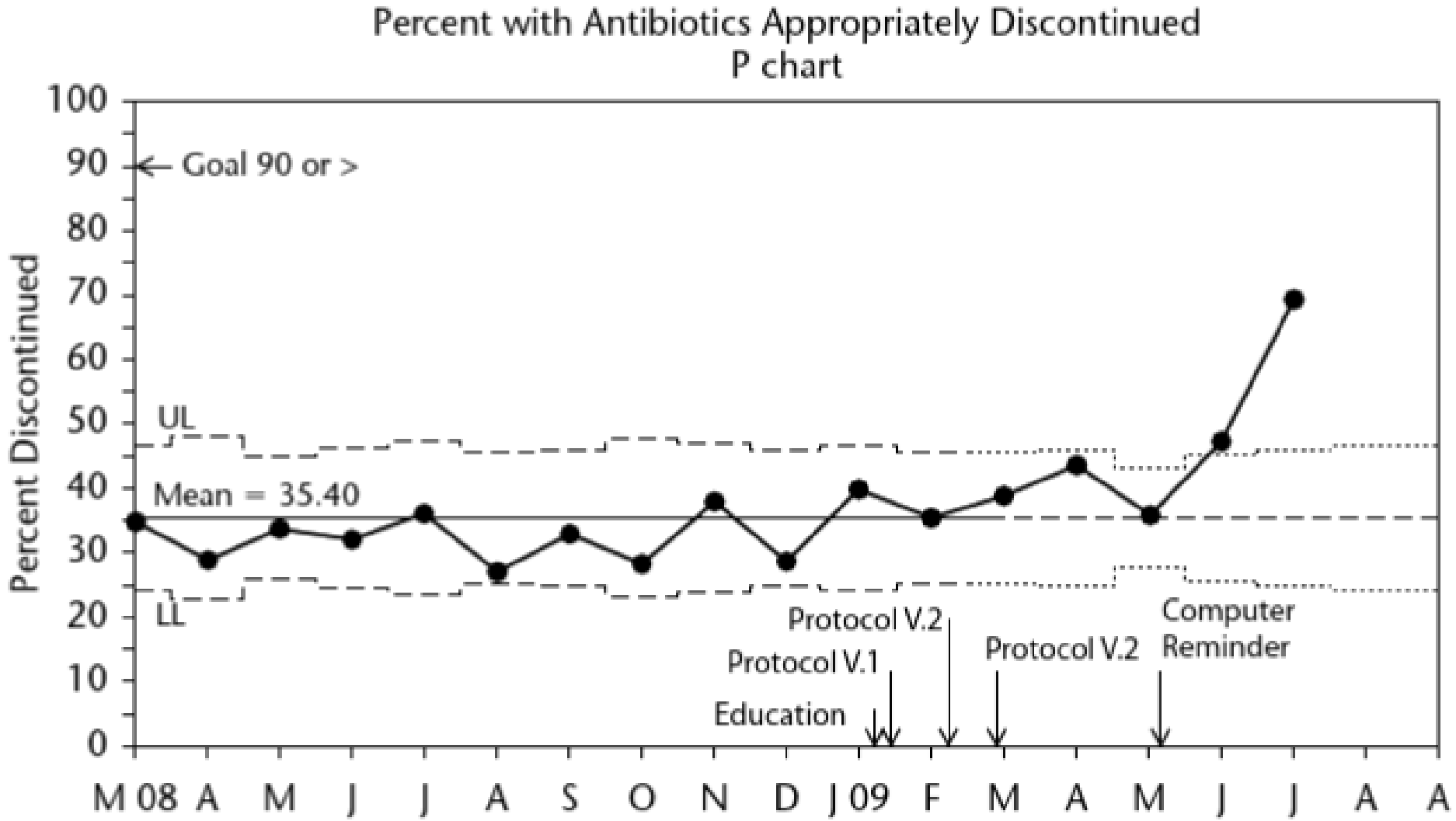
A **trend** of 6 or more points in one direction, up or down (two consecutive points of equal value count as one).

SPC Chart – Interpretation (Special Cause Variation)



Two out of any three consecutive points falling in the outer one third of the control limit.

