Application of Lean Manufacturing Techniques in the Emergency Department

Eric W. Dickson, MD, **MHCM**, Department of Emergency Medicine, University of Iowa Roy J. and Lucille A. Carver College of Medicine, Iowa City, IA; **Sabi Singh, MS, MA**, Department of Operations Improvement, University of Iowa Hospitals and Clinics, Iowa city, IA; **Dickson S. Cheung MD, MBA, MPH-C** Department of Emergency Medicine, Johns Hopkins University, Baltimore, MD; **Christopher C. Wyatt, MD, MBA**, Department of Emergency Medicine, University of Iowa Roy J. and Lucille A. Carver College of Medicine, Iowa City, IA; **Andrew S. Nugent MD,** Department of Emergency Medicine, University of Iowa Roy J. and Lucille A. Carver College of Medicine, Iowa City, IA

[Abstract]

Background: Toyota is considered the automobile industry's leader in delivering quality and overall value. The company credits Lean Manufacturing principles and techniques as the key to its success. Lean principles focus on enhancing product flow, while concurrently raising product quality and engaging frontline workers in innovation and constant improvement of processes.

Objectives: When applied to healthcare, Lean enhances process steps that are necessary, relevant, and valuable to the patient experience, while eliminating those that fail to add value. In turn, providers feel empowered to improve patient care and are more satisfied with their jobs.

Methods: In December 2005, we used a five-day Kaizen event as the kickoff for our long-term adoption of Lean principles in our Emergency Department (ED).

Results: Since that time, we have experienced a continuous decrease in average length-of-stay (now at 150 minutes, including admissions); an increase in patient satisfaction; and consequently, a steady rise in patient visits and market share. The changes have been sustainable over a 15-month period without increasing expense per patient or the number of ED treatment areas. Generating and instituting process improvement ideas from our frontline providers has been the key to the success of our Lean program.

Conclusions: Although the Lean principles represent a fundamental change in the way we think of delivering care, the specific process changes we employed tended to be simple, small procedure modifications specific to our unique people, process, and place. We therefore believe that institutions or departments aspiring to use Lean should focus on the core principles of Lean, not specific process changes made at other institutions.

INTRODUCTION

In November of 1999, the Institute of Medicine's landmark report "*To Err Is Human*" showed that 44,000-98,000 patients die in the U.S. each year from medical errors.[1] In a follow-up report,[2] the Institute called for a fundamental redesigning of America's health care system with focus on safety and quality. Unlike other reports, these two did not escape the public's attention and, since their release, there has been a palpable tension between health care systems and purchasers of their services. Patients, third party payors, and the government are now demanding health care delivery systems be safe, efficient, and quality-driven.

Informed consumers have forced change in a variety of industries, for example, in automobile manufacturing. Information about automobile safety and quality began to spread in the mid 1960s after the publication of Ralph Nader's book *Unsafe at Any Speed*,[3] which prompted consumers to demand safer, higher quality cars. The constant pressure from informed consumers drove the automobile industry toward improving safety, quality, and the overall value of their products, and is now driving health care in the same direction.[4]

How can medical centers that recognize the patient-oriented focus in health care respond to this challenge and succeed in a changing health care marketplace? To begin with, they must embrace transparent external reporting of quality and safety information to all interested parties. Next, they need to develop, implement, and sustain process management systems that welcome innovative and creative solutions to the health care delivery processes. These new systems must improve patient and worker safety while enhancing the quality of care delivered and keeping costs down. For a number of institutions this means a re-engineering of their current process management system. According to the Institute of Medicine, "innovations in industrial engineering that have swept through other sectors of the economy, from banking to air travel to manufacturing, have failed to take hold in health care delivery."[5]

