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Use of Lean and Related Transformational Performance Improvement Systems in Hospitals in the United States: Results From a National Survey

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Background: The health care system in the United States is costly with high variance in quality. There is growing interest in transformational performance improvement initiatives, such as the Lean management system, to eliminate waste and inefficiency and improve quality of care for patients.

Methods: A national survey of all 4,500 short-term acute general medical/surgical and pediatric hospitals in the United States was fielded between May and September 2017 by the Survey Data Center of the American Hospital Association.

Results: Responses were received from 1,222 hospitals (27.3% response rate). Sixty-nine percent (69.3%) reported use Lean or related Lean plus Six Sigma or Robust Process Improvement approaches. Not-for-profit hospitals, hospitals located in metro/urban areas, those belonging to a system/network, and those with 100–399 beds were most likely to be engaged in these activities and for an average of 5.2 years. However, only 12.6% ($n = 102$) of hospitals reported being at a mature hospitalwide stage of implementation. The degree of maturity, leadership commitment, daily management system use, and training were each positively associated with reported positive performance outcomes.

Conclusion: A majority of hospitals have adopted Lean-based transformational performance improvement approaches but with wide variance in the degree of implementation. It takes time for Lean to gain traction. The length of time doing Lean is positively associated with implementation progress and reported positive performance impacts. The extent to which Lean has an organizationwide performance impact awaits further research that links the variables in this study with objective cost and quality measures.

Despite pockets of excellence,[1,2] the quality and cost of health care remains the challenge for the health care in the United States system that "won't go away." Costs continue to increase faster than the rate of inflation, while improvements in patient safety and quality of care remain small, slow to achieve, and highly variable across the country. The net result is a health care system that ranks last on commonly accepted measures among other high-income countries, including the United Kingdom, France, Germany, Canada, and Norway, among others.[3] Although there is growing recognition of the importance of maintaining and enhancing health insurance coverage[4] and of the social determinants of health,[5] there remain concerns about the degree of waste and lack of reliability in the systems of delivering care.[6] Increases in prices and the intensity of services accounted for 50% of the increase in health care spending between 1996 and 2013,[7] highlighting the need to eliminate services that do not add value for patients and providing those that do more efficiently. These cost and quality concerns are likely to grow as the demand for care increases with an aging population and biomedical and technological advances.

Many hospitals in the United States are attempting to respond to these challenges by adopting transformational performance improvement approaches.[8] These are aimed at creating greater than incremental changes by empowering people with resources, skills, and tools and developing a continuous improvement culture, thereby improving patient outcomes while constraining the rate of growth in costs. What is not yet fully recognized is that this will require a radically new and different way of leading and managing our nation's hospitals.

One potential approach is the Lean management system philosophy, principles, and tools originally developed at Toyota,[9,10] and then spread to many manufacturers in the United States,[11] and, more recently, to service-based organizations as well.[12] For health sector purposes, Lean is defined as an overall management/operating system that uses a continuous improvement culture that empowers frontline workers (nurses, physicians, other caregivers and support staff) to solve problems and eliminate waste by standardizing work to improve the value of care delivered to patients. Related approaches are Lean plus Six Sigma, which adds a focus on variance reduction, and Robust Process Improvement, which adds a structured change management component.[6] Consistent with Malcolm Baldrige Award criteria,[13] Lean is a sociotechnical system approach[14–17] that recognizes that culture and leadership are needed for the tools to have an effect. The Lean management system is a comprehensive integrated approach to breaking down the silos that prevent patients from receiving more reliable and high-value care. It is intended

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to bridge the too frequent gap that exists in hospitals between C-suite leaders and the frontline nurses, physicians, and other health care professionals who touch the patient.

There is a growing literature on the application of Lean to hospitals and other health care organizations, Small-scale studies of Lean application in discrete units such as the emergency department (ED),[18,19] ICU,[20] and operating room (OR)[21] have demonstrated positive results. However, most of these studies lack comparison or randomized control groups, suggesting that the findings may be due to self-selection of committed unit staff and/or alternative competing explanations.[22–27] With the exception of a few notable case studies,[22–26,28–32] there have been almost no studies of organization- or enterprisewide implementation and assessment of Lean.[33,34] Further, no information is available on the extent to which hospitals in the United States are adopting and implementing Lean or with what results. To begin to address these gaps in knowledge and lay a foundation for future research, we report the results of a national survey of Lean and related performance improvement initiatives in hospitals.

