Lean Healthcare - Process Improvement in a Cancer Outpatient Chemotherapy Unit

Stela Maris Coelho* [#], Carlos Frederico Pinto* [#], Robisom Damasceno Calado***
Evelin Araujo Marotta[#], Elisangela Romano[#] and Messias Borges Silva* **

** School of Engineering of Guaratinguetá (FEG –UNESP) Guaratinguetá, SP Brazil,*
*** School of Engineering of Lorena (EEL –USP) Lorena, SP, Brazil*
(e-mail: messias@dequi.eel.usp.br)
**** School of Management (FA - PUC), Campinas, SP, Brazil*
(e-mail: robisomcalado@gmail.com)
[#] Instituto de Oncologia do Vale, São José do Campos, SP
Brazil (Tel: +55 12 3924-9055; e-mail: carlosfpinto@iov.com.br)

Abstract:
The case study/report presented describes how processes were improved using Lean Value Stream Mapping tools and Queue Theory tools. Major outcomes were focused on reducing waiting time to patient access to radiation treatment and to reducing daily waiting time to access to treatment slots. The performance improvement was in the order of 75% to treatment slots access, reducing from two hours to 30 minutes; and access to care waiting time reduced from more than three months to same day access to special cases; and one week waiting time or "planned access" to all other. The process redesign also eliminated up to three hours of overtime daily.

Keywords
Keywords: Lean Manufacturing, Production Control, Queues.

1. INTRODUCTION

The concept called of "lean thinking" is most commonly associated with Japanese manufacturing, particularly the Toyota Production System (TPS). Much of the TPS way of thinking is based on the work of quality Edwards Deming, who taught,who taught, among other things, that managers should stop depending on mass inspection to achieve quality and, instead, focus on improving the production process and building quality into the product in the first place.

Since the first reports of lean initiatives in healthcare in US by Virginia Mason Medical Center, many others attempted to apply lean thinking in healthcare to address crowding, delays and safety (Holden 2011). One of the landmark results presented by Virginia Mason was the substantial capacity improvement with only area redesign (Womack 2005). The Brazilian government has the constitutional obligation to provide healthcare assistance to the entire Brazilian population; however, it faces serious capacity and quality restrictions while promoting it. One of the most serious restrictions related to the lack of ability to care provided by the public sector is the resource allocation that is insufficient and poorly managed. According to several national surveys, healthcare assistance is the second most cited problem needing better attention (Aranda 2012). In several countries lean thinking applied to healthcare has proven to improve access and quality of the services provided; even in private organizations or mixed systems (like Brazilian and American); lean thinking in healthcare has produced impressive results. Lean consists basically in separating waste from value; removing non-added value activities from value streams and eliminating waste in a continuous pattern. Most common wastes are transportation, activities or unnecessary processes, material or patient handling, inventory, defects or failures, delays and overproduction. Other problems addresses as waste as well are interactions between enterprises or areas; poor communication and misuse of resources. Most common benefits are associated to direct and indirect cost reduction, set free capacity and personnel. Initiatives to implement the lean thinking in medical

services and healthcare are just the beginning (Womack and Jones, 2003; Spears 2005 and Silberstein, 2006).
Queues is healthcare are quite frequent and are usually considered to be created by bottlenecks in the process.
For Womack and Jones (1998) lean is a way to do more with less and at the same time offer customers exactly what they want. This means using less human effort, equipment, time and space to increase the value and minimize waste simultaneously. There are five general principles of lean thinking as shown: specify value from the standpoint of the end customer by product family, identify all the steps in the value stream for each product family, eliminating whenever possible those steps that do not create value, make the value-creating steps occur in tight sequence so the product will flow smoothly toward the customer, As flow is introduced, let customers pull value from the next upstream activity and as value is specified, value streams are identified, wasted steps are removed, and flow and pull are introduced, begin the process again until a state of perfection is reached.

2. LITERATURE REVIEW

There is no common sense about the definition of lean production and there is not a "single point" to guide the concept definition (Howleg 2007). Lean Production is a dynamic, multifaceted and complex system with multiple interdependent connections. Academic books and articles still struggle to define clear measures for lean production (Shah 2007); one well established and popular tool, Value Stream Mapping (VSM) as proposed by Shook and Rother (1999) is used to identify and analyze, as well as suggest solutions to production problems.

