Introduction

What are Learning Health System competencies?

The competencies listed below include the knowledge and skills that learning health systems scientists develop and use during their careers. The competencies are organized into seven broad areas termed “domains”. These domains and competencies were developed by experts in the field of Learning Health Systems research. (Agency for Healthcare Research and Quality [AHRQ], 2021)

There are a number of competencies in each domain. However, we do not expect scholars to become expert in every domain or in every competency. Rather, LHS scholars will focus their training on a few domains and a number of the competencies within the domain. For some domains and competencies, trainees may aim to develop foundational knowledge, while in other domains they may aim to become expert, or they may fall somewhere in between for other domains and competencies. We recognize that every LHS trainee is an individual and that some scholars will enter the program with expert skills in some domains and competencies and may have never been exposed to other domains and competencies. Ultimately, LHS science is an inter-disciplinary field and researchers often assemble teams of people together to conduct research and together they bring expertise across these domains.

What are competency assessments and how will they be used?

The competencies assessments have been developed so that you and your mentors can assess your proficiency with each competency at the beginning of LHS training and at least annually during your LHS training and career. The competencies can help you and your mentors set training goals, and the assessments list examples of the evidence to support expertise with a particular level of proficiency. We propose four levels of proficiency:

- No exposure
- Foundational (Awareness/Understanding)
- Emerging (Application)
- Proficient (Application with a High Level of Skill)

The competency assessments were developed by teams of learning health systems experts at Northwestern University.

You can use the LHS competency assessments to generate discussion with your mentors about training progress and competency development. This tool can be used for self-assessment and to guide dialogue with your mentors to establish priority competencies to develop, to assess your level of current performance, and to review evidence of your level of proficiency. Most importantly, you and your
mentor will talk about the types of training, experience, and evidence you need to progress to the next level of proficiency during your career.

Completing the Assessment

1. Together with your mentors, identify the domains within which you would like to develop proficiency.
2. Complete a baseline assessment for all domains, indicating No Exposure, Foundational or Evidence of Emerging Skills.
3. Move to the Proficiency tables for the domains that are an area of emphasis and identify competencies that have been met.
4. Reassess competency bi-annually during the training period and at least annually during your early formative years.
Baseline Standard Assessment: No Exposure, Foundational Skills, Emerging Skills

**Domain 1: Systems Science Assessment Workgroup**

**Domain Definition:** To understand how health systems operate and how to apply systems theory to research and implementation.

(D1.1) Demonstrate knowledge of how systems theories can be used to understand how the interactions of the parts of health systems operate to produce value for stakeholders.

| No Exposure | Foundational Skills                                                                 | Emerging Skills                                                                 |
|-------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
|             | □ A1. Aware of the literature in systems thinking and its application to healthcare. | □ A2. Understands systems theory and how systems concepts are used to explain how systems function (or do not function). |
|             | □ B1. Aware of models to explicate both external and internal systems (e.g., implementation models) that influence health care delivery. | □ B2. Identifies how health care delivery is influenced by systems that are both external (e.g., policy, incentives, funding) and internal (e.g., competing clinical resources, staffing) to the health care system. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D1.2) Demonstrate systems thinking in the design and conduct of research and implementation of its findings within the context of complex health systems.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ C1. Aware of potential external and internal factors that may influence an intervention and implementation strategies in a complex health system. | □ C2. Defines external and internal system determinants that can influence implementation strategies and the impact of an intervention in a complex health system. |
|             | □ D1. Aware of the role and use of an implementation logic model with diverse determinants and intervention components. | □ D2. Develops an implementation logic model that considers diverse determinants, implementation strategies, intervention components, process/use outcomes, and health outcomes. |
|             | □ E1. Aware of potential external and internal factors that may influence the intervention effect in a complex system. | □ E2. Understands the environment in which the complex health intervention will be tested and approaches to tailor the intervention to optimize intervention effect. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
(D1.3) Demonstrate knowledge of the financing, organization, delivery, and outcomes of health care services and their interrelationships.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | F1. Aware of the diverse leadership roles in health systems or community health organizations including clinical services, finance, operations, strategic planning, and quality improvement. | F2. Explains roles that various professionals in health system or community health administration play including clinical services, finance, operations, quality, and the interdependencies of their roles. |
|             | G1. Aware of the diverse committees that manage health system or community health organization functions, including those governing clinical practice standards and quality of care. | G2. Understands the roles of diverse health system or community health organization oversight and management committees and their functions. |
|             | H1. Aware of financial and cost concepts in healthcare and research. | H2. Uses financial and economic cost terminology appropriately in conversation with leaders and in research. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D1.4) Demonstrate the ability to assess the extent to which research activities will likely contribute to the quality, equity, or value of health systems.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | I1. Aware of structural, financial, access, and other sources of disparity in healthcare delivery. | I2. Understands baseline disparity in health care delivery within the clinical domain to be studied. |
|             | J1. Aware of contemporary approaches to defining value and “high value care” in health systems or community health organizations. | J2. Understands how the health system values specific health care or community health interventions and anticipates the potential impact on value when modified through research or quality efforts. |
|             | K1. Aware of the concepts of quality-of-care delivery, access to care, and outcomes in a health system quality or value plan. | K2. Understands the inter-relationships among quality of care, access to care, and outcomes of care in specific clinical domains. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
Domain 2: Research Questions and Standards of Scientific Evidence Workgroup