METHODS

Study Design and Measures

Based on literature review, discussion with Lean experts, and pilot testing with 12 Lean performance improvement specialists, we developed a 20-minute online survey fielded by the American Hospital Association. The survey was sent to the 4,500 acute care general medical and surgical hospitals in the United States, including pediatric medical and general hospitals. The survey was completed by the chief transformation officer, chief performance improvement officer, chief quality officer, or equivalent position title in each hospital. Major topics covered by the survey included whether or not the hospital had adopted and implemented the Lean or related performance improvement system; date of adoption; extent of current use; approach to implementing Lean; self-reported maturity in using Lean; experience with model cells; hospital policies with respect to Lean; use of a central improvement team; use of the daily management system; use of Lean tools; number of units using Lean; use of outside consultants; whether or not there was a True North vison; the roles played by the finance, human resources, and information technology departments; staffing and training; and self-reported performance impact measures primarily attributable to Lean. The survey was administered between May and September 2017, with a 27.3% completion rate ($n = 1,222$ hospitals). The survey was approved by the Institutional Review Board of the University of California, Berkeley.

We expected that those hospitals that had more experience in doing Lean and that were further along on their "Lean journey" would have greater leadership commitment to Lean, engage in more of the Lean daily management system, and have trained a greater percentage of their managers, nurses, and physicians in Lean methods and tools. In turn, we expected that summary scales of these variables would be positively associated with greater self-reported performance primarily attributable to Lean.

Composite Scales

The survey is based on a comprehensive approach to assessing the degree of Lean implementation in hospitals grounded in the work of Chassin et al.,[6] Liker,[12] Shook,[35] and Toussaint and Gerard.[31]

Overall Leadership Commitment

A key aspect of Lean is leadership commitment to provide the cultural transformation required.[33,34,36–38] This was measured by an eight-item index: whether leaders clearly communicated the reason(s) for implementing Lean, the desired outcomes, the degree of employee investment in Lean, selecting projects for early success and learning, setting benchmarks to assess progress, providing needed resources, identifying team champions/sponsors, and making an explicit commitment to patient-centered care. The response scale to each item ranged from strongly disagree with the statement to strongly agree. We grouped the agree and strongly agree responses and allocated one point to each of the eight items, so the scale ranged from 0 to 8. Cronbach's alpha reliability coefficient for the scale was 0.81.

Daily Management System

Key to Lean implementation is the use of the daily management system, which helps with the cultural transformation and to ensure sustainability over time.[36,39,40] We developed a nine-item index: whether or not managers on a routine basis participate in daily huddles, go on gemba walks, use visual management, use analysis tools such as scatter plots, practice A3 thinking, teach Lean methods/tools, use standard work, use value stream mapping, and use Plan-Do-Study-Act (PDSA) cycles. Respondents were given one point for each of the nine items that were checked with a "yes," so the scale ranged from 0 to 9. Cronbach's alpha reliability coefficient was 0.75.

Education and Training

Education and training in Lean philosophy, principles, and tools provides the foundation for Lean work. We measured the degree of Lean education and training by assessing the percentage of managers, nurses, and physicians who had received training in scientific approaches to problem solving, such as the use of PDSA cycles. Response categories were 0%, 1%–24%, 25%–49%, 50%–74%, and 75%–100%. Respondents were grouped into the categories of 0, 1 if they were in the 1%–24% category, 2 if in the 25%–49% category, 3 if in the 50%–74% category, and 4 if in the 75%–100% category. They were then averaged across the three groups—managers, nurses, and physicians—to form an average score that could range from 0 to 4. The Cronbach's alpha reliability coefficient was 0.82.

