Feidhmeannacht na Seirbhíse Sláinte
Health Service Executive

Quality Improvement Division

QI TALK TIME

Building an Irish Network of Quality Improvers

Measurement for Improvement

Lloyd Provost

3rd July 2018

Connect **Improve** **Innovate**

Speaker

Lloyd P Provost:

An improvement advisor with Associates in Process Improvement who has worked worldwide to apply the science of improvement. His experience includes consulting and teaching in collaborative improvement, planning, management systems, measurement, planned experimentation, and statistical process control. Lloyd is also senior fellow of the Institute of Healthcare Improvement (IHI). Lloyd also works with IHI on their "Improvement Advisor Development Program".

Lloyd holds has a Bachelor of Science in Statistics from the University of Tennessee and a Master of Science in Statistics from the University of Florida. He is the author of multiple papers relating to quality and measurement and co-author of three books on planned improvement including the Health Care Data Guide (Jossey-Bass, 2011).

Instructions

- Interactive

- Sound:

Computer or dial in:

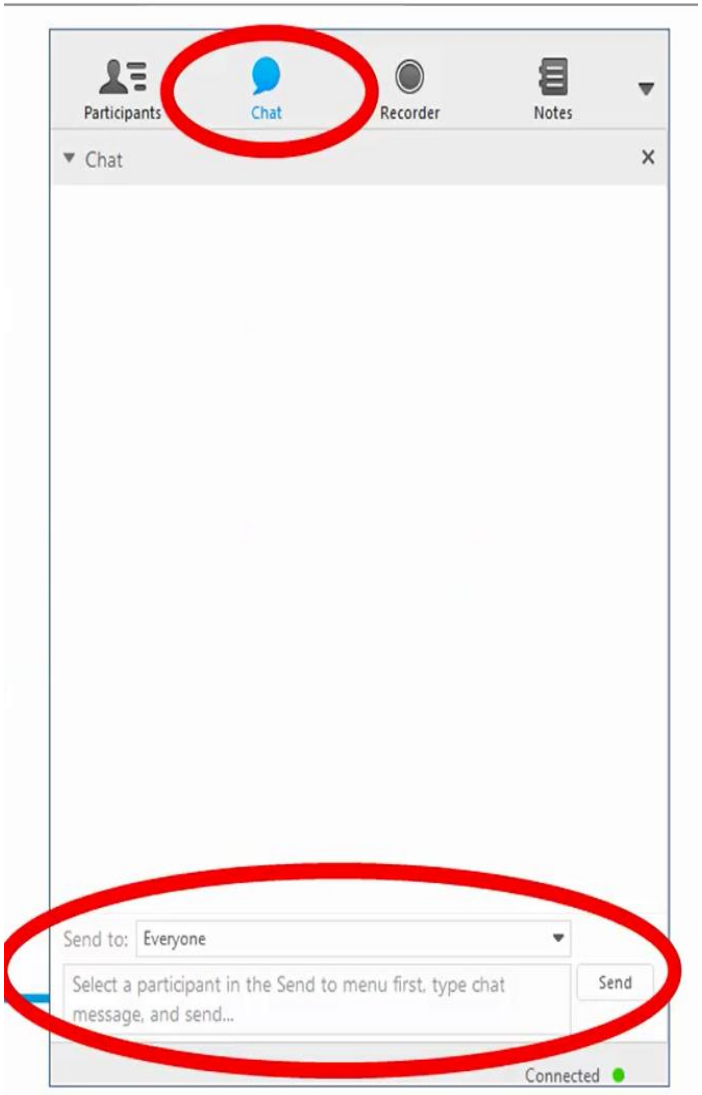
Telephone no: 01-5260058

Event number:840 185 291 #

- Chat box function
  - Comments/Ideas
  - Questions

- Keep the questions coming

- **Twitter: @QITalktime**



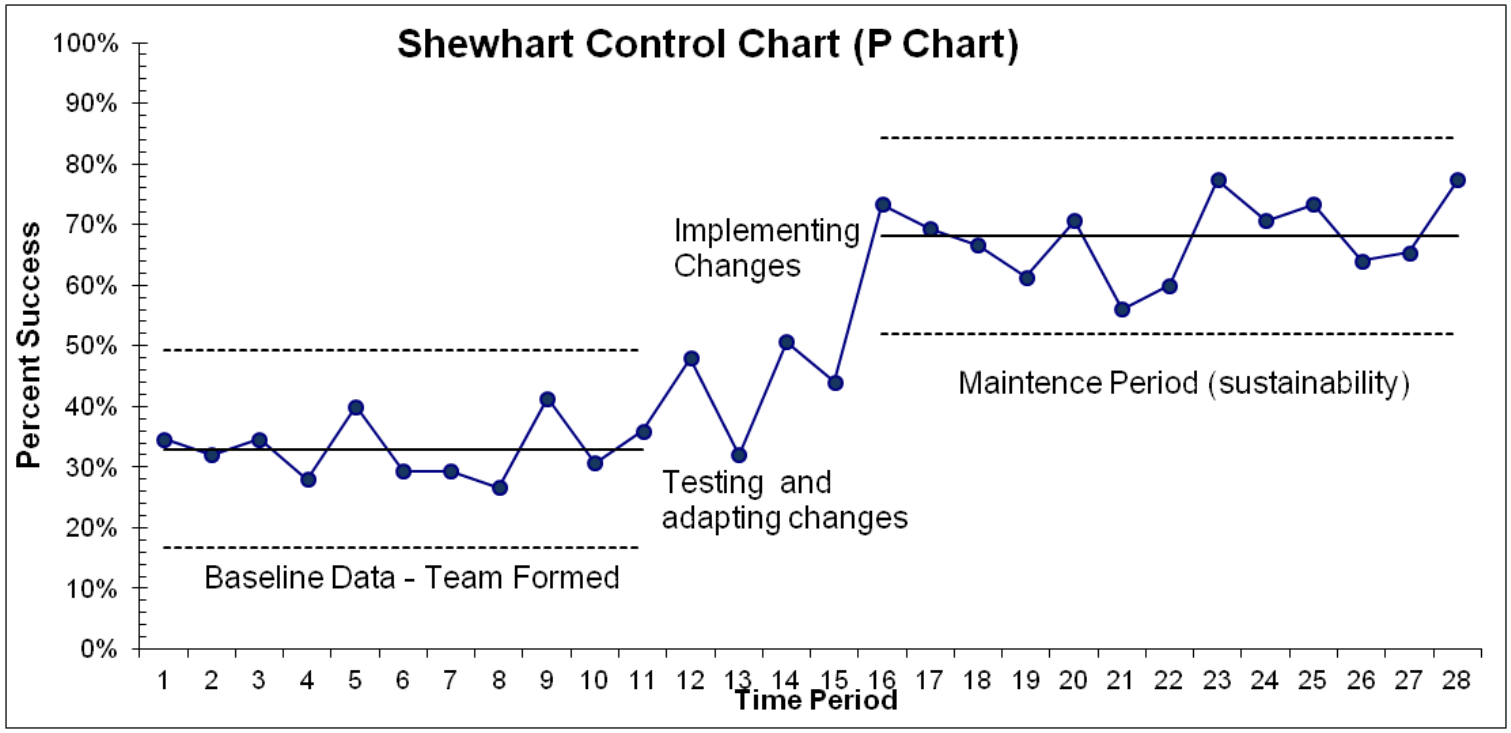
QI TALK TIME

Building an Irish Network of Quality improvers

Measurement for Improvement

3 July, 2018

Lloyd P. Provost
Associates in Process Improvement
lprovost@apiweb.org

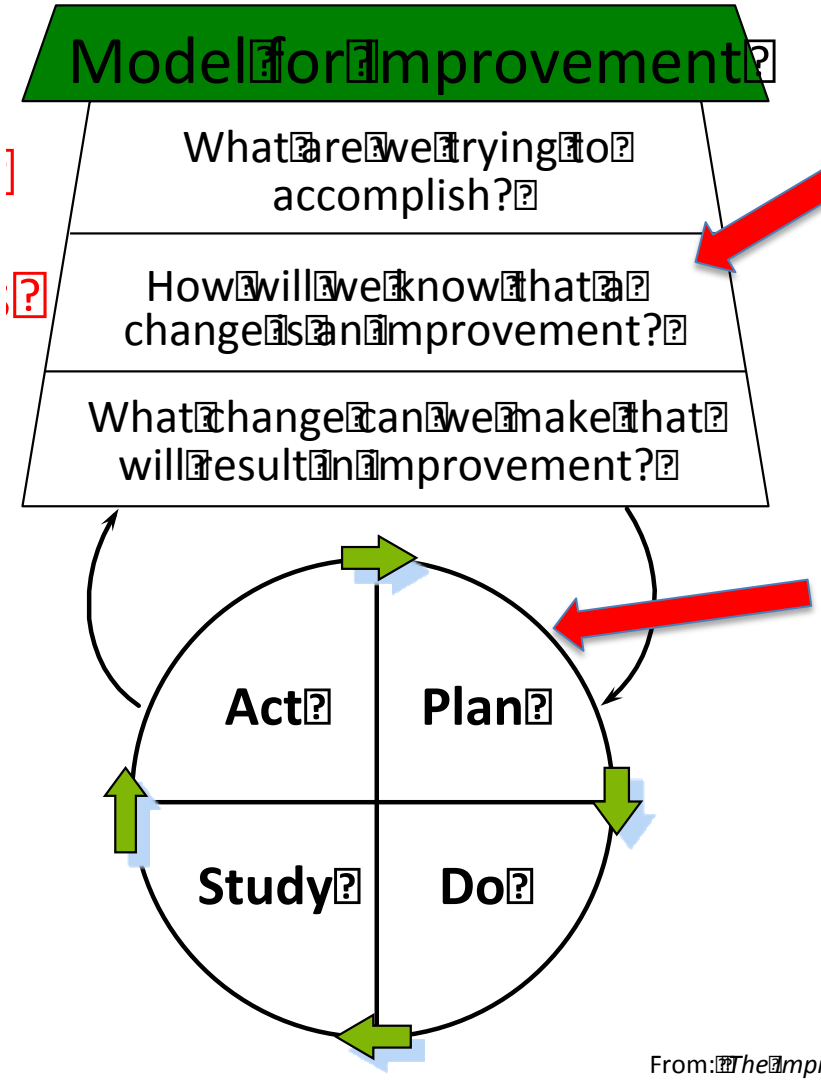


Webinar Objectives

- Review the key ideas on measuring for improvement.
- Appreciate the importance of analysing measures using time series charts.
- Appreciate learning from special causes.
- Review some examples of the useful types of control charts in healthcare applications.

Reference: *The Health Care Data Guide*, Provost and Murray, 2012

Measurement for Improvement



Project Measures:

Overall **results** related to the project aim (outcome and process measures). Also Balancing measures

PDSA Measures

- Quantitative data on the impact of a particular change
- Qualitative data to help refine the change
- Subsets or stratification of project measures for particular patients

From: *The Improvement Guide*, Associates in Process Improvement

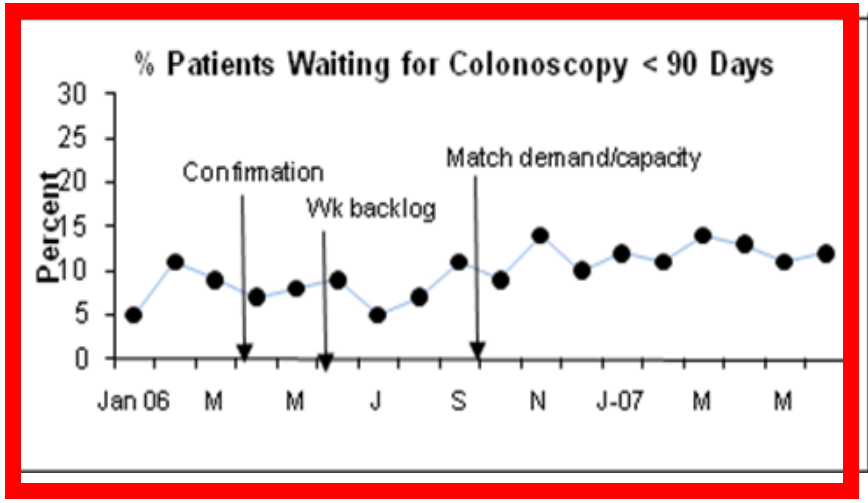
The Three Faces of Performance Measurement: Improvement, Accountability, and Research

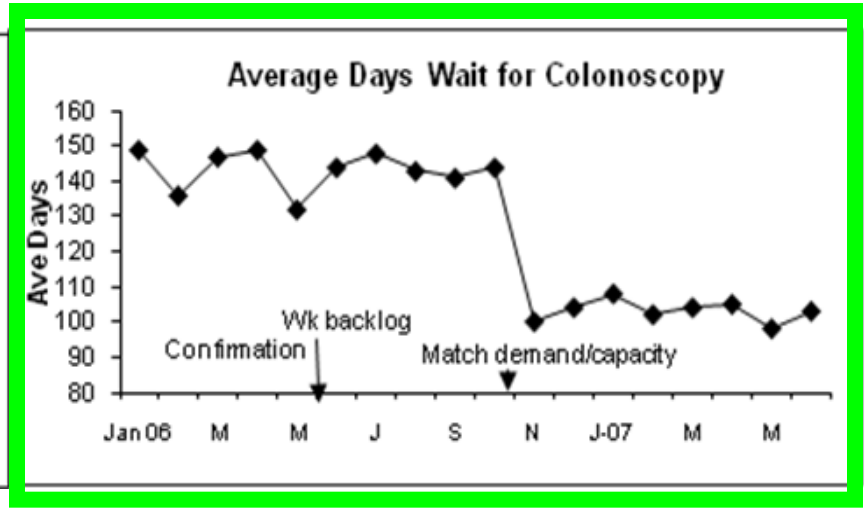
LEIF I. SOLBERG, MD
GORDON MOSSER, MD
SHARON MCDONALD, RN, PHD

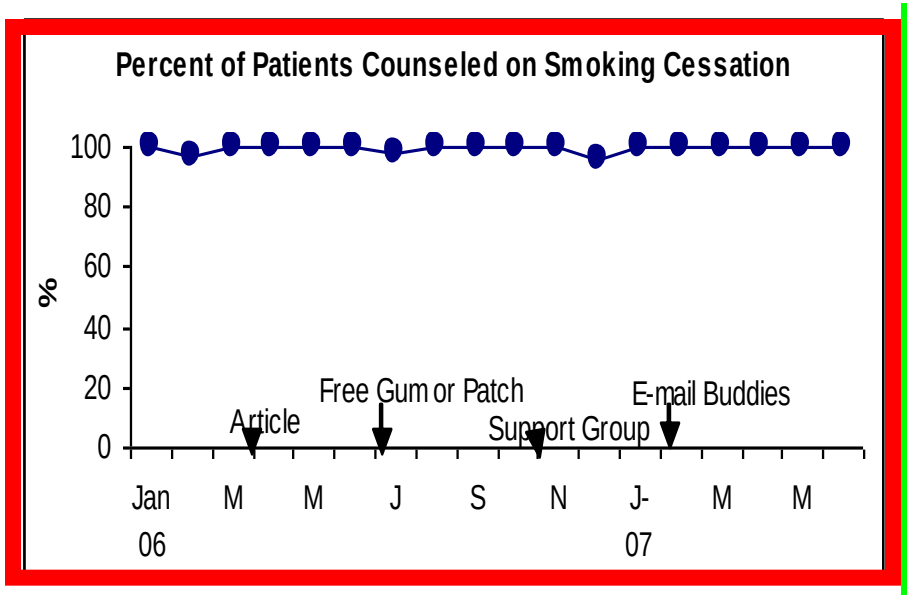
March, 1997 The Joint Commission
Journal on Quality Improvement,
Vol 23, No 3.

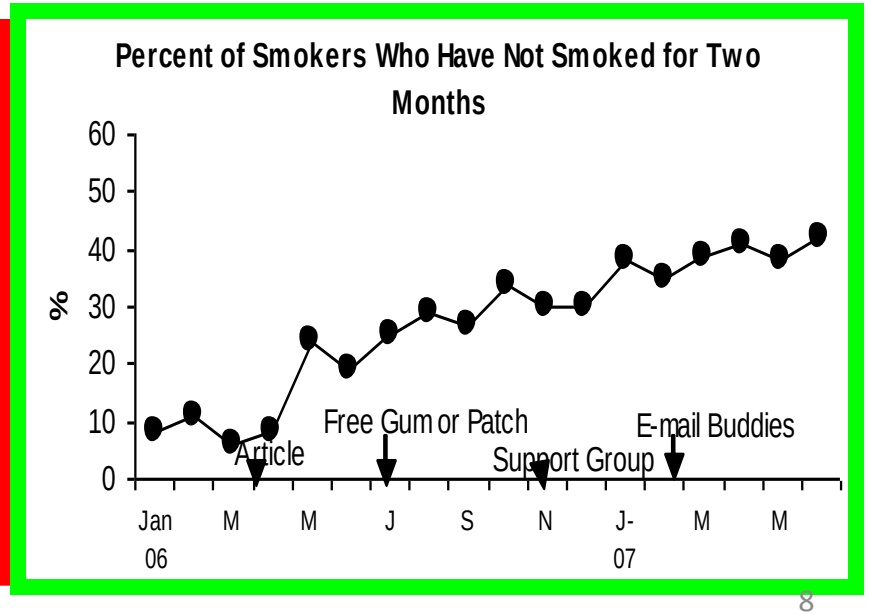
We are increasingly realizing not only how critical measurement is to the quality improvement we seek but also how counterproductive it can be to mix measurement for accountability or research with measurement for improvement.

Data for Judgment vs. Improvement



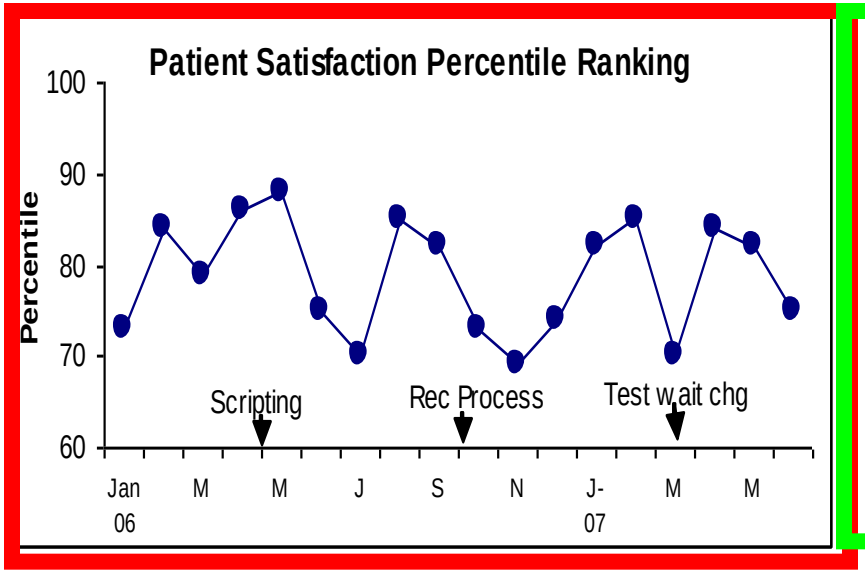


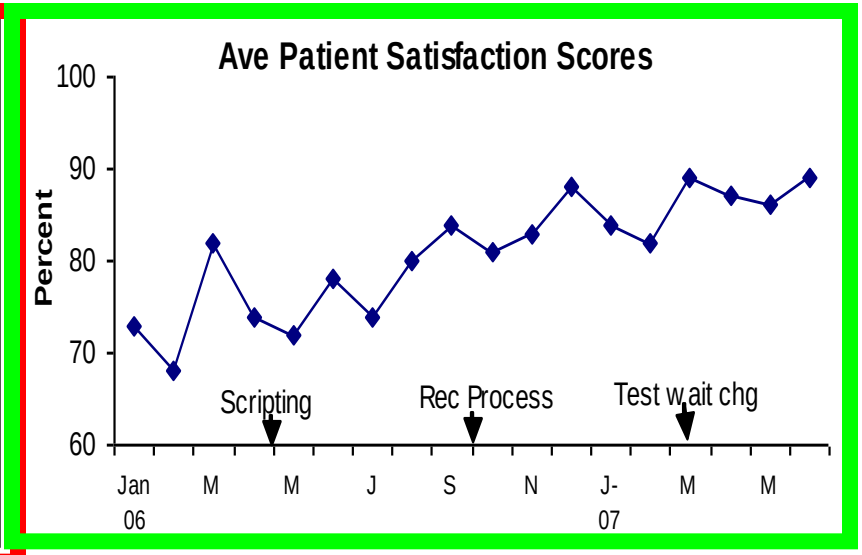




HC Data Guide, p 29, 30

Data for Judgment vs. Improvement





HC Data Guide, p 31

Guidelines for Collecting Data for Improvement

- A few key measures that clarify the aim of the improvement effort and make it tangible should be regularly reported throughout the life of the project.
- Be careful about over-doing process measures. A balance of outcome, process and balancing measures is important.
- Plot data visually on the key measures over time.
- Make use of existing databases and data already collected for developing measures.
- Whenever feasible, integrate data collection for measurement into the daily work routine.

HC Data Guide, p 32

Three Categories of Measures

Outcome Measures: Voice of the customer or patient. How is the system performing? What is the result?

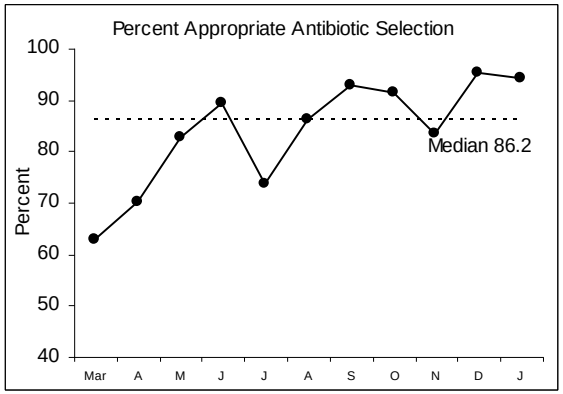
Process Measures: Voice of the workings of the system. Are the parts/steps in the system performing as planned?

