

THE FINAL TOLLGATE

CT Scan Throughput

BY NANCY B. RIEBLING, ANGELO PELLICONE,
ANTZ JOSEPH AND CHARLES WINTERFELDT

At a 731-bed tertiary hospital in the North Shore-Long Island Jewish Health System, radiology throughput became an issue as the facility struggled to meet the demands of patients, providers and physicians. Effective management of patient flow and length of stay within this large facility required throughput optimization of the hospital's two CT scanners for inpatients and outpatients. A Lean Six Sigma team addressed the problem through a Kaizen event.

The Final Tollgate features a Six Sigma project as it would be presented to a panel of company executives at the final project review. The objectives of such a presentation are to communicate significant results of the project and share

highlights of how results were achieved. The slides are the Black Belt's visual presentation and the accompanying text is the verbal presentation. It is assumed that the audience has a basic understanding of Six Sigma.

Do you have an exemplary Six Sigma project to share? Would you like to see it here? Submit it to us at isixsigma.com/submit



From the January/February 2007 Issue ■ Volume 3, Number 1



This reprint is provided by:

innovation³⁶⁰
institute

DEFINE

D M A I C

CT Scan Throughput

Lean Approach to Six Sigma at North Shore University Hospital



Purpose: Improve daily patient throughput on two CT scanners, Monday - Friday, 8 a.m. - midnight

Goal: Increase daily patient throughput by 20%
This meant increasing patient volume from 45 to 54 daily

Benefits: Decreased length of stay and scheduling delays, increased patient and physician satisfaction

Project utilized Lean and Six Sigma tools in a Kaizen format

Define

The turnaround time for the radiology CT (computerized tomography) department at North Shore University Hospital was falling significantly short of expectations. Voice-of-the-customer data indicated that the expected turnaround time (TAT) for a routine CT scan was one operational day, or 16 hours. In this case, the customers included physicians with high utilization of CT scans, case management RNs (registered nurses) and the hospital leadership. Current data, however, showed that TAT averaged 20.7 hours, varying anywhere from 8 hours to 34 hours.

A cross-functional Lean Six Sigma team was formed to address the issue. The team was composed of physician,

technical, managerial, transport and secretarial staff from the radiology department, as well as Six Sigma experts from the Center of Learning and Innovation, part of the health system's corporate university.

The team's goal was to increase by 20 percent the average daily patient

throughput on the two CT scanners, Monday through Friday, 8 a.m. to midnight. This meant increasing patient volume from 45 patients a day to 54 patients. Our performance target was based on benchmarking best-in-class hospitals. The benefit to the organization would be to decrease scheduling delays and a patient's length of stay, and to increase patient and physician satisfaction.

The first step was to gather baseline performance information and collect additional voice-of-the-customer data. From this information, we identified initial areas of concern:

- The CT technologists fielded up to 75 calls per day from the nursing units or CT reception desk regarding scheduling questions, taking them away from scanning.
- The lead technologist had no designated workspace and the general work environment was cluttered.
- The CT technologists felt the current methods to prepare and deliver oral contrast media were too time consuming.
- Transporter availability (which depended on the radiology transporter pool) and the pre-transport process were slow.

The team decided to use a Kaizen event to identify solutions and effect change. Kaizen is a method for accel-

North Shore-Long Island Jewish Health System is the third largest non-profit secular healthcare system in the United States. **North Shore University Hospital** in Manhasset, New York, is a cornerstone of the health system, as well as an academic campus for the New York University School of Medicine and the Albert Einstein College of Medicine. The hospital has 731 beds and a staff of 2,700 specialist and sub-specialist physicians. It offers advanced care in all medical specialties.



MEASURE

D

M

A

I

C

CT Scan Throughput

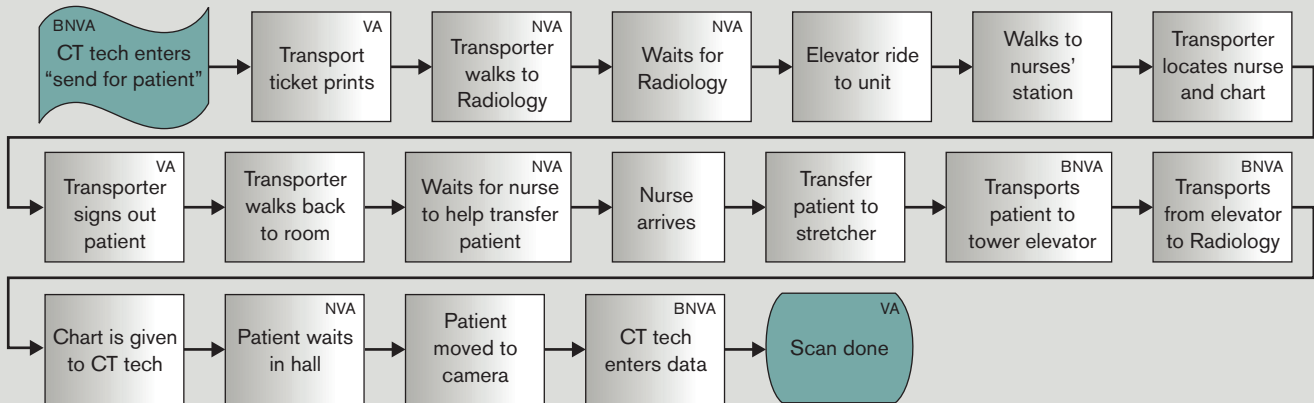
Turnaround time: The time from when a CT test is ordered until the test is performed

