2C: Healthcare Quality Improvement

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Clinical Informatics Board Review Course

Clinical Informatics Subspecialty Delineation of Practice (CIS DoP)

Domain 1: Fundamental Knowledge and Skills (no Tasks are associated with this Domain which is focused on fundamental knowledge and skills)

Clinical Informatics

K001. The discipline of informatics (e.g., definitions, history, careers, professional organizations)
K002. Fundamental informatics concepts, models, and theories
K003. Core clinical informatics literature (e.g., foundational literature, principle journals, critical analysis of literature, use of evidence to inform practice)
K004. Descriptive and inferential statistics
K005. Health Information Technology (HIT) principles and science
K006. Computer programming fundamentals and computational thinking
K007. Basic systems and network architectures
K008. Basic database structure, data retrieval and analytics techniques and tools
K009. Development and use of interoperability/exchange standards (e.g., Fast Health Interoperability Resources [FHIR], Digital Imaging and Communications in Medicine [DICOM])
K010. Development and use of transaction standards (e.g., American National Standards Institute X12)
K011. Development and use of messaging standards (e.g., Health Level Seven [HL7] v2)
K012. Development and use of ancillary data standards (e.g., imaging and Laboratory Information System[LIS])
K013. Development and use of data model standards
K014. Vocabularies, terminologies, and nomenclatures (e.g., Logical Observation Identifiers Names and Codes [LOINC], Systematized Nomenclature of Medicine --Clinical Terms [SNOMED-CT], RxNorm, International Classification Of Diseases[ICD], Current Procedural Terminology [CPT])
K015. Data taxonomies and ontologies
K016. Security, privacy, and confidentiality requirements and practices
K017. Legal and regulatory issues related to clinical data and information sharing
K018. Technical and non-technical approaches and barriers to interoperability
K019. Ethics and professionalism

The Health System

K020. Primary domains of health, organizational structures, cultures, and processes (e.g., health care delivery, public health, personal health, population health, education of health professionals, clinical research)
K021. Determinants of individual and population health
K022. Forces shaping health care delivery and considerations regarding health care access
K023. Health economics and financing
K024. Policy and regulatory frameworks related to the healthcare system
K025. The flow of data, information, and knowledge within the health system

Domain 2: Improving Care Delivery and Outcomes

K026. Decision science (e.g., Bayes theorem, decision analysis, probability theory, utility and preference assessment, test characteristics)
K027. Clinical decision support standards and processes for development, implementation, evaluation, and maintenance
K028. Five Rights of clinical decision support (i.e., information, person, intervention formats, channel, and point/time in workflow)
K029. Legal, regulatory, and ethical issues regarding clinical decision support
K030. Methods of workflow analysis
K031. Principles of workflow re-engineering
K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)
K033. User-centered design principles (e.g., iterative design process)
K034. Usability testing
K035. Definitions of measures (e.g., quality performance, regulatory, pay for performance, public health surveillance)
K036. Measure development and evaluation processes and criteria
K037. Key performance indicators (KPIs)
K038. Claims analytics and benchmarks
K039. Predictive analytic techniques, indications, and limitations
K040. Clinical and financial benchmarking sources (e.g., Gartner, Healthcare Information and Management Systems Society [HIMSS] Analytics, Centers for Medicare and Medicaid Services [CMS], Leapfrog)
K041. Quality standards and measures promulgated by quality organizations (e.g., National Quality Forum [NQF], Centers for Medicare and Medicaid Services [CMS], National Committee for Quality Assurance [NCQA])
K042. Facility accreditation quality and safety standards (e.g., The Joint Commission, Clinical Laboratory Improvement Amendments [CLIA])
K043. Clinical quality standards (e.g., Physician Quality Reporting System [PQRS], Agency for Healthcare Research and Quality [AHRQ], National Surgical Quality Improvement Program [NSQIP], Quality Reporting Document Architecture [QRDA], Health Quality Measure Format [HQMF], Council on Quality and Leadership [CQL], Fast Health Interoperability Resources [FHIR] Clinical Reasoning)
K044. Reporting requirements
K045. Methods to measure and report organizational performance
K046. Adoption metrics (e.g., Electronic Medical Records Adoption Model [EMRAM], Adoption Model for Analytics Maturity [AMAM])
K047. Social determinants of health
K048. Use of patient-generated data
K049. Prediction models
K050. Risk stratification and adjustment
K051. Concepts and tools for care coordination
K052. Care delivery and payment models

Domain 3: Enterprise Information Systems

K053. Health information technology landscape (e.g., innovation strategies, emerging technologies)
K054. Institutional governance of clinical information systems
K055. Information system maintenance requirements
K056. Information needs analysis and information system selection
K057. Information system implementation procedures
K058. Information system evaluation techniques and methods
K059. Information system and integration testing techniques and methodologies
K060. Enterprise architecture (databases, storage, application, interface engine)
K061. Methods of communication between various software components
K062. Network communications infrastructure and protocols between information systems (e.g., Transmission Control Protocol/Internet Protocol [TCP/IP], switches, routers)
K063. Types of settings (e.g., labs, ambulatory, radiology, home) where various systems are used
K064. Clinical system functional requirements
K065. Models and theories of human-computer (machine) interaction (HCI)
K066. HCI evaluation, usability engineering and testing, study design and methods
K067. HCI design standards and design principles
K068. Functionalities of clinical information systems (e.g., Electronic Health Records [EHR], Laboratory Information System [LIS], Picture Archiving and Communication System [PACS], Radiology Information System [RIS] vendor-neutral archive, pharmacy, revenue cycle)
K069. Consumer-facing health informatics applications (e.g., patient portals, mobile health apps and devices, disease management, patient education, behavior modification)
K070. User types and roles, institutional policy and access control
K071. Clinical communication channels and best practices for use (e.g., secure messaging, closed loop communication)
K072. Security threat assessment methods and mitigation strategies
K073. Security standards and safeguards
K074. Clinical impact of scheduled and unscheduled system downtimes
K075. Information system failure modes and downtime mitigation strategies (e.g., replicated data centers, log shipping)
K076. Approaches to knowledge repositories and their implementation and maintenance
K077. Data storage options and their implications
K078. Clinical registries
K079. Health information exchanges
K080. Patient matching strategies
K081. Master patient index
K082. Data reconciliation
K083. Regulated medical devices (e.g., pumps, telemetry monitors) that may be integrated into information systems
K084. Non-regulated medical devices (e.g., consumer devices)
K085. Telehealth workflows and resources (e.g., software, hardware, staff)

Domain 4: Data Governance and Data Analytics

K086. Stewardship of data
K087. Regulations, organizations, and best practice related to data access and sharing agreements, data use, privacy, security, and portability
K088. Metadata and data dictionaries
K089. Data life cycle
K090. Transactional and reporting/research databases
K091. Techniques for the storage of disparate data types
K092. Techniques to extract, transform, and load data
K093. Data associated with workflow processes and clinical context
K094. Data management and validation techniques
K095. Standards related to storage and retrieval from specialized and emerging data sources
K096. Types and uses of specialized and emerging data sources (e.g., imaging, bioinformatics, internet of things (IoT), patient-generated, social determinants)
K097. Issues related to integrating emerging data sources into business and clinical decision making
K098. Information architecture
K099. Query tools and techniques
K100. Flat files, relational and non-relational/NoSQL database structures, distributed file systems
K101. Definitions and appropriate use of descriptive, diagnostic, predictive, and prescriptive analytics
K102. Analytic tools and techniques (e.g., Boolean, Bayesian, statistical/mathematical modeling)
K103. Advanced modeling and algorithms
K104. Artificial intelligence
K105. Machine learning (e.g., neural networks, support vector machines, Bayesian network)
K106. Data visualization (e.g., graphical, geospatial, 3D modeling, dashboards, heat maps)
K107. Natural language processing
K108. Precision medicine (customized treatment plans based on patient-specific data)
K109. Knowledge management and archiving science
K110. Methods for knowledge persistence and sharing
K111. Methods and standards for data sharing across systems (e.g., health information exchanges, public health reporting)

Domain 5: Leadership and Professionalism

K112. Environmental scanning and assessment methods and techniques
K113. Consensus building, collaboration, and conflict management
K114. Business plan development for informatics projects and activities (e.g., return on investment, business case analysis, pro forma projections)
K115. Basic revenue cycle
K116. Basic managerial/cost accounting principles and concepts
K117. Capital and operating budgeting
K118. Strategy formulation and evaluation
K119. Approaches to establishing Health Information Technology (HIT) mission and objectives
K120. Communication strategies, including one-on-one, presentation to groups, and asynchronous communication
K121. Effective communication programs to support and sustain systems implementation
K122. Writing effectively for various audiences and goals
K123. Negotiation strategies, methods, and techniques
K124. Conflict management strategies, methods, and techniques
K125. Change management principles, models, and methods
K126. Assessment of organizational culture and behavior change theories
K127. Theory and methods for promoting the adoption and effective use of clinical information systems
K128. Motivational strategies, methods, and techniques
K129. Basic principles and practices of project management
K130. Project management tools and techniques
K131. Leadership principles, models, and methods
K132. Intergenerational communication techniques
K133. Coaching, mentoring, championing and cheerleading methods
K134. Adult learning theories, methods, and techniques
K135. Teaching modalities for individuals and groups
K136. Methods to assess the effectiveness of training and competency development
K137. Principles, models, and methods for building and managing effective interdisciplinary teams
K138. Team productivity and effectiveness (e.g., articulating team goals, defining rules of operation, clarifying individual roles, team management, identifying and addressing challenges)
K139. Group management processes (e.g., nominal group, consensus mapping, Delphi method)

Knowledge Statements from the DoP

K032. Quality improvement principles and practices (e.g., Six Sigma, Lean, Plan-Do-Study-Act [PDSA] cycle, root cause analysis)

Healthcare Quality Improvement

Distinguish Quality Assurance (QA) from Quality Improvement (QI)

- Quality Assurance
  - Focused on the individual
  - Inspection, critique, correction of performance, but no focus on system change
  - Tends to “punish,” doesn’t delve into root cause
- Quality Improvement
  - Systems-focused
  - Fallibility is recognized and errors seen as opportunities to improve
  - Peer review of errors is encouraged to identify and improve systems

QI Historical Perspective

Informed by work in manufacturing, process control

1890s – Frederick Taylor

- **"Scientific Management"** movement
- By modern standards, he thought poorly of workers
    - *"In the majority of cases this man deliberately plans to do as little as he safely can"*
    - *"When he tells you to pick up a pig and walk, you pick it up and walk, and when he tells you to sit down and rest, you sit down. You do that right through the day. And what's more, no back talk"*

1930s –Walter Shewhart, Western Electric Co.

