

LSS TOOLS IMPROVE MORE THAN TAT FOR ED BLOOD DRAWS

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Abstract

One of the most fundamental needs of the Emergency Department (ED) clinician is accurate and timely results for blood chemistry and hematology. In most clinical settings the basic metric for the effectiveness of this process is turn-around-time (TAT). As with many metrics, the term TAT is defined differently between the clinician needing the blood draw data and the Laboratory performing the ordered tests. This case study presents the initial analysis of the ED-LAB blood draw System for a large tertiary teaching hospital. To control the scope of the project the wide variety of blood tests and cultures were reduced to those most frequently ordered and included: 1) CBC (with manual diff), 2) BMP (Chem 7), 3) Troponin, and 4) Urine (UPRN). The application of various Lean Six Sigma tools led to surprising results involving electronic health records (EHR) and the Lab tracking software and work standards for blood draws. The application also uncovered clear opportunities to improve not only the TAT but the entire ED-Lab System.

Introduction

Increasingly, the health care industry is embracing the application of Lean and Six Sigma methodologies for improvement in processes (ADD REFS). Like most companies who have used either one or a combination of the methodologies, health care companies have learned that many of the manufacturing-born tools are surprisingly effective in their environment. The MEP Lean Network defines Lean as “A systematic approach to identifying and eliminating waste (non-value-added activities) through continuous improvement by flowing the product at the pull of the customer, in pursuit of perfection.” (ADD REF). Lean is essentially a methodology with a toolbox of tools that can be used to eliminate waste in processes. Six Sigma has various definitions that shadow the context in which it is expressed. In the context of a methodology, Six Sigma can be defined as a business philosophy of focusing on continuous improvement by understanding customers’ needs, analyzing business processes, and instituting

proper measurement methods (ADD REF). From the context of its focus on results, Six Sigma can be defined as a statistical concept that represents the amount of variation present in a process relative to customer requirements or specifications; or a statistical concept that measures a process in terms of defects - where the defect goal is no more than 3.4 defects per million opportunities and the process yield is 99.9997%. Like Lean, Six Sigma comes with a toolbox of tools to help an organization reach the defect goals. The Six Sigma methodology applied to this project was the five step Define, Measure, Analyze, Improve, and Control (DMAIC) methodology. This methodology is used to improve the performance of an existing process. In combination, these two different methodologies have become a common approach termed Lean Six Sigma. While Lean focuses on efficiency and throughput by eliminating non-value-added events in the process flows, Six Sigma methods address the minimization of variation. The combined approach uses tools from each methodology to form a synergetic process improvement methodology.

The project in this case study used the Lean Six Sigma (LSS) approach to improve a common hospital blood draw process. This case study presents the initial analysis of the ED-LAB blood draw System for a large tertiary teaching hospital. The blood draw process is a standard process used in hospitals to collect blood chemistry and hematology information for clinicians. To control the scope of the project, the focus of this project was confined to the most frequently ordered blood tests and cultures – i.e. CBC (with manual diff), BMP (Chem 7), Troponin, and Urine (UPRN).

The initial Lean tool used for this project was an unusual version of a Rapid Improvement Event (RIE). The RIE is another name for a Kaizen event . The REI is a structured team-based effort that directly targets a specific problem or area at an accelerated pace (MacInnes, 2009; Sayer and Williams, 2007; George, et. al., 2005; Womack and Jones, 2003). However, to minimize the effect on the schedules of the project team,

a two-tiered organizational structure was arranged. The Working Team was comprised of Emergency Department (ED) Registered Nurses (RN's), Hema and Chem Lab personnel, and process improvement team members. The Working Team typically met bi-weekly for less than two hours. For Leadership guidance and assistance, a Steering Committee of leadership personnel was formed. Included on this committee were the project champions. In total, the Working Team meetings and Steering Committee presentations totaled less than 40 hours of attendance time but over a period of months.

