

Lean Process Improvement in the Emergency Department



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KEYWORDS

- Lean • Process improvement • Patient flow • Emergency department operations
- Six sigma

KEY POINTS

- Lean is a collection of methodologies aimed at eliminating waste in any process and can readily be applied to emergency department (ED) care.
- Studies have shown improvement in multiple areas of emergency care (such as door-to-provider time, patient satisfaction scores, and patient length of stay in the ED) using Lean methodologies.
- Best practices exist and increase the likelihood that changes implemented are robust and sustainable.

LEAN: GENERAL PRINCIPLES

The unsustainable growth of health care costs is leading to transformational change in day-to-day operations, incentives, and cost structures in the American health care system. In the resulting landscape, the application of Lean process engineering presents an opportunity to enhance efficiency, improve timeliness, and reduce costs.

Lean engineering has its origins with the Toyota Production System and has been defined as “an integrated sociotechnical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability.”¹ In other words, Lean may be defined as a system of management used to minimize process lead time, maximize utilization of available capacity, and eliminate steps that do not add value, or waste, in a process² (**Box 1**).

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Box 1**Lean general principles**

Lean management principles include the following:

- Eliminating all forms of waste
- Fixing problems at their root
- Learning from the frontline
- Continuously improving
- Enhancing value flow
- Empowering frontline staff to “stop the line” when an error is recognized and to create the solution, as they are the subject matter experts

LEAN APPLICATIONS IN HEALTH CARE

Rotter and colleagues³ described 2 key components to Lean management in health care: Lean philosophy (the underlying Lean principles discussed earlier, including the idea of continuous improvement) and Lean activities (assessment and improvement focused). Lean assessment activities, which we will detail later include Gemba walk, value stream mapping, creation and integration of A3s, and rapid process improvement workshops or rapid improvement events (**Box 2**). Lean improvement activities include creation of standard work, 5S organizing, “stop the line” techniques or Andon, and daily visual management.

Gemba Walk

Gemba, the Japanese term for “the real place,” is the place where value is created.⁴ In health care, this can be in the clinic, the laboratory, the radiology suite, or in the back office. A Gemba walk refers to going to that place of work and observing. This activity can inform both decision-making and experiment design. Going to the Gemba may be most important when decision-makers hold preconceived notions about the way forward.

Examples of Gemba walks described in the literature include use as a general management strategy, as a tool for assessing and improving laboratory turn-around-time,⁵ improving safe medication administration,⁶ and enhancing efficiency in an outpatient clinic.⁷

The power of the Gemba walk is in the ability of project stakeholders to follow the patient’s journey or observe the staff’s actual workflow and then engage in honest dialogue about options for going forward.

Box 2**Lean applications in health care**

Lean assessment activities include the following:

- Gemba walk
- Value stream mapping
- Creation and integration of A3s
- Rapid process improvement workshops or rapid improvement events

Lean improvement activities include

- Creation of standard work
- “Stop the line” techniques or Andon
- 5S
- Daily visual management

Value Stream Mapping

Another key principle of Lean methodologies is enhancing the flow of value and eliminating non-value-added steps. A value stream mapping exercise first defines the concrete steps in a process and then evaluates each step, and delay between steps, in terms of whether or not it adds value to the consumer. In many health care examples, the consumer is the patient, but at times it is also providers or staff. Typically, a value stream mapping exercise starts with a map of current state. Non-value-added steps and delays between steps are then identified and that information is used to inform creation of an ideal or future state process that eliminates non-value-added steps and reduces delays between steps.

Value stream mapping can be used to redesign any patient flow process, such as intake into or flow through an emergency department (ED). But it is important to recognize that the same methodology can be applied to the flow of information, equipment, or medications. **Fig. 1** is an example of value stream mapping in the rapid medical evaluation area of the ED.

A3

One strategy for new initiatives is the creation of an A3. A3 refers to a size of paper (11" by 17") that is (in the context of Lean) formatted in a way that helps frame a problem in a structured manner and address root causes. A3s' content varies, but they typically include a project's title and owner, the background of the problem, a description of current conditions, a definition of the goal or target conditions, an analysis describing root causes of the issue, a list of countermeasures, an implementation plan, and description of follow-up. The A3 thus helps to visualize the plan-do-study/check-act cycle.

