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Metrics and Graphics for Quality Improvement Projects

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Doctoral Education Conference
January 22, 2016

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Improvement Tools

Agenda:
- Data, Information, Indicators
- Bar Chart
- Histogram
- Pareto Chart
- Line Graph
- Run Chart
- Control Chart
- Demonstration, Discussion, and Questions

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Data

Data: Clearly defined and meaningful
- Data are facts, clinical observations, or measurements that have been collected, and perhaps put into some sort of orderly arrangement, but which have not yet been interpreted.
  - Before data are interpreted or analyzed, they are sometimes referred to as raw data
- Data answers the question **"How many … ?"**
  - …Adverse events this month
  - …Patients responded to a survey
  - …Admitted patients were recently discharged
  - **Take Screen Shots of applications to show IS for reports**
  - **Be specific and let the data evolve, no data-set is perfect**

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Data, Information

Information: Context and understanding
- Consists of data that have been interpreted and that can assist a team with decision making.
- Data becomes information
  - Adverse events this month
    - Patient Falls per 1000 patient days
  - Patients responded to a survey
    - % said Nurses "Always" communicated well
  - Admitted patients were recently discharged
    - 30-Day Readmission Rate (%) of patients discharged alive
- **Qualify data and add control**
  - If you are charting monthly volume, such as volume in the ED: Chart visits per day, by month; Feb is a 28-day month flanked by two 31-day months; 200 visits per day would make January and March appear to be 10% higher than February [(3*200=600)/(31*200=6200)] because it is a short month.

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Data, Information, Indicators

Indicator : Appropriate and explanatory
- Used to determine, over time, an organizations performance of functions, processes, and outcome.
- Health Care Organizations must select, measure, and use appropriate indicators
- Indicators are typically established by expert third parties; such as: CMS; AHRQ; NHSN; NIH
- Specifications should be clear, published, citable
- Adjust and accommodate to make measures appropriate and standard

Indicators

- **Qualify data and add control**
  - If you are charting falls without patient days and you had twice as many falls one month, but 3-4 times more patient days, your fall rate reduced by 25-50%.
- **Qualify data and add control**
  - If you are charting HCAHPS by month of discharge, you must wait long enough after that discharge date to allow for enough surveys to be returned until your data is valid. Real-time reports can be run, but when historically reporting for trends, 8-9 weeks should produce a valid sample-size that will not be significantly altered with late incoming surveys.
    - Tools such as PressGaney make it very easy to re-run previous months, including late incoming survey data for previously reported months.

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Bar, Histogram, Pareto

- **For a demonstration of Bar, Histogram and Pareto charts:**
  - Medicare Hospital Compare
  - Database download via http://www.medicare.gov/hospitalcompare/search.html

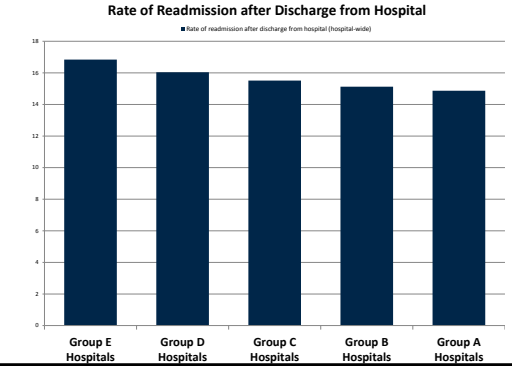
INDICATORS:

- **Rate of readmission after discharge from hospital (hospital-wide);** READM_30_HOSP_WIDE; Reporting hospitals, where 'Score' does not equal "Not Available."
- **% of Patients who reported that YES, they were given information about what to do during their recovery at home;** H_COMP_6_Y_P; Number of completed surveys = ""300 or more."

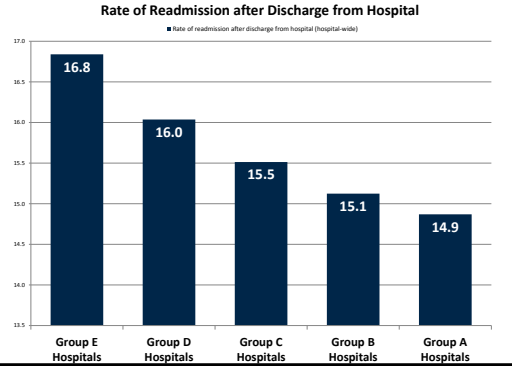
Bar, Histogram, Pareto

- **Rate of readmission after discharge from hospital (hospital-wide);** READM_30_HOSP_WIDE; 7/1/2012 – 6/30/2013; Reporting hospitals, where 'Score' does not equal "Not Available."
  - **4,459 Hospitals**
- **% of Patients who reported that YES, they were given information about what to do during their recovery at home;** H_COMP_6_Y_P; 1/1/2013 – 12/31/2013; Number of completed surveys = ""300 or more."
  - **2,838 Hospitals**
- **Overlapping Hospitals, included in these analyses:**
  - **2,831 Hospitals**

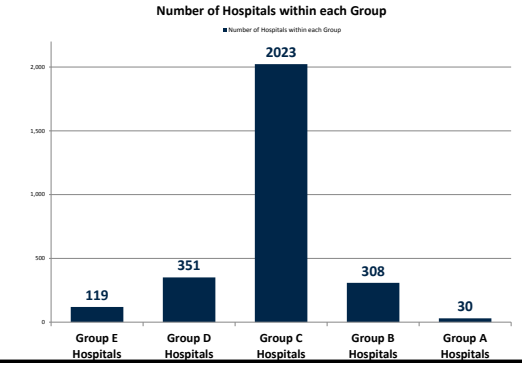
Bar Chart (Column)



Bar Chart



Bar Chart > Histogram: Analysis of frequency



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Pareto Chart

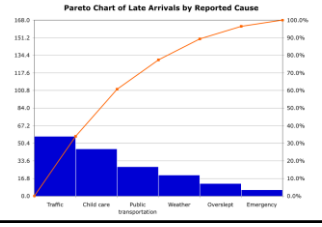
- Named after an economist (Vilfredo Pareto) that hypothesized the 80/20 rule
  - Business-management consultant Joseph Juran suggested the principle and named it after the Italian economist Pareto, who observed in 1906 that 80% of the land in Italy was owned by 20% of the population
- The Pareto chart is one of the seven basic tools of quality control*
  - Original designation was "Seven tools" and their content was formed during the fifties and sixties in Japan by K. Ishikawa and E. Deming
  - *Nancy R. Tague (2004). "Seven Basic Quality Tools". The Quality Toolbox. Milwaukee, Wisconsin: American Society for Quality.*

Pareto Chart

- **A chart that contains both bars and a line graph, where individual values are represented in descending order by bars**
  - The left vertical axis is the frequency of occurrence, but it can represent cost or another important unit of measure
  - The right vertical axis is the cumulative percentage of the total number of occurrences, total cost, or total of the particular unit of measure
  - http://en.wikipedia.org/wiki/Pareto_chart:
    - *"Causes for being late" arranged by specific reason and actual # per 100 respondents, in bars on the left-axis with the most frequent reason on the left in descending order to the right;*
    - *And the cumulative percentage of reasons as a line and charted on the right axis, totaling to 100% to the far right of the chart.*

Pareto Chart

- Combines analysis of frequency (or other quantity) of a problem with analysis of its causes
  - Will tell you which of the various causes of a problem are the most influential and which are less important
  - *'Tools for Performance Management'; Joint Commission*



Pareto Chart

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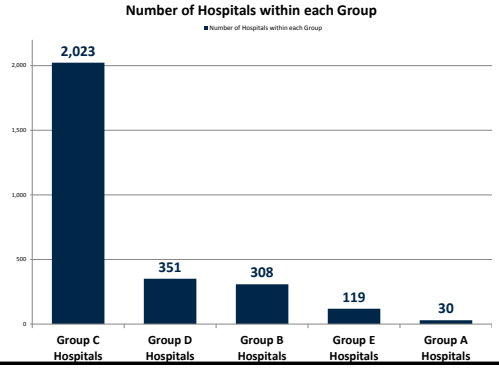
Bar Chart > Pareto Chart