Domain Definition: To ask meaningful questions and evaluate the usefulness of scientific evidence and insights.

(D2.1) Demonstrate the ability to compose feasible and timely research questions and hypotheses, incorporating stakeholder priorities, to generate evidence that informs meaningful clinical and policy decisions.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ A1. Able to construct a research question. | □ A2. Able to assess if research questions are feasible and relevant to health care delivery or policy makers. |
|             | □ B1. Aware that research questions can be constructed in collaboration with stakeholders | □ B2. Constructs research questions that integrate stakeholder perspectives but primarily are based on what the trainee has read in the literature and/or their own clinical knowledge. |
|             | □ C1. Understands how health policies can contribute to positive (intended) and negative (unintended) outcomes in the health system. | □ C2. Identifies both positive (intended) and negative (unintended) possible outcomes of a specific policy or clinical practice. |
|             | □ D1. Understands how health policies and clinical practices can differentially affect diverse populations. | □ D2. Identifies variation in clinical or policy impact among diverse populations. |
|             | □ E1. Understands the impact of patient, practitioner, and system factors that influence implementation of healthcare interventions. | □ E2. Defines the patient, practitioner, and system factors that influence specific intervention effects in the local health system. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to Proficiency.

(D2.2) Demonstrate the ability to engage with all relevant stakeholders (patients, families, clinicians, and system leaders) in the elicitation and prioritization of research questions that address current and future stakeholder needs.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ F1. Aware that stakeholder perspectives can be taken into consideration in research. | □ F2. Identifies relevant stakeholders and invites differing perspectives. |
|             | □ G1. Aware that research can be conducted in partnership between researchers and stakeholders. Aware of techniques to engage and communicate with diverse stakeholders. | □ G2. Works toward partnerships, which involve information flow from trainee to stakeholder or information is conveyed from the stakeholder to the researcher in a consultation framework via focus groups, key informant |
If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D2.3) Demonstrate the ability to critically analyze and assess available scientific evidence from peer-reviewed articles, systematic reviews, meta-analyses, and gray literature to identify novel LHS questions and to judge the applicability of the evidence to a local care setting.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | H1. Aware that roles and decision-making authority of research partners need to be defined. | interviews. (Rowe & Frewer, 2005; Deverka et al., 2013) |
|             | I1. Aware of the kinds of decisions to which stakeholders can contribute. | H2. Roles and decision-making authority of all research partners, including the patient and other stakeholder partners, are defined and clearly stated by the researcher. (Sheridan et al., 2017) |
|             | J1. Aware that time and contributions of stakeholders should be valued and acknowledged. | I2. Major decisions are discussed with all stakeholders. |
|             | J2. Recognizes time and contribution of patient and other stakeholder partners and includes them in the research plan. | J2. Recognizes time and contribution of patient and other stakeholder partners and includes them in the research plan. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | K1. Aware of frameworks for critically appraising peer-reviewed articles, meta-analyses and systematic reviews. | K2. Able to critically appraise peer-reviewed articles, systematic reviews and meta-analyses. Selects high quality evidence to generate research questions. |
|             | L1. Aware that data from published studies, as well as qualitative information from health system personnel and patients, can be integrated to inform research questions and study designs. | L2. Uses evidence from high quality systematic reviews and meta-analyses, combined with local information, to define research questions and study design. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
## Domain 3: Research Methods

**Domain Definition:** To conduct research within the context of complex health systems using appropriate study designs and analytic methods to assess outcomes of interest to health systems stakeholders.

