

# Lean process improvement in outpatient healthcare systems

Linda R. LaGanga  
[linda.laganga@mhcd.org](mailto:linda.laganga@mhcd.org)  
Mental Health Center of Denver

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## Abstract

This paper considers the migration of lean process improvement methods from hospital systems to outpatient clinics. We review the strengths and weaknesses of a series of lean projects that were conducted in a community mental health center over a four-year period. We consider the evolution of the organization's lean approaches and project results to identify areas of continuing research that appear promising to improve practical application of lean principles in outpatient settings.

**Keywords:** Lean, Healthcare, Outpatient

## Introduction

Quality management practices such as continuous quality improvement, total quality management, six sigma, and the Malcolm Baldrige National Quality Award, which have been widely used in manufacturing, have been adapted and implemented successfully in healthcare (Gowen et al., 2006). Many of these traditional quality improvement practices focus on improving processes, reducing variability, and identifying root causes of problems. With continued need for cost-effective and high-quality healthcare, there is heightened interest in also adopting lean practices such as focusing on patient flow, value-stream mapping, and kaizen events (Bernstein, 2008).

Our action research fosters participative problem-solving and learning in concurrence with research (Coughlan and Coughlan, 2002). This research has been conducted in the implementation of a lean process improvement program in an outpatient behavioral healthcare setting over the past four years. During that time, the researcher has been involved in launching and participating in the lean projects described in this paper, analyzing results, and applying organizational learning to continuously improve the practice of lean process improvement in the organization. Through this approach, we consider how to improve the process of implementing lean projects and suggest factors for further study.

Healthcare delivery is evolving to emphasize integrated physical and behavioral healthcare services along with coordinated care between inpatient and outpatient settings. Outpatient settings in small and local clinics provide services that help patients maintain good health. Services in such outpatient settings may prevent or reduce the need for more costly services in larger hospital and inpatient settings (Woolf, 2009). Behavioral

health services are important. In all regions of the world, neuropsychiatric conditions are the most important causes of disability, accounting for around one third of years lost to disability (years of healthy life lost through time spent in conditions of less than full health) among people age 15 years and over (World Health Organization, 2004). In 2008, 13.4 percent of adults in the United States received treatment for a mental health problem. This includes all adults who received care in inpatient or outpatient settings and/or used prescription medication for mental or emotional problems (National Institute of Mental Health, 2012). The percentage of adults aged 18 or older receiving outpatient treatment for mental health problems in the past year was 6.7 percent in 2006 (Substance Abuse and Mental Health Services Administration, 2006). Thus, although documented cases of successful lean projects in outpatient behavioral health settings are scarce, process improvement in such settings can provide value to overall healthcare systems. In a project we study later in this paper, we demonstrate the value of applying lean approaches to improve coordination between inpatient and outpatient behavioral healthcare.

### **The Evolution of Lean in Healthcare**

In the automobile industry, the focus on the reduction or elimination of waste (unproductive effort that does not create value for the end customer) led to the term *lean* to describe systems that consumed fewer resources and delivered superior results (Womack et al., 1991). Although lean principles were developed and applied initially in manufacturing, they are being used successfully in healthcare, where demand for services often exceed supply, service delivery can have serious outcomes – even life-or-death results, and there is no room for waste or errors. However, the portion of citations referring specifically to the term “lean” in healthcare titles and abstracts on Medline and the Health Management Information Consortium databases from years 1998 through 2007 was close to zero relative to nine other common quality improvement terms, with a sharp increase in the presence of lean concepts beginning in 2003 (Walshe, 2009).

More recently, lean approaches are included in the quality improvement approaches recommended for organization-wide system transformation in public health (Riley et al., 2010). Now there are many documented cases of successful lean projects conducted in hospitals, which started experimenting with lean methods in the 1990s to solve systematic problems and improve patient care by reducing errors and waiting times, reducing costs, enhancing interdepartmental interaction, and improving employee satisfaction (Graban, 2008). However, only a few prior studies have been found that referred to lean principles in improving outpatient service operations.

