Lean maturity and quality in primary care

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Abstract

Purpose – The purpose of this paper is twofold: first, to describe Lean maturity in primary care using a questionnaire based on Liker's description of Lean, complemented with observations; and second, to determine the extent to which Lean maturity is associated with quality of care measured as staff-rated satisfaction with care and adherence to national guidelines (NG). High Lean maturity indicates adoption of all Lean principles throughout the organization and by all staff.

Design/methodology/approach – Data were collected using a survey based on Liker's four principles, divided into 16 items ($n = 298$ staff in 45 units). Complementary observations ($n = 28$ staff) were carried out at four units.

Findings – Lean maturity varied both between and within units. The highest Lean maturity was found for "adhering to routines" and the lowest for "having a change agent at the unit." Lean maturity was positively associated with satisfaction with care and with adherence to NG to improve healthcare quality.

Practical implications – Quality of primary care may benefit from increasing Lean maturity. When implementing Lean, managers could benefit from measuring and adopting Lean maturity repeatedly, addressing all Liker's principles and using the results as guidance for further development.

Originality/value – This is one of the first studies to evaluate Lean maturity in primary care, addressing all Liker's principles from the perspective of quality of care. The results suggest that repeated actions based on evaluations of Lean maturity may help to improve quality of care.

Keywords Lean principles, Observations, Qualitative, Healthcare, Liker

Paper type Research paper

Introduction

In Sweden, primary care is the first level in the healthcare system, offering basic medical care to citizens and residents (Swedish Board of Health and Welfare (SBHWb)). The healthcare system strives to deliver care of good quality using fewer resources (Wilson, 2009), while facing emerging demands (Osborn *et al.*, 2015). National guidelines (NG) have been developed to improve healthcare quality, and all staff are expected to adhere to them (SBHWa, 2016). To achieve care of good quality and to increase productivity, Lean

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principles have spread to healthcare systems worldwide (Brandao de Souza, 2009; Joosten *et al.*, 2009). In healthcare, it is common to adopt Lean using value stream mapping (VSM), improvement events and standardization (Costa and Godinho Filho, 2016). However, only a few studies of Lean have addressed the extent to which different aspects of Lean have been implemented (Brackett *et al.*, 2013). Moreover, most Lean studies in healthcare primarily focus on productivity (Brandao de Souza, 2009; Costa and Godinho Filho, 2016; Mazzocato *et al.*, 2010) and less on quality of care (D'Andreamatteo *et al.*, 2014). The present study addresses Lean maturity in Swedish primary care, investigating the extent to which it is associated with quality of care.

Lean according to Liker

In the present study, Lean is addressed using Liker's (2004) description, which includes 14 principles organized into a 4P model: philosophy, processes, people and partners, and problem solving. Briefly, philosophy involves focusing on the customer and engaging the whole organization to bring value to the customer, the organization and society as a whole. A long-term philosophy is prioritized even if this may be expensive in the short term. Processes concerns creating flow through, e.g., standardization and reduction of waste, such as decreasing waiting time, quality deficiencies, excessive inventories and unnecessary movements. People and partners concerns, e.g., showing respect for people in and related to the organization as well as creating prerequisites for them to grow. The managers should know and communicate the company's philosophy, and the organization and staff should know what is valuable for the customer. Problem solving refers to the notion that staff are devoted to continuously improving processes and quality. Liker (2004) claimed that, if set goals are to be achieved, all Lean principles should be present throughout the organization and used by all staff. In the present paper, the extent to which this is accomplished is termed Lean maturity. Often Lean principles are only partially adopted in healthcare (Brackett *et al.*, 2013) and not throughout the organization (Costa and Godinho Filho, 2016).