We believe that operations improvement techniques, such as Lean Manufacturing and Six Sigma, used in other industries are well suited to assist health care organizations committed to meeting the challenge. Yet, why have they failed to take hold in health care delivery? First, process improvement techniques are considered core competencies in manufacturing, but few people in the health care industry are trained and experienced in process improvement methodologies. Second, there is a lack of

goal congruence between physicians and hospitals because of the separation between hospital and physician payment. And finally, despite the advances made in patient-driven health care delivery, hospitals fear that shifting the focus to the patient experience will be perceived as shifting the focus away from the physician and lead to a swing in admissions to "physician-centered" hospitals. These factors are particularly strong in community practices of primary care and surgery. However, they tend to be less powerful in Emergency Medicine and academic medical centers where the physician practice plan and the hospital are often owned by the same parent company, making them particularly good candidates for the application of Lean.

THE LEAN PRINCIPLES

Lean is a term adopted from Japanese manufacturing principles defining a philosophy that abhors waste in any form and relentlessly strives to eliminate defects. Waste is defined as any action that does not add value to the product; in health care this should be the patient experience. All too often, current health care processes are designed with a focus on the clinicians and how to make them more efficient and minimize their waste. This approach is contradictory to Lean Manufacturing principles: it is like designing a process with a focus on the factory workers rather than the product they make.

The Lean process evaluates operations step by step to identify waste and inefficiency and then, creates new solutions to improve operations, increase efficiency, and reduce expenses. Lean Manufacturing principles, also referred to as Toyota Production System (TPS) principles, are ubiquitous in the manufacturing environment, especially, in the automotive industry. Two basic Lean concepts are: the relentless elimination of waste through standardization of processes and the involvement of all employees in process improvement.[6] Empowerment of workers by providing them with the necessary tools to effect changes in their area of work is the cornerstone of the TPS. The two priority duties of the employee's job then become: a) making the product; and b) finding ways to make the product better by improving **flow** and **quality**. Transferred to health care, this means that all clinician jobs become focused not only on taking care of the patient, but also on finding better ways to take better care of patients.

An extremely useful first step in starting a Lean process improvement project is the mapping out of the process using a process map (figure 1), then assessing the amount of waste in the system using a

Value Stream Map (VSM, figure 2).[7] The VSM documents the time for each process step and quantifies the amount of value added and no-value added time (waste) in each step. This snapshot of the process helps the improvement team to step back and determine which steps in a process add value to the patient's experience and which steps take up resources and time and incur cost without adding value. Next, the team determines if each step in the VSM is indeed necessary. The goal is to redesign the process with a new process map and VSM that either minimizes or completely eliminates the uncovered waste.

At the center of Lean is product flow. In a Lean assembly line, the product continuously flows with no queues, even at the expense of having some downtime for the individual worker. Although the latter may seem like waste, in reality any downtime that occurs as pieces move from station to station is made up for by the reduction of waste in work-in-process inventory and additional movement of partially completed cars that would otherwise stack up. Think of all the extra work that is required for the patients waiting in a bed for an ancillary service, test results, or movement to the floor for admission.

In order for Lean to work effectively, managers must undergo a paradigm shift in considering efficiency and flow. In the non-Lean environment, managers typically work on reducing costs by constantly improving the efficiency of individual processes. In contrast, Lean managers begin by focusing on quality and flow even at the expense of utilizing greater resources. Once flow and quality have been improved, synchronization of staff becomes the focus. Finally, without ever backtracking on quality, flow, or synchronization, Lean managers work on improving efficiency. The end result is a much higher-value product than the one produced using a management style focused solely on improving single step efficiency.

Allowing for queues to build up would require a plant bigger than one in which a continuous flow system is in place. By focusing on flow and reducing work-in-process inventory Lean plants tend to take up much less space. Think of all the space in emergency departments used for patients waiting to be seen and treatment areas occupied by patients waiting for a consult, test results, or disposition.