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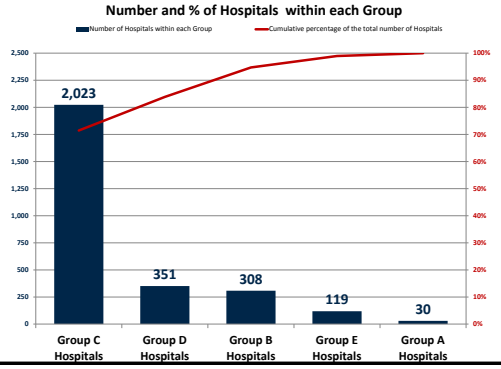
Pareto Chart



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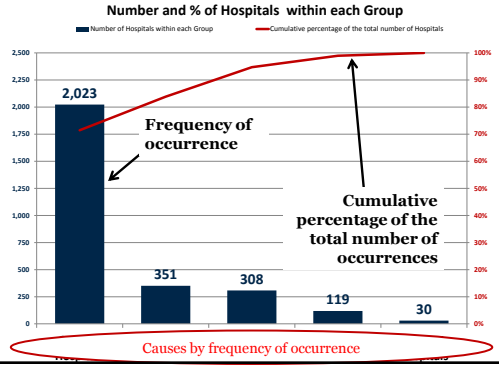
Pareto Chart



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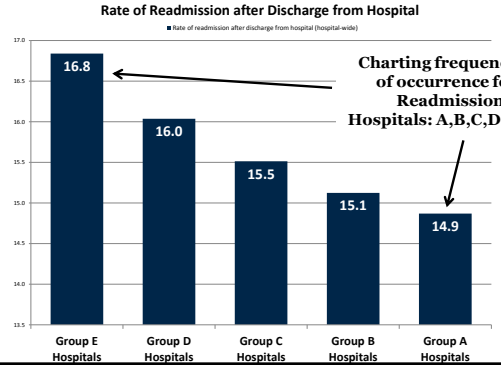
Pareto to Bar and Line; Bar chart



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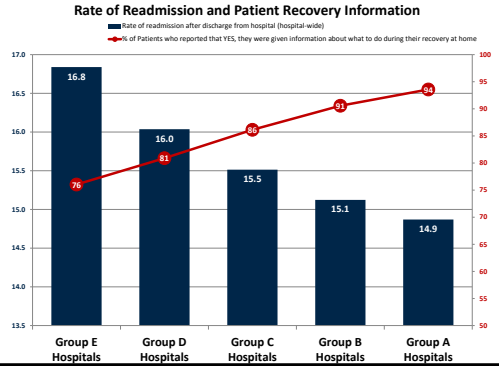
Bar and Line Chart



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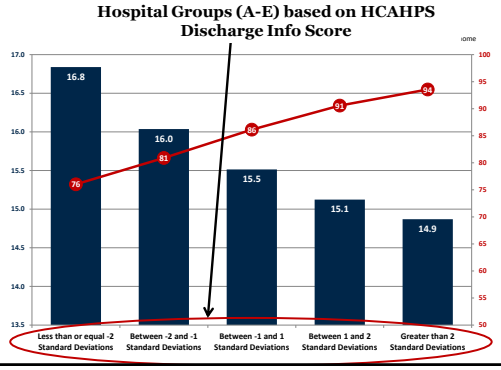
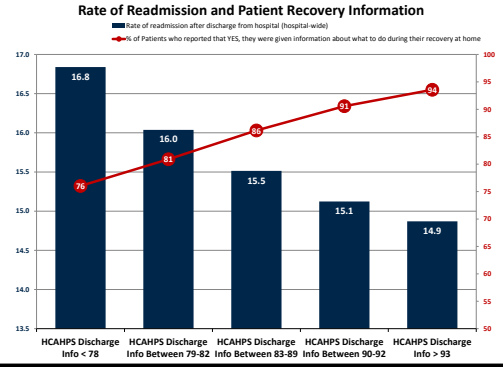
Bar and Line Chart



Bar and Line Chart



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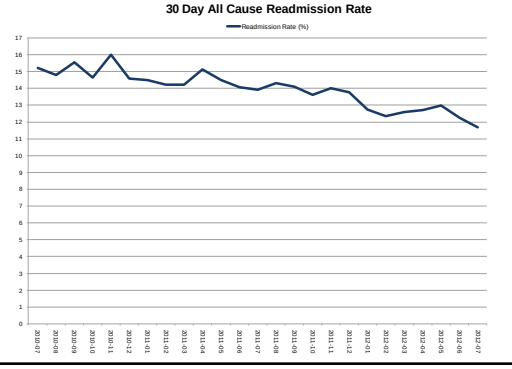
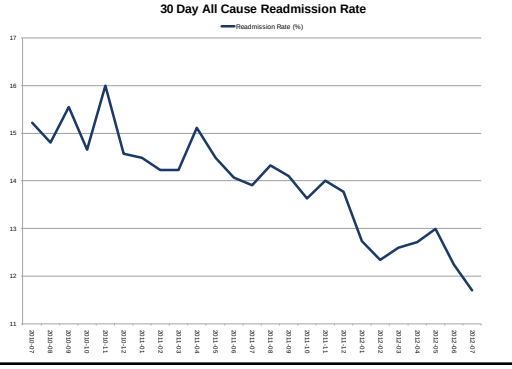
Line Graph

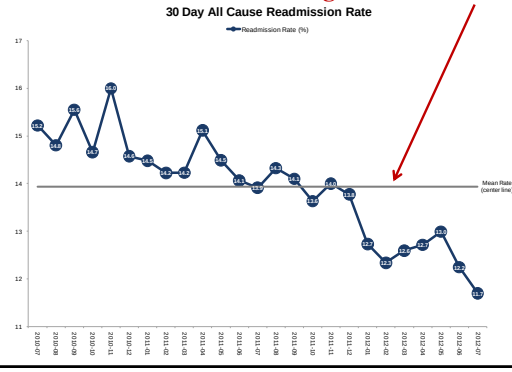


Line Graph



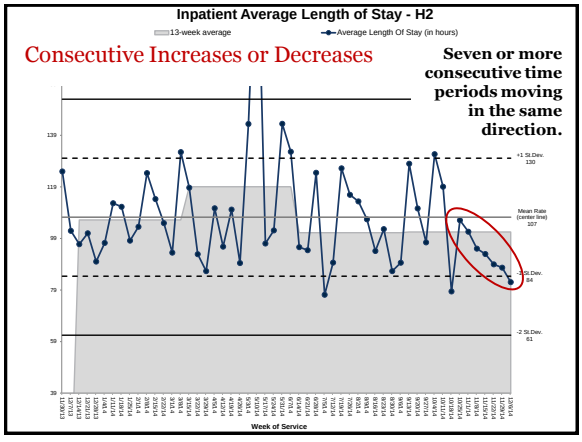
Run Chart

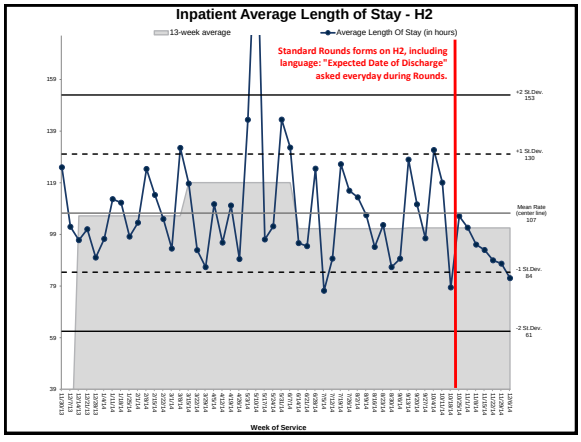
Center Line: The mean (average) charted value

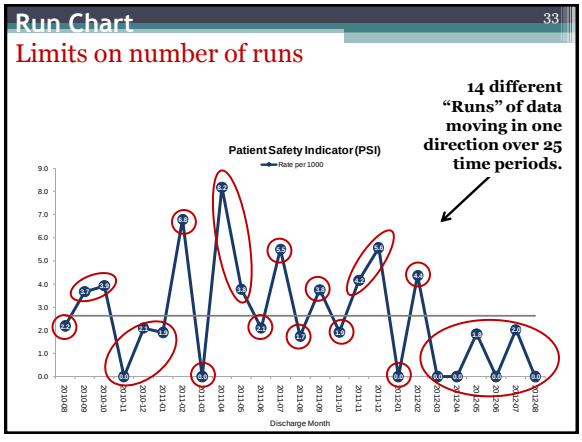


Run Chart

- Run Chart = Interpreting a Line Chart for trends
  - Consecutive Increases or Decreases
    - Seven or more consecutive time periods moving in the same direction.
  - Limits on number of runs
    - The number of runs in consecutive directions; if charting 25 time periods, there could be 24 runs, each consecutive time period moving in a different direction
  - Maximum run length
    - Eight or more consecutive time periods on one side of the mean line. In a standard distribution, each time period has a 50/50 chance of landing on one side or the other; this is eight in a row on one side.


