Implementation of Systems Redesign: Approaches to Spread and Sustain Adoption

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Abstract

The widespread gap between evidence and practice for clinical and preventive services argues for a deeper understanding of effective quality improvement (QI) and system change. Using implementation and system redesign sciences, we have developed and used an effective strategy to enable robust implementation of QI initiatives, including clinical practice bundles, within a health care setting. Our program, which applies Lean and systems engineering methodologies, is specifically designed to exploit the five characteristics of effective innovations, as outlined by Berwick. This strategy has been applied in over 21 hospitals (six hospital systems) throughout the State of Indiana and is currently being used as part of the Radically Reducing methicillin-resistant *Staphylococcus aureus* (MRSA) initiative funded by the Agency for Healthcare Research and Quality (AHRQ). The benefits of the process redesign activities are detailed at the business level through a business case analysis. Additionally, benefits at the personal level are quantified through workflow analysis (prior to and following the interventions). The intervention strategy is integrated into the current quality framework for each organization to ensure compatibility with existing organizational programs. Our staff engagement, training, and educational programs make systems engineering methodologies and principles readily accessible to frontline staff. Additionally, each project session requires immediate application of tools and techniques. This article will discuss our implementation strategy, provide examples of Lean and systems engineering tool applications, and provide an assessment of spread adoption and sustainability as a function of this implementation strategy.

Introduction

Quality improvement (QI) initiatives within health care facilities are often designed to improve the safety and reliability of patient care processes. Unfortunately, as detailed in several studies,[1] health care organizations often cycle through the multiple QI initiatives without sustained improvement in either process effectiveness or patient outcomes. The result is often increased staff fatigue, a more stressful work environment, and increased patient care costs.

The challenges of transitioning from the decision to utilize an innovation (adoption) to skilled and consistent use of an innovation (implementation)[2] are well documented in health care and non-health care organizations.[3, 4, 5, 6] These challenges or barriers include lack of sustained leadership support, inadequate resources allocated for implementation, insufficient staff time to participate, failure to develop robust measurement and data feedback systems, misalignment of incentive structures, and cultural resistance to change. It is estimated that fewer than 40 percent of health care initiatives successfully transition from adoption to long-term, sustained implementation.[7]

According to Rogers' "Diffusion of Innovations" model, specific characteristics of innovations influence the rate of spread.[8] Rogers describes the characteristics of an initiative affecting the perceptions of an innovation as "predict[ing] between 49 and 87 percent of the variance in the rate of spread." Moreover, in adaptating this model specifically to health care, and citing works by Van de Ven,[9] Berwick notes five characteristics of innovations that are particularly influential among potential adopters within a health care setting: (1) the "perceived benefit of the change," 2) "observability" of the innovation, (3) "compatibility" of the change with the current organizational culture and personal belief systems, (4) level of "simplicity" of the innovation, and (5) "trialability" of the innovation.[10]

In 2003, the Institute of Medicine's (IOM) report "Crossing the Quality Chasm"[11] recommended the use of systems and industrial engineering techniques to systematically examine and redesign clinical processes. A subsequent National Academy of Engineering report made the same recommendations.[12] Lean is a QI methodology based on systems and industrial engineering techniques. Lean techniques have been empirically documented as highly effective for systems redesign within manufacturing environments. Moreover, ample evidence suggests that appropriately developed and optimized Lean techniques are effective within health care settings.

Since 2004, faculty from the Purdue University College of Technology, Indiana University-Purdue University Indianapolis (IUPUI)'s School of Engineering and Technology, Purdue University-Calumet College of Technology, the Regenstrief Center for Healthcare Engineering (RCHE), and the Indiana University Center for Health Services and Outcomes Research at the Regenstrief Institute, Inc. have partnered with several Indiana hospitals and hospital systems to create Lean and Six Sigma® health care programs. As a part of this program, we developed, implemented, and refined strategies to enable robust QI implementation through application of Lean and Six Sigma tools, methodologies, and techniques.

Our program was specifically designed to incorporate findings from the implementation science literature and to exploit the five characteristics of successful innovations as defined by Berwick.[10] As a result of this program, over 40 projects are ongoing or completed across 21 hospitals and 6 hospital systems. These projects have shown remarkable success; more than 78 percent of completed projects exhibit sustained improvement of at least 6 months, with our longest running projects now in their second year of sustained implementation.

This article discusses our Lean Healthcare program and implementation strategy, provides specific examples of Lean and systems engineering tool applications, and assesses sustainability and spread adoption as a function of this implementation strategy.

