

LEAN System Management in Hospitals

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Statement of problem: Healthcare industry is struggling under an increasing pressure of constantly rising costs as the science opens new horizons in the development of new drugs and technologies making thus the task of employing resources in an effective manner more challenging than ever before. LEAN system management in hospitals can contribute to effective costs management and better results. We analyzed industrial LEAN model management and its implementation in hospitals. LEAN management has its roots in Just-In-time management implemented by the company Toyota that has provided for this company to become a fierce competitor to the United States car industry. The aim of LEAN is to eliminate waste and reduce production time. The basic principle of LEAN philosophy is to determine where the value is added in the process and where it is not. LEAN consists of several tools: five S, Kaizen events, standardized work, kanbans, spaghetti diagrams. Spaghetti diagrams are used to track the movement of employees, materials and patients. Effective implementation can reduce the time used for different needs of patients and tasks of employees, so this is an example of lost effectiveness that can be eliminated. Kaizen events include a project team selected from hospital staff, whose goal is to solve efficacy problem by defining the problem and reasonable output and then implement new ideas. An example may be a disorganized inventory of hospital pharmacy that consequently prolongs the time of drug delivery. The project team can locate the problem and suggest inventory changes. Competitive market companies must constantly innovate and implement new ideas to win a market share. Such innovations can sometimes be used in healthcare industry, and effective implementation can increase the quality of health service provided by hospitals, and also reduce never ending rising costs, a challenge that hospital management encounters.

Keywords: LEAN, rising costs, hospital management, waste elimination

Introduction

The process of management, controlling of the costs of hospitals and of other health institutions is a very challenging part of quality management. The main question is how we can provide the best health care to patients and achieve the highest healthcare standards in spite of constantly rising costs based on new diagnostic and therapeutic possibilities. Hence, the objective of this study is to present modern managerial method, LEAN management introduced by manufacturing companies, as well as the possibilities and results of LEAN management implementation in a complex hospital environment (Centauri et al. 2018). In the year 1999, the Medical Institute in the United States of America published a paper reporting that 98,000 patients died in hospitals because of medical errors that could have been prevented. In 2012, the report of the Institute of Medicine titled Best Care at Lower Cost: The Path to Continuously Learning Health Care in America showed the underperformance in healthcare system: 750

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billion dollars were needlessly spent in the year 2009. There were 75,000 needless deaths that could have been averted in the year 2005 if every state had performed at its best (Grabau and Swartz 2014).

The quality problem in healthcare institutions can be seen in the quality care for patients provided by employees and in a number of errors that could be prevented. Errors done by physicians can have profound effect on patients' health, as well as clinician's confidence on practicing medicine. Healthcare institutions have rigid policies in dealing with those issues (Rodziewicz and Hipskind 2020). The difference in quality management between healthcare system and other industries is that, for example, car industry quality is based on the object of production, like cars and individual parts, and a buyer pays for the product. In healthcare system, a buyer of services is at the same time an object the service is provided for, so two services are related to one person. The process can be observed from several angles. One of them is the purchase of material and equipment at lower costs. However, the equipment management requires experts. The other possibility is based on creating the economic process value through efficient healthcare management in health institutions and by removing, remaking process inefficiencies, and thus creates better and more efficient process chain system. LEAN management system is one of modern management methods in industrial sector and service industries (McLaughlin and Hays 2008).

The history of LEAN system is based on Toyota Just-In-Time model that includes cost minimisation and waste reduction. LEAN system implemented in a process chain provides improvement at all levels, which gives the company competitive edge over other competitors. The goal is to eliminate dead weight loss and process inefficiencies. Lean system is based on a few basic principles: muda, muri, mura. Muri stands for planning the business process. Muda is based on efficiency of business process, product quality and quality design of business process and lack of efficiency elimination. Muda (waste) is the resulting output of the process. The role of management is seen mainly in muda, in other words, muda is affected by muri and mura. Muri and mura are parts of Porter chain of value, the process elements which have the function of adding value to output in health industry, the patient health (Womack et al. 1990). Original seven mudas are: transport, inventory, people and product movement, time of waiting, overproduction, over processing and defects. In healthcare industry, the industries that do not have product part like car industry, the seven types of wastes are defined as follows: 1. waiting time of service buyer 2. duplicating (now and again information writing, cross information taking, taking same information more than once) 3. unnecessary movement (ergonomic science) 4. lack of quality communication 5. inventory errors (lack of supplies, badly organized supplies) 6. loss of opportunity of keeping a customer, or winning a new customer (ignoring customer, rudeness toward customer, lack of contact) 7. errors in transaction of service (lost or damaged equipment) 8. providing a service below expected standards (McLaughlin and Hays 2008).

Methodology

Problem statement: Along with the progress of medicine, hospitals are constantly facing the requirement to provide the best quality medical service, but also the increased costs based on new treatments. All of that puts pressures on hospitals.

Research: Through the research of relevant managerial and healthcare management literature, the review of scientific papers, and meta-analysis in healthcare management, we have analyzed modern management tools that can improve hospital effectiveness and give added value to hospital services. **Hypothesis:** There are management systems and tools that can improve the quality of healthcare management and the quality of service. We have analyzed the data of LEAN implementation in different hospitals and found the results of hospital cost-effectiveness.

