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Author: Erdmann Marjorie A. MS, PhD; Paramel Ipe S. MHA; Marshall Carolyn M.

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Lean Health Care Internships: A Novel Systems-Based Practice Education Program for Undergraduate Medical Students

Marjorie A. Erdmann, MS, PhD, Ipe S. Paramel, MHA, and Carolyn M. Marshall

M.A. Erdmann is director, Center for Health Systems Innovation, Spears School of Business and Center for Health Sciences, Oklahoma State University, Tulsa, Oklahoma.

I.S. Paramel is project manager and Lean Health Care consultant, Spears School of Business and Center for Health Sciences, Oklahoma State University, Tulsa, Oklahoma.

C.M. Marshall is project manager and Lean Health Care consultant, Center for Health Systems Innovation, Spears School of Business and Center for Health Sciences, Oklahoma State University, Tulsa, Oklahoma.

Correspondence should be addressed to Marjorie A. Erdmann, Center for Health Systems Innovation, Spears School of Business and Center for Health Sciences, Oklahoma State University, 1111 West 17th St., Tulsa, OK 74107; telephone: (918) 640-2006; email: marjorie.erdmann@okstate.edu.

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Abstract

Problem

Given the United States' urgency for systemic-level improvements to care, advancing systems-based practice (SBP) competency among future physicians is crucial. However, SBP education is inadequate, lacks a unifying framework and faculty confidence in its teaching, and is taught late in the medical education journey.

Approach

The Oklahoma State University Center for Health Systems Innovation (CHSI) created an SBP program relying on Lean Health Care for a framework and targeted medical students before their second year began. Lean curricula were developed (lecture and simulation) and a partnership with a hospital was secured for work-based practice. The CHSI developed a skills assessment tool for preliminary evaluation of the program. In June 2022, 9 undergraduate medical students responded to a Lean Health Care Internship (LHCI) presentation.

Outcomes

Student SBP skills increased after training and again after work-based practice. All 9 students reported that their conceptualization of problems in health care changed "extraordinarily," and they were "extraordinarily" confident in their ability to approach another health care problem by applying the Lean method. The LHCI fostered an awareness of physicians as interdependent systems citizens, a key goal of SBP competency. After the internship concluded, the Lean team recommendations generated a resident-led quality assurance performance improvement initiative for bed throughput.

Next Steps

The LHCI was effective in engaging students and building SBP skills among undergraduate medical education students. The levels of student enthusiasm and skill acquisition exceeded the Lean trainers' expectations. The researchers will continue to measure LHCI's effect on students' rotation experiences to better evaluate the long-term benefit of introducing SBP concepts earlier in medical education. The program's success has spurred enthusiasm for continued collaboration with hospital and residency programs. Program administrators are exploring how to broaden access.

Problem

In 1999, systems-based practice (SBP) became the sixth core competency of the Accreditation Council for Graduate Medical Education, intended to ensure physicians could provide effective direct care as well as meaningfully contribute to improving health care systems.[1] Two decades later, SBP education is inadequate and in need of an improvement strategy.[2-4] Given the United States' urgency for systemic-level improvements to care,[5] advancing SBP competency among future physicians is more crucial now than ever.

Currently, SBP education suffers from a lack of a unifying framework and low faculty comfort in teaching it.[2-4] Further limiting SBP competency growth is how late it is taught in the medical school journey. Consider the SBP development losses from not equipping third- and fourth-year students with systems-thinking skills before observing diverse clinical settings and specialties. Therefore, we identified a systems-thinking framework and innovated an SBP program for undergraduate medical education (UME) students to lengthen the SBP developmental continuum. We aimed to create an engaging program in which methods and assessment are feasibly standardizable.

We created the Lean Health Care Internship (LHCI) program for second-year medical students. Lean is a recognized health care quality improvement method adapted from the Toyota Production System.[6] It empowers employees to continuously improve processes by staying focused on delivering what customers value while minimizing wastes of time and motion. Lean Health Care provides a framework for systems-thinking and has significant SBP competency overlap (e.g., system awareness, patient safety, teamwork, care design, and patient advocacy).[2] Lean experts trained students, formed them into a single Lean team, and then guided them at a hospital where they investigated and designed solutions for an existing, real-world, system-level problem. We evaluated students 3 times to capture skill progression: before the program, after training, and after the Lean team's work-based experience.