(D3.1) Demonstrate the ability to use theory and conceptual models in the design and interpretation of LHS research.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | A1. Understands the key features of learning health system and implementation science theories and models, e.g., RE-AIM, CFIR. | A2. Differentiates between the theories and models and applies relevant frameworks to conducting research projects. |
|             | B1. Aware of models from dissemination and implementation science, quality improvement, systems science, and complex health interventions when designing LHS research studies. | B2. Integrates preferred theories and models, including dissemination and implementation, quality improvement, and complex health intervention models into LHS research design. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D3.2) Demonstrate the ability to develop an appropriate observational, quasi-experimental, or experimental study design while mitigating threats to internal and external validity for research that is minimally disruptive to operations in real world health systems and practices.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | C1. Aware of the range of factors that can threaten the rigor, and internal and external validity of LHS research. | C2. Designs a study that is rigorous and valid. Identifies threats to the internal and external validity to one’s LHS research. |
|             | D1. Understands the key features of experimental and quasi-experimental studies and threats to their validity. | D2. Identifies internal and external threats to validity of one’s experimental or quasi-experimental study. |
|             | E1. Understands how stakeholders’ involvement can enhance study procedures and success. | E2. Accurately assesses the feasibility of conducting the study protocol including consideration of workflow, issues regarding randomization, and anticipation of the stakeholders who need to be engaged. |
(D3.3) Demonstrate knowledge of mixed methods and how they can be used to improve LHS research studies.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ F1. Aware of factors that influence the sustainability of an intervention. | □ F2. Accurately assesses the feasibility of conducting the study protocol including consideration of workflow, issues re randomization, anticipation of the stakeholders who need to be engaged. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D3.4) Demonstrate knowledge of how to assess multilevel determinants of health and health care disparities when designing studies.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ G1. Aware of how mixed-methods studies enhance research. | □ G2. Identifies opportunities where use of a mixed-methods design will enhance one’s study. |
|             | □ H1. Aware of full range of mixed-methods approaches and their strengths and weaknesses. | □ H2. Designs a mixed methods study, with qualitative and quantitative components either in sequence or in combination. |
|             | □ I1. Aware of methods for analyzing mixed-methods data | □ I2. Selects appropriate approaches to analyze mixed-method data. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D3.5) Demonstrate the ability to select and interpret appropriate clinical, financial, and patient-centered outcomes of interest based on the concepts they measure and their measurement properties.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|----------------------------|
|             | M1. Aware of the multiple factors that influence health and outcome measure capture when selecting measures. | M2. Designs a study that acknowledges diverse factors influencing health outcome measure capture and that reflects diverse stakeholder engagement. |
|             | N1. Aware of the range of valid, reproducible, and standardized clinical, utilization, cost, and patient-centered outcomes. | N2. Designs a study that includes selection of valid, reproducible, and standardized clinical, utilization, cost, and patient-centered outcomes. |
|             | O1. Aware of differing perspectives of multiple stakeholders, including patients, caregivers, families, clinicians, and health systems when defining outcome measures. | O2. Works with diverse stakeholders to solicit their perspectives in selecting relevant outcome measures. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D3.6) Demonstrate the ability to apply the principles of hypothesis testing and statistical inference to data collected routinely through the course of care as well as supplemental data from patients, providers, and health systems.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|----------------------------|
|             | P1. Understands issues of poor data quality and missingness in real-world data collected in the course of clinical care. | P2. Anticipates data quality and missingness issues for data in one’s study. |
|             | Q1. Understands the rationale and methods for data imputation to enhance data quality and completeness when using real-world data. | Q2. Identifies appropriate methods for data imputation in one’s study. |
|             | R1. Understands the role of power calculations in planning sample size. | R2. Anticipates issues of sample size to serve statistical analyses and incorporates power calculations and retention strategies to minimize data incompleteness (e.g., lost to follow-up) in study design. |
### Domain 4: Informatics

**Domain Definition:** To know how to use information systems to conduct LHS research and improve.

(D4.1) Demonstrate the ability to use data derived from electronic health records and other clinical information sources for research and quality improvement.

