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Examining the Relationship Between the Lean Management System and Quality Improvement Care Management Processes

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Abstract

Background and Objectives: The United States has an under-performing healthcare system on both cost and quality criteria in comparison with other developed countries. One approach to improving system performance on both cost and quality is to use the Lean management system based on the Shingo principles originally developed by Toyota in Japan. Our objective is to examine the association between hospital use of the Lean management system and evidence-based or recommended quality improvement care management processes.

Methods: A cross sectional analysis of data from 223 hospitals that responded to both the 2017 National Survey of Healthcare Organizations and Systems (NSHOS) and the 2017 National Survey of Lean/Transformational Performance Improvement in Hospitals (NSL) was conducted.

Results: Controlling for hospital organizational and market characteristics, the number of years doing Lean was positively associated with use of electronic health record-based decision support, use of quality-focused information management, use of evidence-based guidelines, and support for care transitions at the $p<0.05$ level. The degree of education and training in Lean methods and processes was also positively associated ($p<0.05$) with greater support for care transitions. The number of years doing Lean was marginally associated with screening for clinical conditions at the $p<0.10$ level. There was an unexpected negative association between education and training scores and screening for clinical conditions.

Conclusions: Greater experience in using the Lean management system is positively associated with several evidence-based and/or recommended quality improvement care management processes.

Keywords

Lean management; quality of care; care management processes; organization & administration; hospital performance improvement

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Introduction

The United States has an under-performing healthcare system on both cost and quality criteria in comparison with other developed countries.[1] Waste, inefficiency, and a lack of reliability in the systems that deliver care are factors that could be contributing to this low performance.[2,3] There are no “silver bullets” or easy solutions to mitigating these concerns. From an organizational and management perspective, however, a potential promising approach is to use the Lean management system based on the Shingo principles originally developed by Toyota in Japan to help increase quality and efficiency, contain costs, and offer a comprehensive approach for improvement.[4] The Lean management system is defined as an overall management/operating system that uses a continuous improvement culture that empowers front line workers (nurses, physicians, support staff) to solve problems and eliminate waste by standardizing work to improve the value of care delivered to patients.[5] Among the specific tools and processes used are A3 structured problem solving, daily huddles, rapid cycle plan-do-study-act (PDSA) quality improvement cycles, visual management, and improvement events (Kaizen).[6] Lean Thinking encourages the minimization of waste, increase of accountability and transparency, and a constant drive towards enhancing quality.[7,8,9] Lean has been shown to have positive effects in specific healthcare settings such as the emergency department, ICU, and operating room.[10,11,12,13] Also, previous research has found a positive association between Lean adoption and self-reported hospital-wide quality and efficiency improvements, as well as with objective efficiency measures such as lower Medicare spending per beneficiary, length of stay, and patient wait times.[14,15,16,17]

Largely missing from the current literature, however, is examination of the extent of Lean implementation or the maturity of the management system’s associations with important outcomes.[18,19,20,21,22,23] Recent studies have shown that despite short-term adoption, many attempts at creating a Lean management system result in transformational failure. Lean adoption takes time to bear fruit and the impacts may not be immediate.[5,24] Since it is known that the extent of implementation of Lean practices among adopting health care organizations varies greatly, we focus on assessing the extent of Lean implementation and intermediate actions that hospitals may take to improve performance. Specifically, we suggest that the extent of implementation of the Lean management system is more likely to be associated with the use of quality improvement care management processes to improve hospital performance.[25] We explore the associations between Lean management and the use of nine care delivery and payment reforms developed by Fisher and colleagues.[26] Our overall hypothesis is that the greater the extent to which the Lean management system is implemented, the greater will be the scores on nine selected quality improvement care management processes.

