Annotated Bibliography on Lean in Healthcare Organizations
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Overview
This document compiles a comprehensive list and summary of systematic reviews and primary research articles focused on Lean management’s application in healthcare settings. All papers were published between 2000 and 2016. Primary research articles were restricted to those that focused solely on Lean in healthcare. The articles are organized by whether they addressed 1) health, process, satisfaction, and cost outcomes or 2) components, methods, barriers, and facilitators of Lean healthcare interventions. For primary articles, papers are further sub-categorized by organizational unit (e.g. ER, surgery, laboratory) in which Lean was implemented.

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*some department labels (i.e. outpatient care) are not shown in both sections because zero articles in a section fit that department.
Systematic Reviews

**Systematic reviews of published articles assessing health, process, satisfaction, and cost outcomes of Lean in healthcare organizations**


A systematic literature review was conducted to determine whether Lean, Six Sigma, or Lean Sigma have been effectively used to create and sustain improvements in the acute care setting. Databases were searched for articles published in the healthcare, business, and engineering literatures. Study inclusion criteria required identification of a Six Sigma, Lean, or Lean Sigma project; quality improvement efforts focused on hospitalized patients; descriptions of project improvements; and reported results. 47 out of 539 potential articles met inclusion criteria. The authors concluded that Lean, Six Sigma, and Lean Sigma all can address a wide variety of acute care problems, but that the true impact of these methodologies is difficult to judge given the lack of rigorous evaluation or evidence of clearly sustained improvements. More research is needed to provide greater understanding of these approaches and how to achieve sustainable improvement.


This article critically reviewed 18 articles describing the implementation of Lean in 15 Emergency Departments (EDs) in the United States, Australia, and Canada. The author used an analytical framework from occupational research to generate 6 core questions regarding Lean’s effect on ED work structures and processes, patient care, and employees, as well as Lean’s success factors. Identified Lean process changes often involved the creation of separate patient streams along with structural changes including new technologies, communication systems, staffing modifications, and reorganization of physical space. Patient care was usually found to improve, as many EDs reported decreases in length of stay, waiting times, and proportion of patients leaving the ED without being seen. Few null or negative effects were reported, with explored patient effects typically limited to patient satisfaction. The effect on employees was rarely measured, but there were some indicators of positive effects. Factors for Lean success included employee involvement, management support, and preparedness for change. The author concluded that Lean appears to offer significant improvement
opportunities in spite of methodological concerns, and that more research is needed on Lean’s effects on patient health and employees and how Lean can be best implemented in healthcare.

Moraros, J., Lemstra, M., and Nwankwo, C. (2016). ‘Lean interventions in healthcare: do they actually work? A systematic literature review’, *International Journal for Quality in Health Care*, 28 (2), pp. 150-165. A systematic literature review was conducted to assess the effect of Lean on worker and patient satisfaction, health and process outcomes, and financial costs. 9 different databases (including PubMed and Medline) were searched for peer-reviewed articles that examined a Lean intervention and included quantitative data, resulting in 22 articles inspected. Data on design, methods, interventions and key outcomes were extracted and collated. They found that there was 1) no statistically significant association with patient satisfaction and health outcomes, 2) a negative association with financial costs and worker satisfaction, and 3) a potential but inconsistent benefit to process outcomes like patient flow and safety. The authors concluded that evidence to date does not support the belief that Lean leads to healthcare quality improvements. They called for more rigorous, higher quality and better conducted scientific research to definitively ascertain the impact and effectiveness of Lean in healthcare.

Shazali, N.A., Habidin, N.F., Ali, N. et al. (2013). ‘Lean Healthcare Practice and Healthcare Performance in Malaysian Healthcare Industry’, *International Journal of Scientific and Research Publication*, 3 (1). The authors conducted a literature review of Lean healthcare practices. They aimed to analyze the relationship between Lean healthcare and healthcare performance as defined by 3 elements: financial performance, customer satisfaction, and employee performance. The researchers found that while previous studies have identified critical success factors for Lean implementation, limited empirical studies have investigated the relationship between Lean and healthcare performance. They also proposed future research in designing a structured questionnaire to obtain pilot study data for healthcare practices in Malaysia.

Vest, J.R. and Gamm, L.D. (2009). ‘A critical review of the research literature on Six Sigma, Lean and StuderGroup's Hardwiring Excellence in the United States: the need to demonstrate and communicate the effectiveness of transformation strategies in healthcare’, *Implementation Science*, 4, pp. 35-43. Vest and Gamm conducted a systematic literature review of 3 current popular change strategies, including Lean, and examined peer-reviewed evidence of their effectiveness. The authors found that studies universally concluded the strategies’ success and applicability to a wide variety of settings and problems. However, the vast majority of these studies contained methodological limitations including
weak study designs, inappropriate analyses, and failure to rule out alternate hypotheses. Additionally, many studies did not provide substantial evidence for lasting effects or changes in organizational culture. The paper concluded that improved design and analysis of these change theories would provide more effective guidance to healthcare managers; more rigorous evaluation of project consultants and partnerships with academic healthcare researchers were suggested as ways to accomplish this.
Systematic reviews of published articles identifying components, methods, barriers and facilitators for implementing Lean in healthcare organizations


This paper sought to determine readiness factors critical to the success of Lean applications in healthcare. To this end, a comprehensive literature review focusing on lean and lean healthcare was conducted. Commonly cited readiness factors were leadership, organizational culture, communication, training, measurement, and reward systems. The authors also found that an organization’s ability to implement a decentralized management style and undertake an end-to-end process view were important, which was noted as particularly difficult for complex healthcare settings.


The authors noted that there is conflicting evidence regarding Lean outcomes, with quantitative and qualitative studies often contradicting each other. The article aimed to identify factors facilitating intended outcomes from lean interventions, and to understand when and how different facilitators contribute. A 2-dimensional conceptual framework combining Shortell’s *Dimensions of capability* and Walshes’ *Domains of an intervention* was used in conducting a systematic review of lean review articles concerning hospitals, published in the period 2000–2012. Identified lean facilitators were then categorized according to the intervention domains and dimensions of capability provided by the framework. 23 factors were identified for successful Lean intervention, with supportive management and culture, training, accurate data, physicians and team involvement cited most frequently.


In this paper, Brandao de Souza conducted a systematic search and critical literature review of Lean healthcare articles up to 2008 in ten countries. The author employed search and metasearch engines to identify relevant works, using key words such as “Lean healthcare”, “Lean hospital”, and “Lean medical”. This search garnered over 90 sources, which the author then cross-referenced to find further works. Multiple speculative U.S. studies reported positive results from use of Lean initiatives in improving patient flow and in both clinical and non-clinical settings. However, none of these studies provided explicit evidence of their results. The review also found that healthcare lags far behind the manufacturing industry’s level of excellence in Lean applications, and that many case studies have
been branded as Lean while only applying one or two of Lean’s concepts. Overall, this paper concluded that while there seems to be consensus over Lean’s potential for improving healthcare delivery, more critical and concrete evidence is needed. Cross-organizational interaction was stated as a further avenue of exploration.


A comprehensive literature review was conducted to find Lean healthcare articles published up to 2013. Thematic analysis was then performed to extract and synthesize data for 243 articles. Lean was mostly explored in a hospital setting, with theoretical works focusing mostly on barriers, challenges, and success factors. Underexplored areas of analysis included Lean sustainability, measurement frameworks, and system-wide approaches. Authors concluded that while promising, more conclusive findings on Lean are needed; particular investigation on the magnitude of investments required and engagement of the whole organization were suggested. Managers and policy makers were additionally encouraged to use research to learn how to play a pivotal role for more effective Lean implementation in different health contexts.


