ORIGINAL ARTICLE

Adopting Lean Methodology to Reduce Turnaround Time of Gastrointestinal Biopsies - an experience at Histopathology Department of King Edward Medical University, Lahore

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ABSTRACT

Background: Surgical pathology laboratories have a main leading role towards diagnosis and management of patients. There is always a need to improve quality towin physician's trust in pathology reports. In the recent decades, the emphasis on quality control and continuous process improvement has gained much more importance. These are the non-value added activities and unwanted or waste time.
Aim: To see the effect of implementing lean methodology to decrease the turnaround time of the gastrointestinal biopsies submitted to the surgical pathology laboratory of King Edward Medical University.
Methods: A total of 70 gastrointestinal endoscopic biopsies were evaluated turnaround time of 35 gastrointestinal biopsies submitted routinely to pathology reception. Then by using the principle of lean, we assessed next 35 gastrointestinal biopsies and identified non-value added time in our work flow process. The non-value added activities were recognized from the transportation of the sample till the dispatch of the final report.
Study design: Comparative cross sectional study.
Results: We evaluated the turnaround time of gastrointestinal biopsies by using value stream mapping. Before lean implementation, non-value added minutes were 6647 and the process cycle efficiency was 17.14%. After lean implementation the non-value added time was reduced to 510 minutes, which shows removal of 1885 non-value added minutes. Process cycle efficiency was 72.94%.
Conclusions: Lean principles can be used in a surgical pathology laboratory to remove the non-value added activities and to minimize the total turnaround time.
Keywords: Gastrointestinal biopsy, Lean principles, Turnaround time, Value stream map

INTRODUCTION

Gastrointestinal Biopsy burden constitutes a major bulk of biopsy specimens submitted to surgical pathology laboratory. As it comes in the category of gross only specimen so there is a dire need for timely processing, accurate histopathological diagnosis without increase in turnaround time. Many quality management systems focus on streamlining routine process of which lean methodology helps in achieving these targets very effectively[1].

Lean production system is a Japanese business avenue based on (TPS), which was used in manufacturing industries until 1990's[2]. But now it is also used by multiple organizations other than industrial systems. The main approach was to reduce waste to increase throughput by making staff responsible for the improvement of efficiency and quality. Lean consists of following activities:

- Value stream mapping: A map showing unnecessary waste in different steps.
- SIPOC: Suppliers, inputs, process, outputs and customers[3].

The main aim of these tools is to remove all kind of waste source in a system i.e., cost, inventory, time and space while improving productivity and maintaining quality[2]. It understands customer's value and emphasizes on quality management, identify and remove waste and eliminate non-value added activities[3].

Lean philosophy has also been applied in healthcare laboratories. Sugianto JZ conducted a study on gastrointestinal biopsy handling and reduce their total time process from 507 minutes to 238 minutes by applying lean principles[3]. The need to apply lean production in a laboratory is due to increasing volume of gastrointestinal biopsies[3] and patients' dissatisfaction due to extensive time. Lean reduces turnaround time (TAT), removes waste and directly improves patients' satisfaction with laboratory process and reports and also empower workers[4]. The main pillar of Lean methodology is to classify waste. Ohno (1988) has described seven types of waste (shipping, inventory, motion, waiting, over-processing, over-production and defects)[5].

Local data regarding application of lean principles is lacking. In this research, we will apply lean production in our surgical pathology lab specifically for gastrointestinal biopsies. It will help our workers to work effectively and on time to satisfy our patients'.

The objectives of the study were to remove the non-value added activities (waste) and to decrease turnaround time

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MATERIALS AND METHODS

Before the start of research, a pre-research planning was done in which all the aspects were considered. It included selection of target population, sample size, self-designed proforma and value stream map, sampling method, research methodology, organizational issues and work plan.

It was a comparative cross sectional study conducted atPathology Department, King Edward Medical University/ Mayo Hospital, Lahore.

Sample size of 70 patients (35 patients in each group) was estimated by using 5% level of significance, 90% power of test with expected %age without lean principle as 29% and with lean principle as 63%[15]. All Gastrointestinal biopsy specimens submitted to anatomical pathology laboratory were included in this study whereas crushed and inadequate biopsies were excluded.