Methods

We capitalized on data from two surveys of U.S. hospitals: the 2017 National Survey of Healthcare Organizations and Systems (NSHOS) and the 2017 National Survey of Lean/Transformational Performance Improvement in Hospitals (NSL). The NSHOS is a national survey focused on adoption of various innovations in care delivery, and was conducted by

the Dartmouth Institute, UC Berkeley School of Public Health, Harvard University, and the High Value, High Quality Collaborative funded by the Agency for Healthcare Research and Quality (AHRQ). The survey used a stratified-cluster sampling design across U.S. health systems, hospitals, and practices, and collected responses from a total of 693 hospitals.[27] The NSL is a national survey of all 4,500 U.S. general acute and pediatric medical/surgical hospitals (a total of 1,222 hospitals completed the survey). It was fielded by the Survey Data Center of the American Hospital Association (AHA) and focused on the extent to which hospitals had adopted certain transformational performance improvement approaches such as Lean, Lean plus Six Sigma, or Robust Process Improvement.[5]

We were able to identify 223 hospitals that responded to both surveys, and to link the responses. Of the 223 hospitals, 183 (78.5%) were doing some form of Lean versus 43 (21.5%) that were not. A summary of how the 223 hospitals in our sample differed from other hospitals that did not respond to both surveys (n=4,223) is included in Table 1. We found that the hospitals that completed both surveys were more likely to be not-for-profit rather than investor-owned or public, a member of a system or a network, a member of the Council of Teaching Hospitals of the Association of American Medical Colleges (COTH), and to be a larger hospital as measured by the number of hospital beds.

Building on existing research we drew on nine summary scales created from NSHOS data that focused on domains of evidence-based and recommended practices (see Appendix for description of items included in each scale).[27] These scales include: (1) care of complex, high needs patients, (2) participation in quality-focused payment programs, (3) screening for clinical conditions, (4) screening for social needs, (5) use of evidence-based guidelines, (6) use of electronic health record (EHR)-based decision support, (7) use of patient engagement strategies, (8) use of quality-focused information management, and (9) support for care transitions. Scores generated by each scale were standardized, preserving the same mean and spread as the raw scores.

The extent of Lean implementation was measured by (1) the number of years the hospital had been doing Lean, (2) an index of the number of daily management activities (out of a total of nine), and (3) an index that represents the average percentage of management staff, nurses and doctors that have undergone education and training in Lean methods and processes (ranging from 0-4). To calculate the education and training index, categorical responses to survey questions about the extent of training for managers, nurses, and doctors were assigned the following values: “0%” = 0; “1%–24%” = 1; “25%–49%” = 2; “50%–74%” = 3; “75%–100%” = 4. The values were averaged across the three job categories (managers, nurses, and doctors), forming an average score that could range from 0 to 4. Further details of each scale are included in the Appendix.

Regression models used probability weights to account for the NSHOS sampling design using the R *survey* package.[28] We controlled for (1) hospital ownership (public, not-for-profit, investor-owned), (2) location (3) system or network membership, (4) membership in the COTH, and (5) hospital bed size in each regression. Location was categorized according to each core-based statistical area type as defined by the Office of Management and Budget (OMB) - metropolitan, micropolitan, and rural, Hospital bed size was tiered

into three categories: 1-99, 100-399, or 400 or more beds. All control variables were coded as categorical variables and are described in the Appendix. We controlled for these measures because hospitals that are members of COTH have greater teaching capability to implement Lean. Hospitals that belong to a system or network, are not-for-profit or investor-owned rather than public, are located in metropolitan and micropolitan areas, and/or are larger in size, may generate more resources or have more advanced infrastructure. Hence, these characteristics may increase the likelihood of implementing evidence-based or recommended practices aside from any effect of implementing Lean. All analyses were conducted using RStudio, version 1.2.1335.[28]

Results

Table 2 summarizes our main findings (see Appendix for full details of each regression). We found that the number of years doing Lean was positively associated with use of EHR-based decision support (β=0.011, p=0.045), use of quality-focused information management (β=0.010, p=0.045), use of evidence-based guidelines (β=0.011, p=0.054) and support for care transitions (β=0.008, p=0.030). We also found a marginally positive association between number of years doing Lean and screening for clinical conditions (β=0.009, p=0.087). There was also a positive association between the level of education and training in Lean methods and processes and support for care transitions (β=0.046, p=0.027). However, education and training in Lean methods was negatively associated with screening for clinical conditions (β=−0.073, p=0.006). There were no associations with the daily management system index. In analyses not presented here we found significant negative associations between being a publicly owned hospital and four of the quality domains – care of complex, high need patients, participation in quality-focused payment reforms, use of evidence-based guidelines, and support for care transitions.

