101: Building Basic Run Charts – Tools You Should be Using Today!

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Heather Kaplan MD, MSCE is an Assistant Professor of Pediatrics in the Perinatal Institute and the James M. Anderson Center for Health Systems Excellence at Cincinnati Children's Hospital Medical Center (CCHMC). Heather is a neonatologist and health services researcher interested in enhancing care delivery and studying how systems of care can be improved using innovative approaches. She completed her neonatal-perinatal fellowship training, including earning a Master's degree of science in clinical epidemiology, at The Children's Hospital of Philadelphia/University of Pennsylvania. She joined the faculty at CCHMC in August 2007.

Heather's early research focused on understanding variation in adoption of evidence-based practices in neonatal care and quality improvement as a strategy for implementing evidence in practice. With funding from the Robert Wood Johnson Foundation, she studied the role of context in the success of quality improvement initiatives and developed a model, the Model for Understanding Success in Quality (MUSIQ). MUSIQ is a tool for developing theories about which aspects of context help or hinder a specific project, and designing and implementing tests of changes to modify those aspects of context. Her current work examines the way research and improvement networks ("learning networks") can be used to improve care delivery and outcomes.

She is specifically interested in scaling improvement to reach entire populations of patients and the ways technology, quality improvement methods, and N-of-1 trial methods can be combined to create a personalized learning healthcare system for the individual. Heather also has extensive experience with front-line quality improvement in perinatal care. Dr. Kaplan serves as the Improvement Advisor for the

Ohio Perinatal Quality Collaborative (OPQC) neonatal improvement work. She also serves as a faculty expert for Vermont Oxford Network quality collaboratives and has been working with teams to improve their system of improvement by using MUSIQ to identify and modify key aspects of context that are affecting the success of the quality improvement projects and to help them engage with senior leadership around their improvement work.

Annual Quality Congress Breakout Session, Saturday, September 10, 2016
101: Building Basic Run Charts – Tools You Should be Using Today!

Objective: Participate in a workshop linking evidence and action to improve the care of infants and families.

Heather Kaplan MD, MSCE / Munish Gupta MD, MMSc

Measurement 101: Building Basic Run Charts

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VON Annual Meeting & Quality Congress
Workshop
September 10, 2016

Disclosures

- Heather Kaplan and Munish Gupta have no relevant financial disclosures related to the content of this workshop.

Learning Objectives

Participate in a workshop linking evidence and action to improve the care of infants and families.

- Understand role of data in QI
- Understand variation seen in systems
- Build and analyze run charts

Outline

- Introductions
- Data for Quality Improvement
- Understanding Variation
- Run Charts

Introductions

- Heather Kaplan
- Munish Gupta
- All of you…..

A Bit of Theory…

Measurement 101: Building Basic Run Charts

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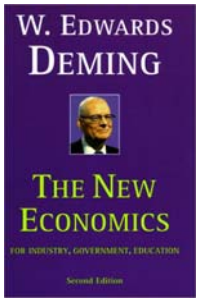
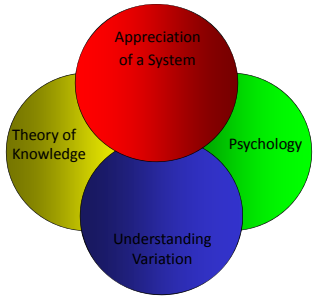
W. Edwards Deming



- Statistician, professor, author, and consultant
- Best known for introducing quality improvement to Japan in the 1950s, therefore contributing to it's renown for innovative high-quality products and strong economic position
- Championed methods to improve design (and thus service), product quality, testing and sales through the application of statistical methods
- A leader of in quality and performance excellence
- Stressed the importance of multiple types of knowledge ("Profound Knowledge") to be effective at improvement

Deming's Profound Knowledge



W. Edwards Deming, *The New Economics*

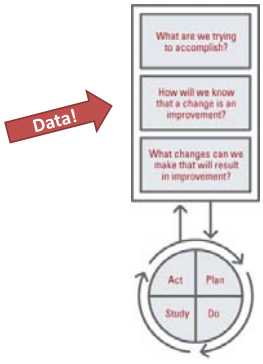
Deming's Profound Knowledge

Understanding Variation

- Systems constantly exhibit variation
- Ability to interpret this variation is key to making improvements
- Separate signal from noise