The migration of lean principles from manufacturing to healthcare settings was demonstrated by hospitals such as Denver Health Medical Center, whose administrators met with Toyota and systematically applied the lean principles based on Toyota's approach to streamlining its operations and eliminating waste (Nuzum et al., 2007). The results endorse the value of applying lean principles. In 2006, the hospital saved about \$2.8 million without reducing staffing or cutting back on patient care (Shanley, 2007). ThedaCare, a hospital system in Wisconsin, also began its lean initiation by studying a manufacturing system based on the Toyota Production System and attributed its savings of \$10 million in 2005 to its lean programs (Matzek, 2006). Lean approaches have produced other measurable improvements such as shortened time to admit patients at

Prairie Lakes Healthcare (Homolo and Fuller, 2008). Three successful applications at the University of Pittsburgh Medical Center focused on an emergency intake process to improve patient flow and reduce waiting times, an outpatient foot-and-ankle clinic to improve patient flow while reducing the workday and eliminating unnecessary paperwork, and the process of discharging cancer patients from inpatient to ambulatory services (Martin et al., 2009). At St. Luke's Hospital in Houston, Texas, lean approaches helped to reduce variability, standardize healthcare, and improve quality by meeting national standards of care 100% of the time. St. Luke's CEO, Dr. David Pate, emphasizes the importance of understanding the whole system and the waste that can occur in inter-departmental processes. (Cook, 2008)

Hospital services, particularly for inpatient care, are very expensive and improved processes add up to large savings. Outpatient settings can also reap the rewards of improving processes and eliminating waste. For example, a Consumer Reports survey of 39,000 patients and 335 primary care doctors found that the top patient complaint (24% of patients) was about time spent in the waiting room, followed by 19% of patients who complained that they couldn't get an appointment within a week. Forty-one percent of doctors in the survey complained that patients waited too long to schedule appointments (Hitti, 2007). Much research on service operations in outpatient clinics has focused extensively on appointment scheduling, an area where waste accumulates when patients don't show up for appointments and providers consider overbooking appointments (LaGanga and Lawrence, 2007b). Leaner operations have been accomplished with the same-day and open-access appointment scheduling approaches developed at Kaiser Permanente outpatient clinics (Murray and Berwick, 2003) to reduce patient no-shows, waiting, and delays in receiving care.

The Mental Health Center of Denver, which is the setting for our action research, began its adoption of lean process improvement in response to the persistent problem of patient no-shows for initial intake appointments (LaGanga, 2011). The lean program was initiated there when the manager of the access center learned about lean from participating in a rapid improvement event at Denver Health designed to reduce inpatient discharge delays and improve patient care through coordination with the outpatient care system. Subsequent projects, reviewed in this paper, cover other aspects of patient admissions and coordinated care as well as non-clinical administrative processes such as hiring, training, and financial management.

### **Overview of Lean Projects at the Mental Health Center of Denver**

Here we identify briefly the initial lean projects the organization launched to show how the program evolved in its first year. Further details are held until the next section. The initial lean project, named Rapid Improvement Capacity Expansion, began in January, 2008 to reduce no-shows in initial intake appointments. The solutions developed in the four-day rapid improvement planning event were implemented one month after the event. The project achieved additional operational transformation through realignment of appointment days, combining service steps, engaging consumers in initial welcoming reminder calls, and building flexible capacity to respond to variations in consumer demand. The immediate implementation and success of the first project engaged staff and consumers in creating solutions, which led to rapid adoption of the lean approach. The 27% increase in completed intake appointments in the first year demonstrated the

measurable value of lean approaches. (LaGanga, 2011)

The initial success of the first project built interest and momentum for the next one. The first project created and filled more appointment slots, which increased intake service capacity and reduced the delay time for consumers seeking to enter the system. The second lean project, Express Intake, was started in August, 2008 and implemented in three months. It built on improving access by reducing paperwork to shorten intake appointments and get consumers enrolled and receiving services more quickly. The third project, Human Resources Hiring, was conducted in October, 2008 and took six months to implement. It was the organization's first lean project to focus on a business process. The goal was to reduce delays in hiring new staff and getting them to productive levels of performance. The fourth lean project started in December, 2008 and was focused on another business process, Grants Financial Management. It took a year to implement. The fifth, launched in January, 2009, focused on New Clinician Training to reduce training delays and expedite new clinicians' preparation to provide and document their services to consumers. It took two years to produce visible resulting products. The next section discusses insights from the first year of operation, which were used to improve later lean improvement practices and suggest further research.