A3s have many applications in health care; for example, they can be used at the project level or for tracking of a committee's broader work. **Fig. 2** is an example of an A3.

Rapid Process Improvement Workshops or Rapid Improvement Events

Structured events, often called rapid improvement events, or Kaizen events, can be organized in order to bring stakeholders together to design and rapidly experiment with changes to a given process. Within the event, various Lean assessment methodologies are used to inform the event's progress. Often the goal of such events is to eliminate workarounds or ambiguity and create standard work. Interdisciplinary, team-based problem solving is key to the success of rapid improvement events.

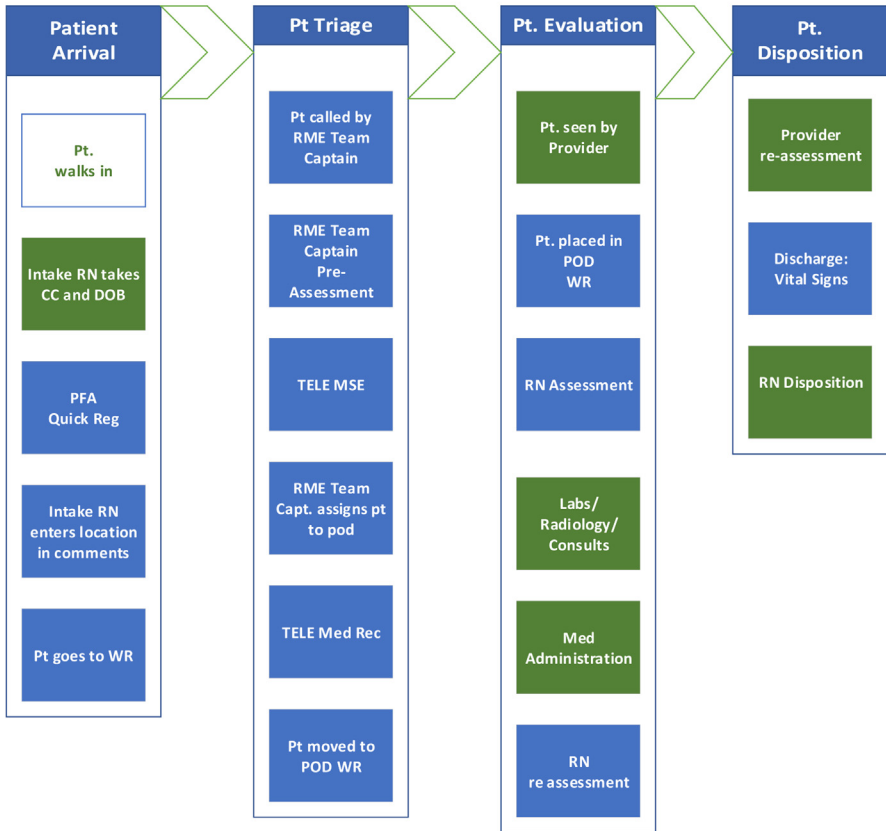
Andon or Stop the Line

Setting the standard that anyone can "stop the line" (ie, halt routine work until a quality issue is addressed) is another important aspect of Lean. In health care, it is also a strategy that has been deployed in operating rooms, clinics, EDs, and intensive care units. Often in high-pressure, fast-paced environments, errors can occur if a process is relying on one person's ability to identify a potential problem. Because health care is a team sport, giving anyone who recognizes a problem the ability to "stop the line" or "pull the Andon cord" is both meaningful and impactful.