Lean in healthcare

In healthcare, Lean is most commonly implemented and assessed using value stream and process mapping (Costa and Godinho Filho, 2016; Mazzocato *et al.*, 2010; Poksinska, 2010), improvement events (Brackett *et al.*, 2013; Costa and Godinho Filho, 2016; Mazzocato *et al.*, 2010) and standardization (Costa and Godinho Filho, 2016; Mazzocato *et al.*, 2010). The extent to which Lean is adopted has mainly been investigated using document studies (e.g. Burgess and Radnor, 2013; Langstrand and Drotz, 2016), observations (e.g. Langstrand and Drotz, 2016; Holden *et al.*, 2015) and interviews (e.g. Langstrand and Drotz, 2016; Grove *et al.*, 2010), while a few studies have used questionnaires involving all staff (Roszell, 2013) or managers only (Dellve *et al.*, 2015). In the context of primary care, few studies have focused on Lean. One interview study in both primary care and hospitals in Sweden addressed the use of VSM, continuous improvements, standardization, identifying waste, teamwork, daily short meetings, supporting and coaching leadership style, visual control and 5S (Drotz and Poksinska, 2014). An interview study with staff in primary care in the UK described adoption of VSM and stakeholder mapping (Grove *et al.*, 2010), while a study of primary care in the USA described standardization, work flow, redesigning rooms and holding daily morning meetings (Hung *et al.*, 2016). The above studies have provided only a partial insight into Lean maturity, in that they have failed to address Lean maturity using Liker's entire 4P model and to collect information on Lean from all staff members, both of which, according to Liker, are paramount to successful implementation and maintenance of Lean.

Effects of Lean in healthcare

Different outcomes appear to be related to Lean in healthcare, e.g., staff members' working conditions and stress (e.g. Dellve *et al.*, 2015), productivity measured as number of treated patients (Edwards *et al.*, 2012; Hwang *et al.*, 2014) and reduced waiting time (Fillingham, 2007; Simons *et al.*, 2017). As regards quality of care, results indicate that Lean may improve patient safety (Jorma *et al.*, 2016; Simons *et al.*, 2017), decrease mortality and lead to faster patient recovery (Fillingham, 2007; Yousri *et al.*, 2011).

In primary care, knowledge concerning Lean maturity and quality of care is lacking (D'Andreamatteo *et al.*, 2014). One case study (Poksinska *et al.*, 2016) showed no difference in patient satisfaction with units that had adopted Lean compared to units that had not. The study reports that two primary care units with purported successful Lean adoption showed only limited focus on the patient perspective, e.g., on what patients consider valuable, and whether patients are satisfied. Assessments of Lean maturity based on staff perceptions and opinions are rare, although Liker (2004) emphasized that Lean should be practiced by all staff and managers in the organization. Thus, the aim of the present study was twofold: first, to describe Lean maturity in primary care using a questionnaire based on Liker's description of Lean and observations; and second, to determine the extent to which Lean maturity is associated with quality of care measured as staff-rated satisfaction with care and adherence to NG to improve healthcare quality. In Sweden, NG can be related to quality of care, as they contain recommendations aimed at guiding healthcare staff in selecting appropriate treatment and methods (SBHWa, 2016); staff usually strive to adhere to these guidelines.

Methods

Design

The study had a descriptive, correlational design and used a mixed-methods approach. Results from analyzes of quantitative questionnaire data are illustrated using qualitative observation and interview data.

Setting and sample, questionnaires

All 52 eligible primary care units in a region in central Sweden were asked to participate: 42 accepted, whereof 4 were private for-profit providers. To achieve greater dispersion among participating units, one of the largest private for-profit healthcare providers in Sweden was also asked to participate, provided the units had adopted Lean; 6 of 85 units accepted. In total, 850 staff at 48 units were eligible for the study. The manager first informed the staff about the study, and then staff received a questionnaire, sent to their work e-mail address, which also contained further information about the study. A total of 351 staff members responded to the questionnaire; 30 of them were excluded because they did not completely answered the Lean items. Further analyses of the 4P's included only participants who had responded to at least 50 percent of the Lean items ($n = 298$ (35 percent) of eligible staff, working at 45 units). Most participants were female (86 percent) and registered nurses (41 percent). Mean age was 51 years (Table I).

Setting and sample, observations and interviews

Two units with high and two with low Lean maturity, as indicated by staff ratings in the questionnaire, were selected by convenience for observation. By coincidence, all four units were located in rural areas. At these units, a purposive sample of staff was asked to further participate; sampling aimed at variation in profession, age and gender. In total, 28 participants were observed, six to eight participants/unit. Most participants were female ($n = 24$) and about half were registered nurses ($n = 13$) (Table I).