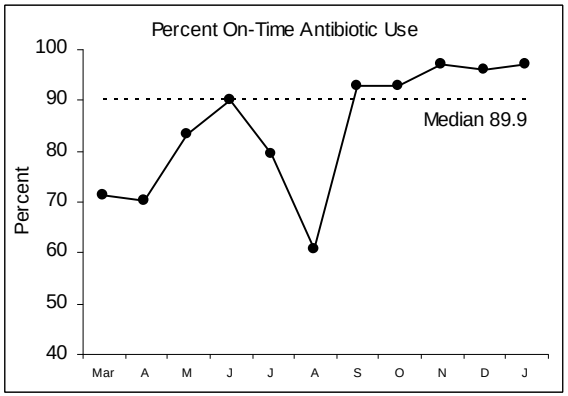
Balancing Measures: Looking at a system from different directions/dimensions. What happened to the system as we improved the outcome and process measures? (e.g. unanticipated consequences, other factors influencing outcome)

HC Data Guide, p 36

Family of Measures for Improvement Project

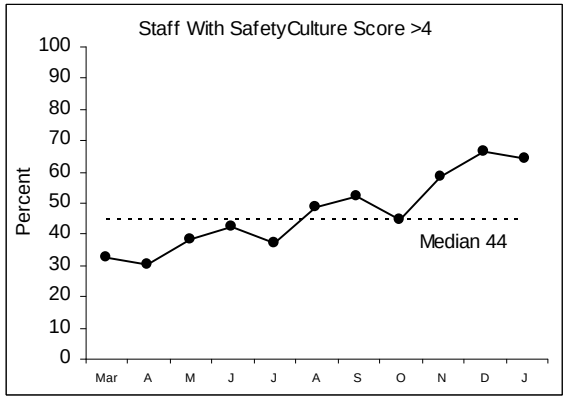
Process Measure

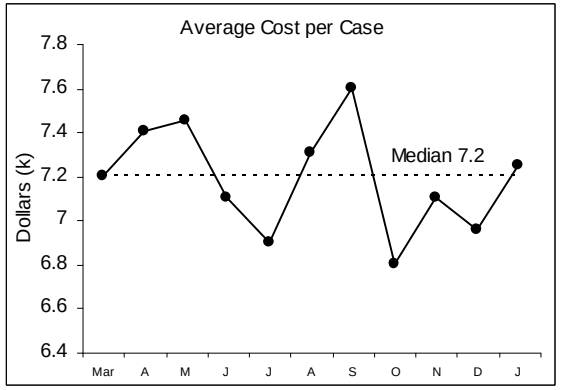




Process Measure

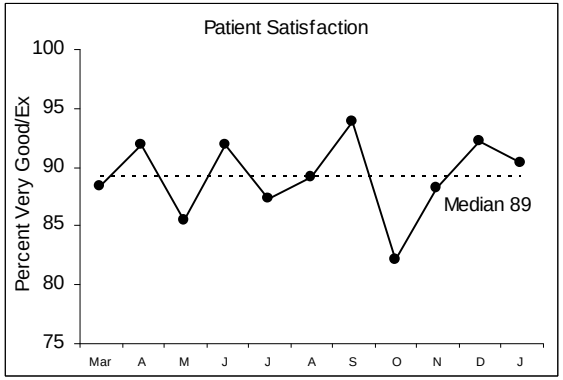
Process Measure

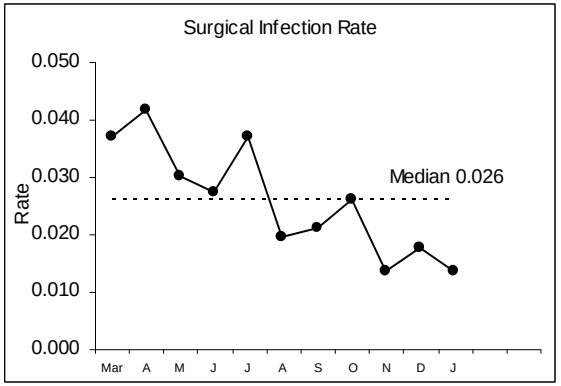




Balancing Measure

Balancing Measure





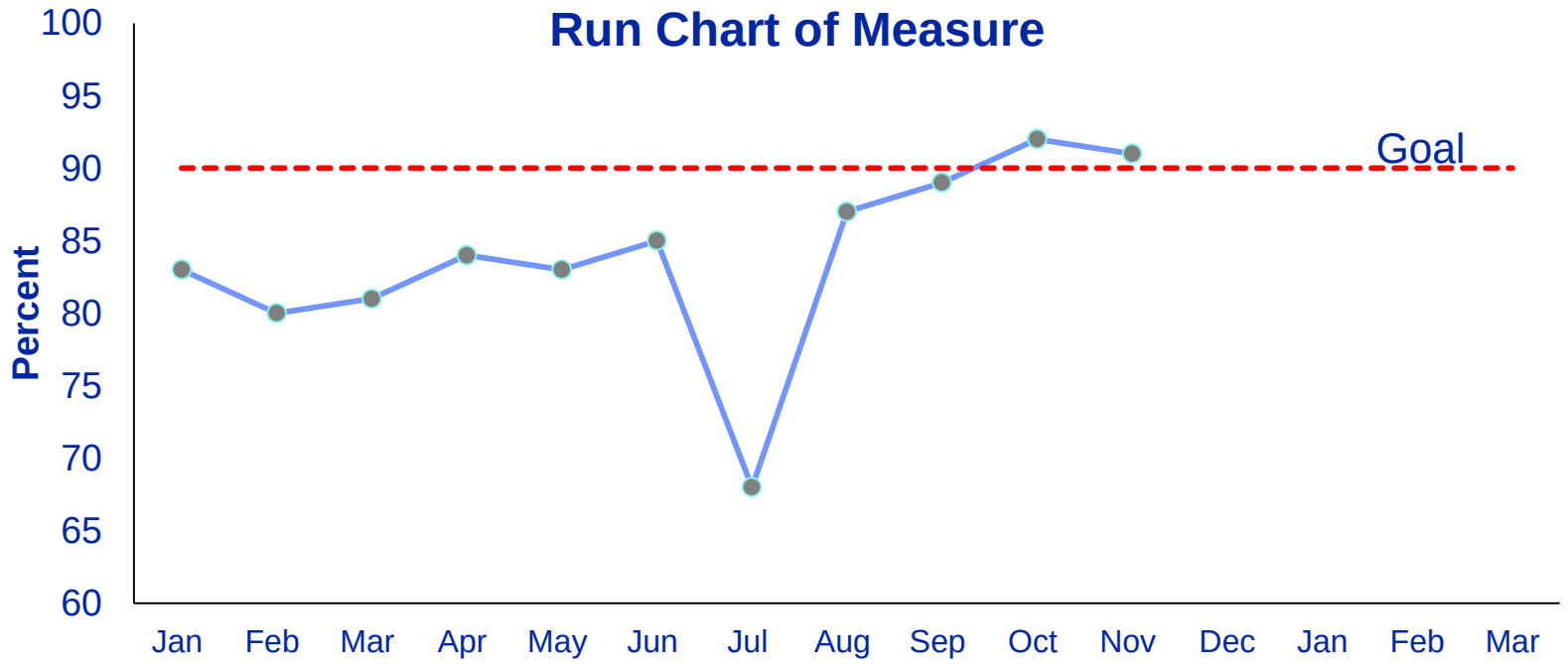
Outcome Measure

Figure 2.27: Surgical Safety Family of Measures

HC Data Guide, p 61-64

Why a run chart? Why not just a table?

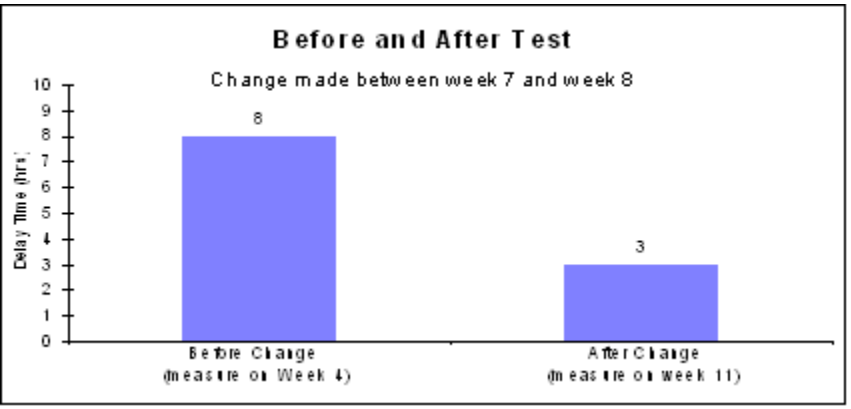
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Measure	83	80	81	84	83	85	68	87	89	92	91

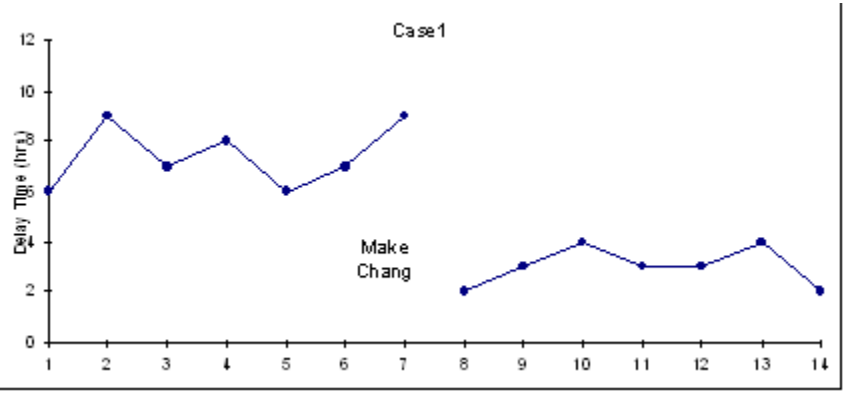


Monthly Measure – Goal = 90%

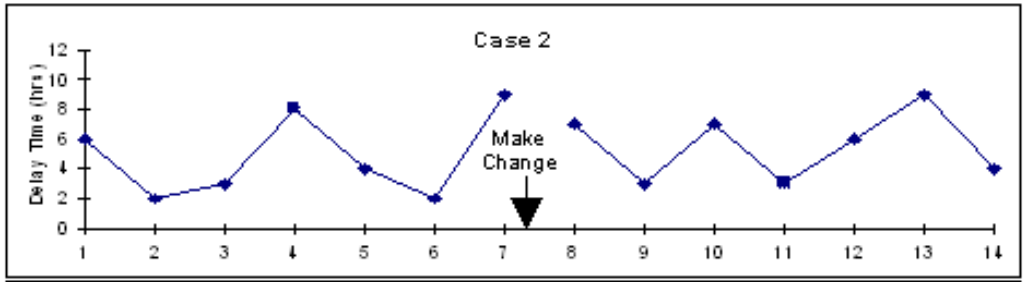
HC Data Guide, p 68

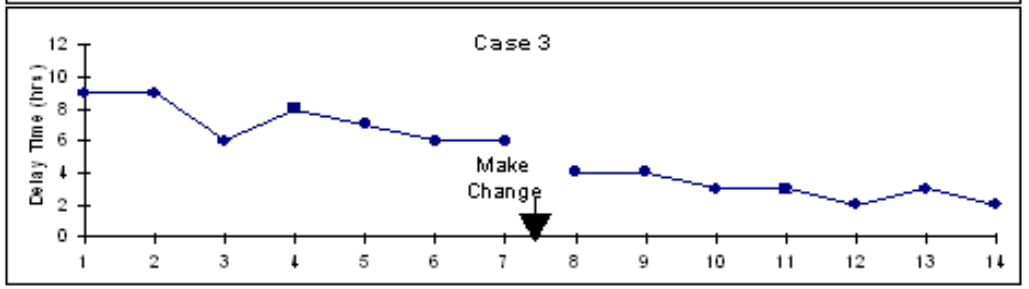
Need for Run Charts on Improvement Projects

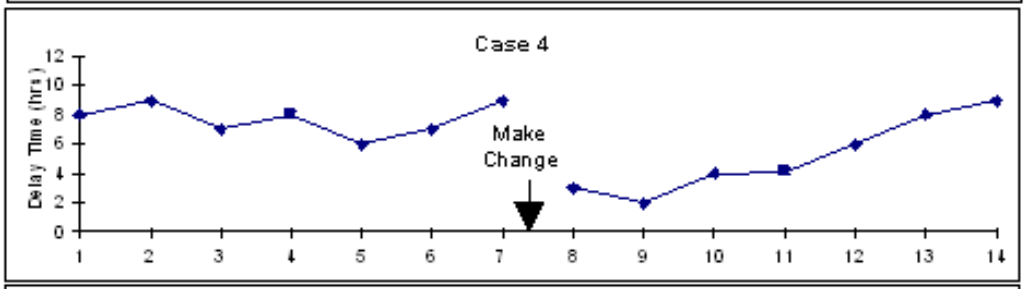


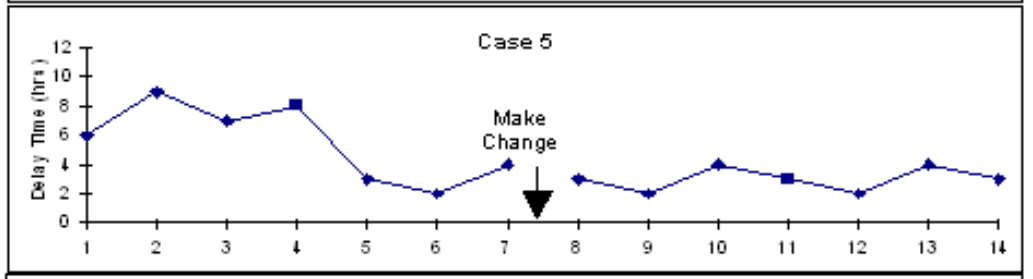


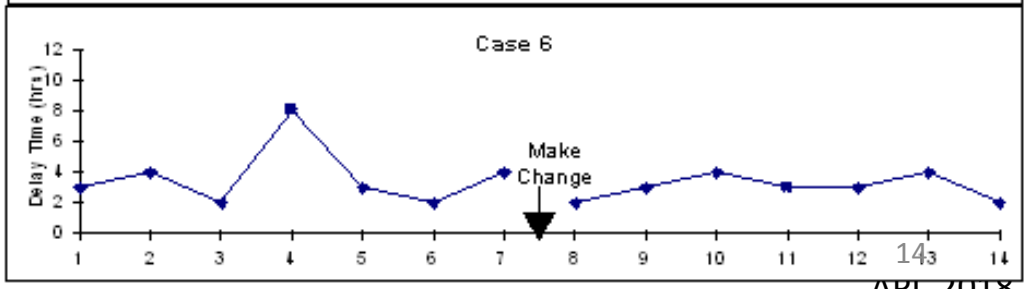
Average Before=8 hours delay
Average After=3 hours delay





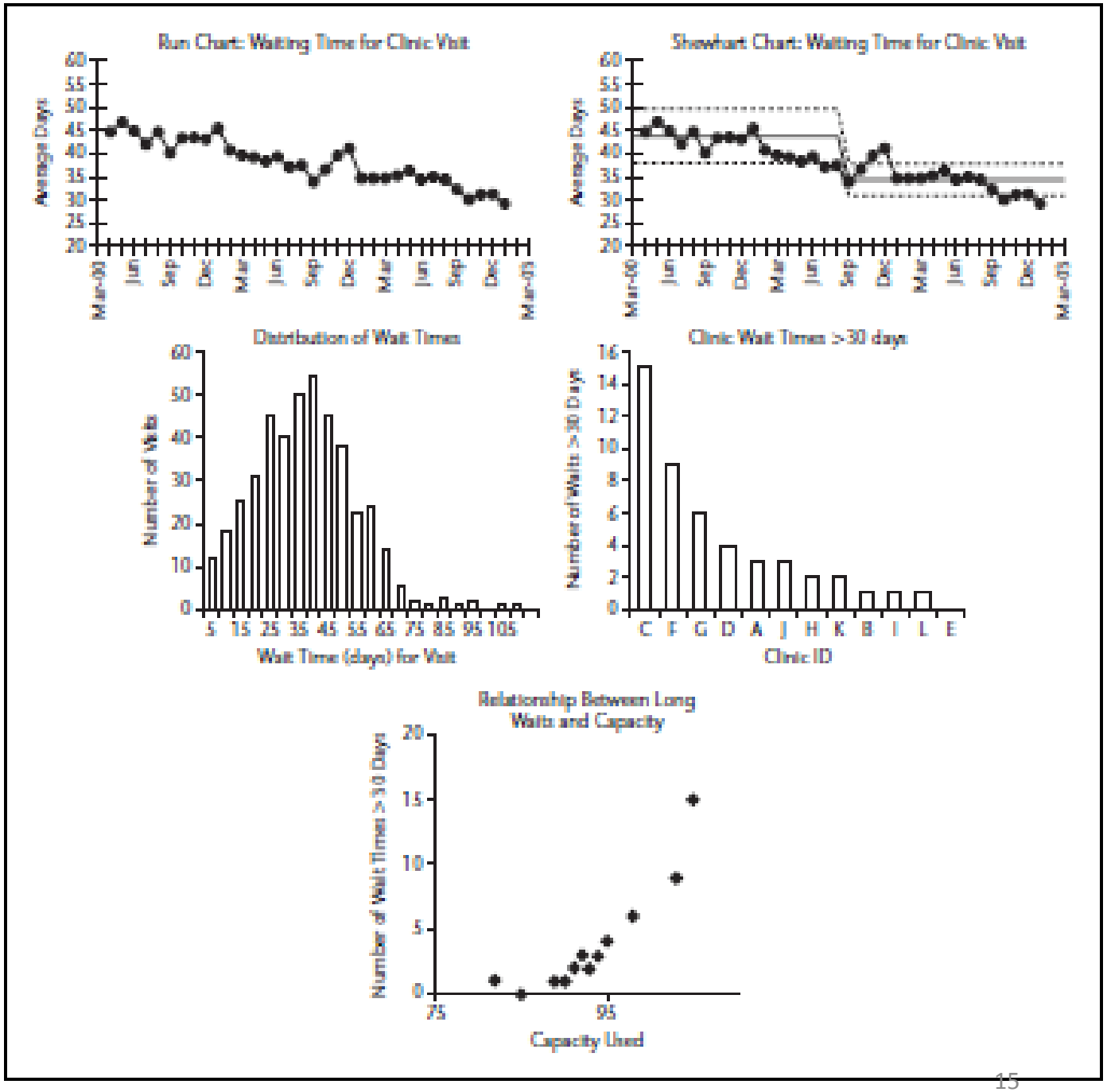






HC Data Guide, p 16-17

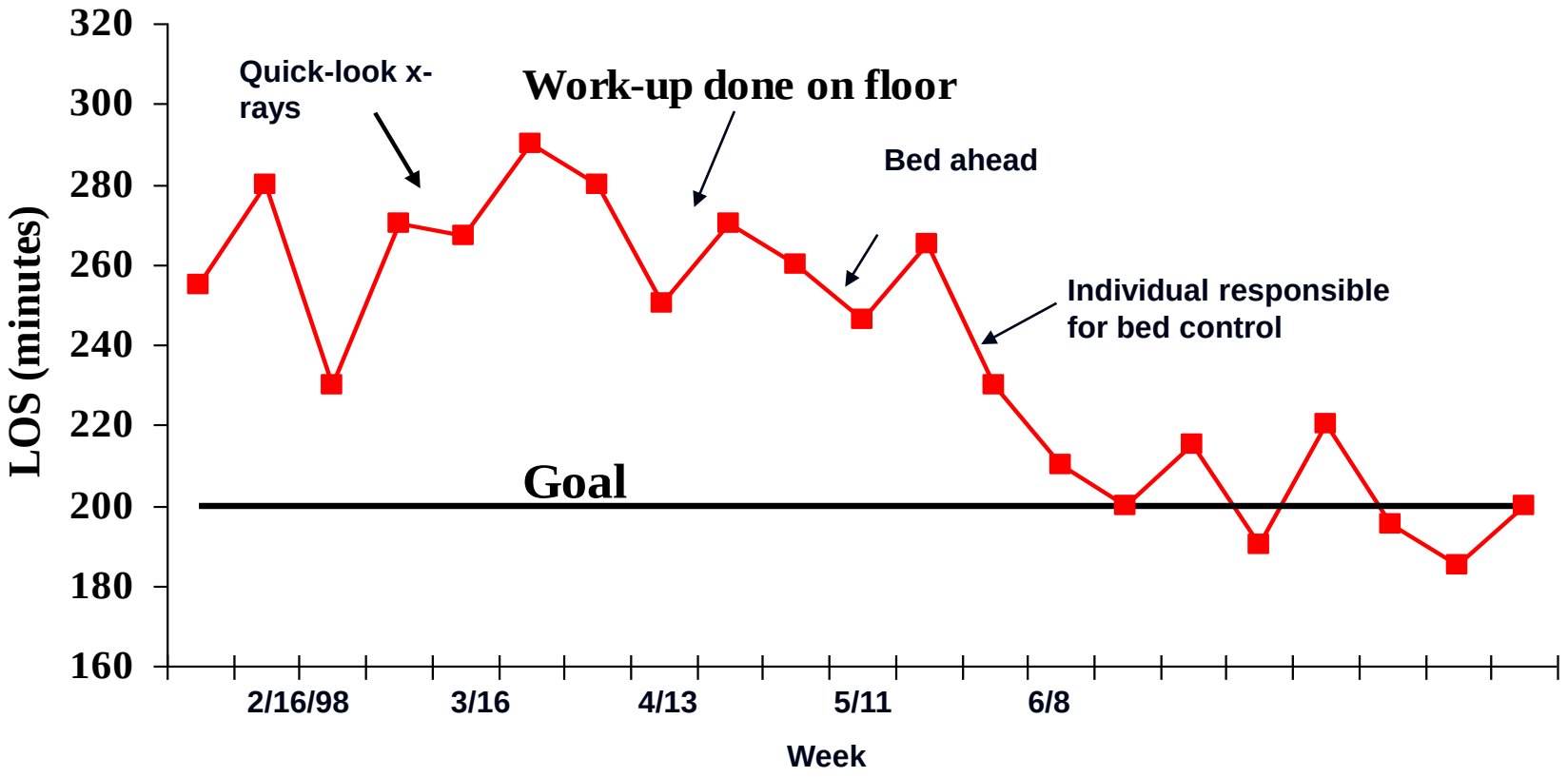
QI Tools to Learn from Variation in Data