The Process Defined

Because of the high volume of requested ED blood and urine tests, the team decided that the inclusion of all requested blood chemistry and hematology tests in this project was not feasible. Therefore, the ED leadership selected the CBCA, Chem 7 (BMP), Troponin, and Urine (URPN) samples as the ones of major interest. In keeping with a standard Six Sigma project, a SIPOC diagram was completed at the beginning (Define stage) of the project. SIPOC is an acronym for Supplier, Inputs, Process, Outputs, and Customer. The tool is used to produce a diagram that documents a process at a high level and visually shows the process, from suppliers' inputs to the products and services received by customers. The diagram helps to develop a high-level understanding of the process that is under study, including upstream & downstream links.

Next the team developed and analyzed a flow chart of the ED blood and urine test process. A flow chart is a graphical representation of the steps involved in an entire process or a segment of a process. In alignment with the Lean methodology, the flow chart was analyzed to study the current state condition of the process. The team discussed observations and questions about the process steps and noted possible solutions. Additional information was added to the flow chart as a result of these activities. The impact of different process steps and factors were categorized for their influence on one or more of the following three key elements:

1. Defects – their causes and potential effects
2. Deviations – variation away from standards, best practices, and intended outcomes
3. Delays – the wait time of both ED and Lab personnel and the patients in the ED as

measured by *all of the tests* ordered for the patient and not just the individual test results

These three elements were identified as impediments to better throughput and as sources of process variation. The outcome of the discussions was the development of a future state process flow.

Measure Phase

In the Six Sigma Measure Phase, the team's goal is to gather information on the current performance of the process and determine the baseline and target performance of the process. The team gathered information on the current performance of the ED blood and urine test process to determine its baseline and target performance. The team determined the following about the process:

- The monthly average of accessioned samples from ED to Lab was 12,600.
- The average vials used per sample was seven to nine.
- 500 vials of blood were discarded daily.
- 2897 extra ED samples were collected during the first month of the project.
- 1485 samples without orders were received during the first month of the project.
- Each sample required a "Controlled" paper copy of the tests needed. The Lab receives approximately 38 pounds of paper copies daily. They were stored and scrapped weekly.
- Lab test processing and reporting involves six highly complex systems, databases, and interfaces. Since these systems/databases have different capacity levels and different data fields, all of the desired information is not housed in each system. Therefore, reporting reconciliation between them is difficult.
- The specimen issue problem from the ED was approximately 2.2% and approximately 4.4% for the other service lines. The result was approximately 300 specimen issues from the ED monthly. The average daily re-draws was 10 per day but can range to more than 20 per area. Site wide, the IU's, ICU's and Gen Med Units were the primary contributors to monthly specimen issues involving quality.

Analyze Phase

In the Six Sigma Analyze Phase, the team goals are to establish the key process inputs that affect the process outputs and to identify and determine the root cause(s) of defects and confirm them with data. Data analysis was conducted using electronic health record (EHR) values and time studies. The time studies calculated the total elapsed time from the point at which the specimen was received in the Lab to the time that the results of the completed tests were entered into the system. The data showed that Hemolyzed samples accounted for 50% of the issues, QNS caused about 25% and Clotted samples accounted for about 15% of the total. Relative to the turn-around-time (TAT), the data showed:

- The industry standard of reporting the 95th and 50th percentiles for individual test Lab TAT were used. At the high end, the 95th percentile meant that 1 out of 20 tests could have exceeded the expected time limit. At the lower end, manual data input errors may result in very low test TATs that were not being detected.
- The CBCA with diff lab test is one of the most complex tests for which to adequately report turnaround times. If no manual slide analysis was required, the median time for the CBCA was approximately 15 minutes for nearly 75% of all ED test requests. If a slide had to be prepared and analyzed, an additional 45 to 60 minutes was added to the process cycle time. Both slide issues and patient issues and the possibility of a results review by a Pathologist could add even more time to the final resulted timestamp. Essentially, there are four different timestamps that could be generated by this test—(1) CBCA of 15 minutes, (2) CBCA with/diff and slide prep for 45-60 minutes, (3) post slide reviews taking less than an hour up to 72 hours, and (4) all others such as slide issues, QNS issues, etc. The use of this blending statistic of four data distributions could be misleading because the 75% of tests with a 15 minute TAT could offset and hide a small but unacceptable percentage that exceeded the reasonable upper limits.
- Relative to the Pyxis, searching for the correct vials and supplies, and then returning to the patient easily added two to five minutes of non-

value added time to the blood draw process per patient.