- **Statistical Process Control**
- Creator of control charts

clipart credit: http://flatico

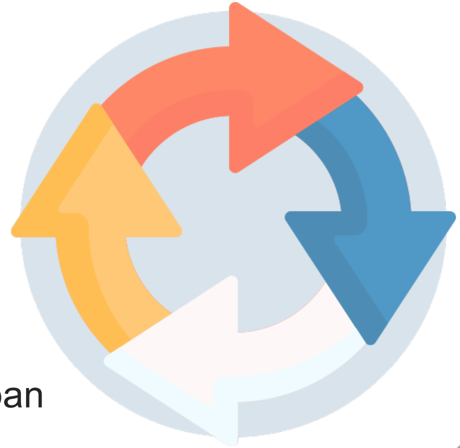
QI Historical Perspective

1950s – Taiichi Ohno

- Developed Toyota Production System, aka “**Toyota Lean**”
- System focuses on removing all activity that has no value, contributes to waste or “*muda*”

1970s – W. Edwards Deming

- **Theory of Improvement**
- **Plan-Do-Study-Act** cycle for learning and improvement
- Hired as consultant to improve production methods in post-WWII Japan



clipart credit: at.co .com

The IHI Model for Improvement

- Developed by Institute for Healthcare Improvement (IHI) in 1996, based on work by W. Edwards Deming (1900-1993), based on the work of Walter A. Shewhart (1891-1967)
- While model is attributed to Deming, he called it the "Shewhart Cycle"
- Uses rapid-cycle process called Plan Do Study Act (PDSA)
- Model starts with defining the problem, a strategy for measurement of magnitude/improvement, and a test of change
- Then, you plan the test of change (plan), implement it (do), evaluate whether it worked (check/study), and disseminate or adjust (act). The new standard solidifies the improvement, prevents backsliding
- In this way, you continuously and incrementally improve a system

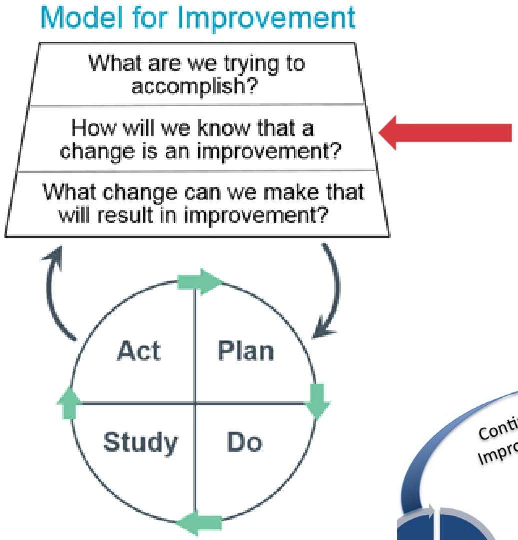


Image credit: IHI

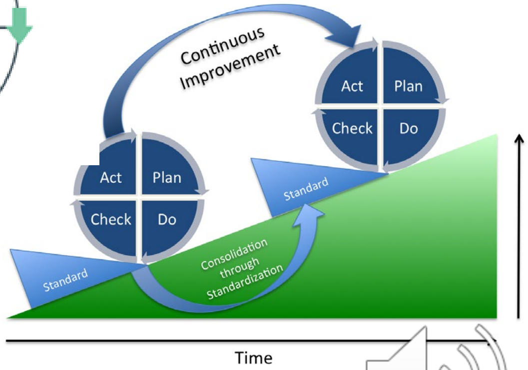


Image credit: Wik a

The Importance of Measurement

One day when I was a junior medical student, a very important Boston surgeon visited the school and delivered a great treatise on a large number of patients who had undergone successful operations for vascular reconstruction.

At the end of the lecture, a young student at the back of the room timidly asked, ***"Do you have any controls?”*** *Well, the great surgeon drew himself up to his full height, hit the desk, and said,* ***"Do you mean did I not operate on half the patients?"*** *The hall grew very quiet then. The voice at the back of the room very hesitantly replied,* ***"Yes, that's what I had in mind.”***

Then the visitor's fist really came down as he thundered, ***"Of course not. That would have doomed half of them to their death.”*** *God, it was quiet then, and one could scarcely hear the small voice ask,* ***"Which half?”***

- E.E. Peacock, 1972

in Tufte Data Analysis for Politics and Policy

Measurement is the Foundation of QI

What to measure – Donabedian Framework

- Structure?
- Process?
- Outcome?

- Lagging vs. Leading Indicator
- Characteristics of a good quality indicator

Donabedian Quality Framework

Structure – Attributes of setting in which care occurs

- Number of specialists for a given patient population
- Number of clinical guidelines implemented

Process – How care is actually provided and received

- Proportion of diabetic patients who are screened for proteinuria
- Proportion of children with otitis media who are treated appropriately with narrow-spectrum penicillins

Outcome – Effects of care on patient status

- Intermediate measures
  - HbA1c results for diabetic patients
  - Lipid profile results for patients with hyperlipidemia
- End measures
  - Quality of life for patients with degenerative joint disease
  - Functional status for stroke patients
  - Patient satisfaction

Donabedian, A. Evaluating the quality of medical care. 1966. *Milbank Q.* **83,** 691–729 (2005).

The Same Quality Indicator, Measured Differently

Goal: "All emergency department rooms should be stocked with equipment for bag-mask ventilation"

- **Structure:** "does your hospital have a policy or standard that specifies what equipment should be in every room in the ED"?
- **Process:** "In weekly audits of ED rooms, what percent of the time is a room found to be improperly stocked?"
- **Outcome:** "How many occurrences are there annually of trauma/resuscitation events in the ED where a bad outcome was attributed to missing airway equipment?"

Lagging vs. Leading Indicators

Leading Indicator: An indicator that anticipates future events, changes detectable before the events occur.

- Examples: physical activity, weight, immunizations, antibiotics given prior to surgery, timely corticosteroid treatments for acute asthma, etc.

Lagging Indicator: An indicator that follows an event.

- Examples: infections (lagging) caused by hand washing rate (leading); ventilator acquired pneumonia; complication rates, asthma hospitalization or revisit rates

Compare “Leading” to “Process” & “Lagging” to “Outcome”

- **Process/Leading:** rate of pediatric immunization
- **Outcome/Lagging:** rates of pertussis and measles in a community

Attributes of Good Indicators

- Definitions are **agreed upon**
- Optimally **sensitive** and **specific**
- **Valid** – does the indicator **discriminate** between good and bad quality?
- **Reliable** – are **repeated measurements** stable, reproducible, consistent?
- Relates to **identifiable user events** (cause → effect)
- **Permits useful comparison**
- **Evidence-based**

Error-Proofing Tools and Concepts

- High Reliability Organizations
- Checklists
- James T. Reason's "Swiss Cheese" Model
  - Latent and active failures are like "holes in the cheese"
  - Processes, safeguards, and workflows are "layers of cheese"
  - Accidents / errors occur when the latent and active failures in different layers line up, allowing hazards to lead to losses.
- Failure Mode and Effects Analysis (FMEA)
- Statistical Process Control (SPC) Charts

Reason JT. The Contribution of Latent Human Failures to the Breakdown of Complex Systems. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences 327 (1241): 475–484. [Abstract]

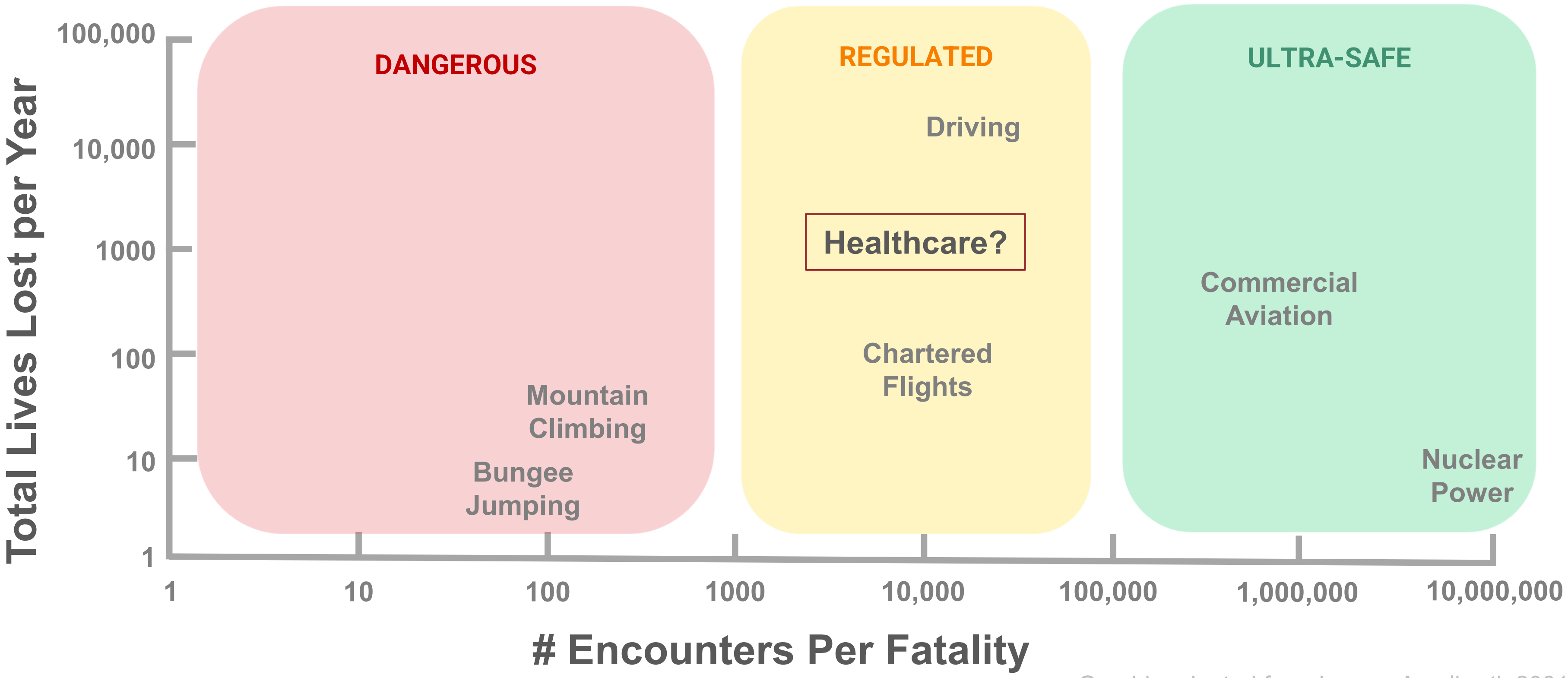
High Reliability Organizations

- Features of high-hazard industries (like healthcare, aviation) that ensure they can operate for extended periods without serious accidents or catastrophic failures.