Methods

Lean Healthcare

Lean is derived from methodologies developed in the Japanese automobile industry. It is a systematic approach to improving the reliability of processes through the identification and elimination of operational barriers and sources of variability within a process or system.

Within health care processes, the application of Lean tools involves an in-depth examination of the clinical and operational processes from the perspective of the patient or staff member in order to identify value added and non-value added steps—i.e., “wasteful” processing steps within the system. This analysis is limited in scope to the process under investigation and might include qualitative and quantitative assessments.

Our Lean Healthcare methodology utilizes a project team that is typically composed of frontline staff (e.g., nurses, clerks) and area supervisors from the project focus area. The project team is responsible for redesign of current processes or systems to meet the objectives, timeline, and deliverables set out by an administrative Champion Team. The Champion Team is typically composed of hospital administrators and department managers for the process under investigation. Our current strategy calls for a 12-week implementation cycle, composed of eight 3-hour project team sessions, held approximately 1 week apart, with 4 weeks of pilot implementation. Additionally, we are currently developing and testing a rapid cycle (5-day) implementation process.

Each project session incorporates approximately 1 hour of instruction in systems redesign and implementation science principles, methods, and tools, including practical examples based in health care and case studies. Then, hands-on exercises are used to reinforce principles and provide a mechanism for more active engagement. Following the instructional portion of each session, the team members apply these systems engineering and Lean techniques to the assessment and redesign of current processes associated with implementation of a set of clinical practice guidelines or operational improvements. Intersession deliverables are assigned to accomplish project tasks not completed during team sessions.

The objectives for the project team sessions included the following:

1. Define the problem/processes under investigation.
2. Collect baseline data on current systems and processes.
3. Identify operational barriers and failure modes in current processes.
4. Develop the “Future State Process” through application of basic and advanced Lean tools, systems engineering, and implementation of science principles to redesign current processes to eliminate or mitigate failure modes; design and perform an implementation pilot to test process redesign.
5. Implement new processes/systems with a robust control strategy and integrate them into practice in order to insure long-term sustainability of improvements.

The techniques and methodologies utilized within our Lean Healthcare program are outlined in Figure 1.

Implementation Design

Improving the perceived "benefit" of the change. QI initiatives within health care are, by definition, developed to benefit the patient through improved quality of care. In spite of the potential to improve patient outcomes significantly, these initiatives are often perceived in a negative manner as being just another "flavor of the day" management activity. Both individual (staff member) and administrative (business) perspectives might not appreciate these initiatives for their true purpose. These negative perceptions can develop prior to or during implementation.

Why does this negative perception exist? The reality is that implementation is time- and resource-intensive both from an organizational standpoint and an individual staff member perspective. The enthusiastic fervor that initially accompanies the introduction and adoption phase of an apparent innovation wanes as the burdens of implementation and sustainability are realized.

Furthermore, QI activities often fail to integrate changes within workflow or to adequately assess and provide feedback on progress to staff involved in making the changes. Additionally, health care administrators often hesitate to fully support implementation unless these efforts can be directly linked to a positive financial impact within their organizations.

Without strong administrative support, the time and resources required for full implementation might not be allocated, and the organizational climate needed to drive the transition from the adoption phase into sustainability might not be fully realized. The result is that the sustained system