Self-Reported Performance

Each respondent was asked to indicate whether or not performance in 16 areas, ranging from "eliminating waste in two or more processes or departments" to "reducing medical errors" to "increasing throughput in the ED" could be primarily due to Lean. Each "yes" response was added up to create an index that ranged from 0 to 16. Cronbach's alpha reliability coefficient was 0.89.

Data Analysis

We used descriptive statistics to present the findings on each variable and summary scales of interest. We used chi-square and related measures of association in examining the relationship between various hospital background characteristics, years of experience doing Lean, a question on where each hospital was at in its stage of the Lean journey, and the three summary scale measures of overall leadership commitment, daily management system, and education and training.

We used multivariable regression analysis to assess the relationship between the three summary scale measures, self-reported maturity, years doing Lean, number of units doing Lean, various control variables, and the self-reported performance impact measure. We excluded cases with more than three missing values in the regression model, and used the R package Hmisc for multiple imputation in cases with three or fewer missing values. Multiple imputation was carried out over 10 imputations using the *aregImpute* command, which uses bootstrapping and predictive mean matching. The *fit.mult.impute* command carried out 5 iterations of the regression model using the imputed data, averaging the coefficients and computing imputation-adjusted variances.[41] All analyses were conducted using R version 3.4.1.[42,43]

RESULTS

Table 1 compares the respondents and nonrespondents on background variables. Eight responding and 23 nonresponding hospitals were not included in Table 1 because of missing data for all background variables. As shown, responding hospitals were somewhat more likely to be not-for-profit and less likely to be investor owned, more likely to be a member of the Council of Teaching Hospitals, less likely to be located in the South and more likely to be located in the West, and somewhat less likely to be under 100 beds and more likely to be 400 beds and greater. There were no differences in being a system/network member or in specific geographic location (metro, micro, or rural).

Table 1. Comparison of Respondents and Nonrespondents on Background Variables

Characteristic	Nonresponder $N = 3,255$	Responder $N = 1,214$
Ownership* *n* (%)		
Public	704 (21.6)	288 (23.7)
Not-for-profit	1,928 (59.2)	830 (68.4)
Investor-owned	623 (19.1)	96 (7.9)
Member of a system or network? *n* (%)†		
Yes	2,303 (77.4)	901 (77.6)
No	671 (22.6)	260 (22.4)
Core-based statistical area type *n* (%)		
Metro (urban area at least 50,000 people)	1,916 (58.9)	699 (57.6)
Micro (urban area between 10,000 and 50,000 people)	553 (17.0)	208 (17.1)
Rural	786 (24.1)	307 (25.3)
Member of Council of Teaching Hospitals?* *n* (%)		
Yes	150 (4.6)	107 (8.8)
No	3,105 (95.4)	1,107 (91.2)
Region* *n* (%)		
Midwest	724 (22.2)	317 (26.1)
Northeast	418 (12.8)	131 (10.8)
South	1,528 (46.9)	470 (38.7)
West	585 (18.0)	296 (24.4)
Bed size* *n* (%)		
1–99 beds	1,664 (51.1)	569 (46.9)
100–399 beds	1,298 (39.9)	481 (39.6)
400 or more beds	293 (9.0)	164 (13.5)

*$p < 0.05$ (chi-square test).
†Total *N* varies because of missing data.

Overall Adoption/Implementation of Lean

Table 2 shows the descriptive statistics on all the variables of interest. As indicated, 69.3% of responding hospitals reported being involved in using Lean *in some way*, with 26.4% *primarily* using Lean without Six Sigma, 22.5% using Robust Process Improvement, and 11.4% using Lean plus Six Sigma combined as their primary performance improvement approach. Responding hospitals had been using Lean an average of 5.2 years, with one hospital reporting 22 years beginning as early as 1995. Only 11.3% (91 hospitals) reported that they started using Lean by implementing a comprehensive daily management system hospitalwide—although 36.9% (296 hospitals) indicated that they began with only some elements hospitalwide, and 40.6% (326 hospitals) implemented some elements in a small number of departments. Among the methods used to implement Lean, 66.9% of hospitals started with a model cell, 75.5% had a central improvement team, and 70.9% used an outside consultant.