METHODS USED FOR THE ADOPTION OF LEAN PRINCIPLES IN THE EMERGENCY DEPARTMENT

As part of an organization-wide adoption of Lean principles, we engaged the Emergency Department in a five-day Kaizen event. Kaizen is one of the fundaments of the Lean-based TPS; the name denotes an approach to continuous improvement by eliminating activities not adding value. A Kaizen event occurs when managers in an organization gather in a workshop to set the base of Lean-driven process changes that would be specific to the organization. Our Kaizen event functioned as both an educational session to teach our managers about Lean and as a process improvement event.

The team for the Kaizen event was diverse and made up of 20 people, including two Lean experts, ten individuals not associated with the Emergency Department (including members from a local business council), and eight Emergency Department staff. In addition to lending their extensive experience in employing Lean, team members also provided a patient perspective on how an emergency department should function. The Kaizen event occurred as follows:

Day 1-2: Process observation and mapping (figure 1), measurement, and VSM mapping (figure 2)

Day 3: Waste-generating steps removed and process redesigned; new process design heavily influenced by frontline workers recommendations

Day 4-5: New process implementation, refinement, and re-measurement

As part of the Kaizen event and the overall adoption of Lean, the managers had to acknowledge that frontline staff had greater insight into the processes and were, therefore, more likely to find ways of improving them. Frontline staff, in turn, had to understand this paradigm and be encouraged to find solutions to problems that create waste, slow flow, and decrease the quality of care delivered in our Emergency Department.

The process improvements coming from the Kaizen were not particularly novel. However, because the staff designed them, they were more easily accepted and fully deployed. The key new processes, which continue to be part of the new standard operating procedures for a second year after the initial event, are:

- Utilization of all exam rooms and immediate placement of patients in the rooms, with bedside registration whenever possible

- A team approach whereby a registered nurse, a resident, and the attending physician get the patient's history at the same time when possible thus reducing duplication of history and saving staff time
- Redefined responsibilities of registered nurse, nursing assistant, and intake coordinator
- Labs/X-rays ordering and sending done earlier in the process
- Visual cues for directing patients in and out of the emergency rooms improved
- Identified opportunities for involvement of other services earlier in the process and expedition of admissions.

RESULTS FROM ADOPTING LEAN PRINCIPLES

The adoption of Lean principles in December of 2005 has been associated with both immediate and longer-term positive effects on department operations. Immediately after the Kaizen event, we saw an improvement in patient flow with a reduction in average patient length-of-stay (LOS) from 161 minutes in the three months prior to the adoption of Lean to 148 minutes in the three months after the Kaizen. Despite an annual patient visit growth of 9.1% and an admission growth rate of 15% in 2006, adoption of Lean principles has allowed us to maintain our average LOS at approximately this 148 min level (figure 3). Adoption of Lean has also been associated with significant improvement in patient satisfaction, as is evident from the continuous increase in overall Press-Ganey patient satisfaction survey results (Figure 3). The improvement we experienced in patient flow and patient satisfaction was not associated with an increase in direct cost per patient, which was $116.81 in 2005 and $115.40 in 2006 (includes non-physician staff and medical supplies only).

Our greatest challenge in sustaining the early gains produced by adopting Lean has been keeping up with growth in patient visits. Maintaining the specific process improvement tactics that have been implemented since adopting Lean has been relatively easy since they were generated by the frontline staff that was performing the process. Although we found the week long Kaizen event useful as a kickoff to Lean, it has since been replaced with much shorter events whereby staff make recommendations on how to improve flow and quality and management seeks to institute those suggestions with the greatest impact on value.

DISCCUSION AND CONCLUSION

Institution of Lean in our Emergency Department has been associated with improvements in patient flow, patient satisfaction, and, consequently an increase in patient visits. These changes have been sustainable over a 18-month period without increasing expense per patient or the number of ED treatment areas; thus, we believe we have added overall value to the patient experience, mainly because we have employed Lean not as efficiency-driven but as **value-driven** technique.

A key success factor for our program was that management took a subordinate role when it came to solving flow issues and let the frontline staff identify problems and come up with their own solutions. This led to a more empowered staff eager to institute their ideas as opposed to a reluctant staff feeling forced to institute top down process improvements.