The authors conducted a realist literature review to examine how Lean has been put into practice in healthcare and how it has worked. They limited their review pool to Lean healthcare applications that impacted patient care, and excluded hybrid approaches, resulting in 33 articles for review. A thematic analysis was then conducted. The authors noted 4 different change mechanisms: 1) understanding processes to generate shared understanding, 2) organizing and designing for effectiveness and efficiency, 3) improving error detection to increase awareness and process reliability, and 4) collaborating to systematically solve problems to enhance continual improvement. They concluded that Lean has been successfully applied in a wide range of healthcare settings, and that most Lean healthcare implementations have reported narrower rather than system-wide applications, contrasting with Lean’s holistic view. Recommendations for better implementation were to directly involve senior management, work across functional divides, pursue value creation for patients and other customers, and nurture a long-term view of continual improvement.
Plytuk, C.F., Gouvea da Costa, S.E., and Pinheiro de Lima, E. (2014). ‘Lean in Healthcare: A Systematic Literature Review and Social Network Analysis’, *Production and Operations Management Society*. The authors conducted a systematic review of 139 papers from the Lean Healthcare literature to identify groupings in the Lean research field. Bibliometric citation/ co-citation and Social Network analysis were used to investigate the articles sampled. Common paper themes involved Lean in context of the NHS UK, pathology laboratories, reduction of variability and Six Sigma, other laboratories, and emergency departments. Analysis of number of authors per paper found a high level of collaboration in Lean healthcare research, with 65% of papers having between 3-12 authors. The literature review concluded that the results revealed a still emergent field marked by poorly explored relationships and knowledge, indicating many possibilities for future research.


This article sought to discuss the current state of Lean healthcare implementation through a comprehensive literature review. It found that Lean healthcare improvement focused on 3 main areas: 1) defining value from the patient’s perspective, 2) value stream mapping, and 3) eliminating waste in an attempt to create continuous flow. Value stream mapping was noted as the most frequently applied Lean healthcare tool. Typical implementation steps were to conduct Lean training, initiate pilot projects, and utilize interdisciplinary teams. A noted barrier was lack of applied healthcare knowledge from Lean consultants.


This paper provided a preliminary analysis of areas where the read-across from other sectors to Lean healthcare is relatively well understood, based on a broad review of its impact on care delivery. The authors concluded that there was scope for methodological development in Lean healthcare by defining three themes associated with value—the operational, the clinical and the experiential.
Published Primary Research Articles

Primary research articles assessing health, process, satisfaction, and cost outcomes of Lean in healthcare organizations

Acute Care (Medical/Surgical)


Interrupted time-series analyses were used to assess the impact and sustainability of a multifaceted intervention to prevent methicillin-resistant *Staphylococcus aureus* (MRSA) transmission over 3 chronologically overlapping phases at 1 U.S. hospital. The researchers examined individuals admitted to acute care units between October 1, 1999 and September 30, 2008. They found that after the intervention’s initiation in 2001, clinical incidence of MRSA colonization decreased, culminating in a total 61% decrease in the 7-year post-intervention period (p=0.02). The intervention consisted of 3 elements: 1) Lean and positive deviance change strategies to promote adherence to infection control protocol, 2) enhanced emphasis on hand hygiene and environmental disinfection, and 3) active surveillance testing of anterior nares and open wounds within 48 hours after admission to identify patients asymptotically colonized with MRSA for prompt initiation of contact precautions. The study demonstrated a significant and sustained intervention-associated reduction in hospital-wide MRSA transmission, as defined by clinical incidence of MRSA colonization or infection.

Community Health Clinics (CHCs) & Rural Facilities


The authors attempted to assess the Lean 5S management method’s effect on the workplace, healthcare process and outcomes, and applicability to resource-poor settings based on a pilot intervention of the 5S program in a Senegal health facility. They conducted a qualitative study by interviewing 21 health center staff members 1 year after the pilot intervention. Staff were asked about their views on the changes brought on by the 5S program in their workplace, daily routines, and services provided. Interviews were then transcribed and organized by emerging themes using thematic analysis in the coding process. The authors concluded that the 5S management method was perceived
to have improved the quality of healthcare services and staff motivation in a resource-poor healthcare facility with a disorderly work environment in Senegal.


This paper discussed the journey a 99-bed rural hospital took to integrate Lean into its organization and the outcome. The first year focused on the development of healthcare-specific Lean training modules, honing change management skills and leadership training. The hospital CEO and senior management invited 52 personnel (a mix of managers, nurse supervisors, line staff, and business personnel) to be a part of the program. Team expectations included attendance at all workshops, participation in a Lean project, and willingness to be a trainer or mentor to future Lean teams. Senior management agreed to provide support to all team members, including time and scheduling commitment and assistance in reducing or eliminating barriers for success. Change management workshops were delivered by certified university facilitators. The hospital CEO defined 3 parameters for projects: meet the organization’s strategic mission, include a 70% clinical and 30% nonclinical project mix, and involve no large requests for new money. The first Lean project aimed to decrease time spent obtaining supplies from a particular supply room from entry to exit on the morning shift by 20%. Time savings of 6 minutes, 53 seconds/supply search and annual cost savings of $9851/year were observed. A second project aimed to reduce ED waiting times by 10% and resulted in 68 minute time savings from 230 minutes to 162 minutes after Lean. The third and last project worked to meet a standard the clinical information be documented in e-medical records within 30 minutes post-nursing assessment. Improvements resulted in reducing the average time that elapsed between taking a patient’s vitals and inputting data into the EMR from a high of 538 minutes after to within 30 minutes of taking the patient's vitals. The authors found that these projects showed that similar improvements from Lean are possible within all aspects of the medical community.


Previous research consistently demonstrated that treatment timeliness (the amount of time between consumers’ initial contact with mental health service providers and their first appointment) was an important predictor of whether consumers attended their appointments. Lean was thus evaluated as a method to change intake procedures on treatment timeliness within a semi-rural community mental...
A team of administrators, clinicians, and staff conducted value stream mapping of the clinic’s intake process and identified non-value added elements, potential sources of error, and waste. They then designed a new intake process based on Lean that focused on specifying the process in detail, with unambiguous connections between each step, and a simple and direct pathway. The team found it important to understand average intake/day, times of day with heaviest intake, and months with higher intake volume in order to determine when more help was needed and how much time intake staff would have for other duties. For data analysis, 100 randomly selected cases opened the year before the change and 100 randomly selected cases opened the year after the change were examined using analysis of covariance (ANCOVA). The authors found that changing intake procedures using Lean significantly decreased the average number of days consumers waited for appointments from 11 days to 8 days ($p = .03$).

**Emergency Department (ED)**


A repeated cross-sectional study was conducted to determine the patient safety culture in a county hospital ED and a university hospital ED. The authors used the Hospital Survey On Patient Safety Culture questionnaire to assess this culture before and after a quality improvement project using Lean principles and team triage at both EDs. At the county hospital, a difference between baseline and follow-up was observed in three dimensions. For two of these dimensions, *teamwork within hospital* and *communication openness*, a higher score was measured at follow-up; *information and support to staff at adverse events* was rated lower at follow-up. At the university hospital, 3 dimensions were found as lower at follow-up: *staffing, information and support to patients at adverse events*, and *patient safety grade*. A higher score was measured at follow-up for *teamwork across hospital units* and *teamwork within hospital*. Overall, the authors concluded that the improvement project led to changes in self-estimated patient safety culture, with improvements in perceived teamwork and communication openness, and declines in perceived information and support to staff during adverse events.