### **Lean Projects: Results from the First Year**

The first project, Rapid Improvement Capacity Expansion, set the stage for making leaner choices in response to problems such as no-shows, which could be mitigated instead by overbooking (LaGanga and Lawrence, 2007a). Through structured value stream mapping and cross-functional teamwork, the project team was able to dig into the root causes of no-shows and explore new ways to reduce them by restructuring the work flow of assigning appointments to consumers. LaGanga (2011) shows how the appointment allocation and replenishment process was realigned to meet consumer demand, illustrated in the context of an inventory replenishment system. When individual clinical teams increased the frequency of releasing appointments to the central access team, it created more just-in-time opportunities for calling consumers to be matched with available appointments. In other workflow redesign, service steps that had been scheduled for separate days were rescheduled in immediate sequence on the same day to eliminate further delays and opportunities for consumer no-shows.

An interesting phenomenon of the first lean event was the clinicians' intuitive understanding of system dynamics. Process improvement goals were framed in consumer-centered terminology such as "availability," "welcoming," and "responsive" that was consistent with clinicians' values. There was little use of unfamiliar operations management terminology such as "just-in-time," "inventory," and "allocation" while solutions were being developed. It was apparent in follow-up interviews with clinical participants that they felt pride and ownership in the solutions as they talked about the value of being able to provide services to more consumers with less delay to improve the consumers' lives. Other follow-up analysis of the project revealed that clinicians were accurate in their intuitive assessment of no-show patterns. Analysis of electronic data on more than 1,000 appointments showed that during the lean rapid improvement event, clinicians had correctly identified the days and times that had the highest no-show rates by relying on only their experience and observations, without referring to any recorded data. These observations suggest that language, work culture, and style of thinking play a

role in the successful adoption of lean approaches in new settings and could be the subject of continued research. The post-implementation analysis of results quantified the value of the project in terms of expanded capacity (27% more completed intakes), reduced no-show rates (by 12%), and additional consumers served (187 more people who were able to access needed services in the year after the lean implementation, without increasing staffing or expenses for delivering these services) (LaGanga, 2011). This demonstrated how operationally-oriented measurements were meaningful to staff when connected with results they valued. The results were accomplished by realigning services to more favorable days and times and initiating new communication strategies to engage consumers and increase their likeliness of showing up for their appointments or cancelling ahead of time so the appointments could be refilled. This project demonstrates the importance of alignment in terms of process (matching the timing of service supply with consumer demand) and cultural values (language of staff and behavior of consumers). These cultural elements suggest areas of continued exploration and research focused on behavioral operations management in outpatient settings.

The second project, Express Intake, was chosen to provide more rapid access to services for targeted populations of consumers whose services were funded by special contracts and grants. Such funding provided the opportunity to bypass lengthier service steps driven by traditional state funding that required a seven-page assessment with 25 outcome domains to be completed in the initial intake appointment. Consequently, intakes took over two hours on average and included many forms (17 for adults, 19 for children and adolescents.) The lengthy intake process required long appointments, which led to a scarcity of intake appointment slots. Thus, before the lean project, approximately 2/3 of consumers seeking services were turned away, those who obtained intake appointments had about a two-week delay until the appointment, all of the scarce appointment slots were filled early in the week, and three or more staff members were required to initiate services: an access center clinician/call-taker, information systems staff member to create a new consumer record and identification number, and a separate intake clinician to conduct the lengthy intake questioning and assessment of the consumer and complete the intake forms.

The ideal target state of the system was characterized by high-quality services for the consumer, access for more people who were seeking services, prompt start of treatment service delivery, matching intake work time to reimbursement rates, a positive service experience for the consumer, and good clinical outcomes. Thus, the gaps between the current and ideal states of the system consisted of treatment delays, public perception that the mental health center was not accessible, inadequate reimbursement for the time expended in completing the work (because of the reimbursement structure in which payment is made for each occurrence of an intake service, regardless of the extra time consumed to deliver the service), redundant data collection throughout different forms, and errors in recording and processing the data (because multiple people were involved from different teams and departments.)