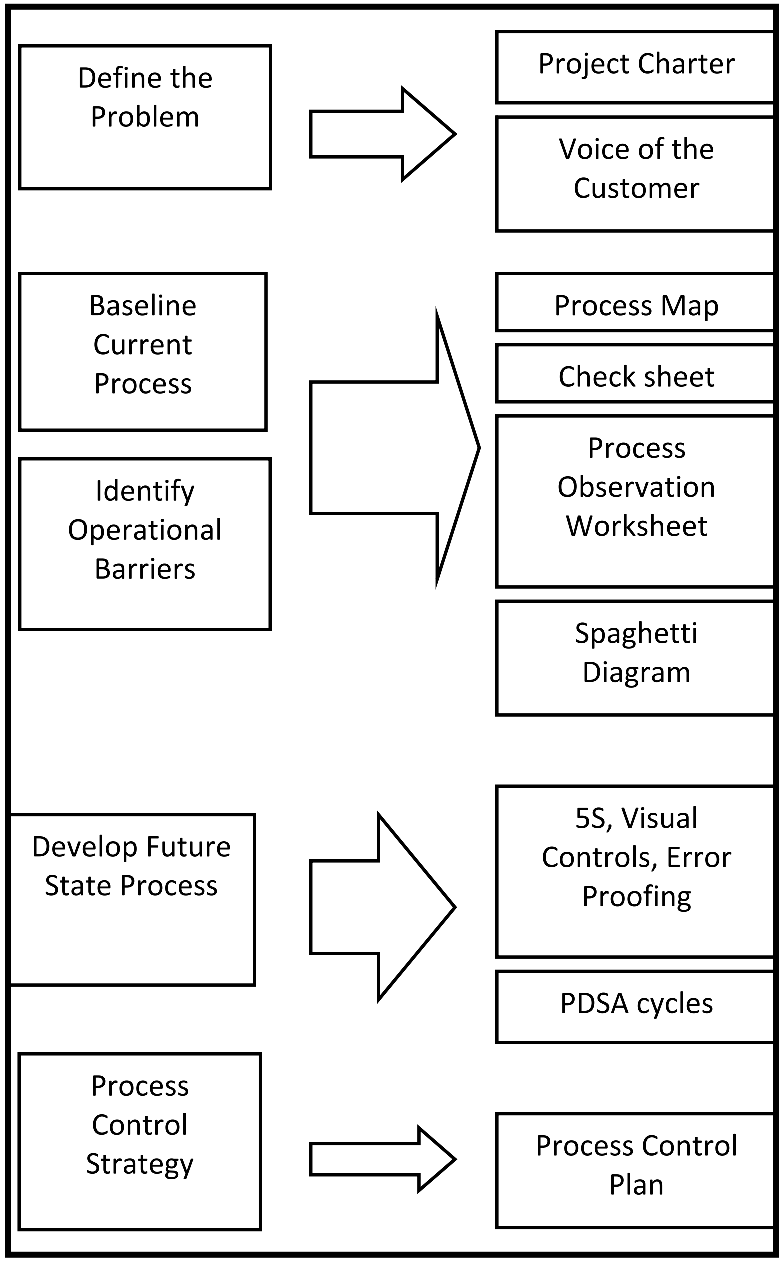

Figure 1. Techniques and methodologies utilized within the Lean Healthcare program.

changes needed to establish the innovation into workflow and the organization do not occur, and the implementation eventually fails. This cycle of failed implementation ultimately jeopardizes the interest of the organization and individual staff members in investing in future initiatives.

The focus of our work in this area has been to fully inform administrators of the organizational benefits of the initiative. This alliance with administrators is accomplished through the engagement of a project champion team to align the initiative with organizational strategic goals and the introduction of economic assessment tools that allow the champion and project teams to directly link the initiative's bottom-line cost savings to improved patient outcomes and staff workflow. This methodology has been termed "building the business case" for QI within health care. The lack of this "business case" has repeatedly been cited as a limiting factor to sustainable implementation within health care.[13, 14, 15, 16]

The project champion team is typically composed of hospital administrators, department managers, and key clinicians (or opinion leaders) who are stakeholders for the process under investigation. During a series of project champion meetings, open discussions are held with respect to the proposed QI initiative, the evidence supporting the innovation, data on relevant local processes and procedures (if any), anticipated barriers and challenges with respect to implementation, and whether an imperative exists within the organization leadership to provide the necessary support (e.g., resources, time) to ensure a successful implementation.

Project champions are also tasked with building an initial business case for the initiative utilizing an economic assessment template [or other internal return on investment (ROI) template]. The business case analysis includes anticipated expenditures resulting from the intervention/ implementation (including training costs), as well a summary of potential economic and strategic benefits to the organization.

As a result of this process, the champion team occasionally decides not to pursue the initiative or to delay until another project cycle, and no further action is taken. Once a decision is made to move forward, the champion team develops the initial project scope, identifies project goals and objectives, and develops a list of expected project deliverables.

Once the project team is chartered and the project initiated, project leaders and team members are expected to appropriately quantify potential project ROI prior to project implementation and validate ROI following implementation. To provide a mechanism for project team members to confidently link their project implementation to direct and indirect economic impacts, we have developed a practical, accessible methodology for standardized evaluation of the financial impact of health care improvement projects.[17] The methodology developed includes Excel® spreadsheet-based ROI tools, accompanying training materials used to enable project leaders and team members to suitably quantify potential project ROI prior to project implementation, and to validate ROI following implementation.