HC Data Guide, p 65

API, 2018

Minimum Standard for QI Studies:
Annotated Time Series for Outcome and Process Measures



Shewhart's Theory of Variation

- **Common Causes**—those causes inherent in the system over time, affect everyone working in the system, and affect all outcomes of the system
  - Common cause of variation
  - Chance cause
  - Stable process
  - Process in statistical control

- **Special Causes**—those causes ***not*** part of the system all the time or do not affect everyone, but arise because of specific circumstances
  - Special cause of variation
  - Assignable cause
  - Unstable process
  - Process not in statistical control

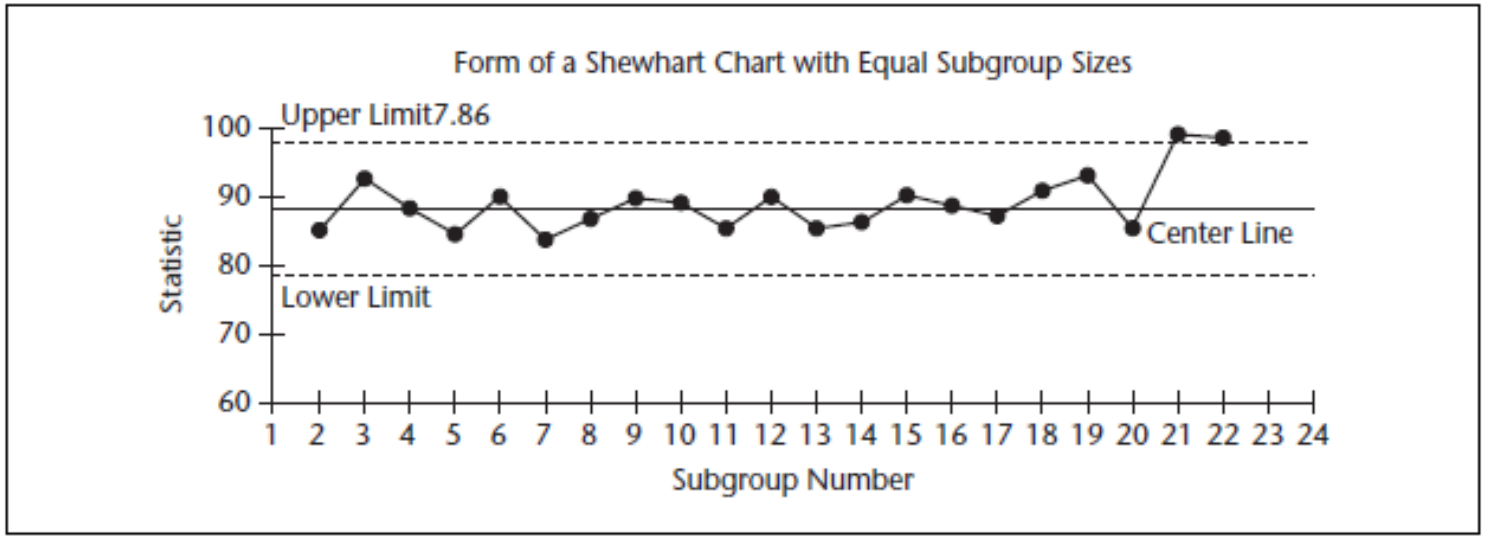
HC Data Guide, p. 108

Special Causes— those causes ***not*** part of the system all the time or do not affect everyone, but arise because of specific circumstances

Shewhart Charts

The Shewhart chart is a statistical tool used to distinguish between variation in a measure due to common causes and variation due to special causes

FIGURE 4.3 Example of Shewhart Chart for Equal Subgroup Size



(Most common name is a control chart, more descriptive would be learning charts or system performance charts)

HC Data Guide, p. 113

Why Not Use a Run Chart for Everything?

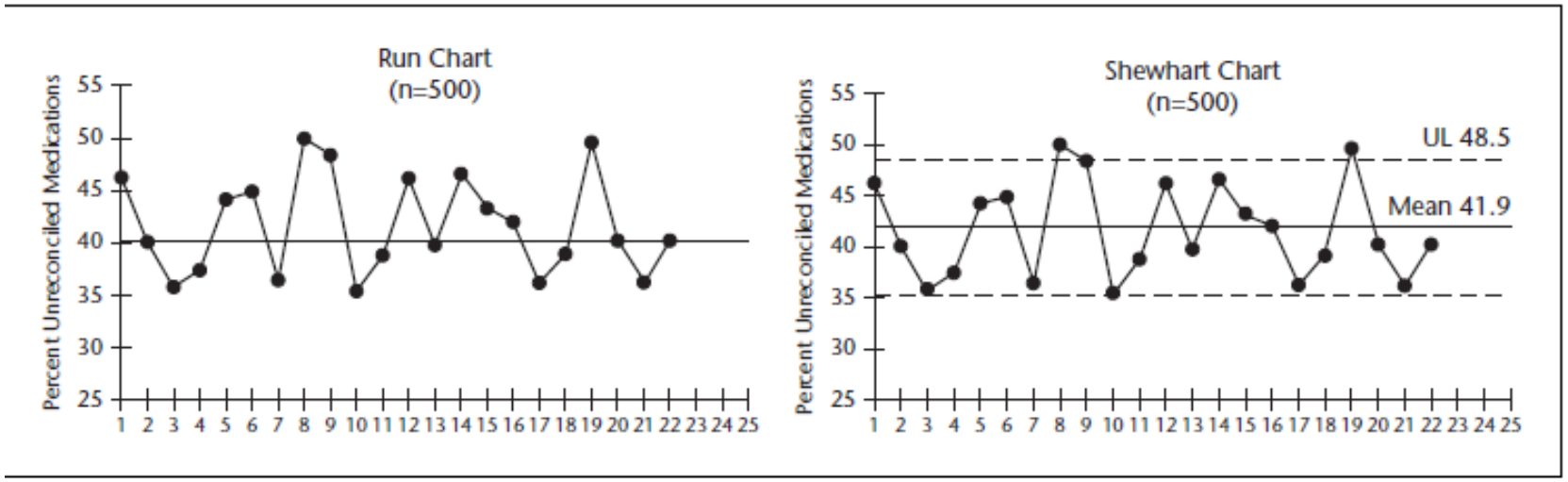
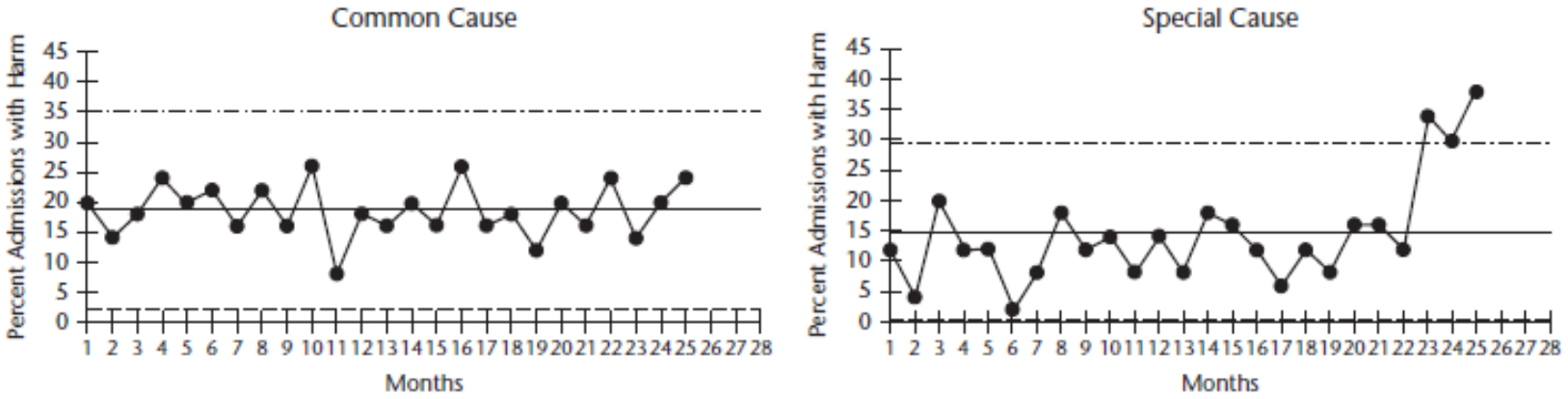


FIGURE 4.8 Shewhart Charts Common Cause and Special Cause Systems



HC Data Guide, p. 118, 119

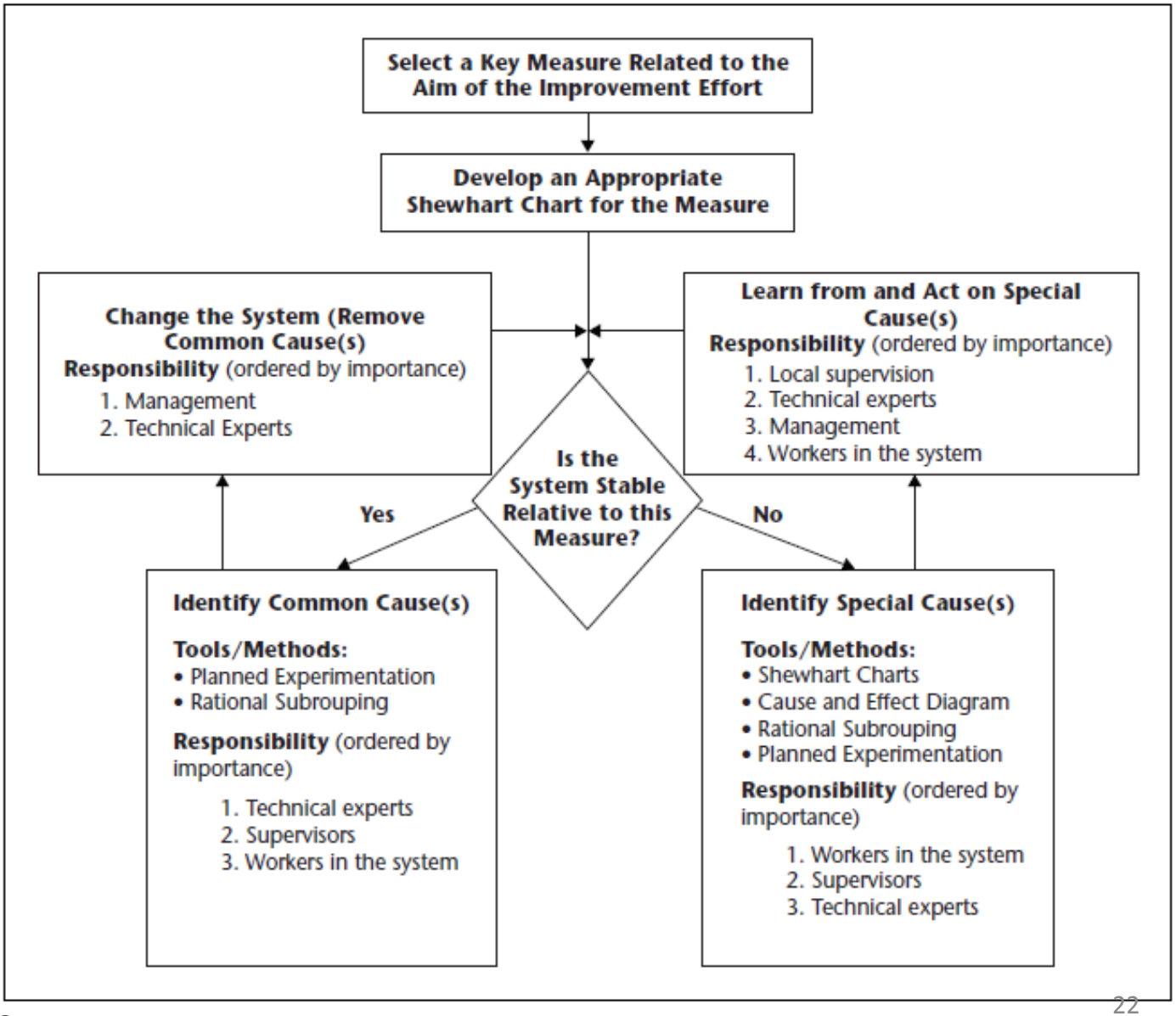
The Method of Shewhart Charts

- Selection of a measure and a statistic to be plotted.
- A method of data collection: observation, measurement and sampling procedures.
- A strategy for determining subgroups of measurements (including subgroup size and frequency).
- Selection of the appropriate Shewhart chart.
- Criteria for identifying a signal of a special cause.

HC Data Guide p. 114

Using Shewhart Chart to Guide Improvement Work

FIGURE 4.1 Using Shewhart Charts to Give Direction to an Improvement Effort



HC Data Guide, p. 109

Learning from Special Causes

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major article

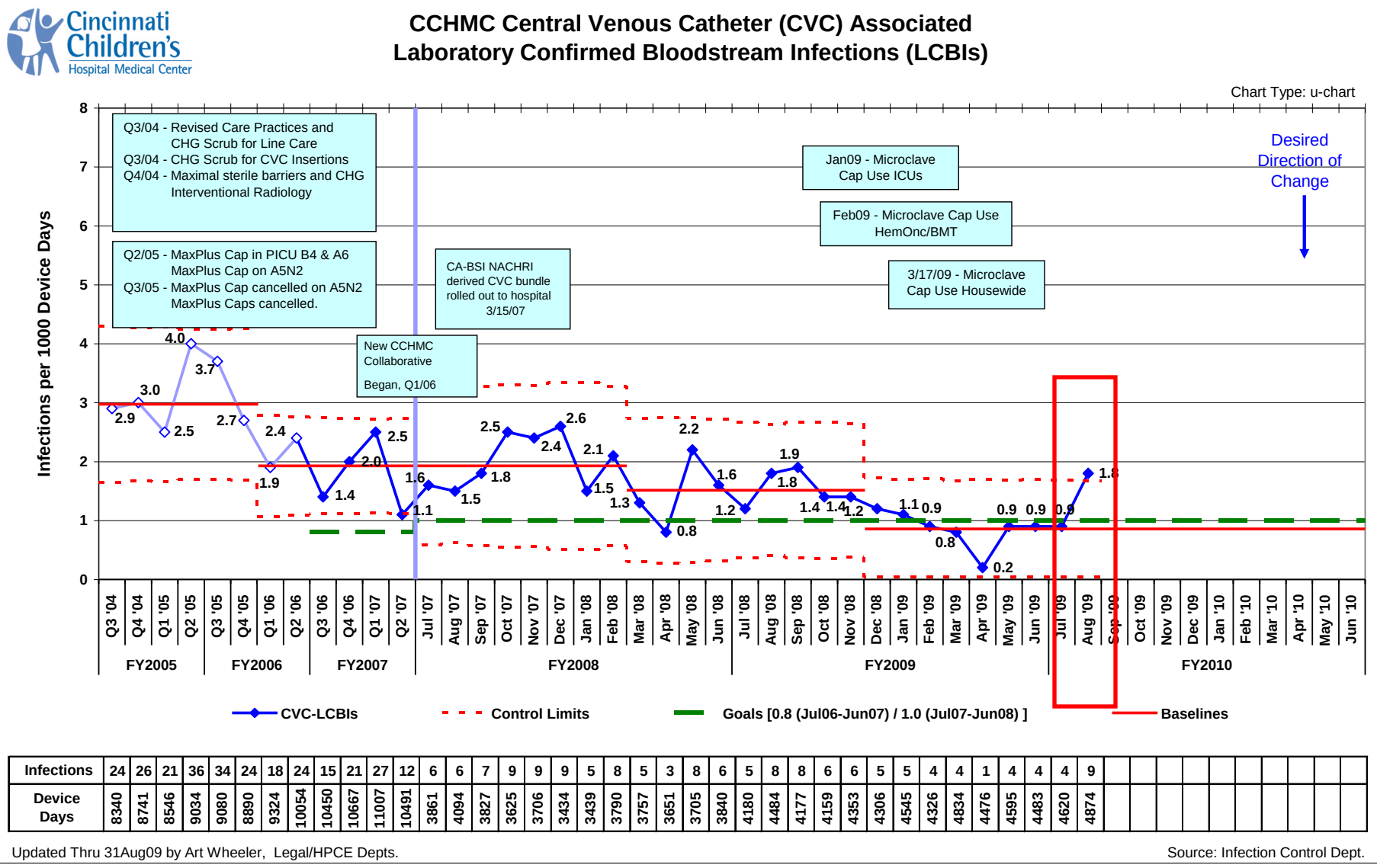
An unexpected increase in catheter-associated bloodstream infections at a children's hospital following introduction of the Spiros closed male connector

Derek S. Wheeler MD [a,b,*], MaryJo Giaccone RN, MSN [c], Nancy Hutchinson RN, MSN, CIC [c], Mary Haygood RN [c], Kathy Demmel RN, MSN [c], Maria T. Britto MD [a,d], Peter A. Margolis MD [a,d], Lloyd P. Provost MS [e]

[a] James M. Anderson Center for Health Systems Excellence, Cincinnati Children's Hospital Medical Center, Cincinnati, OH
[b] Division of Critical Care Medicine, Cincinnati Children's Hospital Medical Center, Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, OH
[c] Department of Patient Services, Cincinnati Children's Hospital Medical Center, Cincinnati, OH
[d] Division of Health Policy and Clinical Effectiveness, Cincinnati Children's Hospital Medical Center, Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati, OH
[e] Associates in Process Improvement, Austin, TX

Conclusion: *This case study highlights the utility of statistical process control in the surveillance and investigation of CA-BSI.*

A Special Cause in August



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Infections	24	26	21	36	34	24	18	24	15	21	27	12	6	6	7	9	9	9	5	8	5	3	8	6	5	8	8	6	6	5	5	4	4	1	4	4	4	9									
Device Days	8340	8741	8546	9034	9080	8890	9324	10054	10450	10667	11007	10491	3861	4094	3827	3625	3706	3434	3439	3790	3757	3651	3705	3840	4180	4484	4177	4159	4353	4306	4545	4326	4834	4476	4595	4483	4620	4874									

Updated Thru 31Aug09 by Art Wheeler, Legal/HPCE Depts.

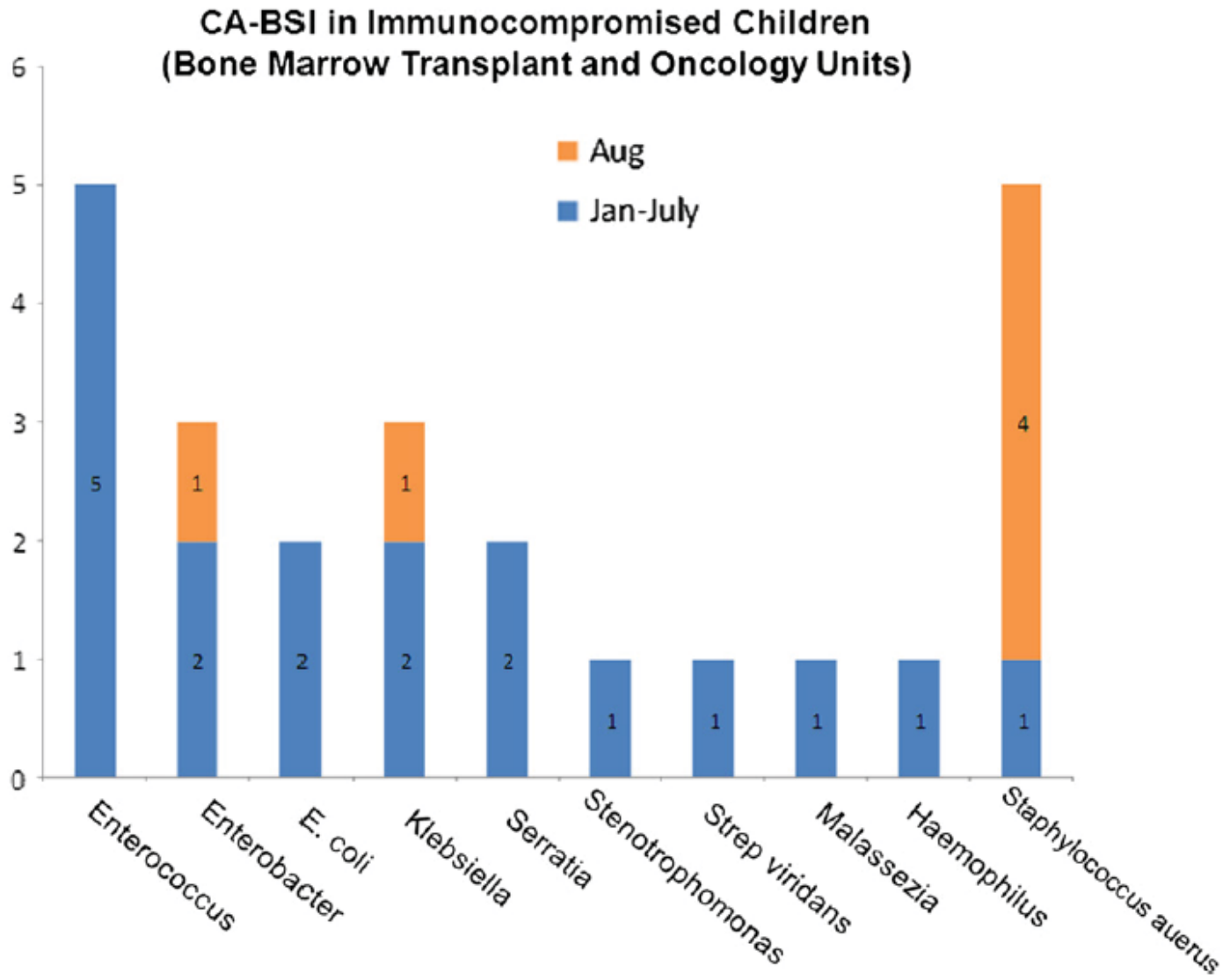
Source: Infection Control Dept.