Inpatient Average Length of Stay - H2
13-week average
Average Length Of Stay (in hours)
Consecutive Increases or Decreases
Seven or more consecutive time periods moving in the same direction.
+1 St.Dev. 130
Mean Rate (center line) 107
-1 St.Dev. 84
-2 St.Dev. 61
Week of Service


Inpatient Average Length of Stay - H2
13-week average
Average Length Of Stay (in hours)
Standard Rounds forms on H2, including language: "Expected Date of Discharge" asked everyday during Rounds.
+2 St.Dev. 153
+1 St.Dev. 130
Mean Rate (center line) 107
-1 St.Dev. 84
-2 St.Dev. 61
Week of Service


Run Chart
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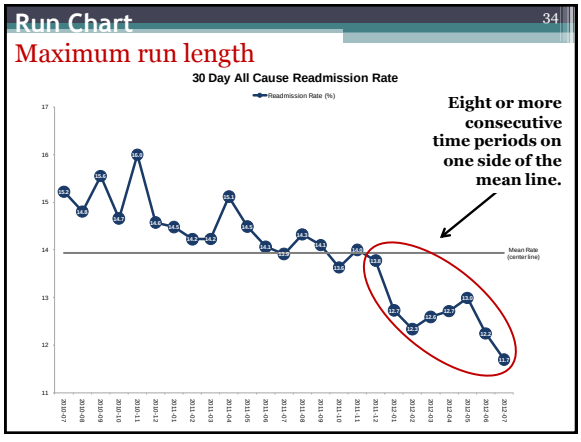
Limits on number of runs
14 different "Runs" of data moving in one direction over 25 time periods.
Patient Safety Indicator (PSI)
Rate per 1000
Discharge Month


Run Chart
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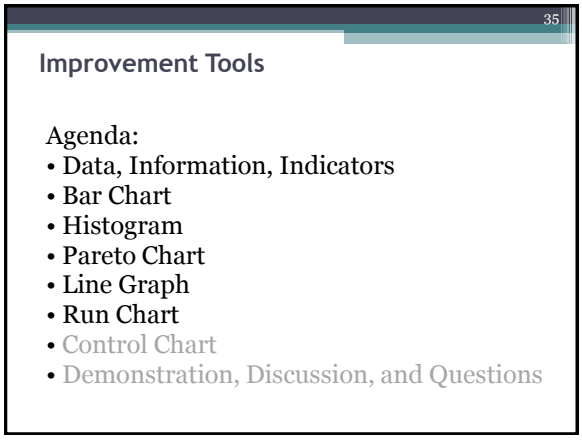
Maximum run length
30 Day All Cause Readmission Rate
Readmission Rate (%)
Eight or more consecutive time periods on one side of the mean line.
Mean Rate (center line)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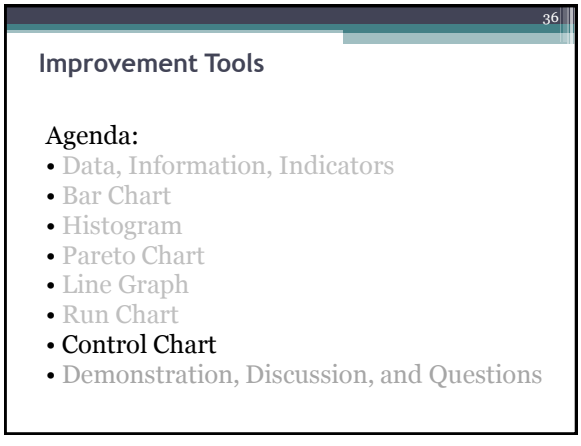
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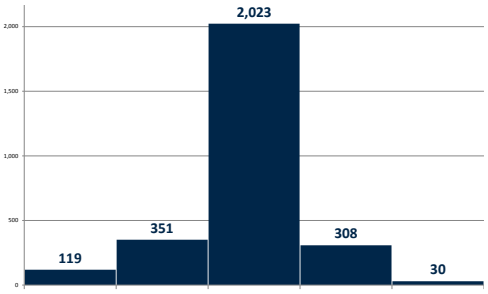
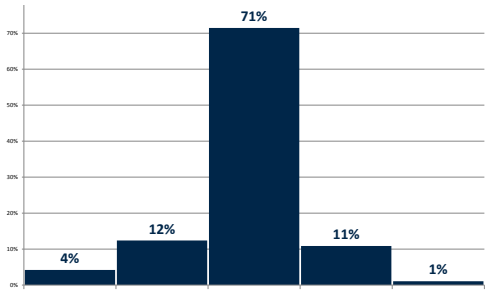
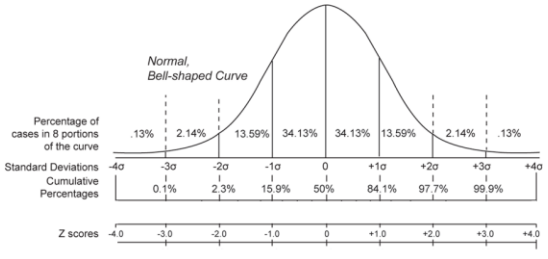
Histogram, frequency distribution. Standard curve; Central Limit Theorem: Based on Standard Deviations from a Mean.



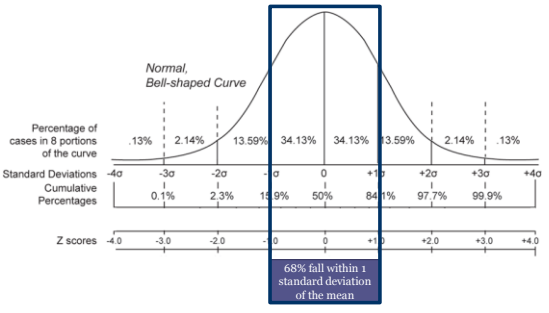
Histogram, frequency distribution. Standard curve; Central Limit Theorem: Based on Standard Deviations from a Mean.



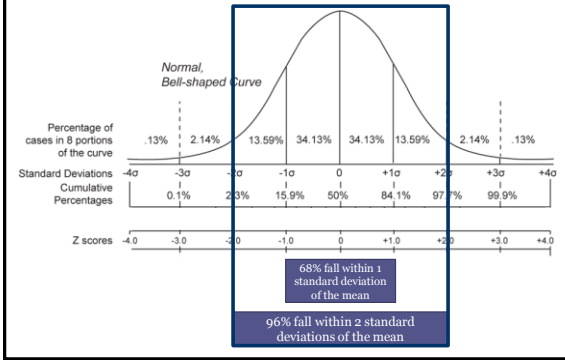
Central Limit Theorem



Central Limit Theorem



Central Limit Theorem



Statistical Process Control (SPC)

- A line graph with a center line is a run chart
  - The center line introduces tests of significance
  - Triggering a rule indicates special cause variation
- Control Charts add upper and lower limits to the center line and increase the tests for significance
  - Let your line graphs evolve into run charts and your run charts evolve into control charts
  - You are adding tests of significance, not complexity

Statistical Process Control

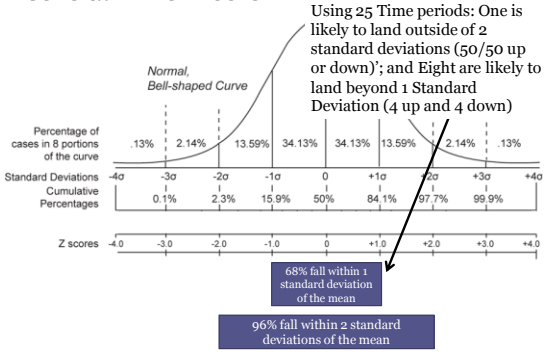
- **Western Electric rules for detecting signals**
  - Created by Walter A. Shewhart as a process-behavior chart; used in statistical process control to determine if a manufacturing or business process is in a state of statistical control.
    - Shewhart framed the problem in terms of Common- and special-causes of variation and, on May 16, 1924, wrote an internal memo introducing the control chart as a tool for distinguishing between the two.
  - **Adopted and used by W. Edwards Deming while working at the Hawthorne Works a Western Electric factory outside Chicago (1924-25).**
    - The place the time coining the "Hawthorne Effect."