EXERCISE 3


Percent with Antibiotics Appropriately Discontinued
P chart
Percent Discontinued
100
90
80
70
60
50
40
30
20
10
0
← Goal 90 or >
UL
Mean = 35.40
LL
Protocol V.2
Protocol V.1
Education
Protocol V.2
Computer
Reminder
M 08 A M J J A S O N D J 09 F M A M J J A A

Making Decisions

ONLY Common Cause (random/normal) Variation Present = System is “in-control”

Special Cause (non-random) Variation Present = System is “out of control”

Making Decisions

Assuming you are not at goal…

ONLY Common Cause (random/normal) Variation Present

System is “in-control”

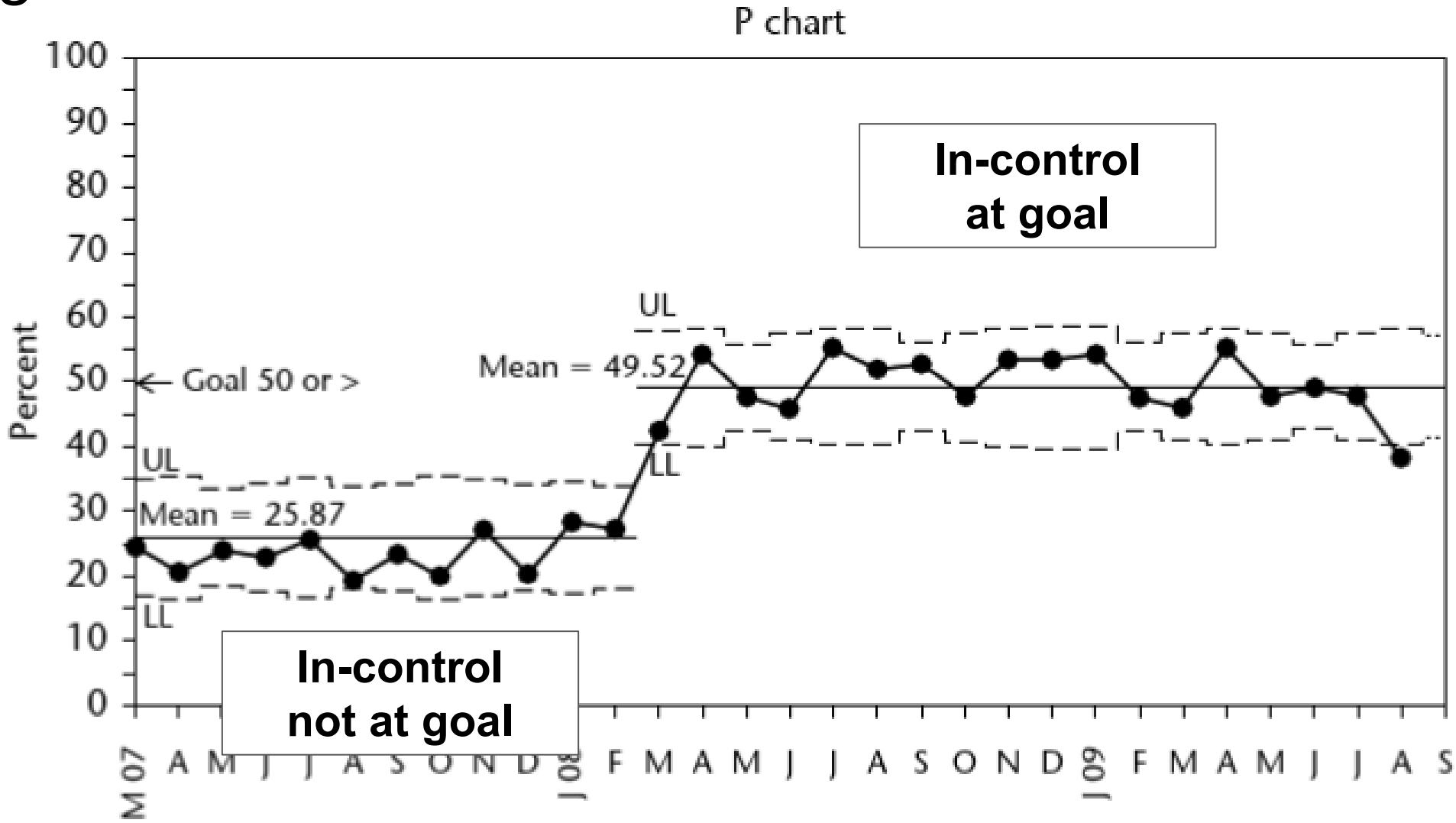
→ Overhaul the system

Special Cause (non-random) Variation Present

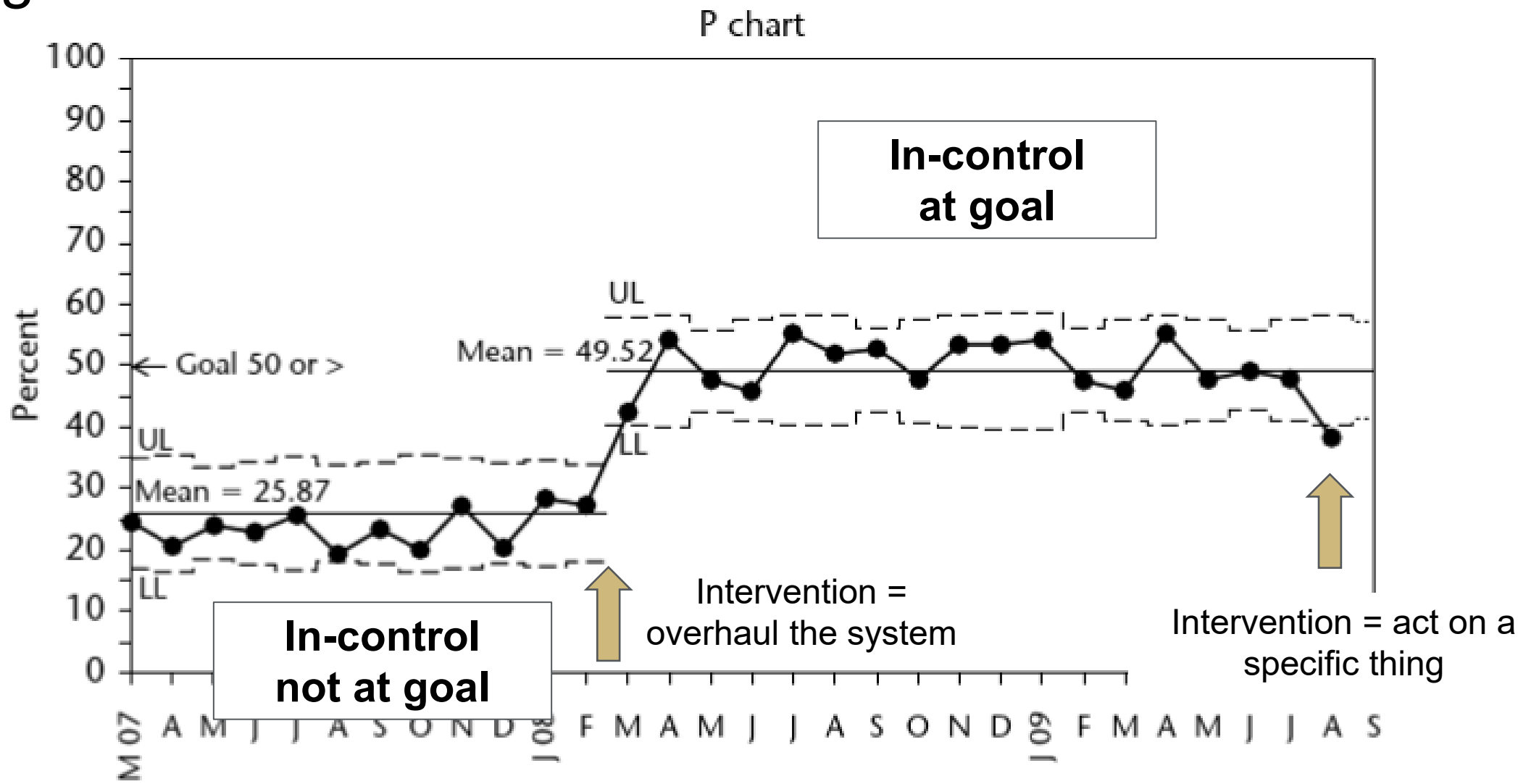
System is “out of control”

→ Act on a *specific part* of the system while leaving the system fundamentally intact.