From Derek Wheeler, CCHMC

Compare Special Cause Period with Common Cause

Pareto Chart of Isolated pathogen

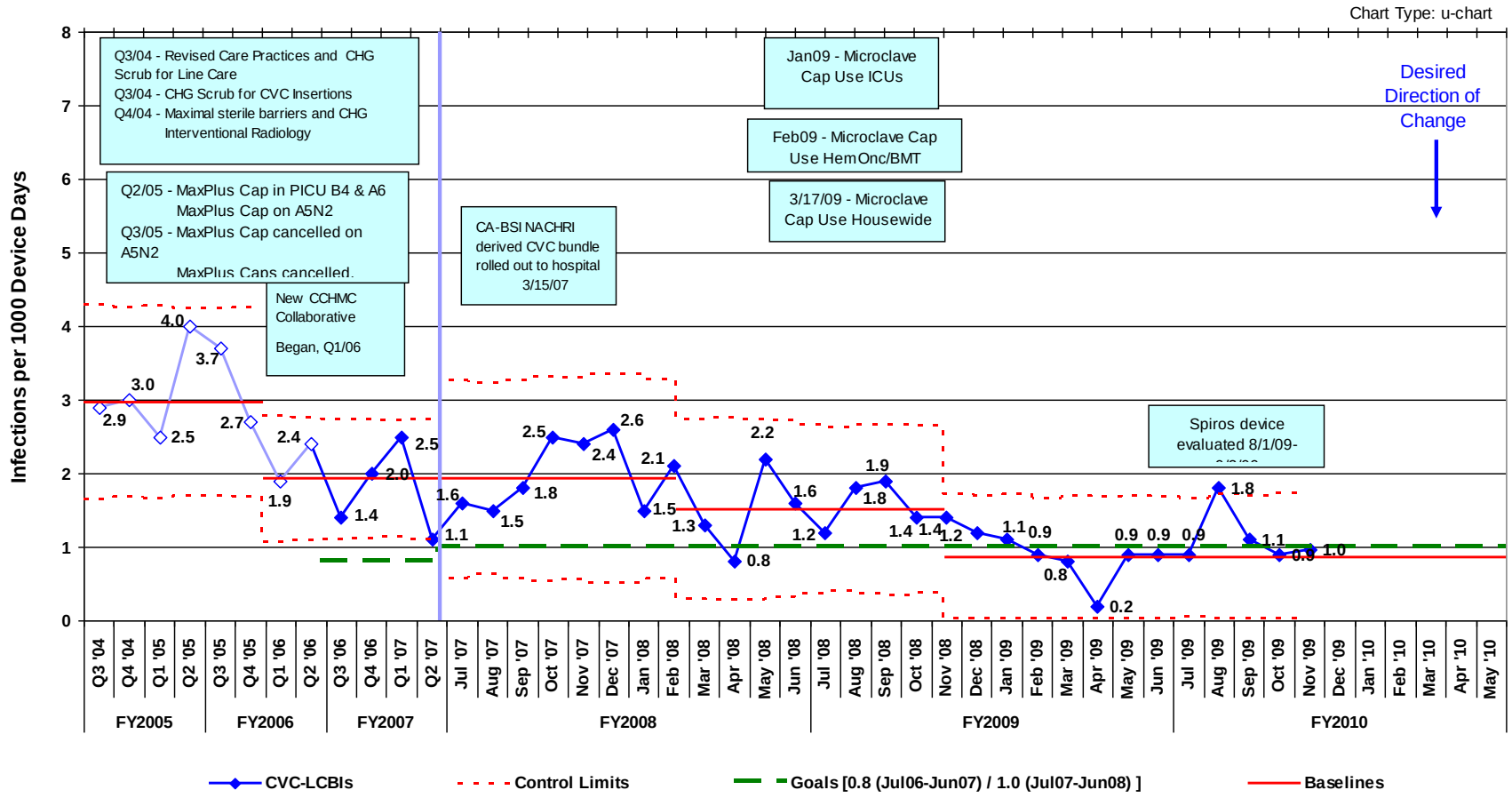
Stratified by Common Cause and Special Cause Periods



From Derek Wheeler, CCHMC

Cincinnati Children's Hospital Medical Center

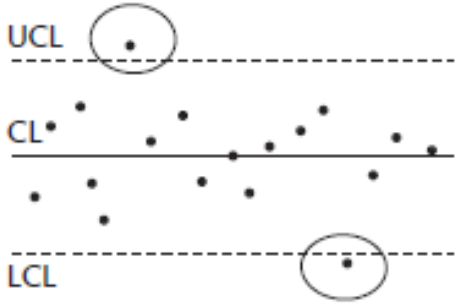
CCHMC Central Venous Catheter (CVC) Associated Laboratory Confirmed Bloodstream Infections (LCBIs)



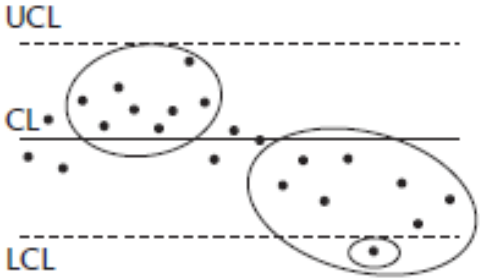
From Derek Wheeler, CCHMC

Rules or determining a special cause

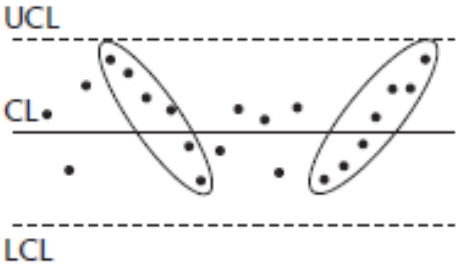
1. A single point outside the control limits.



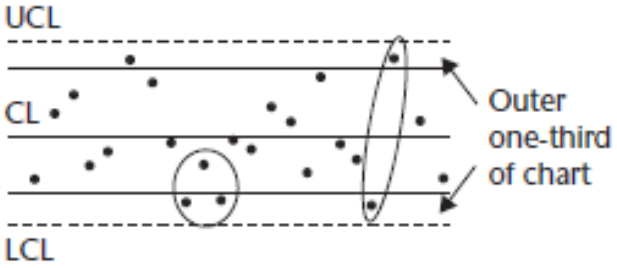
2. A run of eight or more points in a row above (or below) the centerline.



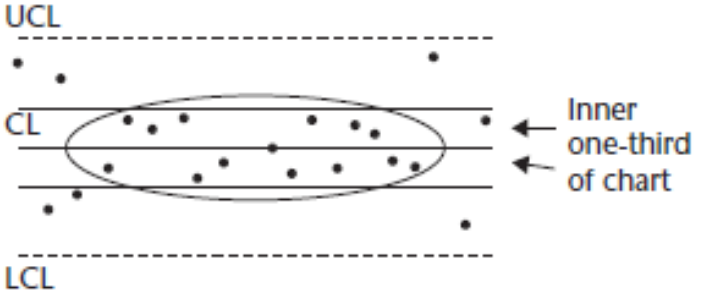
3. Six consecutive points increasing (trend up) or decreasing (trend down).



4. Two out of three consecutive points near (outer one-third) a control limit.



5. Fifteen consecutive points close (inner one-third of the chart) to the centerline.



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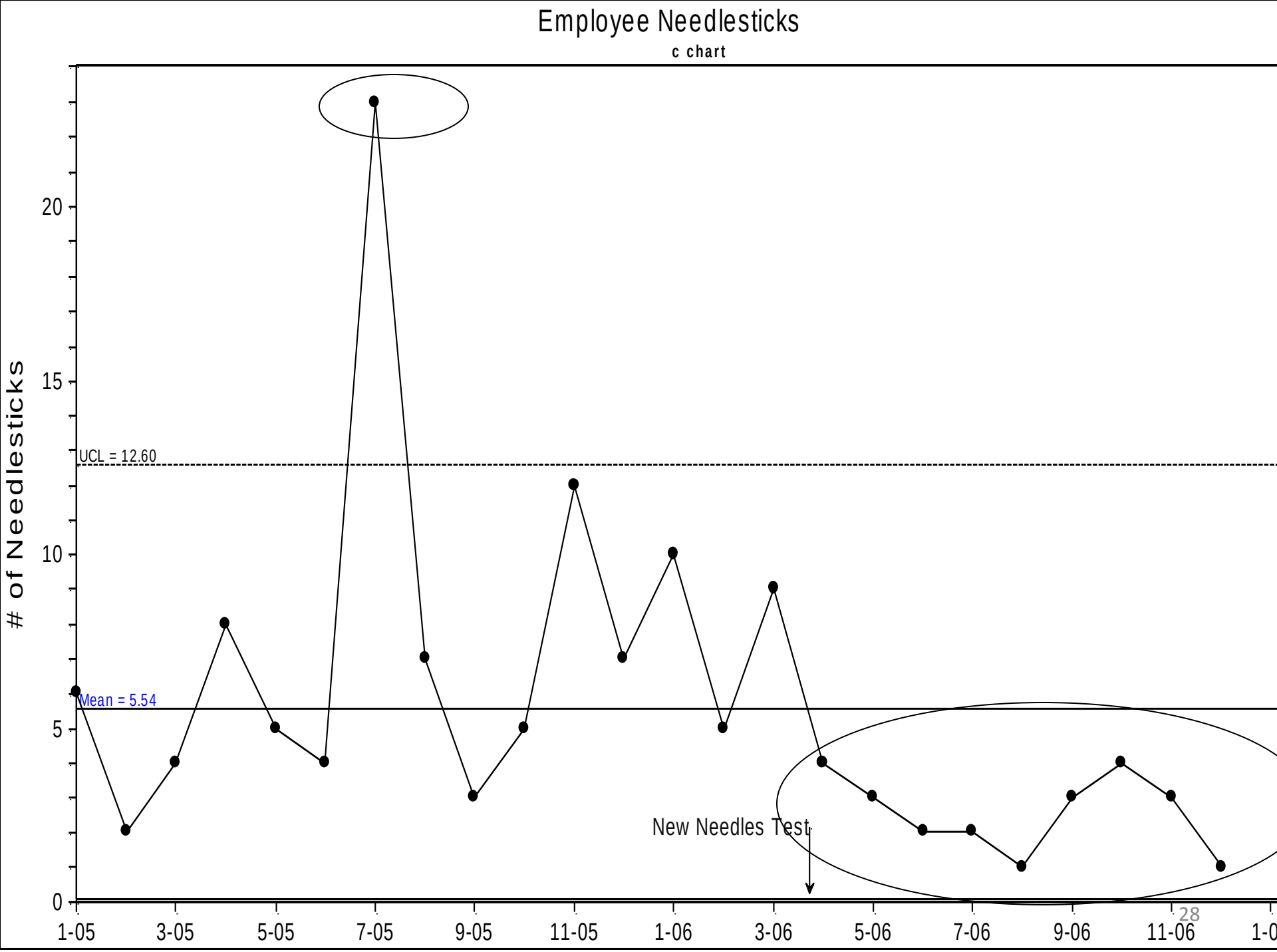
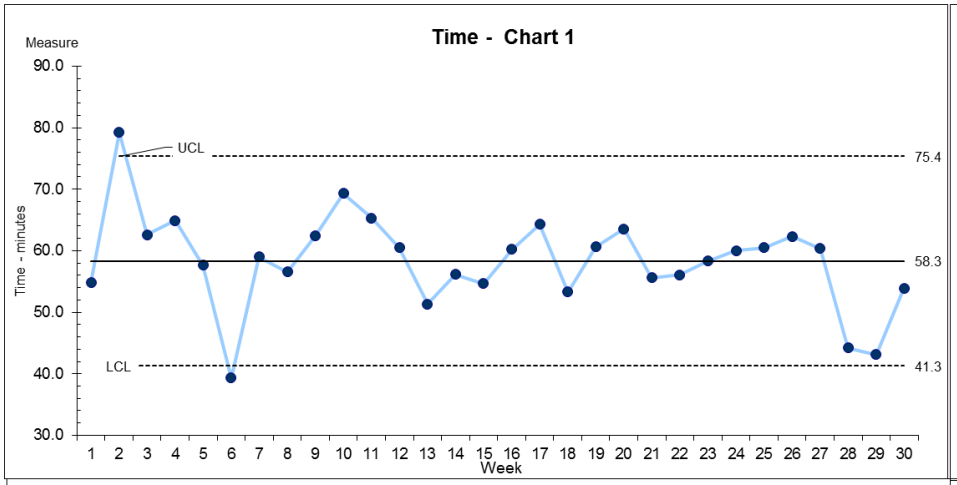
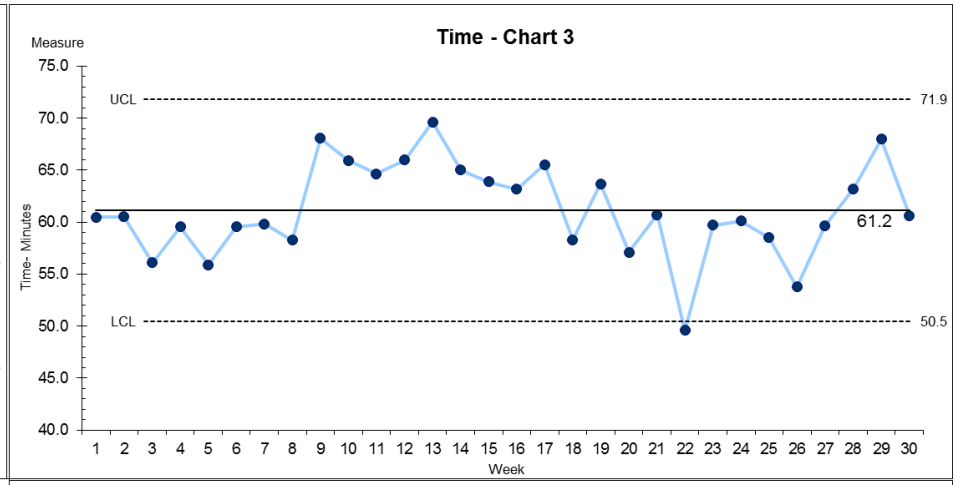
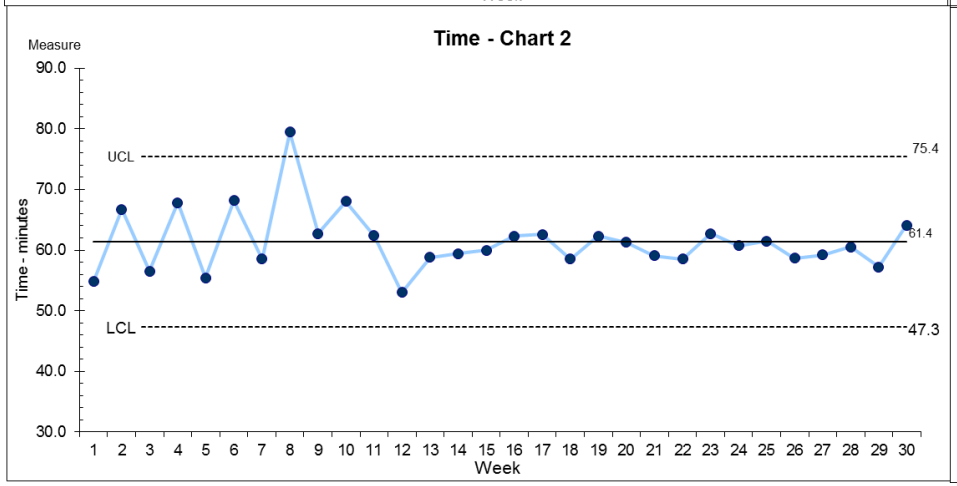
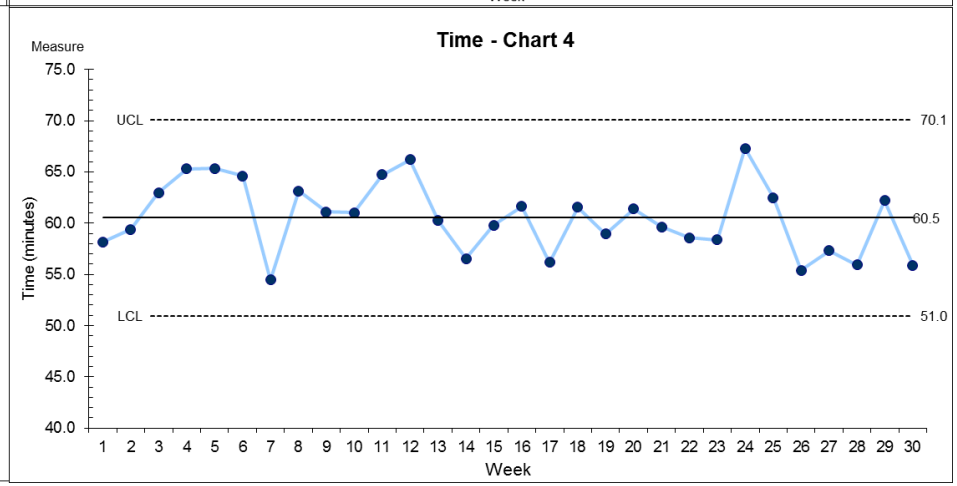

Employee Needlesticks
c chart
# of Needlesticks
20
15
10
5
0
UCL = 12.60
Mean = 5.54
New Needles Test
1-05
3-05
5-05
7-05
9-05
11-05
1-06
3-06
5-06
7-06
9-06
11-06
1-0