Target turnaround time: 16 hours

Defect: More than 16 hours

Baseline performance: 398,258 DPMO → 1.7 sigma

Value Stream Map (Excerpt)



Reduced turnaround time will yield increased patient throughput

erating the pace of process improvement whereby team members spend 100 percent of their time working on DMAIC (Define, Measure, Analyze, Improve, Control) for a limited time. The Black Belts completed preparatory work prior to the Kaizen, defining the scope of the project, collecting baseline data and forming a charter with the project sponsor. The sponsor was the chairman of radiology for the North Shore-Long Island Jewish Health System. The event itself took four days, with implementation following immediately after that.

Measure

The team began the Measure phase on Day 1 of the Kaizen event. Measurement systems analysis was performed on the baseline process performance data to validate that it accurately reflected the process.

The target TAT was 16 hours. Turnaround time was defined as the time from when a CT test is ordered until the test is performed; a defect was defined as anything more than 16 hours. Using the baseline data, we calculated our current performance as 398,258 DPMO, or 1.7 sigma.

We developed a detailed value stream map of the CT process and classified each step as one of the following:

- **Value added (VA)** – an activity that is essential to deliver the service to the customer

- **Business non-value added (BNVA)** – an activity that is required by the business but adds no real value from a customer standpoint
- **Non-value added (NVA)** – an activity that adds no value from the customer's perspective and is not required for financial, legal or other business reasons

As part of a Lean exercise, the team looked at the process for the seven forms of waste: transportation, inventory, motion, waiting, overproduction, overprocessing and defects/rework.

We also looked at key metrics such as the number of patients scanned and reasons for cancellations.

Analyze

Utilizing a cause-and-effect diagram, the team identified the key drivers, or vital x's, that influence the CT throughput rate: workspace, workflow and scheduling.

Analyze continued on Day 2 as we brainstormed solutions, utilizing Lean and Six Sigma tools.

The team addressed the workspace with a coordinated 5S exercise. 5S is a method for creating and maintaining an organized, clean and high-performance workplace. The 5S's are: sort (distinguish needed from unneeded items), simplify (place items in their correct location), shine (make the work environment clean and orderly), standardize (cre-

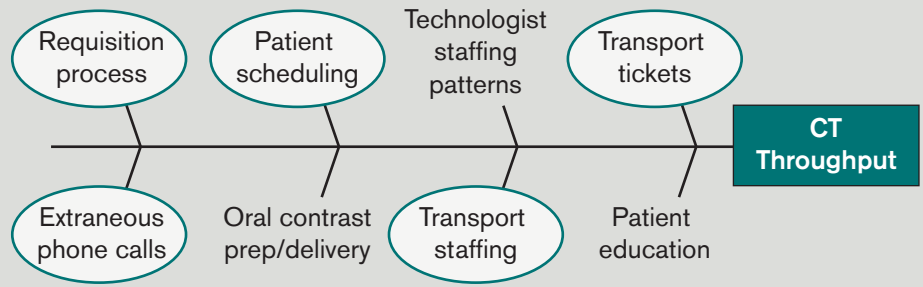
ANALYZE

D M A I C

CT Scan Throughput

Cause-and-effect analysis led to 3 key areas driving CT throughput:

1. Workspace
2. Workflow
3. Scheduling



Before-Kaizen Workspace



After-Kaizen Workspace



ate a consistent way of implementing tasks on a routine basis), and sustain (develop control mechanisms).

As a result of this work, the team created a designated workspace for the CT lead technologist, provided an additional computer station for the technical staff, and added wall-mounted shelves with file holders for better departmental organization. The Kaizen team collaborated with engineering, environmental services and information services to complete this portion of the project.

Next, we took a hard look at the workflow, using the results of the process mapping and VA/NVA classification activities from the Measure phase and completing a spaghetti diagram.

Because the technologists and transporters wore pedometers to record how far they walked each day, we were able to calculate that the average CT technologist traveled 6,480 feet per day to the requisition printer, which was located down the hall from the scanners, to retrieve a scanning order. This translated to 324 miles per year of NVA activity. The transporter traveled an average distance of 432 feet per day going back and forth to the transport notification printer – 21.6 miles per year.