The objective of the ROI tool and exercises includes providing project team members with an in-depth understanding of the importance of appropriate financial analysis in achieving management support of operational and patient care improvement efforts. This understanding is reinforced through a hands-on training exercise that provides practical application in identification and quantification of financial impact, productivity impact and materials, equipment, and purchased services cost savings.

“Observability” of the initiative. Theories of diffusion of innovation within organizations categorize the personality characteristics of potential innovation adopters into five clusters:[4]

1. Innovators.
2. Early adopters.
3. Early majority.
4. Late majority.
5. Laggards.

Within this framework, innovators are estimated to represent about 2.5 percent of the general population, early adopters about 13.5 percent, early majority about 34 percent, late majority about 34 percent, and laggards the remaining 16 percent. Rogers[8] asserts that the transition between adoption and implementation develops a self-sustaining momentum, when 15 to 20 percent of individuals have embraced the initiative (i.e., the “tipping point”). Berwick[10] describes this phenomenon as being dependent on the interactions that occur among innovators, early adopters, and the early majority during the adoption phase.

Unfortunately, the typical model for implementing change within health care organizations provides very little interaction or dialogue between the supervisors planning the initiative and the health care professionals who must sustain the initiative. For example, meetings to plan clinical practice implementations or to improve clinical processes are often conducted well outside the patient care environment without an appropriate team of health care providers who would be responsible for adopting the processes. Staff input may be obtained, but this often occurs on a superficial level after key decisions have been finalized. Additionally, staff members who express concerns about deficiencies in new processes or procedures are often marginalized or ignored, limiting their capacity or interest in actively engaging in the implementation process and systematizing the changes to the organization.

Our focus in this area has been to develop implementation strategies that (1) promote positive engagement and interaction of the project team with staff members, (2) maximize the “observability” of the project team work, and (3) measure progress and provide feedback regularly.

Within our Lean Healthcare program, the engagement cycles of project team members with outside staff members begin immediately through a series of informal staff interviews know as “Voice of the Customer” Analysis. Within this exercise, “customers” are loosely defined as any individuals who would be affected by the adoption and implementation of the program. In addition to staff members (nurses, physicians, pharmacists, clerks, and others) within the patient care areas, customers might include representatives from environmental services, materials management, ancillary services, physicians, managers and supervisors, and administrators. Additionally, project teams often elect to include patients and their families within this process. Typically, each project team member interviews three to four individuals. The project team members are instructed to briefly introduce the initiative and then conduct an informal 5- to 10-minute interview while taking careful notes.

Sample questions for "Voice of the Customer" analysis include:

- What do you like about the current processes/procedures/policies related to the specific QI initiative?
- What do you think needs improvement?
- What would you recommend to improve the current processes/procedures/policies?
- What could potentially threaten the success of this initiative?

The notes from these interview sessions are discussed and summarized during the subsequent project team session. In addition to providing an opportunity for active engagement with staff members, the Voice of the Customer interviews are essential for understanding and validating customer requirements, expectations, and areas of dissatisfaction with the current processes. The most frequently occurring "needs improvement" and "recommendations for improvement" areas are prioritized. Plan-do-study-act (PDSA) cycles to develop, test, and implement solutions are often initiated immediately following this project session. This rapid resolution of "low hanging fruit" issues within the processes also provides a valuable opportunity to positively affect perceived benefit of the initiative.

Although several engagement activities, such as Voice of the Customer analysis, are intentionally built into the implementation, the project team is also challenged in each project session to develop and test innovative methods of engaging staff members and customers. Multiple techniques have been found to effectively increase project team and staff member interaction and to make the work of the project team highly "observable." These techniques include encouraging project team members to identify innovators and early adopters outside the project team and to include these individuals in workflow analyses and Lean tools applications during the PDSA cycles. Additionally, physical process changes are often developed initially as prototypes and are displayed in break rooms for staff feedback.

Ensuring "compatibility" of the change and reducing complexity of the innovation. QI initiatives—such as those for implementing clinical practice guidelines or new health informatics technologies (e.g., clinical reminders)—are often introduced during the adoption phase, utilizing a series of policy and procedure modifications and educational inservices, with minimal consideration for organizational culture, current workflow processes, and the level of engagement of the frontline staff members.[18] What results is often a set of policies, procedures, and processes that might be overly complex, impractical, and difficult for frontline staff to successfully apply and integrate with current patient care practices, regardless of their commitment to improving patient outcomes.

