ICHOM 2022 Boston | USA

MICHIGAN MEDICINE
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A Framework for Value Enhancement through Knowledge Generation and Implementation: Development of a Learning Health System (LHS) Maturity Model

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Background

Learning Health System – Performance Measurement

Measurement of Lagging Indicators

Value Delivery Objectives
- Improve quality of care/ patient outcomes
- Improve patient experience
- Reduce costs
- Improve provider work experience

To what extent are we delivering value to stakeholders?

Measurement of Leading Indicators

LHS Implementation Objectives

Learning Cycle Objectives
- Establish team and define clinical problems of interest
- Capture practice as data (*P2D*)
- Translate data into knowledge (*D2K*)
- Implement knowledge into practice (*K2P*)

To what extent are we instantiating learning cycles?

How mature are our learning communities?

Infrastructure Objectives
- Develop competencies & expertise, incentive structure, teamwork, leadership (*People*)
- Develop standardized policies and processes, standardized methodologies (*Policies & Processes*)
- Develop analytics and visualization capabilities, modelling techniques, software, hardware, data warehouses, interoperability standards (*Technology*)

To what extent are we supporting learning communities with infrastructural services?

How mature is our infrastructure?

We sought to develop a measurement methodology for learning health system (LHS) performance using a maturity model approach. Our aim is to enable measurement of the extent to which LHS objectives are met by any given health system (i.e., the "LHS-ness" of a health system). With such measurement, we may be able evaluate the extent to which an LHS is able to deliver higher value to stakeholders compared to other health care delivery systems.

LHS Conceptual Model

Value to patients, providers, health system, payers, and other stakeholders

Value delivered to multiple stakeholders

Multiple learning communities instantiating learning cycles to solve specific clinical problems of interest

LC 1 (D2K, K2P, P2D) | LC 2 (D2K, K2P, P2D) | ... | LC N (D2K, K2P, P2D)

Common set of infrastructural services supporting all learning communities

Technology | **Policies & Processes** | **People**

Adapted from Friedman et al, Menear et al.

We conceptualize an LHS as multiple teams (clinician-led learning communities) instantiating learning cycles for value improvement. In a learning cycle, teams a) routinely generate knowledge from data extraction, and b) implement knowledge into practice using behavior change techniques and standardization of care practices. In an LHS, teams are supported by infrastructural services that leverage people, processes, and technology.

We have operationalized the "double loop" concept of organizational learning: while clinical teams instantiate their LHS learning cycles, an LHS operations team is able to provide support by instantiating its own LHS development cycle.

3.1. Implement improvement plans for each learning community

3.2. Implement improvement plans at the infrastructure level

Standardized methodology for rapid development cycles

LHS Development Methodology

2.1. Assess maturity level of learning communities

2.2. Assess maturity level for LHS infrastructure

2.3. Prioritization of bottlenecks and design of improvement plans

2. Planning for improvements

LHS Development Methodology

3. Implementing improvements ↔ **LHS Operations Team**

1. Value and LHS Maturity Assessments

Measurement: where are we?

1.1. To what extent are we delivering value to stakeholders?

1.2.To what extent are our learning communities instantiating learning cycles?

1.3. To what extent is our infrastructure able to support our learning communities?

LHS Maturity Model

Lagging performance indicators

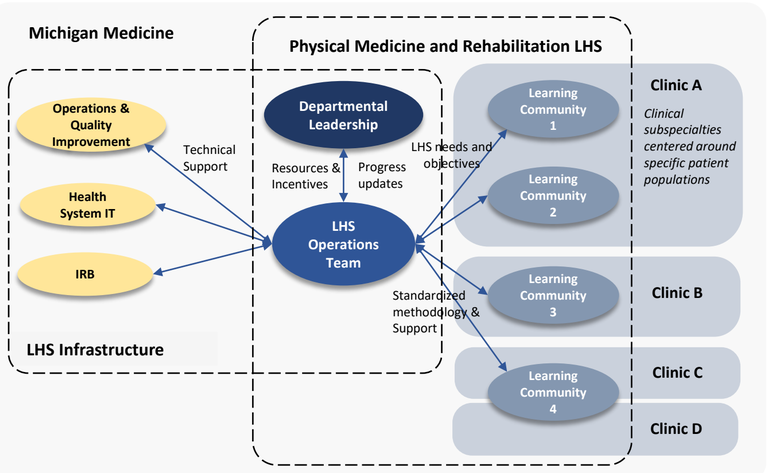
Focus of this iteration of the LHS maturity model

Leading performance indicators

The LHS maturity model is the basis for an LHS development methodology. It measures the extent to which LHS objectives are met (through process capability measures) and prepares for cycles of planning and improvement