	Survey	Observations
Total number of participants, *n*	298	28
Participants at public non-profit/private for-profit provider healthcare units, *n*	230/68	28/0
Women, *n*	255	24
Men, *n*	43	4
Age		
Md (Q_1–Q_3)	53 (43–59)	51 (45–59)
Mean (SD)	51 (10.2)	51 (9.0)
Profession, n		
Registered nurses	121	13
Licensed practical nurse	17	6
Manager	21	–
Physiotherapist	37	3
Occupational therapist	9	–
Physician	45	6
Administrator and secretary	35	–
Dietician	1	–
Social worker and psychologist	24	–
Years worked at the present unit		
Md (Q_1–Q_3)	6 (3–13)	5 (2–15)
Mean (SD)	9 (8.8)	9 (10.0)
Years worked in the profession		
Md (Q_1–Q_3)	20 (13–30)	24 (14–36)
Mean (SD)	21 (11.4)	24 (12.0)

Table I. Demographic data for participants

Notes: Md, median; *Q*, quartiles. Some participants have multiple functions and therefore the number of professions does not add up to 298

Data collection, questionnaires

The survey questionnaire was web-based and sent out in Spring 2016. Two reminders and a paper version were sent to non-responders. Lean maturity was assessed using the 16-item Lean in Healthcare Questionnaire (LiHcQ) (Kaltenbrunner *et al.*, 2017). In the LiHcQ, three of Liker's 4P (philosophy, people and partners, problem solving) (Liker, 2004) are represented by three items, while the fourth (processes) includes seven items. Response alternatives range from 1 (low Lean maturity) to 5 (high Lean maturity). Psychometric tests of the LiHcQ showed acceptable values (Kaltenbrunner *et al.*, 2017). Staff satisfaction with provided care was assessed using the nine-item Staff Satisfaction with Care (SSC) scale (Mårtensson *et al.*, 2010). Responses are measured on a seven-point scale, 7 standing for high satisfaction. The reliability of the scale is satisfactory (Mårtensson *et al.*, 2010). In the present study, one SSC item was discarded because it was not relevant to primary care. In addition, a study-specific questionnaire was developed to measure staff-rated adherence to NG. The NG questionnaire was based on existing Swedish NG (SBHWa) for treating different medical diagnoses. The questionnaire addressed, in total, 13 guidelines for patients with, e.g., diabetes, different cancer diagnoses and stroke. For each guideline, respondents were asked whether their work fully adhered to the NG. Response alternatives ranged from 1 (strongly disagree) to 5 (strongly agree).

Data collection, observations and interviews

Observations were conducted by the first author (MK), shadowing each participant for approximately 4 h to observe behavior in the context of the 4P using a structured

observation protocol. Processes was studied by observing whether appointed times were held, whether any interruptions occurred in the care process, the location of storage rooms and use of standardization visible to the observer. During the observations, MK asked complementary questions and recorded answers on an MP3 player. Open-ended questions captured philosophy (communication of shared goals and long-term thinking), processes (routines, flow and standardization), people and partners (teamwork and respect) and problem solving (problem solving and participation in decision making). In total, 97 h of observation and 5.5 h of interviews were conducted. After every observation day, except for 2, MK had phone contact with the last author, ME, to reflect on the procedure and the collected data.

Data analyses, questionnaires

Data were analyzed using IBM SPSS Statistics version 22. First, bivariate correlations between variables were determined using Spearman's correlation coefficient. Thereafter, generalized estimating equations (GEE) models for binary data were employed to study multivariate relationships, controlling for correlations within units. Because the dependent variables were not normally distributed, data were dichotomized using the median. In a first GEE model, the total score of all items in LiHcQ was used as the independent variable with either SSC or NG as dependent variables. In a second model, scores for each of the 4P were entered instead as independent variables. Internal missing data on Lean were replaced using multiple imputations (MI), as recommended by Newman (2014) and Shrive *et al.* (2006). When employing MI, five sets with imputed data are calculated together with the original data. The GEE models for MI data returned odds ratio (OR), 95% confidence interval (CI) and p-values for each MI data set, as well as the original data set. p-values and regression coefficients, but not OR, were also obtained for pooled data. p-values < 0.05 were considered to indicate statistical significance.

Data analyses, observations and interviews

Observation data were analyzed deductively using qualitative content analysis (Patton, 2002), employing Liker's 4P as a framework for categorizing the data. The MP3 files were transcribed verbatim, and handwritten field notes together with data from the observation protocol were transferred to a Word document. Data were read several times to get a sense of the whole. Thereafter, meaning units linked to the 4P were identified, condensed and categorized. The first (MK) and last author (ME) continuously discussed each step in the analyses process in order to enhance trustworthiness and to reach consensus (Patton, 2002). Moreover, the third author (LB) read and commented on the categorized observation data to gain further insight and increase trustworthiness.