5S

A standardized method for organizing workspace, 5S is shorthand for Sort, Set in order, Shine, Standardize, and Sustain. The most frequent application of the 5S tool in health care is in supplies and equipment storage. Sorting reduces the time to find an item. Setting in order makes it possible for an individual's work to be functionally easy

RME Redesign: Patient Process Value Added and Non Value Added



Value Added Steps in RME



Fig. 1. Rapid medical evaluation redesign: Patient process value added and non value added.

from a movement standpoint. Shining, or cleaning the workspace, makes it more safe and efficient to navigate. Standardization applies to the first 3 steps for all work areas at a facility or within an organization. Finally, sustainment involves implementing 5S across an enterprise. Fig. 3 is an example of the results of the 5S tool.

LEAN IN EMERGENCY DEPARTMENTS

Lean methodologies have been deployed in EDs in many domains. Although often inspired by adverse patient safety events or directives from the executive suite, the

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Owner:
Sponsor(s):

Team:

Title:

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Action Items:	Who	When					
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Fig. 2. Example of an A3.

Lean Activities: 5S

Fig. 3. Example of 5S tool results.

most successful improvement initiatives frequently are derived from a team's desire to compete with themselves and pushed to new heights with current resources. In EDs, project owners may be nursing or physician leaders, but it is important to recognize when ancillary service stakeholders should take ownership and drive change within their domains. Regardless of the initiative, an early first step is identifying all stakeholders involved in the process, and a key next step is recognizing their incentives to change.

Soliciting ideas for improvement is a critical skill for an ED leader. One unique approach that has been used to gather suggestions is the creation "Kaizen portal" where ED residents and attendings can submit suggestions that are evaluated and (when able) implemented by the ED leadership group.⁸ Another group required EM residents to submit "Health Systems" logs with observations of the Health Care System or patient safety reports.⁹ Regardless of methodology, engagement with frontline staff through all phases of improvement is key to a project's success (**Box 3**).

CHANGES RESULTING FROM LEAN EVENTS

Improving the Intake Process

Streamlining the steps from when a patient arrives to when the patient is seen by a provider is an important consideration in ED Lean redesign. Registration and the triage process are common areas of focus in the intake process.¹⁰ Bedside registration is often used to minimize the number of stops a patient has to make after entering the ED.^{11–14} Some of the changes that have been made to triage are reassigning movement of arriving patients to someone other than the triage nurse to avoid taking them away from triage,¹⁵ moving the location of the charts and equipment to the most convenient location for the triage nurse,¹⁶ eliminating non-value-added activities from triage,¹⁷ assigning an additional nurse to triage during peak hours, using nursing order protocols in triage when appropriate,¹⁸ and streamlining the nursing triage questionnaire.¹⁹ Bedside triage, also called "direct bedding," is an approach frequently used to eliminate unnecessary steps in patient flow. This best practice embraces triage as a process, not a place.^{10–12,14,18} One group enabled this process by breaking triage into 3 phases, "15-second triage" done before the patient is placed in a room, "quick triage" documenting critical information such as vital signs and allergies, and "data triage" including information such as smoking history.²⁰ Other groups have found combined nurse and provider triage to be useful.¹⁹ One ED improved door-to-provider times by giving providers the option to triage with nursing staff, with the potential goal of being able to discharge some patients directly from the triage location, having triage nurse-driven orders only be applied to patients who were not

Box 3

Major themes in improved care as a result of applying Lean principles in emergency departments

Major themes in improved care as a result of applying Lean principles in EDs are as follows:

- Improving the intake process
- Maximizing efficiency of care from time of provider evaluation to time of disposition
- Minimizing steps
- Segmenting the patient population into specialized care areas
- Standardizing work for each member of ED team
- Streamlining diagnostic testing
- Standardizing the admission process

expected to see a physician within an hour, having the emergency provider assess patients arriving by ambulance in a hallway instead of waiting for a bed to be free, and informing individual providers their door-to-provider times.²¹

Maximizing Efficiency from Time of Provider Evaluation to Time of Disposition

There have been a wide variety of changes described to try to make ED care more efficient. Changing patient distribution to a round-robin assignment system, adjusting staff breaks to permit better coverage of the ED, and moving frequently used medications to the top drawers in the medicine cart were changes made by one ED based on staff input.²² A unique approach to improving patient flow through the department involved having individuals in a remote location monitor ED patients around the clock electronically. Those individuals monitored processes such as the wait time to see a provider and notified the physician or nurse when they saw delays.²³ Creation of a surge protocol that was based on reports every 2 hours of certain indicators (such as number of beds available, number of admitted patients) helped streamline flow during high-volume times at another ED.²¹