Conclusion: Based on data analysis, we conclude that the management model according to LEAN philosophy improves the cost-effectiveness of hospitals and the outcomes of their daily operations, which contributes to the health and quality of patients' life. This scientific paper has been written by combining the information from various literature sources.

Kaizen (Continuous Improvement)

The term continuous improvement is not mentioned and important only in LEAN philosophy, but also in models like Six Sigma and Total Quality Management. The philosophy of Kaizen is based on continuous improvement of business process and chain value of all hospital employees. LEAN philosophy is a basic mechanism with health as a final output. Incremental changes, incremental improvements bring added value to the improvement of value chain. The focus should not be based only on defects of value chain, or elements that do not bring added value or cause the loss of values in value chain, but also on normal integral parts of value chain that can be improved. So the place of adding value is extended to all elements of improvement process. Baptist Health Care (Florida) had a Kaizen program established in 1995. In their programme every employee is expected to implement three ideas per year that will improve patients' outcome. More than 50,000 ideas have been implemented since the year 2000 and the estimated cost savings are 50 million dollars (Grabau and Swartz 2012). The hierarchical structure is not vertical, but more horizontal and cross functional. Organization is seen through the chains of value in different elements of organization. These value chains interfere with each other in providing certain value to the input, in the care of patients in a hospital setting. The final outcome is based on all effects of inputs. It is important to note that this is a decentralized system of management in which the lowest ranking employees are seen as important factors in value adding mechanism. Kaizen philosophy is based on a few elements: 1. value specification means identifying what gives the biggest value to the patient 2. mapping of process map means identifying activities that give most value and write them down in order 3. flow means making the

advancement of input through value chain without unnecessary stops 4. continuous improvement means continual repetition and focus on the process improvement so progress is constantly being made (Aij and Teunissen 2017).

Quick and easy Kaizen is a method that has the function of implementing improvements and it is divided into several steps: 1. find 2. discuss 3. implement 4. document 5. share. Finding means to actively search for opportunities for continual improvement. One should start from all levels of organisation, especially from the lowest level. The employees should be slowly introduced to implementation of Kaizen methodology with the focus on incremental improvements. It is usually suggested that employees should start with themselves by analyzing their work process and finding methods to improve it. By focusing on continuous improvement, work is more fun, interesting and challenging. As an example of Kaizen implementation, we can consider the allocation of rooms and doctor offices in a hospital. If the doctors have to walk a long way from hospital ward to their office to examine patients, it can be seen as a defect in the chain of value. By focusing on better room, hospital wards and doctor offices, the improvement value measured over time can be added to the chain of value. Taichi Ohno said: 'Why not make the work easier and more interesting so that people do not have to swear? The Toyota style is not to create results by working hard. It is a system that says that there is no limit to people's creativity. People do not go to Toyota to work, they go there to think.' Many Kaizen events function in such a way that boring and self-repetitive jobs are removed, which then provides the time for more rewarding and creative jobs and direct patient care. The example may be the automation of covering the test tubes. The process of automation saves time unlike the process in which a technician covers each test tube himself (Graban and Swartz 2014).

Value Stream Mapping

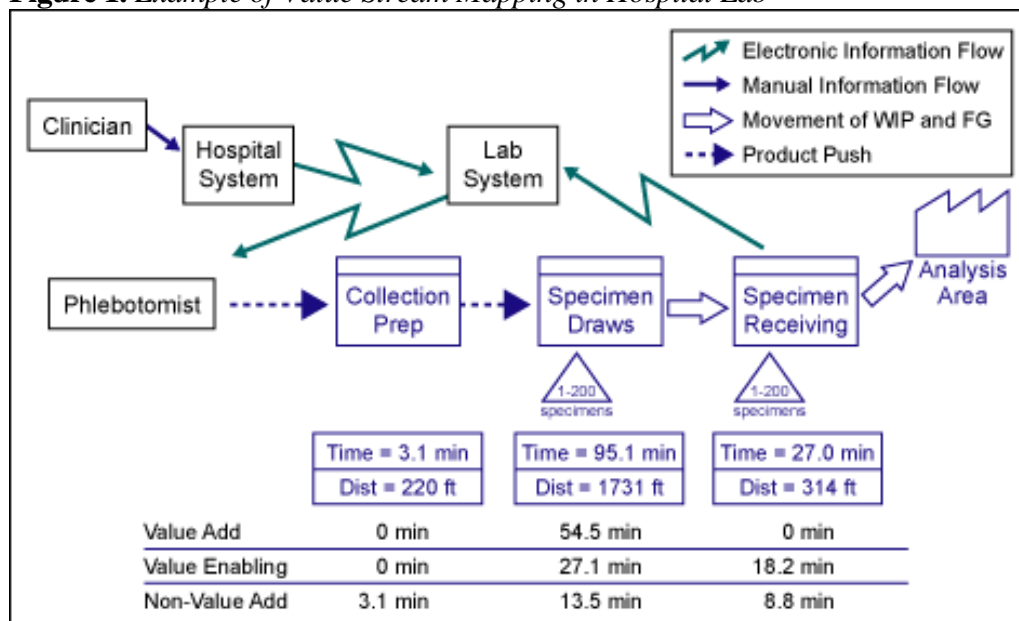
Value stream mapping is a process that includes the analysis of each component of business process and breaks it down to individual elements. Individual process elements are then divided further to smaller individual elements. These steps are described in details in a value map with successive mechanism. It is important to highlight which steps contribute to value adding and the ones that do not add value. Value stream mapping with its analytical mechanism effect provides for the organization the ability to focus on each individual process element. By focusing on process elements, the part that does not add value or subtracts it should be improved to focus on improving each process element. In healthcare hospital system, value stream mapping explains the patient flow through hospital (Figure 1). The process consists of elements like admission to hospital, taking their medical history, hospitalization, patient treatment, transfer to surgical department, reception in intensive care unit, administration of medication, follow-up progress and releasing a patient. All elements are parts of a business process (Gellad and Day 2016).