http://en.wikipedia.org/wiki/Control_chart

Statistical Process Control

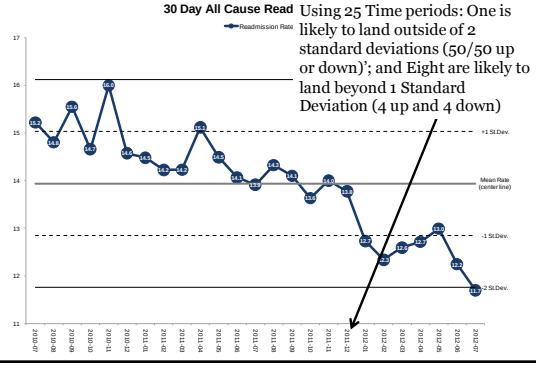
- **Western Electric rules for detecting signals**
  - **Rule 1:** Any single data point falls outside 3-standard deviations from the centerline, on either side of the centerline.
  - **Rule 2:** Two out of three consecutive points fall beyond 2-standard deviations from the centerline, on the same side of the centerline.
  - **Rule 3:** Four out of five consecutive points fall beyond 1-standard deviation from the centerline, on the same side of the centerline
  - **Rule 4:** Eight consecutive points fall on the same side of the centerline.

Central Limit Theorem



Using 25 Time periods: One is likely to land outside of 2 standard deviations (50/50 up or down)'; and Eight are likely to land beyond 1 Standard Deviation (4 up and 4 down)

A run chart with more tests for significance



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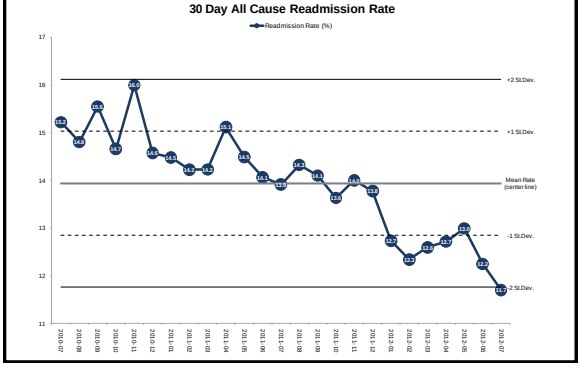
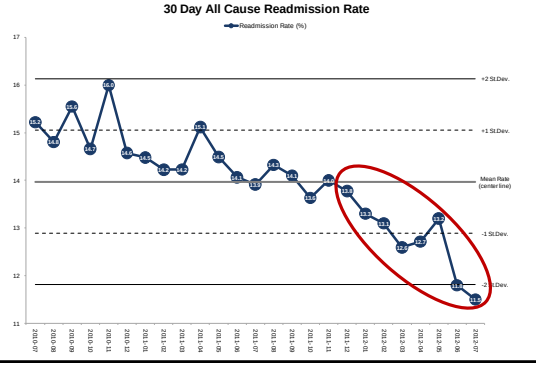
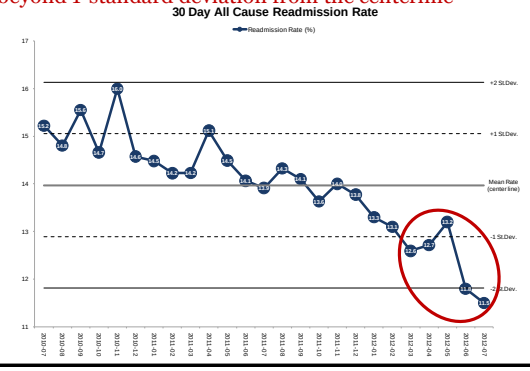


Eight consecutive points fall on one side of the centerline



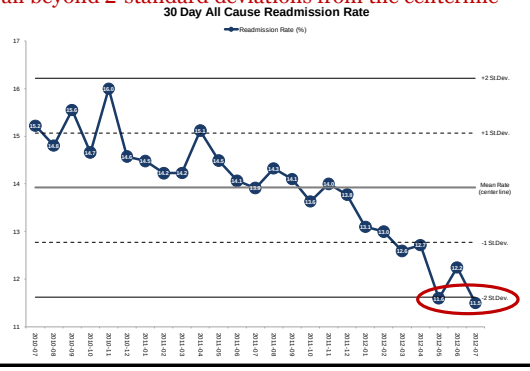
Control Chart

Four out of five consecutive points fall beyond 1-standard deviation from the centerline



Control Chart

Two out of three consecutive points Fall beyond 2-standard deviations from the centerline



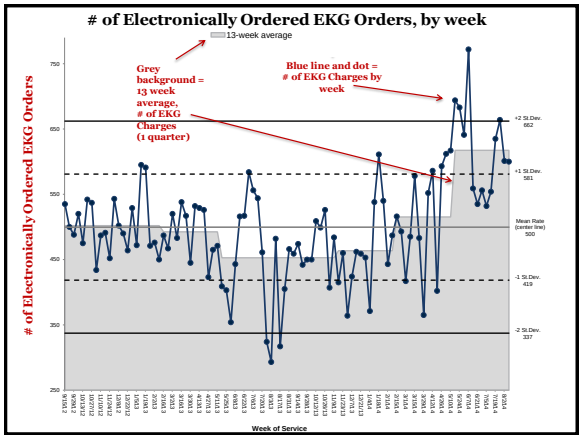
Control Chart Demo

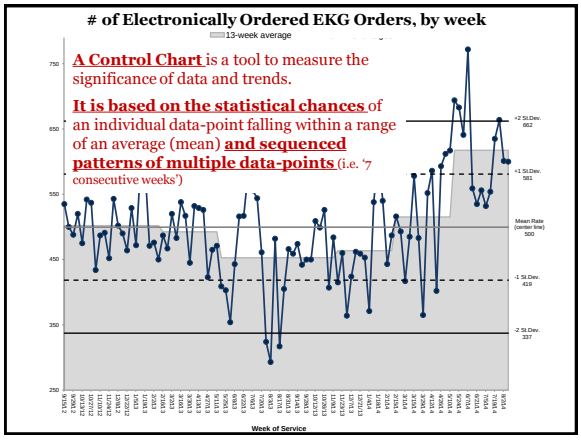
- In MSExcel: From two columns or two rows of data: Time periods and rates
- Create a singe cell calculation of the mean [=AVERAGE(RANGE) in excel]
- Create a single cell calculation of the standard deviation in excel [=STDEV(RANGE) in excel]
- In a new column or row, parallel to the rate data; in the first cell of data (first time period); make an equation for +2 standard deviations [=AVERAGE + (2*STDEV)]; in the second cell for that column or row (second time period), make a formula that points at the first cell, and copy that for each time period; so that entire row/column of data is the same
- Then repeat and make rows or columns for +1sd, Mean, -1sd, -2sd
- Now you will have 7-colums or rows of data to chart: Time Period; Rate; +2 standard deviations ;+1 standard deviations; Mean; -1 standard deviations; -2 standard deviations
- Now use the MSExcel chart wizard to make a line chart!