A quantitative, pre- and post-Lean design study was conducted to evaluate a series of Lean methods implemented to improve admission and blood result waiting times at an ED. These methods included structured re-design process, priority admission triage (PAT) program, enhanced communication with medical department, and use of new high sensitivity troponin-T (hsTnT) blood test. Triage waiting time, consultation waiting time, blood result time, admission waiting time, total processing time and ED length of stay were compared before and after implementation. After Lean implementation, the triage waiting time and end waiting time for consultation were significantly decreased. The admission waiting time to the emergency medical ward (EMW) was also significantly decreased from 54.76 minutes to 24.45 minutes after implementation of the PAT program (P<0.05). The authors concluded that Lean management can improve the patient flow in ED, with adherence to lean principles being crucial to enhance high quality emergency care and patient satisfaction.


Participants in 2 academic and 2 community EDs that instituted Lean as their single process improvement strategy made observations of their behavioral changes over time. They also measured the following metrics related to patient flow, service, and growth from before and after implementation: time from ED arrival to ED departure (length of stay), patient satisfaction, percentage of patients who left without being seen by a physician (2 EDs), the time from ordering to reading radiographs (1 ED), and changes in patient volume. The authors found that one year post-Lean, length of stay was reduced in 3 of the EDs despite an increase in patient volume in all 4. Each observed an increase of patient satisfaction lagging behind by at least a year. They additionally noted that the narratives indicate that the closer Lean implementation was to the original Toyota principles, the better the initial outcomes. The immediate results were also greater in the EDs in which the frontline workers were actively participating in the Lean-driven process changes. A factor that considerably affected the outcomes in the second and third year post-implementation was the level of continuous leadership commitment to Lean.
El Sayed, M.J., El-Eid, G.R., Saliba, M. et al. (2015). ‘Improving Emergency Department Door to Doctor Time and Process Reliability: A Successful Implementation of Lean Methodology’, Medicine, 94 (42), e1679. This study aimed to determine the effectiveness of Lean management on improving emergency department (ED) door-to-doctor times at an academic, urban tertiary care hospital. The authors performed a before and after study at the ED after implementing a series of Lean-driven interventions over a 20-month period. A convenience sample from the pre-intervention phase (February 2012) was compared to another from the post-intervention phase (mid-October to mid-November 2013). Individual control charts were used to assess process stability. Post-intervention, a statistically significant decrease in mean door-to-doctor time (40.0 mins ± 53.44 vs 25.3 mins ± 15.93, P < 0.001) was found. Length of stay of both admitted and discharged patients dropped from 2.6 to 2.0 hours and 9.0 to 5.5 hours, respectively. All other variables including emergency department visit daily volumes, hospital occupancy, and left-without-being-seen rates were comparable.

Ford A.L., Williams J.A., Spencer M. et al. (2012). ‘Reducing door-to-needle times using Toyota’s Lean manufacturing principles and value stream analysis’, Stroke, 43 (12), pp. 3395–3398. Earlier tissue-type plasminogen activator (tPA) treatment for acute ischemic stroke was previously shown to improve the efficacy of tPA, urging national efforts to reduce door-to-needle times. To this end, the authors used Lean process improvement to develop a streamlined intravenous tPA protocol. A multidisciplinary team conducted value stream analysis (VSA) of the acute ischemic stroke patient pathway. 132 stroke patients treated with tPA before VSA and 87 patients treated with tPA after VSA were directly compared on baseline characteristics, protocol metrics, and clinical outcomes. VSA exposed several tPA protocol inefficiencies, which were then addressed through roll-out of a new protocol designed to minimize delays. Average door-to-needle time dropped 21 minutes from 60 to 39 minutes post-VSA (p < 0.0001), and the % of patients treated <= 60 minutes from hospital arrival increased from 52% to 78% post-VSA (p < 0.0001), with no change in hemorrhage rates. The paper concluded that future studies should be implemented to determine whether this intervention is sustainable across various hospital settings.

Kelly A., Bryant M., Cox L. et al. (2007). ‘Improving emergency department efficiency by patient streaming to outcomes-based teams’, Australian Health Review, 31 (1), pp. 16-21. A pre-post study was conducted at an emergency department (ED) at a 300-bed, community teaching hospital in Melbourne, Australia. It aimed to describe the procedure and results of a process redesign based on task analysis and Lean thinking approaches aimed at improving ED efficiency. The study
compared 12-month periods before and after the process redesign for total episodes of ambulance bypass, waiting times (overall and by triage category) and total ED time (overall and by triage category). Time data were then analyzed using non-parametric methods. While the years were broadly comparable, there was an 8.4% increase in total hours of care delivered (a marker of ED workload) in the year after the change. Episodes of ambulance bypass reduced by 55% (120 v. 54). There were statistically significant waiting time reductions for triage categories 3 and 5 (median reductions 5 and 11 minutes respectively). There was an increase in total ED time for triage category 3 (median increase 7 min) and a decrease for categories 4 and 5 (median reduction 14 and 18 min, respectively). The authors concluded that process redesign using task analysis and Lean could improve ED efficiency.


The authors aimed to address the gap in knowledge of how and why lean interventions succeed or fail. They utilized a mixed methods design to evaluate an in-depth case study of a Lean-inspired intervention in a Swedish hospital, particularly in its pediatric Accident & Emergency (A&E) Department - the largest of 3 pediatric A&Es in Stockholm. The study aimed to compare performance before and after lean intervention as well as explain how and why lean worked. The hospital’s weekly average data on waiting times and patient volume were collected for 52 weeks before and 104 weeks after Lean implementation for quantitative analysis. Additionally, qualitative data from interviews and documents were retrospectively collected from the intervention-planning phase and prospectively collected during the implementation phase. Analysis of variance (ANOVA) was used to assess differences in performance pre- and post-Lean, revealing an increase in % of patients completing their A&E visit within 4 hours from 67% to 80% [95% CI (65.5, 69.7), (78.2, 82.4)] that was maintained 2 years after the intervention. Average time to first physician consultation also decreased by 24% from 67 to 51 minutes [95% CI, (61.7, 71.5), (46.5, 56.3)] and was sustained 2 years post-Lean at 54 minutes [95% CI, (49.4, 59.2)]. The authors explained that Lean was effective because it reduced work ambiguity, created clear connections between caregivers who were dependent on each other, developed seamless and uninterrupted flow, and enabled continuous improvement through worker empowerment. Barriers to greater improvements from Lean were cited: these were job mismatch, discomfort with being monitored or with inter-professional collaboration, and some employees’ distance from change-related decision-making, leading to a feeling of being inadequately informed.
The authors suggested further research into which Lean changes contribute most to performance improvement, claims of contextual conditions critical to further success, and the effects of Lean on employee working conditions.


Lean principles were used to implement emergency department (ED) process improvements in 1 U.S. hospital, leading to the development of a Rapid Triage and Treatment (RTT) system. A retrospective, observational study was then conducted comparing electronic medical record data 6 months before and after implementation to determine whether Lean principles had an effect on ED metrics. The researchers found that changes in ED processes using Lean thinking and available resources improved efficiency. Mean ED length of stay was reduced by 36 minutes and the % of patients leaving without being seen by a doctor was reduced from 4.5% to 1.5% (95% CI). Months prior to any changes, weekly process improvement meetings with front-line staff and department leadership were conducted to gain staff input and plan process changes. Value stream mapping was used to analyze the flow of patients through the ED. Non-value-adding steps were identified and then streamlined to remove waste; weekly process meetings continued after implementation to constantly re-evaluate and modify as needed. The researchers emphasized staff and physician involvement throughout the process.