Identify the signals of special causes on these 4 Shewhart Charts



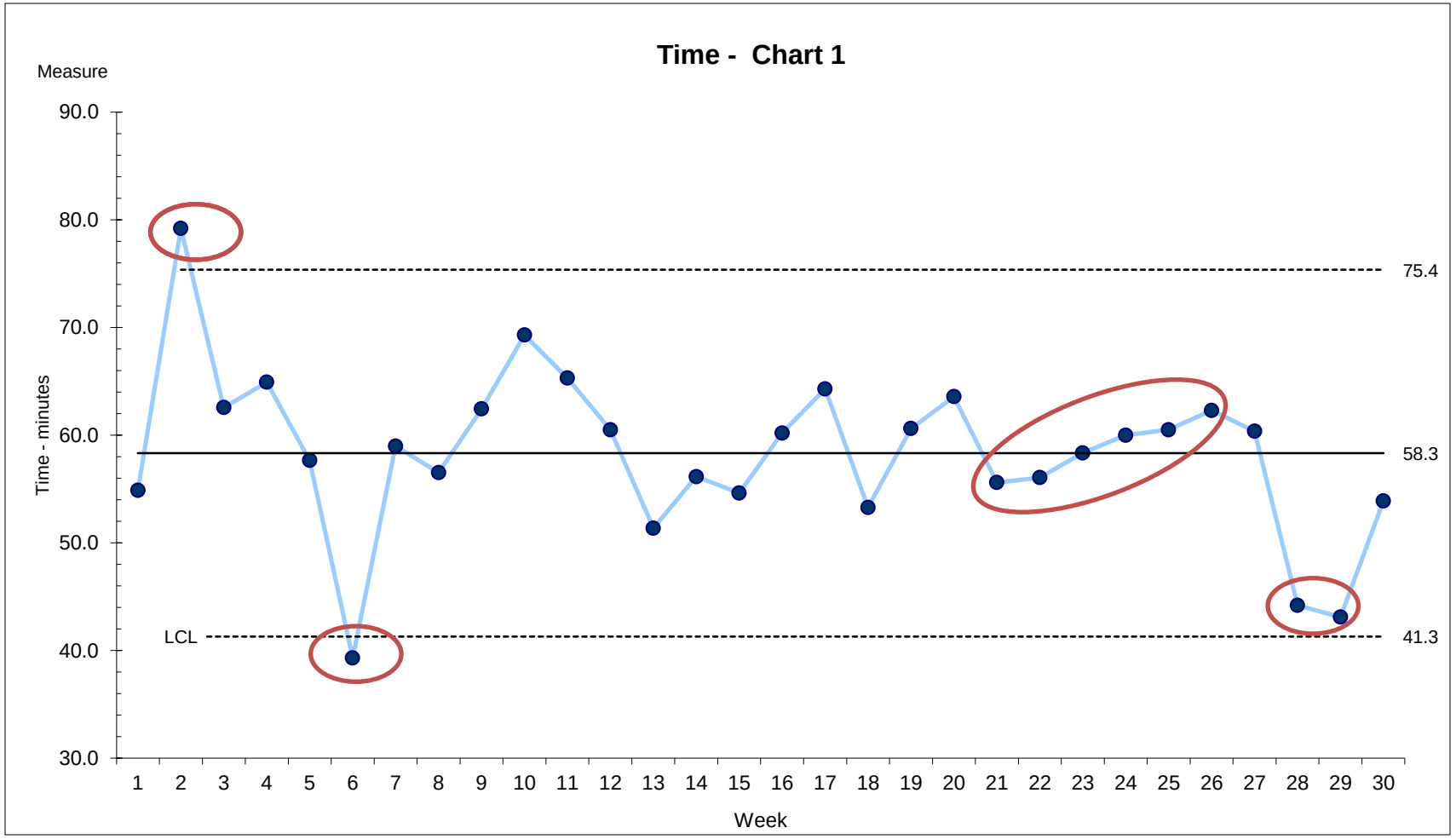






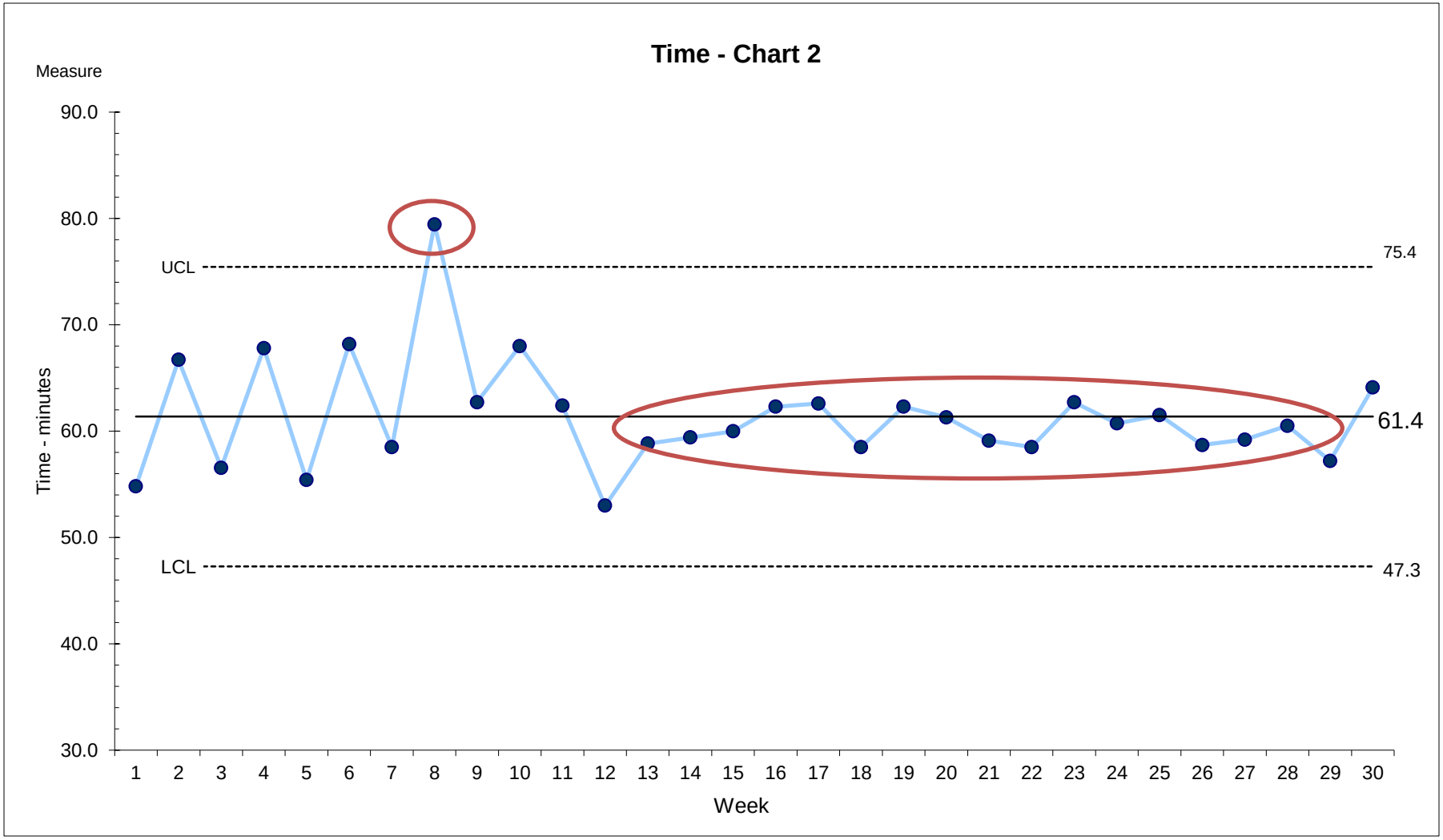
API, 2018

Chart 1



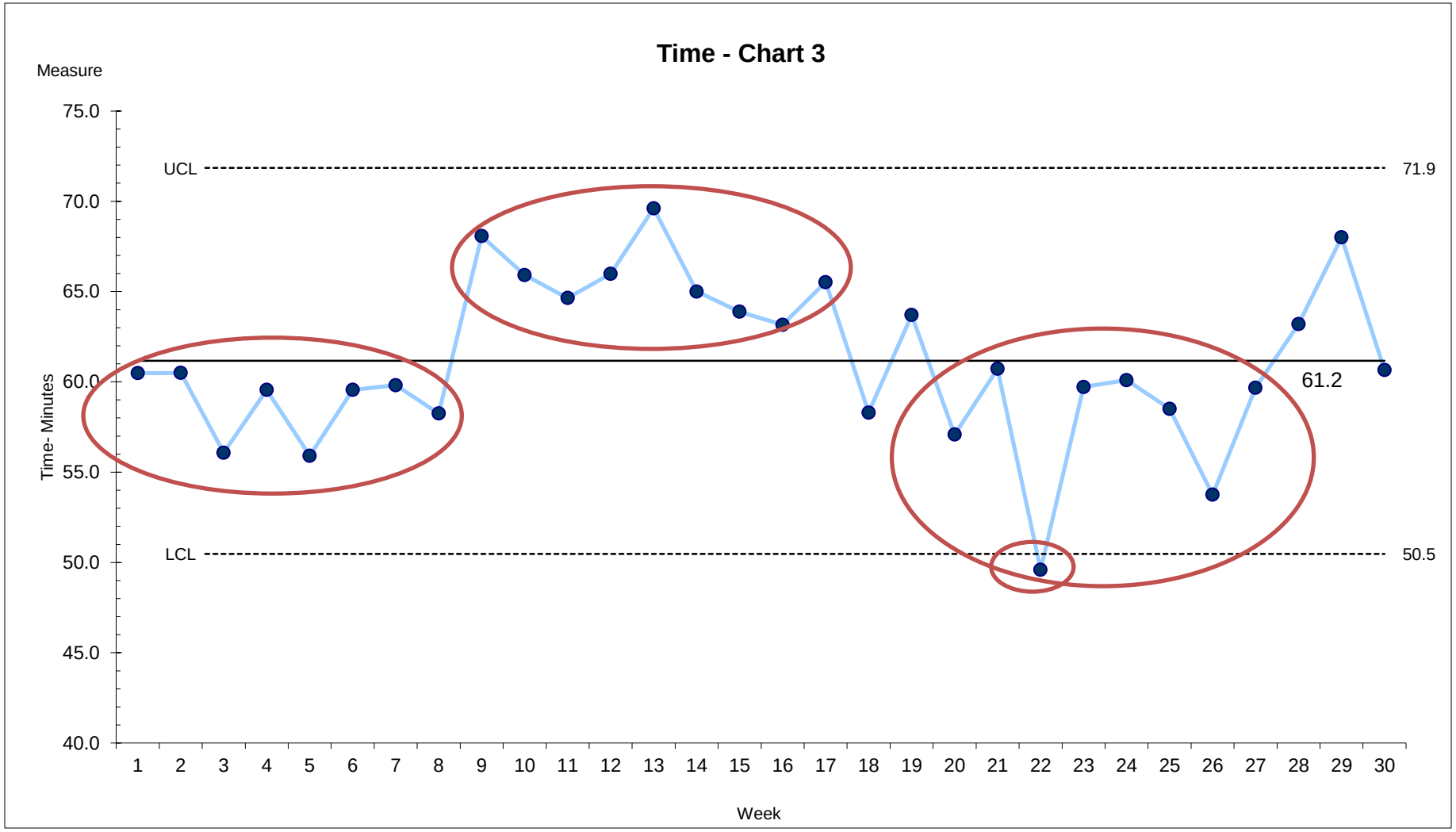
API, 2018

Chart 2



API, 2018

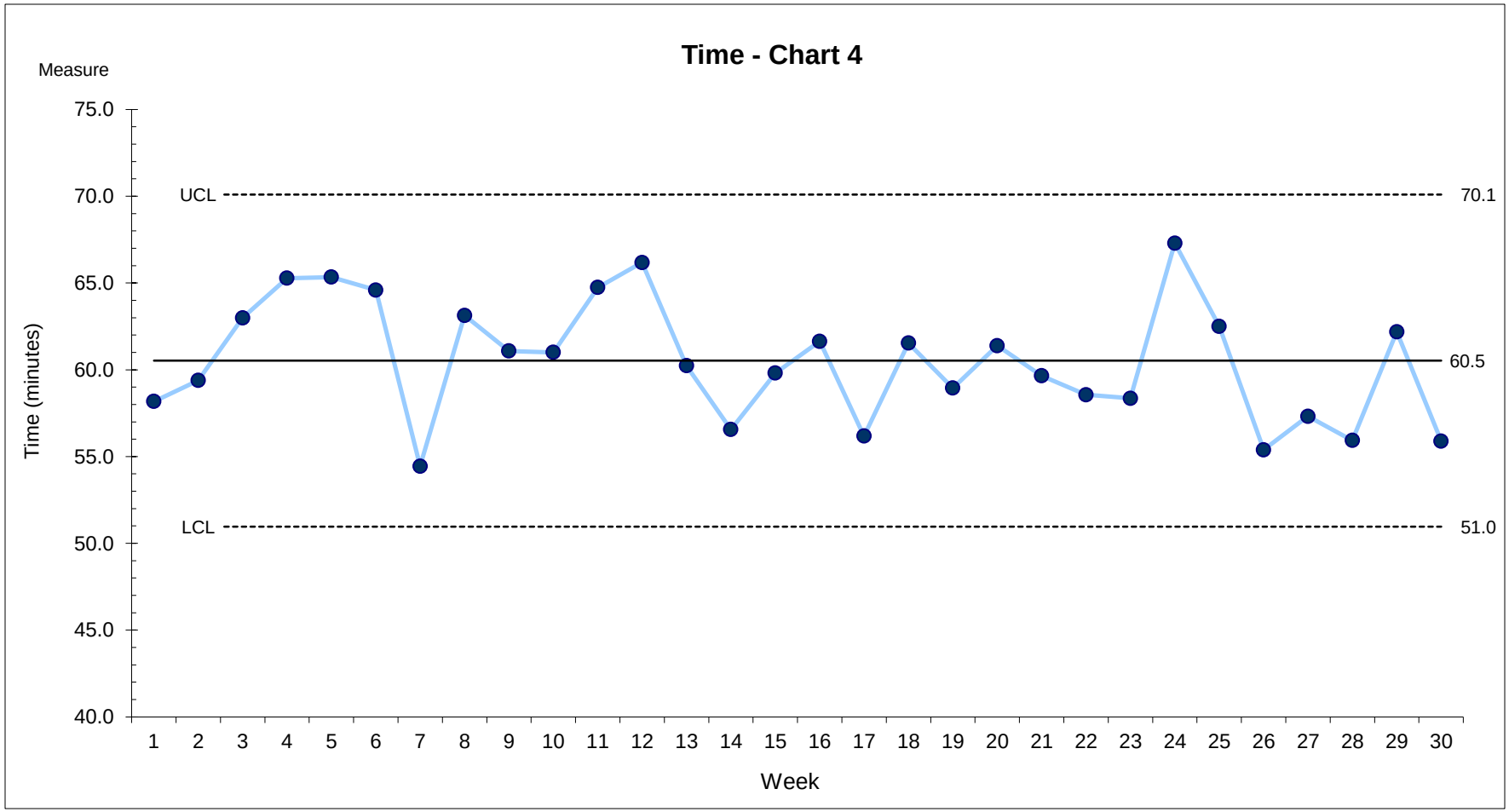
Chart 3



API, 2018

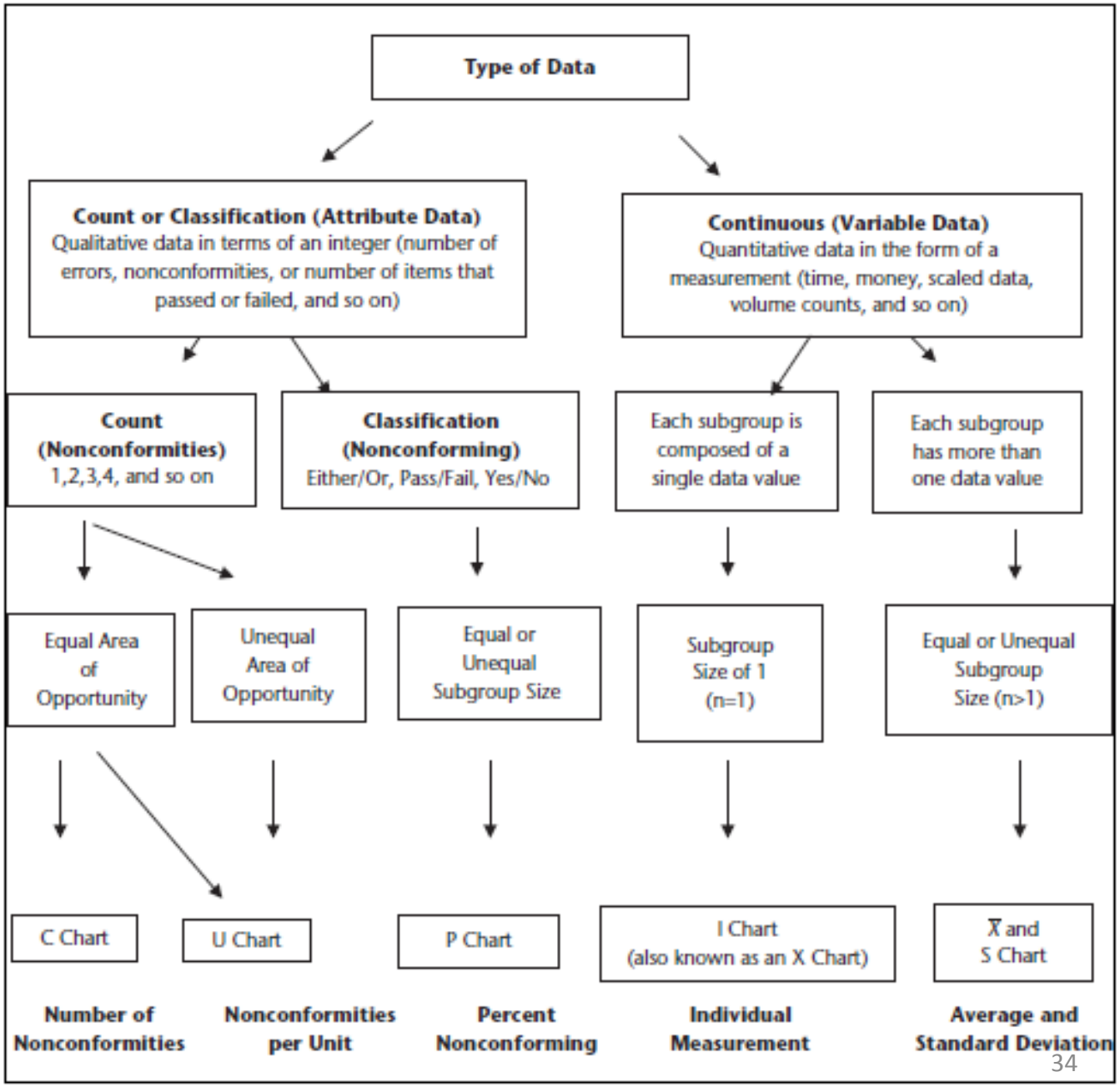
Chart 4

All common cause variation



API, 2018

FIGURE 5.1 Shewhart Chart Selection Guide (Short Form)



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Continuous (aka variables) Data

- Examples of Continuous Data:
  - Waiting time
  - LOS
  - Cost per case for a DRG
  - Daily patient weight
  - Time to complete procedure
  - Number of patients seen per day
  - Monthly accounts receivable
  - Temperature
  - Volume of prescriptions filled

Attribute Data

Count or Classification Data

Examples of Count or Classification Data:

- # of complications per # of surgeries this month
- # of medication errors per 1000 doses
- Percent of patients who were readmitted
- # of patients who fell per 100 admissions
- Percent of diabetic patients who smoke

Control Chart for Continuous Data using Individual Measurements(I Chart)

The I chart for individual data is useful when:

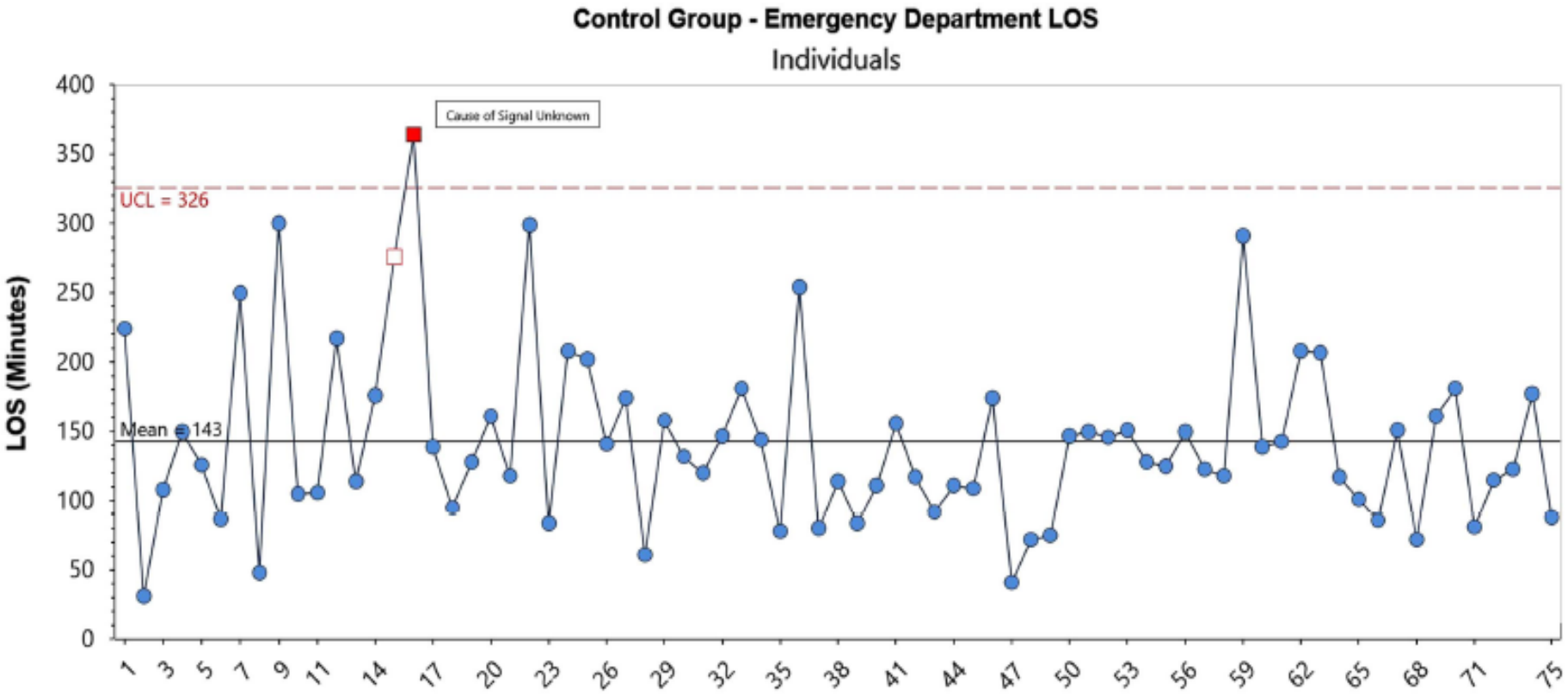
- There is no rational way to organize the data into subgroups.
- Measures of performance of the process can only be obtained infrequently.
- The variation at any one time (within a subgroup) is insignificant relative to the between subgroup variation.

Examples: patient-specific clinical measures, monthly accounting data, laboratory test data, forecasts, and budget variances

HC Data Guide, p. 154

Example of an I chart

A study of Ottawa ankle rules (O
emergency department (ED) tria



Individual Patient Number order they presented to ED

Harries, Filiatrault, and Abu-Laban, “Application of quality improvement analytic methodology in emergency medicine research: A comparative evaluation”, CJEM 2018:1–8.

X-bar and S Shewhart charts

- The collection of data for the construction of X-bar and S Shewhart charts requires that the data be organized in subgroups.

- A subgroup for continuous data is a set of measurements of some characteristic in a process, which were obtained under similar conditions or during the same time period

- The subgroup size may vary for the X-bar and S chart.

- The X-bar chart contains the averages of each subgroup and the S chart the spread (standard deviation) between the measurements within each subgroup.