If we consider hospital setting as a whole Porter value chain that consists of various elements of individual business processes that are intertwined, the

importance of each element in removing the inefficiencies and improving the mechanism of process elements, the improvement of flow in vertical pyramidal organizational structure can be observed. Value stream mapping points to a competitive advantage and improvement of its final output, patient health, and progress of each employee (Buttigieg et al. 2016).

It can be further considered whether this element of chain of value adds some value or not: 'Is the buyer of service willing to pay for the individual activity?' Patient waiting time could be used as an example. Long waiting time is not something a patient is willing to pay for and it is therefore not added to value chain, but subtracted, because the patient may go to another hospital (Lawal et al. 2014).

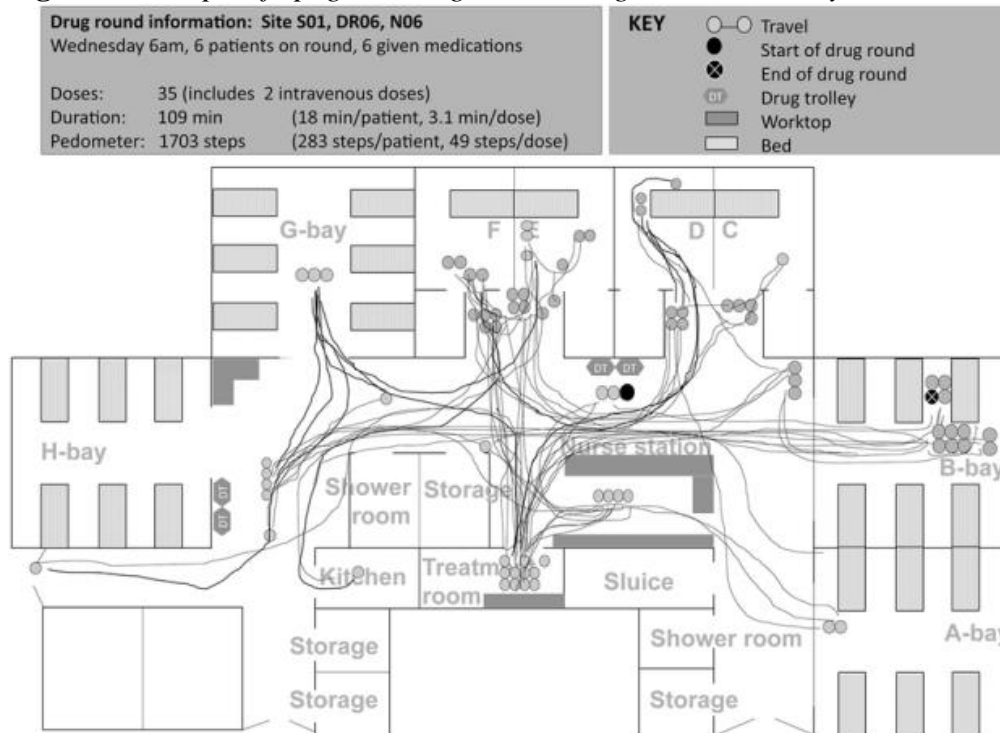
Figure 1. Example of Value Stream Mapping in Hospital Lab



Source: Blaha.

Spaghetti Diagram

Spaghetti diagram is a visual representation of material, employee movement within hospital settings. Its purpose is to use documentation of employee movement and patients within the system and to improve them. Typically, employees do a lot of movements that are duplicated and unnecessary (Figure 2). Movement analysis can be used to find most effective diagram that can contribute to the value chain (McLaughlin and Hays 2008).

Figure 2. Example of Spaghetti Diagram Showing Linear Travel by One Nurse

Source: Mcleod et al. 2015.

Kaizen Event or Blitz

Kaizen event is a project task organized for the purpose of improving the individual parts of business process; it includes 8-10 members. A team consists of cross-functional members. The following elements are included into Kaizen event: 1. selection and definition of objectives 2. determination of the current state of value map 3. determination of the time from the input coming into the system, the time needed for the process until output is created 4. making the implementation plan: who, when, how 5. implementation of improvements 6. checking the efficacies of improvement 7. documenting and standardizing a newly made process 8. continuation of the cycle through the newly made value chain process (Graban and Swartz 2012).

Work Standardization

Work standardization is a written document that explains the ways each element of the process functions. It is based on recent documentation and analysis and has the function to explain the best way of performing certain activity (Tate and Panteghini 2007).