In recognition of patient wait times, and deteriorating patient and staff satisfaction, the authors set out to improve these measures in the emergency department (ED) without adding any new funding or beds. Lean techniques such as value stream mapping, just-in-time delivery techniques, workplace organization, reduction of systemic wastes, use of the worker as the source of quality improvement, and ongoing refinement of process steps formed the basis of the project. This resulted in major improvements in departmental flow without adding any additional ED or inpatient beds. The mean registration to physician time decreased from 111 minutes to 78 minutes. The number of patients who left without being seen decreased from 7.1% to 4.3%. The length of stay (LOS) for discharged patients also decreased from a mean of 3.6 to 2.8 hours. Lastly, an improvement in ED patient satisfaction scores was noted following the implementation of Lean principles.
Vermeulen M.J., Stukel T.A., Guttmann A. et al. (2014). ‘Evaluation of an Emergency Department Lean process improvement program to reduce length of stay’, *Annals of Emergency Medicine*, 64 (5), pp. 427–438. Researchers sought to determine the effects of a Lean Emergency Department (ED) process improvement program on ED wait times and quality of care. They directed a retrospective cohort study of all ED visits at program and control sites during 3 waves from April 2007 to June 2011 in Ontario, Canada. The authors then conducted time series analyses comparing pre- and post-Lean implementation at program sites as well as difference-in-differences analyses comparing changes in program sites versus control sites. They found that while median ED waiting times did decrease at program sites, those benefits were diminished or disappeared when compared to control sites, which were exposed to system-wide initiatives such as public reporting and pay-for-performance. Further research was suggested to evaluate the effectiveness of Lean methods in the ED before warranting widespread use.

**Intensive Care Unit (ICU)**


A before-after intervention study was conducted to measure the effectiveness of a Lean approach to implementing a methicillin-resistant *Staphylococcus aureus* (MRSA) prevention program. The study took place in an ICU and a surgical unit in the Pittsburgh Veterans Administration hospital and included all patients admitted to these units. The MRSA prevention program was comprised of 4 elements: 1) the use of standard precautions for all patient contact, with emphasis on hand hygiene; 2) the use of contact precautions for interactions with patients known to be infected or colonized with MRSA; 3) the use of active surveillance cultures to identify patients who were asymptomatically colonized with MRSA; and 4) use of Lean to facilitate consistent and reliable adherence to the infection control program. The rate of healthcare-associated MRSA infection in the surgical unit decreased from 1.56 infections per 1,000 patient-days in the 2 years before the intervention to 0.63 infections per 1,000 patient-days in the 4 years after the intervention (a 60% reduction; *P* = .003). The rate of healthcare-associated MRSA infection in the ICU decreased from 5.45 infections per 1,000 patient-days in the 2 years before to the intervention to 1.35 infections per 1,000 patient-days in the 3 years after the intervention (a 75% reduction; *P* = .001). The combined estimate for reduction in the incidence of infection after the intervention in the 2 units was 68% (95% confidence interval, 50%-79%; *P* < .001).
Laboratory


Lean was used in a molecular diagnostic laboratory to assess inefficiencies and improve speed of result generation. Baseline data analysis revealed that the greatest challenge to timely result generation occurred in the pre-analytic phase of specimen collection and transport; as such, efforts focused primarily on re-designing pre-analytic processes using Lean principles. The lab’s goal was to complete greater than 90% of the molecular tests in less than 3 days. The authors stated that Lean processes resulted in fewer steps, approaching the ideal of a one-piece flow for specimens through collection/retrieval, transport, and different aspects of the testing process. Lean created a 44% reduction in molecular test turnaround time for tissue specimens, from an average of 2.7 to 1.5 days. In addition, extending Lean principles to clinician suppliers resulted in a markedly increased number of properly collected and shipped blood specimens (from 50 to 87%). These continuous quality improvements were accomplished by empowered workers in a blame-free environment and are now being sustained with minimal management involvement.


Multidisciplinary response and rapid implementation of process changes based on Lean methods were used at a provincial public health laboratory in British Columbia, Canada, to improve laboratory surge capacity in the 2009 influenza H1N1 pandemic. In the face of a 10-fold increase in demand for influenza testing without approval for additional staff, the lab needed to improve efficiency by changing workflow processes. Before the onset of the pandemic, PHMRL staff had been trained in Lean methods, and many had participated in activities to enhance laboratory processes. A Lean Team comprising medical, scientific, senior, and bench-level technical staff and some administrative and support personnel was set up to apply Lean methods to the influenza laboratory workflow. They created a visually displayed value stream of all discrete steps in the lab workflow for influenza detection. Review of ‘waste’ steps was conducted and a kaizen session performed by lab staff, culminating in the creation of a scalable and standardized work process. Observed and computer
simulating evaluation results from rapid process changes showed that use of Lean tools successfully expanded surge capacity, which enabled response to a 10-fold increase in testing demands.


This article aimed to provide commentary on Lean’s applications to microbiology labs, while discussing at length the development and results of a Lean program at the HFHS Department of Pathology and Laboratory Medicine. In 2007, the HFHS Department of Pathology and Laboratory Medicine used a Lean management approach to consolidate 4 microbiology labs into 1 lab with a projected 55 full-time staff conducting 700,000 tests annually. In using this approach, the department was able to achieve consolidation and take on additional work during the integration process, without a comparable increase in staffing. The authors concluded that Lean management practices have brought standardization, savings, and quality to many different industries; Lean management practices within the clinical microbiology laboratory could help to address the many economic, political, and medical challenges that labs face today and in the future.

**Outpatient Care**


A Lean process improvement project was implemented that aimed to increase capacity to admit new patients into a healthcare service operation system. Analysis of 1,726 appointments in outpatient services for the year before and after the project found a 27% increase in capacity to intake new patients and a 12% reduction in patient no-show rates as a result of changes in service processes from the improvement project.

**Pharmacy**


The effect of Lean process improvement on an inpatient university hospital pharmacy, the University of Minnesota Medical Center (UMMC), was evaluated. Workflow in the sterile products area (SPA) was improved through the creation of accountability, standard work, and movement toward one-piece flow. Increasing the number of IV batches decreased pharmaceutical waste by 40%. Through SPA
environment improvements and enhanced workload sharing, two FTE technicians from the SPA were redistributed within the department. SPA waste reduction yielded an annual saving of $275,500. Quality and safety were also improved, as measured by reductions in missing doses, expired products, and production errors. In the inventory area, visual control was improved through the use of a double-bin system, the number of outdated drugs decreased by 20%, and medication inventory was reduced by $50,000. Benefits of this process included an estimated annual cost saving of $289,256 due to waste reduction, improvements in workflow, and decreased staffing requirements.

**Primary & Preventive Care**


A breast clinic was implemented at Virginia Mason Medical Center in Seattle, Washington using Lean methods. The clinic was found to substantially improve care timeliness and efficiency for women with symptomatic benign breast conditions. Women received their final benign diagnosis in an average of four rather than 16 days, with fewer imaging studies and physician visits, when compared to a control group. Savings to the employer were estimated at $316/patient, primarily from increased work productivity. Direct care costs decreased an estimated 19%, to $213/patient. The authors stated that by decreasing both direct medical costs and indirect costs such as work absenteeism and presenteeism, the Virginia Mason Breast Clinic created substantial savings for providers and employers while delivering care that patients rated highly.


The authors conducted an observational study of phased Lean implementation among 328 physicians in 46 primary care departments housed within 17 geographically distinct clinic locations. Performance metrics included: workflow efficiency, productivity, operating expenses, clinical quality and patient, physician and staff satisfaction. Interrupted time series analysis using generalized linear mixed models was used to examine lean impacts on organizational performance over time. They found that Lean implementation resulted in system-wide improvements in workflow efficiencies, physician productivity and clinical quality metrics (P < 0.05). Patient satisfaction with access to care, handling of personal issues and overall experience of care also increased, but decreased with respect to interactions with care providers (P < 0.05). Departmental operating costs decreased, though this was not statistically
significant. Finally, annual staff and physician satisfaction scores increased in key domains, ranging from employee engagement and connection to purpose to relationships with staff and physician time spent working. The authors concluded that Lean system redesigns resulted in improvements on a variety of metrics ranging from provider workflow efficiencies to satisfaction among patients and staff.