Other solutions proposed by front-line staff and used during process change events were ordering and sending laboratory and radiology tests earlier in the process, improving signage for patients entering and leaving the ED, and identifying opportunities to involve other services earlier.¹³ One effective method involved having the nurse, resident, and attending get the patients' history at the same time whenever possible to reduce duplication of work and save staff time.¹³ Matching nurse practitioner shifts to patient arrival times was a change made in one department.¹⁹

Other examples of changes made include the utilization of care coordinators to expedite appropriate admission and facilitate discharges, regular meetings between ED nursing leadership and inpatient nurse managers, switching from portable telephones to walkie-talkies to facilitate staff and physician communication and reduce noise, and rearranging use of storage spaces to make room for more computer stations.²⁰ One group had ED nurses use an "upstream patient flow tool" to notify the intensive care unit what patient load it could expect from the ED within a 2- to 4-hour window.²⁴ Communication was improved significantly by standardizing huddle schedules, including all ED staff in huddles and using the electronic tracking system and comment field to guide huddle discussions and communicate patient care plans.¹⁸

Minimizing Steps

Many of the changes put into place during Lean events involved minimizing unnecessary steps for members of the ED staff. One ED reduced nurses' average miles walked per shift from 8 to 11 miles to 3 to 6 miles by creating a central supply room and by creating standardized bedside carts and procedure carts, which eliminated the need to have specialty rooms.²⁵ One department highlighted the excess walking being done by the ED secretaries by using pedometers. Realizing that they were walking an average of 6 miles per shift showed the need to change their workflow so that they could be readily available to answer the phone.²⁰ By dividing the ED into sections that correlated with nursing assignments, steps between patients were minimized.²⁰ Another ED improved metrics during a Lean event that involved standardizing intravenous carts, reorganizing stock carts so that 90% of the most used stock were within steps of the patient with all physician-required material to the patient's right.²⁶ Yet another standard procedure cart is placed in each procedure room so that providers would not need to leave the room each time to gather supplies.²⁷

Segmenting the Patient Population into Specialized Care Areas

Creating different care locations for different types of patients (often called “split flow”) is a common theme in many EDs that use Lean methodologies, particularly as ED volumes grow. Examples of care area changes include ED that created a rapid triage and treatment system in which a physician was immediately adjacent to triage nurses to address triage questions and treat Emergency Severity Index 4 and 5 patients; a fast track area for patients with low-acuity complaints^{10,21}; a separate rapid assessment and disposition area for patient who do not require beds^{28–30}; a separate physical area of the ED (which was previously inefficiently used) for a rapid medical evaluation unit^{31,32}; a “flex-pod” that could be used for various types of patient care designed from underutilized ED space³³; separate zones for complex, medium, and fast patients^{34,35}; and a “Care Initiation area” (carved out of ED space not being used any more) of 16 chairs and 4 bays for patients to come directly to that area rather than wait in the waiting room.³⁶ A “flow nurse” position that was converted from another nursing position made sure patients were placed in the appropriate care area.¹⁶

Standardizing Work for Each Member of the Emergency Department Team

Giving charge nurses the responsibility to monitor and facilitate the flow of patients to providers was also found to be helpful.¹⁰ One ED rewrote job descriptions for everyone in the department, being explicit about what the exact roles and responsibilities were for each person.²⁰ Another clearly defined the roles of specific nurses (such as charge nurse, primary nurse, fast track nurse) as well as nursing assistant, flow physician, and communication physician.¹⁸ Redefining responsibilities of nurses, nurses assistants, and the intake coordinator streamlined care in one case.¹³ One group established a “communication specialist” role to coordinate incoming referrals and communication regarding ED patients (current or expected) with other providers (such as primary care providers and in-hospital providers). They also created an automated phone system that allowed callers to be routed directly to the communication specialist.³⁴