The examples of standardization in healthcare system are the healthcare guidelines provided both for diseases or hospital processes. Massachusetts General Hospital has implemented a guideline related to coronary artery bypass in cardiac surgery that has resulted in reducing the length of hospital stay to 1.5 days. The

contents of guidelines for hospitals advise on what should be done with a patient on admission day, operation day and the day after operation. The goal is to reduce the variability and discrepancies in the business process (Grabau and Swartz 2014).

Jidoka and Andon

Jidoka is a Japanese term referring to the possibility for a worker to stop a process in case of some problem or detection of a defect. The role of Jidoka in LEAN philosophy is to detect and correct mistakes. If a mistake is found in the flow of process, the process should be stopped and all employees should try to identify and correct the mistake that may fall beyond the standard deviation framework. Andon is a system of signalization intended to notify that the process is stopped because an error has occurred (Soliman 2016).

Kanban

Kanban is a Japanese word for signal. Kanban in industrial product sectors is determined as an upstream container where workers would signalize that they have finished their job. In this way, empty kanbans are moved upstream toward the beginning of business process so they could signal additional work flow (Sugimori et al. 1977). Hospital pharmacy can be used as an example. It can have two kanbans. After emptying the first one, a signal is sent to notify that additional orders of drugs are needed. The second kanban is being emptied until the ordered items arrive. The number and size of kanbans determines the size of drug stock.

Single Minute Exchange of Die (SMED)

In healthcare system, Single minute exchange of die represents time spent between one and the other procedure of business process. Single minute exchange of die consists of three steps: 1. separating internal from external activities 2. converting internal in external activities. 3. streaming of all activities. Internal activities are such activities that have to be done in a system, they cannot be done offline (Karstoft and Tarp 2011).

The example of internal activities is cleaning the operating room before the next operation. Organization of surgical instruments is an example of external activity. It can be performed outside the operating room so the number of surgeries can increase.

Flow and Pull

The term flow refers to continuing movement of jobs, patients and products through business process without waiting and stoppages. Pull is a system in which products and services are not provided if a buyer does not ask for them. LEAN philosophy is continuously working on the improvement of both goals. In recent years the importance of patient flow has been recognized by a hospital system. To

satisfy optimal patient flow, hospitals must implement standards and business process to ensure continual improvement and flow of inputs in the system (Pinkney et al. 2016).

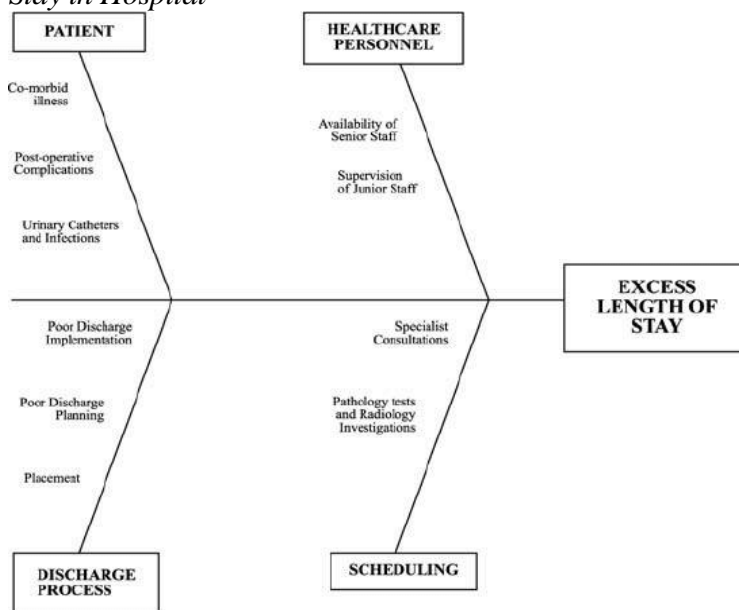
Heijunka and Advanced Access

Heijunka is a system that provides the elimination of the diversity in volume and types of waste. In healthcare system it is referred to levelling showing patient demands for services. If the demand can be quantified over different time periods based on previous data analysis and future prognostic data, hospitals can be more agile in reacting to changes and different expectations in the future. The basic example of Heijunka is related to scheduling patient examination in specific time period. Heijunka and Advanced Access are used in primary health care, especially family medicine. Ordering and examining patients in appointed time provides improvement in patient flow through the system, as well as the satisfaction of patients. It is basically required to predict the demand for services related to specific diseases in different yearly time intervals. It is important to note that hospitals must be ready for the upcoming demand, and the change in demand should be expected and prepared properly. The application of proactive policy will allow the reduction of waste in the system and the improvement of patient flow. This results in adding value to the patients and hospital value chain (Witt 2006).