In further analyses (data not shown), those that started with a model cell and those that had a central improvement team had spread Lean to more units, used more tools, and were more likely to report being a mature performance improvement hospital. Hospitals that started with a comprehensive daily management system also reported currently using Lean in more units and using more Lean tools to improve performance.

Specific Elements of Adoption/Implementation

Hospitals reported that an average of 14 units were involved in Lean in some form. The most frequently involved

Table 2. Descriptive Statistics on Study Variables

Characteristic	*n**	% or Mean (SD); Range
Doing any Lean?		
Yes	847	69.3
No	375	30.7
Primary performance improvement approach		
Lean without Six Sigma	217	26.4
Lean Six Sigma combined	94	11.4
Robust Process Improvement	185	22.5
Six Sigma without Lean	3	0.4
The Model for Improvement	49	6.0
Benchmarking for best practices	37	4.5
High Reliability Organization	44	5.4
FOCUS—PDCA	143	17.4
None	5	0.6
Other	44	5.4
Number of years doing Lean	778	5.2 (3.6); 0–22
Approach to beginning Lean implementation		
Some elements hospital-wide	296	36.9
Some elements in a small number of departments	326	40.6
Some elements in a single department	48	6.0
Comprehensive DMS hospital-wide	91	11.3
Comprehensive DMS in a small number of departments	29	3.6
Comprehensive DMS in a single department	13	1.6
Number of units doing Lean	807	14.2 (7.3); 0–29
Number of tools reported as high or very high use	745	5.1 (3.8); 0–15
Initiated Lean with a model cell		
Yes	542	66.9
No	268	33.1
Have a central improvement team		
Yes	581	75.5
No	189	24.5
Ever used an outside consultant		
Yes	542	70.9
No	222	29.1
Have a True North vision		
Yes	451	58.6
No	319	41.4
Overall Lean leadership commitment index	772	5.3 (2.4); 0–8
Daily management system index	752	5.7 (2.3); 0–9
Education and training index	735	1.9 (0.9); 0–4
Self-reported performance index	731	9.1 (4.0); 0–16

*Total *n* may vary due to skipped questions.
SD, standard deviation; FOCUS, Find, Organize, Clarify, Understand, Select; PDSA, Plan-Do-Study-Act; DMS, daily management system.

units were the ED, the medical/surgical nursing unit, the OR, the executive leadership, and the laboratory. An average of five tools or methods were used, with the most frequent tools or methods used being daily huddles, PDSA cycles, visual management, standard work processes, and analysis tools such as scatter plots and Pareto charts. Only 58.6% of hospitals indicated a "True North" vision for its Lean transformation. The mean of the overall Lean leadership commitment index was 5.3 (0–8 range), the mean of the daily management system index was 5.7 (0–9 range), and the mean of the education and training index was 1.9 (0–4 range). The average self-reported performance index measure was 9.1 (0–16 range). The most frequently reported performance achievements that respondents primarily attributed to Lean were elimination of waste in two or more processes or departments, improved employee engagement in their work, increased throughput in the ED, and reduced expenditures in two or more departments.

Table 3 shows the differences in the length of time hospitals have been using Lean, number of units using Lean, number of tools used, overall leadership commitment index, daily management system index, training and education index, and self-reported performance measures by the background characteristics. In general, hospitals in metro areas, that were not-for-for profit or investor owned, had at least 100 beds, and were part of a system or network reported deeper Lean implementation and attributed more performance improvements to Lean (see further details in Table 3).

Table 4 shows the differences in the self-reported Lean maturity level and the background characteristics. As shown, only the difference by ownership was significant, with the not-for-profit and investor-owned hospitals being further along in their implementation than public hospitals.

There was a significant positive association ($r = 0.35$) between self-reported maturity level and number of years using Lean: Hospitals in the new start-up stage averaged 2.3 years, those in the beyond start-up and expanding to other units stages averaged 5.3 years, and those that reported they'd become a mature transformational performance improvement hospital averaged 7.8 years.