Placing flow ahead of efficiency was also critical to the success of our program. The standard of Lean (first flow, then synchronization, then efficiency) has been heard more and more frequently as Lean principles were becoming part of our culture.

Last but not least, it was not large breakthrough innovations in patient flow that lead to our success, but rather multiple small process enhancements idiosyncratic to our unique people, processes, and environment. This led us to believe that it is the principles and not the specific process changes that are instrumental in successfully employing Lean. If GM tried to follow the exact processes of Toyota, most likely they would not be able to emulate Toyota’s success, as the Toyota processes have evolved over many years of small employee recommendations specific to their people, processes, environment, and culture. We, therefore, believe that institutions or departments aspiring to use Lean should focus on the principles we employed rather than the specific process changes we made.

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Emergency Treatment Center (ETC) General Process Flow Chart

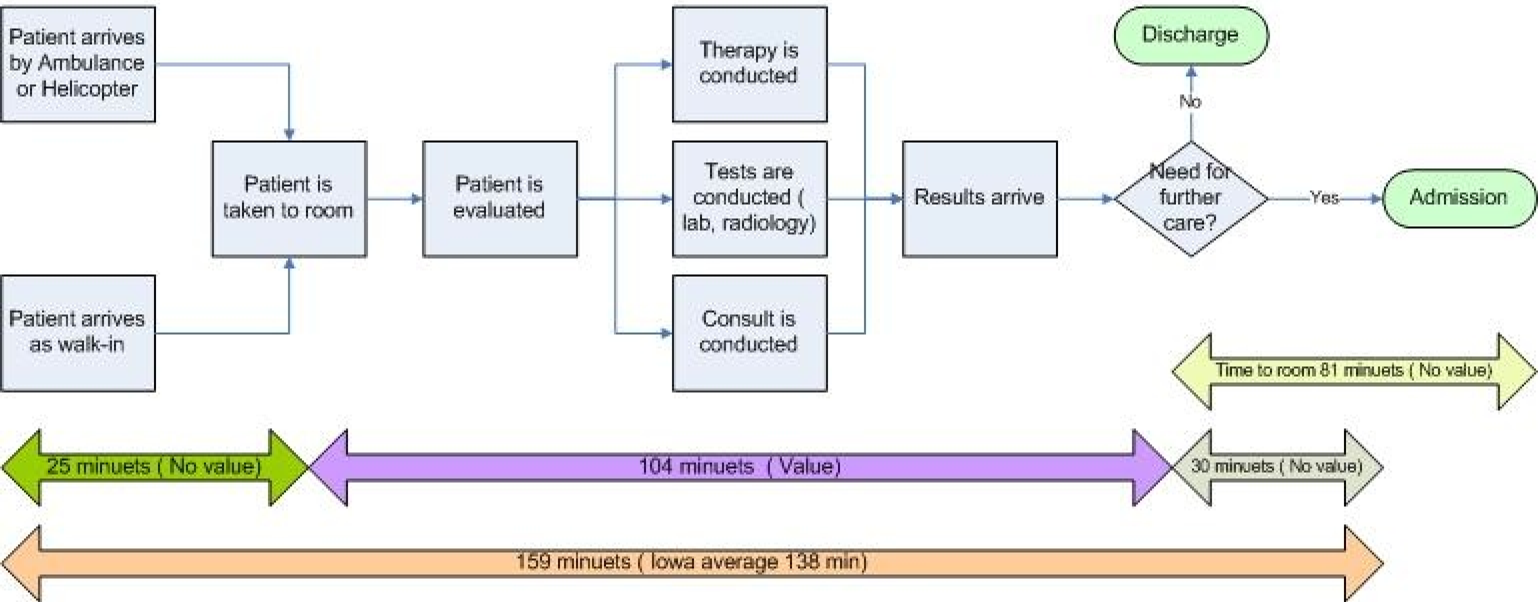

Figure 2.