Additionally, in spite of the success of systems redesign methodologies (e.g., Lean and Six Sigma) in manufacturing environments, these tools often are not directly applicable within a health care setting.[19] They also might be difficult for frontline staff members with no formal systems engineering background to utilize. The absence of the "translation" to the health care language for Lean and the need for developing relevant case studies and examples into a health care dialect have been cited as factors limiting the adoption of these practices within health care.

In order to increase the "compatibility" factor of implementation efforts, our work has strongly focused on the design of systems engineering methodologies and principles that are readily accessible and relevant to health care frontline staff members with little or no prior background in application of these tools and the use of these “translated” systems-engineering methodologies to assist frontline staff members in the redesign and optimization of staff workflow practices to complement components of the quality initiative.

Within our Lean Healthcare program, a technique called Workflow Analysis is used by the project team to examine the clinical and operational processes from the perspective of the patient or staff member and to identify opportunities for systems redesign. Workflow analysis is derived from human factors engineering, where this term describes the study of the human-computer interaction with software and hardware systems. A workflow analysis study[20] is typically used to obtain data on baseline existing clinical processes prior to the improvement cycle and to validate process outputs following system redesign. While conducting an analysis study, direct process observation techniques are used to physically observe the process under investigation. Lean tools and techniques, such as process flow diagramming, direct process observation, spaghetti diagramming, and checksheets, are used by the project team members to collect data to identify and quantify the impact of operational barriers.

An example of workflow analysis outputs from a project to implement intensive glycemic control in a critical care unit is shown in Figures 2a-c.[19] These figures are from a published case study detailing the implementation of several clinical care bundles on a critical care unit. This particular workflow analysis examined the process of performing a glucose test on that unit. Note that the process observation worksheet (Figure 2b) indicates that, for this particular observation, the nurse spent 10 minutes searching for a glucometer to perform the glucose test on a patient. As published in this case study, the average time to find a glucometer on this unit was 11 minutes. The path the nurse took during the search for equipment and supplies is shown in the spaghetti diagram (Figure 2c).

Following identification of operational barriers, Lean tools and concepts—such as 5S, visual controls, and constraint management—are introduced to the project team through the use of health care-based case studies and hands-on simulation exercises. The latter exercises are developed specifically to mimic actual health care situations, such as locating equipment and supplies on a nursing unit and patient flow through an emergency department. Multiple rounds are conducted to simulate actual process improvement and to build team members’ confidence in applying Lean tools. These tools are then directly applied to the project team members systems and processes in order to improve the functionality of clinical processes associated with practice bundles.

Within our Lean Healthcare program, the faculty facilitator typically allows 1 week between the training session and a designated “report out” session. Each training group is given a stopwatch, multiple process observation worksheets, and a digital camera.