**Radiology**


Lean principles were applied in a radiology department at a very large non-profit hospital, Odense University Hospital (OUH) in Denmark. The radiology department received support from a private consultant who assessed the “hows” and “whys” of the department’s work. A multidisciplinary Lean team was formed and a clinically respected radiographer appointed as its leader. Kaizen, value stream mapping (VSM), 5S, and single minute exchange of die (SMED) were all used to increase efficiency in the department’s CT section. The tools resulted in the radiology department’s ability to examine 6 more patients during the day (900 more patients/year). Consequently, waiting lists fell dramatically across all department sections after the introduction of Lean. The authors noted that the response from the staff was positive—they had an easier overview of the day’s program, a better workflow/environment, and became focused on continuing improvement.


This article reported on how systems were enhanced through the application of Lean principles within a UK hospital division of diagnostics and clinical support. The NHS Improvement Plan required that by 2008 the maximum wait from a general practitioner referring a patient, to that patient commencing definitive treatment should be 18 weeks. Early estimates in the division indicated that in order to meet this 18-week target, access to services must be in a zero- to four-week window. Lean was proposed as a mode to accomplish this. Working groups, comprising a cross-section of professional disciplines and grades, were set up with membership from across the department, division and the wider organization to understand the current performance of radiology services. The views of service users (patients and referrers) were sought, along with those of staff working in the departments in order to generate a picture of the current service provision from which to model the required changes. The working groups decided to implement an internet-based waiting list for radiology services. All radiology departments began using the internet-based waiting list module in September 2006, which since then contributed to
a significant reduction in waiting times across the different imaging modalities. The longest waiting time was decreased by over 30% in all areas due to more efficient waiting list management.


In this mixed model approach, researchers evaluated Lean’s effectiveness as a method to improve an orthopaedic healthcare service with long waiting times and poor satisfaction among patients and staff. Data were collected before and after Lean implementation from staff and patient questionnaires, as well as from the Radiology Information System. The authors used proportionate stratified random sampling for patient data collection and a theoretical sample for staff data collection. Pre-implementation data were collected during the team’s value stream mapping process, and used to plan and implement changes. Data before and after implementation were compared using Levine’s test for equality of variance and a 2-sample t-test; results demonstrated that Lean resulted in better patient experiences, higher staff satisfaction, and an increase in productivity. The authors concluded that these findings supported the proposition that Lean is an effective way to improve healthcare service.

**Surgery**


A pre-post quasi-experimental study was conducted to assess the role of a Lean intervention on appropriateness of perioperative antibiotic therapy and in length of hospital stay (LOS) among surgical patients. Local and national retrospective cohorts were used. The authors used Lean methods to implement a multifaceted intervention to reduce nosocomial methicillin-resistant Staphylococcus aureus (MRSA) infections on a Veterans Affairs surgical unit, which led to a QI intervention targeting appropriate perioperative antibiotic prophylaxis. Appropriate perioperative antibiotic therapy was defined as selection of the recommended antibiotic agents for a duration not exceeding 24 hours from the time of the operation. The local electronic medical record system was used to identify patients undergoing the 25 most common surgical procedures and to examine changes in appropriate antibiotic therapy and LOS over time. Overall, 2550 surgical admissions were identified from the local computerized medical records. The proportion of surgical admissions receiving appropriate perioperative antibiotics was significantly higher (P <.01) in 2004 after initiation of Lean (44.0%) compared with the previous 4 years (range, 23.4%-29.8%) primarily because of improvements in
compliance with antibiotic therapy duration rather than appropriate antibiotic selection. There was no statistically significant decrease in LOS over time.


Surgical practice was identified as a specialty providing many opportunities to improve efficiency. To this end, this study evaluated Lean thinking in an academic otolaryngology operating room (OR) as a method to improve efficiency and profits, while preserving team morale and educational opportunities. An 18-month prospective ‘quasi-experimental’ study was used, with a multidisciplinary team systematically implementing Lean thinking. The team recorded OR turnover and turnaround time during an observer-effect period as well as after Lean implementation, and measured Lean’s impact on teamwork, morale, and surgical resident education through validated surveys. During the Lean intervention period, significant decreases in turnover and turnaround time were noted (29 v. 38 minutes; p < 0.001 and 69 v. 89 minutes; p < 0.001, respectively). Composite morale scores also found improved morale after implementation (p = 0.011), with no effect on resident education. Lastly, financial implications of Lean found an annual opportunity revenue of $330,000 for one OR used twice weekly. The authors noted that Lean requires cultural change through empowerment of workers to engage in continuous quality improvement, thus contradicting traditional hierarchical management. They also emphasized the importance of sustaining Lean improvements; regular meetings among key stakeholders (including management and OR employees) to review data and refine plans were used toward this end, and continued on a quarterly basis after the study.


The authors investigated the effect of Lean quality improvement methods on service reliability and efficiency in an emergency general surgery ward of a university hospital in the UK. It used an interrupted time series study design and determined outcomes by measuring 7 safety relevant care processes. This was based on 969 patients admitted during the 4-month study period before Lean intervention, and 1114 patients admitted during the 4-month study period after Lean intervention was completed. The researchers found that for the 5 process measures targeted for Lean intervention, there were significant relative improvements in compliance, ranging from 28% to 149% with a p-value < 0.007. 2 processes measures were not targeted for Lean intervention and did not improve significantly. There was also a significant reduction in new safety events after transfer to other wards
(p < 0.028), though most adverse events were attributed to delays in investigations and treatment from factors outside of the emergency ward’s control. In conclusion, the authors found that Lean can substantially improve compliance across multiple safety-related processes at the same time. They noted that given hospital care’s interrelated nature, this may not translate into improvements in safety outcomes unless system-wide approaches are adopted.


A before-after intervention study was conducted to measure the effectiveness of a Lean approach to implementing a methicillin-resistant Staphylococcus aureus (MRSA) prevention program. The study took place in an ICU and a surgical unit in the Pittsburgh Veterans Administration hospital and included all patients admitted to these units. The MRSA prevention program was comprised of 4 elements: 1) the use of standard precautions for all patient contact, with emphasis on hand hygiene; 2) the use of contact precautions for interactions with patients known to be infected or colonized with MRSA; 3) the use of active surveillance cultures to identify patients who were asymptptomatically colonized with MRSA; and 4) use of Lean to facilitate consistent and reliable adherence to the infection control program. The rate of healthcare-associated MRSA infection in the surgical unit decreased from 1.56 infections per 1,000 patient-days in the 2 years before the intervention to 0.63 infections per 1,000 patient-days in the 4 years after the intervention (a 60% reduction; P = .003). The rate of healthcare-associated MRSA infection in the ICU decreased from 5.45 infections per 1,000 patient-days in the 2 years before to the intervention to 1.35 infections per 1,000 patient-days in the 3 years after the intervention (a 75% reduction; P = .001). The combined estimate for reduction in the incidence of infection after the intervention in the 2 units was 68% (95% confidence interval, 50%-79%; P < .001).