Ethical approval

The study was approved by the Regional Ethical Review Board in Uppsala (Reg. No. 2014/525 and 2014/525/1).

Results

Lean maturity

The questionnaire results (Table II) will be presented along with illustrations and quotes (Table III) from the observations. The focus will be on contrasting low Lean maturity (levels 1 and 2) and high Lean maturity (levels 4 and 5).

Philosophy: regarding staff members' (Item 1 (I1)) and first-line managers' (I2) commitment to and engagement with Lean, a maturity level of 4–5 was reported by 34 and 42 percent, respectively. During the observations, staff at all four units mentioned that the

Table II.
Number of participants (with percent in parentheses) answering each item in the LiHcQ, organized according to Liker's 4P

4P	Items LiHcQ	Maturity, response LiHcQ 1	2	3	4	5	Md (Q_1–Q_3)	Mean (SD)	Valid *n*
Philosophy	1. Staff engagement and commitment to Lean	42 (14%)	59 (20%)	96 (32%)	54 (18%)	46 (16%)	3 (2–4)	3.0 (1.3)	297
	2. First-line managers' engagement and commitment to Lean	29 (10%)	34 (12%)	98 (36%)	73 (27%)	41 (15%)	3 (3–4)	3.2 (1.2)	275
	3. Allocation of time to improvement work	63 (20%)	81 (26%)	82 (27%)	39 (13%)	42 (14%)	3 (2–4)	2.7 (1.3)	307
Processes	6. Use of value stream mapping	45 (16%)	91 (32%)	83 (29%)	45 (16%)	21 (7%)	3 (2–3)	2.7 (1.1)	285
	7. Developing and following routines	5 (2%)	53 (18%)	77 (25%)	109 (36%)	59 (20%)	4 (3–4)	3.5 (1.0)	303
	8. Planning work based on patients' needs	34 (12%)	82 (29%)	93 (33%)	50 (17%)	25 (9%)	3 (2–4)	2.8 (1.1)	284
	9. Implementing and using automatic quality controls	74 (27%)	63 (23%)	69 (26%)	46 (17%)	18 (7%)	2(1–3)	2.5 (1.2)	270
	10. Basing the provided care on what patients desire	32 (12%)	59 (21%)	101 (36%)	40 (14%)	47 (17%)	3 (2–4)	3.0 (1.2)	279
	11. Visualizing improvements and placing them strategically	14 (5%)	77 (28%)	106 (38%)	66 (24%)	15 (5%)	3 (2–4)	3.0 (1.0)	278
	15. Purchasing and implementing new products	17 (6%)	33 (11%)	118 (40%)	109 (36%)	20 (7%)	3 (3–4)	3.3 (1.0)	297
People and partners	4. Access to a change agent at each unit	204 (69%)	36 (12%)	24 (8%)	15 (5%)	17 (6%)	1 (1–2)	1.7 (1.2)	296
	5. Skills in describing value from the patient perspective	23 (8%)	55 (19%)	75 (25%)	106 (36%)	35 (12%)	3(2–4)	3.3 (1.1)	294
	16. Collaborating with partners and suppliers	35 (12%)	141 (49%)	78 (27%)	19 (6%)	18 (6%)	2 (2–3)	2.5 (1.0)	291
Problem solving	12. Staff evaluating the care	86 (31%)	46 (17%)	64 (23%)	68 (25%)	12 (4%)	3 (1–4)	2.5 (1.3)	276
	13. Solving problems	49 (17%)	70 (24%)	90 (31%)	50 (17%)	28 (10%)	3 (2–4)	2.8 (1.2)	287
	14. Decision making involving both staff and manager	12 (4%)	72 (24%)	83 (28%)	95 (32%)	34 (12%)	3 (2–4)	3.2 (1.1)	296

Notes: LiHcQ, Lean in Healthcare Questionnaire; 4P, philosophy, processes, people and partners, problem solving; Md, median; Q, quartiles. Response alternatives ranging from 1 (low maturity) to 5 (high maturity)