Discussion

Our findings indicate positive but relatively small effect size associations between number of years of doing Lean management with use of EHR-based decision support, use of quality-focused information management, use of evidence-based guidelines, and support for care transitions. We also found a marginally significant positive association with screening for clinical conditions among participants. It is unclear whether these changes are easier to undertake when adopting Lean or if these improvements are adopted first for other reasons. Improved use of quality-focused information management and evidence-based guidelines could be preliminary steps in Lean adoption and subsequent use. However, we believe that due to their complexity, increased use of EHR-based decision support and support for care transitions are more likely to be signs of a more advanced and mature Lean system or an indicator that hospitals that adopt Lean have more advanced infrastructures prior to adoption. This may also be true for the ability to screen for a wide variety of clinical conditions. Further research is needed to assess the order in which these innovations are adopted in the process of implementing the Lean management system.

The findings in this paper extend current research on Lean and performance improvement by showing that greater experience in implementing Lean is associated with some important

evidence-based or recommended quality improvement processes. This is consistent with existing literature that suggests that while adopting Lean is a great first step towards quality improvement the benefits of Lean may only be realized with time. [5,25] Our work is unique in that it presents measurement beyond adoption and tests this assumption. The lack of association with the daily management system index suggests that it is the overall experience in implementing Lean rather than any specific component part that may be key to improving the delivery of care.

The above findings should be considered within the context of some limitations. Hospitals that responded to both surveys differed from those that did not on several organizational characteristics. Although we controlled for these in the analysis, there are likely other factors that influence hospital response to surveys. The relatively small sample size (n=223) restricted our ability to detect associations. The unexpected inverse relationship between Lean education and training and screening for clinical conditions may be due in part to our inability to measure the actual degree of Lean training that physicians, nurses, and staff received. The findings are based on cross-sectional data negating the possibility of drawing any causal inferences. It may be that hospitals already engaged in quality improvement processes are more likely to adopt the Lean management system than the reverse. Finally, there may be other more relevant measures of implementation than those used here. In sensitivity analysis we examined additional measures of Lean implementation including a Lean leadership commitment index, a self-reported maturity index and a measure of the number of units doing Lean, but did not include them in the final model due to high correlations (0.46-0.50, $p<0.05$) with the daily management system index.