Likewise, both length of time doing Lean and self-reported maturity were significantly correlated with measures of Lean implementation. Years doing Lean was correlated with the number of tools used ($r = 0.26$), the number of units using Lean ($r = 0.28$), the daily management system index ($r = 0.23$), the training and education index ($r = 0.19$), and the self-reported performance measures summary score ($r = 0.28$). Self-reported maturity was correlated with the number of tools used ($r = 0.57$), the number of units using Lean ($r = 0.56$), the overall leadership commitment index ($r = 0.48$), the daily management system index ($r = 0.46$), the training and education index ($r = 0.32$), and the self-reported performance measures summary score ($r = 0.47$).

Self-Reported Performance Multivariable Regression

Table 5 shows the results for the multivariable regression of the Lean degree of implementation variables on the number of self-reported performance effects, controlling for the background characteristics of respondents. The largest possible

Table 3. Background Characteristics and Comparison with Lean Implementation Measures and Self-Reported Performance

	Number of Years doing Lean $n = 774$	Number of Units Doing Lean $n = 802$	Number of Tools Reported as High or Very High use $n = 741$	Overall Lean Leadership Commitment Index $n = 768$	Daily Management System Index $n = 748$	Education and Training Scale $n = 731$	Self-Reported Performance Index $n = 727$
Ownership							
a. Public	4.6 (3.5)	11.9 (7.5)	4.4 (3.7)	4.8 (2.5)	4.9 (2.6)	1.8 (0.9)	7.6 (4.1)
b. Not-for-profit	5.4 (3.6)	14.8 (7.2)	5.2 (3.8)	5.4 (2.4)	5.8 (2.2)	1.9 (0.9)	9.4 (3.9)
c. Investor-owned	3.7 (4.1)	14.6 (7.0)	5.8 (3.1)	6.3 (1.8)	6.0 (2.0)	2.1 (0.9)	8.9 (4.1)
	F = 6.14*	**F = 9.19†**	**F = 3.41‡**	**F = 6.31***	**F = 10.75†**	F = 1.81	**F = 11.73†**
	a < b; b > c	**a < b**	**a < b**	**a < b; a < c**	**a < b; a < c**		**a < b**
Member of a system or network?							
Yes	5.4 (3.6)	14.5 (7.3)	5.3 (3.8)	5.4 (2.3)	5.8 (2.3)	2.0 (0.9)	9.4 (3.9)
No	4.6 (3.6)	13.3 (7.2)	4.4 (3.8)	5.2 (2.4)	5.3 (2.4)	1.8 (0.8)	7.8 (3.9)
	t = 2.32‡	*t* = 1.84	**t = 2.54‡**	*t* = 0.84	**t = 2.16‡**	**t = 2.55‡**	**t = 4.13†**
Core-based statistical area type							
a. Metro (urban area ≥ 50,000 people)	5.6 (3.7)	14.4 (7.3)	5.2 (3.8)	5.4 (2.4)	5.8 (2.3)	1.9 (0.8)	9.3 (4.0)
b. Micro (urban area 10,000–50,000 people)	4.3 (3.4)	14.3 (7.5)	4.7 (3.6)	5.3 (2.4)	5.3 (2.2)	1.9 (0.9)	8.4 (3.7)
c. Rural	4.4 (3.1)	13.7 (7.3)	4.8 (3.7)	5.1 (2.3)	5.3 (2.3)	2.0 (1.0)	8.5 (4.2)
	F = 9.4†	F = 0.5	F = 1.22	F = 0.67	**F = 3.63‡§**	F = 0.55	**F = 3.81‡§**
	a > b; a > c						
Member of Council of Teaching Hospitals?							
Yes	5.9 (4.1)	15.5 (7.9)	5.1 (3.9)	5.0 (2.3)	5.5 (2.2)	1.8 (0.8)	9.2 (4.2)
No	5.1 (3.5)	14.1 (7.3)	5.1 (3.8)	5.4 (2.4)	5.7 (2.3)	1.9 (0.9)	9.1 (4.0)
	t = 1.79	*t* = –1.58	*t* = –0.148	*t* = 1.46	*t* = 0.59	**t = 2.05‡**	*t* = –0.26
Bed size							
a. 1–99 beds	4.3 (3.2)	13.5 (7.3)	4.9 (3.7)	5.4 (2.3)	5.4 (2.4)	2.0 (1.0)	8.5 (4.0)
b. 100–399 beds	5.5 (3.7)	14.6 (7.2)	5.2 (3.7)	5.3 (2.5)	5.9 (2.2)	1.9 (0.8)	9.4 (3.9)
c. 400 or more beds	6.1 (4.0)	15.2 (7.5)	5.2 (4.1)	5.3 (2.3)	5.7 (2.4)	1.8 (0.8)	9.5 (4.2)
	F = 14.6†	**F = 3.34‡**	F = 0.54	F = 0.24	**F = 3.99‡**	F = 1.13	**F = 4.44‡**
	a < b; a < c	**a < c**			**a < b**		**a < b; a < c**