Finally, we investigated issues with scheduling. As noted in the pre-Kaizen Define phase, CT technologists approximated that they received 75 calls per day from the

nursing staff or CT reception desk with scheduling questions. These phone calls took the technologist away from their value-added job of scanning patients and contributed to a longer turnaround time.

We discovered that the reason for the many scheduling questions was because the schedule was maintained through a manual process. The CT supervisor handwrote a schedule and continuously revised it to meet the daily demands of the department. Because it was a handwritten schedule, the hospital nursing units as well as the CT clerical staff had limited or no access to it; thus, they relied on calling the technologist to resolve any scheduling questions.

Moreover, the inability of the nursing units to easily check the schedule also caused delays in the process because inpatients whose nurse was unaware of a scheduled scan would not be ready when the transporter arrived.

Improve

On the third day of the Kaizen, the team try-stormed potential solutions for the key issues of workflow and scheduling.

For workflow, in order to reduce the travel time of the CT technologist and transporters within the radiology department, the team designated one printer for CT and routed both the requisitions and transport requests to this



IMPROVE

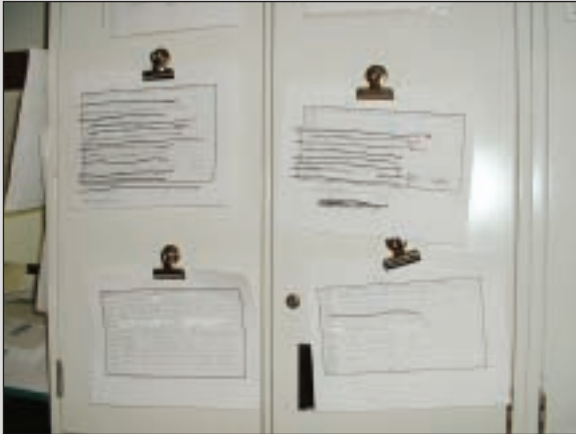
D M A I C

*CT Scan Throughput***Scheduling Problems**

- Handwritten schedule revised continuously to meet demand
- No schedule visibility for CT clerical staff and hospital nursing units

Actions Taken

- Created new schedule in Excel format
- Instituted process to provide schedule visibility within and outside the CT department
- Added 10 outpatient slots on Mondays
- Implemented “pull” scheduling process – scanning next patient as soon as ready, regardless of time
- Designated one CT scanner for complex procedures and one for routine procedures

Before-Kaizen Schedule**After-Kaizen Schedule**

No.	Route	Time	Patient Name	Exam Type	Location	Ref	Ref	Ref	Ref
1	0	8:30		Exam	MSU				
2	0	8:30		Exam	MSU				
3	0	8:40		Exam	MSU				
4	0	8:50		Exam	MSU				
5	0	11:00		Exam	MSU				
6	0	13:00		CT	Chem				
7	0	13:30							
8	0	13:30		CT	Chem				
9	0	14:00		Exam	MSU				
10	0	14:20		Exam	MSU				
11	0	14:40							
12	0	18:00		Exam	MSU				
13	0	18:20		CT	Chem				

printer. The printer was relocated to a more central location in one of the CT scanner rooms, thereby eliminating more than 300 miles per year in NVA walking by technologists and transporters. The new printer location created an additional benefit of better communication between the CT technical staff and transporters, while at the same time reducing the traffic in the main hallway in the radiology department.

The team also recommended dedicating a transporter specifically for the CT department, rather than relying on the radiology transport pool. This further improved the communication between the CT technologist and the transporter, thereby increasing the speed with which patients are brought to and from the CT department.

Construction and reorganization of the reception area included a new refrigerator so the receptionist could distribute the oral contrast to outpatients, further reducing the NVA activities of the CT technologist. Oral contrast preparation was reassigned to the evening shift and the delivery of morning contrast was incorporated into the transporter's first morning run for inpatients. The new process eliminated an additional NVA activity of the CT technologist.

To address the scheduling problems, the team decided to implement an electronic schedule in Excel. We devel-

oped a process to fax schedules to all floors of the hospital, and, more importantly, to provide electronic access through Outlook for both the CT department and the nursing units on each floor. Additionally, instead of relying on a rigid schedule with fixed time slots, the team designed a “pull” process – as a patient scan is completed, the next patient is advanced regardless of time. If a stat order is received, it is inserted into the schedule and after completion, the next patient on the schedule moves forward.

Providing the nursing units with access to the schedule reduced the number of phone calls received by the technical staff inquiring about patient prep and scheduled procedure time. It also reduced the number of cancellations caused by improper patient prep or patient unavailability, which occurred on a daily basis. In the past, because the schedule was not well communicated to the nursing staff, the nurses would not always know to get patients prepped in time for a scan.