The solution involved identifying appropriate payer and contract sources that did not require all the usual state-contract-driven data collection. Then, for consumers funded by such sources, actions consisted of determining which information was value-added for the consumer's treatment, reducing the number of forms from 17-19 to just four, eliminating the state assessment form entirely, and selecting appropriate clinical outcome

measures that demonstrate value to payers. Thus, the project focused on appropriateness through streamlining processes for cases where extra data collection was not required by the payer. The streamlining was accomplished by allowing appropriate cases to bypass the access team when the referral was received from appropriate sources, and directing the cases immediately to designated clinicians who were trained to work with such consumers. The old form for contact and triage was halved from four to two pages and completed directly by the clinicians, so this eliminated the delay of waiting for the form to be completed by non-clinical staff before the clinicians could begin their work.

The initial implementation of the lean project was with consumers who were prison parolees referred by the state department of corrections. Initially, one clinician worked with this population. In the first three months of implementation, his rate of intakes tripled, and he admitted consumers into treatment within two days, an 85% reduction of previous lead time. Other clinicians began to use the redesigned intake forms. Analysis of their 728 intakes showed encouraging results. The average service time decreased from 2.06 to 1.98 hours, a small but significant effect ( $p < .05$ ). More encouraging is the change in the distribution of service time. The percentage of total intakes exceeding two hours decreased from 32.5% to 25%. The initial analysis produced an unexpected result, which revealed that the initial clinician had continued to record his work time using the previous standard of 3 hours, and his increased volume of intakes skewed the data to inaccurately suggest that the average time to complete intakes had increased rather than decreased. The effect of this inaccurate data recording was eliminated by removing such data from the initial analysis (LaGanga and Lawrence, 2009) and the staff member was trained to record his actual service time.

Clinical staff performance measures included meeting standards for the number of hours spent with consumers, which could create a clinician bias toward inflating (possibly unintentionally) the actual or recorded service times. Thus, in this case the accuracy of data recording might have been influenced by the staff member's alignment with a performance measure that was not appropriate to achieving the actual goal of the system improvement, which was to serve more people by reducing the time required for each service occurrence. This highlights the need for accurate, appropriate measurement of lean process improvement and alignment with desired results of the lean project.

The third project, Human Resources Hiring, was the organization's first lean project focused on a business process. The goal was to reduce delays in hiring new staff. The process was manual and required supervisors and human resources staff to sign and send paper forms back and forth to approve the opening and filling of an employee position. The solution developed by the project team focused on automating the process to reduce delays and bottlenecks in communication. The team chose to leverage existing but unused capability of the electronic medical record system that was serving as an enterprise system for managing human resource data connected to clinical recording and billing functions. Implementing the solution required extensive systems analysis and programming from scarce analytical staff and took six months to complete because of the bottleneck caused by the growing work queue of such staff. Unlike the first two projects, which involved clinical processes recorded in the electronic medical record system, there were not good measures of prior system performance before the lean project. Therefore, improvement was more difficult to measure than for the clinical improvement projects. The human resources department estimated that the average time to fill employee

positions was reduced by three days. For this project, availability of measurement data was an issue that highlights the value of electronic data systems to support the lean program in measuring progress and improvement.