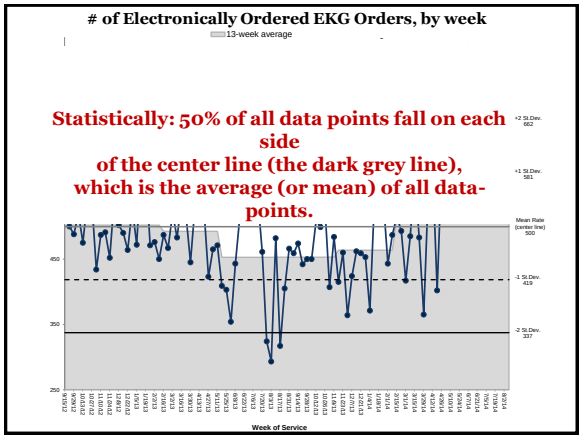
Quality Improvement Tools and Processes for Practice

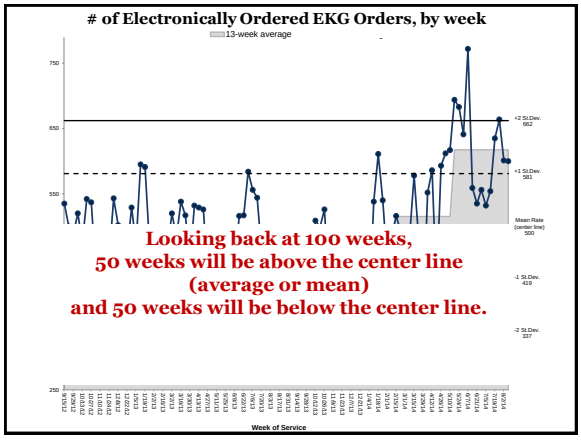
Discussion, Examples, Questions

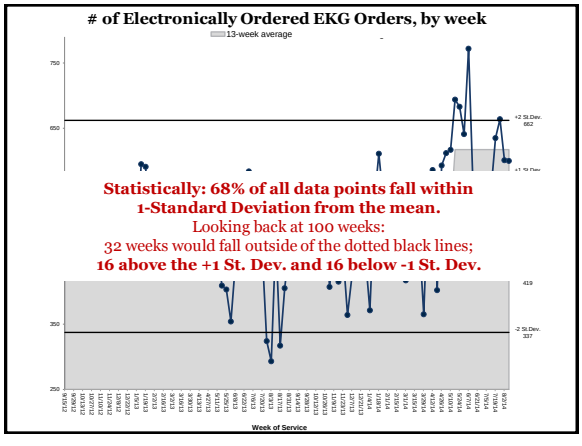
- On-average, an electrocardiogram (EKG) is posted to an account more than 1-week after the date of service.
  - This takes an extraordinary amount of time to reverse an overall claim (billed at 3-days), enter a charge and re-bill a claim, for a service that is often not reimbursed
- EKG Charge Lag
  - From 7-9 days to 2-3 days
- # of EKG Orders and Charges
  - **From <500 per week to >650 per week**

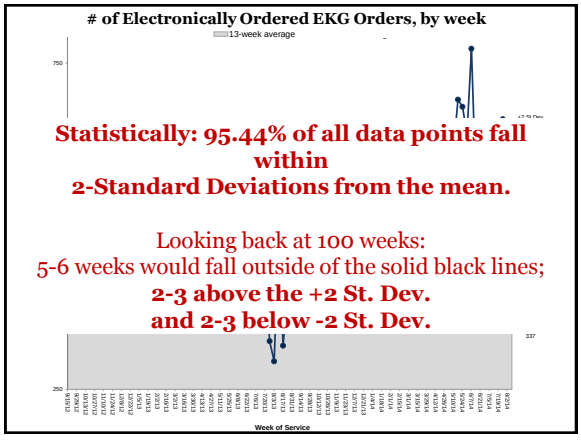


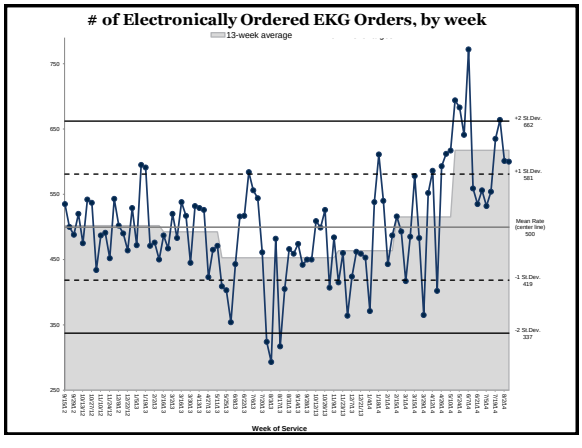


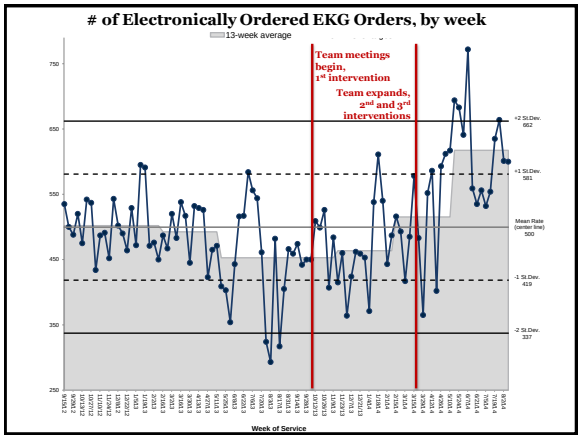

# of Electronically Ordered EKG Orders, by week
13-week average
Statistically: 50% of all data points fall on each side
of the center line (the dark grey line),
which is the average (or mean) of all data-points.
+2 St.Dev. 662
+1 St.Dev. 581
Mean Rate (center line) 500
-1 St.Dev. 419
-2 St.Dev. 337
Week of Service

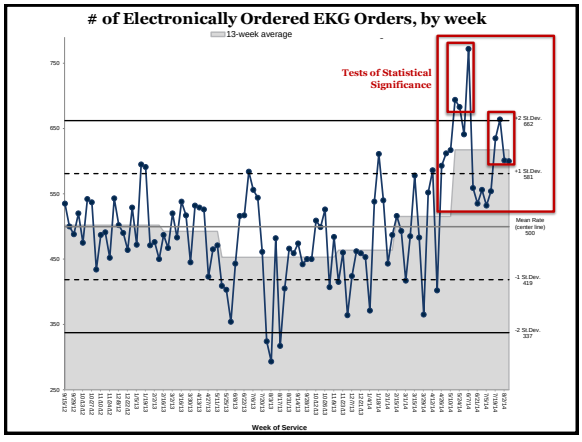

# of Electronically Ordered EKG Orders, by week
13-week average
Looking back at 100 weeks,
50 weeks will be above the center line
(average or mean)
and 50 weeks will be below the center line.
Week of Service

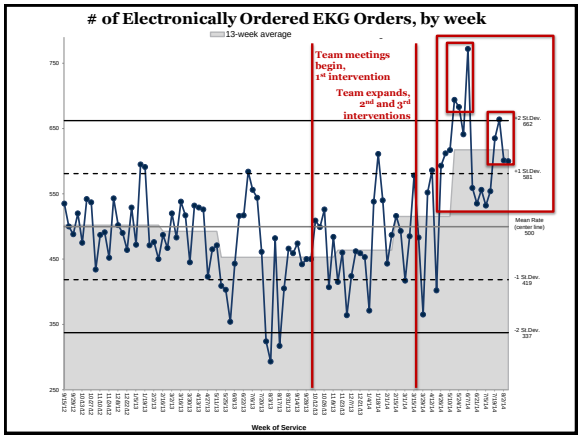

# of Electronically Ordered EKG Orders, by week
13-week average
Statistically: 68% of all data points fall within
1-Standard Deviation from the mean.
Looking back at 100 weeks:
32 weeks would fall outside of the dotted black lines;
16 above the +1 St. Dev. and 16 below -1 St. Dev.
Week of Service


# of Electronically Ordered EKG Orders, by week
13-week average
Statistically: 95.44% of all data points fall within
2-Standard Deviations from the mean.
Looking back at 100 weeks:
5-6 weeks would fall outside of the solid black lines;
2-3 above the +2 St. Dev.
and 2-3 below -2 St. Dev.
Week of Service


# of Electronically Ordered EKG Orders, by week
13-week average
+2 St.Dev. 662
+1 St.Dev. 581
Mean Rate (center line) 500
-1 St.Dev. 419
-2 St.Dev. 337
Week of Service

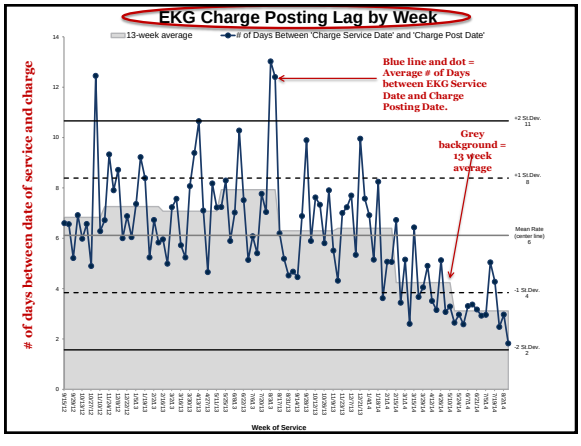

# of Electronically Ordered EKG Orders, by week
13-week average
Team meetings begin, 1st intervention
Team expands, 2nd and 3rd interventions
+2 St.Dev. 662
+1 St.Dev. 581
Mean Rate (center line) 500
-1 St.Dev. 419
-2 St.Dev. 337
Week of Service