The LHCI required the collaboration of an academics-based innovation center, a medical school, a simulation center, and a hospital. This collaboration is a novel model of how SBP education can be coproduced, aligning academia and health care systems—a method called for by SBP experts to remedy poor SBP competency achievements.[2]

The Oklahoma State University Center for Health Systems Innovation (CHSI) embraces the urgency to develop SBP skills. Our mission is to transform rural health care and eliminate disparity through systems innovation, aligning our work with SBP competency goals. The purpose of this article is to briefly describe the LHCI program and share preliminary evaluation of its effectiveness, share student and hospital enthusiasm for the program, and highlight how the program unexpectedly benefited the hospital's residency programs.

Approach

Program development

The Oklahoma State University College of Osteopathic Medicine paid the medical students for the 1-month internship. The interns also received a certificate of LHCI completion. Innovating a program for UME students meant overcoming the following 3 barriers: (1) limited open times in the UME schedule, (2) lack of a curriculum, and (3) students' lack of access to clinical environments. After analyzing the schedule for first- and second-year medical students, we identified the summer before year 2 as the most flexible and when students usually independently sought internships. Their schedule flexibility during this time contributed to creating an intensive program to make significant systems-thinking gains in a short timeframe.

We chose to teach Lean Health Care for 3 primary reasons. First, and most important for UME placement, the Lean method is composed of easy-to-learn, practical strategies for understanding complex systems and designing solutions. Second, because Lean is a process improvement method used by as many as 61% of hospitals for clinical, operational, and financial advancements,[6] it is promising as a unifying systems-thinking framework, something which health care lacks.[2-4] Third, teaching Lean principles and strategies supported our goal to promote innovation skills because it is associated with both incremental and breakthrough improvements.[6] The CHSI employs Lean Health Care consultants who innovate or redesign care access and implement improvements with health system collaborators. We leveraged these experts' curriculum used to train practicing physicians. We supplemented the lecture curriculum with simulation experiences to better develop observational skills, which are necessary for identifying errors, workarounds, and waste as well as translating workplace activity to process maps and flow diagrams.

We wanted the students to practice their skills in a clinical setting for better learner outcomes[7]; therefore, we recruited a health system partner. Hospital leadership introduced the Lean team to staff to ensure cooperation and provided a dedicated "war room" at the hospital, where process mapping and other analyses could be confidentially posted on walls. A Lean specialist supervised the team. Formal presentation of findings and solutions was set for the end of the internship. In sum, we developed an intensive, 4-week, in-person, 20-hours-per-week internship composed of 2 elements: training (lecture and simulation exercises in week 1) and work-based practice (problem investigation and mapping in weeks 2 and 3; solution design and patient advocacy to leadership in week 4).

The LHCI

We piloted the 4-week program in June 2019. Five students volunteered (3 women and 2 men). Students addressed problems associated with electrocardiographic clinical processes and billing. Unfortunately, because of the COVID-19 pandemic and the hospital location of the program, the program was closed for 2 years until hospital access for students was reinstated. During that time, we refined the program and garnered financial support from the medical school. The program was relaunched in June 2022. At that time, 9 second-year medical students (7 women and 2 men) responded to a class presentation about the LHCI. On average, participants had 2.5 years (range, 0-5 years) of experience working in a clinical setting. One participant had heard of the Lean method before the program.

Training. An overview of the Lean curriculum is presented in Table 1. Students learned Lean concepts and methods during didactic lectures. During simulations, students practiced observational skills and systems-thinking. They identified approximately 25 latent safety threats in a staged patient room, brainstormed diverse potential upstream causes (to instill the importance of thorough investigations before problem-solving), and listed likely downstream harms (to instill urgency for improvements). The team then strategized Lean methods to understand and remedy the unsafe workplace.

Work-based practice. The hospital leadership challenged the students to solve bed throughput delays, a good fit with SBP's focus on care transitions.[1,2,4] The team was not charged with implementation of solutions, only design. The team observed and interviewed more than 100 staff members across 7 different departments, creating multiple wall maps and matrices to identify root causes and prioritize solutions. The team presented their analysis (including several unknown barriers to bed throughput) and recommendations to leadership and provided a detailed written report.

Working to solve bed throughput delays exposed students to 4 core, interrelated hospital systems: *information systems* (electronic health record system), *staffing systems* (including staffing strategies), *care systems* (emergency department processes, transfer and transport systems, and nursing protocols), and *operational systems* (environmental services systems and discharge protocols). Overall, the program was embraced by the hospital leadership. The president shared the following:

> The 2022 Lean Summer program was instrumental in helping us understand long standing patient flow issues. The depth of investigation combined with the students' natural curiosity and aptitude helped us quickly advance towards a workable solution that will positively impact patients.