W. Edwards Deming, *The New Economics*

The Model for Improvement



AIMS

MEASURES

CHANGES

Testing Changes

Figure from Institute for Healthcare Improvement (www.ihi.org)

A (Real) NICU Example

- You would like to reduce the incidence of NEC in your NICU.
- You have identified two evidence-based strategies for reducing risk of NEC:
  - Increasing the use of human milk; and
  - Standardizing feeding practices.

Start w/ VON data: Any BM at Discharge

GA Category	Center (2013) Cases	N	%	Network (2013) N	%	Q1	Q3
< 24 Weeks	0	0		2,268	20.1%	0.0%	33.3%
24-26 Weeks	7	27	25.9%	13,744	36.1%	17.1%	50.0%
27-29 Weeks	30	44	68.2%	21,991	51.7%	35.3%	66.7%
30-32 Weeks	22	29	75.9%	16,060	61.5%	44.4%	77.8%
> 32 Weeks	7	10	70.0%	4,478	64.8%	50.0%	100.0%
All	66	110	60.0%	58,541	50.5%	36.7%	64.1%

Birth Year	Center Cases	N	%	Network N	%	Q1	Q3
2002							
2003							
2004							
2005							
2006							
2007	65	138	47.1%	51,915	40.0%	26.9%	52.9%
2008	77	130	59.2%	54,954	41.6%	28.6%	54.7%
2009	69	132	52.3%	56,085	44.1%	30.8%	57.4%
2010	75	123	61.0%	55,426	45.6%	31.5%	59.3%
2011	66	108	61.1%	56,981	47.9%	33.3%	62.5%
2012	69	110	62.7%	57,492	49.1%	34.2%	62.9%
2013	66	110	60.0%	58,550	50.5%	36.7%	64.1%

What's good about this approach?
What's missing?

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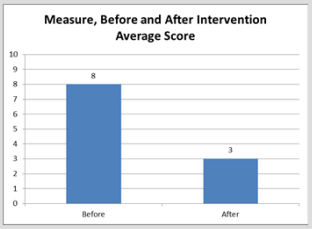
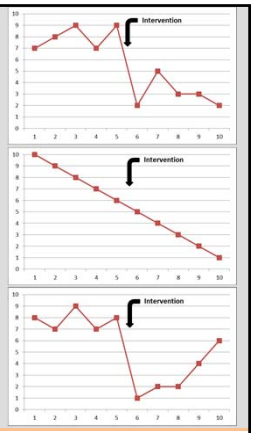
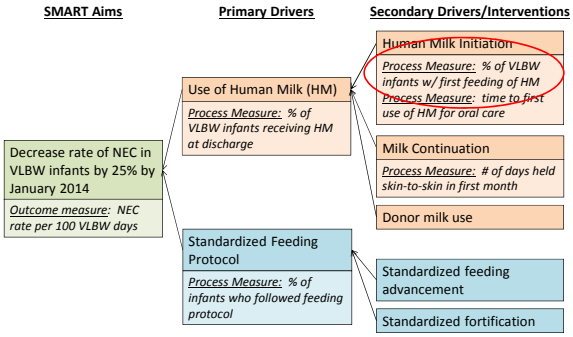
Why Important





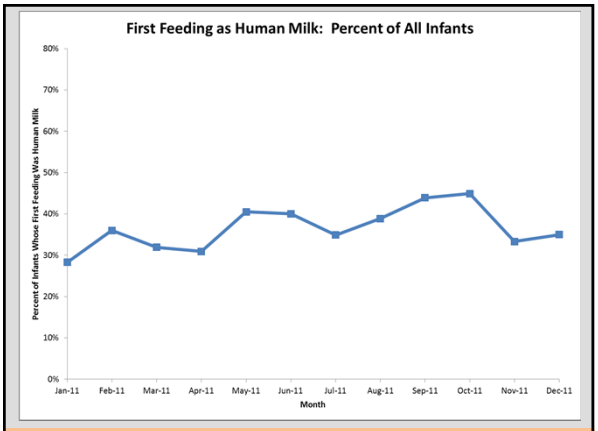
Quality Improvement: Need Data over Time!

