Decreasing the Variability in Turnaround Time for Radiography Studies from the Emergency Department

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Problem:

- Between January and August of 2011 there were multiple complaints from the Emergency Department (ED) regarding the turnaround time (TAT) for radiology reports.
- Review of the preliminary data showed that the mean TAT was excellent; however, there was considerable day-to-day variability in the TAT, especially after normal business hours.
- The purpose of this project was to decrease the variability in TAT for radiography studies from the ED, and evaluate if a reduction in variation would improve patient throughput in the ED.

Specific Aim:

- The goal of this project was to increase the percentage of ED radiographs with a TAT of 35 minutes or less from 82% to greater than 90% by January 13, 2012.

Methods:

- An interdepartmental improvement team was assembled with members from the radiology department, the division of emergency medicine, and the James M. Anderson Center for Health Systems Excellence.
- The team first determined the goal and defined the metric
  * Overall goal: to have a final report for radiographs available within 1 hour of when the study was ordered
    » Mean time from order to image was measured to be 25 minutes on average
    » This left the radiologist with 35 minutes to interpret and dictate the study
  * Defining the metrics
    » Primary metric – the percentage of ED radiographs with a TAT of 35 minutes or less was defined as the primary metric in order to focus on decreasing variability rather than overall TAT.
    » TAT – the time when the study is completed by the technologist in the radiology information system to the time when the report is finalized by the staff radiologist
- Reasons to focus on ED radiographs
  * They disproportionally affect the overall TAT for ED patients – 85% of all radiology studies performed on patients from the ED are radiographs
  * Has the largest impact on ED patient throughput as a rapid TAT would allow the ED staff to quickly treat and discharge the lower acuity patients that make up a large percentage of the ED census.
  * TAT for ED radiographs provides a reasonable real-time measure of how well the department is keeping up with overall demand
- The team then created a process map to describe the radiologist's reading workflow as well as a modified failure mode and effects analysis (Fig. 1) in order to determine potential areas for improvement.

Interventions:

- Finally, the team designed several interventions
  * Increase awareness of problem
    » Email to staff from chair describing problem
    » Presentation at faculty meeting describing problem
  * Direct feedback to faculty
    » Daily TAT report
    » Daily TAT report with comparative data (Fig 2)
    » Increase staffing
    » Double cover call shifts
  * Efficiency training
    » Email tips to improve efficiency
    » One-on-one training teaching tips to improve efficiency
- The daily TAT report with comparative data was the main intervention.

Figure 1:

Modified failure mode effects analysis diagram showing the process (black boxes) required to interpret and dictate a radiograph from the emergency department. The failure modes listed in the red boxes show the potential reasons an individual step could fail. The interventions listed in the green boxes show all of the interventions that have been implemented or could be implemented to ensure that a failure does not occur. The interventions listed in red text are the interventions that were considered in this improvement project.

Figure 2A:

Radiologist X 12/7
n=49; mean 6.8; Median 6; 100% < 35 min

Figure 2B:

Daily TAT report for 12/7/2011. a) This email report is sent to the radiologist the day after he or she is on call. It tells the radiologist how he or she performed and how he or she compares to their peers. In addition, a chart showing the TAT for each radiograph is attached (b). On the chart, the x-axis shows the time the study was completed in the radiology information system and the y-axis shows the TAT. The blue point represents the TAT for one ED radiograph. The red line represents the median TAT for the call shift and the green line is the target of 35 minutes. Each radiologist is provided with the number of studies he or she read (n), their mean TAT, median TAT, and percent of studies read in 35 minutes or less.

Methods of analysis:

- Statistical process control
  * Obtained TAT values for every ED radiograph performed over each 24-hour calendar day
  * The percent of ED radiographs with a TAT of 35 minutes or less was calculated for each day and charted on a p-chart.
  * X-bar and S-bar charts were used to measure the change in the variability of the TAT for ED radiographs.
  * In order to measure if the changes in radiology had an effect on patient flow in the ED, the time from when the ED staff first met with the patient to the time a final treatment decision was made ("doc to disposition" time) was measured and charted on x-bar and s-charts.
  * Statistical significance for all process control charts was determined using the accepted rules for identifying special cause variation.
- Statistical analysis
  * Two-tailed t-test for independent variables to compare means
  * Wilcoxon rank sum to compare medians
  * Two sample t-test to compare percentages.