- Characteristics of High Reliability
  - Preoccupation with Failure – vigilance, practice with a questioning attitude, escalation
  - Reluctance to Simplify – look for systemic causes, not superficial explanations
  - Sensitivity to Operations – vigilance to state of work, emerging issues, input from staff
  - Deference to Expertise – people closest to work are most knowledgeable
  - Commitment to Resilience – rapid assessments of threats, respond or mitigate quickly

Source: AHRQ High Reliability Primer

How Do Healthcare and Aviation Compare in Terms of High Reliability?



Graphic adapted from Leape, Amalberti, 2001

Surgical Safety Checklist (First Edition)

World Health Organization

Before induction of anaesthesia ▸▸▸▸▸▸▸▸▸ Before skin incision ▸▸▸▸▸▸▸▸▸▸▸▸▸▸ Before patient leaves operating room

SIGN IN

- ☐ **PATIENT HAS CONFIRMED**
  - IDENTITY
  - SITE
  - PROCEDURE
  - CONSENT
- ☐ **SITE MARKED/NOT APPLICABLE**
- ☐ **ANAESTHESIA SAFETY CHECK COMPLETED**
- ☐ **PULSE OXIMETER ON PATIENT AND FUNCTIONING**

DOES PATIENT HAVE A:

KNOWN ALLERGY?
- ☐ NO
- ☐ YES

DIFFICULT AIRWAY/ASPIRATION RISK?
- ☐ NO
- ☐ YES, AND EQUIPMENT/ASSISTANCE AVAILABLE

RISK OF >500ML BLOOD LOSS (7ML/KG IN CHILDREN)?
- ☐ NO
- ☐ YES, AND ADEQUATE INTRAVENOUS ACCESS AND FLUIDS PLANNED

TIME OUT

- ☐ **CONFIRM ALL TEAM MEMBERS HAVE INTRODUCED THEMSELVES BY NAME AND ROLE**
- ☐ **SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE VERBALLY CONFIRM**
  - PATIENT
  - SITE
  - PROCEDURE

ANTICIPATED CRITICAL EVENTS

- ☐ **SURGEON REVIEWS:** WHAT ARE THE CRITICAL OR UNEXPECTED STEPS, OPERATIVE DURATION, ANTICIPATED BLOOD LOSS?
- ☐ **ANAESTHESIA TEAM REVIEWS:** ARE THERE ANY PATIENT-SPECIFIC CONCERNS?
- ☐ **NURSING TEAM REVIEWS:** HAS STERILITY (INCLUDING INDICATOR RESULTS) BEEN CONFIRMED? ARE THERE EQUIPMENT ISSUES OR ANY CONCERNS?

HAS ANTIBIOTIC PROPHYLAXIS BEEN GIVEN WITHIN THE LAST 60 MINUTES?
- ☐ YES
- ☐ NOT APPLICABLE

IS ESSENTIAL IMAGING DISPLAYED?
- ☐ YES
- ☐ NOT APPLICABLE

SIGN OUT

NURSE VERBALLY CONFIRMS WITH THE TEAM:

- ☐ **THE NAME OF THE PROCEDURE RECORDED**
- ☐ **THAT INSTRUMENT, SPONGE AND NEEDLE COUNTS ARE CORRECT** (OR NOT APPLICABLE)
- ☐ **HOW THE SPECIMEN IS LABELLED** (INCLUDING PATIENT NAME)
- ☐ **WHETHER THERE ARE ANY EQUIPMENT PROBLEMS TO BE ADDRESSED**
- ☐ **SURGEON, ANAESTHESIA PROFESSIONAL AND NURSE REVIEW THE KEY CONCERNS FOR RECOVERY AND MANAGEMENT OF THIS PATIENT**

World Health Organization Surgical Safety Checklist. Available at: https://www.who.int/patientsafety/safesurgery/ss_checklist/en/

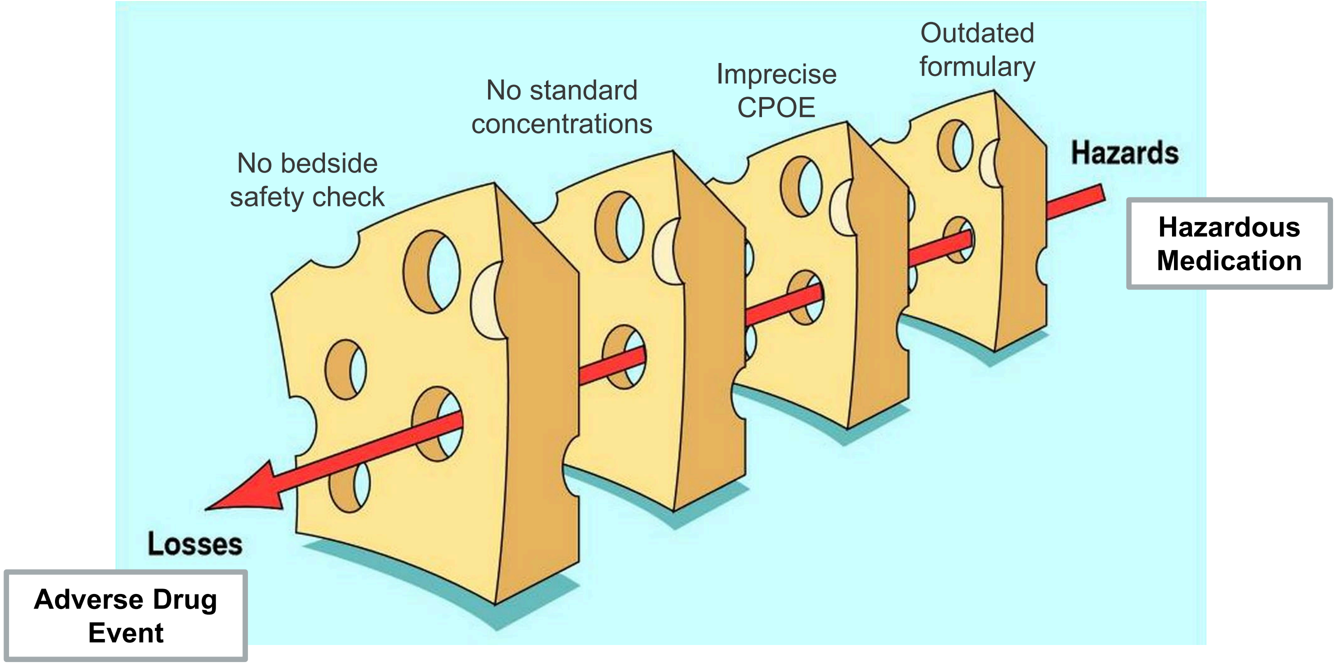
WHO Surgical Checklist

Weiser TG, Haynes AB, et al. **Effect of a 19-item surgical safety checklist during urgent operations in a global patient population.** Ann Surg. 2010 May;251(5):976-80. [Abstract]

1750 consecutively enrolled patients >16 years old at 8 hospitals across the world

> *"The complication rate was 18.4% (n=151) at baseline and 11.7% (n=102) after the checklist was introduced (P=0.0001). Death rates dropped from 3.7% to 1.4% following checklist introduction (P=0.0067). Adherence to 6 measured safety steps improved from 18.6% to 50.7% (P<0.0001)."*

Reason "Swiss Cheese" Model



Original image from: Reason J. Human error: models and management. BMJ. Mar 18, 2000; 320(7237): 768–770.

Failure Mode & Effects Analysis

"FMEA"

- Devised by the US Military in 1949
- Used in aerospace, automotive industry
- Later adopted for healthcare use

Modes of failure in a process can be risk-prioritized according to **severity** of the failure, frequency of **occurrence**, and **detectability**

Failure Mode & Effects Analysis

Step 1: Create detailed flow diagram of a process

Step 2: For each step, describe what happens if process fails

Step 3: Rate each failure on a standardized scale x 3

- Severity of harm if failure occurs **(S)**
  - 1=none; 5=fatal
- Likelihood of occurrence **(O)**
  - 1=rare; 5=common
- Inability of existing controls to detect failure **(D)**
  - 1=easily detectable; 5=failure would not be evident

Step 4: Calculate Risk Priority Number **(RPN = S x O x D)**

Example: A fatal, but rare and detectable error = 5 x 1 x 1 = RPN 5

Shewhart / Control Charts

- Not a hypothesis test
- Definitions of “common cause” and “special cause” are based in statistics
- When monitored over time, an indicator will fluctuate around an average value, defined by upper and lower control limits. This fluctuation is called **“common cause”** variation.
- Improbable patterns of fluctuation suggest the process has changed due to some special reason, hence then name **“special cause”** variation.