Key Driver Diagram



First Measure: First Feeding as HM

Month	First Feeding HM	Total Infants
Jan-11	15	53
Feb-11	9	25
Mar-11	15	47
Apr-11	17	55
May-11	17	42
Jun-11	18	45
Jul-11	17	43
Aug-11	21	54
Sep-11	18	41
Oct-11	20	49
Nov-11	13	39
Dec-11	14	40



Statistical Process Control Theory

"I'm not superstitious either, but those were the three days Harris wore his lucky socks."

History of SPC

- Manufacturing origins
- 1920s - Walter Shewhart, W.E. Deming (Bell Labs)
- Easy for non-statisticians detect process changes
- Ramped up extensively during WWII, post-war Japan, U.S. mfg
- Used in all industries, including health care

Walter Shewhart

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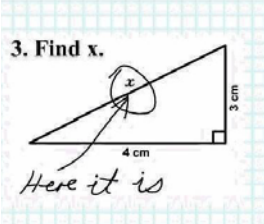
Statistical Process Control (SPC) and QI

- Measurement over time critical for QI
- But all things vary
- SPC: analysis of data over time
- Understand variation

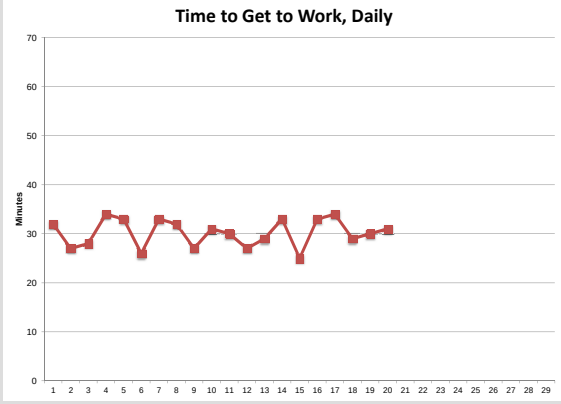


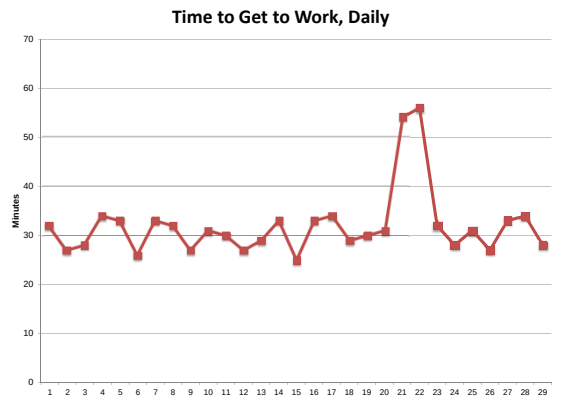
Measuring Change in Variation

- We are looking for improvement / change in key data
- But natural background variation in all things we do – fact of life
- Need tools to interpret process changes (in data) versus natural variation in data
- We would like to detect true change fast

Definitions

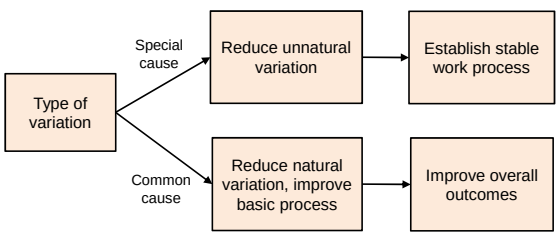
1. Common Cause Variation: Causes inherent as part of usual process (good or bad).
2. Special Cause Variation: Specific causes not part of usual process (good or bad).
3. Stable Process: Predictable variation within natural common cause bounds.
4. Unstable Process: Both special and common cause variation, variation unpredictable.