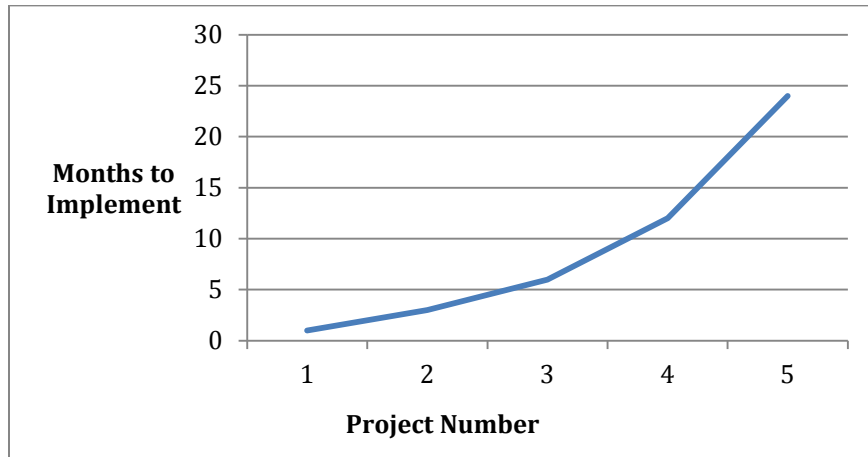
The fourth lean project, Grants Financial Management, was the second one focused on a business process. The project was motivated by the organization's lack of reporting and feedback about spending and performance for its increasing volume of grant-funded programs. Because of the lack of reporting, the project team focused on developing automated electronic solutions. As the lean program evolved in the organization, project team members gained an appreciation for addressing the root causes of problems. As a result, they resisted prior organizational tendencies to implement quick fixes, such as developing simple spreadsheets that would propagate multiple versions of data that would ultimately lead to duplication of efforts and incorrect conclusions drawn from outdated versions of data files. The trade-off for developing more elegant electronic solutions was that the solutions took over a year to implement. One reason for the delay was that an electronic solution for this project required the completion of the previous human resources project to implement employee allocation and tracking to accurately charge employee time to appropriate grant-funded activities. Another delay was caused by lack of accountability for project follow-up and progress; this made it difficult to keep the project on track because there was not clear authority or responsibility for project completion and results.

The fifth project focused on New Clinician Training, an administrative process. The goal was to reduce training delays and expedite new clinicians' preparation to provide and document their services to consumers. The team chose to focus again on computer-enabled solutions. The objective to train new staff immediately to access basic computer systems was accomplished immediately with the enlistment of information systems staff, who agreed to train new employees on their first day on the job to access their e-mail, the electronic payroll system, and other basic functions. The lean team determined that much of the extensive effort required to train new clinicians to navigate the electronic medical records system and to document their clinical service delivery and treatment planning was routine and repetitive. Such training consumed significant time each month by clinical trainers. So, it would be more efficient for training providers and recipients if on-line training modules were developed and made available for new staff to access in the existing on-line learning management as soon as they were hired rather than waiting until the next twice-monthly live classroom training. Again, the project team chose an elegant solution that addressed root-cause problems of training delays, but the goal was not achievable promptly because of the extensive time and effort required from appropriate staff with scarce time available to develop and implement the on-line training modules.

### **Insights from the First Year**

The organization launched a successful implementation of lean process improvement that leveraged organizational strengths such as engagement of employees and consumers, utilizing employees' understanding of system dynamics, adapting lean approaches to the values and culture of the organization, and leveraging of existing electronic systems. The electronic medical record system was a valuable organizational asset that facilitated measurement of clinical process indicators such as no-show rates, clinical activities scheduled and completed, and clinical service durations. The first five projects also

revealed several issues. For instance, Figure 1 illustrates the dramatically increasing time to completion for each successive project launched in the first year as an inverted learning curve.



*Figure 1 - Lean project completion time.*

This phenomenon suggests a lean paradox where the attempt to reduce delays in processes introduced bottlenecks in other areas of the organization required to implement the chosen solutions. Much of the delay was attributable to the electronic nature of solutions that required computer programming to customize forms and automate workflow in the electronic medical record system (starting with the second project and continuing in the third), develop new electronic financial tracking systems (for the fourth), and develop new on-line training content to implement in the electronic learning management system. In all cases the project team quickly identified problem sources and agreed to solutions; however, only the first project had immediate implementation of the solution. In that project, the electronic medical record system provided valuable measurement but did not require any changes to support the chosen solutions. It became apparent with the increasing backlog of work that the rate of conducting lean projects exceeded the organizational capacity to implement the solutions. Thus, despite the organization’s enthusiasm for tackling problems through lean projects, discipline was needed to prioritize and select appropriate projects to achieve desired results better aligned in time to finish implementing one project before starting another. After the first year, lean projects were spaced farther apart and sometimes reduced in scope to tackle smaller problems faster. Two later examples of appropriateness are discussed below.