Shewhart / Control Charts

Upper Control Limit (UCL) = +3 sigma limit

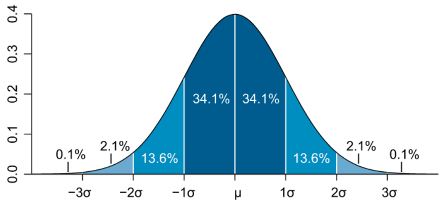
Lower Control Limit (LCL) = -3 sigma Limit

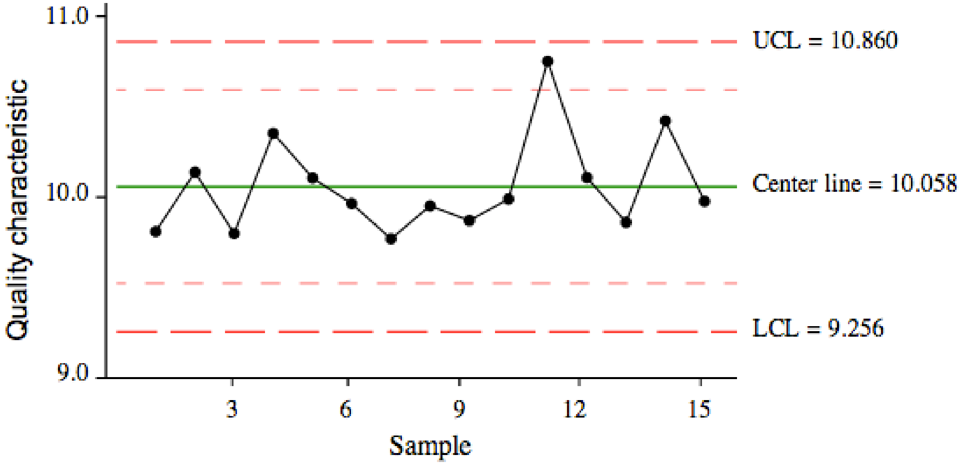
99.73% of observations should fall within +/-3 sigma

Upper Warning Limit (UWL) = +2 sigma limit

Lower Warning Limit (LWL) = -2 sigma limit

95% of of observations should fall within +/-3 sigma

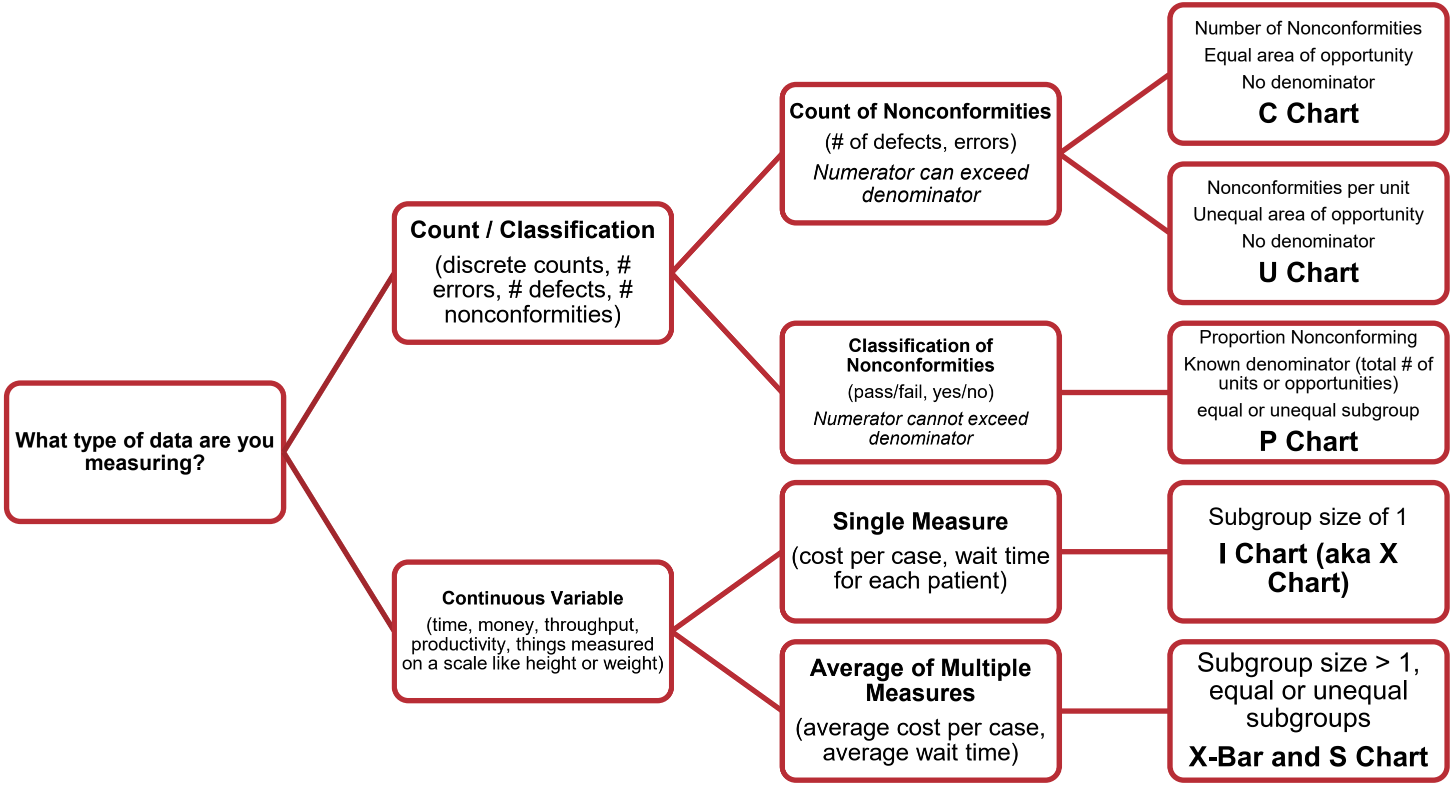




Formula for calculating those limits depends on type of data and type of control chart

UCL/UWL Calculations Determined by Chart Type

See **SUPPLEMENT** for healthcare examples of these



Control Chart Center Line

“Common Cause” Fluctuation

- Within UCL and LCL (99.73% of random fluctuation should fall within 3-sigma)
- **AND** has no unnatural patterns

“Special Cause” Fluctuation

- Falls outside UCL or LCL
- **OR** meets criteria for any “Special Cause” pattern

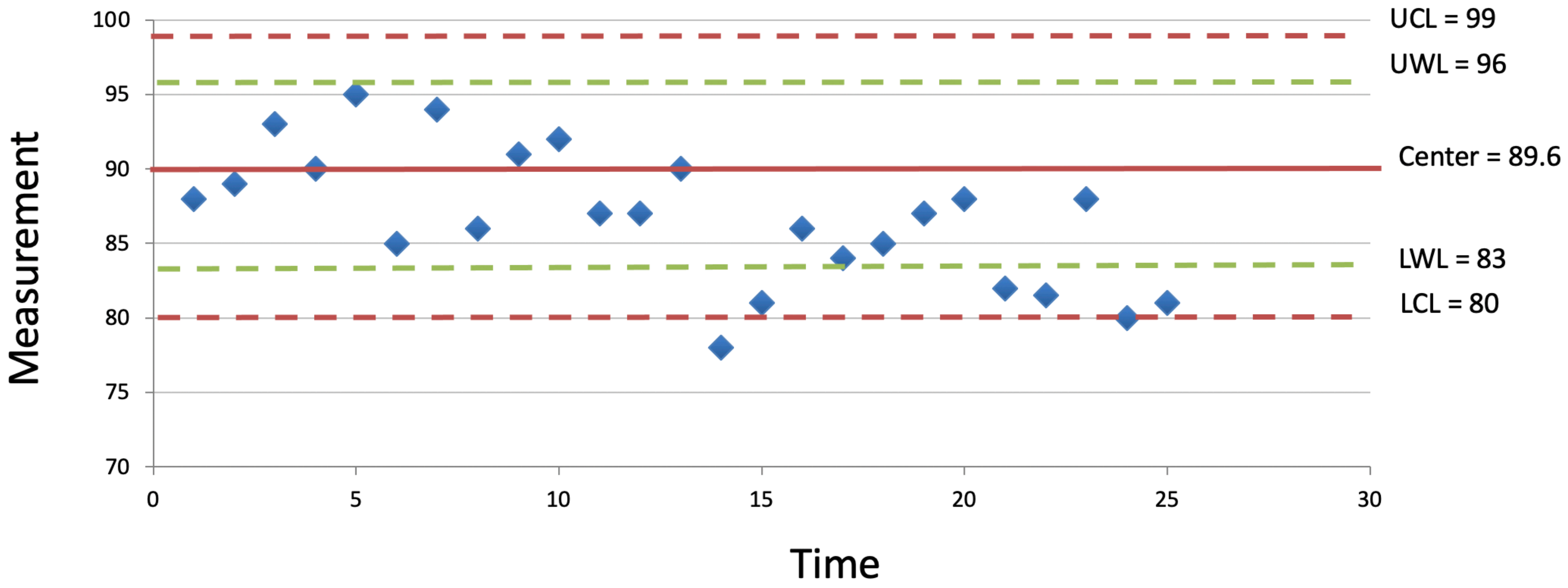
Special Cause Patterns

They all describe statistically improbable events or series of events

Definitions differ, but some commonly accepted patterns:

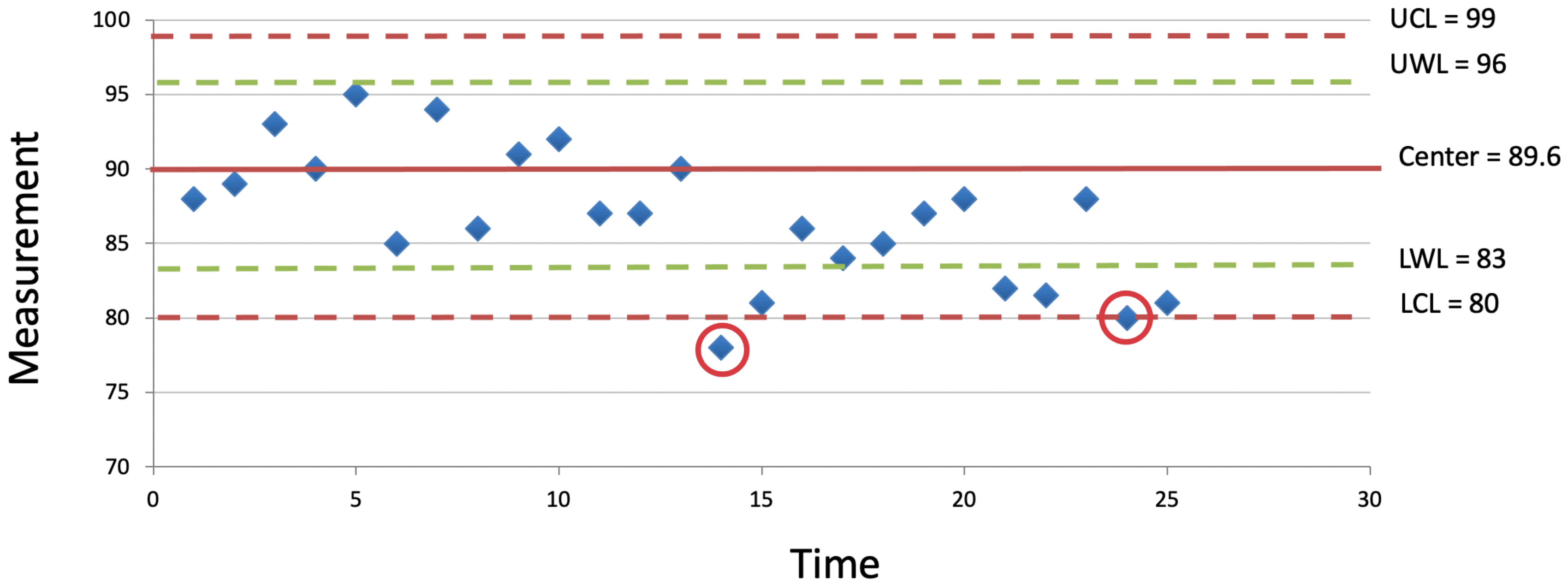
- Any single point outside 3-sigma
- Two out of three points between 2 and 3-sigma
- Four out of five consecutive points beyond 1-sigma on the same side of the centerline
- Eight consecutive points on the same side of the centerline
- Six in a row continually increasing or decreasing (drift)
- And the list goes on…

