Utilizing Six Sigma Lean Strategies to Expedite Emergency Department CT Scan Throughput in a Tertiary Care Facility

Devon Klein, MD, MPH, Vandana Khan, EMBA, RT(R)(M)

INTRODUCTION

Lenox Hill Hospital, like many other metropolitan hospitals, is witnessing an increase in emergency department (ED) visits. The increased patient visits subsequently result in increased demands on existing fixed resources such as CT scanners. Observed delays and variability in the process have resulted in investigation of ED CT scan throughput as an item to review for continued practice improvement.

ACTION

Located in the Upper East Side of Manhattan, Lenox Hill Hospital is one of five tertiary care teaching institutions of Northwell Healthcare. We have a growing emergency department with over 50,000 visits per year. As a result, there is a subsequent increase in utilization of hospital resources, including resources in the radiology department. Within the radiology department, CT scanners are a fixed resource. At Lenox Hill Hospital, three CT scanners serve inpatient, outpatient, and ED needs. One measure of quality for both the radiology and emergency departments is patient throughput. To help reduce variability and bias, we elected to investigate the throughput of noncontrast CT scan from the ED.

Applying business manufacturing models to the health care industry is not a unique or novel idea. Early adopters focused on applying these models to shifting organizational culture and continuous quality improvement [1]. Prior authors have demonstrated the applicability of business management strategies to health care in general and more specifically to radiology [2,3]. By offering educational seminars and classes in improvement sciences through its Center of Learning and Innovation, our institution encourages the application of the Six Sigma Lean management approach by its employees across all facets of the health care system.

The aforementioned pressures upon the fixed resources in our facility had hindered our ability to achieve our institutional expectations for noncontrast emergency CT scan (NCECT) throughput. Anecdotal and single-point-in-time investigations of our process revealed that we strayed far afield from our desired goals for throughput. At the time of the initial assessment, the CT scanners were located on a different floor than the ED. This factor was a known but not easily correctable contributor to the prolonged throughput time. Several other recognized and unrecognized factors were thought to contribute to the throughput time. Despite continued but loosely organized efforts to improve throughput over 3 years, no significant reduction in mean time was realized.

Baseline data were then collected on 285 examinations performed between October 19, 2014 and October 30, 2014. The data, with a sample size of 285, revealed the average time from electronic order placement to completion of a noncontrast CT scan from the ED to be 146 minutes (2 hours and 25 minutes), with a standard deviation of 63 minutes (Fig. 1). As a result of the large standard deviation, we recognized that there was great process variation and our operational structure required modification to meet our objectives. However, owing to the previously unorganized approach to studying the problem, the areas of "waste" had yet to be identified.

In response, a multidisciplinary task force was created to address the problem. The next month a Six Sigma Lean Kaizan event was convened to break down the process of completing noncontrast CT scans from the ED to a granular level—that is, to identify the "waste," to identify individuals who impact each step, and to ultimately reduce the inefficiencies that cause delay and impact patient care. The team, consisting of representatives from ED nursing, transportation, radiology reception, and CT technologists, assembled for 3 days. The scope of the project was limited only to noncontrast CT scans to reduce the variability introduced by oral and intravenous contrast