Tools Used for Data Analysis

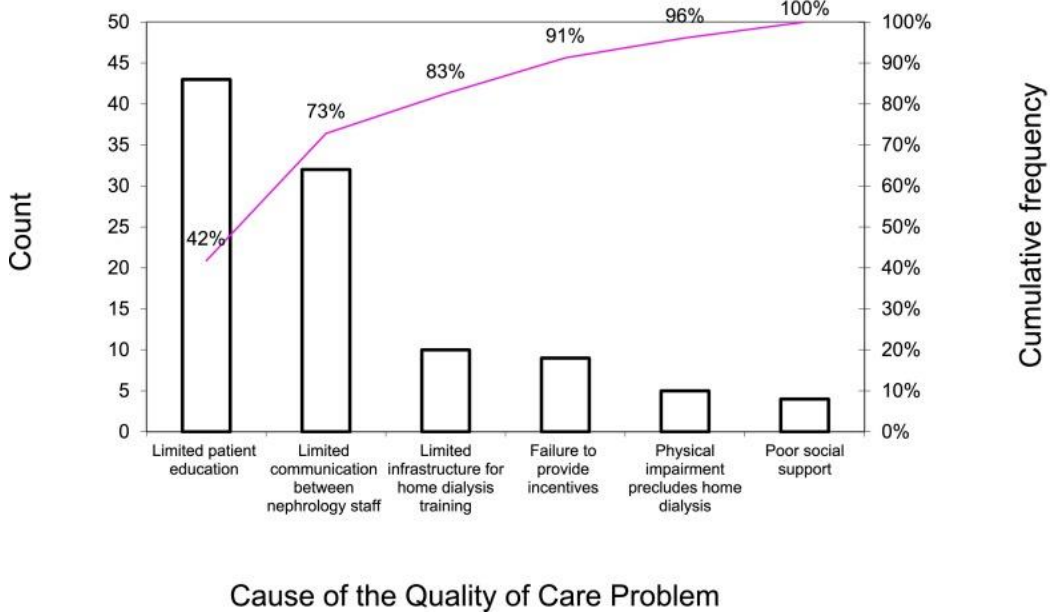
Tools used in process analysis are the following: fishbone diagram, check sheet, Pareto chart, flowchart, run chart (Figures 3-5).

Figure 3. Example of Fishbone Diagram for Possible Causes of Excess Length Stay in Hospital



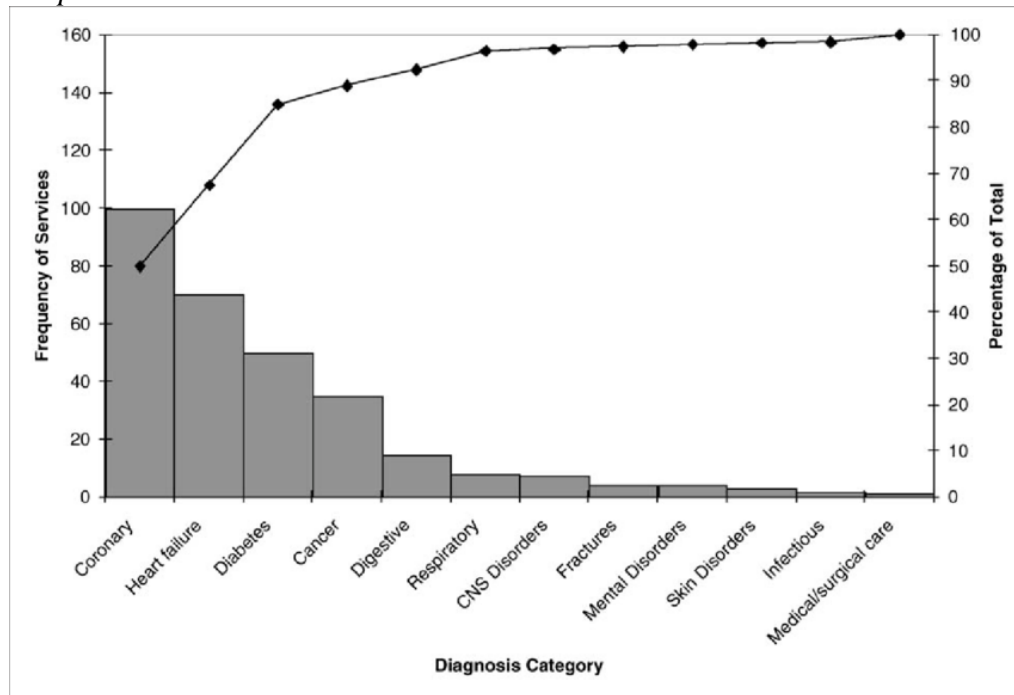
Source: Taner et al. 2007.

Figure 4. Histogram Represents Visual Representation of Data Divided in Classes



Source: Taner et al. 2007.

Figure 5. Pareto Chart Illustrating Frequency of Health Services Utilization in Hospital