Special Cause Examples



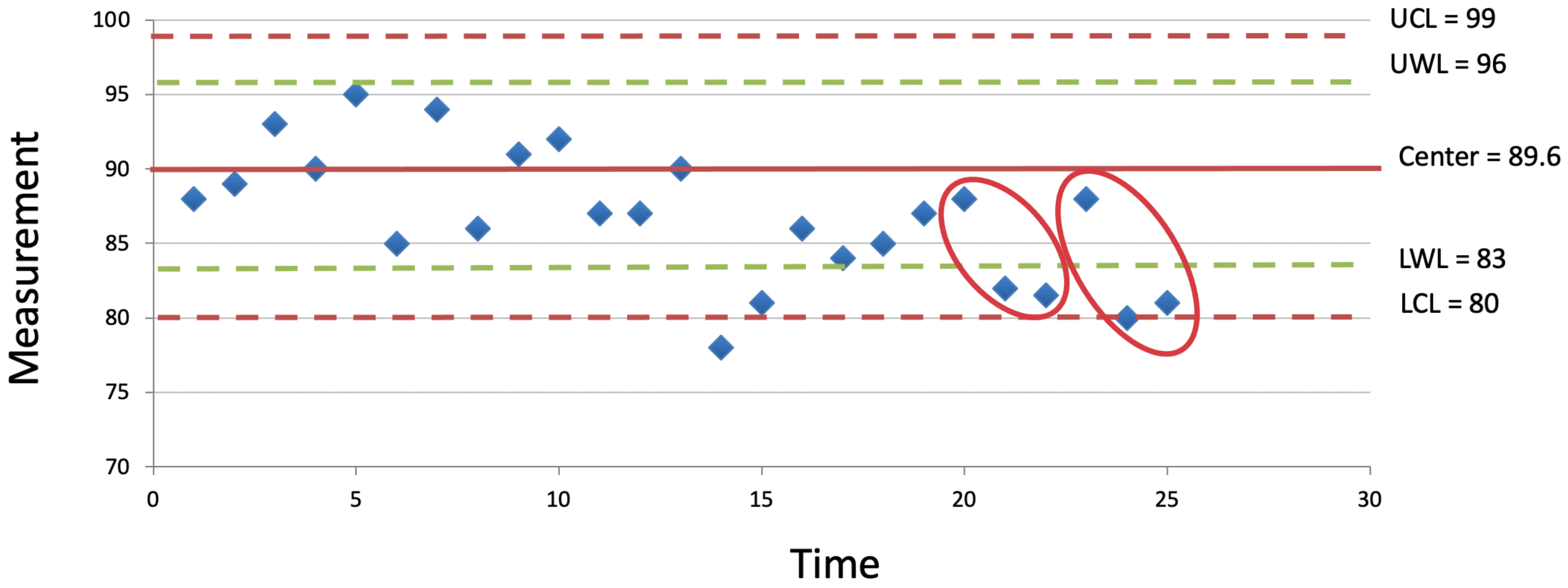
How many special cause patterns can you identify in this graph?

Special Cause Examples



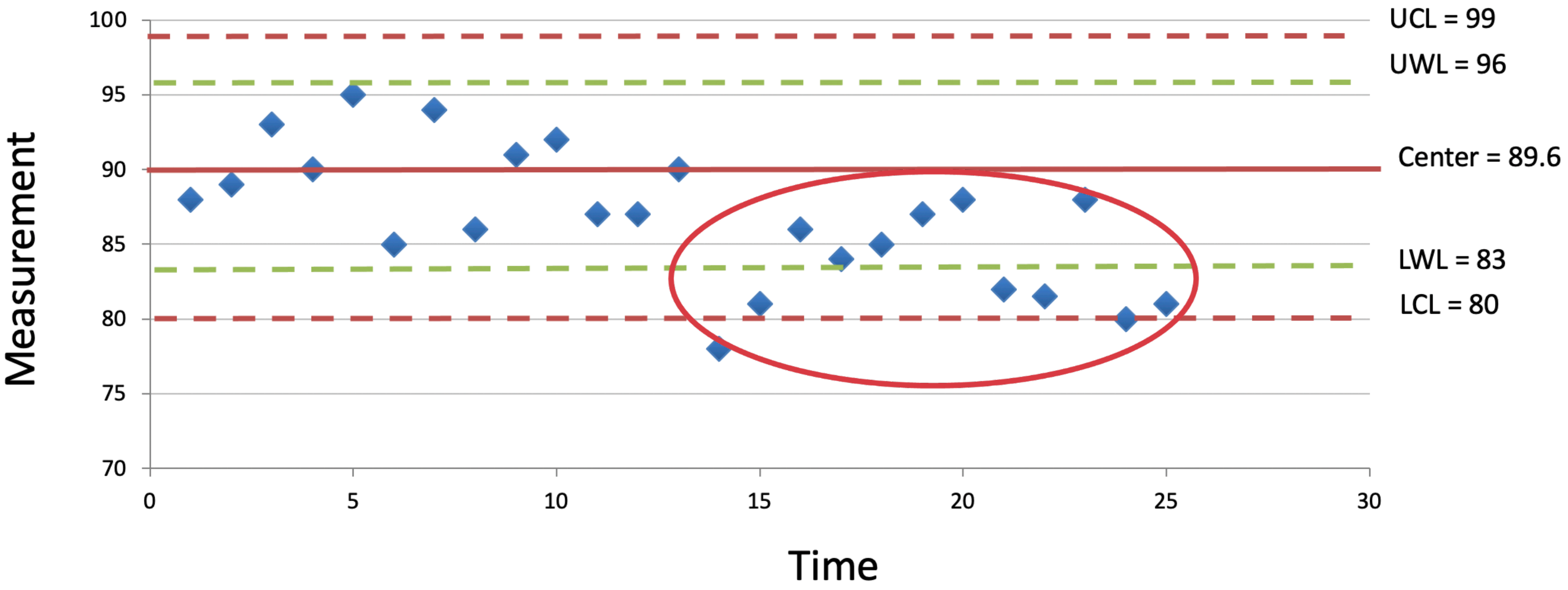
Any single point beyond 3-sigma is due to "special cause"

Special Cause Examples



Two out of 3 points between 2- and 3-sigma

Special Cause Examples



Eight consecutive on the same side of center line

Other Special Cause Terminology

Shift – "a run of 6 or more points on same side of center line"

Trend – "five consecutive points going in same direction"

Run - "too few or too many events crossing the center line"

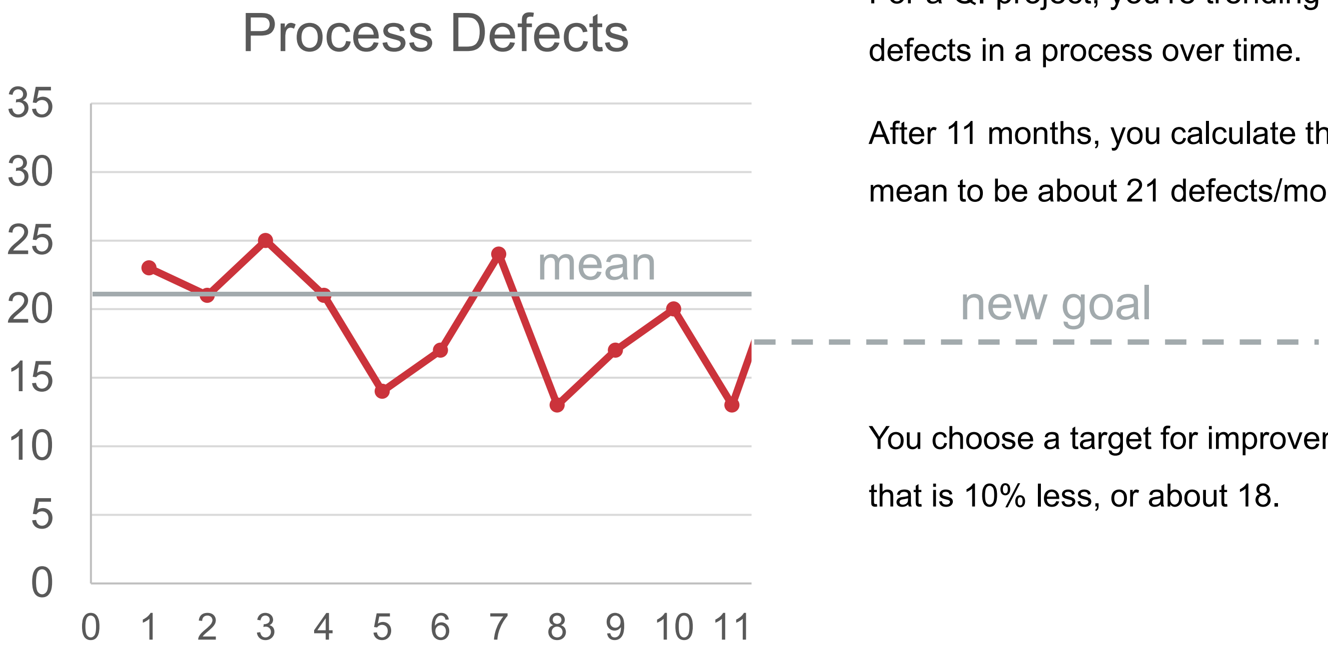
Cycle – periodicity in data suggests special cause

- Eg: "difference in STAT lab delays during night shift"

Pattern – cycles in data attributable to other factors besides time

- Eg: "higher override rates when a specific pharmacist is on duty"

