

Lean Healthcare: Current State and Future Directions

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Abstract

This paper presents the results of an exhaustive literature review on lean manufacturing and related process improvement methodologies in terms of their application to healthcare. The intent is to assess the current state of lean healthcare: what tools are finding the greatest application, what approaches are most prevalent, what success factors and inhibitors to success are commonly reported, how well do the tools and concepts apply. The future of lean healthcare is then discussed based upon the trends observed, including opportunities for Industrial Engineers to contribute to an industry turnaround.

Keywords

Lean, lean healthcare, process improvement, healthcare engineering

1. Introduction

It's no secret that the U.S. healthcare system faces a looming crisis. Costs continue to escalate, known quality problems persist, labor shortages are prevalent, health worker productivity and morale are often low, and the system is and will continue to experience increasing demands as the U.S. baby boomer generation ages. To help address these issues and avert a total system breakdown, hospitals and other healthcare organizations are focusing more attention on operational excellence. A number of healthcare organizations have discovered lean manufacturing as a model for simultaneously improving quality and productivity of operations, and have successfully applied tools and concepts from this model of operations management. The results in many cases have been remarkable. Consequently, the practices are spreading and the industry is on the cusp of a "lean healthcare movement."

Lean is an approach to operations management that considers any resource expended that does not add value to the end customer to be waste. Lean emphasizes an array of tools and methods to aid managers and workers in improvement, each designed for specific types of problems to illuminate and remove sources of waste through systems redesign. These tools and methods include value stream mapping, kanban and pull, demand leveling, single-piece flow, 5S, kaizen events, A3 reports, visual management and more.

A recent review of the healthcare management literature identified over 60 articles and reports describing application of tools, principles and concepts from lean manufacturing to hospitals and other healthcare organizations. Nearly all report significant improvement along one or more dimensions of organizational performance. From this review, we identify several trends related to use of specific lean practices, and to implementation success factors or inhibitors. Due to space limitations, we include only representative articles in this paper, and assume a working knowledge of lean manufacturing practices. Overall, the evidence suggests that lean tools and concepts have strong applicability to healthcare operations, that the degree of success is strongly tied to how hospitals go about implementation, and that there is still a great deal of potential for even wider impact.

2. Lean Tool Usage

Lean encompasses an assortment of tools for solving common types of problems in operations. Although the literature review suggests that lean applications are starting to spread rapidly within the healthcare sector, we also found that most implementations, as documented in the literature, focus on a subset of the available tools. We have divided them into high use, moderate use, and low use categories based upon the incidence rate reported in the literature.

2.1 High Use Tools

The lean tool receiving the most attention in the healthcare process improvement literature is value stream mapping (VSM). VSM is a graphical tool developed in manufacturing to analyze the flow of materials and information required to bring a product or service to a customer. Value stream maps are designed to distinguish value-adding versus non-value-adding steps. A number of authors (e.g., [1-3]) report formal studies with some form of quantified results indicating the applicability of VSM to healthcare processes. Other articles identify VSM as a useful tool in process improvement, but provide only anecdotal evidence based on personal experience or observations [4-8]. VSM has been applied to processes ranging from office, laboratory and non-clinical processes, to emergency department and operating room patient flows, and used in the development of standard processes. Each article reports some success, usually in the form of a decrease in process time or elimination of steps in the process.

5S also receives a significant amount of attention. 5S is a workplace discipline used to ensure a clean and orderly working environment and a reliable work practices. Reported uses were in offices, surgical departments, nursing wards, pharmacies, labs, and storage rooms [4, 5, 7, 9]. Like articles describing the application of VSM, some authors provide quantifiable evidence of improvement, while others describe qualitatively the improvements generated by the use of 5S. Authors reported improvements such as: increased space utilization, productivity improvements, reduced steps to find equipment, and decreases in turnaround time.

The third most common lean practice noted in the literature is the kaizen event (also called rapid improvement event, RIE). A kaizen event brings together a cross-functional team of key participants to analyze and solve a focused problem on a short timeframe (i.e., four to five days). Teams often utilize other lean tools as part of their improvement focus. From the reviewed literature, 16 articles mention some use of RIE (e.g., [2, 7, 8, 10]) covering everything from a one-time event at a facility, to a major initiative involving hundreds of events throughout a hospital system. Areas of application include pharmacies, operating suites, emergency departments, offices, oncology, and physician out of practice routines. Authors report strong results such as: reduced turnaround time, better methods to get lab results to patients, reduced patient and physician wait time, increased patient throughput with existing staff capacity, increased staff motivation and communication, increased accuracy of patient financial and clinical reports, and better patient flows.