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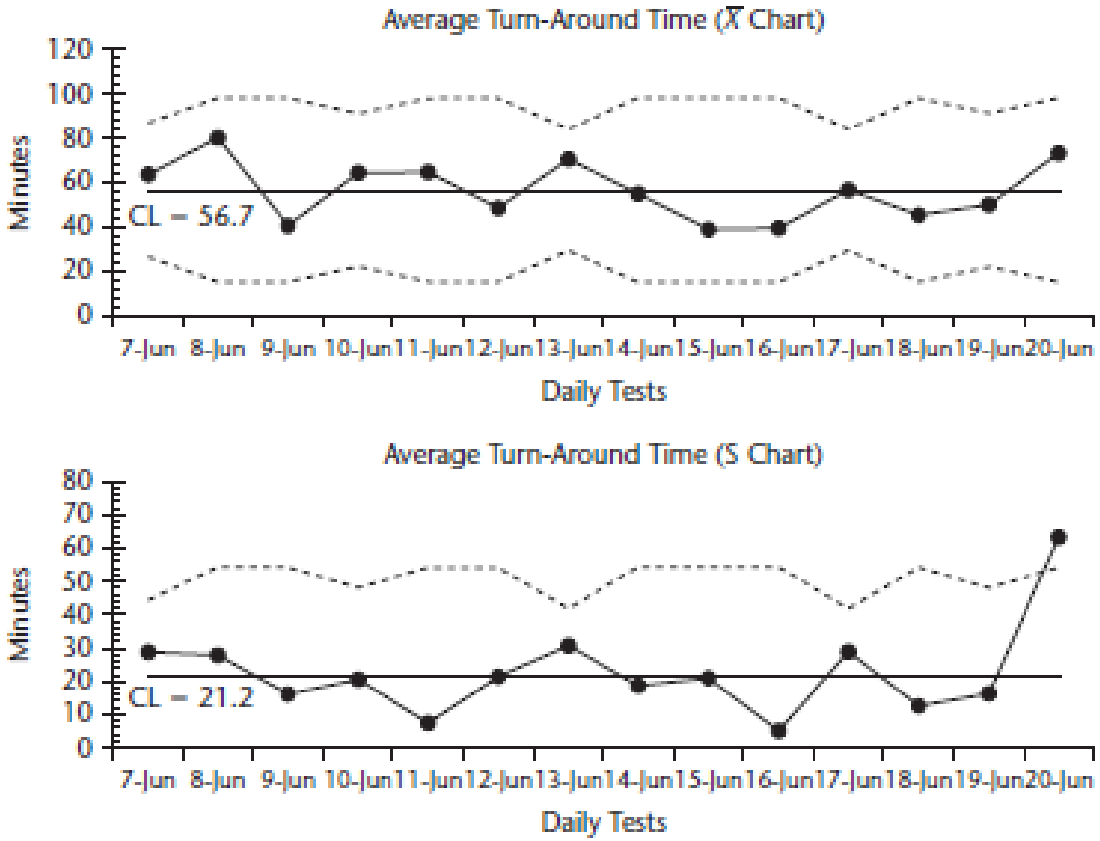
Xbar and S Chart- Radiology Test Turn-around

	June 7	June 8	June 9	June 10	June 11	June 12	June 13	June 14	June 15	June 16	June 17	June 18	June 19	June 20
Test 1	105	50	58	67	73	57	78	76	18	39	86	32	70	39
Test 2	54	105	26	52	59	64	96	49	60	45	27	47	56	34
Test 3	79	85	38	92	62	24	107	40	39	35	91	57	40	146
Test 4	49			46			72				49		34	
Test 5	31						27				23			
Test 6							43				65			

FIGURE 5.5 $\bar{X}$ and S Shewhart Chart for Radiology Test Turn-Around Time



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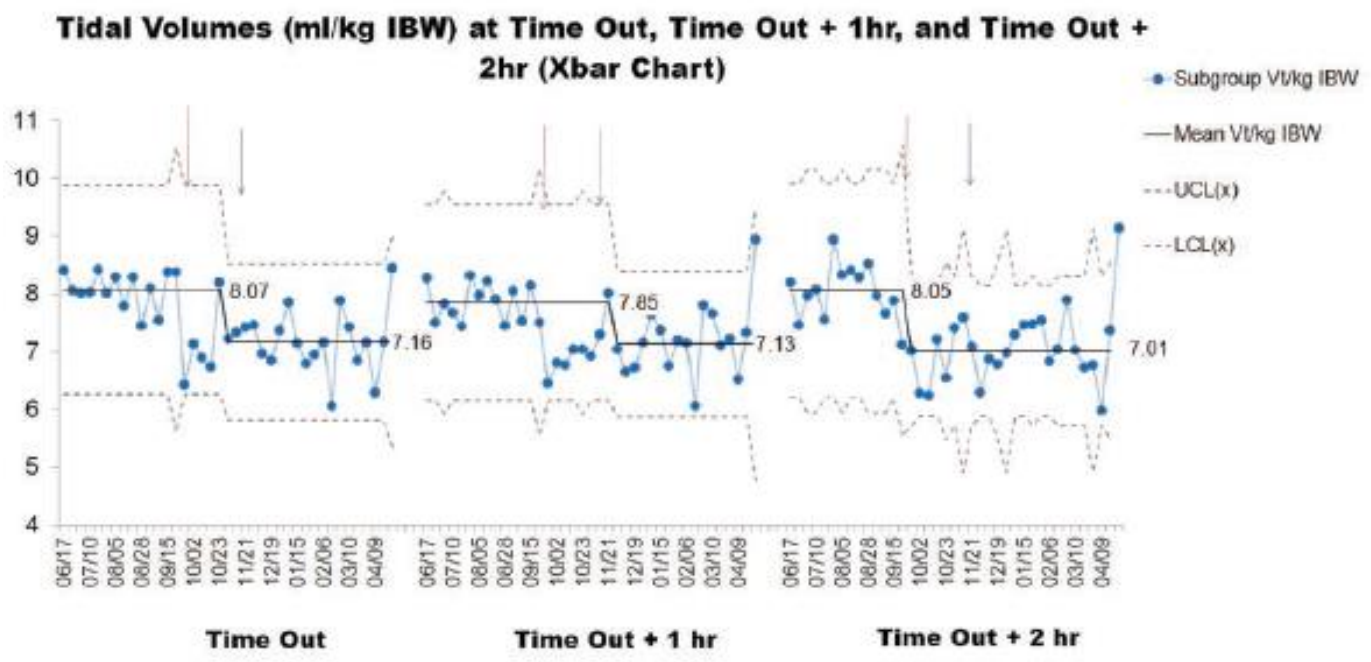
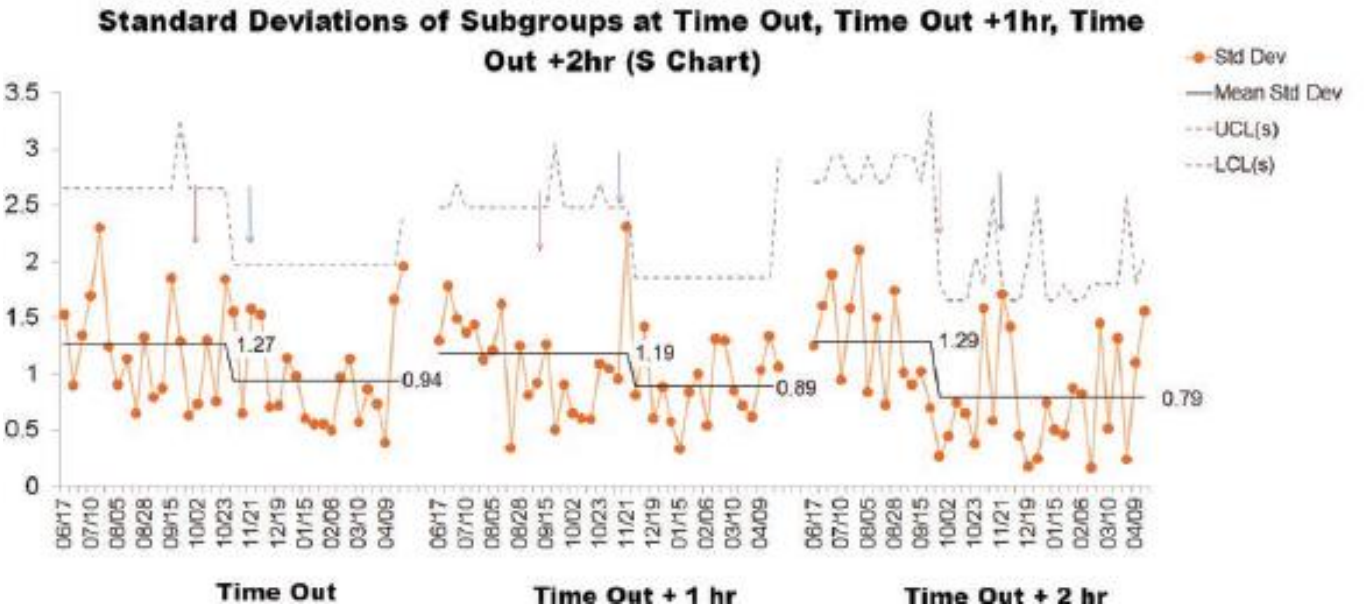
API, 2018

Example
Xbar/S Chart

Intraoperative lung-protective ventilation (ILPV) is defined as tidal volumes <8 mL/kg ideal bodyweight and is increasingly a standard of care for major abdominal surgical procedures performed under general anesthesia.



Subgroups of patients based on time periods



"Improving Adherence to Intraoperative Lung-Protective Ventilation Strategies at a University Medical Center" Josephs, Lemmink, Strong, Barry, Hurford, www.anesthesia-analgesia.org

Xbar S – Subgroups by Provider and Quarter

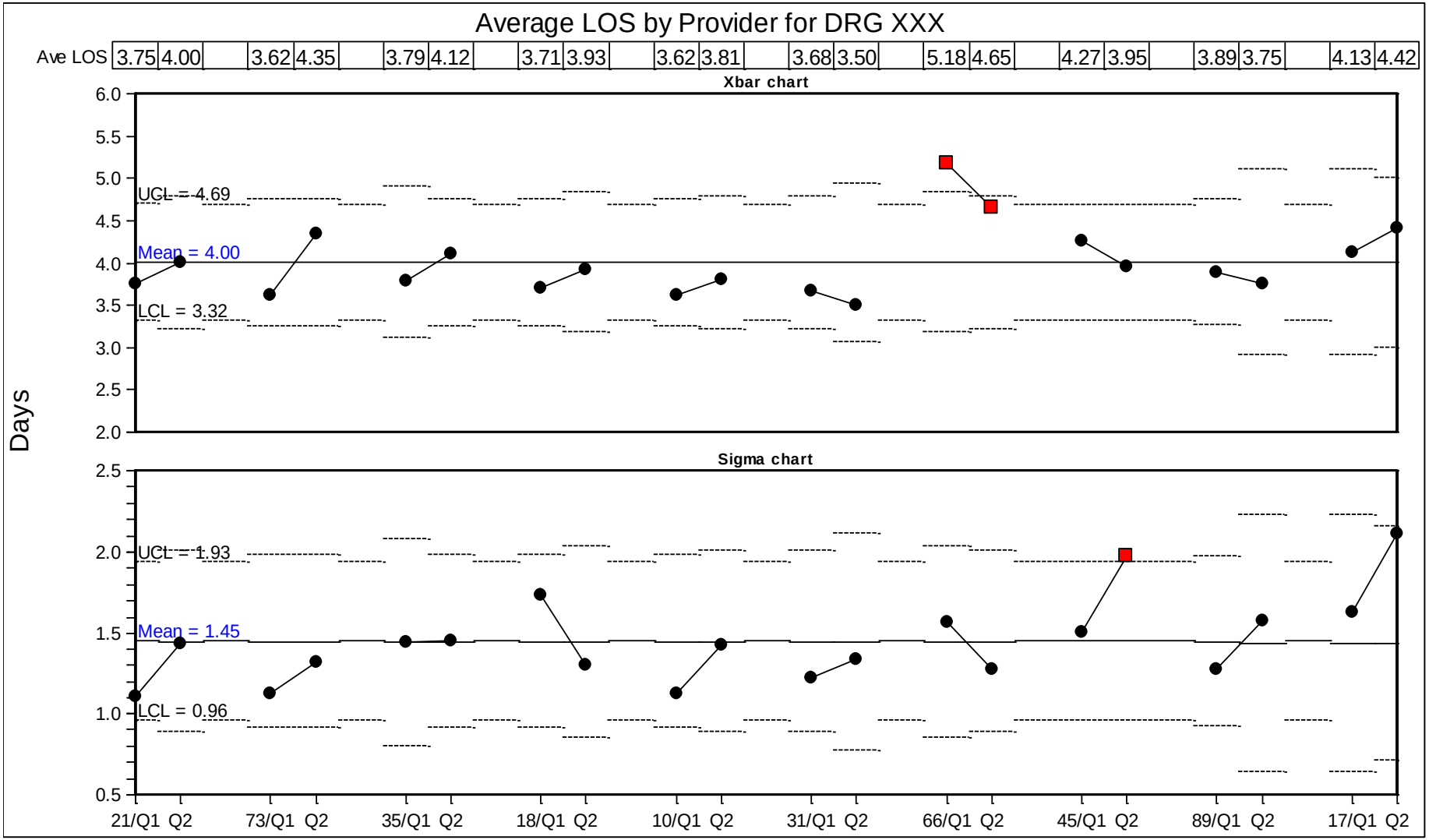


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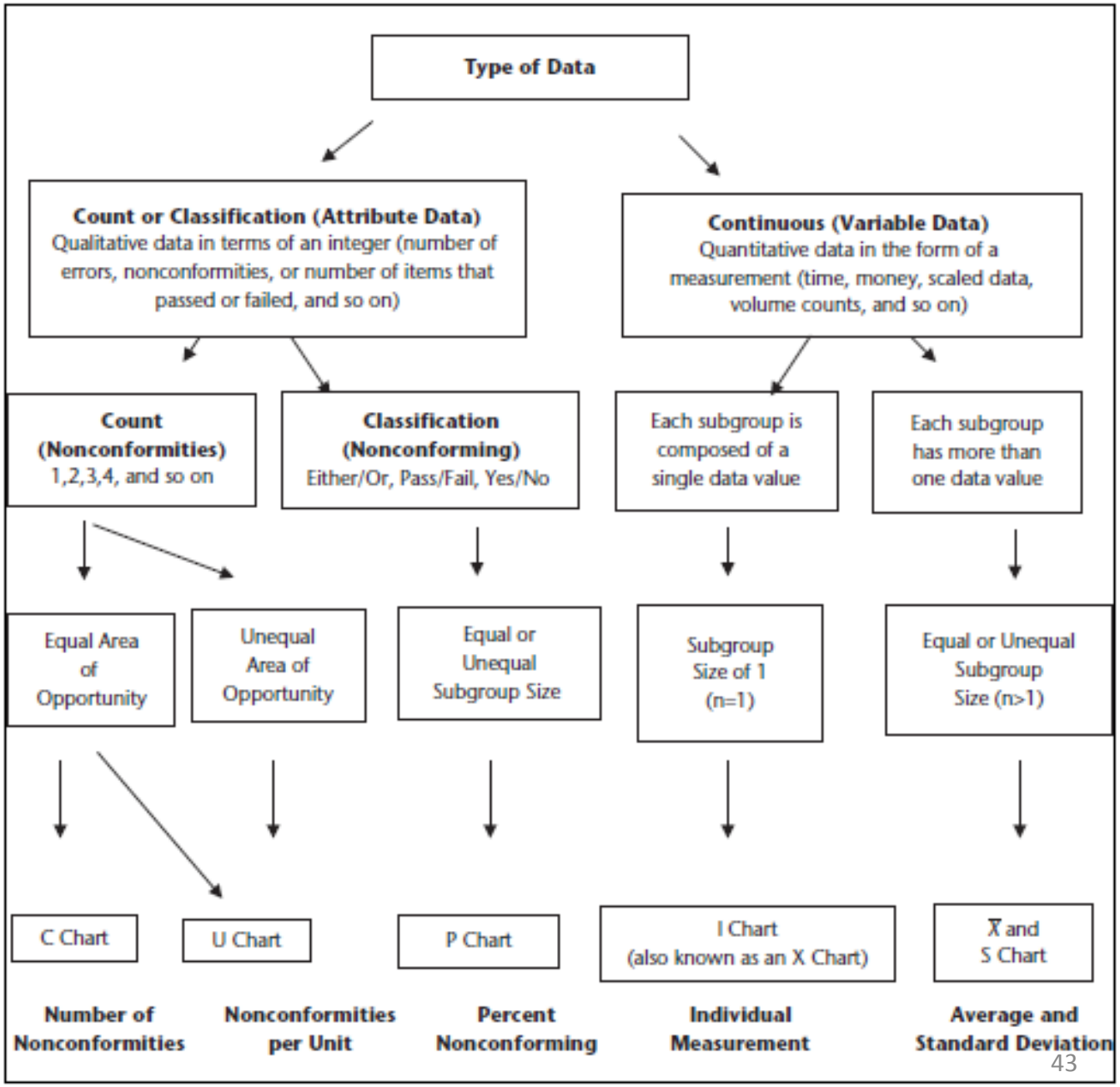
FIGURE 5.1 Shewhart Chart Selection Guide (Short Form)



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Shewhart Charts for Attribute Data

Classifications of units: each unit is classified as either conforming or nonconforming, pass/fail, blue/not blue, go/no-go, etc.

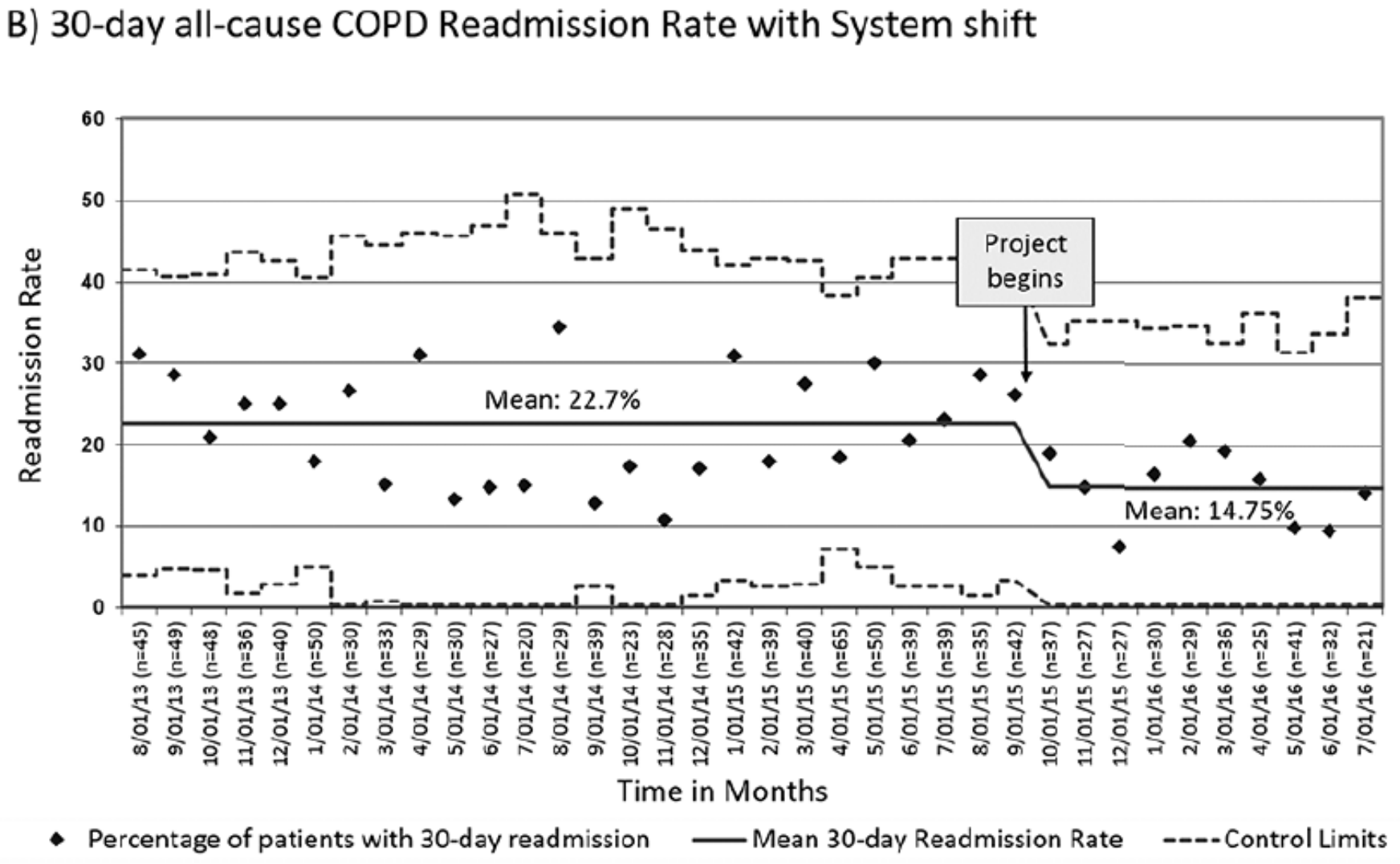
Count of incidence: a count of the number of nonconformities, defects (complications, infections, errors), accidents, trips, telephone calls, etc.