1546-1440/16/$36.00 ■ http://dx.doi.org/10.1016/j.jacr.2016.06.032

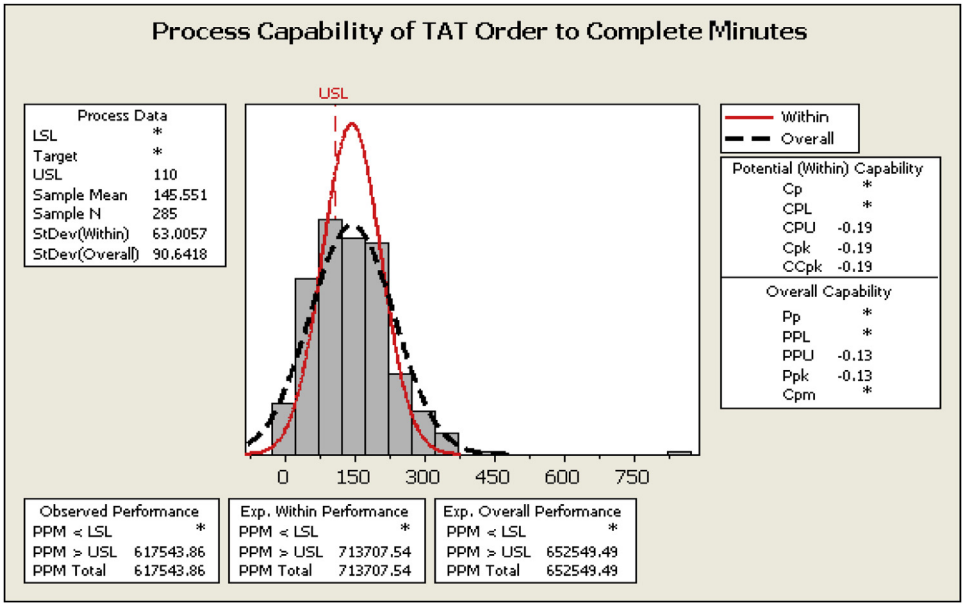

Fig 1. Baseline data analysis curve. Sample size = 285. Mean time 146 minutes. USL = upper specification limits; TAT = turnaround time.

examinations. The team, in conjunction with senior leadership, decided upon a goal of 110 minutes (mean) and a standard deviation of 55 minutes.

The Kaizan team's first activity was to develop a high-level process map to understand the key steps in the process (Fig. 2). Using this information a swimlane diagram was drawn, enabling the Kaizan participants from the different departments to better understand the key steps, sequences, roles, and responsibilities required to complete the examination. An analysis of the collected data highlighted different operational steps with the greatest variation. On day one, a team brainstorm was held to identify causes of delay and variability. The identified barriers to efficiency were affinitized, that is, grouped or clustered by similar ideas or concepts. Value-stream mapping was then performed. As a result of these activities, the operational process for an NCECT was conceptually divided into three key steps: (1) *Possible* - The ED has evaluated the patient and a clinician has placed an order for NCECT; (2)

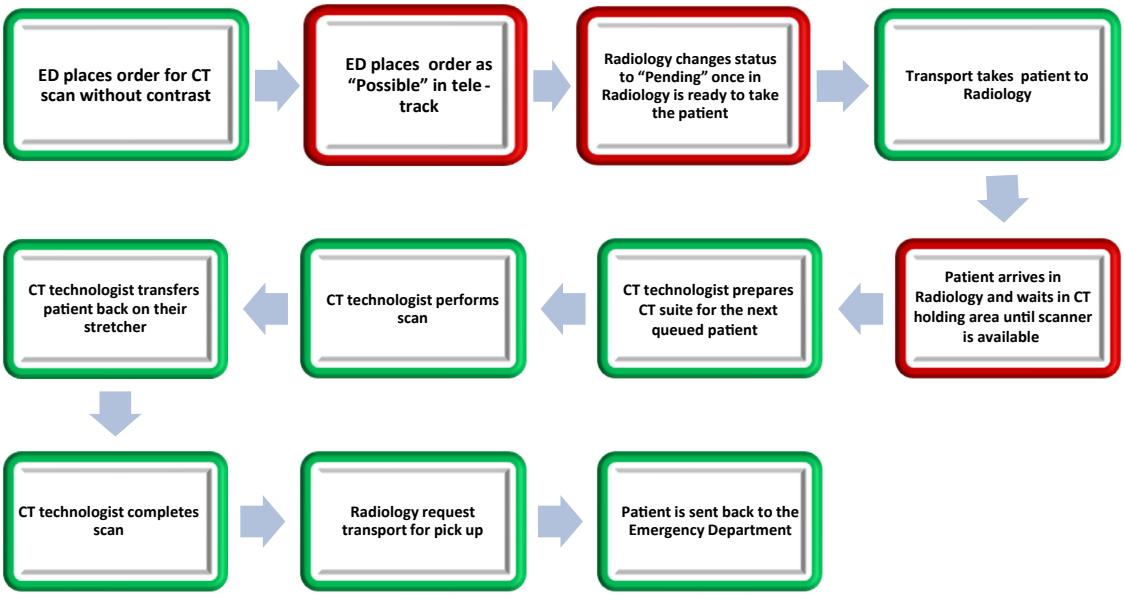

Fig 2. High-level process map. ED = Emergency Department.