Value of Using Control Charts



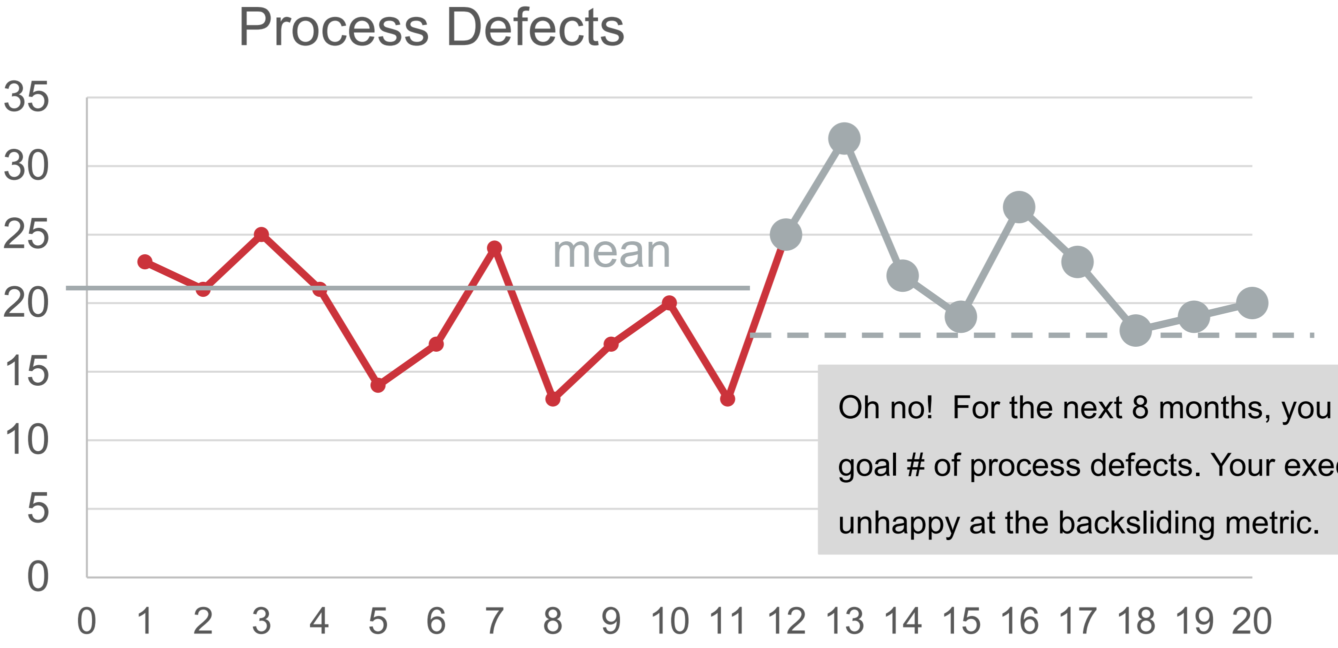
For a QI project, you're trending defects in a process over time.

After 11 months, you calculate the mean to be about 21 defects/month

You choose a target for improvement that is 10% less, or about 18.

Courtesy Ron Keren, MD • Used with permission

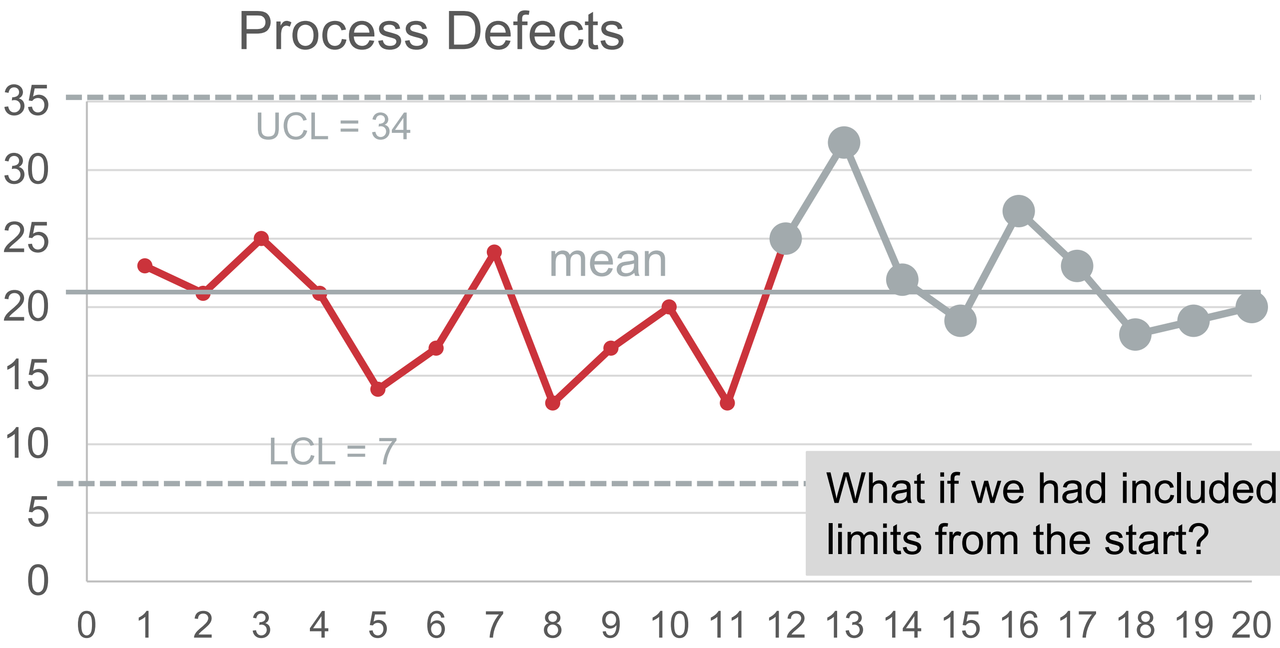
Value of Using Control Charts



Oh no! For the next 8 months, you exceed your goal # of process defects. Your executives are unhappy at the backsliding metric.

Courtesy Ron Keren, MD • Used with permission

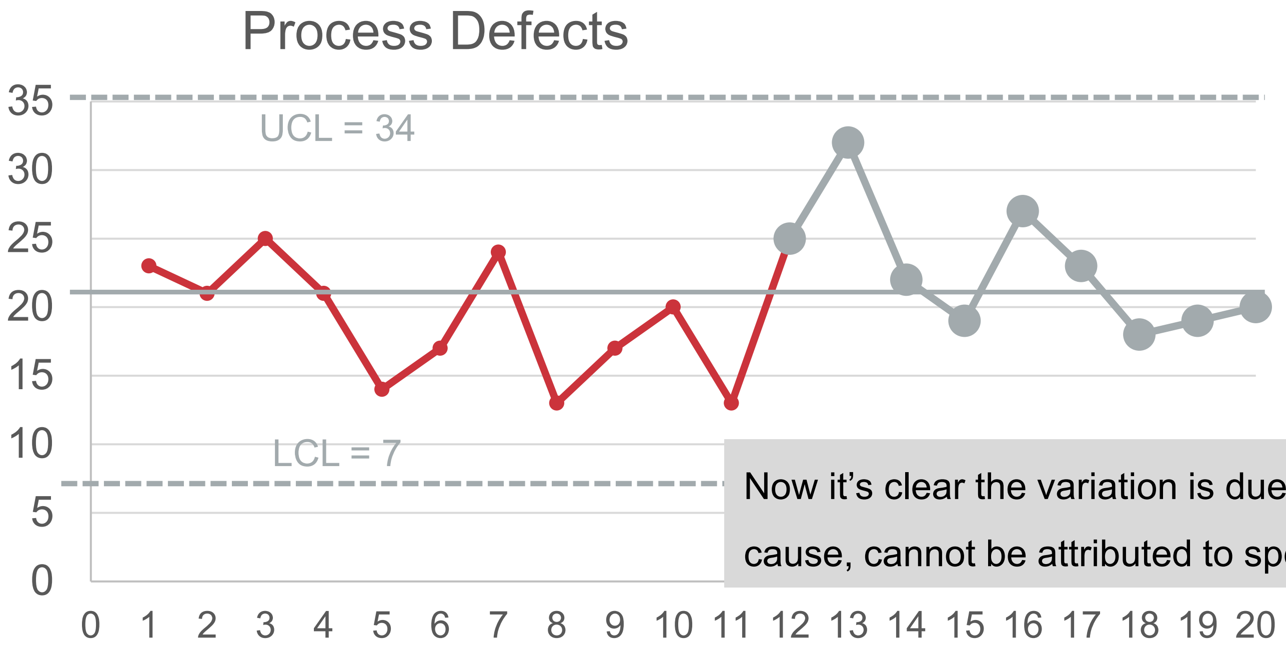
Value of Using Control Charts



What if we had included control limits from the start?

Courtesy Ron Keren, MD • Used with permission

Value of Using Control Charts



Now it's clear the variation is due to common cause, cannot be attributed to special cause.

Courtesy Ron Keren, MD • Used with permission

Other QI Tools

Flowchart

- Graphically represent a process step-by-step
- Model of workflow and cognitive steps with inputs, decisions, outputs

Cause-Effect / Ishikawa / Fishbone diagram

- Identify possible targets for improvement
- Trace back to root cause by asking “Five Whys”
- Represent as an outcome (head) and domains (bones)

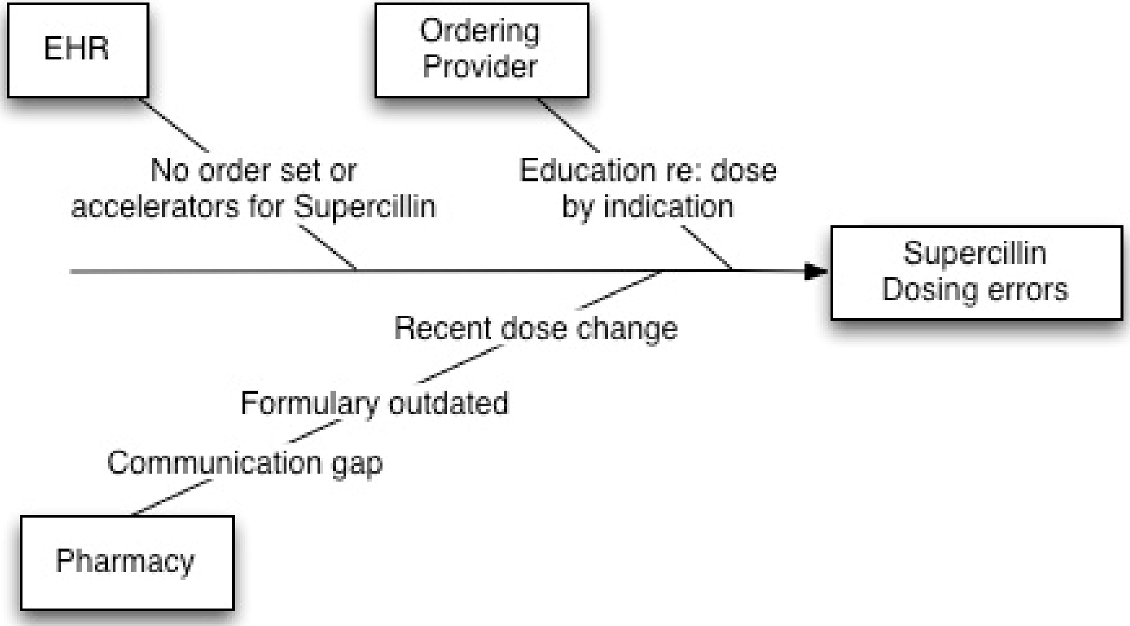
Pareto Chart

- Frequency-sorted graph of events with a cumulative percent line
- Origin of the “80:20” rule
- Used commonly to identify the most valuable targets for improvement