Improve Phase

In the Six Sigma Improve phase, the team is expected to develop, try out, and implement solutions that address and eliminate the root cause(s) of the problem. In doing this, they use data to evaluate the solutions and improve the inputs that affect the output. For the ED blood and urine process, the following changes were made:

1. The ED “Rainbows” were redefined from 7 to 9 vials of blood to 4 to 5
2. The team planned to move to computerized orders to replace the controlled paper copies for each test. This was not done with the initial launch of EHR.
3. The lab uses percentile metrics for reporting individual test completion times – i.e. “95% of tests were completed in 60 minutes or less.” However, the ED Physician and patient do not recognize wait times by individual tests but by the cluster or grouping of tests ordered. Therefore, the percentile metric may underestimate wait times that are truly the longest TAT of any individual test cluster ordered by the ED physician. A new EHR report based on order clusters was developed to capture these clustered TATs.
4. To reduce the ED RN’s search time for phlebotomy supplies, the following was completed:
 - a. 36 lockable wall or shelf mounted cabinets with supplies were ordered for the “Gold” side ED bays to minimize the time needed to search for vials.
 - b. Rainbow stickers with the proper blood draw sequence was added as visual locators for supplies.
 - c. A diagram of the draw order was posted on the Pyxis door for all Pyxis supply units. See Figure 1 below.

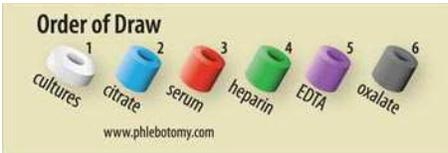


Figure 1. Order of Blood Draw Diagram.

To address the four different timestamps that can be generated by the CBCA test, one approach under consideration was to add an additional event timestamps in the process so that the 75% of the CBCAs could be segregated and reported separately without the impact of mixing data from the other distributions.

Control Phase

In the Six Sigma Control phase, the primary goal is to maintain the gains achieved in the project by documenting, standardizing, and monitoring the work methods and processes. Also the team should communicate the project results and preserve the lessons learned. Below are control mechanisms put in place to sustain the gains from the Improve phase:

1. To reduce the ED RN search time for phlebotomy supplies, the vial supplier was asked to band tubes according to the revised 4-tube rainbow plan so that stored rainbow vials could be quickly and easily withdrawn from the Pyxis machines and the cabinets.
2. Site wide training of personnel performing the blood draw was placed on the 2012/21013 schedule to address the top three specimen issues – i.e. clotted, QNS, and Hemolyzed.
3. ED tracking boards were placed in the call center in the lab as a visual for the monitoring of test times. The resulting outcome is expected to act as a visual safeguard against excessive delays and wait times.
4. Access and posting of more real time TAT process event data was being investigated with software suppliers.
5. Both the median test TAT values and the variations in the Lab processes were tracking downward. A special Statistical Process Chart (SPC) chart known as a Precontrol chart was recommended for LAB TAT tracking purposes. The labs process improvements and the Precontrol chart are intended to drive all test clusters per patient to less than 60 minutes.

6. While the Precontrol Chart will be used for test clusters, individual tests will be monitored daily using a Control Chart for Individuals.
7. Improved maintenance schedules and downtime tracking logs were introduced to reduce automated handling lines and machine downtime issues for the chemistry labs.
8. A simple but effective change for the CBCA was the reactivation of a second slide maker and the use of frosted slides to visually identify ED work pieces.
9. For the Precontrol Chart that graphically displays each test cluster over time, plotted data points under or over these limits will be subjected to root cause analysis and corrective actions.