Chart Name	Type of Attribute Data	Statistic Charted	Subgroup Size
P Chart	classification	% nonconforming units (P)	constant or may vary
C Chart	count	number of incidence (C)	constant
U Chart	count	incidents per unit (U)	may vary

Table 5.4: Three Types of Attribute Shewhart Charts

HC Data Guide, p. 163

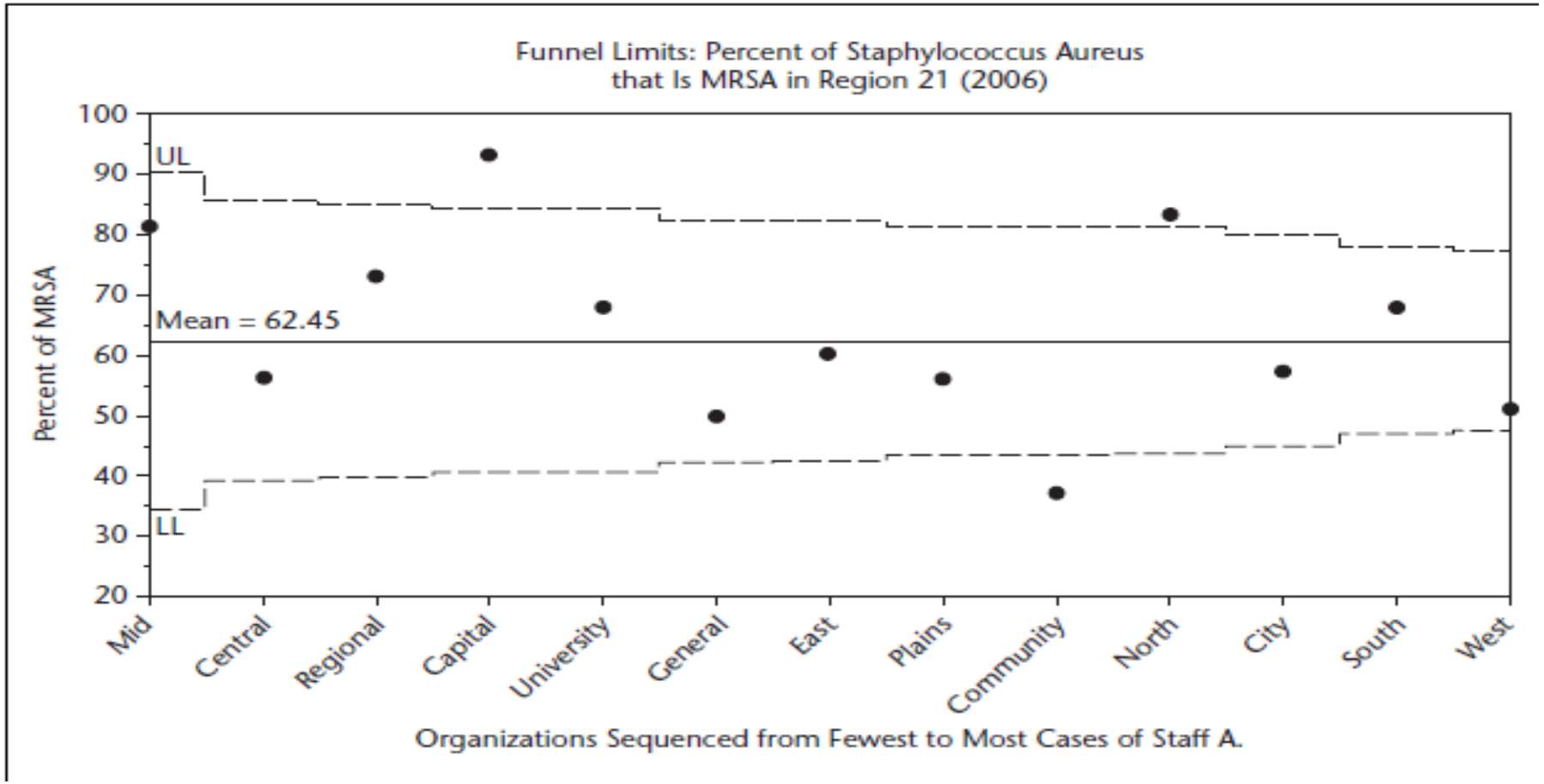
P- Charts Example



Zafar MA, et al. BMJ Qual Saf 2017;**26**:908–918. doi:10.1136/bmjqs-2017-006529

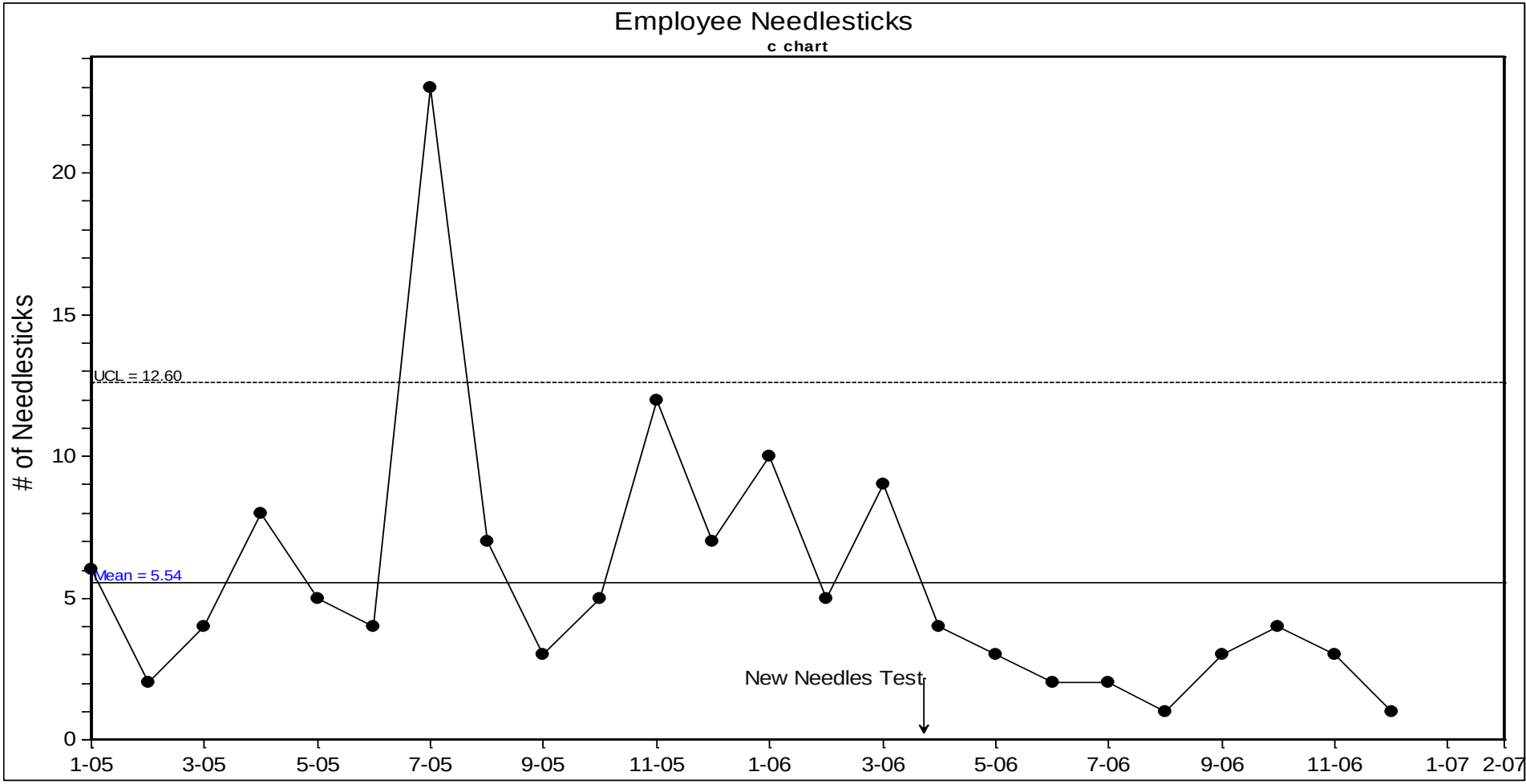
P chart for MRSA Subgroups are Hospitals

FIGURE 5.13 P Chart of Percentage of MRSA with Funnel Limits



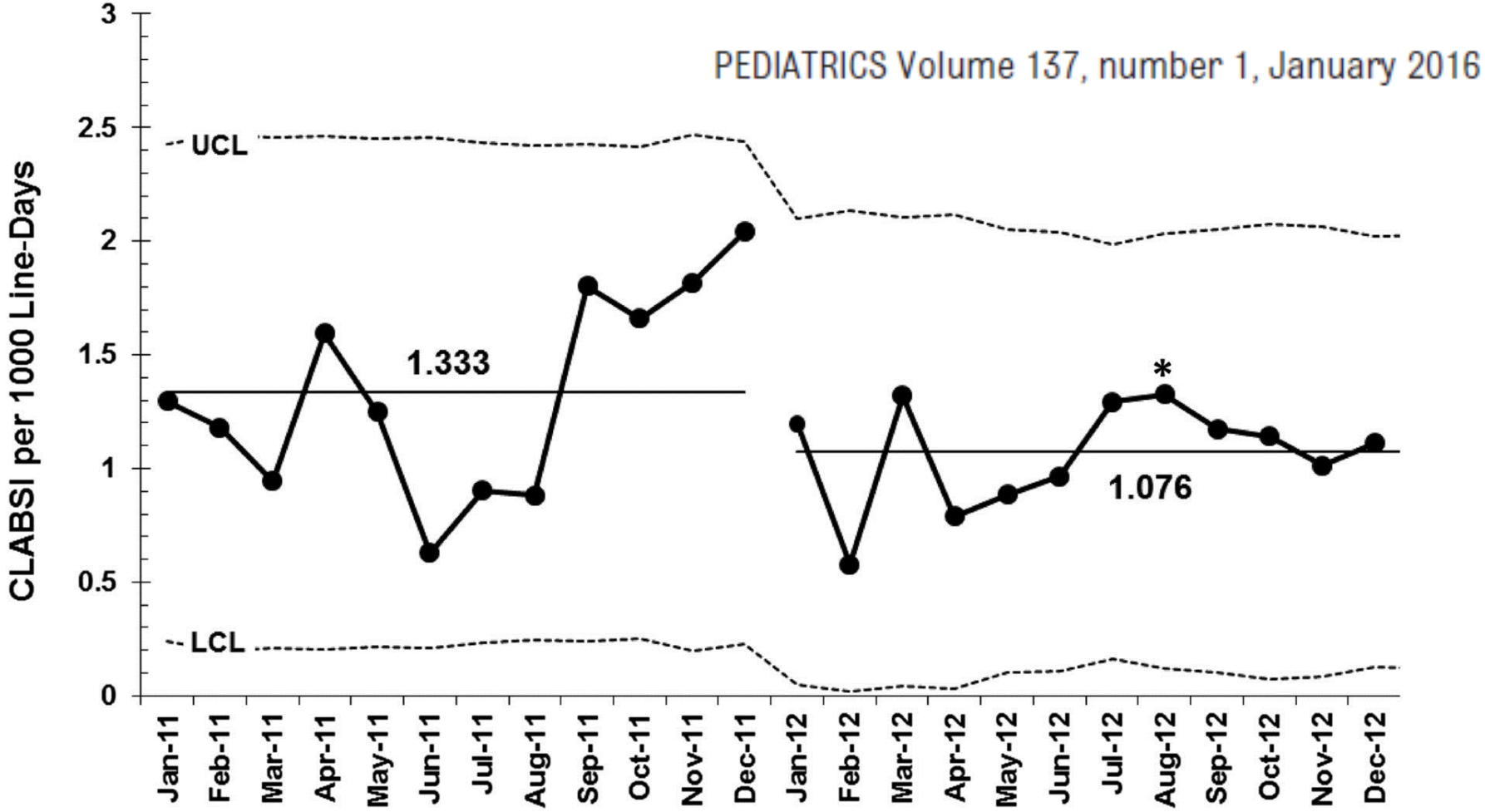
P chart as Funnel Plot

C- Chart



HC Data Guide, p. 177-178

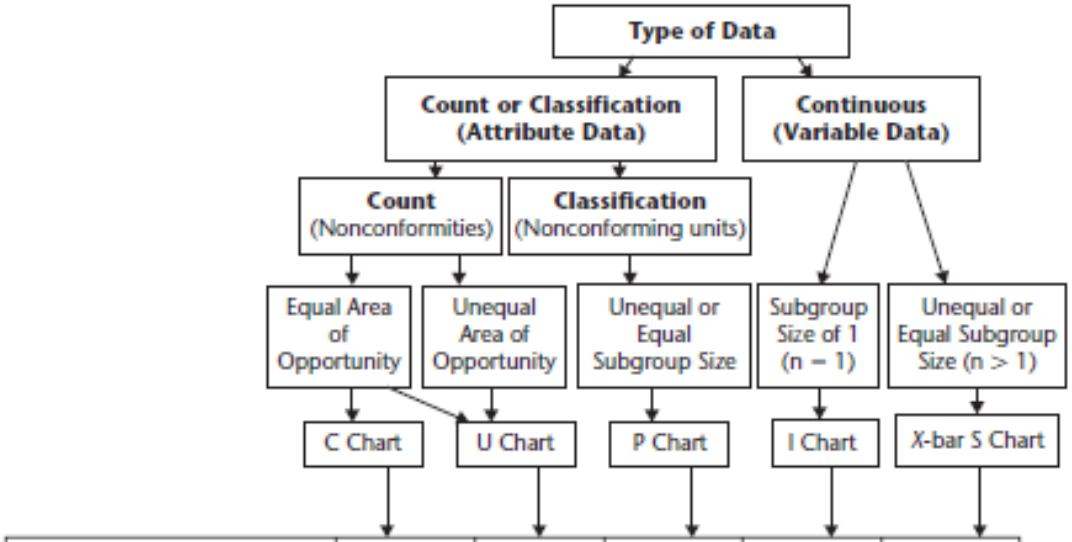
Example U Chart



SLUG Bug CLABSI rates from extended baseline throughout the study period for 17 participating centers. The u chart displays a decrease in CLABSI rates, from 1.333 to 1.076 per 1000 line-days. Statistical Process Control special-cause signaling (8 consecutive points below the mean). There was no further signaling for the duration of the study period. The overall reduction was 19.28%. LCL, lower control limit; UCL, upper control limit.

API, 2018

FIGURE 7.1 Expanded Chart Selection Guide to Include Alternative Charts



Alternative Advanced Types of Shewhart or Time Series Charts	C Chart	U Chart	P Chart	I Chart	Xbar S Chart
NP Chart			X		
$\bar{X}$-bar and range Chart					X
Median Chart					X
T chart (time between rare events)	X	X			
G Chart (opportunities between rare events)	X	X	X		
Moving average Chart				X	X
Cumulative sum (CUSUM) Chart	X	X	X	X	X
Exponentially weighted moving average	X	X	X	X	X
Standardized Control Chart	X	X	X	X	X
Multivariate Control Chart				X	X

Note: The "x" in the table indicates that the alternate chart in the table row could be considered for use instead of the basic chart in the table column.

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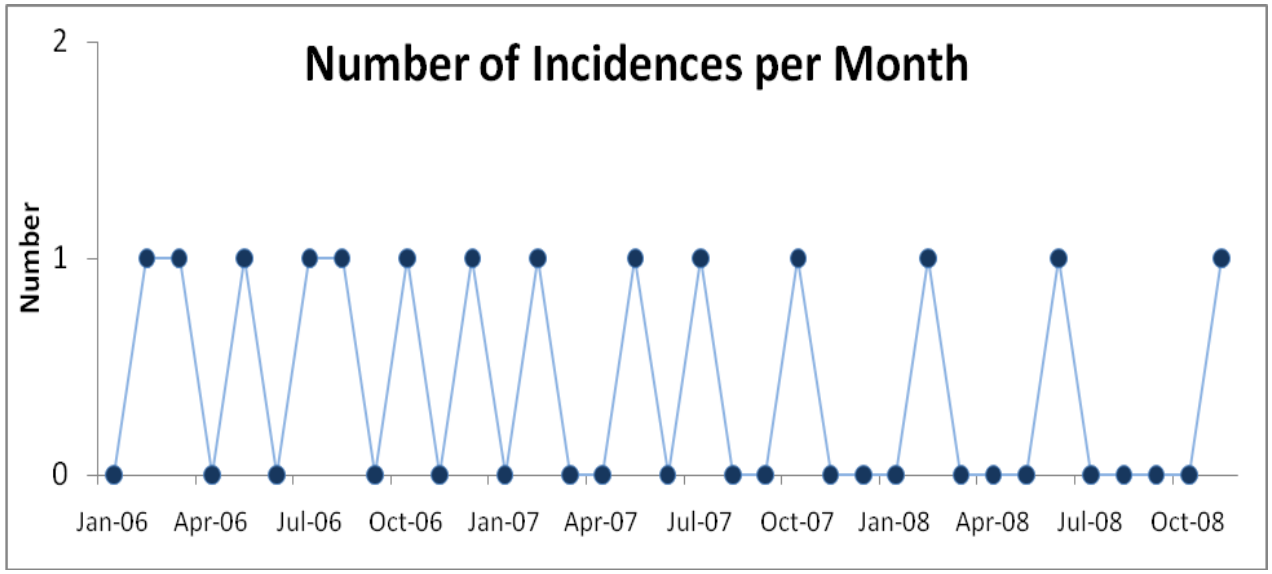
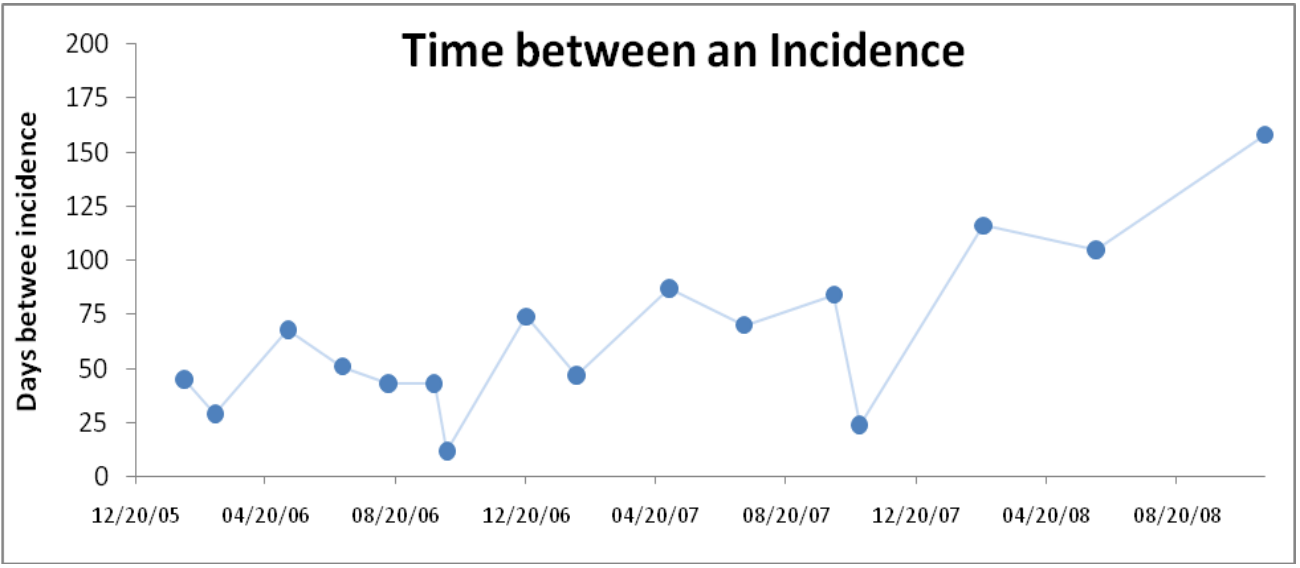
API, 2018

“Cases Between” Occurrences of Rare Events



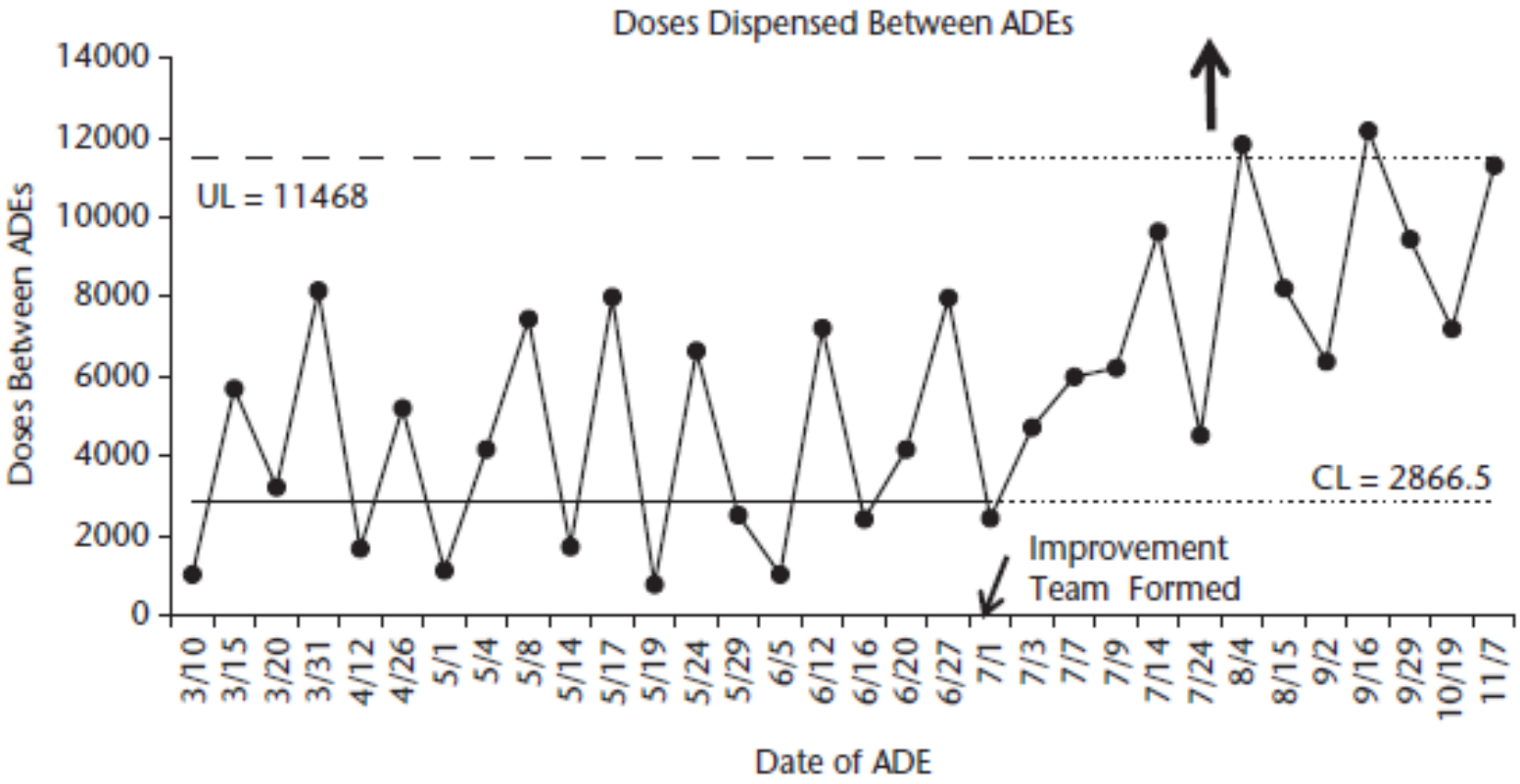
Instead of plotting the number of incidences each month, plot the time (or number of cases, patients, visits, etc.) between incidences.