(D4.2) Demonstrate knowledge about additional data sources that can be linked to health system clinical data in order to augment exposure and outcome ascertainment.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | S1. Understands principles of statistical tests, including univariate and multivariate methods to interpret quantitative data. | S2. Outlines a statistical analysis plan that includes appropriate univariate and multivariate (e.g., regression) models, independently or in collaboration with a biostatistician. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             |              | EHR data but does not design data collection methods. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D4.3) Demonstrate the ability to assess data quality and apply data quality assurance processes, including error prevention, data cleaning, data monitoring, documentation, and relevant data standards.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ F1. Uses existing data to answer research questions but has not investigated data sources and assumptions about data collection and completeness. | □ F2. Asks questions to investigate the assumptions that underlie data definitions and quality such as “Where did the data come from?” or “How was this measurement obtained?” |
|             | □ G1. Understands how missing data can lead to bias in research studies. | □ G2. Knows approaches to address missing data. |
|             | □ H1. Aware of strengths and weaknesses of EHR data. | □ H2. Accesses and uses data entered at the point of care appropriately. Evaluates EHR data for inaccuracies and biases. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D4.4) Demonstrate knowledge of population health informatics, including disease surveillance, monitoring of community health, assessment of social and behavioral determinants of health, and geographic information systems.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ I1. Aware of the range of regional, state, and national health data sources available for learning health systems research projects. | □ I2. Identifies the patchwork of public health related data, ranging from systems to track immunizations, to reportable conditions, to geographic data coding, and syndromic surveillance. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
(D4.5) Demonstrate knowledge of clinical information systems, including electronic health records, clinical documentation, computerized physician order entry (CPOE), clinical decision support systems, electronic prescribing, medical imaging, and clinical/population dashboards.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ J1. Aware of the range of clinical information’s structure and functions (e.g., EHR, CPOE, CDS) and how it can be useful to patients and clinicians. | □ J2. Identifies clinical information system’s relevancy to individual research project. Recognizes clinical decision support tools as a means to influence clinician behavior. |
|             | □ K1. Aware of how advanced analytics such as machine learning (ML) and AI can be used in learning health systems research. | □ K2. Recognizes opportunities and challenges when applying advanced analytic methods such as ML and AI in prediction or profiling. |
|             | □ L1. Understands the emerging scope of novel digital data and how it can be integrated into learning health systems research. | □ L2. Integrates novel digital data (e.g., from quantified self) in a real world study. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to Proficiency.

Domain 5: Ethics of Research and Implementation in Health Systems

Domain Definition: To ensure that research and quality improvement done in health care settings adhere to the highest ethical standards.

(D5.1) Demonstrate the ability to apply ethical principles in the engagement of health systems, including issues of business ethics and the importance of publishing both positive and negative findings in the public domain.

(D5.2) Demonstrate knowledge of what activities constitute research as opposed to quality improvement activities and seek appropriate oversight for each.

(D5.3) Demonstrate knowledge of specific Health Insurance Portability and Accountability Act (HIPAA) requirements associated with varied data sources used in health systems research activities and seek appropriate approvals.

(D5.4) Demonstrate the ability to identify and minimize potential conflicts of interest in the design, conduct, and reporting of research conducted in health systems.

(D5.5) Demonstrate knowledge of ethical and legal considerations when engaging in multi-system studies.
| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | A1. Understands the roles of the IRB, compliance, and ethics committees and the vocabulary of ethics and regulation relating to research. | A2. Prepares IRB applications to conduct research to anticipate and address key regulatory procedures in study design, participant consent, and data management and that assure compliance with regulation and ethical guidelines. |
|             | B1. Identifies ethical issues from own experience that should be addressed in the design of a study, including issues that are gray. | B2. Recognizes and responds to most ethical issues when prompted, including issues that occur from engaging diverse stakeholders. Defines solutions for issues that are gray. |
|             | C1. Understands how ethical and regulatory issues, such as HIPAA, are defined but is not able to distinguish between the two or generate solutions. | C2. Distinguishes between ethical and regulatory issues and their management in order to engage optimal professional guidance and prevent research issues. |
|             | D1. Articulates the distinction between human subjects research and quality improvement studies with regard to ethical considerations. | D2. Establishes the design and level of ethical oversight appropriate for research and quality improvement studies and assures adherence to procedures. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

### Domain 6: Improvement and Implementation Science

**Domain Definition:** To reduce avoidable variation in process and outcome and ensure the systematic uptake of research findings in a health system.