Why is this Important

Type of variation → type improvement action



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SPC Tools for Measurement

1. Run charts – minimal standard
2. Control charts

Keys:

- Plot and evaluate over time
- Interpret visually and statistically

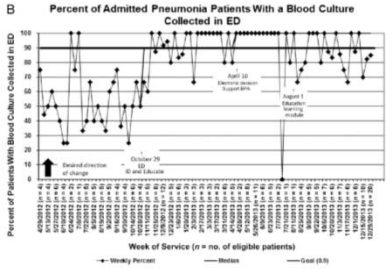
Run Charts

What is a Run Chart

- Visual display of data over time, annotated
- Center line: Median or mean value

Improvement Methodology Increases Guideline Recommended Blood Cultures in Children With Pneumonia

PEDIATRICS Volume 135, number 4, April 2015



Run Chart: Signal v. Noise

- ***Signal:*** means something; contains information; difference with a distinction; special cause variation
- ***Noise:*** statistically indistinguishable from other data points; contains no new information; difference without a distinction; common cause variation
- You do not want to over-react to single data points, leads to "tampering" (e.g., respond to a value thinking it's a signal when actually it's noise) because it increases process and system variability

Distinguishing Signal v. Noise

- Rules to analyze a run chart for non-random patterns:
  1. Shift
  2. Trend
  3. Runs
  4. Obvious/extreme spike

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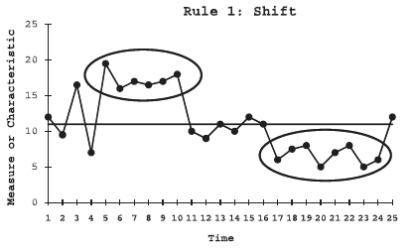
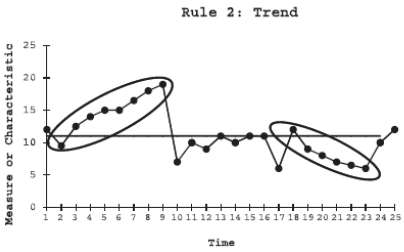
1. Shift



6 or more consecutive points either all above or all below the median

BMJ Qual Saf 2011;20:46–51. doi:10.1136/bmjqs.2009.037895

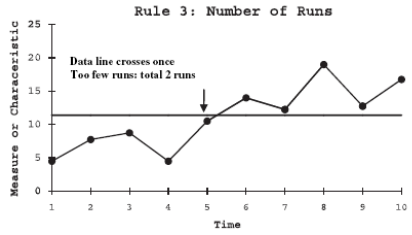
2. Trend



5 or more consecutive points all going up or all going down

BMJ Qual Saf 2011;20:46–51. doi:10.1136/bmjqs.2009.037895

3. Runs



Number runs = Number of median cross + 1

BMJ Qual Saf 2011;20:46–51. doi:10.1136/bmjqs.2009.037895

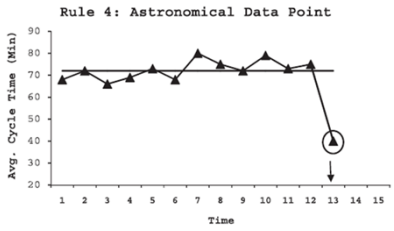
Too few, too many runs

Table 1 Checking for too many or too few runs on a run chart. Table is based on about a 5% risk of failing the run test for random patterns of data

Total number of data points on the run chart that do not fall on the median	Lower limit for the number of runs (< than this number runs is 'too few')	Upper limit for the number of runs (> than this number runs is 'too many')
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

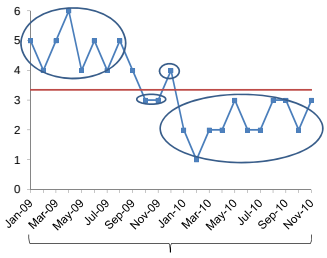
BMJ Qual Saf 2011;20:46–51. doi:10.1136/bmjqs.2009.037895

4. Obvious spike



1-2 points extremely far from the rest

Example



n = 24 data

Spike?

NO

Shift?

YES: 6+ points above or below median

Runs?