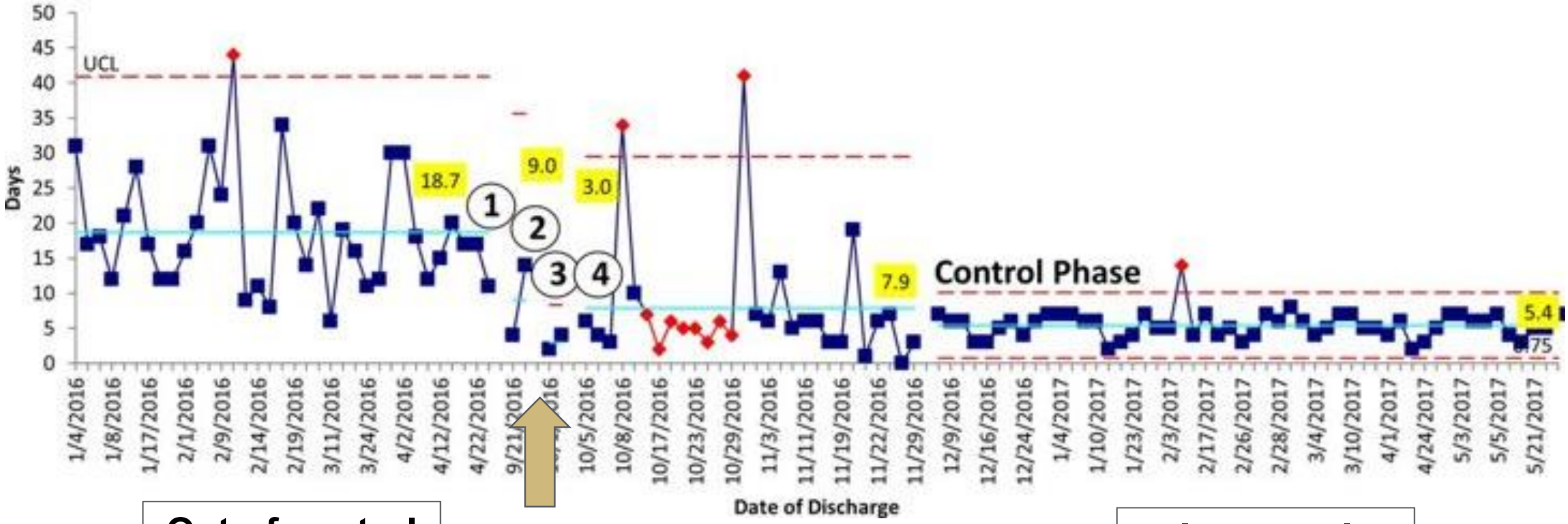
Making Decisions



Making Decisions



Making Decisions



Out-of-control not at goal

Intervention = act on specific thing(s)

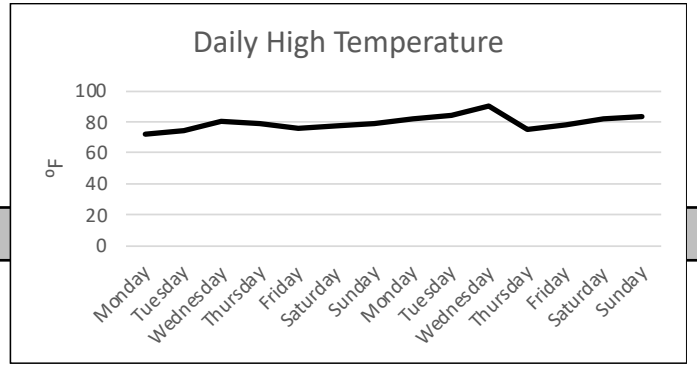
In-control at goal

How much do you trust the results?

What will the weather be like today?