Results are presented as mean (SD [standard deviation]), and test statistic. Significant F and t values are boldfaced. Significant ($p < 0.05$) post-hoc comparisons (Tukey's Honest Significant Difference method) are listed under significant overall F-statistics.

*$p < 0.01$.

†$p < 0.001$.

‡$p < 0.05$.

§None of the post-hoc pairwise comparisons reached significance.

Table 4. Background Characteristics and Comparison with Self-Reported Maturity

Characteristic	Self-Reported Maturity: New Start-Up Stage *n* = 117	Beyond Start-Up, but Challenged Moving Forward *n* = 212	Expanding to Other Units and Getting Traction Throughout the Hospital *n* = 375	Have Become a Mature Transformational Performance Improvement Hospital *n* = 102
Ownership* *n* (%)				
Public	32 (21.3)	50 (33.3)	59 (39.3)	9 (6.0)
Not-for-profit	78 (12.5)	156 (25.0)	303 (48.6)	86 (13.8)
Investor-owned	7 (21.2)	6 (18.2)	13 (39.4)	7 (21.2)
System or network member? *n* (%)				
Yes	85 (13.1)	165 (25.3)	313 (48.1)	88 (13.5)
No	25 (18.5)	41 (30.4)	56 (41.5)	13 (9.6)
Core-based statistical area type *n* (%)				
Metro (urban area at least 50,000 people)	74 (13.4)	139 (25.2)	256 (46.4)	83 (15.0)
Micro (urban area between 10,000 and 50,000 people)	21 (16.0)	39 (29.8)	60 (45.8)	11 (8.4)
Rural	22 (17.9)	34 (27.6)	59 (48.0)	8 (6.5)
Member of Council of Teaching Hospitals? *n* (%)				
Yes	13 (14.3)	17 (18.7)	46 (50.5)	15 (16.5)
No	104 (14.5)	195 (27.3)	329 (46.0)	87 (12.2)
Bed size *n* (%)				
1–99 beds	53 (18.3)	78 (27.0)	132 (45.7)	26 (9.0)
100–399 beds	47 (12.6)	96 (25.7)	180 (48.1)	51 (13.6)
400 or more beds	17 (11.9)	38 (26.6)	63 (44.1)	25 (17.5)

Results are presented as counts and row percentages.
*$p < 0.05$ (chi-square test).

sample for the regression was the 847 responding hospitals who reported using Lean, 658 (77.7%) of which had complete data. We excluded 81 respondents who had missing data for four or more of the regression variables, and imputed missing data for an additional 108 respondents, resulting in a final sample size of 766. The maximum number of values imputed for any single variable was 35 (4.6%). As hypothesized, self-assessed maturity level, the number of units using Lean, the length of time since adopting Lean, the overall leadership commitment index, the daily management system index, and the education and training index are each significantly associated with self-reported performance achievements. With the exception of being a member of a system or network (positive association), none of the background variables were significantly associated with self-reported performance. Different specifications of the model, such as adding in the number of tools used, using different measures of education and training, and including only complete cases, did not change the results.