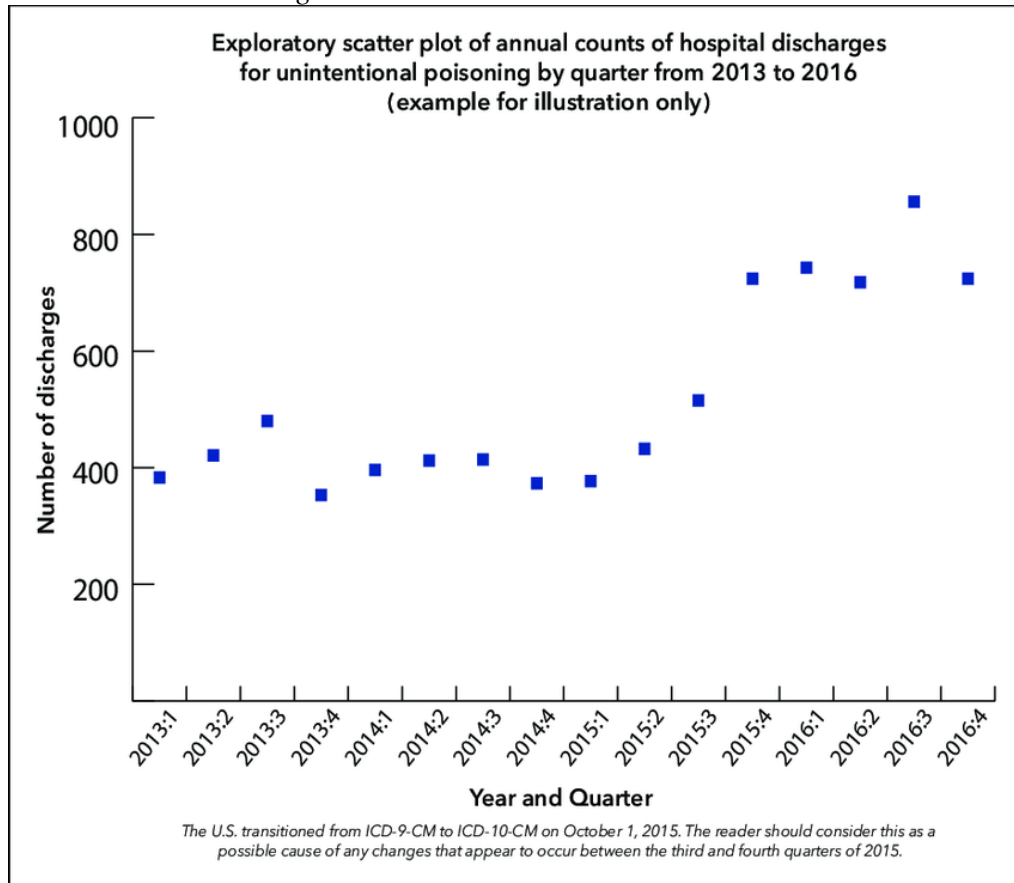


Source: Harel et al. 2016.

Scatter Plot

Scatter plot is a two dimensional data visualization diagram that shows data distribution between two numerical quantitative variables (Figure 6). Two variables can be in three different relationships: linear, nonlinear and curved relationship (Friendly and Denis 2005).

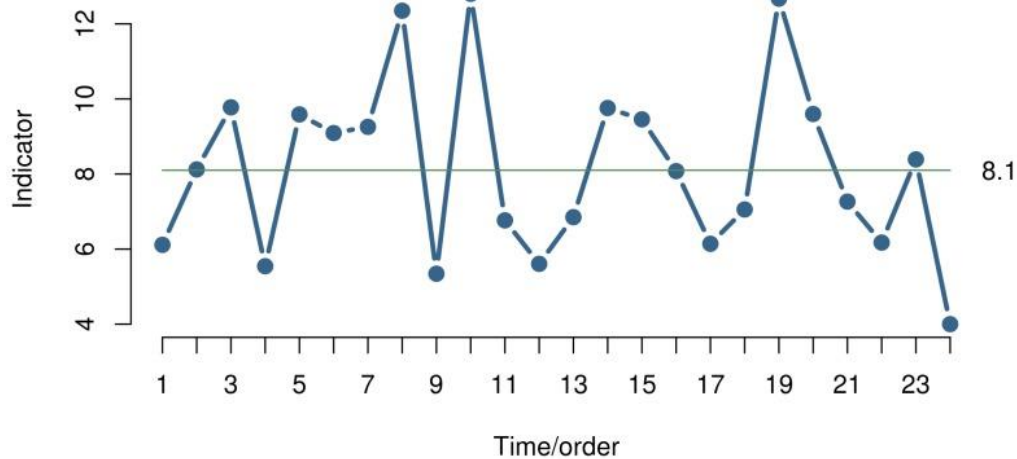
Figure 6. Example of Scatter Plot of Annual Counts of Hospital Discharges for Unintentional Poisoning



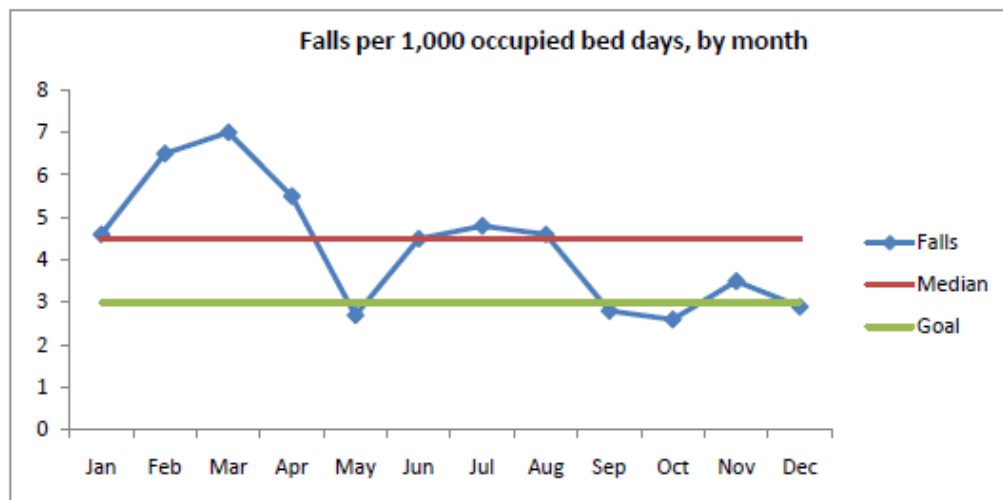
Source: Safe States 2016.