Outcomes

We used the Kirkpatrick model[8] to determine student outcomes of satisfaction and skill acquisition. To assess satisfaction and self-reported program impact, we surveyed students at the end of the program; this survey is available in Supplemental Digital Appendix 1 at http://links.lww.com/ACADMED/B443.

For skill evaluation, we created the Lean Skill Evaluation Tool (LSET) (see Supplemental Digital Appendix 2 at http://links.lww.com/ACADMED/B443). Students were presented with 2 scenarios and wrote free-text responses explaining strategies to (1) *validate* a problem, (2) *generate* a solution, (3) *communicate* root problem(s) and recommended solutions, and (4) *monitor* a solution. Answers were scored on Lean language and methods use. The rubric was created by generating lists of expected differences among low, medium, and higher skill based on curriculum content and drawing from years of training experience. The rubric with content guidance is available in Supplemental Digital Appendix 3 (http://links.lww.com/ACADMED/B443). The LSET's approach is modeled after the Quality Improvement Knowledge Application Tool, which also assesses systems-thinking from free-text responses to scenarios and qualifies answers as poor, good, or excellent.[9] The 2 Lean trainers (I.S.P. and C.M.M.) scored answers and generated consensus scores after program completion.

Skills

Students were assessed before the program, after training, and after the program. Summative results for learning progression are given in Figure 1. Skill progression had the most significant increase after training, reflecting how quickly and thoroughly medical students can learn Lean concepts. All skills increased in response to real-world practice. The highest competency was achieved for problem validation strategy on which the students spent most of their time, observing throughput processes and mapping them. At the end of the program, all 9 students reported that their conceptualization of problems in health care changed "extraordinarily," and they were "extraordinarily" confident in their ability to approach another health care problem and apply Lean principles (Table 2).

On review of the students' satisfaction surveys, we realized that the LHCI fostered an awareness of physicians as interdependent systems citizens, a key goal of SBP competency.[2] We asked, "Do you think this internship will aid you in your future career as a doctor? Please explain." Responses included the following:

> Now I am able to think in terms of visualizing the entire process in terms of patient care.…I was exposed to different staff in the hospital, so it'll make me a better physician in terms of understanding different roles.

Yes, most definitely. Every single individual has a part in the process as a whole.

Satisfaction

Students used 5-point scales to rate how much they liked each program component as well as the program overall (Table 2). Students rated the relevance of the overall Lean program as "extraordinary," expressing great enthusiasm for the hospital challenge. They liked the teamwork approach and learning incremental steps to understand complex systems:

> In my opinion, I think that teamwork was one of the most important aspects of the internship. The team - ourselves - had to use teamwork through the entire process. I also noticed how important teamwork is everywhere else, especially in a healthcare setting.
>
> I didn't understand the point of the sticky-wall flow chart at first. I felt like we were going back in time and that we would miss things by using pen and paper. However, once it all started coming together, I was blown away by how it was to see everything in one place.

After the internship concluded, the Lean team recommendations generated a resident-led quality assurance performance improvement initiative for bed throughput. The development of this initiative was unexpected and uncovered how the on-site UME LHCI may enrich graduate medical education SBP education as well as accelerate improvements.

Next Steps

The LHCI was effective in engaging students and building SBP skills and systems-thinking among UME students. The levels of student enthusiasm and skill acquisition exceeded Lean trainers' expectations. The students continue to meet voluntarily, have referred other students, have translated their work into a poster presentation, and are developing a manuscript about system-level bed-throughput barriers, a need identified in quality improvement literature.[10] Next, we will focus on the impact of early SBP education to students' rotation and residency experiences. The 2022 cohort consented to participate in ongoing research to better evaluate the long-term benefits of introducing SBP concepts earlier in medical education.

This study is limited by the small size of the cohort, the application to a single facility, and our origination of the LSET and grading rubric. The generalizability is limited by access to knowledgeable Lean professionals, which may not be associated with all medical schools' communities.

Notwithstanding these limitations, the success of the LHCI program created enthusiasm to deepen the collaboration with hospital and residency programs. We are exploring how to broaden access. In 1 or 2 weeks, a CHSI Lean trainer can train a medical school class, including simulation training. In addition to offering more LHCI positions, we are exploring incorporating work-based practice within UME rotations. We estimate that the development of numerous LHCI sites to support all-student access would require 1 full-time Lean specialist.