Data was collected from the gastrointestinal biopsy specimens submitted to surgical pathology laboratory of King Edward Medical University by non-probability, convenient sampling. The gastrointestinal biopsies were processed by 1 receptionist, 5 histotechnologists and in the end,1 transcriptionist was responsible for typing final report. Several pathologists examined tissue slides during their rotating days.

Data was collected using pre-designed proforma which covers various aspects of all the processes involved from specimen requisition till dispatch of final report. Lean principle was used to decrease turnaround time and minimizing time waste.

Lean methodology: Lean is a thinking that approaches to provide quality work to an organization. It usually based on the removal of non-value added activities, to reduce turnaround time as well as waste.

We started our research with the formation of value stream map. This map is a flow chart with boxes of each step showing their total time value added time with non-value added time. It began with the collection of gastrointestinal biopsies coming to our laboratory and ended at the delivery of final report after the microscopic examination of the biopsy. Our main purpose was to decrease the turnaround time of gastrointestinal biopsies and in this way, we focused on the continuous improvement by removing non-value added activities.

Value-added activities are those stages that are compulsory for our final product i.e. required fixation time, gross examination of specimen, proper processing, tissue embedding and cutting, staining of the cut section of the tissue, mounting, microscopic examination and in the end transcription of the diagnosed report. In contrast, Non-value added activities are needless steps in finishing off our final product i.e. prolong transportation time and any delay time for next step[15].

With all this background, we identified and eliminated time waste and directly see the decrease in our throughput time and by doing this ultimately we increased the quality of our laboratory procedures. We took 70 biopsies and processed them (35 before and 35 after using lean principles). Non-value added time was identified by drawing value stream map.Data collected was entered by using Statistical package for social sciences (SPSS vr 21). Quantitative variables like time will be presented as mean ±S.D. Qualitative variables like process cycle efficiency will be presented as frequency and percentage. Comparison of two groups without lean and with lean principle applies one sample t-test. P value <.05 was considered significant.

RESULTS

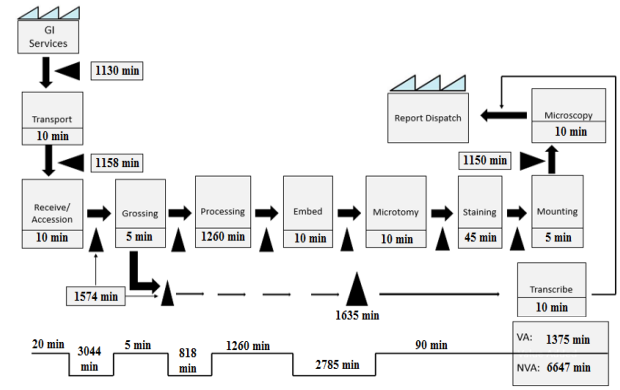
To evaluate the turnaround time of gastrointestinal (GI) biopsies coming to our surgical pathology laboratory, we processed total 70 samples (35 before applying lean principle and 35 after applying lean principle). The total time, value added time and non-value added time of each step during the processing is represented by using value stream map (VSM).

Figure 1 shows the current state value stream map (before lean implementation). The total time shown by current state value stream map is 8022 minutes, which includes 1375 value added minutes and 6647 non-value added minutes. The process cycle efficiency calculated was 17.14%. The efficiency shows there are a lot of non-value added activities and waste time in our work flow.

Figure 2 shows the revised value stream map (after lean implementation). Total time in processing 35 gastrointestinal biopsies was 1885 minutes. Value added minutes were 1375 and non-value added minutes were 510 which mean total 6137 non-value added minutes were removed.When we calculated process cycle efficiency, the results came were astonishing. The efficiency was increased by 72.94%. Our process cycle efficiency was increased by 4 times. This shows our previous strategy was not very efficient or poor in the handling process of gastrointestinal biopsies.

Process Cycle Efficiency (PCE) = Value Added time/Total Cycle Time

Tables1, 2 shows average results of total time. Value added time and non-value added time of 35, 35 samples before and after lean implementation.