Run Chart

Run chart is a graph that shows the data recorded over time. Using the acquired data, the line graph can show different trends through time (Figure 7). It is important because it can show if trends are out of or within given limits (Figure 8).

Figure 7. Run Chart

Source: Anhoj and Olesen 2014.

Figure 8. Example of Run Chart Showing Falls per 1000 Occupied Bed Days

Source: Agency for Healthcare Research and Quality 2013.

Difference between LEAN and Parkinson Law in Hospital

Parkinson law states that administrative units always have tendency to increase the number of their employees. Parkinson law can give an explanation why there has been an increase in hierarchical vertical structure of hospitals throughout the history. Hierarchical structure can be unnecessarily increased by promotion of employees, which eventually urges the employment of new workers. If a hospital has several consultants and subordinates, and all of them feel they work to the limit of their capacity, they can reach an agreement with director of hospital to promote the existing consultants to hospital directors, and senior registrars to consultants. New employees will be needed soon. Lean philosophy does not give support to this level of thinking simply by focusing on system efficiency (The Economist 1955).

Results

Example of LEAN Hospital

St. Francis Health System is a hospital system established in Indianapolis, Indiana, divided in thirteen hospitals located all over Indiana and north-eastern Illinois that has used Lean philosophy, Kaizen and continuous improvement methodologies to improve its results. In the year 2012, they were granted the clinical excellence award for being in the top 5% in the nation overall clinical quality. In the year 2007, four thousand individuals in the hospitals generated over 17,000 ideas with estimated dollar savings over 4,700,000 million dollars. The crucial factor in being able to obtain such a result is the implementation of LEAN and Kaizen culture in organisations. Kaizen gives employees the chance to participate and contribute to hospital operations. If the employees are given the opportunity to present their ideas and if their opinion is appreciated, their performance is higher, as well as job satisfaction.

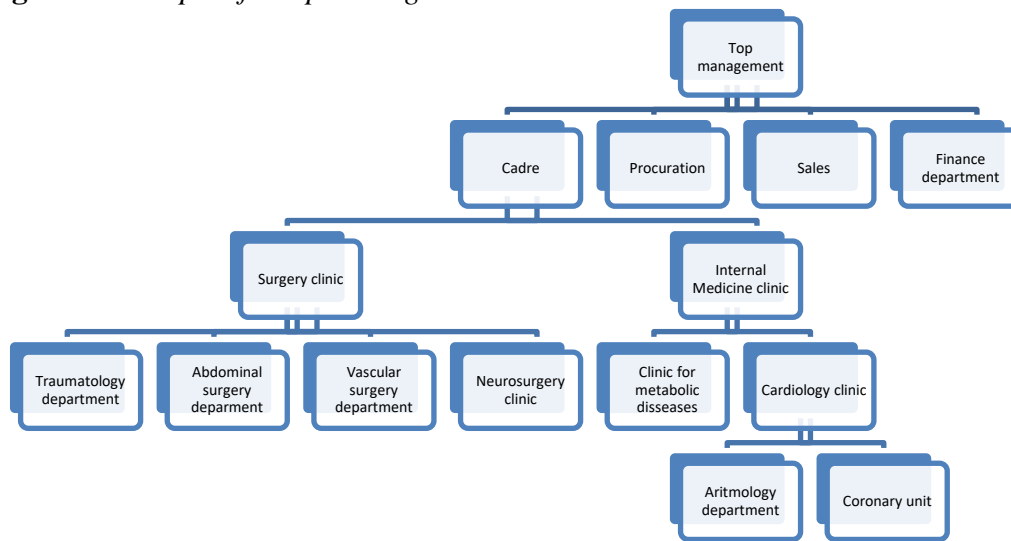
The next example presents a summary of Lean methods used by St. Francis Health System. Paula's husband had open-heart surgery in Franciscan St. Francis Health Centre. Paula is a nurse, and she and her husband found it hard to communicate in the recovery room after he woke up. Paula communicated with her husband by observing his eyebrows and squinting. Her husband could not use his hands as he wanted to. Paula started panicking when she found out that her husband could not use his hands properly. Both of them were deeply distressed until the anaesthetics wore off and they could speak normally again. After realizing that her husband's hands were numb, she later noticed the same symptoms with other patients being operated by cardiac surgeons. She found out the surgeons leaned on patient's hands reducing thus blood supply and causing numbness. She found sled positioners that could be used to reduce pressure on patient's arm. This is an example of how the process can be improved by an employee. Her idea added value to all patients who were taken care of after her husband. The ultrasound technician in Franciscan St. Francis Health Centre noticed that paediatric patients felt uncomfortable when she pressed ultrasound probe to their skin. Children would not stand still during the examination. She had an idea how to distract her patients. She told parents to bring small bottles of bubbles and asked parents to blow them over the child to entertain them. Children were distracted and technicians were better and faster in capturing quality images for radiologist making the job easier for technicians, radiologists, parents and patients. This small improvement adds a lot of value to increasing the patient volume. Another example of small improvement in Franciscan St. Francis Health Center is the replacement of manual paper towel dispensers with hands-free automatic paper towel dispensers in paediatric departments. Once the automated dispensers were mounted in rooms, nurses noticed that more babies made grinding noises and started crying when the automated dispenser was activated. The noise of a dispenser produced reduced resting times for babies. Nurses suggested going back to manual dispensers. After measuring the loudness of automatic dispensers, it was found out that the noise was 50 decibels. The staff concluded they should bring

