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Lean six sigma process improvement in specimen receiving to improve stat chemistry turnaround times

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ABSTRACT

As a consequence of stat turnaround times (TATs) chronically exceeding 60 minutes, our laboratory was facing pressure to divert limited resources toward the implementation of an emergency department satellite laboratory. Peer-reviewed literature in clinical laboratory quality assurance and improvement indicates that between 60-70% of errors occur at the pre-analytical level. Thus, we sought to improve overall TATs by focusing on reducing pre-analytical lag times. Lean six sigma process improvement owes its origins to industry, and may be universally applied in healthcare settings to improve outcomes. We report the application of Lean six sigma process improvement tools in the clinical laboratory specimen accession and processing area of a busy tertiary care center to improve chemistry stat TATs. The prospective before-and-after redesign encompassed a detailed evaluation of existing system, assessment of established monitors and historical data, formulation and implementation of a plan, and post-move data collection and analysis. Allocation of laboratory space was based on Lean six sigma quality improvement methods. Test TAT and volumes were obtained from the LIS. Spaghetti diagrams were utilized to assess workflow in the existing space and in layout planning for the new space. An assessment of the pre-analytical steps in the receiving and processing area, in tandem with pre and post move Pareto chart data enabled the calculation of the reduction of defects per million opportunities that could be ascribed to this effort. 12 months mean ED CMP TATs before the move was 44.4 minutes with 90% of results reported in 60 minutes or less; after the move this improved to a mean of 37.1 minutes with 90% of results reported in 49 minutes or less. 12-month ED troponin mean TAT was 49.5 minutes with 83% of results reported in 60 minutes or less; after the move this improved to mean TAT of 43.4 minutes with 90% of results reported in 55 minutes or less. Given seven touch points per result, this project enabled a 75% reduction in defects per million opportunities. Lean-six sigma tools facilitated the identification and elimination of inefficiencies in specimen receiving to enable sustained improvements in TATs. Thus, defining and measuring problems, planning, taking necessary steps and implementing them are effective techniques to improve throughput in pre-analytical specimen handling. The one-time expenses associated with the moves were minimal, and the cost-avoidance of satellite laboratory oversight and operation is substantial. Lean six sigma techniques can be applied in a cost-effective manner to minimize pre-analytical wastes and improve patient care.

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Abbreviations

TATs, turnaround times; CMP, comprehensive metabolic panel; BMP, basic metabolic panel; ER, emergency room

Introduction

Clinical laboratories, like all healthcare venues, face continual pressure to improve both throughput and quality while containing costs in the effort to enable delivery of optimal patient care. Automated laboratory equipment and modern LIS systems have both enabled substantial sustained improvements in quality, reducing both the number and frequency of analytical and post analytical errors (1-2). At present, the majority of laboratory errors occur at the pre-analytical level, which encompasses the patient condition and all steps prior to specimen analysis (3-4).

Pre-analytical errors are extremely heterogeneous, and those inherent to the patient's medical condition thus may not be entirely avoided. Preventable pre-analytical errors almost inevitably originate at one or more of the human touch points prior to specimen analysis. These range from wrong test ordered, specimen labelling errors, wrong tube additive collections, clotted or hemolyzed specimens, quantity not sufficient, and excessive lag time from collection to analysis and reporting. Herein, we report our experiences to improve the interval from specimen receipt to results by applying lean-six sigma methodologies to our specimen receiving and processing area.

Lean derives from lean manufacturing, which simply seeks to identify and reduce wastes that do not create value within a system (5-9). The wastes that do not add value are: transportation, inventory, motion, waiting, overproduction, over processing, and defects. Most lean manufacturing principles lend themselves readily to clinical laboratory application. Six Sigma process improvement tools are utilized to improve quality and the name derives from the statistical definition of perfection; a system operating at the sixth sigma has just 3.4 defects per million opportunities. Six Sigma relies on DMAIC: define the goal(s), measuring key indicators, analyze the data and identify the root cause(s), improve current process, and control the system to prevent future lapses in quality.

Lean-Six Sigma combines both lean manufacturing and Six Sigma process improvement tools to improve quality. These techniques owe their origins to industry efforts to improve resource allocation and utilization while reducing product variability, and we describe our experiences in their successful application within the clinical laboratory.

Methods

TAT from receipt to result is assessed on a monthly basis against a benchmark for multiple analytes in multiple divisions to ensure timely delivery of results in the interests of patient care (10-11). Monthly TAT data was monitored retrospectively and prospectively over the course of this project.
TAT from receipt to result is assessed on a monthly basis against a benchmark for multiple analytes in multiple divisions to ensure timely delivery of results in the interests of patient care. Monthly TAT data was monitored retrospectively and prospectively over the course of this project. In seven of twelve months, TAT percentages move up or down in tandem for multiple laboratory instruments/divisions, suggesting substantial front-end contribution to overall throughput limitations.
Scale architectural drawings of the main laboratory were obtained. Scale drawings were then created for the existing specimen receiving area and the proposed receiving area to ensure that the existing equipment could be safely accommodated.

Results

12-month mean ED CMP TATs before the move was 44.4 minutes with 90% of results reported in 60 minutes or less; after the move this improved to a mean of 37.1 minutes with 90% of results reported in 49 minutes or less. 12-month ED troponin mean TAT was 49.5 minutes with 83% of results reported in 60 minutes or less; after the move this improved to mean TAT of 43.4 minutes with 90% of results reported in 55 minutes or less. Given seven touch points per result, this project enabled a 75% reduction in defects per million opportunities.