Total Time = 8022 minutes
Process Cycle Efficiency (PCE) = 17.14%

Figure 1: Current state Value-stream map for gastrointestinal (GI) biopsy processing. Wait time and delay time consist of non-value-added time. *VA* indicates value-added activities; *NVA,* non-value-added activities

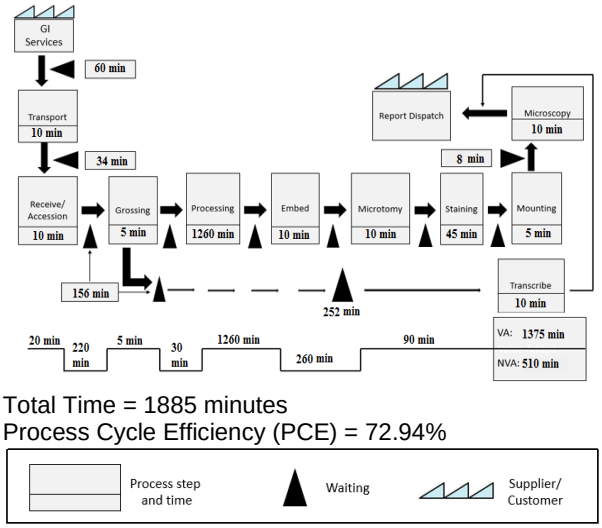
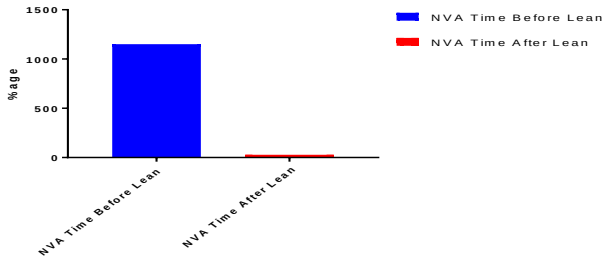


Figure 2: Revised Value-stream map for gastrointestinal (GI) biopsy processing. Wait time and delay time consist of non-value-added time. *VA* indicates value-added activities; *NVA,* non-value-added activities

Data was analyzed by using one sample t-test. The p-value was <0.05. Therefore, it can be concluded that the population means are statistically significantly different. If p-value >.005, the difference between the sample-estimated population mean and the comparison population mean would not be statistically significantly different.

The graphical representation of non-value added time (NVA) of each step and total process cycle efficiency (before and after) is also given below.



Graph 1: Non-value added time (NVA) of reporting. before lean (785 min). After lean (8 min).

Table 1: Time involved before lean application:

Sr. No.	Steps involved	Time (min)		
		Total time involved	Non value added time	Value added time
1.	Transportation	1140 min	1130 min	10 min
2.	Receiving/Accessioning	1168 min	1158 min	10 min
3.	Grossing	761 min	756 min	5 min
4.	Processing	2078 min	818 min	1260 min
5.	Embedding	170 min	160 min	10 min
6.	Microtomy	272 min	262 min	10 min
7.	Staining	160 min	115 min	45 min
8.	Mounting	318 min	313 min	5 min
9.	Microscopy	1160 min	1150 min	10 min
10.	Reporting	795 min	785 min	10 min

Table 2: Time involved after lean application:

Sr. No.	Steps involved	Time (Minutes)		
		Total time involved	Non value added time	Value added time
1.	Transportation	70 min	60 min	10 min
2.	Receiving/Accessioning	44 min	34 min	10 min
3.	Grossing	131 min	126 min	5 min
4.	Processing	1290 min	30 min	1260 min
5.	Embedding	116 min	106 min	10 min
6.	Microtomy	86 min	76 min	10 min
7.	Staining	53 min	8 min	45 min
8.	Mounting	61 min	56 min	5 min
9.	Microscopy	16 min	6 min	10 min
10.	Reporting	18 min	8 min	10 min

DISCUSSION

The burden on the histopathology laboratory of King Edward Medical University is increasing with each passing year[1]. Therefore, to maintain our quality results and to enhance our efficiency, we used Lean Principle. The main goal of this study was to eradicate the waste and unnecessary steps and the delaytime in our gastrointestinal biopsy handling[15].

Lean principle was initially introduced by Toyota Production System (TPS)[11]. The main purpose of the technique was to use the whole man force in our work place[43] and to increase our productivity and efficiency by decreasing waste[44].

In our study, we apply lean principle and firstly we recognized waste in our process cycle. Ohno has described the seven types of waste[24]. It includes the time waste, the increased processing time, augmented production, any delay due to transportation, any error or delay in any step due to our instruments, motion and formation of defective products[45,24].