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Figure Legend

Figure 1

Mean skill scores from June 2022 of 9 second-year medical students' answer ratings using the Oklahoma State University Lean Skill Evaluation Tool (LSET) before training (T1), after training (T2), and after participation (T3) in a 1-month Lean Health Care Internship. The LSET assessed the students' abilities to form 4 critical problem-solving strategies: problem validation, solution generation, communication (of problem and solutions), and solution monitoring. Student answers were rated on a scale of 1 to 5, with 1 indicating poor, 3 indicating good, and 5 indicating excellent.

Table 1

2022 Oklahoma State University Undergraduate Medical Student Lean Health Care Curriculum and Modality Applications

Component	Definition	Modality
Learning objective 1: Key concepts of Lean		
Culture	The principles of an organization or system in responding to improvement needs	D, S, C
Change in management	An organization's approach to improve goals, processes, or technologies to effect or control change and help people to adapt	D, S, C
Kaizen (Lean)	A quality improvement method meaning continuous improvement	D, S, C
Lean team	Diverse group with members collaborating in problem solving with defined roles, a leader, and executive endorsement	D, S, C
Urgency	Structures in place to deal with continuous change and improvement, emphasizing speed and reliability	D, S, C
Value	What customers determine as the worth of an experience, a purchase, or a process	D, S, C
Value stream	Experiences and/or processes that occur before (upstream) and after (downstream) the valued experience, product, or process	D, S, C
Process and flow	A series of actions that brings about a result	D, S, C
Goals and aims	Desired outcome(s) and project scope with start and stop boundaries within the system	D, S, C
Waste	Any action that does not add customer value, such as unnecessary work, process bottlenecks, or customer value (output) delays	D, S, C
PDSA cycle	Plan, Do, Study, Act cycle, which helps develop critical thinking and guides users to their goal	D, S, C
Measures	Methods to quantify processes and outcomes	D, S, C

Learning objective 2: Strategies for problem validation and information organization		
GEMBA walk	Defined as "Go to the real place" (from the Japanese word "Gemba" or "Gembutsu," which means the real place); brings team members to the frontline people, processes, and process tools	D, S, C
Observation	Watching and noting how work and activity occur around the problem, looking for signs of waste, errors, and inefficiency	D, S, C
Interview	Listening to staff who are part of the processes, noting their insights, attempted solutions, frustrations, and ideas	D, C
5 Whys	A strategy of questioning the cause of an action in a process 5 times to discover root causes	D, S, C
Parking lots	Designated areas on walls to keep information visible (e.g., system information parking lot, problem parking lot for barriers)	D, C
Current state	A flowchart depicting the actual process (vs planned) with bottlenecks and confusion marked with storm clouds	D, C
Spaghetti chart	A mapping of activity (usually steps) of staff in executing a process	D, C
Fishbone chart	A cause and effect diagram used to understand the relationship between causal factors and undesirable effects	D, C
Root cause(s)	Determination(s) of all processes and conditions that underlie process barriers	D, C
Learning objective 3: Strategies for solution design and selection		
Targeted goal	Refining the objectives and tactics after root cause discovery to achieve the Lean team goal	D, C
Brainstorming	Technique of creating as many solution ideas as possible separate from the evaluation of ideas	D, C
Matrices	A method to rate solution options by rating 2 or 3 qualities, often benefit (high/low) by effort (high/low) or degree of system control (high, medium, low) by cost (high, low, no cost)	D, C
Ideal state	A flowchart depicting how the best process would flow with solutions adopted by the system	D, C

Learning objective 4: Strategies for solution communication and monitoring		
Implementation team	Group with members that need to have consensus and commitment to implement a solution	D, C
Visualizations	Images of both problems and solutions to concisely communicate, gain feedback, and build consensus for action plan	D, C
Accountability	Determination of measures to quantify process improvement success and identify reporting, indicators, and responsible parties	D, C
Resistance plan	Foresee systemic push-back(s) to change and plan to preempt or mitigate those negative responses	D, C
Readiness	Assess system readiness for change, such as technology, training, and communication	D, C
Timelines	Schedules for change implementation to occur and for sustained improvement accountability	D, C