Previous research stressed the importance of reducing door movement during surgery to prevent surgical site infections. The authors used Lean A3 thinking to reduce door movement in one operating room for orthopedic surgery, executing an A3 report that promoted structured problem-solving based on Plan-Do-Check-Act (PDCA) cycles. A multidisciplinary team was assembled for the A3 intervention, which first defined the problem, and then investigated the current situation. They found current
average door movements/hour and variations in average door movement/hour between surgeons. From these findings, the team determined a target condition for door movement, deemed as zero door movements between incision and closing of wound (except for specific clinical reasons; e.g. X-rays, unexpected materials, employee breaks, emergencies). The gap between current and target condition was then analyzed using a fish-bone diagram to identify 13 root causes of door movement in 4 categories (people, machines, methods, and materials). Actions for improvement were directed toward these 13 root causes and the effects of changes were monitored over 12 months. The intervention led to a sustained 78% decrease in door movements, bringing down the mean number of door movements/hour from 24 to 4 in the OR.


A prospective cohort of 616 cataract patients receiving Lean care was compared to both a historical cohort of 591 patients that received traditional care and to patients waiting for Lean care in the prospective cohort. To determine efficacy, the authors analyzed how many patients received care that adhered to Lean cataract pathway specifications. To evaluate efficiency, they analyzed how often patients visited the hospital and how many additional patients were able to access the pathway. The authors found that patient visits decreased by 23% and access to the cataract pathway increased by 42%; they noted that these percentages would have been nearly twice as large if healthcare staff had adhered to Lean pathway specifications. Based on these findings, the authors emphasized the importance of ensuring buy-in from healthcare providers to adhere consistently to Lean pathway specifications.

**Hospital (Non-Department Specific)**


This paper aimed to contribute toward a deeper understanding of the new roles, responsibilities, and job characteristics of employees in Lean healthcare organizations. The paper was based on 3 cases studies of healthcare organizations that were regarded as successful examples of Lean healthcare applications. Data were collected by methods including interviews, observations, and document studies. The authors found that Lean caused organizational focus to shift from healthcare professionals, where clinical autonomy and professional skills were the guiding principles, to process improvement and teamwork. They noted that different job characteristics may make it difficult to
implement certain Lean practices in healthcare. Teamwork and decentralization of authority were given as examples of Lean practices that could be considered counter-cultural because of healthcare’s strong professional culture and uneven power distribution, with doctors as dominant decision makers.


The authors attempted to address the questions: “What changes in leadership practices are associated with the implementation of Lean?” and “When leadership practices change, how do the changed practices contribute to subsequent outcomes?” using a qualitative, multi-step approach. They collected data through a key informant consultation, a stakeholder workshop, documentary review, 26 audiotaped and transcribed interviews with health region personnel, and team discussions. These data yielded seven initial hypotheses, finding that Lean: 1) aligns the aims and objectives of health regions; 2) permits attention and resources to quality improvement and change management; 3) provides an integrated set of tools for particular tasks; 4) changes leaders’ attitudes or beliefs about appropriate leadership and management behaviors; 5) demands increased levels of expertise, accountability, and commitment from leaders; 6) measures and uses data effectively to identify actual and relevant local problems and root causes of those problems; and 7) creates/supports a ‘learning organization’ culture.


This article looked into two key areas for further Lean research: 1) the effect of contextual factors on Lean, and 2) healthcare workers’ perceptions of Lean. The authors specifically addressed how hospital workers’ perceptions of Lean implementation varied across contexts. Standardized surveys were completed by RNs and physicians across hospital units (N=236, 57% response rate). The study found that employees’ perceptions varied by hospital, and that employees in higher-acuity units reported more favorable perceptions of Lean. The study also found that nurses reported more favorable perceptions than physicians.


Lean tools, specifically value stream maps (VSMs) and A3 reports were used in a pilot project at Intermountain Healthcare to improve efficiencies. Participants made many improvements, ranging from simple changes implemented immediately (for example, heart monitor paper not available when
a patient presented with a dysrhythmia) to larger projects involving patient or information flow issues across multiple departments. Most of the improvements required little or no investment and reduced significant amounts of wasted time for front-line workers. In one unit, turnaround time for pathologist reports from an anatomical pathology lab was reduced from 5 to 2 days.


Over an 18-month time period, healthcare staff applied a patient-centric approach that included Lean methodology of Value Stream Mapping (VSM) to improve wait times to care. The evaluation framework was grounded in the needs and perspectives of patients and individuals waiting to receive care. Patient-centric views were obtained through surveys such as Patient Assessment of Chronic Illness Care (PACIC) and process engineering-based questions. In addition, Lean VSM was added to identify non-value added processes contributing to wait times. From this process, the care team successfully reduced wait times to 2 months in 2014 with no wait times for care anticipated in 2015. Increased patient engagement and satisfaction were also noted. In addition, successful transformations and implementation resulted in resource efficiencies without cost increases. The authors stated that patients showed significant improvements in functional health after intervention.


The results of a Lean implementation at an Italian hospital were presented, stemming from a need to cut cost and reduce inventory. A large reduction in inventory was achieved, and broken processes leading to excessive inventories were identified to remove the problem’s root causes. Finally, hospital staff was taught to think differently about materials management activities: rather than by batching (e.g. ordering 3 weeks’ worth of a medicine at once), better and faster results were achieved by standardizing activities and managing orders and activities throughout the week (e.g. ordering medicines every day to replace those consumed).


This paper examined the impact of a large-scale Lean Quality Improvement program, the ‘Productive Ward’, on work engagement of involved nurses and ward teams in the UK. Using the Utrecht Work
Engagement Scale (UWES), the authors surveyed, measured, and analyzed work engagement in a representative test group of hospital-based ward teams who had recently commenced the latest phase of the national ‘Productive Ward’ initiative in Ireland and compared them to a control group of similar size and matched (as far as is possible) on variables such as ward size, employment grade and clinical specialty area. 338 individual datasets were recorded, \( n = 180 \) (53.6%) from the Productive Ward group, and \( n = 158 \) (46.4%) from the control group; the overall response rate was 67%, and did not differ significantly between the Productive Ward and control groups. The work engagement mean score (±standard deviation) in the Productive group was 4.33(±0.88), and 4.07(±1.06) in the control group, representing a modest but statistically significant between-group difference (\( p = 0.013 \), independent samples t-test). Similarly modest differences were observed in all three dimensions of the work engagement construct. Employment grade and the clinical specialty area were also significantly related to the work engagement score (\( p < 0.001 \), general linear model) and (for the most part), to its components, with both clerical and nurse manager grades, and the elderly specialist areas, exhibiting substantially higher scores. The authors concluded that their findings demonstrate how Lean QI activities appear to positively impact work engagement of ward-based teams.

**Other**


A rapid improvement team at Lehigh Valley Health Network, Allentown, Pennsylvania, implemented a plan, do, check, act cycle to determine problems in the central sterile processing department, test solutions, and document improved processes. By using A3 thinking, a consensus building process that graphically depicts the current state, the target state, and the gaps between the two, the team worked to improve efficiency and safety, and to decrease costs. Gap analysis was conducted to examine the initial and future state of the staff’s tool sterilization cycle. By eliminating jack jams and increasing drying temperature to the expected level, staff increased capacity by 30%. Additionally, after repairing and calibrating tools, staff members were able to eliminate the flash cycle portion of the sterilization cycle, saving 10 hours of work per day. The sterile processing team and senior leaders found that non-preventive maintenance calls decreased from 6 per month to 2. The cost of non-preventive maintenance decreased from $12,000 per month to $3,600 per month. The average use of the equipment increased from 60% to 90%, and the use of a responsibility plan for routine inspection and maintenance of equipment increased from 0% to 90%. The end result was cancellation of a unit upgrade because it was no longer needed.
Primary research articles identifying components, methods, barriers and facilitators for implementing Lean in healthcare organizations

**Cardiology**


This case study investigated a cardiology department’s experience from initial adoption to adaptation of Lean thinking. It sought to determine how the department - which had a long history of quality improvement - decided to introduce Lean, and how Lean impacted employees’ work. The authors used semi-structured interviews, non-participant observations, and document studies to gather this information. They then conducted content analysis of the data, finding that the department’s previous improvement efforts may have facilitated the introduction of Lean thinking. This history was not as important in predicting the sustained usage of Lean over time. Additionally, individual differences in staff members’ perceived need for change led to varying degrees of Lean adoption. For successful Lean implementation, the authors found work re-design and teamwork beneficial to improving patient care. Similarly, problem solving was deemed helpful in maintaining staff engagement and thus sustained improvements.