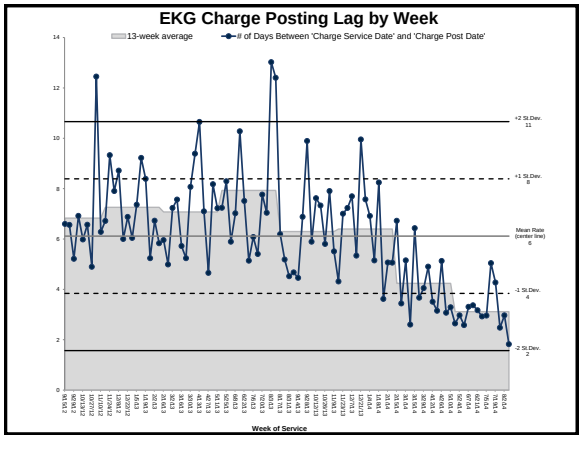


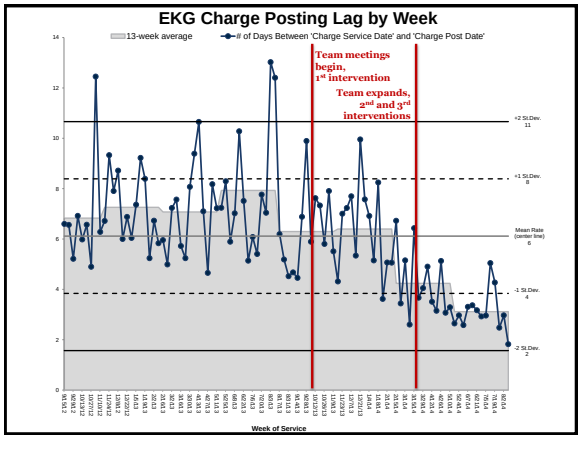


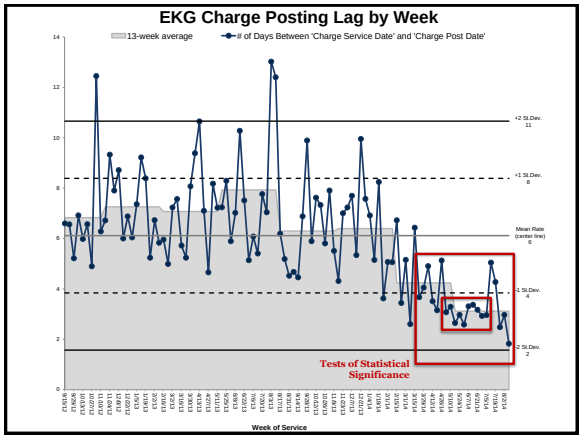
The point of this project was not the # of EKG orders or # of EKG charges…

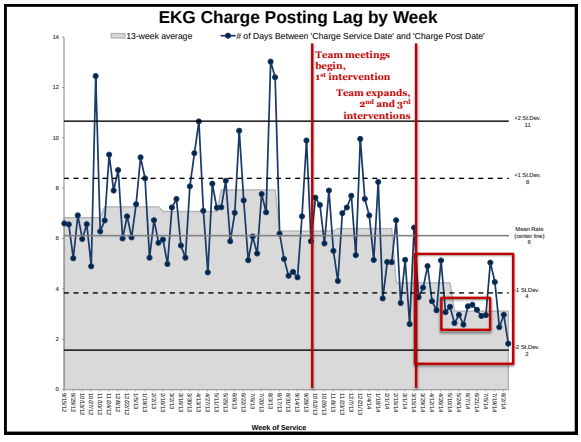
It was the # of days between the date of service and the charge posting date







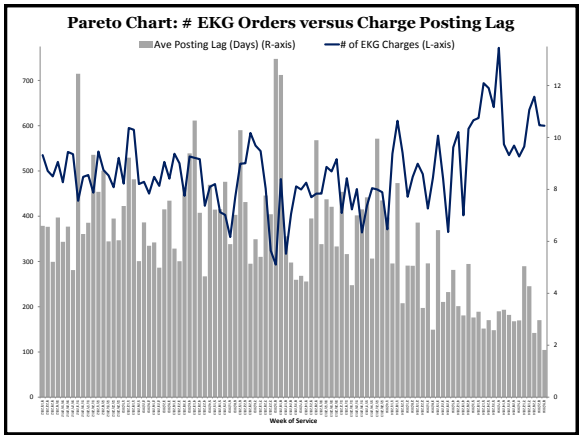




The # of electronically entered EKG orders and the # of days between date of service and charge posting date…

The # of electronically entered EKG orders and the # of days between date of service and charge posting date…

What kind of chart do you want to see



Quality Improvement Tools and Processes for Practice

Throughput, bed availability, access

Bed Flow: Availability of inpatient beds for emergency department (ED) inpatient-boarders to alleviate ED overcrowding.

- Intelliflow Bed management tool
  - Classic lean interventions: Visualization and queuing
- **Increased the rate of beds available before 3PM by over 30%**

Intelliflow Bed Board

Bed Board Background

Situation: There is no real-time, electronic view of patient census and bed availability

Background: EVS was scheduled to install bed board per the Aramark contract; EVS budgeted $110K FY'15.

Assessment: A majority of discharges occur after 3PM.

- Significant delays are introduced when 4 staff are faced with 15 near-simultaneous requests; beds 5-8 will take twice as long to turnover and beds 9-12 will take three times longer.
- While looking to adjust EVS staffing, batching and delays were identified per SBAR bed reporting.

Intelliflow Bed Board

Bed Board Background

Recommendation: Implement a real-time, visual queuing system; improve the process.

- Measures of Success:
  - Ability Track Room Status: Clean, Dirty, precaution status, other restrictions.
  - Report turnover times, performance and ensure proper EVS staffing levels.
  - Reduce time lags in the bed turnover process.
  - Reduce STAT cleaning requests by proactively prioritizing, assigning and cleaning rooms before the need for "STAT".

Intelliflow Bed Board

Intelliflow Go-live and Utilization

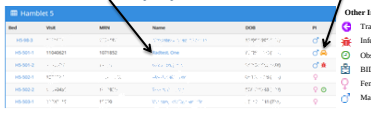
- Weekly meetings began in October 2014
- New Discharge Order report was created and tested as the trigger for this process and used in interim (January 2015)
- July 20, 2015: Pilot-launch Telemetry (H5)
  - Continued pilot for development through house-wide go-live
- August-September 2015: Super-user training and go-live preparation
- September 15, 2015 7AM: House-wide go-live

Intelliflow Bed Board

Nursing Unit view

Patients with a Discharge Order have an Orange Car Symbol

1. Click the **Patient Name** to open a patient-view



2. Select the **Discharge Status** for the patient from the drop-down menu (Status = Home, SNF, VNA, etc.) then click the orange button: **Set discharge location**

3. When the patient leaves, click the green button: **Confirm patient discharged**

Once discharged, the **unit-view** will have an empty line and brown Room/Bed indicator.
A message will automatically be sent to Environmental Services and Admitting. No further nursing action is required.

From 'Vacant but dirty' (BROWN) to the room being assigned to a housekeeper **(RED) and cleaned (ORANGE), this room # will change colors until 'Vacant and Clean' (GREEN).**

Intelliflow Bed Board

Environmental Services

This new system replaces the bed flow paging and beeper system.

Housekeepers sign for an IPOD at the beginning of every shift with Supervisor/Shift Lead.

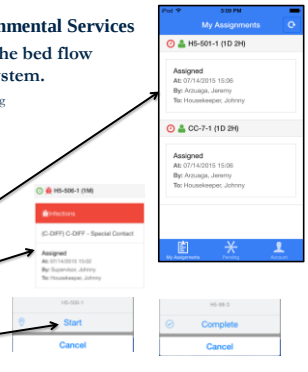
Discharged or transferred patients trigger a request to the EVS Supervisor/Shift Lead.

Supervisor/Shift Lead assigns a dirty room to a Housekeeper.