Conclusion

There is continued pressure for hospitals to improve quality and patient safety while constraining the rate of growth in costs. This is further amplified by the impact of the COVID-19 pandemic. Our findings suggest that it will take time to put into place such a comprehensive overall management system before fundamental changes in the spread of evidence based guidelines, use of EHR decision support systems, targeted actionable information feedback, care transitions management support, and related quality improvement processes are realized. In turn, the impact of these changes on such hospital-wide performance measures as overall costs per discharge, risk-adjusted mortality, or patient safety may take even longer. Further research may identify ways that clinical and managerial leaders may accelerate performance improvement through advancing such value-based care and mechanisms by which policymakers might encourage performance improvement through payment and accountability reforms.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Schneider EC, Squires D. From last to first—could the U.S. health care system become the best in the world? N Engl J Med. 2017 Sep 7;377:901–904. [PubMed: 28708020]
2. Chassin MR, Loeb JM. High-reliability health care: getting there from here. Milbank Q. 2013;91:459–490. [PubMed: 24028696]
3. Shrank WH, Rogstad TL, Parekh N. Waste in the US Health Care System: Estimated Costs and Potential for Savings. JAMA. 2019;322(15):1501–1509. doi:10.1001/jama.2019.13978 [PubMed: 31589283]
4. Toussaint JS, Griffith JR, Shortell SM. Lean, Shingo, and the Baldrige Framework: A Comprehensive Method to Achieve a Continuous-Improvement Management System. NEJM Catalyst. 2020;1(3). doi:10.1056/CAT.20.0114
5. Shortell SM, Blodgett JC, Rundall TG, Kralovec P. Use of Lean and Related Transformational Performance Improvement Systems in Hospitals in the United States: Results From a National Survey. Joint Commission Journal on Quality and Patient Safety. 2018;44(10):574–582. doi:10.1016/j.jcjq.2018.03.002 [PubMed: 30243359]
6. Liker J & Morgan J. The Toyota Way in Services: The Case of Lean Product Development. Academy of Management Perspectives. 2006;20(2):5–20. 10.5465/AMP.2006.20591002
7. Catalyst N What Is Lean Healthcare? NEJM Catalyst. Published online April 27, 2018. Accessed December 7, 2020. https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0193" https://catalyst.nejm.org/doi/full/10.1056/CAT.18.0193
8. James B Lean Healthcare : 6 Methodologies for Improvement. Health Catalyst. 2018:1–6.
9. Section 4: Ways To Approach the Quality Improvement Process (Page 2 of 2). Content last reviewed January 2020. Agency for Healthcare Research and Quality, Rockville, MD. https://www.ahrq.gov/cahps/quality-improvement/improvement-guide/4-approach-qi-process/sect4part2.html
10. Welch WP, Cuellar AE, Stearns SC, Bindman AB. Proportion of physicians in large group practices continued to grow in 2009–11. Health Aff (Millwood). 2013;32(9):1659–66. [PubMed: 24019373]
11. Kocher R, Sahni NR. Hospitals' race to employ physicians—the logic be-hind a money-losing proposition. N Engl J Med. 2011;364(19):1790–3. [PubMed: 21449774]
12. Furukawa MF, Machta RM, Barrett KA, Jones DJ, Shortell SM, Scanlon DP, et al. Landscape of health systems in the United States. Med Care Res Rev. 2020;77(4):357–66. doi:10.1177/1077558718823130 [PubMed: 30674227]
13. Austin DR, Baker LC. Less physician practice competition is associated with higher prices paid for common procedures. Health Aff (Millwood). 2015;34(10):1753–60. [PubMed: 26438753]
14. Tlapa D, Zepeda-Lugo CA, Tortorella GL, Baez-Lopez YA, Limon-Romero J, Alvarado-Iniesta A, Rodriguez-Borbon MI. Effects of Lean Healthcare on Patient Flow: A Systematic Review. Value in Health. 2020; 23(2):260–273. 10.1016/j.jval.2019.11.002 [PubMed: 32113632]
15. Serrano L, Hegge P, Sato B, Richmond B, Stahnke L (2010) Using LEAN principles to improve quality, patient safety, and workflow in histology and anatomic pathology. Adv Anat Pathol 17(3):215–221 [PubMed: 20418676]

16. Smith ML, Wilkerson T, Grzybicki DM, Raab SS (2012) The effect of a lean quality improvement implementation program on surgical pathology specimen accessioning and gross preparation error frequency. Am J Clin Pathol 138(3):367–373 [PubMed: 22912352]
17. Zarbo RJ (2012) Creating and sustaining a lean culture of continuous process improvement. Am J Clin Pathol 138(3):321–326 [PubMed: 22912347]
18. Robinson JC, Miller K. Total expenditures per patient in hospital-owned and physician-owned physician organizations in California. JAMA. 2014;312(16):1663–9. [PubMed: 25335148]
19. Gaynor M Examining the impact of health care consolidation: statement before the Committee on Energy and Commerce Oversight and Investigations Subcommittee. Washington (DC): US House of Representatives; 2018.
20. Post B, Buchmueller T, Ryan AM. Vertical integration of hospitals and physicians: economic theory and empirical evidence on spending and quality. Med Care Res Rev. 2018;75(4):399–433. [PubMed: 29148355]
21. Beaulieu ND, Dafny LS, Landon BE, Dalton JB, Kuye I, McWilliams JM. Changes in quality of care after hospital mergers and acquisitions. N Engl J Med. 2020;382(1):51–9. [PubMed: 31893515]
22. Carlin CS, Dowd B, Feldman R. Changes in quality of health care delivery after vertical integration. Health Serv Res. 2015;50(4):1043–68. [PubMed: 25529312]
23. Po Justine; Rundall Thomas G.; PhD; Shortell Stephen M. PhD; Blodgett Janet C. Lean Management and U.S. Public Hospital Performance, Journal of Healthcare Management. 2019;64(6):363–79. doi:10.1097/JHM-D-18-00163 [PubMed: 31725563]
24. Kotter JP (1995) Leading change: why transformation efforts fail. Harv Bus Rev 73(2):59–67
25. Rundall TG, Shortell SM, Blodgett JC, Henke RM, Foster D. Adoption of Lean management and hospital performance: Results from a national survey. Health Care Management Review. 2020. doi:10.1097/hmr.0000000000000287
26. Fisher ES, Shortell SM, Fraze TK, O'Malley AJ, Wood AJ, Palm ME, Colla CH, Rosenthal ME, Rodriguez HP, Lewis VA, Woloshin S, Shah ND, Meara E. Do Financial Integration's Impact On Care Delivery And Payment Reforms: A Survey Of Hospitals And Physician Practices. Health Affairs. 2020;39(8):1302–1311. [PubMed: 32744948]
27. Lumley T (2020). "survey: analysis of complex survey samples." R package version 4.0
28. RStudio Team (2018). RStudio: Integrated Development for R. RStudio, Inc., Boston, MA. http://www.rstudio.com/. 10.1377/hlthaff.2019.01813