Dimension	Context	Quote
Philosophy	The participant was asked whether shared goals were expressed by the first-line manager and whether the communicated goals were important and relevant for the participant. The response also illustrates that the participant was confident that trust supports accurate decisions	"Yes, for sure, for sure, they are (the goals). And we have these performance-related payments and that's kind of […] at the moment it's, for instance, home visits by health visitors from the baby clinic and that's because it's important, they (the healthcare trust) think, to get it underway, that routine, and well you get extra money too"
Processes	The quote considers routines, whether the participant knew if there were any routines for the work tasks he/she conducted	"Well, I think we have written routines somewhere here, but I don't know where they are. When it comes to typical wound dressings and things like that, then we use the document developed by the trust or The Handbook for Healthcare, or there are a lot of routines on the intranet. But, regarding (routines) for a workday, I don't know where they are. If I need them I'll find them"
People and partners	The participant was asked whether the first-line manager listened to and respected staff and their problems, ideas and questions. The quota also illustrates that all staff helped each other in efforts to meet the patient's needs	"Yes, definitely! She/he always listens, and if you go to her/him and need some help or information you get a pretty quick answer, she/he looks it up at once. It's almost like a family here I think, everyone, everybody helps each other, you can ask anybody and everybody just helps, it's great"
Problem solving	The quote illustrates how problem solving can be conducted. First, the participant describes how one aspect of problem solving was improved when a visual management board was implemented. The information board showed one month, and the colors made it easy to see whether work was generally satisfying, and it highlighted issues or problems of importance for continuous improvements in care processes	"We just got a visual management board with green, yellow, red and orange, colors you can fill in. Well, green is good things and red means that some disturbing patient harm has occurred. It's a kind of assessment of how we do our work. This is all new, earlier we just talked about it, now it is more graphic"

Note: The "Context" column provides a description of the background of each quote

Table III.
Quotes related to each of the 4P

first-line managers often communicated goals. Regarding time for continuous improvement of work (I3), 46 percent rated that no time was specifically allocated to this, or that time was allocated only in rare cases (maturity levels 1–2); 27 percent rated a maturity levels 4–5.

Processes: for VSM (I6), 48 percent rated maturity levels 1–2, saying that no or only some processes were mapped, and that awareness of value and waste was low. The highest Lean maturity was found for routines (I7), where more than half (56 percent) of staff members rated maturity levels 4–5, i.e., that most teams had routines, or that everyone was highly skilled in developing, updating and following routines. However, during the observation, staff also mentioned a certain lack of routines, difficulties in finding them and low compliance concerning, e.g., hygiene routines and refilling trolleys. Item 8 concerned whether the staff planed their work based on patients' needs; 41 percent rated maturity levels 1–2, i.e., that the unit investigated patient influx and necessary resources minimally or not at all. During observation, some staff members mentioned that they planned their work based on patient statistics. Concerning automatic quality controls, Lean maturity was also low (I9); 50 percent rated maturity levels 1–2, indicating

no or little awareness of how automatic quality controls could be practiced. Regarding care based on patient demands, flow and the use of signs/signals (I10), staff ratings varied greatly: about one-third rated 1–2, and one-third 4–5. During observation of all four units, the facilities used were often organized and structured. However, some unorganized rooms were also observed, e.g., where sheets of papers were placed on the floor or behind the curtains. Interruptions were common at all units, during which staff were searching for information, retrieving material or medications or asking others for advice. The storerooms at two units were centrally placed, while they were more peripherally placed at the other two units. To facilitate overview, one unit had cupboards with glass doors and used a mirror to detect new patients coming in. Regarding visualizing improvements (I11), about one-third rated maturity to be 1–2 (no or some improvements visualized, and if so in an unstructured manner), and one-third rated 4–5 (improvements are visualized at the unit, and the unit is highly skilled in visualizing improvements). As to whether staff were involved in purchasing new products (I15), 43 percent responded that they were always involved, i.e., maturity levels 4–5. Observations of whether appointed times were held could not be performed as planned, and data on this aspect are disregarded.