(D6.1) Demonstrate the ability to employ specific quality improvement methods to reduce avoidable variation and improve performance in clinical processes and outcomes in routine practice.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | A1. Demonstrates a familiarity with the major sources of literature on best practices, clinical guidelines and standards, accepted measures of performance, and achievable performance on the process/outcome under review. | A2. Identifies range of options using a range of expert sources to guide the improvement of systematic delivery of care. Chooses among basic accepted processes and measures as most appropriate to advance the study of a specific process or outcome. |
|             | B1. Understand methods of rapid cycle change (e.g., plan-do-study-act, DMAIC), process improvement analytic methods adapted from systems engineers (e.g., control/run charts, common cause/special cause variation) and | B2. Participates in a full rapid cycle change initiative or leads part of a rapid cycle change initiative, including analyzing the causes of variation in practice through defining and |

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| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | theories of organizational and health system change management. | implementing changes / improvements to measuring change over time. |
|             | □ C1. Identifies methods to monitor variation in health care practice over time and recognizes an opportunity to reduce that variation to improve outcomes. | □ C2. Monitors variation in healthcare practice and identifies unnecessary variation, including causes, patterns/themes and suboptimal performance in care delivery. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D6.2) Demonstrate the ability to employ specific implementation science or quality improvement methods to study and promote systematic uptake of research findings and other clinical evidence into routine practice.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ D1. Understands principles of learning health systems where new research and/or evidence and best practices are translated to practice. | □ D2. Assesses local readiness to change and opportunities to translate new research and best practice evidence to improve care. |
|             | □ E1. Recognizes opportunity to translate new research or evidence to care delivery. | □ E2. Identifies local health system leaders, clinicians, and staff to plan and implement system changes to translate new research evidence to improved care delivery. |
|             | □ F1. Identifies strategies to implement new best practices through clinician behavior change and improved systems of care that improve healthcare processes and outcomes. | □ F2. Supports implementation of effective change management strategies and monitors impact to deliver new best practices. |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D6.3) Demonstrate knowledge regarding when and how to mount larger efforts to scale-up, spread, and sustain successful interventions based on strength of clinical evidence and organizational and provider readiness for change.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|-----------------------------|
|             | □ G1. Recognizes emerging evidence supporting generalizable benefits of new best practice and the opportunity to translate to care | □ G2. Identifies system changes that would benefit from the translation of new research evidence to improve care practices. |

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delivery in regional or national health care systems.

☐ H1. Knows strategies to implement best practices in clinical care through clinician behavior change.

☐ I1. Understands evolving reasons for clinical practice variation in diverse healthcare settings and its impact on health outcomes.

☐ J1. Recognizes opportunities to improve reach, adoption, and maintenance of best practices in clinical care and healthcare delivery.

☐ H2. Defines generalizable behavioral and organizational (e.g., IT, policies) changes to support implementation, maintenance, and scaling of new clinical practices to improve health outcomes in diverse healthcare settings.

☐ I2. Identifies and monitors varied reasons for clinical practice variation in diverse healthcare settings and its impact on health outcomes.

☐ J2. Implements strategies to improve reach, adoption, and maintenance of best practices in clinical care and healthcare delivery and analyzes impact.

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to Proficiency.

Domain 7: Engagement, Leadership and Research Management

Domain Definition: To engage stakeholders in all aspects of the research process and effectively lead and manage LHS research teams and projects.

(D7.1) Demonstrate the ability to build and lead research teams with diverse health system stakeholder representation.

(D7.4) Demonstrate the ability to conduct effective team-based project management, employing skills in leadership, communication, negotiation, consensus building, and problem-solving.

(D7.7) Demonstrate knowledge of participatory research approaches that foster participation and engagement of vulnerable populations.

☐ A1. Identifies key stakeholders and communicates individually through planned meetings.

☐ B1. Knows the types of input stakeholders can provide and the type of questions to ask stakeholders.

☐ A2. Manages stakeholder group meetings in a way that allows all to be heard. Listens, adjusts meeting activities in response to input from participants, summarizes different perspectives and facilitates active discussion.