Table 1.

Hospital demographics (2017 NSHOS and NSL surveys)

	Hospitals that completed both surveys, n(%)	Other US hospitals, n(%)	p-value overall
	N=233	N=4223	
Hospital Ownership			<0.001
Investor-owned	8 (3.43)	694 (16.4)	
Not-for-profit	179 (76.8)	2611 (61.8)	
Public	46 (19.7)	918 (21.7)	
Member of a system or network?			0.001
No	26 (11.6)	797 (20.8)	
Yes	199 (88.4)	3033 (79.2)	
Core-based statistical area type (OMB definition)			0.122
Metropolitan	149 (63.9)	2464 (58.3)	
Micropolitan	40 (17.2)	718 (17.0)	
Rural	44 (18.9)	1041 (24.7)	
Member of Council of Teaching Hospitals of the Association of American Medical Colleges (COTH)			<0.001
No	200 (85.8)	4009 (94.9)	
Yes	33 (14.2)	214 (5.07)	
Total hospital beds (3-level)			<0.001
1-99 beds	94 (40.3)	2143 (50.7)	
100-399 beds	88 (37.8)	1668 (39.5)	
400 or more beds	51 (21.9)	412 (9.76)	

NSHOS = National Survey of Healthcare Organizations and Systems

NSL = National Survey of Lean/Transformational Performance Improvement in Hospitals

Table 2.

Summary of results of regression analyses of NSHOS domains and extent of Lean implementation

Extent of Lean implementation measure	NSHOS domain, β and [95% CI]								
	Care of complex, high need patients	**Participation in quality-focused payment**	**Screening for clinical conditions**	**Screening for social needs**	**Use of evidence-based guidelines**	**Use of EHR-based decision support**	**Use of patient engagement strategies**	**Use of quality-focused information management**	**Support for care transitions**
Number of years doing Lean	0.003 [−0.007-0.014]	0.004 [−0.013-0.022]	0.009 * [−0.001-0.019]	−0.004 [−0.018-0.009]	0.011 ** [0.000-0.023]	0.011 ** [0.000-0.022]	−0.001 [−0.011-0.01]	0.010 ** [0.000-0.019]	0.008 ** [0.001-0.016]
Daily Management System index	−0.003 [−0.022-0.016]	0.021 [−0.01-0.052]	−0.001 [−0.018-0.015]	−0.008 [−0.034-0.018]	−0.002 [−0.021-0.017]	0.01 [−0.012-0.031]	−0.005 [−0.025-0.015]	0 [−0.016-0.016]	−0.007 [−0.021-0.007]
Education and training	−0.009 [−0.053-0.035]	−0.05 [−0.123-0.023]	−0.073 ** [−0.124-0.022]	−0.005 [−0.072-0.062]	0.011 [−0.046-0.068]	−0.001 [−0.063-0.061]	0.015 [−0.034-0.064]	−0.002 [−0.056-0.052]	0.046 ** [0.006-0.086]

* significant at the 0.10 level

** significant at the 0.05 level

All associations were adjusted for our 4 control variables: (1) the type of authority responsible for establishing policy concerning the overall operation of each hospital (2) location in each core-based statistical area type as defined by the Office of Management and Budget (OMB), (3) system or network membership, (4) membership in the COTH, and (5) hospital bed size.

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