People and partners: staff at all four units described working in fixed teams, and that multi-functional teams were formed based on patients' needs. They mentioned that the first-line manager was not always knowledgeable about staff members' work tasks. On the other hand, the staff said that the first-line manager showed them respect by listening to them and showing an interest in their opinions. The lowest Lean maturity concerned whether the unit had an appointed change agent (I4); 81 percent of the staff rated a maturity level of 1 (indicating that the unit did not have such an agent) or 2. The second highest Lean maturity among all items was reported for value as described from the patient perspective (I5). Nearly half (48 percent) of the staff rated maturity levels 4–5 on this item, meaning that most or all staff can see and describe the processes at the unit and identify their value for the patient. Staff contact with partners and suppliers (I16) showed the second lowest maturity of all items; 61 percent rated maturity level 1 (staff having no contact at all) or 2 (some staff had contact with partners and suppliers). During the observations, staff at all four units described good collaborations with the municipality and other healthcare service providers. Some staff mentioned difficulties in influencing suppliers and long delivery times.

Problem solving: regarding evaluations (I12), 48 percent rated maturity levels 1–2, i.e., that staff had difficulties influencing what and how to evaluate or that some staff had recently begun searching for evaluation methods. For problem solving (I13), 41 percent rated levels 1–2, i.e., that improvement work was largely unplanned and unstructured. The observations showed that all four units had daily meetings at the visual management board, however, with various contents. One unit had two visual management boards centrally placed, which were used when they had their daily discussion of problems and improvements. The same unit had a list in every room for documenting problems to be addressed later at the unit meeting. Other problem-solving methods reported by staff were based on, e.g., set goals, guidelines or statistics. Sometimes the problem was solved, and the solution presented *post hoc* to the first-line manager, who, according to staff, was most often positive. However, they also mentioned lack of follow-up. Item 14 concerns staff involvement in decision making, and the ratings showed that 44 percent of staff felt that they were involved and that the unit had structured meetings aimed at consensus (i.e. maturity levels 4–5).

Median and quartiles (Q1–Q3) for individual items in philosophy were: 3(2–4), in processes: 3(1–4), in people and partners: 2(1–4) and in problem solving: 3(1–4).

Positive and significant associations were found between all 4P (Table IV). Intra-class correlation coefficient (ICC) values for clustering effect within units for

Variables	SSC	NG	Philosophy	Processes	People and partners	Problem solving	LiHcQ tot
SSC	*α 0.90*						
NG	0.111	*α 0.94*					
p-value	0.118						
Philosophy	**0.142**	**0.293**	*α 0.76*				
p-value	**0.022**	**< 0.001**					
Processes	**0.199**	**0.403**	**0.664**	*α 0.87*			
p-value	**< 0.001**	**< 0.001**	**< 0.001**				
People and partners	**0.164**	**0.314**	**0.627**	**0.729**	*α 0.59*		
p-value	**0.009**	**< 0.001**	**< 0.001**	**< 0.001**			
Problem solving	**0.128**	**0.347**	**0.597**	**0.771**	**0.687**	*α 0.81*	
p-value	**0.040**	**< 0.001**	**< 0.001**	**< 0.001**	**< 0.001**		
LiHcQ tot	**0.189**	**0.394**					*α 0.93*
p-value	**0.002**	**< 0.001**					

Notes: *α*, Cronbach's *α* values are given along the diagonal for SSC, Staff Satisfaction with Care; NG, national guidelines; LiHcQ, Lean in Healthcare Questionnaire. LiHcQ tot includes a total score for all items in the LiHcQ. The results are based on imputed data (MI, multiple imputation). Boldface type indicates statistically significant *p*-values

Table IV.
Internal consistency (Cronbach's *α*) and associations (Spearman; with *p*-values) between staff assessments of Lean, Staff Satisfaction with Care (SSC) and adherence to national guidelines (NG)

philosophy were: ICC 0.24, processes: ICC 0.24, people and partners: ICC 0.25 and problem solving: ICC 0.22. An overview of Lean maturity across all units is presented in Figure 1, illustrating that units differed, with respect to both each of the 4P and overall Lean maturity. As seen in Figure 1, the possible total score for philosophy, people and partners and problem solving can range from 3 to 15, whereas processes can range from 7 to 35; Lean in total, i.e., the sum of all scores from all items in the LiHcQ, can take values from 16 to 80. In Figure 1, where the graph rises rapidly, this indicating that several units have this same score.