Making schedule changes also helped. Previously, no outpatients were scheduled for scans on Monday in order to accommodate the backlog of inpatients generated over the weekend. The data showed, however, that even though there was an increase in the number of inpatients scanned on Monday, the total CT patient volume was statistically higher on Tuesday through Thursday – the days

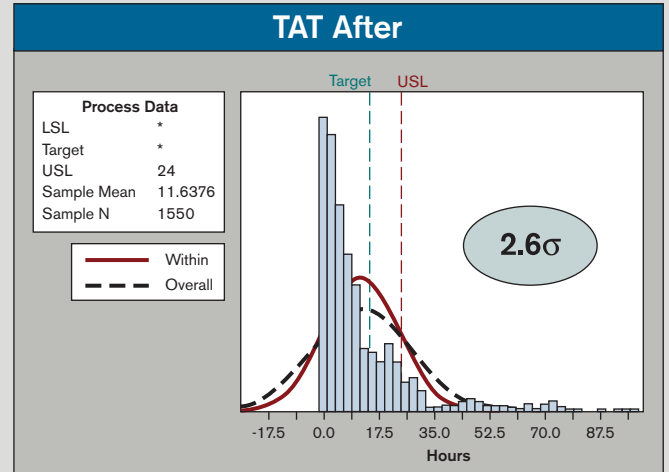
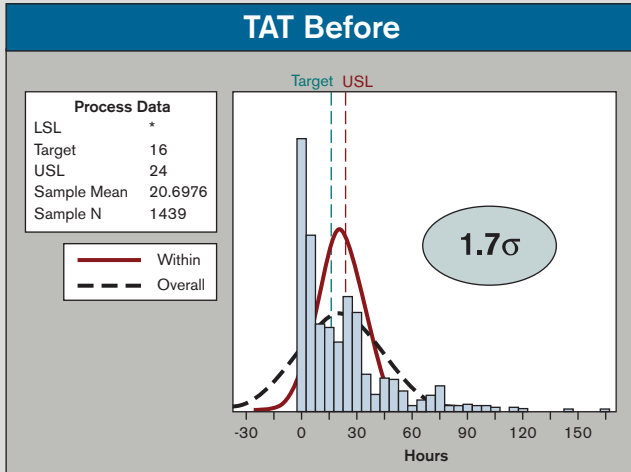
CONTROL

D M A I C

CT Scan Throughput

Project Results

- Reduced average TAT from 20.7 hours to 11.6 hours
- 200 additional inpatient procedures per month
- 60 additional outpatient procedures per month
- \$375,000 in additional revenue from increased outpatient volume
- Average number of patients scanned per day increased from 45 to 51
- Standard deviation decreased from 7 patients to 4 patients
- Cancellations due to improper patient prep decreased from 30.6% to 22.7%



that the department scheduled outpatient procedures. The team added 10 additional outpatient slots to Monday, thereby generating additional revenue for the department.

Another solution by the team was to designate one of the hospital's two CT scanners for complex procedures, and the second for routine, high-volume procedures. By modifying the procedure types served by each scanner, we were able to facilitate optimal patient flow.

Finally, the team developed a "WWW" (who, what, when) system of accountability to ensure that every action item from the Kaizen event was assigned to a team member, with a deliverable date.

Control

On Day 4, the team piloted the improvements. The improved processes achieved a 33 percent increase in CT patient throughput on the two CT scanners. Feedback from the pilot nursing units was that the nurses loved the access to the CT schedule. They felt that it allowed them to better coordinate a patient's activities, thus improving workflow in their units.

The team reconvened to develop rollout strategies for hospital-wide implementation of the solutions and to develop metrics to ensure that the improvements stay in place. We developed a rollout with visibility through Outlook for

all nursing units in the hospital. I-MR control charts were used to track daily patient volume, and process capability charts were used to monitor turnaround time.

In a relatively short period (30 days), the daily number of patients scanned increased from an average of 45, with a standard deviation (SD) of 7, to 51 patients scanned, with a SD of 4. Additionally, procedure cancellations due to improper patient prep decreased from 30.6 percent to 22.7 percent.

The increased capacity yielded approximately 200 additional inpatient procedures per month and an additional 60 outpatient procedures per month. The additional outpatient volume generates approximately \$375,000 in revenue for the radiology department.

Finally, the average turnaround time for inpatient CT scans decreased from 20.7 hours before the project to 11.6 hours. The new process yielded a DPMO of 141,428, or 2.6 sigma. ♦

Nancy B. Riebling is the director of operational performance solutions at North Shore University Hospital (NSUH) and a Master Black Belt. Angelo Pellicone is a certified Black Belt at NSUH. Antz Joseph is a certified Black Belt at NSUH. Charles Winterfeldt is the hospital's associate director of radiology and a Green Belt.