☐ B2. When conversing with stakeholder groups, addresses preset agenda items and engages stakeholders in discussion but lacks flexibility and is reactive to group.
If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.

(D7.5) Demonstrate the ability to develop protocols consistent with health systems needs and timelines, employing patient and clinician engagement, and using a mix of conventional and alternative funding sources.

(D7.6) Demonstrate the ability to implement protocols aligned with health systems operations and integrated into clinical settings, including engaging clinicians in the research process.

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to **Proficiency**.
(D7.2) Demonstrate knowledge of the values and communication mechanisms used by stakeholder groups involved in research in health systems.

(D7.3) Demonstrate the ability to translate, disseminate, and communicate the value proposition and business case for research to diverse health system stakeholders.

| No Exposure | Foundational | Evidence of Emerging Skills |
|-------------|--------------|----------------------------|
|             | I1. Understands effective procedures for engaging stakeholders. | I2. Defines written and oral team procedures to support respectful, transparent, and equal engagement of all stakeholders and their perspectives |
|             | J1. Aware of need to for equal engagement of stakeholders | J2. Identifies imbalances in knowledge across stakeholders that may influence open discussion and equal engagement |

If this is an area of emphasis for you and Foundational and Emerging Skills are achieved, proceed to Proficiency.

Proficiency in LHS Competencies

When evidence of emerging skills has been achieved within a competency, trainees may elect to develop proficiency in domains of special interest. The following tables include evidence of proficiency.

**Domain 1: Systems Science Assessment Workgroup -- Proficiency**

(D1.1P) Demonstrate knowledge of how systems theories can be used to understand how the interactions of the parts of health systems operate to produce value for stakeholders.

| Evidence of Proficient Skills |
|--------------------------------|
| A3. Identifies specific system contributions to health care delivery from the perspectives of diverse stakeholders including patients, clinicians, health system leaders and payers. |
| B3. Analyzes and defines the successful and unsuccessful contributions of diverse systems (e.g., financing, public health) to imagine and test new solutions to improve the health care delivery system. |

Back to Domain 1, Competency 2

(D1.2P) Demonstrate systems thinking in the design and conduct of research and implementation of its findings within the context of complex health systems.

| Evidence of Proficient Skills |
|--------------------------------|
| C3. Designs complex health intervention studies that uses adaptable implementation approaches and measures the contribution of multilevel determinants on outcomes as measured by process/use measures. |
| Evidence of Proficient Skills |
|-------------------------------|
| □ D3. Conducts studies of a complex intervention that monitors and, if necessary, adapts implementation strategies. Measures the impact of the study intervention on process and use metrics and health outcomes. |
| □ E3. Conducts studies that implements a complex health intervention that aligns with the healthcare delivery environment, and tailors intervention to optimize intervention effect. |

Back to Domain 1, Competency 3

(D1.3P) Demonstrate knowledge of the financing, organization, delivery, and outcomes of health care services and their interrelationships.

| Evidence of Proficient Skills |
|-------------------------------|
| □ F3. Engages clinical services, finance, operations, strategic planning, and quality leaders in dialogue to define opportunities for improvement in health systems or community health organizations. |
| □ G3. Tailors presentations to academic, hospital or community health organization administrative groups to assure diverse audience understanding and engagement. |
| □ H3. Defines and analyzes the cost, reimbursement, and resource constraints of alternate interventions in health systems or community health organizations to define research opportunities. |

Back to Domain 1, Competency 4

(D1.4P) Demonstrate the ability to assess the extent to which research activities will likely contribute to the quality, equity, or value of health systems.

| Evidence of Proficient Skills |
|-------------------------------|
| □ I3. Refines health care delivery interventions to address disparities in use and access to healthcare systems. |
| □ J3. Analyzes the change in value caused by a specific health system or community health organization intervention from the perspectives of access, quality, cost, and equity. |
| □ K3. Evaluates interventions that improve health care quality, access to care, equity, and the association with health outcomes in specific clinical domains. |

Back to Domain 2
Domain 2. Research Questions and standards of Scientific Evidence Workgroup - Proficiency

(D2.1P) Demonstrate the ability to compose feasible and timely research questions and hypotheses, incorporating stakeholder priorities, to generate evidence that informs meaningful clinical and policy decisions.