Methods

LHS Organizational Structure



We co-developed the LHS maturity model with the Physical Medicine and Rehabilitation (PM&R) Department at the University of Michigan Medical School. In 2018, PM&R set up its LHS program aiming to continuously improve quality of care for patients by leveraging the power of data for knowledge generation and implementation. By combining the appropriate expertise (a clarity-certified data analyst, project manager, business operations, rehabilitation and measurement science), the LHS operations team is able to standardize processes and technical solutions across LHS teams (i.e., clinician-led learning communities) while honoring the diversity of practice. The LHS operations team interacts with departmental leadership and other departments at Michigan Medicine for technical support. While the maturity model was developed within PM&R as a case study, it uses clinically-neutral terminology: it is intended to be generalizable across clinical domains and settings.

We used design research methodology to develop the model:
- Iterative development process: multiple cycles of design, construct validation, and refinement
- Replicable process: detailed development steps for reproducibility
- Participatory action-research: co-development between researchers and practitioners/users
- Final product: meets the needs of the practitioners/users: usability, practicality attributes

LHS Maturity Model – Development Process

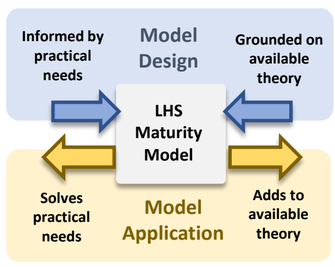
Cycle 1: Empirical Development → 1st Iteration → Expert Review; Literature Review

Cycle 2: Consolidation → 2nd Iteration

Cycle 3: Cognitive Interviews → 3rd Iteration

Design Research Methodology

Real-World Case Study
- Michigan Medicine Infrastructure
- PM&R Department
- Learning Communities within PM&R
  - Focused on specific clinical questions
  - Instantiating learning cycles
- LHS Operations Team
  - Expertise, culture, values
  - Processes, procedures, policies
  - Information technology, data extraction, analytics and governance



Adapted from Hevner et al – Design Research Methodology for Information Systems

LHS Theoretical Framework

Body of Literature
- LHS Theoretical Models
- LHS Published Case Studies

Research questions:

a) What does a mature learning community look like?
b) What are the learning cycle processes that need to be executed and measured?
c) How should learning communities assess their current state and plan for improvements over time ?

Cycle 1

Empirical Development		Literature Review	

Activities	• Brainstorming sessions
	• Participation in operations team weekly meetings
	• Meetings with learning community champions
		Activities	• Reviewed literature (narrative review):
			  • 20 implementation process frameworks
			  • 16 LHS frameworks and case studies
			  • 22 Maturity model development methods
			  • 13 Design-science and action research publications

Stakeholders	• Researcher (PhD student) • LHS operations team leadership • Learning community champions	Stakeholders	• Researcher (PhD student + committee)
Output	• 1st iteration of the instrument based on practical experience	Output	• Themes and constructs to be incorporated into the model

Cycle 2

Expert Review		Consolidation	
Activities	• Development of expert review data collection form • IRB application: exemption approval • Expert review data collection and data entry	Activities	• Integration of findings from literature review and expert review data • Discussions with committee and iterative development (multiple sub-iterations) • Simplification and considerations of instrument usability
Stakeholders	• Participants: 11 faculty and staff members from Michigan Medicine (DLHS and PM&R) (52% response rate) • Analysis: PhD researcher	Stakeholders	• PhD researcher • PhD committee
Output	• Consolidated themes & suggestions for refinement	Output	• 2nd iteration of the instrument (including questionnaire)

Cycle 3

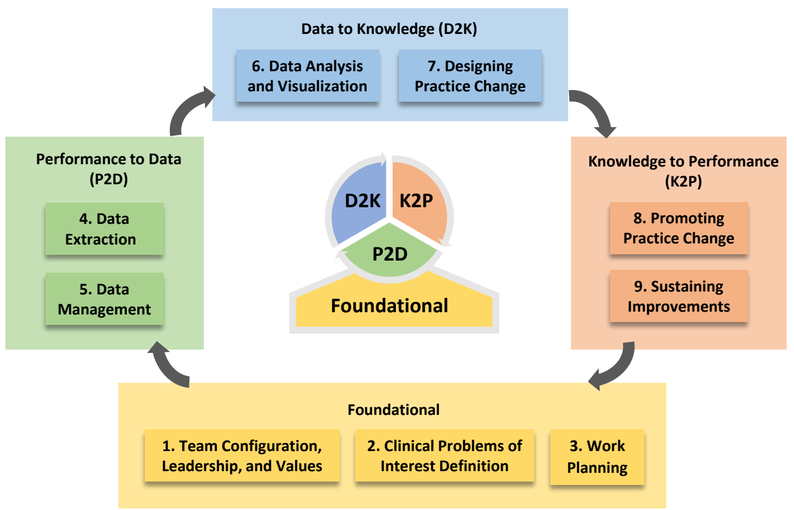
Cognitive Interviews	
Activities	• Development of cognitive interview protocol • IRB application: exemption approval • Conducted 21 cognitive interviews with 7 users - cognitive interviews: use of *think out-loud* technique with respondents for questionnaire refinement • Transcript analysis and identification of themes
Stakeholders	• Participants: 5 clinicians, 1 data analyst, 1 program administrator • Interviewer: PhD researcher
Output	• Themes, feedback, suggestions for improvement • 3rd iteration of the instrument informed by results from interviews