DISCUSSION

Nearly 70% of hospitals report using Lean, Lean plus Six Sigma, or Robust Process Improvement as one of their approaches to transforming the care that they deliver to patients (and for 60.3% of hospitals, it was their primary approach). While this figure may be surprising to some, it is important to note that the responding hospitals are likely to be biased toward those more likely to be using Lean. A follow-up brief phone interview of 96 randomly selected nonresponding hospitals, using the same Lean identification questions as in the survey, revealed that 57.2% reported using Lean and related approaches. Applying this percentage to all nonresponding hospitals, and combining with the responding hospitals, yields an overall adjusted 61.6% estimate of hospitals who are using Lean, Lean plus Six Sigma, or Robust Process Improvement.

Further, it is important to note that only 12.6% (102 hospitals) believed that they are at a mature hospitalwide stage of being a Lean hospital, although an additional 46.4 % (376 hospitals) believed that they were spreading Lean to multiple units and beginning to gain traction. The 102 "mature" Lean hospitals averaged 7.8 years in their use of Lean, while the 376 hospitals that were beginning to spread Lean throughout the hospital averaged 5.3 years since adoption, indicating that it takes some time before potential thresholds of spread are reached.

Hospitals generally appear to be following the advice of Lean leaders[30,31] in starting a model cell unit before spreading more broadly to other units and developing a central improvement team to provide coaching, training, and guidance. But somewhat surprising, less than 60% have identified a "True North" goal of what the hospital aspires to become

Table 5. Regression Model Results: Self-Reported Performance Improvement ($n = 766$)

Predictor	*b*	*b* 95% CI [LL, UL]
(Intercept)	1.07*	[–0.04, 2.18]
Ownership: Not-for-profit	0.36	[–0.25, 0.98]
Ownership: Investor-owned	–0.22	[–1.50, 1.05]
System or network member: Yes	0.79*	[0.17, 1.42]
CBSA type: Metro (urban area at least 50,000 people)	0.03	[–0.77, 0.83]
CBSA type: Micro (urban area between 10,000 and 50,000 people)	–0.03	[–0.88, 0.82]
Member of Council of Teaching Hospitals: Yes	–0.40	[–1.33, 0.53]
Bed size: 100–399 beds	0.46	[–0.17, 1.10]
Bed size: 400 or more beds	0.79	[–0.12, 1.70]
Self-reported maturity: Beyond start-up, but challenged moving forward	0.37	[–0.44, 1.17]
Self-reported maturity: Expanding to other units and getting traction throughout the hospital	0.91*	[0.07, 1.74]
Self-reported maturity: Have become a mature transformational performance improvement hospital	1.50†	[0.29, 2.71]
Number of units doing Lean	0.17†	[0.13, 0.21]
Number of years doing Lean	0.11†	[0.04, 0.18]
Overall Lean leadership commitment index	0.22†	[0.09, 0.35]
Daily management system index	0.20†	[0.06, 0.33]
Education and training scale	0.38†	[0.09, 0.66]
Fit	$R^2 = .410$†	95% CI [.35,.44]

*$p < 0.05$.
†$p < 0.01$. A significant *b*-weight indicates that the semi-partial correlation is also significant. *b* represents unstandardized regression weights. *LL* and *UL* indicate the lower and upper limits of a confidence interval (CI), respectively.

and which provides the basis for alignment of all of their Lean efforts. This suggest that in these hospitals Lean may be used in isolated units and departments, perhaps to achieve short-term efficiency and cost savings, but unrelated or related only by chance to the hospital's overall strategic priorities or aspirations.

The findings underscore the importance of leadership commitment, having a daily management system, and education and training in the overall Lean implementation effort. Those hospitals that were further along on these dimensions of Lean had a greater number of positive self-reported performance impacts.