Plot a point each time an incidence occurs

g-chart for Doses Dispenses between ADE's

FIGURE 7.10 G Chart for Doses Dispensed Between ADEs

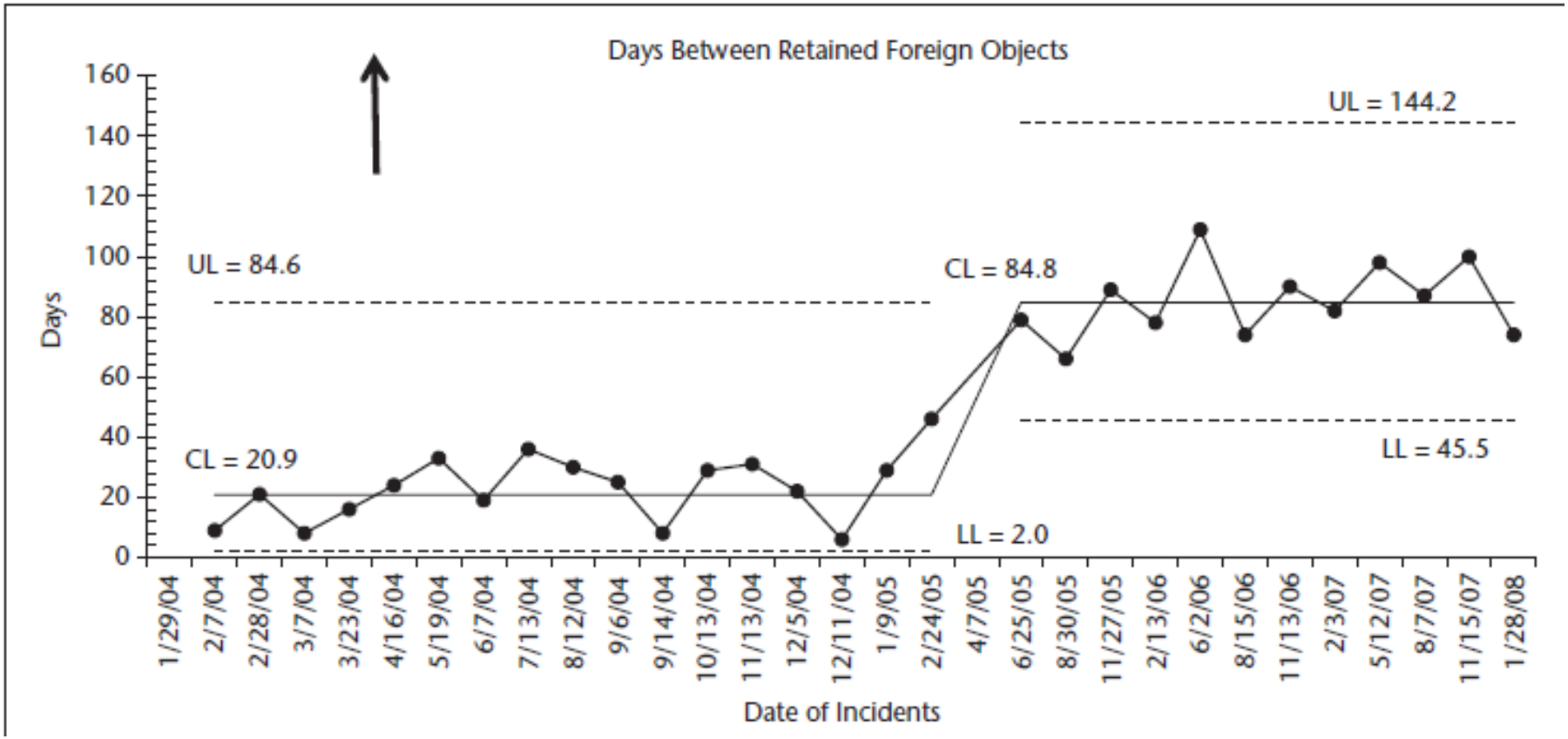


gbar = average of g's (units between events)
CL = 0.693 * gbar (estimate of median for geometric distribution)
UL = gbar + 3 * square root [gbar * (gbar +1)]

HC Data Guide: p. 228, 230

T chart Showing Improvement

FIGURE 7.12 T Chart for Days Between Retained Foreign Objects



HC Data Guide: p. 233

Establishing and Revising Limits for a Shewhart Charts

Start with a Run Chart

Calculate Trial Limits

Update Trial Limits

FIGURE 4.13 Run Charts and Shewhart Charts for Waiting Time Data

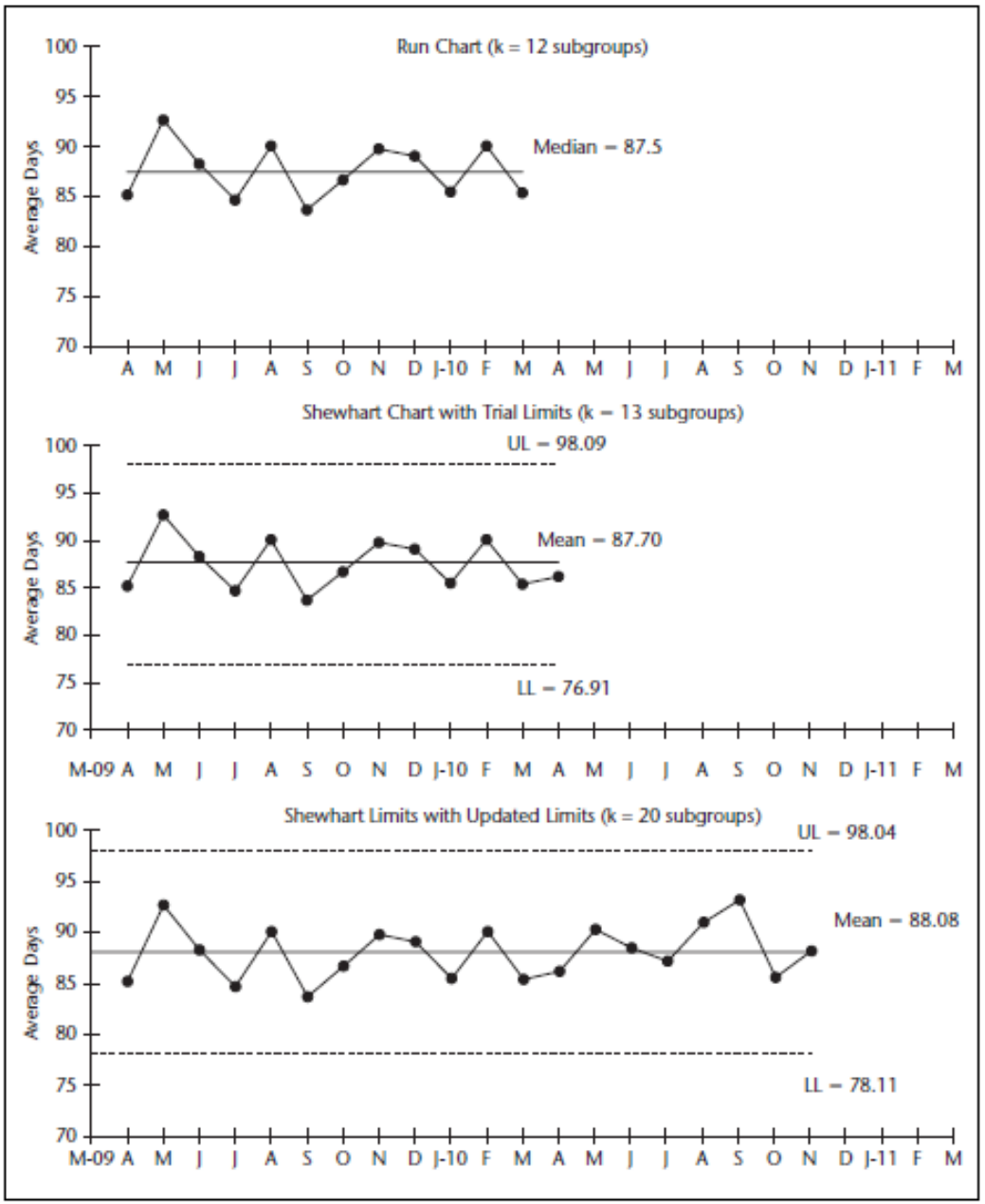


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FIGURE 4.9 Shewhart Chart Revealing Process or System Improvement

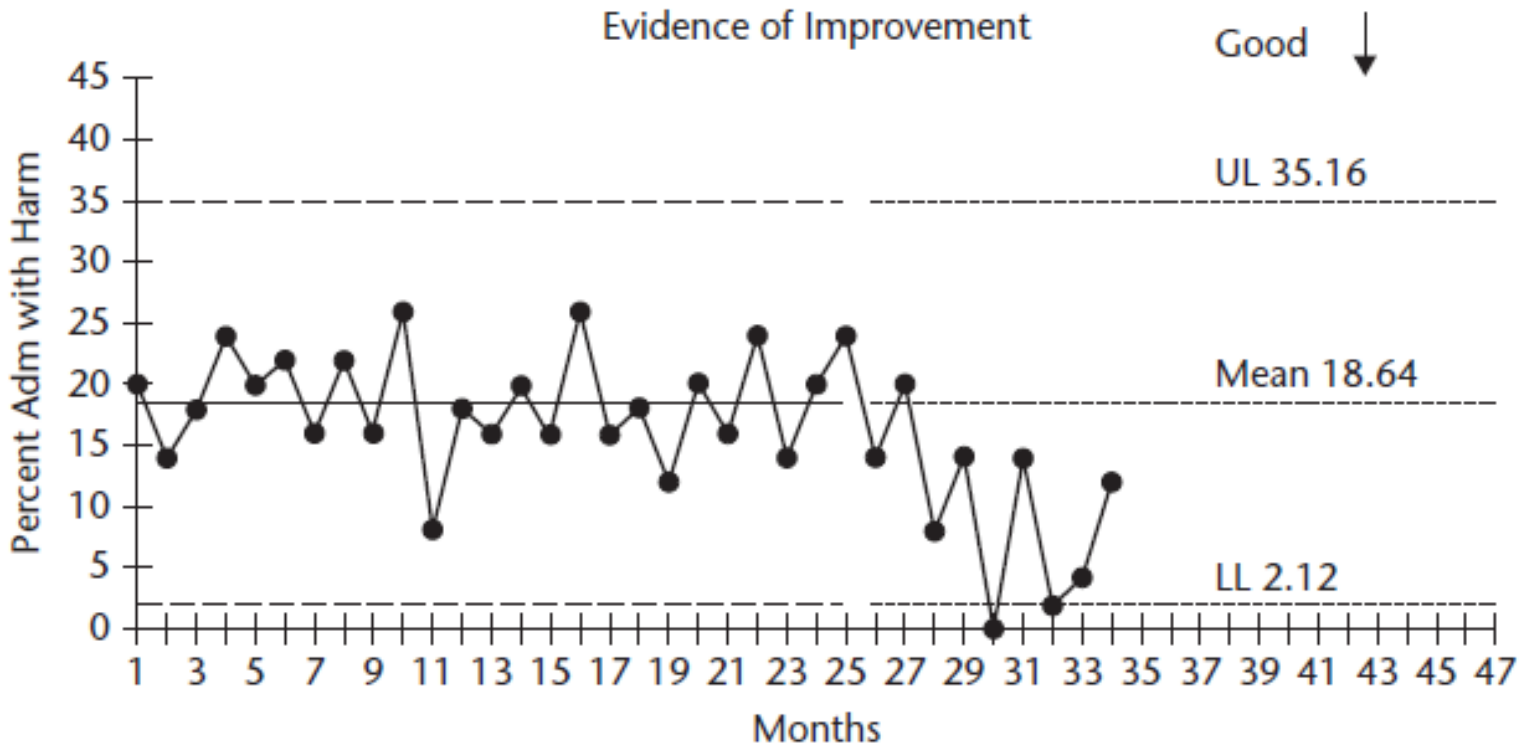

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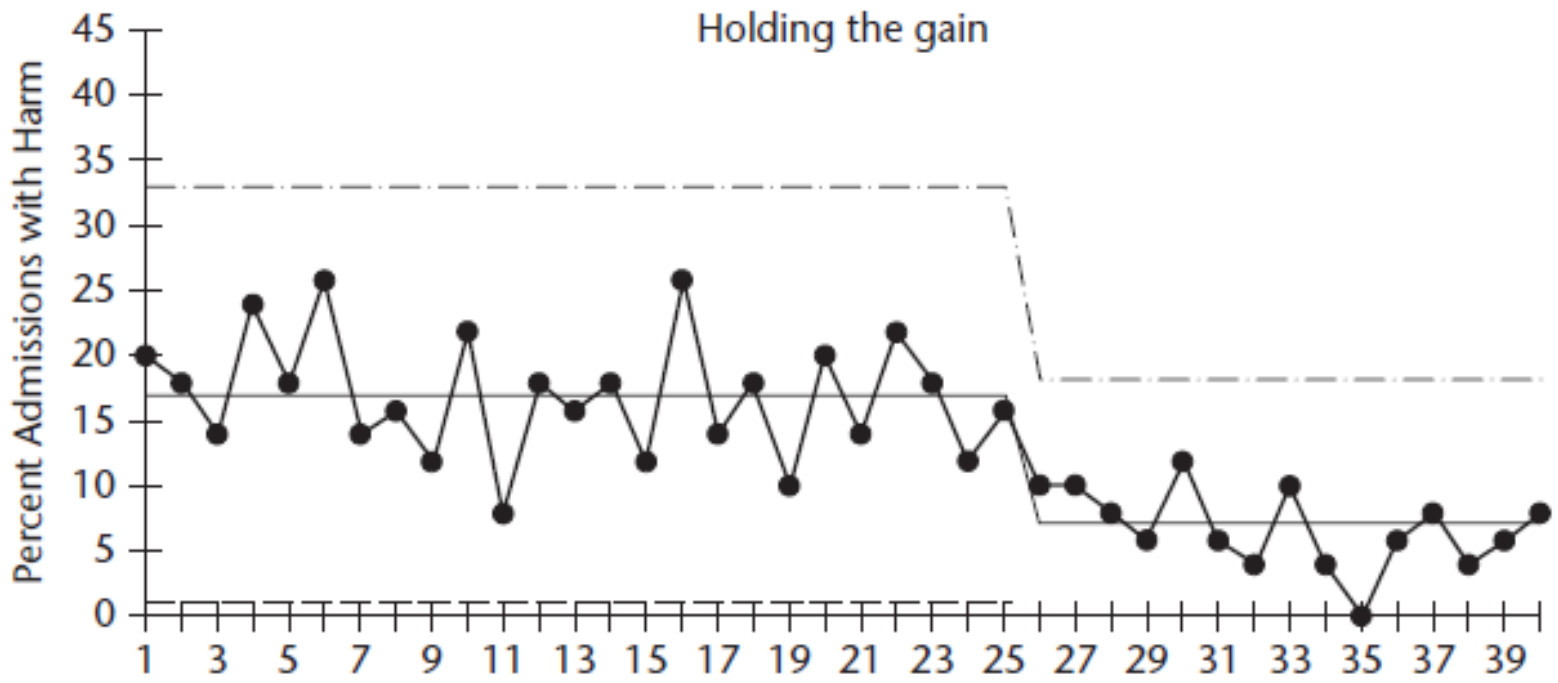
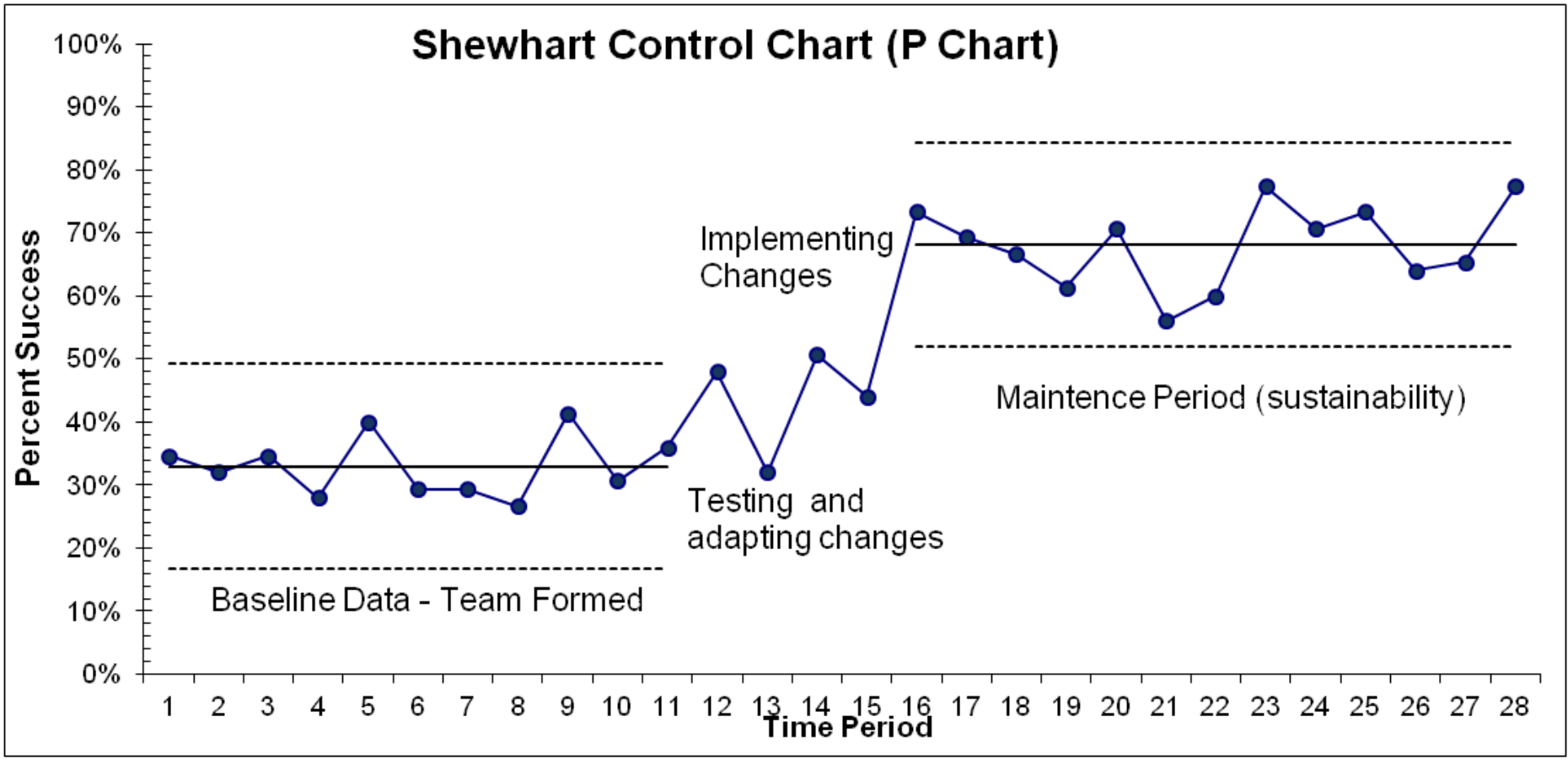
FIGURE 4.12 Shewhart Charts Depicting a Process or System "Holding the Gain"



HC Data Guide p. 121

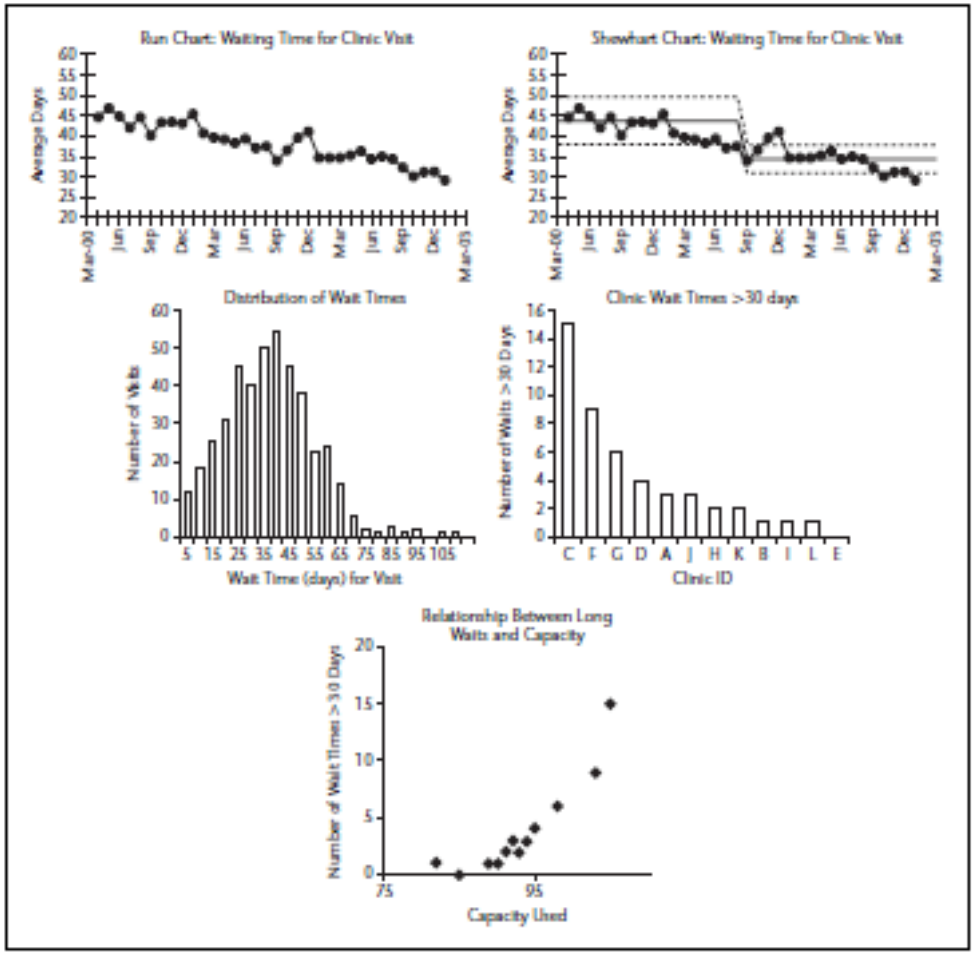
Updating Limits



Walter A. Shewhart, Ph.D.
1891–1967

Another half-century may pass
before the full spectrum of Dr. Shewhart's contributions
has been revealed in liberal education, science, and industry.

W. Edwards Deming



Deming, W. Edwards: *Foreword in Statistical Method from the Viewpoint of Quality Control*. Dover Publications, 1986, p. ii. ONLY 18 MORE YEARS!

Helpful links

Framework for Improving quality

www.qualityimprovement.ie

Improvement Knowledge and Skills Guide

http://www.hse.ie/eng/about/Who/QID/aboutQID/

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Please give us some feedback on survey monkey:

https://www.surveymonkey.com/r/8WNQVH9

We will be back with some exciting events post summer.

Thank you from all the team @QITalktime

Roisin.breen@hse.ie
Noemi.palacios@hse.ie

QI TALK TIME

Building an Irish Network of Quality Improvers