2.1. Value Stream Map

The value stream consists in identifying "all the value added and non-value-added actions required to bring a specific product, service, or combination of products and services to a customer; including those in the overall supply chain as well as those in internal operations" (Womack, Jones and Roos, 1990). The value stream mapping enables the organization to understand the current process, identify the three types of tasks: (1) value-added, (2) necessary but not value-added, and (3) non-added-value steps (Womack and Jones 2003); and provide a vision of gains and benefits associated with waste removal. The VSM is basically a PDCA cycle (PlanDo-Check-Act) involving the following simplified steps: identify the value stream (current state); problem analysis; value proposition (future state); action plan (value delivery); and sustainability (action). For problem analysis we used common lean and quality tools: Pareto Analysis; Cause-Effect Diagrams; Affinity Diagrams; Five Whys; and Spaghetti Diagram (Pinto 2010).

2.2. Queue Theory Tools

Queue theory is the study of queue process formation and propagation to access any kind of service and its formation is a common phenomenon is systems with unbalanced capacity and demand. Queue theory is used by lean thinking to address capacity problems and is one of the seven wastes (waiting). In the Brazilian healthcare systems, queues are usually accepted and perceived as a capacity problem: the capacity is always below demand. This assumption is frequently a misconception and expresses poor management of the queue. Queue disciplines are rules applied to queues to reduce waiting times and process (Hiller and Lieberman, 1995) 3. METHODS Case Study, problem analysis and value proposal

2.3. Kanban

Is any mechanism to communicate the time to replenish or produce exactly what is being requested and the amount due, enabling the production flow is pulled (Junior *et al*., 2008; Slack, 2008).
The principal reasons to employ Kanban System instead of computerized system are:

The principal reasons to employ Kanban System instead of computerized system are (Y. Sugimori *et al*, 2007).

(1) Reduction of cost processing information. It calls for huge cost to implement a system that provides production schedule to all the processes and suppliers .
(2) Rapid and precise aquisition off acts.
(3) Limiting surplus capacity of preceding shops.

2.4. Pareto analysis

A quality tool called "Pareto analysis" is commonly referred as a statistical technique in decision making that is used for the selection of a limited number of tasks that produce significant overalleffect. It is a relatively simple methodology that is used when trying to determine which tasks or factors in na organization will have the most impact (Cervone, 2009). It ranks the data/factors in the descending order from the highest frequency of occurrences to the lowest frequency of occurrences. The total frequency is summed to 100 percent. The*"vital few"* items occupy a substantial amount (80 percent) of cumulative percentage of occurrences and the "useful many" occupy only the remaining 20 percent of occurrences, which is also known as the 80-20 rule .The results of a Pareto analysis are represented in a bar graph in the form of a descending order and helps to predict easily which factors are vital few and those factors which have least amount of benefits (Talib *et al.,.* 2011).

3. METHODOLOGICAL PROCEDURES
This is an action research study, where we identified a problem, used problem analysis tools and defined a value proposal, as stated by Shook et al (1999). In this part of the article will be presented in the local case study and service procedures.

3.1. First generation of Value Stream Map Chemotherapy - 2011

The chemotherapy treatment process involves (a) patient arrival at front desk, where patient chart is prepared. (b) Triage process for vital signs and basic interview. (c) Medical appointment where he or she will be evaluated and a prescription is filled with the required drugs for chemotherapy treatment; (d) then the prescription is checked and treatment is scheduled, usually for the same day. (e) The nurse double check the prescription (for name, dose, age, and other safety barriers); (f) and send it to the pharmacy; (g) there is another crosscheck by the pharmacist and then it is filled. (h) At the treatment slot, the patient is evaluated by nurse before chemotherapy is started, each treatment plan requires different criteria; (i) if the patient is cleared, chemotherapy and medication is administered. (j) By the end of the treatment patient is reassessed for clinical condition; (k) the patient is then discharged and then leave the unit.