Lean maturity, SSC and adherence to NG

For the pooled MI data, bivariate correlations analyses showed that the LiHcQ total score was significantly associated with both SSC (r_s 0.19, $p = 0.002$) and NG (r_s 0.39, $p < 0.001$) (Table IV). Each of the 4P was also significantly associated with SSC ($p < 0.001$ to 0.040) and NG ($p < 0.001$ for all). Thus, in units with high Lean maturity, SSC and NG also received high ratings.

The GEE models (Table V) confirmed that the LiHcQ total score was significantly associated with both SSC and NG. Multivariate analyses including each of the 4P as independent variables revealed that, for the MI data, processes was significantly associated with both SSC and NG. Multivariate analyses on original data without imputation showed that processes and problem solving were significantly associated with NG, while none of the 4P was significant for SSC.

Discussion

Our study is one of the first to report on Lean maturity in primary care based on a comprehensive instrument using staff ratings to measure Lean. The results showed large dispersion in Lean maturity, both between care units and within the same care unit for the 4P, some principles receiving considerably higher maturity ratings than others. Variation in Lean adoption between organizations has been described in several reviews (Antierens *et al.*, 2018; Brackett *et al.*, 2013; Costa and Godinho Filho, 2016). Reasons for Lean adoption only being partial, and for not achieving high Lean maturity, include staff

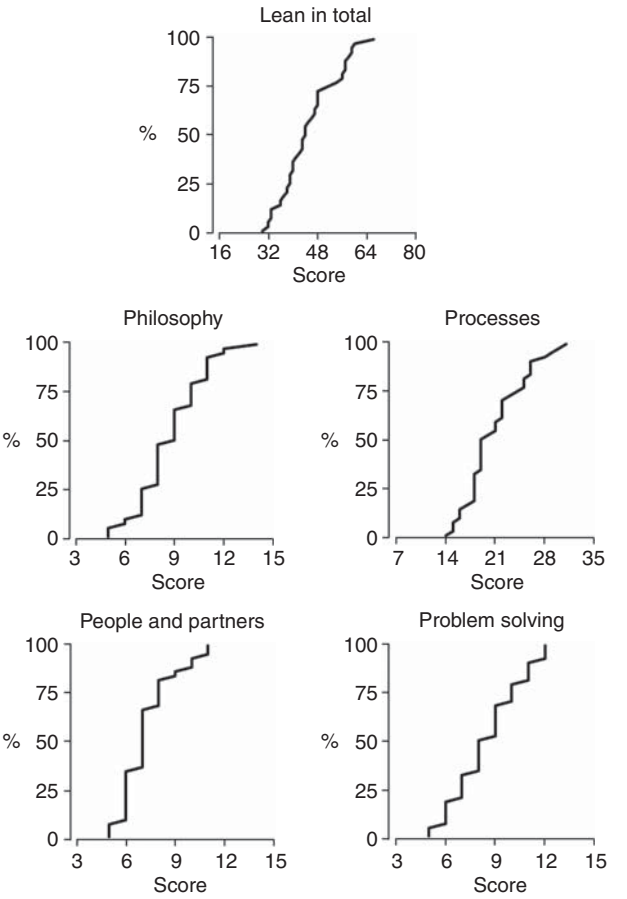

Figure 1.
Cumulative distributions across the 45 investigated units of their median LiHcQ scores for Lean in total, and each of the 4P

Note: In all panels, the abscissa covers the full min–max range of possible scores

showing limited interest in and having little experience of Lean (Dellve *et al.*, 2015; Drotz and Poksinska, 2014; Hasle *et al.*, 2016), factors also identified in the observational data in our study. According to Liker, to achieve success based on Lean, all staff need to be involved and all Lean principles need to be used. Nonetheless, improvements in quality of care and patient safety have been reported even in cases of partial adoption of Lean (Antierens *et al.*, 2018). Our results indicate that quality of care increases when Lean maturity increases. However, when multivariate relationships were analyzed, controlling for correlations within units, only processes was significantly associated with quality of care. It would seem that some principles contribute more to quality of care than others do, or that certain principles are easier to implement than others, depending on setting and organizational culture.