STAT Rooms will be listed on device by priority level as requested by Nursing Supervisor. (For example: H5-501-1 is a higher priority than CC-7-1 in the picture above.)

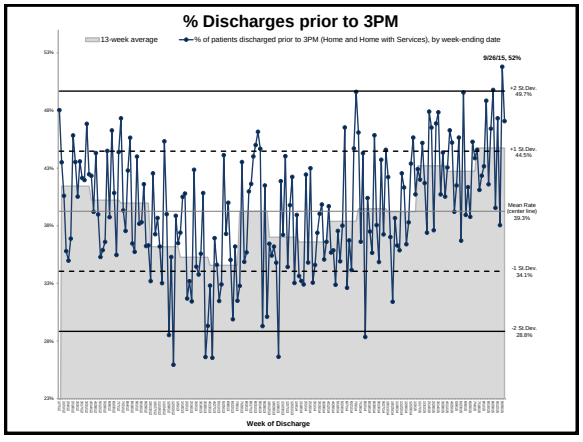
All pre-caution rooms will be identified by a "Bug" next to Rm. #.

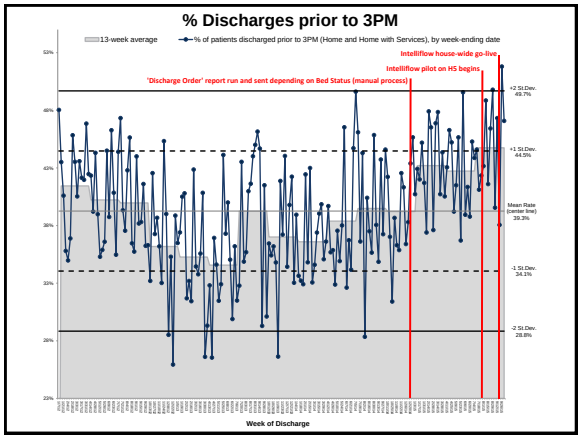
To Start, click **"My Assignments", touch/select room then "Start." Then "Complete" once done.**

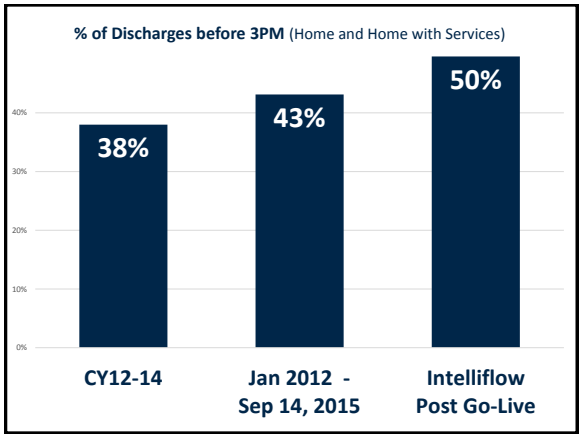


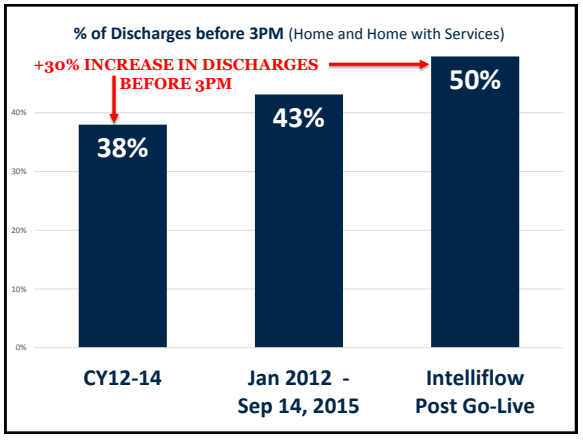
Intelliflow Results

- All bed and other EVS requests are now coming through Intelliflow.
- EVS now has a real-time information on requests.
- Looking at % of patients discharged by 3PM as a key metric
  - Weekly data by week-ending date
  - **From week-ending 1/7/2012 through 10/3/2015**







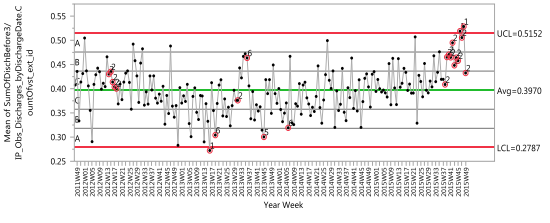


Same set of data run through statistical software, JMP by SAS

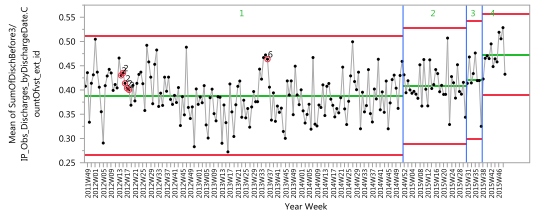
Intervention dates validated

New norms established

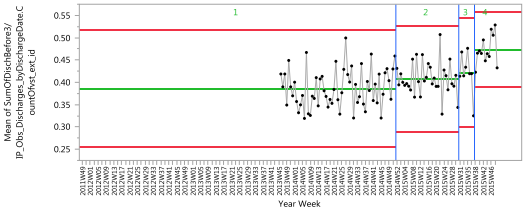
JMP from SAS, % Discharges before 3P



JMP from SAS, % Discharges before 3P



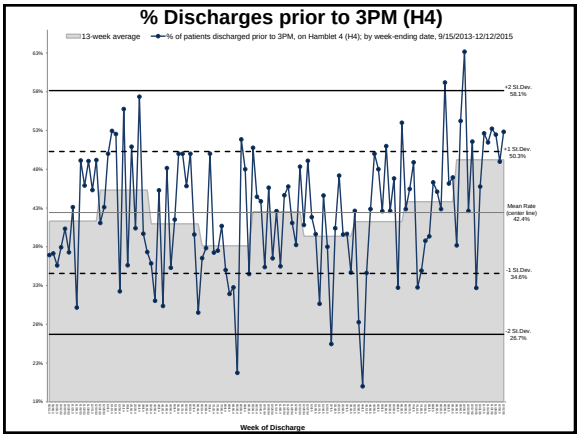
JMP from SAS, % Discharges before 3P

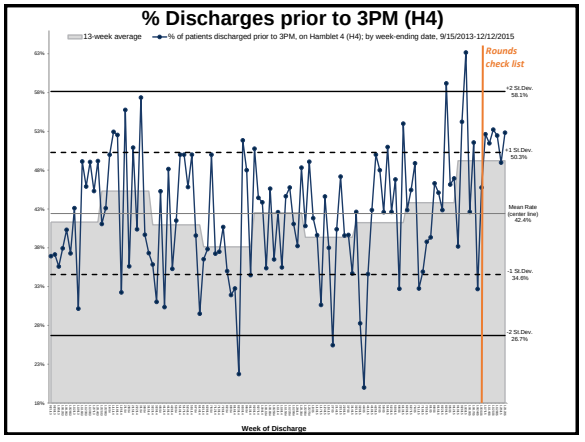


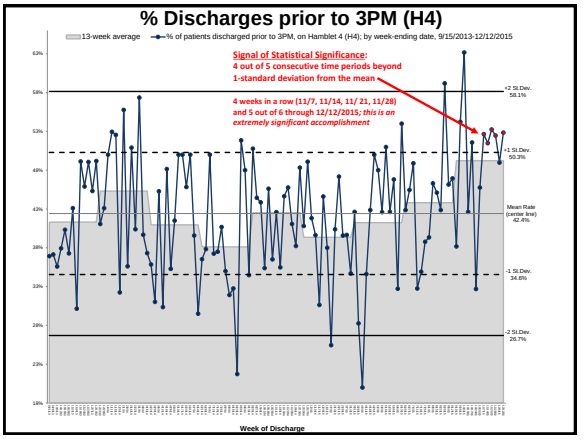
Improvement on improvement on improvement…