**Community Health Clinics (CHCs) & Rural Facilities**


This study aimed to describe the application of Lean to improve clinical operations at Komfo Anokye Teaching Hospital in Ghana, while identifying key lessons learned to aid future global improvement initiatives. A 3-week Lean improvement program focused on the admissions process at the hospital was completed by a 14-person team in six stages: problem definition, scope of project planning, value stream mapping, root cause analysis, future state planning, and implementation planning. Additionally, 8 lessons learned from the initiative were identified: 1) the Lean process aided in building a partnership with Ghanaian colleagues; 2) obtaining and maintaining senior institutional support was necessary and challenging; 3) addressing power differences among the team to obtain feedback from all team members was critical to successful Lean analysis; 4) choosing a manageable initial project was critical...
to influence long-term Lean use in a new environment; 5) data intensive Lean tools could be adapted and were effective in a less-resourced health system; 6) several Lean tools focused on team problem-solving techniques worked well in a low-resource system without modification; 7) using Lean highlighted that important changes do not require an influx of resources; 8) despite different levels of resources, root causes of system inefficiencies were often similar across healthcare systems, but require unique solutions appropriate to the clinical setting.

**Emergency Department (ED)**


The authors outlined a systemic method to apply Lean principles across the entire emergency department (ED) patient experience to transform a high volume ED in 1 hospital. They then compared ED performance metrics before and after Lean implementation, finding that median and IQR results showed improvement on several metrics after implementation. The hospital partnered with a Lean consulting firm, established an executive Lean steering committee that ranked True North metrics for the hospital’s improvement vision, and then determined major value streams based on their contribution to True North metrics. The ED was identified as a key value driver and selected as 1 of 4 service lines for initial Lean intervention. At the emergency department level, an ED Lean steering committee was created and trained in a 2-day Lean introduction program. The committee consisted of departmental leadership and other key stakeholders, such as representatives from finance and hospital operations. The steering committee participated in a 3-day value stream analysis to map out implementation over the first year. Rapid Improvement Events (RIEs) were held monthly, and enlisted an 8 – 12 member team of front-line staff (e.g. MDs, RNs, support staff) with varying degrees of relationship to the process of focus, providing diverse perspectives. A facilitator experienced in Lean principles guided the team, and a member with intimate knowledge of the process (often a director/manager) was assigned as ‘process owner,’ with oversight of implementation/sustainment. A new standard workflow and responsibilities were then immediately shared with front-line staff following RIEs. Visible executive commitment at all levels was noted as critical to successful Lean transformation.
Pharmacy


The authors applied selected principles of Lean management to reduce time associated with drug dispensing at an inpatient pharmacy at a local hospital. Thorough investigation of the drug dispensing process revealed unnecessary complexities leading to delays in medication delivery. DMAIC (Define, Measure, Analyze, Improve, Control) and 5S (Sort, Set-in-order, Shine, Standardize, Sustain) were used to identify and reduce waste that increased the lead-time in healthcare operations at the pharmacy understudy. The study’s results revealed potential savings of >45% in drug dispensing cycle time.

Primary & Preventive Care


Findings were presented on a 13-month Lean implementation in National Health Service (NHS) primary care health visiting (HV) services from May 2008 to June 2009. A Lean Thinking project team was established which included staff and management from a variety of roles related to the HV service, without formalized roles or project champions. This team took part in 8 workshops throughout the project to share ideas and learn from one another, and were assisted by Lean consultants. Stakeholder and value stream mapping (VSM) was used to determine essential tasks in health visiting services and links between relevant stakeholders. Through discussion with these stakeholders, waste processes were identified and new process maps were produced. Quantitative data were provided through a 10-day time-and-motion study of a selected number of staff. Analysis of VSM processes revealed that 67% of 67 identified processes were waste; the revised process map reduced this to 23 process steps. One notable example of improved processes was a change to methods of contacting central administration. Initially, administrative staff would wait for large quantities of documents to accumulate before dispatching them in weekly batches to central administration; this led to extended waits for patient appointments and increased stress to employees due to uneven workloads. To improve this process, the Lean Thinking team introduced more document envelopes that could be dispatched daily, thus eliminating uneven workloads from batching of documents and shortening the average wait for a new appointment from 1 week to 2 days. The study concluded that a large amount of waste could be eliminated through simplification and standardisation of day-to-day tasks, without the need for
expensive or time-consuming organisational changes. The authors noted that members of the Lean team continue to make small improvements in their respective areas, but that changes in organizational culture and management practice will be required to provide a supportive environment for change. Management support across the entire organization was also cited as necessary to sustain and introduce future Lean initiatives.


This study qualitatively evaluated a Lean implementation at a large healthcare organization. Researchers conducted observations of key implementation events and interviewed frontline leaders, as well as physicians, nurses, and medical assistants who participated in the change effort. The data produced from these qualitative methods were analyzed and coded using an inducted, grounded approach. The paper highlighted five main changes that produced cultural conflict when this healthcare organization implemented Lean. They were 1) adopting team care approaches, 2) democratization of the workplace and the erosion of hierarchies, 3) reducing variation and standardizing work, 4) surveillance of staff and employees, and 5) a perceived emphasis on profit over patient care. The authors concluded that implementing new ways of delivering care in healthcare organizations is often met with many challenges. Some of these challenges may be rooted in a conflict between new sets of cultural values and those that have historically existed in the field of medicine. Reconciling these conflicts may be one of the most difficult challenges healthcare organizations face as they try to implement wide-scale change.


The paper presented challenges identified during a lean implementation in a health visiting service within a large primary care trust in NHS UK. A triangulated approach to data collection was used to determine the root cause of challenges faced during lean implementation. The 3 methods were selected for qualitative analysis were semi-structured interviews, document analyses, and researcher participant observation. From these methods, 6 key challenges were identified: 1) high process variability, 2) a lack of understanding of lean, 3) poor communication and leadership, 4) target focused implementation, 5) problems defining waste, and 6) difficulty in defining the customer and what the customer values.

This study aimed to identify contextual factors that were most critical to implementing and scaling Lean redesigns in all primary care clinics of a large ambulatory care system. The authors conducted over 100 interviews and focus groups with frontline physicians, clinical staff, and operational leaders. Data analysis was then conducted using a modified Consolidated Framework for Implementation Research, called CFIR-PR. Several domains identified through CFIR-PR were vital to acceptance of Lean redesigns. In the implementation process, acceptance was influenced by time and intensity of exposure to changes, top-down versus bottom-up implementations, and degree of employee engagement in developing new workflows. Important factors of the inner setting were the clinic’s culture and style of leadership, and availability of information on Lean’s effectiveness. Lastly, individual and team characteristics regarding changed work roles, and related issues of professional identity, authority, and autonomy were important.

**Hospital (Non-Department Specific)**


This study aimed to systematically investigate the experiences of leaders in the implementation of Lean within a teaching hospital in the Netherlands. Authors conducted semi-structured, in-depth interviews of 31 medical, surgical and nursing professionals with an average of 19.2 years of supervisory experience. All professionals were appointed to a Lean Training Program and were directly involved in the implementation of Lean. Based on interview results, the researchers found that leadership management support, a continuous learning environment, and cross-departmental cooperation were seen as significant for successful Lean implementation. The results suggested that a Lean Training Program contributed to positive outcomes in personal and professional skills that were evident during the first 4 months after program completion.