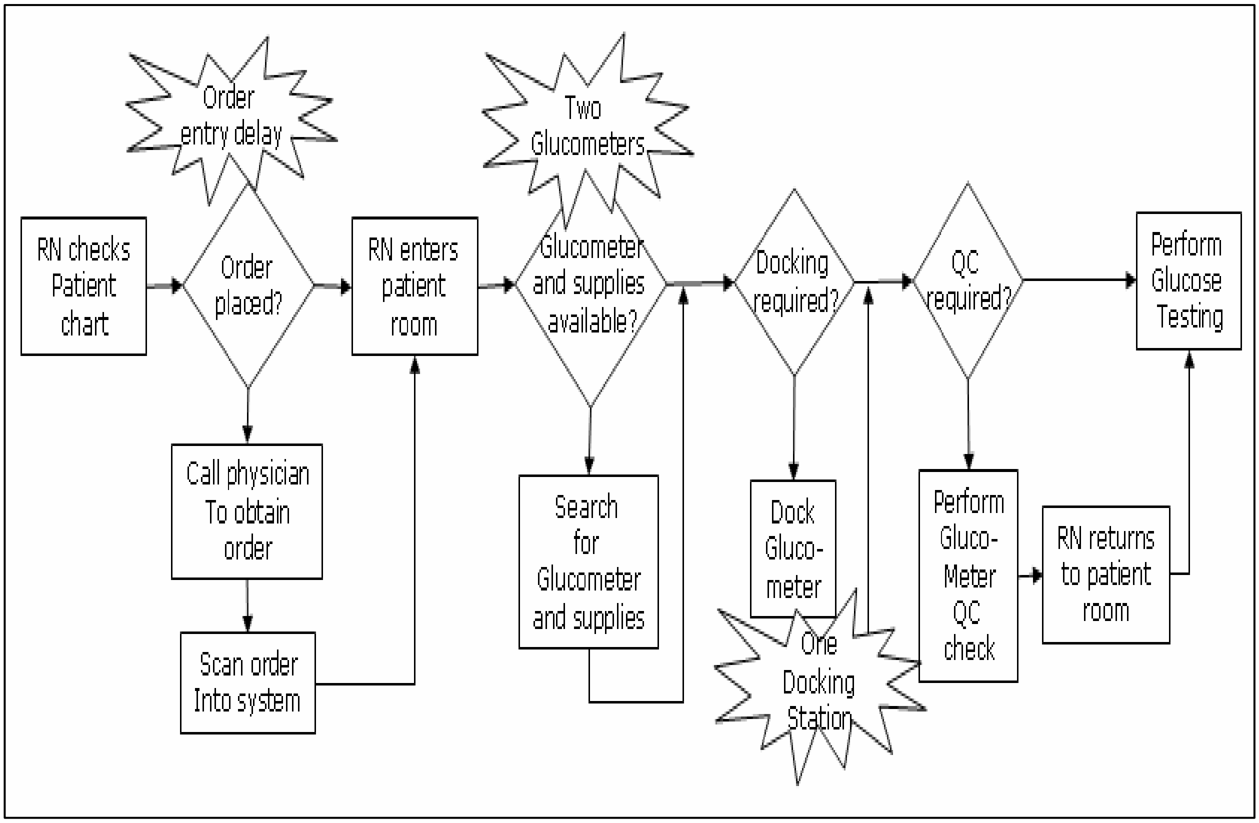

Figure 2a. Process flow diagram for performing a glucose test on a critical-care patient. Adapted from Woodward-Hagg H, El-Harit J, Vanni C, et al. Application of Lean Six Sigma techniques to reduce workload impact during implementation of patient care bundles within critical care – A case study. Proceedings of the 2007 American Society for Engineering Education Indiana/Illinois Section Conference; 2007 Mar; Indianapolis, IN. Used with permission.

Process Observation Worksheet

Step #	Description	Distance	Clock Time	Task Time	Wait Time	Observations
		0	0			
1	RN checks patient chart		2:00	2:00		
2	Order Obtained?					
	- If No, call physician to obtain order, scan order					
3	RN enters patient room	20	2:30	0:30		
4	Glucometer and Supplies available?					
	- If no, then search for Glucometer and Supplies.	500	12:30	10:00		entered 4 rooms to find glucometer
5	Docking required?					
	- If Yes, then goto Docking station.					
6	QC? If Yes then find QC equipment.					
	- If Yes, then perform QC.					
	- RN Returns to patient room	20	13:00	1:30		
7	Perform Glucose testing	0	13:30	0:30		

Figure 2b. Example of process observation worksheet used during workflow analysis for Glycemic Control Project. Adapted from Woodward-Hagg H, El-Harit J, Vanni C, et al. Application of Lean Six Sigma techniques to reduce workload impact during implementation of patient care bundles within critical care – A case study. Proceedings of the 2007 American Society for Engineering Education Indiana/Illinois Section Conference; 2007 Mar; Indianapolis, IN. Used with permission.

The training groups apply workflow analysis techniques to baseline their current processes, identify an area or instance of "waste" within their processes, and apply Lean tools to improve the processes. The groups are then expected to collect processing time information for the improved process in order to quantify the improvement.

The results are also translated into cost impact as part of the business case analysis, quantifying the benefit on an individual and organization level. The digital camera is used to record processing conditions prior to and following improvements. Team members are encouraged to summarize their results, including photos, into a 5- to 10-minute presentation or storyboard for the report-out session.