Results

Process Reference Model – LHS Learning Cycle

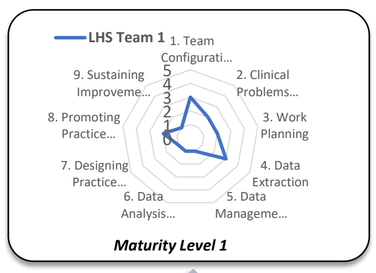
Cycle Phase	Process Domain	Process Domain Area	Process
Foundational	1. Team Configuration, Leadership, and Values	1.1. Stakeholder configuration and partnerships	1.1.1. Form the learning community
			1.1.2. Develop and manage partnerships
		1.2. Leadership and team values	1.2.1. Develop participatory leadership
			1.2.2. Develop team identity and culture
	2. Clinical Problems of Interest Definition	2.1. Defining clinical problems of interest	2.1.1. Define patient population
			2.1.2. Define clinical questions
			2.1.3. Define outcomes of interest
			2.1.4. Define clinical improvement goals
		2.2. Literature review and synthesis	2.2.1. Review and synthesize available literature
	3. Work Planning	3.1. Project management	3.1.1. Develop and implement a project plan
			3.1.2. Develop team communication and coordination systems
		3.2. Resources	3.2.1. Acquire and manage necessary resources
Performance to Data P2D)	4. Data Extraction	4.1. Data extraction and integration	4.1.1. Optimize documentation practices for data extraction
			4.1.2. Develop and implement data collection methods
			4.1.3. Integrate data sources and measure outcomes of interest
		4.2. Data quality and refinements	4.2.1. Develop and implement a data quality control plan
	5. Data Management	5.1. Data management system	5.1.1. Develop and maintain a data management and delivery system
		5.2. Data flow automation	5.2.1. Develop and manage data flow automation
Data to Knowledge (D2K)	6. Data Analysis and Visualization	6.1. Regulatory compliance	6.1.1. Ensure regulatory compliance
		6.2. Data analytics & visualizations	6.2.1. Develop and implement a data analytics plan
			6.2.2. Develop and implement data visualization
	7. Designing Practice Change	7.1. Knowledge generation	7.1.1. Identify clinical knowledge for implementation
		7.2. Determinants to knowledge implementation	7.2.1. Identify and prioritize determinants to implementation
Knowledge to Performance (K2P)	8. Promoting Practice Change	8.1. Designing implementation strategies	8.1.1. Design implementation strategies
			8.1.2. Pilot test implementation strategies
		8.2. Implementation strategy deployment	8.2.1. Deploy implementation strategies
			8.2.2. Ensure adaptations and fidelity
			8.2.3. Evaluate implementation outcomes
	9. Sustaining Improvements	9.1. Sustainment of improvements	9.1.1. Ensure sustainability of improvements
		9.2. Knowledge dissemination	9.2.2. Disseminate knowledge from learning cycle
N = 4	*N = 9*	*N = 18*	*N = 30*

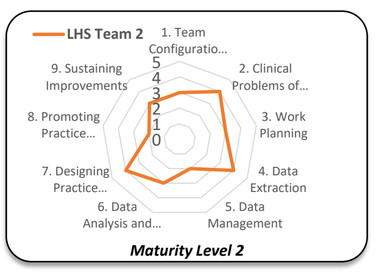
LHS Learning Cycle Process Domains



We developed a process reference model for the LHS learning cycle and a self-assessment questionnaire for teams to evaluate their LHS process capabilities. For each process in the model, associated Likert-scale questions are designed to evaluate process capability. The questionnaire design method used best practices for outcomes measurement development, including cognitive interviews with users. Process capability scores produced by the answers to the questionnaire are then aggregated into a learning community maturity level score for each team. Using results from their self-assessment, teams may track progress across learning cycle process domains and plan for improvements.