Figure 3:

Annotated p-chart showing the daily percentage (blue points) of ED radiographs read within 35 minutes. The mean percentage of radiographs read with a TAT within 35 minutes is represented by the solid red line. The annotations (yellow boxes) describe the dates of different interventions. Note that the mean shifted downward in mid-to-late December. This occurred primarily because a radiologist on the overnight call shift was batch reading exams. After discussing the downsides of this process with the radiologist on 12/21/2011, the radiologist's practice changed and the mean percentage of radiographs with a TAT within 35 minutes improved again.

Figure 4A:

Figure 4B:

X-Bar (a) and S-Bar (b) charts showing the daily mean (X-bar) and daily mean standard deviation (S-bar) for the TAT for radiographs from the emergency department. On each chart, the points represent either the daily mean (x-bar) or mean standard deviation (s). The solid red line represents the average mean TAT or the average mean standard deviation for the TAT.

Results:

- Baseline
  * 80 days between July 1, 2011, and September 19, 2011
  * 8,602 ED radiographs performed
  * Mean TAT was 23.9 minutes
  * Median TAT was 15 minutes.
  * 7,073 or 82.2% of all ED radiographs were read with a TAT of 35 minutes or less
  * Standard deviation for TAT was 22.8 minutes
- After implementation
  * 89 days between October 17, 2011, and January 13, 2012.
  * 8,913 ED radiographs performed
  * Mean TAT improved to 14.6 minutes (p<0.01)
  * Median TAT improved to 10 minutes (p<0.01)
  * 8,283 or 92.9% (p<0.01) of all ED radiographs were read with a TAT of 35 minutes or less (Fig 3)
  * Standard deviation for TAT was 12.7 minutes (Fig 4)
- Additional benefits
  * Daily TAT reports helped to identify reading practices that negatively affected TAT (Fig 5)
- Balance measures
  * Percentage of studies read by trainees
    » Baseline: 62%
    » After intervention: 59.9%
  * TAT for non-ED Radiographs
    » Baseline: 65 minutes
    » After intervention: 46 minutes (p<0.01)
  * TAT for all imaging studies
    » Baseline: 102 minutes
    » After intervention: 78 minutes (p<0.01)
- Effect on ED Doc to disposition time
  * Baseline: 88.7 minutes
  * After intervention: 79.8 minutes

Radiologist Y 10/9 – 10/10
n=36; mean 48; Median 50; 30.5% < 35 min

Figure 5:

Daily TAT report for the overnight call shift between October 9 and October 10, 2011. This report shows a batch reading pattern. In this example, the radiologist waited long periods of time between signing reports. As the radiologist signed a group of reports, the TAT became shorter for reports in the queue. Once the radiologist caught up, he or she then waited for another batch of reports. This is shown by the sudden jump in TAT.

Conclusion:

- As the departmental TAT falls under 25 minutes, further improvement is possible.
  * In order to continue to improve the TAT, technologic interventions are not necessary.
  * In the past, we have improved the TAT through workflow design, reading room enhancements, and standardizing/structured reporting.
  * In order to continue to improve, we worked to decrease provider variability.
- We were successful in decreasing the average TAT for ED radiographs as well as the variability, as manifested by:
  * Decrease in mean TAT from 23.8 to 14.6 minutes
  * Increase in the percentage of ED radiographs with a TAT of within 35 minutes from 82.2% to 92.9%
  * Decrease in the standard deviation for TAT from 22.8 to 12.7 minutes.
- The improvements in radiology TAT had a direct effect on the overall ED patient experience
  * Decrease in ED Doc to disposition time from 88.7 to 79.8 minutes
- Overall improvements accomplished through increased transparency, feedback, and individual coaching in a setting where workflow and electronic systems had already been redesigned to optimize TAT.