### **Appropriateness of Projects and Measurements**

A lean project to reduce emergency room and inpatient expenses was conducted in February, 2010. This was the first project to address coordinated care between the outpatient mental health center and local hospitals that provided emergency and inpatient services to the same consumers. The project was requested by the behavioral health organization that manages Medicaid funds for behavioral health services in Denver because inpatient costs were too high, as shown by the claims data and comparisons with costs and inpatient utilization for other behavioral health organizations in the state. This was an appropriate lean improvement project because there was significant opportunity to reduce costs (wasteful use of expensive hospital services) and improve coordination of



care (service value for consumers) through better coordination of care. Accessibility of cost and performance data facilitated setting performance improvement targets prior to the process improvement event and supported later assessment of progress. Solutions involved proactive communication between staff across inpatient and outpatient organizations and enhanced utilization of less expensive outpatient case management and care coordination services.

The project's success was demonstrated by improvement in relevant indicators such as reduced hospital admissions and readmissions along with reduced emergency room visits. Recent retrospective analysis of the initial improvement goals shows how the organization has improved its understanding of appropriate goals for lean process improvement. For instance, the stated reason for the project was to reduce emergency room and inpatient use. Therefore, the initial goal to increase hospital bed capacity was not aligned with the true purpose of decreasing expenses. The stated goal implies there should be more beds to accommodate more admissions or longer lengths of stay, which would increase rather than decrease hospital expenses. A more aligned goal is to have bed availability when needed, which is accomplished by reducing utilization through fewer admissions and shorter lengths of stay.

Another project was conducted more recently, in December, 2011, to improve the accuracy and counting of consumers whose services were funded through one of the organization's contracts. The directors accountable for contract compliance with admission targets did not trust the data and accuracy of the electronic reports they were receiving, so a lean improvement project was suggested to examine and improve the process of tracking and reporting admissions. There was difficulty in reaching agreement within the organization regarding an appropriate project scope. Some members wanted to examine the organization's entire data reporting processes while others believed the project should have a clearly stated, narrow scope with achievable goals focused only on reporting for one specific contract. Eventually, the narrower goals were accepted and achieved, but the project was not considered successful in solving the reporting problem because it was not aligned with the real issues some participants wanted resolved. It became apparent during the lean improvement event that it was not the most appropriate approach for solving the problem. Some participants thought the improvement process should focus more on the details of systems analysis and programming. Such areas were unfamiliar to some participants, who felt the process should focus less on technical issues and more on organizational concerns related to team structures and work relationships. Thus, lack of alignment was related to the perceived failure of the project to achieve the results desired by some members of the organization.

## **Conclusion**

Through this analysis of a lean process improvement program in an outpatient behavioral health setting, several factors emerged that could be explored in further research to determine their relationship to successful adoption in similar healthcare settings. Alignment reflects the need for project direction to be consistent with the culture of the organization and the values of its members, which could differ between large hospital settings and smaller outpatient clinics. Appropriateness suggests there are characteristics of potential lean projects that could be related to project success, perhaps with regard to project scope and goals along with the probability of a project achieving successful

results within an organization. Availability of electronic systems and accessibility of data appeared to have an impact on the projects studied in terms of measurability and time to implement solutions. Continuing need for efficient service delivery in outpatient settings and growing interest in applying lean approaches to behavioral health are likely to produce growing opportunities for further study.