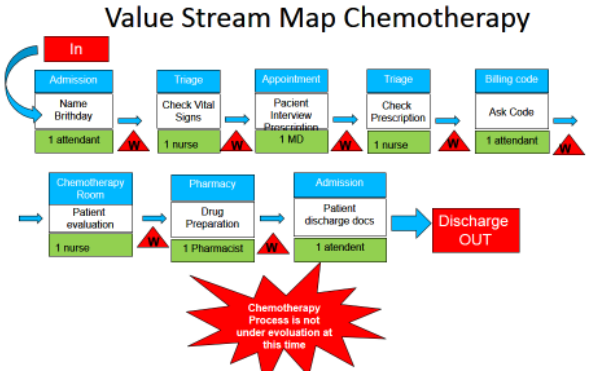


Figure 1. Representation of VSM for Chemotherapy process. Source: Prepared by the author (2012).

First action in 2011
Was studied the epidemiology of weekly chemotherapy treatment schedule at IOV .That showed us the patients were distributed as following: 27% Breast Cancer, 13% colon-rectum cancer, 13% Prostate Cancer, 9% Head & Neck and 5% Lung Cancer.

3.1.1. Major Problems

An anterior Value Stream Map of Chemotherapy had established the utmost limit to treat 30 patients a day, but was observed that in some days we had less than 30 patients with a long delay. On the other hand , in other occasions we had some quiet days with more than 30 patients. For this reason, it was demanded to detail the problem.

We developed a multi professional team involving the stakeholders (chemotherapy nurses, triage nurse, doctor, pharmacist , lean team, director) . We used the value stream mapping (VSM) to design our current state and develop our future state and action plans.

Was identified the unevenness in productivity due to the various protocols carried out during the week. There was a concentration of patients for chemotherapy infusion with the diagnosis of colon-rectum cancer on mondays, tuesdays and Wednesdays represented by red triangle in figure 2 The short-duration chemotherapy (green circle) and breast chemotherapy (red circle) was scheduled as the patient's availability or whithout a standard . The chemotherapy agenda was overloaded not only by the number, but by the complexity of the protocols .

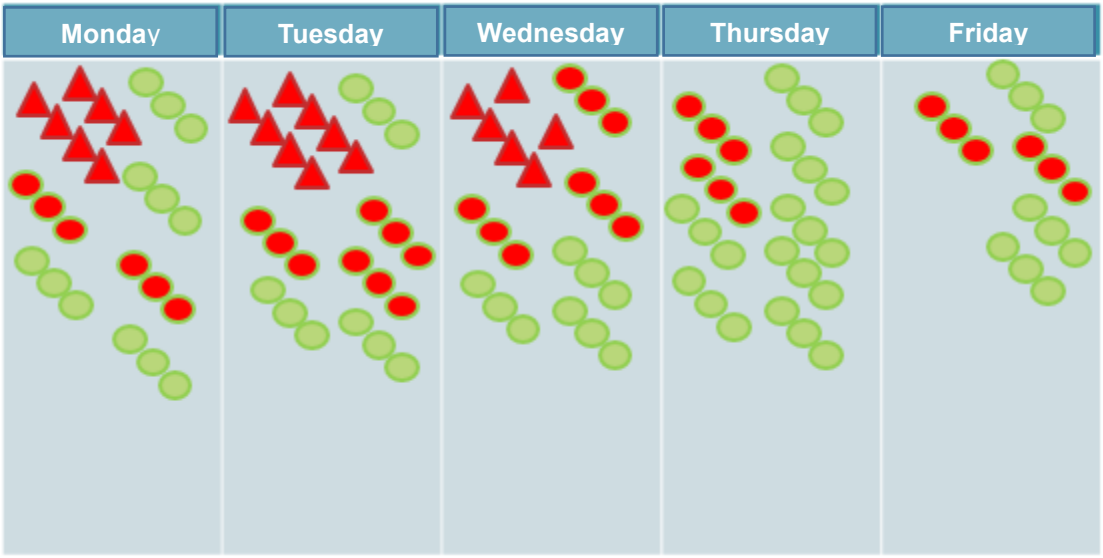


Figure 2: chemotherapy schedule representation before the improvements

3.1.2. Proposed Actions

Leveling the schedule of chemotherapy treatment:

Besides the several improvements possible using lean thinking, the major problem for the unit was the waste associated to waiting time for queues, caused by instability or "MURA" (variation). This instability could be seen on weekly schedules, Daily Treatment Plan (daily production plan) and queue management.