YES: 4 runs (8, 18)

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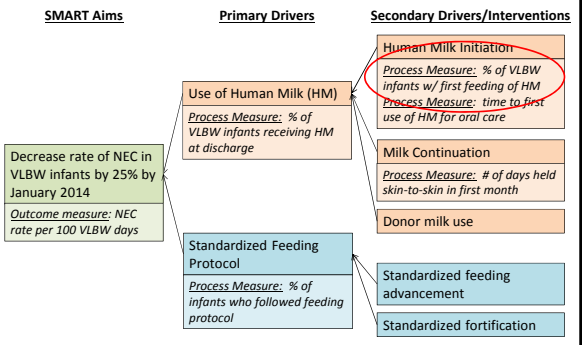
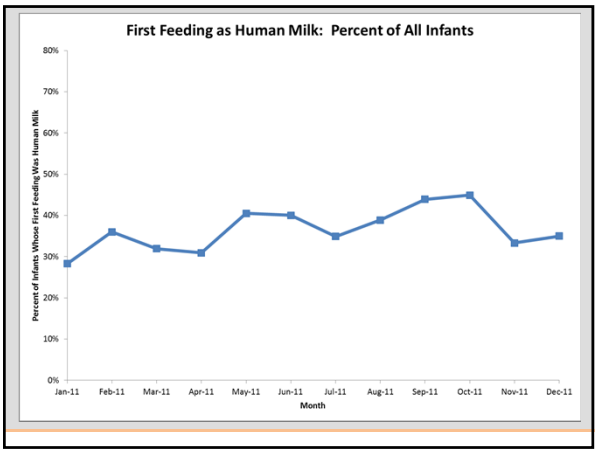
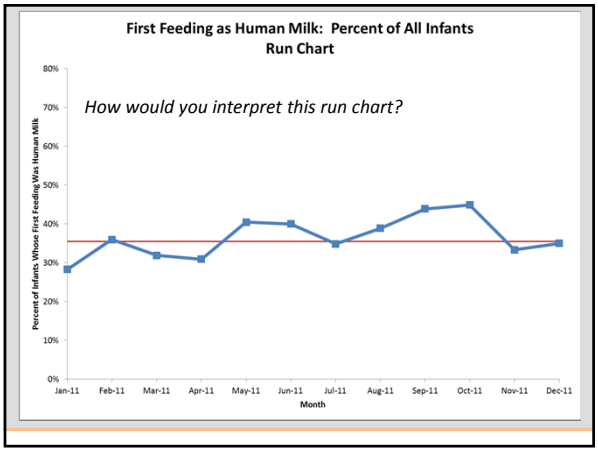
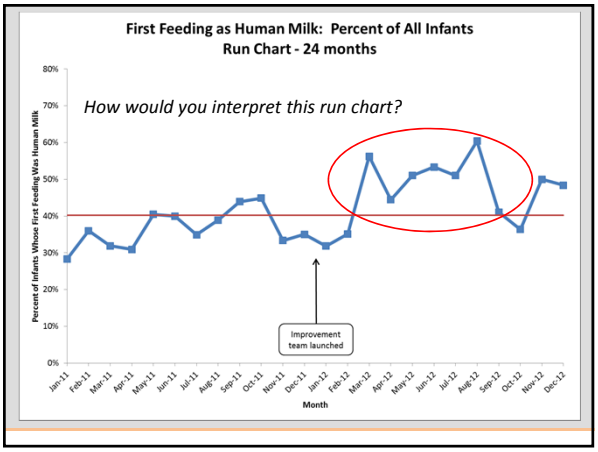
Key Driver Diagram









Run Charts

- Simple but effective tool for analyzing QI data
- Can and should be used for monitoring and feedback
- Ideally is annotated with changes
- With annotations, can be 'summary' of QI project that can be shared widely

Exercises

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Run Charts: Summary

- "Minimum standard" for QI project data
- Can start with first few data points!
- Need at least 10 data points to use rules for detecting special cause
- Simple to create (no software needed)
- Can be used with all types of data
- But… not as powerful as a control chart

References

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Done!

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