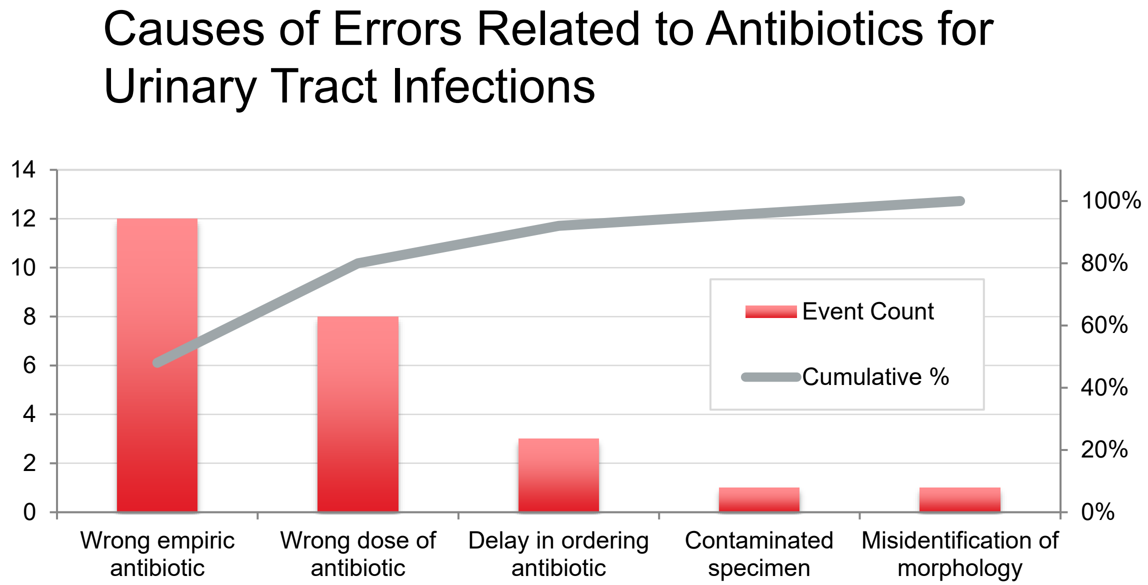
Key Driver Diagram

- Establishes a causal pathway between the intervention and the aim
- Work backwards from Outcomes to Drivers to Changes
- User to identify measurable tests of change

Ishikawa Example



Pareto Chart Example



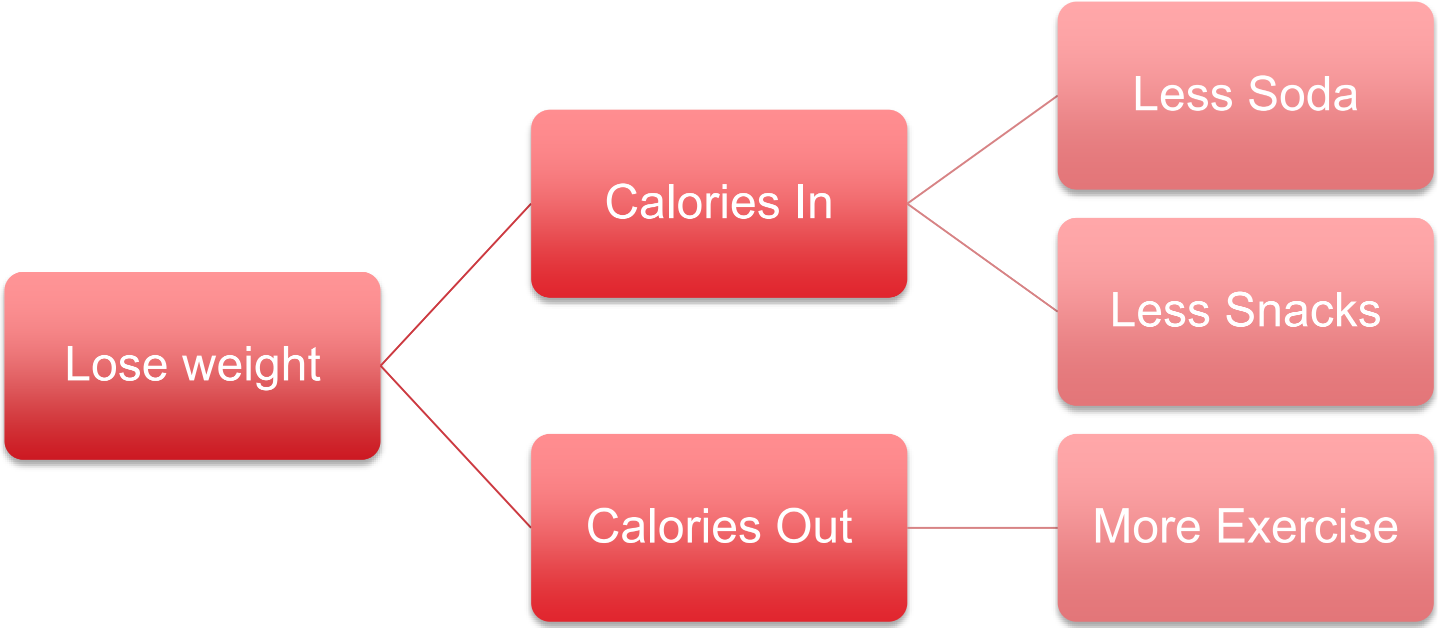
Five Whys Example

(source: https://en.wikipedia.org/wiki/Five_whys)

Problem: The vehicle won't start

- 1st Why? The battery is dead
- 2nd Why? The alternator is not functioning
- 3rd Why? The alternator belt is broken
- 4th Why? The alternator belt was well beyond its useful service life and not replaced
- 5th Why? **The vehicle was not maintained according to the recommended service schedule** (Root Cause)
  - **Solution: start to maintain according to schedule**
- 6th Why? Replacement parts are not available because of the extreme age of the vehicle (optional footnote)
  - **Solution: purchase a different vehicle that is easier to maintain**

Key Driver Diagram



Example adapted from IHI Open School website: http://www.ihi.org

Improvement Methodologies

PDSA = “Plan – Do – Study – Act”

- *(aka “PDCA” or “Plan – Do – Check – Act”)*

Six-Sigma

Toyota Lean and related strategies

Supplemental reading: Varkey P, Reller MK, Resar RK.

Basics of quality improvement in health care. Mayo Clin Proc. 2007;82(6):735-739. [Abstract]

Plan Do Study Act (or Plan Do Check Act)

Key to improvement is small, repeated cycles to select targets, improve on a small scale, implement widely, and measure outcome

- IHI reference: http://www.ihi.org/knowledge/Pages/HowtoImprove/
- Steps:
  - Form the team
  - Set Aims – time specific and measurable
  - Establish measures (ideally, these should be good indicators)
  - Select target for change/improvement (use FMEA, Pareto, Fishbone, and other techniques to identify targets)
  - **Plan – Establish objectives, processes, expectations**
  - **Do – Implement the plan, collect data for analysis**
  - **Study / Check – look at the results and compare against expected results**
  - **Act – request corrective actions, disseminate results to all areas**

Example in Practice

A children's hospital wants to encourage appropriate 1st line antibiotic prescribing for community acquired pneumonia

1: Form a team: hospitalists, ED, ID, pharmacist, and others

2: Develop aims: increase percent of patients admitted with community acquired pneumonia (CAP) on appropriate antibiotics from baseline of 0% to 80%

Ambroggio et al, Pediatrics 2013

Example in Practice

3: Create a process map to understand current workflows

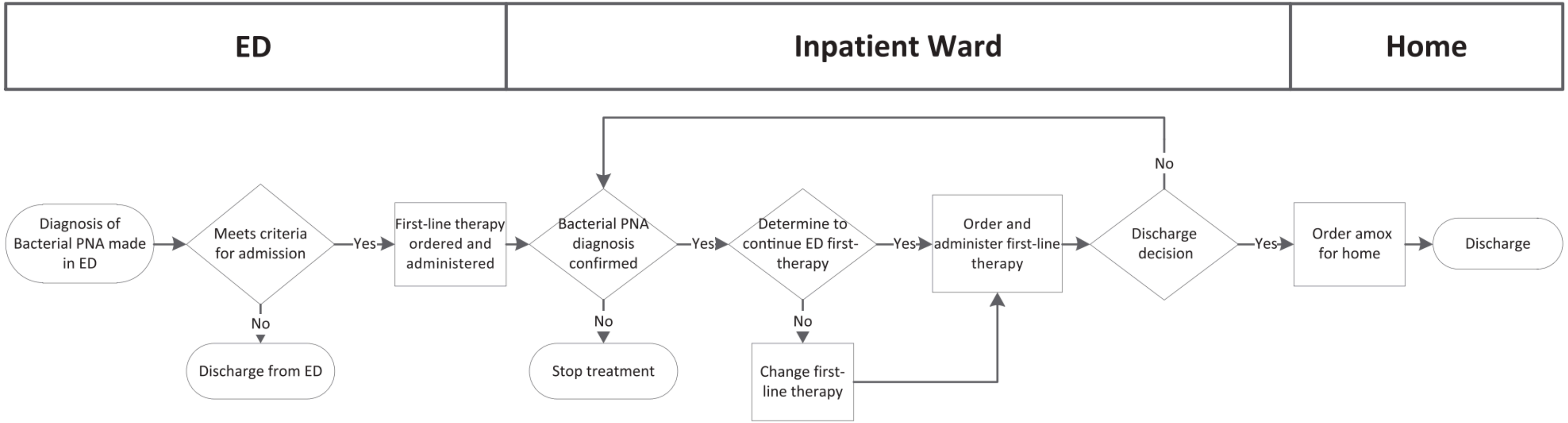


FIGURE 1
Process map of antibiotic prescribing for a patient being admitted for CAP. Amox amoxicillin; PNA, pneuomonia.