The incidence of process maps (or workflow charts) or within lean initiatives is as prevalent as it is for 5S or kaizen events. Process maps (also called standardized work charts in the lean manufacturing literature) provide a visual representation of specific work activities, showing key inputs and outputs, task sequences and personnel flow. Process maps are more detailed and focused on specific jobs versus value stream maps, and bring roadblocks and inefficiencies into graphic relief. Process maps have been applied in emergency departments, operating rooms, laboratories, and general staff flows. They have helped reduce process times, reduce number of steps, reveal process complexity, reduce turnaround time, smooth out patient flow and reduce patient length-of-stay [1, 2, 5, 8, 11, 12].

2.2 Moderate Use Tools/Concepts

From the literature reviewed, certain tools appear in approximately a half-dozen articles. Visual management systems are mentioned as useful for streamlining processes [5, 9]. Applications include visual planning boards to track the status of flow of lab specimens or patients, and graphical display of patient safety trends as visual reminders of performance. A number of authors note how they applied Taiichi Ohno's "Seven Wastes" to identify areas for improvement [7, 9]. These principles have been applied to patient preparation processes, emergency departments, operating suites, laboratories and medical offices to help achieve decreased waiting times, reduced error rates and reduced motion. Several studies cite the intentional application of standardized work principles [9, 14], and cite measurable improvements related to elimination of redundant tray layouts, reduced variations in processes and decreased turnover times, increased accuracy of reports, and reduced inventory costs. A few articles describe the use of some type of kanban or pull system, primarily for control of supplies inventory. Several other articles describe use the "5 Why's" method to identify the root cause of problems identified [3, 9, 12, 13]. Reported results were: reduced preparation times, reduced travel/search time, reduction in stockouts, decreases in missing medication notifications, and decreases in prescription renewal times

The strength of evidence provided on the use of this subset of lean tools is mixed. In most articles, the authors cite the application of the tool or concept and provide qualitative descriptions of their effectiveness. A minority of

authors supply quantified data illustrating the change in improvement; and of those, none have conducted a systematic study as to what kinds of healthcare processes can most benefit from a given tool.

2.2 Low Use Tools/Concepts

Application of a few other lean tools or practices are described in a very small number of articles, including A3 Reports [3, 13], first-hand observation of the floor or actual workflow processes (also called the *gemba* principle) [8], Plan-Do-Check-Act [8], single-piece flow, and leveling. All of these report successful application of the lean tool or practice in improving operational performance.

Interestingly, a number of the tools or concepts most commonly associated with lean manufacturing, such as takt time, single-piece flow, error-proofing, or andon, find scant attention in the lean healthcare literature. Likely, these tools or concepts have not yet been tested; or if they have, they've not been published. It is also possible that some lean concepts appear under a different umbrella, such as patient safety and quality.

3. Implementation Success Factors

Across the dozens of cases of successfully applying Lean tools and concepts to improve healthcare delivery systems documented in the healthcare management literature, authors often point out that the tools or methods would not have led to success on their own. Additional factors are frequently cited as central to the successful implementation. Several themes emerged from an analysis of these factors, the strongest of which are: wide-spread involvement, organization commitment and support, communication, training, and problem solving.

3.1 Wide-spread Involvement

Any process change within an organization will have multiple stakeholders. Authors cite stakeholder involvement in the change effort as a crucial factor to success [7, 12]. In healthcare organizations, the typical stakeholders include frontline staff, local management, upper management, and medical staff.

A number of authors observe that engaging frontline staff in all stages of the problem solving process (identification, analysis, idea generation, design, and implementation planning) motivates, gives ownership and a sense of making a difference [1,2,7,8]. The engagement of frontline staff means real-time, active participation, and responsibility in the process [3,7]. Authors reported that empowering staff to solve problems is important because they are in the best position to understand and solve them. Empowering staff means encouraging and in some cases expecting them to identify and offer suggestions for improvement [11].

Several authors report having management involved in problem solving as important to successful Lean initiatives [7]. Management involvement means spending time providing guidance, leadership, and oversight of staff in identifying problems and in jointly working with them to resolve those problems and implement improvements [14]. A handful of authors also observed that management coordinated physicians and frontline staff in the design of processes, incorporating the perspectives of each [7]. For example, in an emergency department redesign, the management team 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. The frontline staff had to be encouraged to find solutions to the problems that created waste, slowed flow, and decreased overall care quality. The result was a significant increase in patient flow and satisfaction [1].