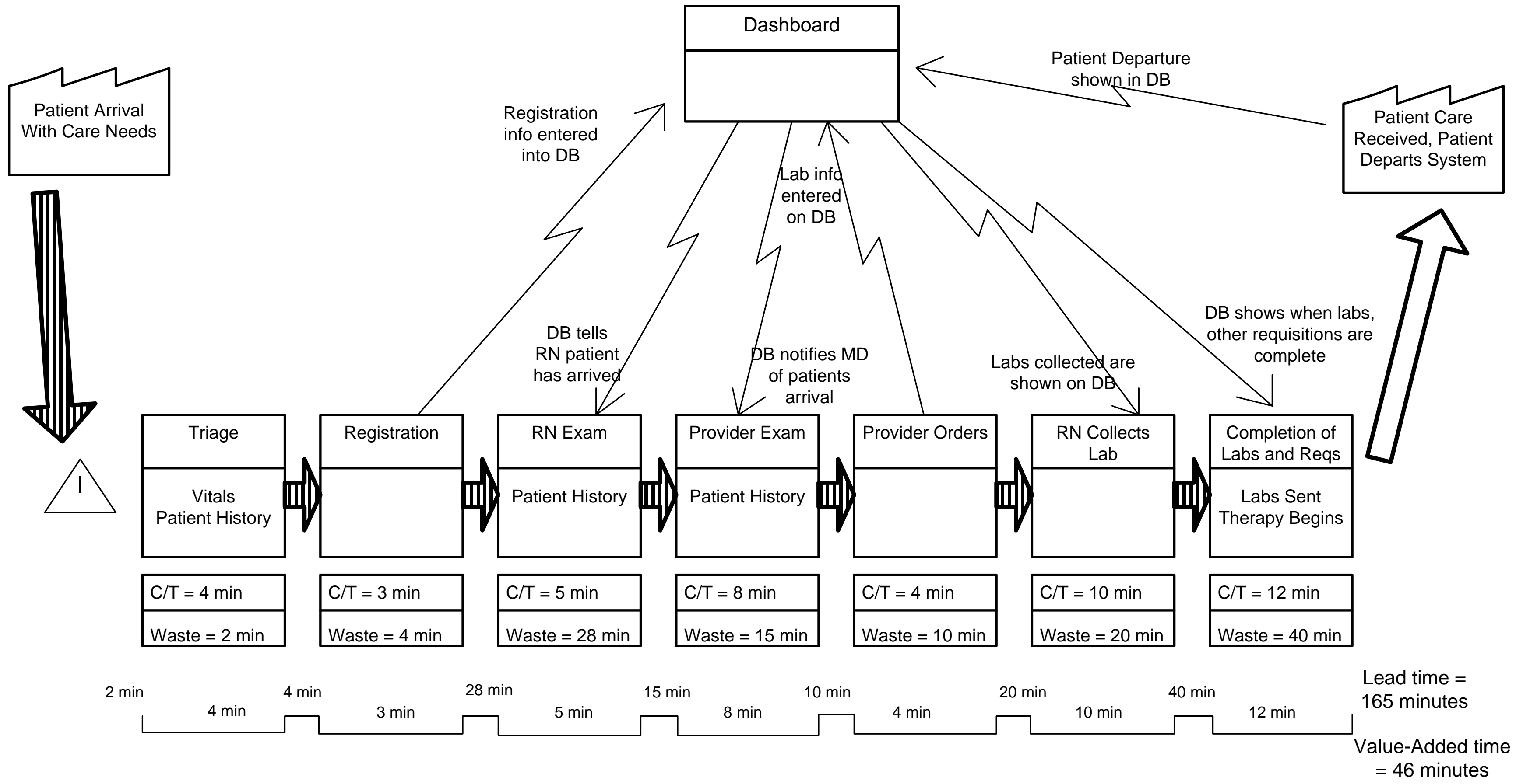

Figure 3.