Ambroggio et al, Pediatrics 2013

Example in Practice

4: Conduct FMEA and determine key drivers

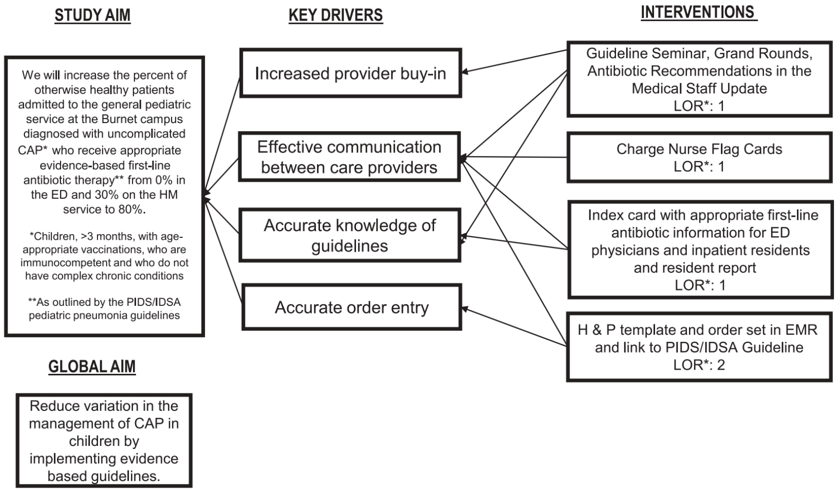


FIGURE 2
Key driver diagram summarizing the project aim and interventions implemented to achieve the study aim. H&P, history and physical examination note; LOR, level of reliability.

Ambroggio et al, Pediatrics 2013

Example in Practice

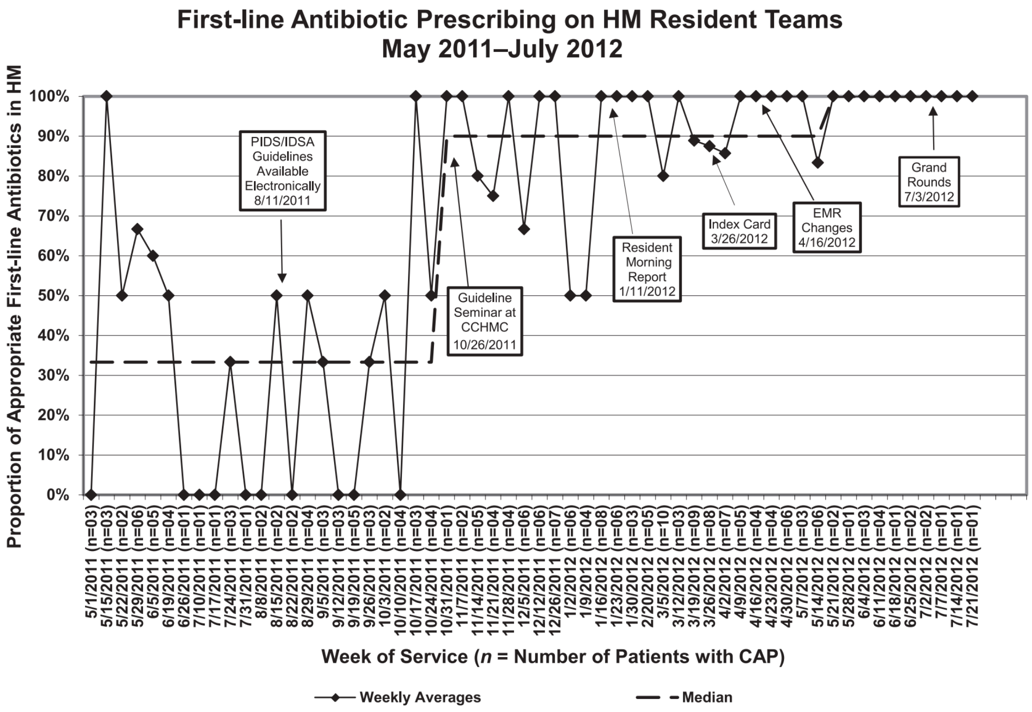
5: Plan and do the intervention(s)

- Educational seminars re: ID guidelines
- 4x6 index card with recommendations in bullet points
- Included recommendations in housestaff guide
- Incorporate CAP guidelines into an existing CAP orderset, with links to guidelines
  - Default orderset to recommended 1st-line antibiotics
- Update EHR note templates to reflect guideline-based plan of care

Ambroggio et al, Pediatrics 2013

Example in Practice

6: Measure the change using run chart



Ambroggio et al, Pediatrics 2013

Six Sigma

Developed by Motorola in the 1980s

Name comes from ideal of having a process in control within six-sigma (“perfect” process) – 3.4 defects per million opportunities, or 99.999% error free.

Steps – DMAIC (note some similarities to PDSA/PDCA)

- **Define** – project charter, needs, scope, goals
- **Measure** – data collection plan, sources of data to measure defects, design control charts to monitor process
- **Analyze** – identify deviation from standards, sources of process variation
- **Improve** – identify creative solutions, implement plans
- **Control** – process is updated; policies, guidelines, error-proofing put in place

Lean Methodology

Taiichi Ohno, Toyota Motor Corporation Engineer in 1950s

Remove all non-value added activities

- *Muda* – “uselessness, wastefulness”
- *Mura* – “irregularity, unevenness”
- *Muri* – “unreasonable, burdensome work”

Seven Types of *Muda*

1. Overproduction / underproduction
2. Inventory (ex: too much inventory of a perishable good in stock)
3. Repairs / rejects (assembly mistakes)
4. Motion (poor work area ergonomics)
5. Processing (e.g. outdated policies, procedures)
6. Waiting (patients languishing in a waiting room)
7. Transport (transporting patients unnecessarily)

Lean: Value Stream Mapping

Graphical depiction of inputs, throughputs, outputs

Highlights opportunities for improvement

Frontline staff bring forth ideas for improvement

Tests of change implemented as “kaizens” or “change for the better” – small improvements, rapid adaptation to results, continuous quality improvement

Lean: Kaizen

Standardize operational activities

Measure operation

Compare measurements to requirements

Engage frontline staff in identifying opportunities to improve

When improvements work, make them the new standard

Repeat

Lean: Supporting Conventions

Kanban cards

- Visual indicators that a supply is empty
- Ex: red flip tabs on the top of hand sanitizer dispensers

Andon

- Visual indication that indicates production status / alerts when assistance is needed
- Ex: "X-Ray In Progress" light

Poka-yoke

- "mistake avoiding" in design or process
- Intentional incompatibility of refill spouts for inhaled anesthetics
- Color-coding of medical gases - yellow for air, green for oxygen
- The notch on your SIM card that only allows it to be inserted in one orientation

Your Homework

Review the PDSA Tutorial on the New York State Perinatal Quality Collaborative website

https://www.albany.edu/cphce/neo_public/pdsa_tutorial.pdf

Pick a hypothetical clinical quality improvement project of your choosing and use the guide to design a PDSA project (you can stop at the "PLAN" stage for this exercise).

End of Lecture

Supplement: SPC "Count" Examples

Number of workplace injuries per month

- Count data → number of injuries, unknown denominator (employee can be injured multiple times)
- "Equal area of opportunity" → workplace doesn't change size, time period is fixed
- **Therefore, you would use a C Chart (think "Count")**

Number of line infections per 1000 patient days

- Count data → # of line infections, but unknown denominator (no limit on # of infections per patient day)
- "Unequal area of opportunity" → # patient days changes per observation period
- **Therefore, you would use a U Chart (think "Unequal")**

Proportion of patients who had medication reconciliation performed per encounter

- Count data with known denominator → total number of patients/encounters is known
- Numerator can't exceed denominator → Med Rec only performed once per encounter
- **Therefore, you would use a P Chart (think "Proportion" Chart)**

Supplement: SPC “Continuous Variable” Examples

Variation in Patient Days per month

- Not a count or classification of nonconformities
- Has a ”scale” (days, time)
- Measurement is individual patient days, not an average → subgroup size = 1
- **Therefore, you would choose an I Chart (think “Individuals”)**

Time from ED to OR for sequential cases of isolated femur fracture

- Scale = time
- Individual, sequential measurements (x-axis is each femur fracture case in sequence)
- **Therefore, you would choose an I Chart**

Supplement: SPC "Continuous Variable" Examples

Average turnaround time for STAT CBC tests per month

- Time is continuous scale
- Measurements are an average, not individual / sequential observations
- Therefore, you would choose an X-bar Chart ($\bar{X}$ Chart)

Average cost per appendicitis case per month

- Scale = cost
- Average of multiple measures
- Therefore, you would choose an X-bar Chart ($\bar{X}$ Chart)

Supplemental QI Materials

Institute for Healthcare Improvement Open School

- http://www.ihi.org/Pages/default.aspx
- https://www.youtube.com/user/IHIOpenSchool/videos

Example of QI tools in action

- Ambroggio L, Thomson J, Murtagh Kurowski E, Courter J, Statile A, Graham C, Sheehan B, Iyer S, Shah SS, White CM. **Quality improvement methods increase appropriate antibiotic prescribing for childhood pneumonia.** Pediatrics. 2013 May;131(5):e1623-31. PubMed PMID: 23589819

Suggested Additional Reading

Mainz J. **Defining and classifying clinical indicators for quality improvement.** *Int J Qual Health Care* 15, 523–530 (2003). [Article]

Ransom SB, Joshi MS, Nash DB. **The healthcare quality book.** Chicago: Health Administration Press, 2005. 495 p.

Varkey P, Reller MK, Resar RK. **Basics of quality improvement in health care.** *Mayo Clin Proc*. 2007;82(6):735-739. [Abstract]

How to Improve [Internet]. Cambridge (MA): Institute for Healthcare Improvement; [cited 2020 Aug 21]. Available from: http://www.ihi.org/resources/Pages/HowtoImprove/default.aspx

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