Discussion

One of the main goal as well as a challenge for a clinical laboratory is to provide accurate results in a timely manner. The quality of the patient care can be greatly affected by the inefficiencies in the workflow processes that can adversely influence laboratory quality and productivity. Studies demonstrated that Lean Six Sigma methodology creates value in a system, by eliminating waste to improve service delivery through redesign. In addition, Studies showed the significance of Lean methodology in pathology laboratories for enhancing the accuracy of testing, reducing TATs, and increasing physician and patient satisfaction. Patient and provider satisfaction is highly dependent on the turnaround times of test results, in the current health care system. Studies reported that after the application of Lean methodology to their laboratory, improvement of patient satisfaction and reduction in the number of complaints regarding delays were observed (12-14). Clinical laboratories needs continuous improvement in the quality of testing and to meet stringent guidelines, while trying to decrease costs. The application of Lean concepts to the laboratory environment seems to be very useful to examine its normal operation, highlighting where typical problems occur and eventually improving processes and quality of care.

Through the initiation and implementation of the Lean process in the specimen receiving of our laboratory, a significant improvement in TAT was observed. Besides, there were elimination of the steps prone to pre-analytical errors and that were associated with potential risk of exposure to biological hazards.

Among the limitations of our study, the most significant one is that this was a single center study and the findings might not be generalizable to other clinical laboratories with markedly different demographics as well as laboratory process flows. Nevertheless, given the improvement demonstrated in our findings by the implementation of Lean, can be of value to other laboratories at some level. Additionally, changes in patient and provider satisfaction due to process improvement initiatives were not assessed in this study. However, it is presumable that shortened waiting times and improved TATs would increase patient and provider satisfaction.

In addition, determining the cost-effectiveness of implementing the process improvements and proving the causality from the demonstrated changes of outcome were outside the purview of this study (14).

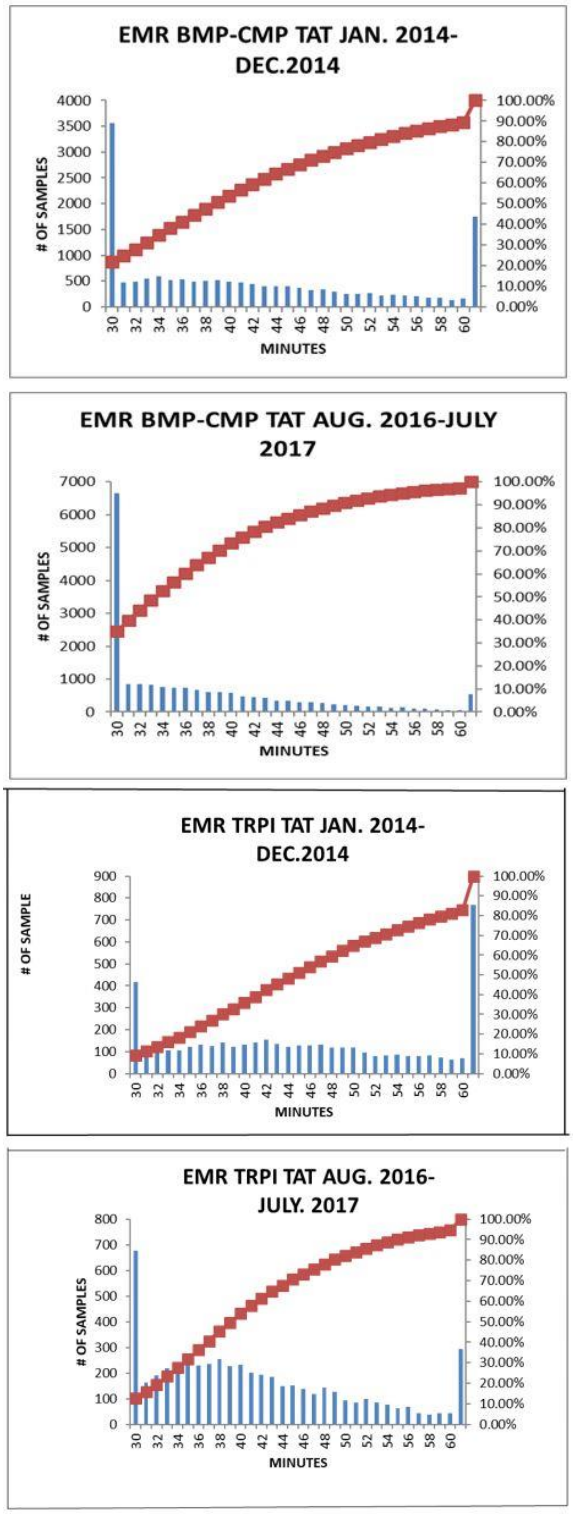

Figure 1. Chemistry Stat TATs before and after implementation

Finally, after the successful implementation of Lean-six sigma tools, it facilitated the identification and elimination of inefficiencies

in specimen receiving to enable sustained improvements in TATs. Thus, defining and measuring problems, planning, taking necessary steps and implementing them are effective techniques to improve throughput in pre-analytical specimen handling. The one-time expenses associated with the moves were minimal, and the cost-avoidance of satellite laboratory oversight and operation was substantial. To our experience Lean six sigma techniques can be applied in a cost-effective manner to minimize pre-analytical wastes and improve patient care.

Declaration

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Conflicts of interest
None.

Authors' contributions
FMHR and PVA conceived the design of the study. FMHR and MWA collected the data and analyzed the results. FMHR and PVA prepared the draft manuscript. PVA and JTF reviewed the manuscript.

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