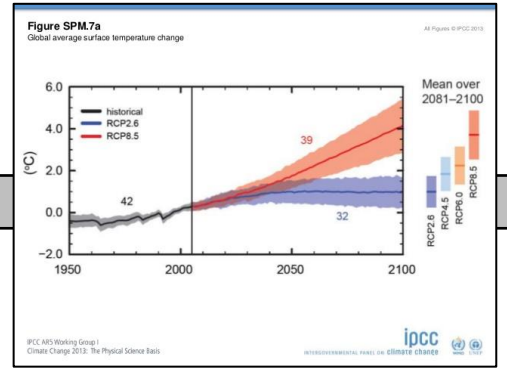
Guessing

- Anecdotal data
- Single data points without trends
- Equivalent of expert opinion



Some Data

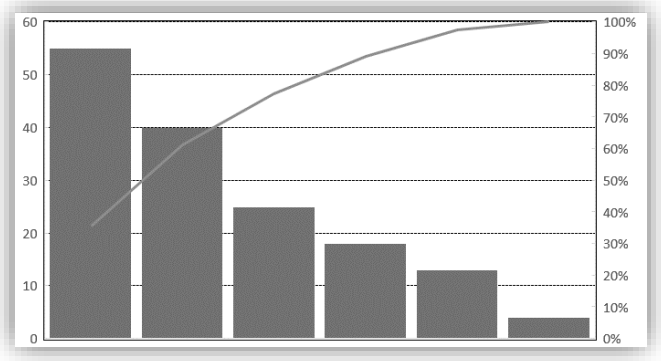
- Very basic statistics such as averages
- No variation shown
- Unqualified metrics; metrics out of context
- Perhaps some trends
- Data grouped too broadly
- Helps understand the past but not the future



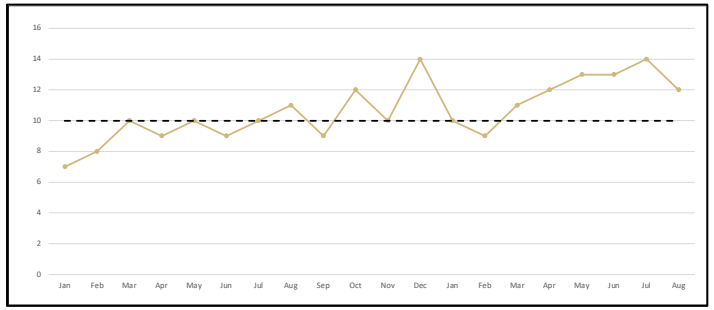
Good, Detailed Data

- Data that can be sub-grouped
- Advanced statistics
- Data that shows variation
- Puts the past in context
- Supports decision making by predicting the future state