In the beginning we started to collect and process our samples on routine basis. Before applying lean principle, the samples were received and processed on routine basis. The received samples were already fixed by the GI services. So, we didn't need to fix them. But the waste was in transportation time. Patients' or their attendants does not deliver the samples immediately. Maximum delay time was about a day. After receiving, accessioning was done. Sometimes there was also delay in it due to work load. Then the most important step came is grossing. Due to overburden in our laboratory, the samples received on the same day were not grossed on the same day. The pathologist on duty has to gross only fixed number of samples on their rotating days.Similarly the processing step was also too long. The maximum processing time required for gastrointestinal biopsies was between 18 to 21 hours, but in our routine practice, after removing the cassettes from processor, cassettes were put into hot wax for next day. Then these cassettes were embedded on the next day, which adds waste time in our flow. We usually did not observe any delay in embedding, but the large consumed time due to biopsies burdenin our laboratory. Moreover, there was no separation between large biopsies and small biopsies. Usually cutting, staining and mounting were done on the same day, but sometimes due to work load delay occurred. After all these slide making processes, the next step appear is microscopy. As we discussed above our histopathology section is the busiest section, therefore, due to high work load the microscopic examination was also delayed. Sometimes the pathologists were examining their old or pending cases and ultimately this results into unclear transcription time.The increasing burden kept the person on transcription busy or sometimes due to delayed microscopic examination the typing procedure were delay irrespective of whether transcriptionist was available or not.

All this discussion reveals that before lean implementation, our maximum waste time gathers around waiting before and after a step, transportation, excess processing time[46], delayed accessioning, next day grossing, and pending microscopic examination and final reporting. We used current value stream map to describe our waste time and for steps representation in a work flow[29]. The calculated non-value added minutes before lean application were 6647 minutes and the calculated process cycle efficiency was 17.14%.

Process cycle efficiency (PCE) shows what part of a cycle is value added[15]. It is represented by percentage. To improve our cycle efficiency and productivity[46] we implemented lean principle. The main focus of this methodology was on to reduce the delivery time to next step. After lean implementation, we revised our value stream map and concluded that our efficiency was increased by 72.94%, which is more than four times of the previous one. This shows our previous strategy was not very efficient or poor in the handling process of gastrointestinal biopsies. We also reduced our non-value added minutes from 6647 to 510 minutes i.e. total 6137 minutes were removed from our work cycle.

This efficiency was achieved by making streamline flow[47], decreasing technologist travel events[37] and by dealing one sample at a time[36] or one piece work flow i.e. process the sample as itsubmitted in our laboratory[15]. We collected the samples immediately from the endoscopic units and grossed then on the same day. The ideal processing time for gastrointestinal biopsies was also maintained. The reports were transcribed as soon as the slides were microscopically examined. We also established few sessions for our technologists, pathologists and transcriptionist for their awareness about lean.

To apply the lean principle in this huge set up were not so easy. Initially we faced some resistance from our workers and staff against this methodology but soon they embraced it[33]. The second limitation we met was lack of Lab Information System (LIS) and Voice Recognition System. We are also planning to establish these innovative and time saving gadgets in future.

We in the surgical pathology laboratory of King Edward Medical University in (2017-2018) used the principle of lean and generate a revised value stream map. The main goal we achieved was the decrease in our turnaround time[12] in gastrointestinal biopsies handling. Lean principle not only reduced our gastrointestinal biopsies turnaround time from 8-9 days to 3-4 days, but it also helps us to quality results and it develops a sense of satisfaction in our patients'. Lean is a future based planning and a continuous improvement program, therefore, we are hoping better results in near future. Moreover, we are also planning to apply this principle in all biopsies other than gastrointestinal biopsies and making plans to reduce our processing time as a whole and particularly for small biopsies like gastrointestinal biopsies.

CONCLUSIONS

Lean principle is an innovative methodology that can help us to recognize and categorize waste in our work flow. The delay time and their root causes can also be identified by this principle. Ultimately it will generate continuous improvement in our system and process.

Our study will help other laboratories to apply lean principle to improve their productivity and efficiency. It will help to handle the burden in histopathology section as well as it can be implemented in other sections of a pathology laboratory. The value steam mapping tool will be beneficial in the discovery of unnecessary waste and delays.

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