New norms and means are set

And more improvements are made…





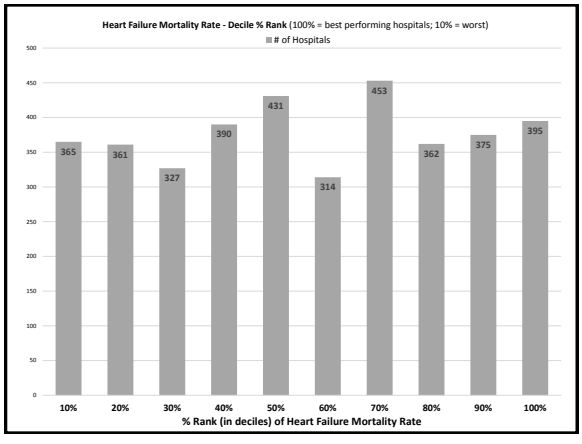


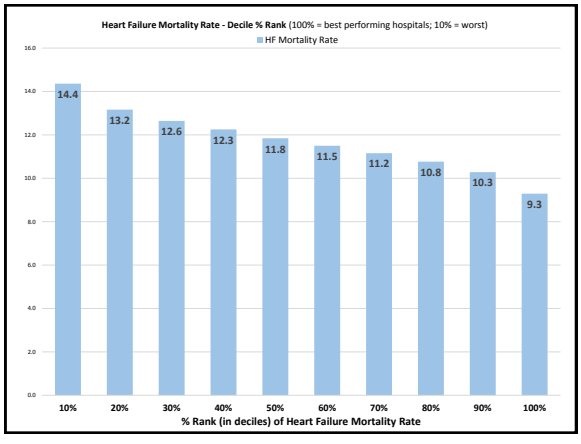
Discussion, Examples, Questions

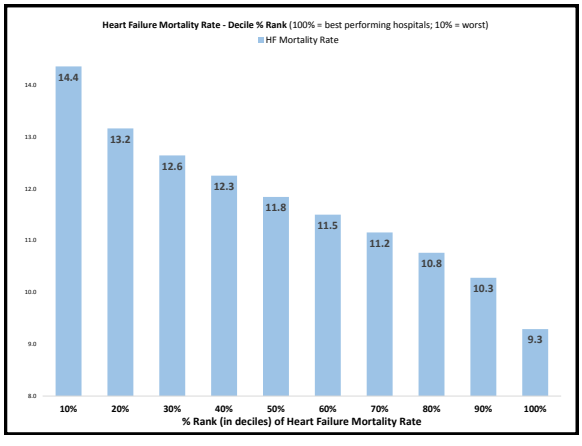
Using Existing Public Data to Illustrate Performance

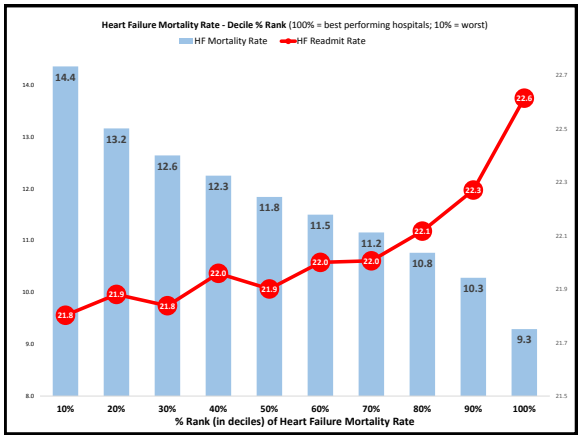
More examples:

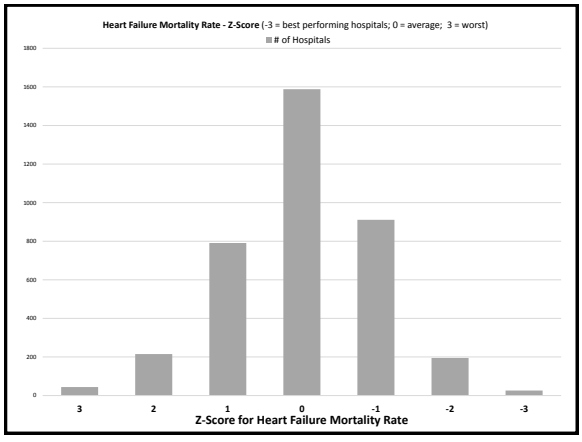
Heart Failure Mortality Versus Heart Failure Readmissions

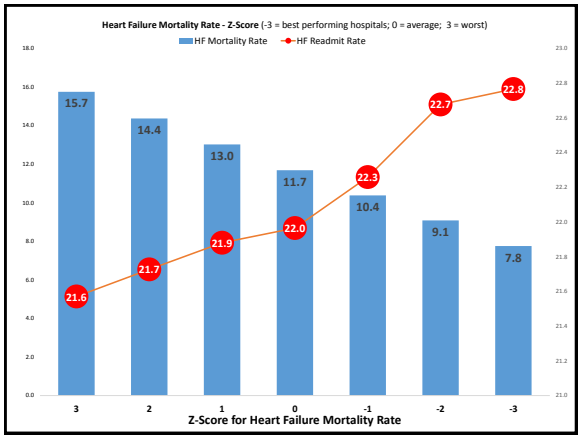


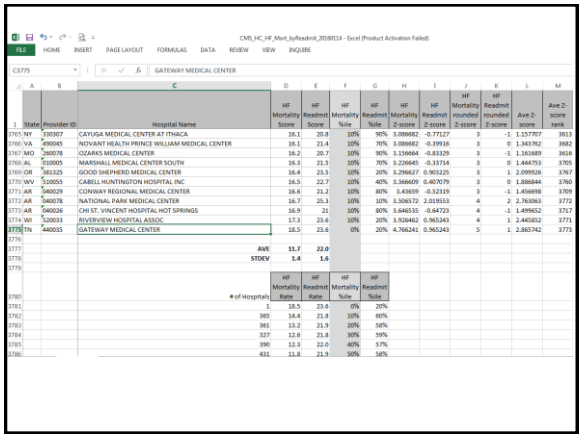












	State	Provider ID	Hospital Name	HF Mortality Score	HF Readmit Score	HF Mortality %ile	HF Readmit %ile	HF Mortality Z-score	HF Readmit Z-score	HF Mortality rounded Z-score	HF Readmit rounded Z-score	Ave Z-score	Ave Z-score rank
3765	NY	330307	CAYUGA MEDICAL CENTER AT ITHACA	16.1	20.8	10%	90%	3.086682	-0.77127	3	-1	1.157787	3613
3766	VA	490045	NOVANT HEALTH PRINCE WILLIAM MEDICAL CENTER	16.1	21.4	10%	70%	3.086682	-0.39916	3	0	1.343762	3682
3767	MO	260078	OZARKS MEDICAL CENTER	16.2	20.7	10%	90%	3.156664	-0.83329	3	-1	1.161889	3616
3768	AL	010005	MARSHALL MEDICAL CENTER SOUTH	16.3	21.5	10%	70%	3.226645	-0.33714	3	0	1.444753	3705
3769	OR	381325	GOOD SHEPHERD MEDICAL CENTER	16.4	23.5	10%	20%	3.296627	0.903225	3	1	2.099926	3767
3770	WV	510055	CABELL HUNTINGTON HOSPITAL INC	16.5	22.7	10%	40%	3.366609	0.407079	3	0	1.886844	3760
3771	AR	040029	CONWAY REGIONAL MEDICAL CENTER	16.6	21.2	10%	80%	3.43659	-0.32319	3	-1	1.456698	3709
3772	AR	040078	NATIONAL PARK MEDICAL CENTER	16.7	25.3	10%	10%	3.506572	2.019553	4	2	2.763063	3772
3773	AR	040026	CHI ST. VINCENT HOSPITAL HOT SPRINGS	16.9	21	10%	80%	3.646535	-0.64723	4	-1	1.499652	3717
3774	WI	520033	RIVERVIEW HOSPITAL ASSOC	17.3	23.6	10%	20%	3.926462	0.965243	4	1	2.445852	3771
3775	TN	440035	GATEWAY MEDICAL CENTER	18.5	23.6	0%	20%	4.766241	0.965243	5	1	2.865742	3773
3776													
3777			AVE	11.7	22.0								
3778			STDEV	1.4	1.6								
3779													

3780 # of Hospitals	HF Mortality Rate	HF Readmit Rate	HF Mortality %ile	HF Readmit %ile
3781 1	18.5	23.6	0%	20%
3782 385	14.4	21.8	10%	80%
3783 361	13.2	21.9	20%	58%
3784 327	12.6	21.8	30%	59%
3785 390	12.3	22.0	40%	57%
3786 431	11.8	21.9	50%	58%

Discussion, Examples, Questions