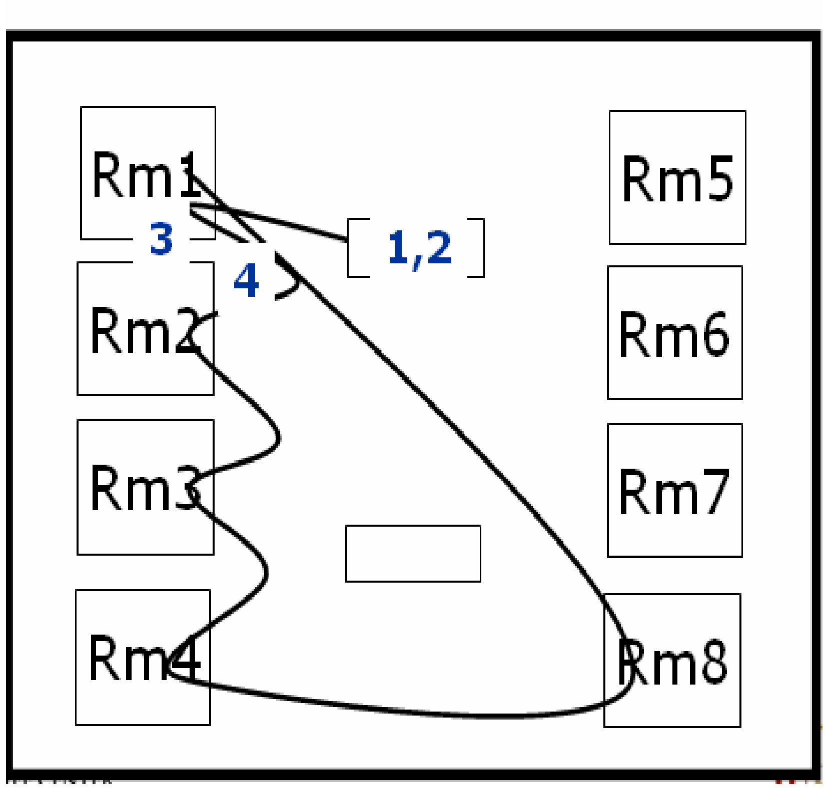

Figure 2c. Example of "spaghetti diagram" used during workflow analysis for Glycemic Control Project. This diagram depicts the movement of the nurse while searching for a glucometer. Adapted from Woodward-Hagg H, El-Harit J, Vanni C, et al. Application of Lean Six Sigma techniques to reduce workload impact during implementation of patient care bundles within critical care – A case study. Proceedings of the 2007 American Society for Engineering Education Indiana/Illinois Section Conference; 2007 Mar; Indianapolis, IN. Used with permission.

"Trialability" of the Initiative

Throughout our experiences in facilitating health care teams in systems redesign, our faculty facilitators have consistently noted that when project team members were encouraged to immediately apply Lean tools introduced during the project sessions to "test" improvements within their own work environments, these teams were more successful with respect to long-term retention and application of these tools, compared to those who might have delayed implementation. The facilitators also noted that these applications were more likely to be sustained over the duration of the implementation if the team went through several test cycles prior to final implementation. Additionally, solutions following these multiple tests of change were often highly customized in comparison to solutions generated by other project teams implementing similar QI initiatives.[20, 21]

The need for adaptation and customization to sustain change in health care is well documented and is believed to be the one of the fundamental requirements for spread of innovations.[22] However, Lean and systems engineering techniques, as applied within manufacturing, rely heavily on a foundation of standardization of processes and systems. As engineering and technology faculty with backgrounds in manufacturing applications of systems redesign, we initially struggled to reconcile the level of customization necessary to provide sustainability and the level of standardization that is often a characteristic of successful Lean process design in a manufacturing environment.

However, the more we investigated this phenomenon, the greater our understanding that the complex and dynamic nature of health care systems and processes often precludes standardization at a level that is typically required within manufacturing applications of systems redesign. As a result, within our program, we have opted to include both customized and standardized components. The general guideline we have developed is that standardization of processes, policies, and procedures must occur where evidence-based literature exists, linking specific clinical practice to patient outcomes.

All other clinical workflow processes related to implementation (and for which no evidence linking to patient outcomes exists) can be customized to best fit the needs of a particular project team or organization. For example, within a recently AHRQ-funded MRSA (methicillin-resistant *Staphylococcus aureus*) collaborative, the requirements for when a patient should be placed in isolation were standardized among participating hospitals because there was evidence to suggest that contact isolation reduced the likelihood of transmission. However, the processes and procedures that have been developed associated with placing colonized and infected patients in contact isolation vary greatly across participating health care facilities and even within facilities. Therefore, customization of these processes and procedures is necessary to compensate for systematic, cultural, and organizational differences.

For aspects of the implementation not requiring standardization, project teams are encouraged to optimize workflow practices through application of Lean and systems engineering principles by utilizing small, incremental tests of change, also known as PDSA cycles. An added benefit of this technique is that allowing project team members to optimize their own workflow processes through the PDSA cycles ensures that the resulting process and system changes fall within the project team members' capacity for technical complexity and within their confidence level to implement the changes successfully.