The involvement of those who are stakeholders extends beyond the local departments to all those who are directly or indirectly influenced by the change. Several authors reported that active involvement and participation by senior management and different divisions in quality improvement activities as important for sustaining changes and for whole organization impact [7, 11, 12]. Involvement at this level means having upper management overseeing relationships between process improvement goals and cost recovery, working with staff to resolve problems and coordinating across different departments to align improvement activities. The goal is to provide a clear and consistent vision to guide the program and to help members of the organization to view quality as an integral part of their everyday work [7, 8, 14].

Physicians are vitally important stakeholders and as such, several authors strongly assert that a successful Lean initiative depends critically on physician involvement [7]. For physicians, involvement means input into and active participation in projects which may affect them. For example, Wisconsin-based Saint Claire's hospital took specific steps to cultivate a culture with a high degree of physician engagement, such as providing dedicated medical director

services for divisions of the medical staff. Several authors also report the importance of physicians being committed to improving work processes and to work as a team with frontline staff, administrators, and other physicians [8,14]. However, for this to work, a few authors found that some physicians may need to change their hierarchical behaviors in their interactions between staff, management, and guidelines [4,15].

3.2 Organization Commitment and Support

Management commitment and support of all levels is reported strongly by many authors as critical to achieving successful and sustainable improvement [2,14,15]. This support means providing sufficient resources such as: funding for staff or IT systems, investment in training and development in project management, and facilitation of change to support improvement activities [7]. For the facilitation and support of change and improvement activities, authors found that it was important for managers to spend time working with staff to resolve problems, and encourage staff to innovate and try new ideas [14,15]. Authors also observe greater success when a structure and support is in place for creating a culture of shared understanding, awareness, and accountability that builds leadership and teamwork at all levels [8,15]. Lastly, although only reported by two authors, it appears important that the organization sticks to its chosen quality improvement method for the long-term to deliver the results [7,16]. Successful change is reported by these authors to take time, perhaps multiple years.

3.3 Communication

Communication is reported by many authors as critical when implementing a Lean initiative. Many authors observe that ongoing and high frequency of communication with those directly involved with making changes, and with other individuals and departments which may be affected by the changes, is essential to the success of a Lean implementation effort [9,11,15]. Forms of communication include: face-to-face meetings, regular meetings of staff and employees, formal and informal presentations, publicizing improvement projects, e-mails, banners, and various forms of visual communication. Several authors also found that celebrating and publicizing the success of Lean projects makes change visible, inspires other units within the hospital, and encourages a culture of continuous improvement [2].

In addition, according to several authors, creating an environment in which people feel safe and free to report errors or issues and/or call attention to the need for a process improvement is essential [8,14]. For example in a pathology department at Children's Medical Center Dallas, a mistake is viewed as a flawed process, not a human error; and while accountability is strong, individual blame is discouraged. When a mistake does occur, the process is examined to see what allowed the mistake to occur [8]. A few authors also mentioned the importance of reassuring staff that the Lean implementation does not mean staffing layoffs, perhaps by assuring staff that any casualty to efficiency is guaranteed a replacement job somewhere and that those surplus positions as a result of Lean would be eliminated through attrition [12]. This requires effective, frequent communication from management to front line workers, and vice-versa.

3.4 Training

Training emerged as a strong implementation success factor on two levels, leadership and front-line staff. Several authors noted competencies that are helpful for a leader to possess, e.g., an ability to teach staff necessary skills, knowledge of work processes, and an understanding of key features of the main approach [7,16]. A few authors specifically stated the importance of senior managers attending special training in the use of Lean tools, so that they are able to teach other managers and staff how to use them [14]. Authors report that leaders also need to prepare staff for change. The goal is to help staff understand and accept the reasons for implementing Lean, the benefits and challenges, and what Lean means for them [11,16]. Ways of preparation include meetings to explain current situation, initial education of Lean, or Lean awareness workshops. Staff preparation time varies from as little as one week to as much as several months.

Numerous authors also espouse staff education in Lean methodologies as crucial to the success of a Lean initiative [8,12]. Education can be in the form of a formal training program [5,12] or through on-the-job coaching and mentoring [3]. Hagg, et al. [5], find more success in the long term retention and application of Lean tools when the tools introduced in training sessions are applied within participants' own work environment. The training should focus on developing internal organizational competency for innovation by the staff and dedicated project leaders who have a real stake in the outcome in terms of their daily work.