back the manual paper dispensers. After returning to manual dispensers, the babies were less distressed, as well as the nurses, which all added value to young patients as well as to nurses. Another example of Kaizen is when an X-ray technician created a shield for patients by moving a shielding device from X-rays device to i.v. pole to support a shield. The i.v. pole could be raised and lowered according to the height of a patient. The technicians no longer needed to wrap up the patients with Velcro straps. This idea provided for technicians a considerable amount of saved time (Grabau and Swartz 2014).

Hospital Organisational Structure

Hospitals usually have functional organisational structure. Functional organisational structure groups the workers based on specific skill and knowledge (Figure 9). Employees are supervised by their superior in the same field (Fiorio et al. 2018).

An example in hospitals would be a resident and chief in cardiac surgery. Employees are classified into specific areas to utilize their skills and help the organisation in achieving its goal. Organisational chart is divided into functional departments like board of directors, financial sector, surgery, internal medicine, pharmacy. Advantages of functional organizational structures are related to grouping the employees having the same skills, to the development of specific skills, fixed and defined responsibilities; one instead of more. There is no job duplication, employee careers have a clear growth path. Disadvantages of functional organisational structure are: employees feel bored at work because their job becomes monotonous, conflicts arise if appraisal system is not adequately managed, short-sightedness of functional managers and care just for their department, one-dimensional thinking of employees just about their department, functional manager makes decisions autocratically. The classical organizational structure in hospitals is based on board of directors, clinic managers, department chiefs, doctors, nurses, administrative departments and human resource management. Functional organizational structure is usually found in organizations with traditional organizational structures. Functional organizational structures can have different process efficacy due to different levels of verticality or horizontality. In Eastern Europe, hospitals have more vertical organizational structure, while in western societies like the United States of America they have less vertical structures. Modern organisation theoreticians propose horizontal and less vertical structures instead of vertical organizational structures (Baligh 2006).

Figure 9. Example of Hospital Organisational Structure

Hospitals usually have 5-7 vertical levels. LEAN philosophy integrates the needed organisational structures into its business process to produce best possible output.

When LEAN Philosophy cannot be applied

Lean philosophy cannot be applied universally. When there is no even flow of demand throughout a year, it becomes challenging to apply LEAN philosophy. This is especially true with seasonal demand. It also does not work if an organisation produces very different products, provides very different services, because kanbans will be colliding. It also cannot be applied to specific demand requests, because the service of production is not standardised in organisations. Lean philosophy is best used in repetitive systems without mass production of many different models.

Discussion

The purpose of this paper is to find best ways for hospital quality management. Since the beginning of 20 the century and the development of scientific management, there were great leaps in management considerations. Firstly, the focus was mostly on organisation and efficacy, and employees were seen just as labourers. A different approach has been developed over time. Managers started to see the value of different employees and their connection with competitive advantage of company and its success. After prioritization of organizational structure design and human resource management, quality management was accepted. Quality management like LEAN management added great value to production companies that started implementing it (Maijala et al. 2018). Since then, lean philosophy has been implemented in service industry. Hospitals are very complex institutions with large requirements for highly educated employees and

with great need for capitalization because of great demand for different medical devices and drugs. We have shown that LEAN management can reduce costs by focusing on hospital business processes and implementing new ideas from LEAN philosophy. By developing the quality of management, more value can be added to patients and medical staff. The purpose of LEAN philosophy is to give the employees at lower levels of organisational structure more decision making power, and the power to develop and apply new ideas that make organisation more efficient.

Conclusion

LEAN philosophy is a philosophy invented by Toyota company. It is a management tool used to reduce waste and add value to process and final output. In recent years more healthcare institutions, especially private hospitals have been implementing LEAN philosophy. By analyzing and creating a business process, managers can establish supervision in each part of business process. Business process consists of a value chain which has many smaller components. Value chain is analyzed. After performing the analysis, managers can, together with employees, find parts that do not function optimally. By focusing on these parts with decentralized decision making, the parts of chain of value can be improved. By improving them, patient value is created and transferred to patients. Time of waiting is reduced, the flow of patients and business processes is more effective, and the satisfaction of employees, as well as the satisfaction of patients, is significantly improved. There is a growing number of hospitals that are using LEAN philosophy, and significant cost reduction and patient satisfaction has been documented. LEAN philosophy can and will be implemented in a growing number of hospitals facing increasing costs in ever more competitive environment.

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