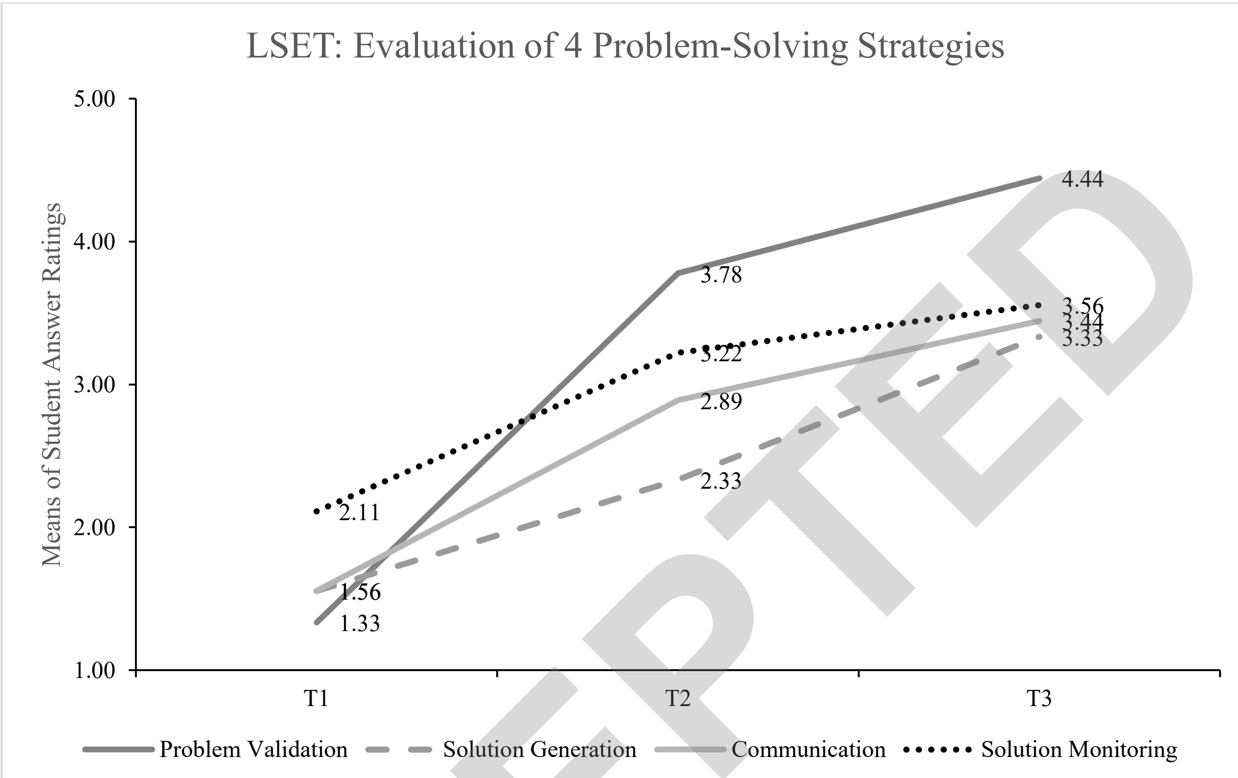
Abbreviations: C, clinical setting; D, didactic lecture; S, simulation.

Table 2

2022 Oklahoma State University Undergraduate Medical Student Lean Health Care Internship Postprogram Student Survey Results (N = 9)

Component	Mean (range)
Program impact	
Please rate how much your understanding of the following increased (from 1 [hardly at all] to 5 [extraordinarily])	
Lean health care overall	5.00
Health care processes	4.89 (4-5)
Problem investigation	4.78 (3-5)
Documentation of processes	4.89 (4-5)
Solution design strategies	4.89 (4-5)
Problem and solution communication	4.89 (4-5)
Self-reported program impact (from 1 [hardly at all] to 5 [extraordinarily])	
How much do you think your conceptualization of problems in health care changed based on this internship?	5.00
How confident are you that you could approach another health care problem and apply Lean principles?	5.00
How important was the teamwork aspect of the internship?	4.78 (4-5)
Satisfaction	
Please rate how much you liked (from 1 [not at all] to 5 [extremely])	
Lean internship overall	4.89 (4-5)
Lecture portion	4.56 (3-5)
Simulation portion	4.44 (3-5)
In-field project portion	5.00
Teamwork approach	5.00
Please rate how relevant and beneficial (from 1 [hardly at all] to 5 [extraordinarily])	
Lean internship overall	5.00
Lecture portion	4.78 (4-5)
Simulation portion	4.56 (3-5)
In-field project portion	5.00
Teamwork approach	4.89 (4-5)

Figure 1



LSET: Evaluation of 4 Problem-Solving Strategies
Means of Student Answer Ratings
5.00
4.00
3.00
2.00
1.00
T1
T2
T3
4.44
3.78
3.56
3.44
3.33
3.22
2.89
2.33
2.11
1.56
1.33
Problem Validation
Solution Generation
Communication
Solution Monitoring