3.5 Problem-solving

While tools are often useful, numerous authors report on the importance of accurately identifying the problem and its root cause, then quickly experimenting on possible solutions to verify that the problem was correctly diagnosed. Direct observation of the problem, and documentation of actual work processes was reported by many authors as a method to ensure sufficient understanding of the problem in context [3,5,8,13]. Root cause analyses attempt to identify the source of a problem at a deep enough level that solutions will prevent recurrence of that problem. Rapid experiments are ways of quickly trying and implementing new ideas. Several authors reported that rapid experiments generated the most effective changes, revealed larger problems that were hidden by the smaller problems and provided instant gratification of actually accomplishing concrete improvements right away [12].

4. Inhibitors to Successful Implementation

In addition to success factors, the literature on lean applications in healthcare also identifies a number of inhibitors to successful implementation. One of the most salient inhibitors for the improvement community is the adaptation of Lean tools and concepts to a healthcare setting. Most of the existing examples and exercises are specific to manufacturing, and there is an absence of translation of the manufacturing language for Lean into healthcare [3,5]. Authors report that the difficulty is due to the steep learning curve, lack of leaders with expertise, and trainees having limited knowledge of basic tools and skills commonly used in manufacturing [1,5,14]. Using unfamiliar terminology and examples foreign to the average healthcare worker hampers the acceptance of the methodology. In addition, because care pathways are complex, processes tend to be highly departmentalized, process simplification without compromising quality is not always straightforward, and good data are not often readily available, it can prove difficult to apply many of the Lean tools and methods [7].

Changing the underlying organizational culture is often reported as a barrier to quality improvement [7,8]. Authors have reported difficulties associated with the departmentalism of physicians and staff [4]. They observe a lack of goal congruence between physicians and hospitals with some salaried physicians facing incentives to generate high service volumes and some physicians resisting change because they would face reduced autonomy [1]. In addition, management styles can inhibit process improvement. Some managers or change agents either have a hard time delegating process improvements to the people doing the work or adopt a command-and-control approach which restrains change and learning [2,4]. Others find it difficult to move away from a quick fix mentality to a more long-term perspective, and to overcome the tendency to rush in and immediately start jumping to solutions before understanding the underlying issues [7,16].

Buy-in of staff is often reported as a significant challenge [3,7]. Some indicate that staff members can be suspicious of the concept of Lean thinking and can perceive Lean as a method for eliminating jobs or as another management fad [7]. Authors observe that getting staff aware and gaining their approval (recognizing the need for change) are difficult because of internal resistance to change [2,7]. Authors found that, because change can be difficult and disruptive, it is beneficial to acknowledge this to staff and let them know that this change is a new way of thinking that will benefit both them and patients [7]. Several authors also observe that motivation for change is challenging because change can be uncomfortable, or because the system has no differentiation for better performers [4,8].

5. Implications and Future Directions

The implications of this literature review are several. First, the healthcare management literature contains dozens of cases where lean tools and concepts have been successfully applied to healthcare processes across a wide swath of organizations. The concepts, therefore, appear to have applicability. However, most of the lean implementation efforts focus on a small number of tools (VSM, 5S, kaizen events, and process mapping). There is opportunity to discover whether and how other, equally powerful lean practices can be applied to aid in helping hospitals achieve operational excellence.

Second, among the dozens of articles surveyed, few explain in detail how the tools were actually used and the results that can be directly attributed to that tool. Also, many of the cases do not use quantitative measures to back up the authors' claims. What the literature lacks are carefully designed research studies to compare and contrast lean implementation efforts across multiple organizations. Such studies could yield insights into the practices, culture, and management styles necessary to adapt lean methodologies to healthcare and sustain improvement over time.

Third, there appears to be a significant need for the development of training materials and curricula that replace manufacturing jargon with healthcare terminology, contain healthcare-related examples, and that speak to the concerns of the healthcare community (e.g., these approaches can help make your job easier so you can spend more time with patients). Much work remains to understand how to contextualize the lean model for healthcare. This suggests a role for practicing professionals to implement (or assist in implementation) and learn from mistakes and successes. It also suggests a role for academics to study, characterize, advance the frontier of knowledge, and disseminate best practices.

Finally, industrial engineers (IE's) entering the healthcare sector would be wise to heed the implementation success factors and inhibitors, and devise their approaches accordingly. For example, that wide-spread involvement is important for successful implementation means that IE's will not likely succeed without engaging front-line staff, management, and physicians in their efforts. There appears to be a tremendous opportunity for IE's to contribute in changing the trends of the current healthcare industry.

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