The paper explore the ‘travel’ of Lean within a Norway hospital by assessing local actors’ Lean perceptions through their images of factors for successful Lean intervention. These perceptions described the characteristics of Lean in use. Perceptions were collected through focus group interviews.
with three groups of stakeholders: managers, internal consultants and staff. A questionnaire was used to reveal the factors’ relative importance. Identified important factors for Lean’s success matched the literature, except that external expert change agents were not perceived to promote Lean. New factors were also added. Two-thirds of the most important identified factors were novel, local ones. Among these were a ‘problem’ rather than ‘method’ focus, a bottom-up approach, internal consultants, credibility, realism, and patience. Local actors had different images of Lean depending on their hierarchical level. The authors concluded that ideas of Lean were transformed more than once within the hospital.


Lean was applied in a hospital ward by nursing staff, who identified a number of complex nursing issues, such as medication distribution errors, catheter infections, nosocomial infections, bedsores. 5S was implemented in storage areas in order to move supplies out of ward corridors and keep corridors clear for safety reasons. Nursing practices were also standardized, resulting in the rate of incidents per patients being reduced by 45% over 2 years. The nursing manager additionally reported that her greatest satisfaction from the Lean process was perceived noticeable improvement in nurse-patient relationships.


This work analyzed implementation barriers in the UK National Health Service’s (NHS) application of Lean healthcare principles. It concluded that with slight modifications for the healthcare industry, Lean thinking can achieve good results. The authors conducted their analysis based on interviews with directors, managers, and healthcare practitioners as well as their own experiences implementing Lean at the NHS. The first major barrier identified was provider concerns that Lean treats patients as uniform ‘parts’; clarification and evidence must be provided to show otherwise. Additional identified barriers were professional and functional silos, organizational hierarchies, and shifting managerial focus from temporary to permanent solutions. In addressing the former two issues, non-hierarchical multidisciplinary teams must be established to ensure unbiased performance improvement across departments. For the latter matter, managers may be trained to make decisions using evidence-based analysis. To prevent the undesirable side effects of using performance measures to quantify Lean’s impact, implementation teams should be involved in defining their own metrics, and Lean terminology
should be standardized to prevent miscommunication. Overall, it was found that provider empowerment and clear structure should be emphasized for Lean implementation to be successful.

The authors presented observations on Lean implementation in UK hospitals based on content analyses of all annual reports and websites for said hospitals over two time periods. They found that Lean implementation overall tends to be isolated to a few projects within organizations, and that across hospitals there exists a spectrum of implementation levels ranging from tentative to systemic. Time-series data noted an increase in Lean usage and system-wide Lean approaches over time. The paper concludes that further analysis is needed to document the effects of organizational context on Lean approaches used and the sustainability of said approaches.

Eiro and Torres-Junior compared the application of Total Quality (TQ) and Lean models in healthcare through a descriptive case study in Brazil. TQ and Lean were compared at a large medical diagnostic service and a medium-sized private hospital that had implemented Lean before. The study found that Lean was better suited for people that work systemically and generate flow, leading to increased adherence to standard work as well as continuous improvement and staff involvement in problem-solving. The TQ model was found to be more widespread, and to involve more bureaucratic procedures that were continuously audited and required more stable control.

A longitudinal study was employed to evaluate the implications of planned and emergent change when deploying 5S Lean at a UK NHS Trust that employed approximately 13,000 staff serving a population of around 600,000 at multiple locations. Formal interviews were conducted with 4 hospital personnel/managers who acted as Lean change agents, a questionnaire was employed that collected data on successes and problems in implementation, and observations were recorded during meetings and workshops. All of the change agents were supportive of 5S, but indicated there were limitations. They thought the tool should not be seen as a vehicle for major change but, rather, as a starting point. It was suggested that 5S is an integral part of wider strategic change management program.

The authors suggested that the level of information required by Lean projects was beyond the capacity of many NHS trusts, and used Galbraith’s information processing theory as a mode of explanation for why many NHS Lean healthcare projects failed. They concluded that, if generalizable, their findings challenge the premise that Lean can be used to deliver sustainable cost reduction while improving quality of care. On a micro-level, the paper cited lack of clinician support and rejection of the ‘cuts’ ideology as reasons for failed Lean implementation. The paper focused on information processing management as a mechanism to examine how the complexity and uncertainty of healthcare affected Lean implementation. It found that most Lean initiatives involved less than 20% of staff, and ‘rapid improvement events’ (RIEs) rather than long-term systemic applications. Other studies were cited stating issues with Lean implementation such as silos of Lean usage, lack of staff training and opportunities for experimentation, and overly long time to complete projects. The authors looked at two Lean implementation projects and conducted interviews with 3 project participants, 2 team leaders, and the Deputy Chief Executive using a prepared survey. They deemed that Lean and all other change projects are ‘information-hungry’. Lacking information processing systems make their sustained success difficult. Inadequate information processing, low senior clinician engagement, and absence of commitment-based HR were seen as difficulties for Lean RIEs.


This paper reported on 4 Lean implementation case studies in the UK National Health Service (NHS). Similar to others, it found that implementation often involved Lean ‘tools’ such as rapid improvement events (RIEs) that led to localized improvements. Contextual differences between Lean healthcare and manufacturing were cited: first, patients’ status as both customers and commissioners of care in the private sector, which impacts how customer value is defined; second, the healthcare industry’s design as ‘capacity-led’, which limits the ability to influence demand and utilize freed-up resources. If not addressed, these differences could severely limit Lean’s impact on healthcare. The authors interviewed senior, middle management, and front-line NHS employees. They assessed implementation on 4 dimensions: 1) Lean’s definition, 2) activities undertaken, 3) organizational readiness, and 4) sustainability of process improvements. The study found that the definition of ‘customer’ and customer value was often variable and not clearly ascertained, leading to improvements guessing at
what customers wanted that were not necessarily aligned or even compatible across care pathways. It also deemed that, similar to in manufacturing, there must be a shift from tool-based to continuous improvement approaches for widespread, sustained productivity gains to be achieved.


This work aimed to ascertain the effects of Lean on the psychosocial work environment. As such, psychosocial work environment was measured twice with the Copenhagen Psychosocial Questionnaire (COPSOQ) employee survey during Lean implementations on May-June 2010 (T1) (n = 129) and November-December 2011 (T2) (n = 131) at three hospital units (an Emergency Department (ED), Ward-I and Ward-II). Information based on qualitative data analysis of the Lean implementations and context from a previous paper was used to predict expected change patterns in the psychosocial work environment from T1 to T2 and subsequently compared with COPSOQ-data through linear regression analysis. Between T1 and T2, qualitative information showed a well-organized and steady Lean implementation on Ward-I with active employee participation, a partial Lean implementation on Ward-II with employees not seeing a clear need for such an intervention, and deterioration in already implemented Lean activities at ED, due to the declining interest of top management. Quantitative data analysis showed a significant relationship between the expected and actual results regarding changes in the psychosocial work environment. Ward-I showed major improvements especially related to job control and social support, ED showed a major decline with some exceptions while Ward-II also showed improvements similar to Ward-I. The study’s results suggested that Lean may have a positive impact on the psychosocial work environment when properly implemented, and that deterioration of Lean work may correlate with deterioration of psychosocial work environment. The authors also noted that employee involvement in Lean change processes may minimize any potential harmful psychosocial effects from Lean intervention.