We focused on queue theory to develop stability to the entire system by applying queue discipline into several steps of the VSM and process leveling to daily and weekly schedules. The unit used the FIFO (First In-First Out) system for all of its queues and delivering poor services due long waiting time.

- Using the queue theory was settled bundles:

- The two larger volumes are colon/ rectum and breast cancer. We distributed then as follows
- Patients of colon and rectum cancer from Mondays to Wednesdays
- Patients with breast cancer from Thursdays to Fridays.
- The rest of the cancers would be distributed according to the complexity : low complexity from Mondays to Wednesdays and high complexity from Thursdays to Fridays.

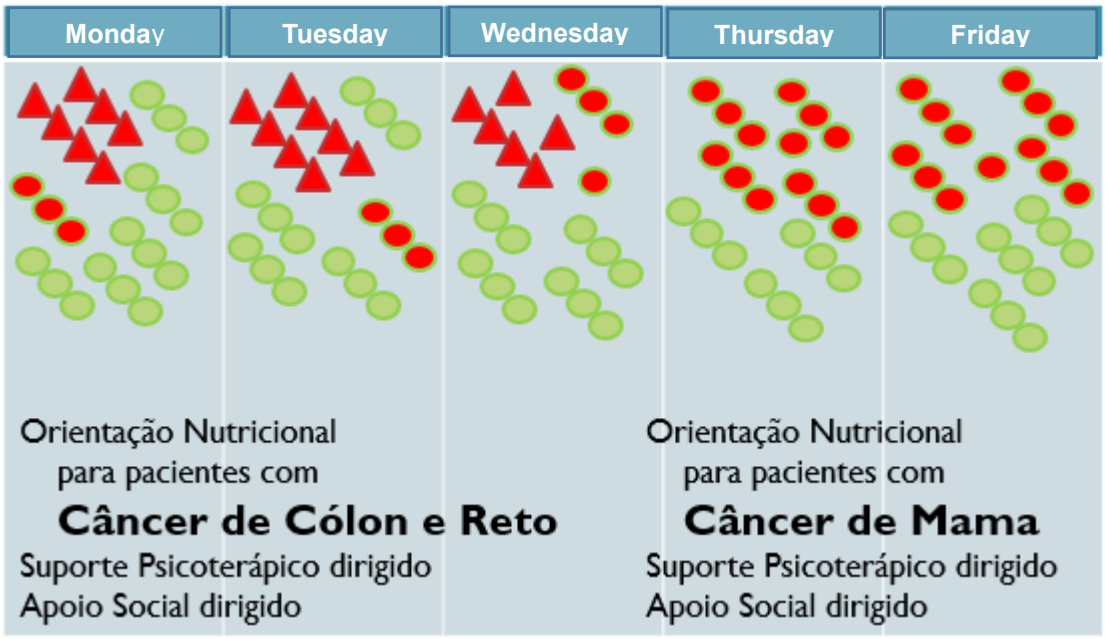


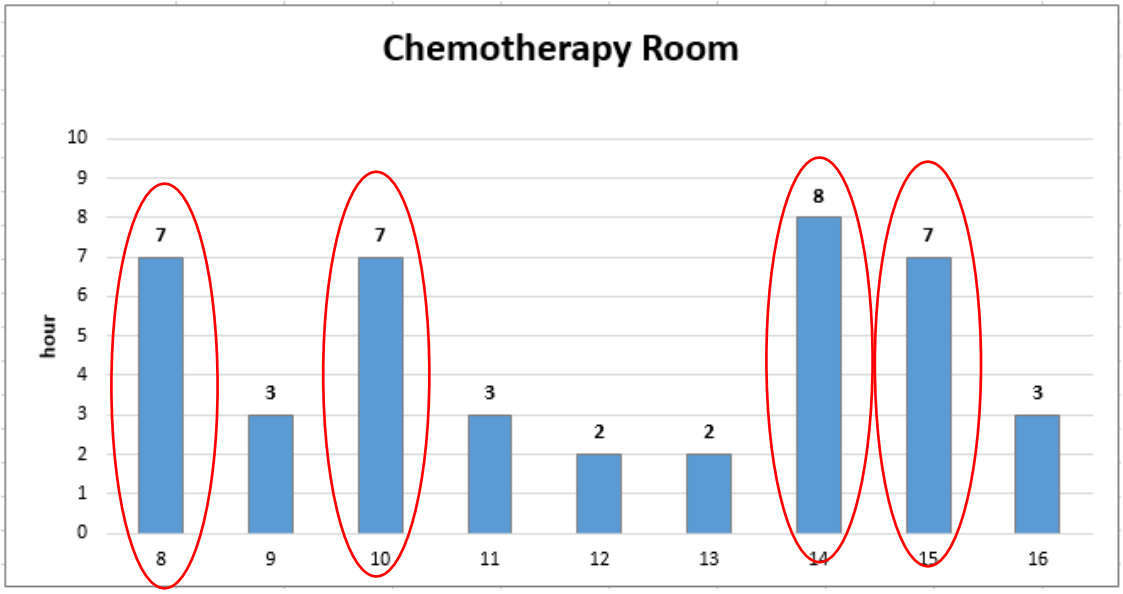
Figure 3: chemotherapy schedule representation after the improvements