The changes implemented in this project resulted in several significant improvements. The improvements are shown in Table 1 below:

Table 1. Summary of Project Results

TOPIC or EVENT	CHANGE
Rainbow of 7 to 9 vials reduced to 4 or 5	50% decrease
500 unused/extra specimens daily	70% decrease
ED specimens w/o Orders	90% decrease
CBCA Median TAT	30% decrease
CBCA TAT Variation	50% decrease
Chem 7 Median TAT	5.0% decrease
Chem 7 TAT Variation	9.0% decrease
Troponin Median TAT	2.0% decrease
Troponin TAT Variation	10.0% decrease
URPN Median TAT	10.5% decrease
URPN TAT Variation	18.2% decrease
ED RN new rainbow draw savings	2-5 min decrease

Conclusions and Key Recommendations

As is typical with a Rapid Improvement Events (RIE), numerous areas of opportunity are often discovered that exceed the scope, time, and assets available to improve them. This project was no exception. Several long term improvements were underway but were not completed by the official closure of this project. However, as a standard step in the RIE methodology, the sustainability of captured improvements were revisited on 30-60-90 day period to assure that the process and personnel did not revert to previous work patterns and paradigms and that long term solutions continued to be followed.

At the close of the project, the following recommendations were made:

1. In the ED complete a small test of change with Lab techs available to collect specimens, assign accession numbers and assure Orders are available. Specimens could then be pneumatically sent directly to the Hema and Chem Lab areas without the handling, labeling, and resending from the Clinical Support Area.
2. Complete the requested project of IS to go paperless and to eliminate hard (paper) copies of all ED (control copies) Orders generated in the ED.
3. Distribute specimen issue data and graphs to Med and Surgical Leadership to raise awareness of the specimen issues occurring in top ten site Units (MIU, SIU, MICU etc).
4. Develop and utilize the test cluster report for the four tests addressed by this project. If successful, then apply the clustering by patient to all ED requested tests.
5. Perform a process tryout of tracking using the Precontrol chart tool for test clusters and identification of specimens where drilling down would be helpful.
6. A phlebotomist in the ED (full or part-time) for assistance of difficult draws and additional training of RNs should be an option left to ED Leadership as a short term consideration.

The Leadership in the ED and the LAB should use the results of this project as a launching pad to develop the appropriate tracking and corrective actions tools so that a mindset of continuous improvement becomes ingrained as a daily practice.

Key Learnings:

Despite the numerous issues and improvement activities detailed herein, two key outcomes summarize the long term benefits of this project;

1. Personnel from both the ED and the Hema and Chem Labs were able to suspend their Unit-centric views and adopt a Systems perspective of ED and Lab interactions. Team members were able to bridge the gap between two islands of excellence.

2. Team members became empowered to eliminate workarounds from obvious and long term barriers and impediments.

Although much more work remains the journey towards creating an atmosphere of continuous improvement has already taken a positive step forward.

References

George, M. L., Rowlands, D., Price, M., Maxey, J. "Lean Six Sigma Pocket Toolbook". McGraw-Hill, New York, New York, 2005.

MacInnes, R. L., "The Lean Enterprise Memory Jogger for Service", GOAL/QPC, Salem, NH, 2009

Sayer, N. J. and Williams, B. "Lean for Dummies, Wiley Publishing, Inc., Hoboken, NJ, 2007.

Womack, J. P. and Jones, D. T. "Lean Thinking", Free Press, New York, New York, 2003.

Biographical Sketch

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April 2012 photo showing average of (500) excess ED samples per day that becomes medical waste.



The Revised Rainbow of Specimens



November 2, 2012 photo showing approximately (140) ED samples that become medical waste.

This change represents a daily reduction of approximately 72% of excess samples.

LAB (BLOOD BANK, CHEM, & HEMA) FLOWCHART