## References

- Bernstein, R. (2008), "Overbooking: the wrong solution for medical clinics", *Lean Insider*, 1/28/2008, <http://leaninsider.productivitypress.com/>, accessed May 1, 2012.
- Cook, L. (2008), "St. Luke's has adopted a business approach to efficiency, and CEO David Pate says the results have been positive", *Houston Chronicle*, April 12, 2008, p.1.
- Coughlan, P. and Coghlan, D. (2002), "Action research for operations management", *International Journal of Operations & Production Management*, Vol. 22, No. 2, pp. 220-240.
- Gowen, C.R., McFadden, K.L., Hoobler, J.M., and Tallon, W.J. (2006), "Exploring the efficacy of healthcare quality practices, employee commitment, and employee control", *Journal of Operations Management*, Vol. 24, No. 6, pp. 765-778.
- Graban, M. (2008), *Lean Hospitals: Improving Quality, Patient Safety, and Employee Satisfaction*, Productivity Press, New York.
- Hitti, M. (2007), "Waiting room tops patient complaints", *WebMD Medical News*, accessed March 23, 2008, at <http://www.medicinenet.com/script/main/art.asp?articlekey=78882>
- Homolo, R. and Fuller, J. (2008), "Team admission: Changing the way we work", *American Journal of Nursing*, Vol. 108, No. 11, pp. 35-39.
- LaGanga, L.R. (2011). "Lean service operations: Reflections and new directions for capacity expansion in outpatient clinics", *Journal of Operations Management*, Vol. 29, pp. 422-433.
- LaGanga, L.R. and Lawrence, S. R. (2007a), "Appointment scheduling with overbooking to mitigate productivity loss from no-shows", *Proceedings of Decision Sciences Institute Annual Conference*, Phoenix, Arizona, November 17-20, 2007.
- LaGanga, L. R. and Lawrence, S. R. (2007b), "Clinic overbooking to improve patient access and increase provider productivity", *Decision Sciences*, Vol. 38, No. 2, pp. 251-276.
- LaGanga, L.R. and Lawrence, S. R. (2009), "Increasing access to healthcare services through service time process improvements", *Proceedings of Production and Operations Management Society Annual Conference*, Orlando, Florida, May 2, 2009.
- Martin, S.C., Greenhouse, P.K., Kowinsky, A.M., McElbeny, R.L, Petras, C.R., and Sharbaugh, D.T. (2009), "Rapid improvement event: An alternative approach to improving care delivery and the patient experience", *Journal of Nursing Care Quality*, Vol. 24, No. 1, pp. 17-24.
- Matzek, M. (2006), "ThedaCare, Affinity adopt 'lean' mentality to improve service", *Knight Ridder Tribune Business News*, Washington, January 23, 2006, p.1.
- Murray, M. and Berwick, D. M. (2003), "Advanced access: Reducing waiting and delays in primary care", *Journal of the American Medical Association*, Vol. 289, No. 8, pp. 1035-1040.
- National Institute of Mental Health (2012), "Use of Mental Health Services and Treatment Among Adults", accessed May 20, 2012 at [http://www.nimh.nih.gov/statistics/3USE\\_MT\\_ADULT.shtml](http://www.nimh.nih.gov/statistics/3USE_MT_ADULT.shtml).
- Nuzum, R., McCarthy, D., Gauthier, A., and Beck, C. (2007). "Denver Health: A high-performance public health care system", *The Commonwealth Fund*, Vol. 63, accessed January 29, 2008, at [http://www.commonwealthfund.org/publications/publications\\_show.htm?doc\\_id=509163](http://www.commonwealthfund.org/publications/publications_show.htm?doc_id=509163).
- Riley, W. J., Moran, J. W., Corso, L. C., Beitsch, L. M., Bialek, R., and Cofsky, A. (2010), "Defining quality improvement in public health", *Journal of Public Health Management Practice*, Vol. 16, No.1, pp. 5-7.
- Shanley, W. (2007), "Interview: Dr. Patricia Gabow", *The Denver Post*, January 14, 2007.
- Substance Abuse and Mental Health Services Administration, Office of Applied Studies (2006), accessed May 20, 2012 at <http://www.oas.samhsa.gov/NSDUH/2k6NSDUH/Alts.htm#Fig8-6>.
- Walshe, K. (2009), "Pseudoinnovation: the development and spread of healthcare quality improvement methodologies", *International Journal for Quality in Health Care*, Vol. 21, No. 3, pp. 153-159.
- World Health Organization (2004), "The Global Burden of Disease", downloaded May 20, 2012 at

[http://www.who.int/healthinfo/global\\_burden\\_disease/2004\\_report\\_update/en/index.html](http://www.who.int/healthinfo/global_burden_disease/2004_report_update/en/index.html)

Womack, J.P., Jones, D.T., and Roos, D. (1991), *The Machine that Changed the World: The Story of Lean Production*, HarperPerennial, New York.

Woolf, S.H. (2009), "A closer look at the economic argument for disease prevention", *Journal of the American Medical Association*, Vol. 301, No. 5, pp. 536-538.