3.2. Second generation fo Value Stream Map- 2014 :

3.2.1. Major Problems

14 chemotherapy chairs with an increased number of patients/day by 31% from the year of 2011 to the year of 2014. Average waiting time of 40 min per patient to get inside the chemotherapy room.

Was identified 2 flows of patients. The principal flow of patients was already scheduled on the agenda and the minor flow was compound by patients that meet the doctor that day , without schedule for treatment (only a prevision) but with the proposal for continuous flow. Based on these flows, we identified times of peaks in the chemotherapy room graph 1: Pareto analysis by hour.



Graph 1: Pareto analysis by hour in chemotherapy room

Countermeasures

1: A new work station (chemotherapy clearance) was defined with work force realocation .The aim was to manage the second flow eliminating wastes to ensure the service "flows" to the customer without any interruption, until the chemotherapy room .

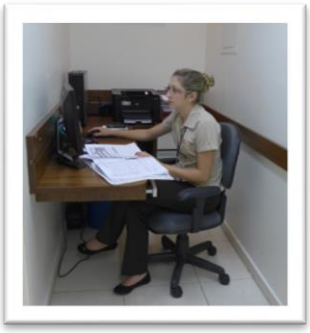


Figure 4: New work station(chemotherapy clearance) / work force realocation

2: Definition of a new agenda of chemotherapy with schedule for patients in the two flows. All the stakeholders were trained to access the agenda.

3: Kanban in the chemotherapy room door:
For managing the vacancies in the chemotherapy room. (green kanban identifies that there is vacancy red kanban identifies that there isn't vacancy).
Visual 4-Visual management in the chemotherapy room door: Whenever there is patient waiting to get inside the chemotherapy room and there is no place in chemotherapy it is identified as a problem with a red folder.

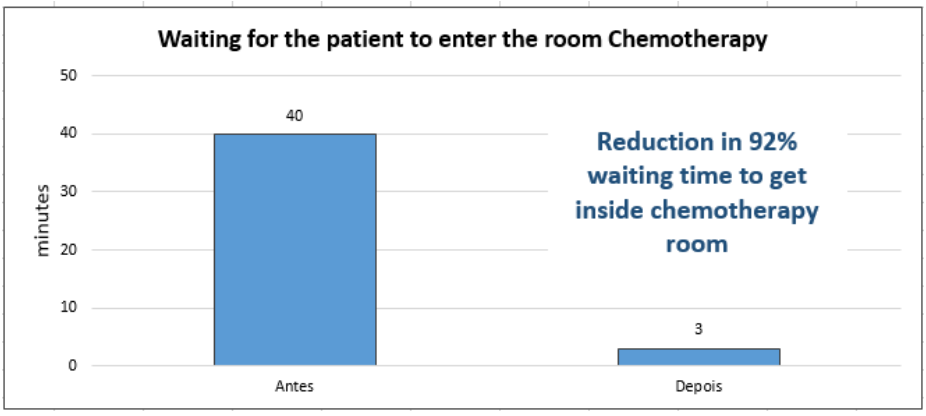
Figure 5: Kanban for managing chemotherapy room

Figure 6: Managing problems with colorful folders

RESULTS

With the first generation map, after distributing the patients in bundles we decreased the variation of the agenda in 60% .