Streamlining Testing

Improving the use of point-of-care laboratory tests has been found to increase efficiency of care.¹⁰ Encouraging the team to stop sending extra tubes of blood to the laboratories “just in case” helped improve laboratory efficiency, which in turn helped drive down ED length of stay.¹⁶ Having stable, ambulatory patients go to outpatient radiology and phlebotomy with a “priority pass” to ensure timely testing freed up ED nurses to focus on sicker patients.¹⁸ Changing computed tomography (CT) protocols such that oral contrast was not automatically given to patients receiving abdominal CTs led to a reduction in time to receive a CT scan.^{16,37} Other successful changes to the CT scan process included having CT techs pull patients, shifting CT tech hours to better cover busiest hours of the day, using wireless communication devices to improve communication between radiology and ED staff, and giving CT techs daily scorecards of their own individual performance with CT turnaround times.³⁷

Standardizing the Admissions Process

Standardizing work and streamlining operations to admit a patient from the ED were the goals of several successful quality improvement initiatives.^{38,39} Measuring time stamps around each step (eg, paging the admitting team, creation and placement of an order set including the minimum orders necessary for the nursing supervisor

to assign an appropriate bed, and development of a handoff tool faxed from ED nurse to floor nurse) allowed standardization of the admissions process.³⁹ In order to expedite patient admissions, one group created a set of orders that could be used for patients who were stable and ready to go to the floor.²⁰ Another eliminated multiple steps in the process between when the ED physician decided to admit a patient and when the patient left the ED.¹⁵ Other efforts to standardize the admission process include the creation of inclusion and exclusion criteria for admitting services, improving the electronic bed request form to include required information more consistently, defining standard work for each person involved in the admitting process, standardizing criteria for steps in care that needed to occur before admission versus those that could wait for after admission, creation of a standardized sign-out tool to be used by the ED provider giving report to the inpatient provider, use of a scorecard indicating potential deterioration of admitted patients (which helped inpatient teams determine which patients to see in the ED before admission),⁴⁰ and the creation of physician and nursing handover checklists in the Electronic Medical Record.⁴¹

USING METRICS TO MONITOR SUCCESS

There is a wide range of metrics that EDs have measured and improved on using Lean processes (**Box 4**).

SUSTAINABILITY AND POTENTIAL PITFALLS

Although Lean events help departments decide which changes to make, it does not help address the need to change culture in order to sustain those changes. There are some recurring recommendations made about making sure that changes that are made are sustained.

Getting Frontline Staff Buy-In

Making sure to get staff input and buy-in is key to success in any process change. One way to do that is to have staff take ownership by participating in the evaluation of current state, design of interventions, and ultimate decisions. A strong leader is necessary but not sufficient for end-user buy-in.²⁰ Focusing on team work and suggesting that staff think of patients as neighbors, friends, and family may help appeal to human factors in the workplace and can improve buy-in to change.¹¹ Other suggestions to improve staff buy-in include the following: making sure communication and in-servicing about new process takes place, initiating the new processes during off-peak times and in the presence of process owners and executive staff, including members from all shifts in the process, and developing clinical “champions” and midlevel managers. One group asked the staff members to present the work that they had done to the hospital board. Each slide was presented by the staff member who had championed that change in the process.³⁶

Ensuring that Leadership Is Engaged

Engagement of leadership from other departments outside of the ED’s control (such as Radiology and Admitting) can be vital to implementing changes. Having engaged leadership who are patient and present on the unit and who set and focus on clear goals that do not change as the process changes occur improves the chance of success.¹⁰ Support from hospital and ED leadership is critical to success with process change. Participation of hospital leaders help with interdepartmental collaboration, ensure alignment with broader organizational goals, and are necessary to remove barriers to adoption of Lean interventions. One study that compared various EDs’ Lean

Box 4**Metrics to monitor success**

Ambulance Diversion^{29,30,36}

Patient walkouts:

Patient leaving before being seen^{10,19–21,23,26,28,30,35,36,40,44–48}

Patient leaving before completing treatment²⁹

Triage:

Door-to-triage times^{48,49}

Number of ESI 3 patients waiting for triage⁵¹

Number of low-acuity patients awaiting triage¹⁷

Nurse-to-patient ratio at triage⁵⁰

Patient movement through the department:

Triage-to-provider time^{12,14}

Door-to-room time³⁵

Time to see a provider^{10–12,20,25,26,28,31,35,47–49}

Registration-to-disposition times⁴⁹

Doctor-to-disposition times³²

Time from decision to admit to transfer to floor¹⁴

Time between “bed ready” and patient arrival on the inpatient unit⁵⁴

Improved testing:

Arrival to first-order, radiograph, laboratory collected³³

Variation in common laboratory turnaround times⁴³

Rates of laboratory specimen hemolysis⁴²

Laboratory turnaround times^{43,55}

Transportation of ED patients for plain films⁵⁶

Time from CT ordered to CT complete⁵⁷

Length of stay (LOS):

Overall LOS^{12,13,16,20,21,23,25,28–30,32,35,36,45,52}

LOS for low-acuity^{16,27,31,46} and mid-acuity⁵³ patients

LOS for discharged patients³⁴

LOS for admitted patients^{34,39,40}

ED crowding:

Use of hallway beds³³

ED boarding time³⁸

Overall ED crowding⁴⁰

Provider productivity:

Patients per MD hour⁴⁹

Patient satisfaction:

Overall patient satisfaction scores^{11,13,20,26,34,36,38,44,45,47}

Increased ED patient volume^{11,13,20,36,45}

Impact to staff:

Cooperation among ED staff members¹¹

Increased staff satisfaction scores and decreased turnover²²

ED noise levels²⁰

Improved safety:

Streamlined medicine reconciliation process⁵⁸

Communication errors between ED and inpatient teams⁴¹

Abbreviation: ESI, Emergency Severity Index.

Data from Refs. ^{10–14,16,17,19–23,25–36,38–58}

Box 5**Suggested practices for making and sustaining changes**

Suggested practices for making and sustaining changes include the following:

- Get staff buy-in
- Make sure other departments are included
- Ensure that leadership is engaged
- Address naysayers
- Give timely feedback
- Make changes as needed

projects showed that the greatest successes were seen when both frontline staff and management were heavily involved in the process and when Lean principles were strictly adhered to.⁵²

Addressing Naysayers

It is also important to have a strategy to address naysayers, as even the best strategies can draw detractors. One principle is to ensure that those who disagree with process improvements have an opportunity to discuss their concerns openly before implementation. However, once a process change with demonstrable benefits has been started, it is important to ensure compliance. One potential avenue to ensuring this is to obtain commitments from a hospital CEO and ED medical director that noncompliance would not be accepted before implementing a change.¹¹

Giving Timely Feedback

Leaders need to review and share data regularly (some recommend daily!) as well as round in the ED every day during the pilot and during the change. One group implemented a daily management system that involved a brief huddle with frontline staff to check on the standard work that had been implemented and review timestamps and LOS metrics to reinforce and track use of the standard work.³⁹ Using a communication board in the department with current metrics, areas in which improvement has occurred, list of target goals, action item list, and comment box (including complaints about the processes) reviewed by the management team daily is one way that has been found to keep staff engaged in process change.²⁹ When ED clinicians and staff are eager to see performance metrics that are posted monthly, they are more likely to be engaged in new processes.¹⁰ Having a plan that specifies ownership for processes and changes brought about during initiatives is important to ensure that the changes are sustained.⁵⁹

Making Changes as Needed

In cases where the new process was not followed, the leaders identified and logged barriers so that leadership could further investigate the most common causes (**Box 5**).

SUMMARY

Lean methodologies are a collection of tools that can be used to maximize the efficiency of care in the ED. The most successful Lean projects involve buy-in from staff and leadership. There are several well-described steps that can be used to decide which issues to prioritize and how to best improve those processes. Providing ongoing and timely feedback are critical, both during and after a Lean event, and vital to increasing the success and sustainability of the project.

DISCLOSURE

The authors have no financial conflicts to disclose.

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