LHS Operations Team Dashboard

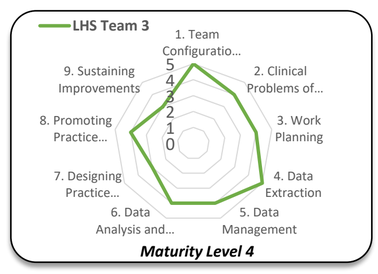




The radar graphs indicate initial data collected from pilot tests (the cognitive interviews). The graphs illustrate the visual dashboard supporting the LHS operations team, enabling them to track progress for each clinician-led learning community within the program:

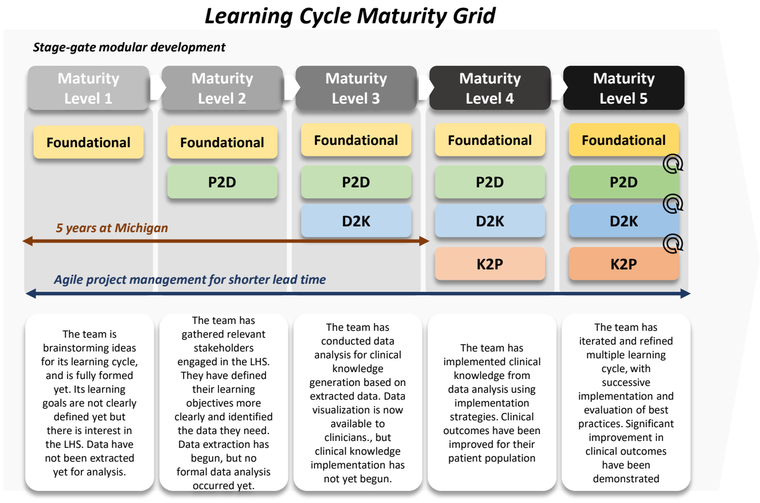
- Slow progress indicates potential infrastructural bottlenecks that need to be addressed
- Teams may use their radar graphs to review progress in meetings and discuss next steps

Sample data from pilot test (cognitive interviews)



Conclusions

Learning Cycle Maturity Grid



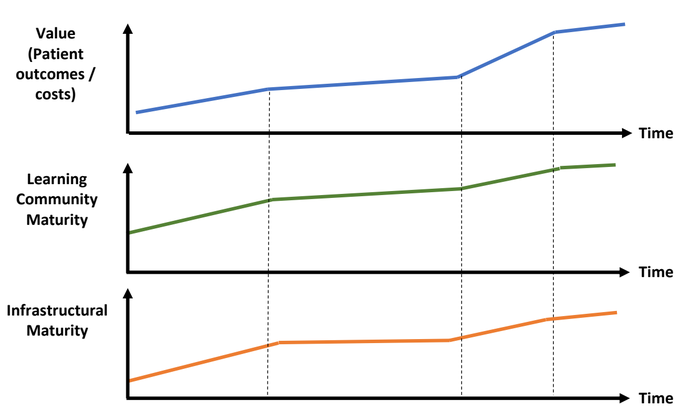
By operationalizing measures for LHS process capability and maturity levels, we developed a reference model for teams developing their LHS programs. Through standardization of processes and agile project management methodology, we aim to shorten lead time to LHS development.

Efficient and effective learning cycles lead to higher value delivery
- Value in health care as a composite score of multiple measures: patient outcomes, patient experience, costs, provider work experience.
- In value-based health care, specific outcomes measures should be developed for specific treatments and clinical conditions.
- The LHS aims to achieve higher value through routine discovery and implementation of knowledge about best practices.

- Learning communities aim to generate knowledge from routinely collected data and implement that knowledge into practice (learning cycles) for higher quality of care
- A mature learning community has developed learning cycle processes and socio-technical capabilities
- Measurement of learning community maturity indicates bottlenecks and provides a roadmap for improvement.

Improvements in infrastructure maturity lead to more effective and efficient learning cycles
- The LHS infrastructure supports the work of learning communities
- Facilitates the instantiation of learning cycles and provides scalability and standardization
- Infrastructure engages people, processes, and technology to support learning cycles
- Measurement of infrastructural maturity indicates bottlenecks and provides a roadmap for improvement.

Measuring the Multiple Dimensions of an LHS



Coupled with clinical outcomes measures, the process capability self-assessment questionnaire enables an evaluation of the extent to which learning community maturity leads to higher value to stakeholders:

Hypotheses:

a) Learning community maturity leads to higher value to patients
b) LHS infrastructure maturity leads to learning community maturity

Test:

i) Measurement of value delivery over time
ii) Measurement of learning community maturity over time
iii) Measurement of LHS infrastructure maturity over time

Future research applications:
- Software application development: infrastructural tool to support standardization of LHS methodology across multiple teams within a health system
- Model refinement: expansion of processes to include infrastructural service capabilities and additional measurement tools and process capability indicators
- LHS research and theory: survey multiple LHS teams across clinical domains using the instrument for theoretical insights into the LHS maturity process

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