With the second generation of the map we were able to reduce 92% of waiting time for patient to get inside chemotherapy room and start treatment.



Graph 2: Reduction in waiting time to get inside chemotherapy room

CONCLUSION

Queue theory is the study of waiting lines and its behavior and predictability. According to Hiller and Lieberman (1995), "Queuing theory itself does not solve this problem directly; however, it does contribute vital information required for such decisions by predicting various characteristics of the waiting lines..." The application of lean techniques helps to identify for the minimization of waste generated in the processes, ensuring greater productivity. Value Stream Mapping and Lean Thinking embraces the waiting process as one of the most frequent seven wastes. Our study addressed countermeasures to deal with a "queue" using lean thinking and queue theory with positive results.

Leveling queue access and integrating apparently independent processes led these major results.

This study showed the unit was able to leveling the agenda in 60% and reduce 92% of waiting time per day using value stream mapping; queue management; and gathering information to improve and connect major flows in the process: the patient, the information and involved personnel.

REFERENCES

Aranda, F. "Brasil soma 85 mil doentes sem radioterapia, Portal IG São Paulo, 26/04/2012, http://saude.ig.com.br/minhasaude/2012-04-26/brasil-soma-85-mil-doentes-sem-radioterapia.html

Barraza MFS, Smith T, Dahlgaard-Park SM (2009). Lean-kaizen public service: an empirical approach in Spanish local governments. *The TQM Journal* 21 (2): pp. 143-167.

Hiller FS and Lieberman GJ. (1995) *Introduction to Operations Research.* 6th Edition, McGraw Hill, New York,.

Holden, RJ (2011). Lean Thinking in Emergency Departments: A Critical Review *Annals of Emergency Medicine* 57(3)

Holweg M. (2007) The genealogy of lean production. *Journal of Operations Management* 25 420–437.

Junior et al., 2008; Slack, 2008. Indepent Jounal of Management & Production (IJM&P). Acesso em http://www.ijmp.jor.br v. 5, n. 11, august 2015.

Mazzocato P, Savage C, Brommels H, et al. (2010) Lean thinking in healthcare: a realist review of the literature. *Qual Saf Health Care*. doi:10.1136/qshc.2009.037986

Pinto C, (2010) "Improving Wait Times at a Medical Oncology Unit" *in* J. Aherne & J. Whelton, editors, "*Applying Lean in Healthcare*", Productivity Press, NY.

Shah R, Ward PT. (2007) Defining and developing measures of lean production. *Journal of Operations Management* 25 785–805.

Shook J and Rother M, (1999) "*Learning to See*", Lean Enterprise Institute, Boston.

Silberstein, A. C. L. (2006) Um estudo de casos sobre a aplicação de princípios enxutos em serviços de saúde no Brasil. Dissertação (mestrado) – UFRJ/ COPPEAD/ Programa de Pós-graduação em Administração.

Spears, S (2005) Fixing Health Care from the Inside, Today**.** *Harvard Business Review* Sept.

Talib Faisal, Rahman Zillur, Qureshi M.N., 2011. Pareto analysis of total quality management factors critical to success for service industries. 5th International Quality Conference Center for Quality, Faculty of Mechanical Engineering, University of Kragujevac.

Womack JP, Byrne AP, Fiume OJ (2005). *Going Lean in Health Care*. Cambridge, MA: Institute for Healthcare Improvement.

Womack, JP, Jones, DT (2003). *Lean Thinking*, revised ed. Free Press, New York.

Womack, JP, Jones DT, and Roos D (1998). *The Machine That Changed the World*. Free Press, New York.

Y. Sugimori a , K. Kusunoki a , F. Cho a & S. Uchikawa (2007). Production Control Department , Toyota Motor Co., Ltd , 1 Toyota-cho, Toyota-shi, 47, Japan. International Journal of Production Research. Acesso em http://www.tandfonline.com/doi/abs/10.1080/00207547708943149, 11, august 2015.

Young T and McClean S. (2008) A critical look at Lean Thinking in healthcare. *Qual Saf Health Care* 17: 382-386.