Building QI Charts

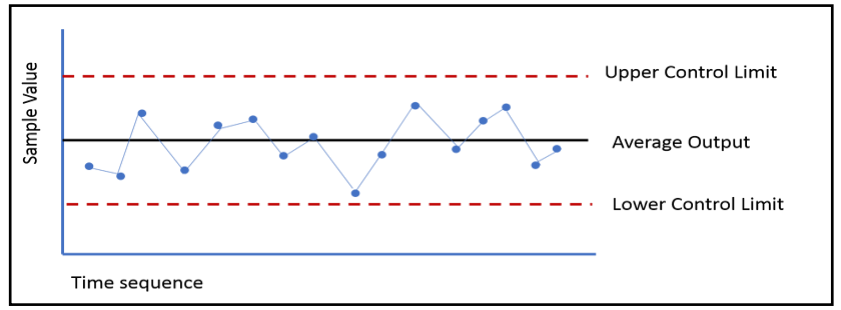


Pareto



Run Chart

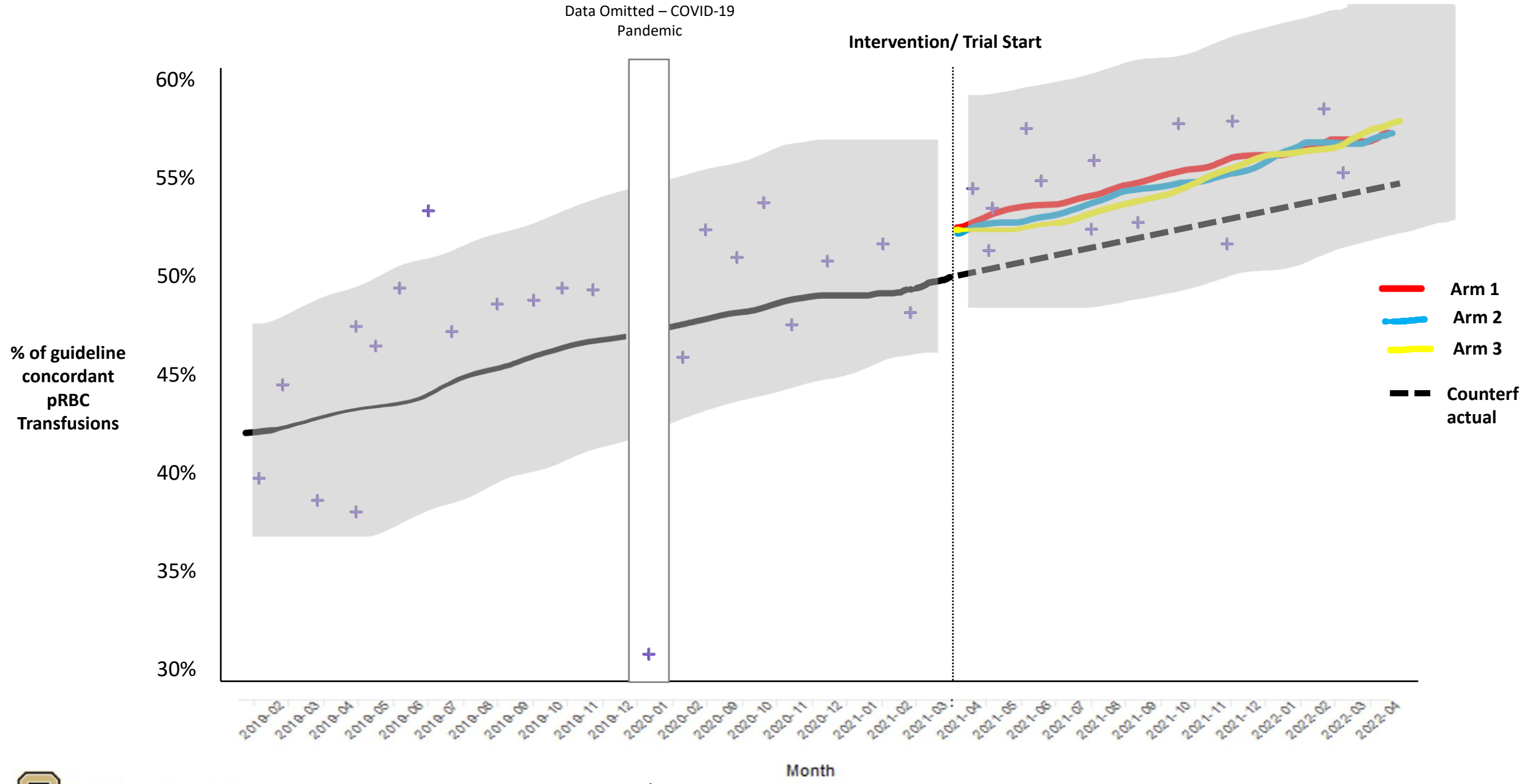
QI Macros



SPC Chart

QI Macros
Expert Help

Mock-up your predicted/expected chart BEFORE you start to help you (and others) visualize your final product.


Data Omitted – COVID-19 Pandemic
Intervention/ Trial Start
60%
55%
50%
45%
40%
35%
30%
% of guideline concordant pRBC Transfusions
Arm 1
Arm 2
Arm 3
Counterf actual
2018-02
2018-03
2018-04
2018-05
2018-06
2018-07
2018-08
2018-09
2018-10
2018-11
2018-12
2020-01
2020-02
2020-09
2020-10
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2020-12
2021-01
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2021-07
2021-08
2021-09
2021-10
2021-11
2021-12
2022-01
2022-02
2022-03
2022-04
Month

Helpful literature for going “in-depth”

- The Health Care Data Guide: Learning from Data for Improvement. Book by Lloyd P. Provost and Sandra Murray. 2011.

- Fundamentals of Health Care Improvement: A Guide to Improving Your Patients' Care (Third Edition). Book by Ogrinc et al. 2018.

In Summary

- Know your data!
- Find the data you need (NOT what you want)
- Know when change has occurred (and whether you can take credit)
- Use data to make *informed* decisions


Anschutz
IHQSE