We found the highest Lean maturity for processes involving routines. During the observations, staff expressed diverse opinions about routines. Describing value from the patient perspective also showed high Lean maturity, a finding related to person-centered care (McCormack and McCance, 2010). Our findings are in accordance with results from

Outcome	Predictors	Original data OR	95% CI	*p*-value	MI data set, variation from 5 data sets OR (min–max)	Pooled MI data *p*-value
SSC	*Model I*					
	LiHcQ tot	1.025	1.007; 1.043	*0.006*	1.044–1.045	*< 0.001*
	Age	0.968	0.947; 0.989	*0.003*	0.968–0.969	*0.001*
	Model II					
	Philosophy	0.994	0.891; 1.108	0.913	0.977–1.017	0.916
	Processes	1.030	0.952; 1.114	0.460	1.076–1.110	*0.027*
	People and partners	1.044	0.896; 1.217	0.579	0.954–0.993	0.830
	Problem solving	1.028	0.908; 1.162	0.666	1.027–1.102	0.407
	Age	0.968	0.948; 0.989	*0.002*	0.965–0.968	*0.001*
NG	*Model I*					
	LiHcQ tot	1.071	1.046; 1.096	*< 0.001*	1.063 for all 5 MI data sets	*< 0.001*
	Model II					
	Philosophy	1.030	0.879; 1.207	0.716	1.029–1.040	0.653
	Process	1.128	1.040; 1.223	*0.004*	1.126–1.138	*0.002*
	People and partners	0.857	0.734; 1.000	*0.050*	0.886–0.933	0.203
	Problem solving	1.152	1.022; 1.298	*0.020*	1.064–1.114	0.221

Notes: SSC, Staff Satisfaction with Care; LiHcQ, Lean in Healthcare Questionnaire; NG, national guidelines; 4P, philosophy, processes, people and partners and problem solving; OR, odds ratio. In all GEE models, an unstructured working correlation matrix was used. Results from GEE models are presented for original data, imputed data (multiple imputation (MI)) and pooled data. Italic face type shows statistically significant values ($p < 0.05$)

Table V. Associations of overall Lean maturity (LiHcQ tot, total score for all items, Model I) and each of the 4P (Model II) with Staff Satisfaction with Care (SSC) and national guidelines (NG)

previous research on Lean in healthcare (Antierens *et al.*, 2018). One explanation for the results can be the tradition in healthcare of having both routines and a patient perspective, making these principles easier to address in efforts to increase Lean maturity.

The principle of VSM has been described as being frequently adopted, among those principles investigated at all (Antierens *et al.*, 2018; Costa and Godinho Filho, 2016). Our results showed low Lean maturity for VSM. This confirms the findings of Drotz and Poksinska (2014), who focused primarily on primary care units, finding that VSM was only partially adopted and that it was terminated after improvements had been made. One reason for low Lean maturity in primary care may be that care processes are more complex because they, e.g., involve different professions working independently, each profession with its own patients, and because processes may extend over a longer period of time than, e.g., in an emergency unit. According to Hasle *et al.* (2016), complex processes involving different professions may be one reason for low Lean maturity. In our study, having a change agent showed low Lean maturity. Greenhalgh *et al.* (2004) claimed that having a change agent or a champion is essential in disseminating an organizational innovation. Low Lean maturity was also seen concerning the question of whether time was allocated to improvement work and problem solving. However, during the observation at one unit with high Lean maturity, different problem-solving methods were used and time was allocated so that all staff could participate. Having resources and being engaged can be essential when striving for high Lean maturity.

Limitations

The present study used a cross-sectional design, which limits our ability to draw conclusions about causality in the relationship between Lean maturity and quality of care. Moreover, we employed non-random sampling and faced a rather low response rate in the questionnaire part of the study, which limit generalizability. The qualitative data in

the study could have been explored more thoroughly; future work may address these data in more depth. However, the study also had several strengths: mixed methods were used and the sample is representative according to national data registers on primary care staff, showing that female registered nurses are the largest licensed group in healthcare (SCB, 2015).

Implications for practice

Lean is present in primary care and associated with quality of care. Therefore, striving to increase quality of care by adopting Lean may be fruitful, although more research is needed on the nature of associations and possible interventions. For managers, when adopting Lean, a long-term aim should be to achieve high Lean maturity even though adoption might have started on a small scale. The manager also needs to repeatedly evaluate Lean maturity and base initiatives for continuous improvement on results from such evaluations.

Conclusions

Lean maturity varied in primary care, both in terms of adoption of different Lean principles and Lean adoption between units. Lean maturity was positively associated with quality of care, indicating that Lean has the potential to meet some of the challenges facing present-day healthcare.

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