Additionally, as the complexity of the interventions increases, project pilots are often utilized to provide a test bed for parallel implementation of multiple PDSA cycles. A pilot implementation plan is generated to test the solutions through a 4- to 6-week timeframe. Often, during the pilot, the scope of the implementation can be reduced to a specific patient population or unit. A pilot implementation plan is created to detail actions that must occur prior to implementation of a specific aspect of the process redesign. Project team members are assigned as owners for individual action items, and dates for completion are determined.

The project team also develops a process control plan prior to implementation. This plan includes components of data feedback from the processes and creation of an administrative infrastructure to encourage sustainability of process improvements.

The control plan is developed to ensure regular feedback of process performance data during and following implementation. Typically, daily data collection and feedback are used throughout the pilot implementation, with the frequency of feedback decreasing as improvements are sustained and the implementation "tipping point" is reached as the project is adopted and integrated.

To continue project observability following implementation, results from daily data collections are often displayed prominently within the process areas to encourage staff discussion of progress and to foster awareness among staff members, including those not on the process team.

Table 1. Assessment scales used in this study

Sustainability assessment scale	
Excellent	Initiative sustained to goal for majority of primary control metrics for >9 months following implementation
Good	Initiative sustained to goal for majority of primary control metrics for >6 months following implementation
Fair	Initiative sustained to goal for majority of primary control metrics for >3 months following implementation
Poor	Initiative did not sustain to goal for majority of primary control metrics for ≤3 months following implementation; other significant implementation issues existed
None	No implementation occurred
Spread assessment scale	
Excellent	Systems engineering principles spread to other unit or project focus with no faculty assistance
Good	Systems engineering principles spread to other unit or project focus with limited faculty assistance
Fair	Some evidence of application of systems engineering principles beyond initial project area
Poor	No evidence of application of systems engineering principles beyond initial project area

Results and Discussion

To date, the implementation strategies outlined above have been used in over 40 QI projects, 21 hospitals, and 6 hospital systems within the State of Indiana.

To evaluate the effectiveness of our implementation strategy, each of the 36 completed projects was retrospectively evaluated to assess the sustainability of improvements over time and the extent of spread of Lean and systems engineering techniques beyond the initial project focus area. Table 1 outlines the evaluation criteria used in this assessment, and Table 2 presents a list and count of projects by topic.

As shown in Table 2, 89 percent of projects (32/36) have been implemented and improvements sustained for at least an initial 4-week pilot period. A summary of the sustainability and spread assessment results is presented in Table 3. Of those projects that were implemented, 78 percent (25/32) were found to have sustained the majority of project goals for more than 6 months. Additionally, 75 percent of projects (24/32) resulted in the spread of Lean, systems engineering, and implementation science principles beyond the initial project focus area with limited faculty assistance.

Of the four projects that failed to make the transition from adoption to implementation, one failed due to the complexity of the proposed redesign; the other three failed due to lack of administrative support during the pilot phase, which likely reflected a failure of perceived benefit to the organization.

Conclusion

Our program for successful implementation and sustainability of QI initiatives in health care emphasizes principles of Lean manufacturing, systems engineering, and implementation science. This approach specifically emphasizes+ working to incorporate staff engagement and ownership, including training programs that make these methodologies and principles readily accessible to frontline staff with little or no prior experience. Furthermore, each project session requires immediate application of tools and techniques to the processes under investigation with ongoing measurement and feedback of the impact. The benefits of the process redesign activities are detailed through a business case analysis and through quantifying the impact of process redesign utilizing workflow analysis. Through a consistent application of these principles, we have found that interventions are integrated into workflow, adopted, and sustained over time.

Table 2. Completed projects by category

	Project implemented? (N)	
Project categories	**Y**	**N**
ED patient flow	1	2
Surgical flow	3	
Outpatient scheduling/registration	2	
ICU admission process redesign	1	
Hospital lab process redesign	4	
Discharge process redesign	2	
IT process redesign	2	
Medication delivery process redesign	2	
Equipment/supply area redesign	2	
ICU LOS reduction (incl VAP / glycemic control bundles)	5	
Implement central line bundle	1	
Implement MRSA bundle	6	
Patient fall reduction	1	
Radiology capacity optimization		2
Totals	**32**	**4**
Percent projects implemented (%)	**88.89**	

Table 3. Summary of project sustainability and spread assessment

Project categories	Sustainability[a]				Spread[a]			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
Number of projects	14	11	7	0	12	12	5	3
Total projects (%)	44	34	22	0	37.5	37.5	16	9
% projects sustained >6 months	78							
% projects exhibiting spread with limited or no faculty assistance	75							

A Sustainability and spread assessment performed only on projects that were implemented.

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