To date, managers and nurses have received significantly more training in Lean scientific performance improvement approaches than physicians. Not all process improvement work affects what physicians do, and those initiatives, therefore, may not require their involvement. But as the Medicare Access and CHIP [Children's Health Insurance Program] Reauthorization Act (MACRA) and related private-sector payment approaches reward hospitals and physicians for value (good outcomes and keeping people well) rather than the volume of services rendered, there will be increased "pull" to eliminate unnecessary steps of care that do not add value for patients. This will require that physicians receive greater training in the philosophy, principles, and tools of Lean and related approaches. Fortunately, the scientific method epitomized by PDSA cycles is the same paradigm that physicians have been exposed to in their training and practice every day in diagnosing and treating patients. Communicating in improvement language rather than Lean terminology, respecting physicians' time, and involving them in A3 thinking and in targeted clinical huddles are all strategies that have been shown to overcome disinterest or resistance to Lean.[30] To the extent that hospital employment of physicians continues to grow, it will become easier to benefit from their involvement, as evidence suggests that such physicians identify more with the hospital and become more engaged.[44]

Not-for-profit hospitals, those located in urban areas, those belonging to a system or network, and those with 100–399 beds appear to be the most prevalent adopters of Lean to date. But the multivariable analysis reveals that only being a member of a system or network appears to matter in terms of the number of self-reported positive outcomes achieved. It may be that these hospitals benefit from the greater scanning opportunities for improvement, opportunities for experimentation and learning, greater resources for education and training, and more dense social networks for transferring best practices that systems and networks can provide. Implementing Lean in small, rural, stand-alone and public hospitals will be a continuing challenge.

The expected findings that greater perceived Lean maturity, leadership commitment, daily management system implementation, and more education and training are associated with a greater number of self-reported performance achievements should be viewed with caution. Respondent self-report data may or may not reflect actual cost, efficiency, productivity, patient experience, or clinical quality measures. It is important to note that the most prevalent achievements reported were in the cost/efficiency domain such as "eliminating waste in two or more processes or departments" or "reduced expenditures in two or more departments," and not in the quality-of-care improvement domain such as "reduced medical errors" or "reduced ambulatory care sensitive admissions." Further, reported process improvements in specific units or departments, such as the ED, may have little aggregate impact on overall organization cost or quality performance. Further research that examines the relationship between Lean maturity, the Lean implementation dimensions, and objective measures of hospital cost, efficiency,

productivity, patient experience, and clinical quality is clearly needed.

Limitations

Our findings need to be considered within the context of study limitations. First, the survey was completed by a single informant. Through discussions with hospital leaders and Lean industry experts and pilot testing, we were able to identify the people in the positions most informed to complete the survey. But other leaders in the organization may have responded to certain questions differently, and we did not have the resources to collect data from multiple respondents or conduct site visits. Second, the multivariable findings are limited by common instrument bias. Specifically, although the question on performance effects was the last question asked on the survey, separated from most of the other questions, respondents could have been influenced by their responses to the earlier questions in considering their response to the performance effects question. Third, as indicated earlier, the self-reported performance data should be viewed with caution. Future research needs to examine the relationship between Lean implementation and objective performance measures. Fourth, we were not able to assess the types of organizational changes that hospital leaders made in implementing Lean in their organizations. Future research using interviews, observations, and related qualitative methods are needed to address this issue. Finally, given the differences in background characteristics between the responding and nonresponding hospitals, we cannot strictly generalize our findings to all hospitals in the United States, although we had reasonable representation of all hospitals in the United States on the background characteristics. The findings, of course, are restricted to the hospital sector of health care and do not address the ambulatory/primary care[45] or post-acute care sectors. Future research should address the Lean implementation-performance relationship in these sectors, particularly as they are likely to grow faster than the acute care hospital sector in the coming years.

CONCLUSION

Nearly 70% of hospitals in the United States report using Lean, Lean plus Six Sigma, or Robust Process Improvement approaches in their transformational improvement initiatives. The degree of maturity in its use and the implementation of specific dimensions, however, vary widely. Only 12.6% report being at a "mature" stage in their journey. The most prevalent users of Lean are hospitals located in urban areas, not-for-profit hospitals, those belonging to a system or network, and those with 100–399 beds. The longer the hospital has been using Lean the greater the degree of their leadership commitment, use of the daily management system, education and training, and self-reported performance impact. The survey and resulting findings provide a foundation for further research on the evolution of the Lean approach and to what extent, if any, it is associated with transformational performance improvement measures that matter to patients, hospitals, and payers alike.

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