| Evidence of Proficient Skills |
|------------------------------|
| A3. Tests research questions that are feasible and relevant to healthcare delivery and policy makers. |
| B3. Constructs and refines research questions based on the literature and in collaboration with patients, clinicians, health care leaders, and policy stakeholders. |
| C3. In collaboration with policy makers and clinical leaders, designs and tests interventions to minimize unintended negative outcomes associated with clinical practices and health policies. |
| D3. Designs research that will anticipate and minimize variation through adaptation to diverse populations in real world populations and health care delivery settings. |
| E3. Designs and tailors implementation strategies to mitigate the influence of patient, practitioner, and system factors to optimize uniform intervention effectiveness. |

Back to Domain 2, Competency 2

(D2.2P) Demonstrate the ability to engage with all relevant stakeholders (patients, families, clinicians, and system leaders) in the elicitation and prioritization of research questions that address current and future stakeholder needs.

| Evidence of Proficient Skills |
|------------------------------|
| F3. Integrates diverse stakeholder perspectives in research questions and conduct of research. |
| G3. Works towards a shared vision for the partnership through an exchange of information between trainee and stakeholders. Communication is bidirectional and includes discussion and deliberation. |
| H3. Roles and decision-making authority of all research partners, including the patient and other stakeholder partners, are defined collaboratively and clearly stated. |
| I3. Major decisions are made inclusively and communicated among all stakeholders. |
| J3. Values time and contribution of patient and other stakeholder partners through fair financial compensation, and reasonable and thoughtful requests for time commitment. |

Back to Domain 2, Competency 3.
(D2.3P) Demonstrate the ability to critically analyze and assess available scientific evidence from peer-reviewed articles, systematic reviews, meta-analyses, and gray literature to identify novel LHS questions and to judge the applicability of the evidence to a local care setting.

| Evidence of Proficient Skills |
|------------------------------|
| K3. Understands the limitations of systematic reviews and meta-analyses in the learning health system context, such as time needed to generate, applicability etc. Uses additional sources of data, generated in real time, to formulate research questions. |
| New Directions in Evidence Synthesis |
| L3. Integrates research synthesis with qualitative information, from health system personnel and patients, and quantitative data, from health systems, to optimally define research questions and design. |
| New Directions in Evidence Synthesis |
| M3. Research synthesis to verify or supplement insights from the literature is part of a wider program to identify, implement, and evaluate useful practices, within a health care system that has the capability to analyze databases, conduct original research, and leverage health data to monitor and improve quality. New Directions in Evidence Synthesis |

Back to Domain 3.

**Domain 3: Research Methods -- Proficiency**

(D3.1P) Demonstrate the ability to use theory and conceptual models in the design and interpretation of LHS research.

| Evidence of Proficient Skills |
|------------------------------|
| A3. Designs and conducts an LHS research project anchored in appropriate conceptual models. |
| B3. Completes a critical appraisal and practical application of LHS theories and models in an ongoing research project. Applies models from dissemination and implementation and quality literature to execute specific LHS study aims. |

Back to Domain 3, Competency 2.

(D3.2P) Demonstrate the ability to develop an appropriate observational, quasi-experimental, or experimental study design while mitigating threats to internal and external validity for research that is minimally disruptive to operations in real world health systems and practices.
Evidence of Proficient Skills

| C3. Designs a study that balances internal rigor and validity with the ability of the study to make an impact on the health system with potential for dissemination. Develops a proposal/publication/presentation that appropriately addresses threats to internal & external validity through the study design. |
|---|
| D3. Develops a research proposal/peer-reviewed publication/presentation with health system or community leaders that includes an appropriately designed experimental or quasi-experimental study and addresses issues of internal and external validity. The proposal/publication/presentation is well reviewed by peers. |
| E3. Designs a study protocol that exhibits evidence of substantive involvement of stakeholders/community in the study design and addresses issues such as workflow and randomization beyond just obtaining a Letter of Support. |
| F3. Designs a study to assess an intervention that would be sustainable after the study has been completed or demonstrates the ability to design an intervention with potential to be disseminated broadly. |

Back to Domain 3, Competency 3.

(D3.3P) Demonstrate knowledge of mixed methods and how they can be used to improve LHS research studies.

Evidence of Proficient Skills

| G3. Designs or implements a study that uses a mixed-methods design. |
| H3. Justifies and applies use of a particular mixed-methods design in a study protocol or research proposal. (Munoz-Plaza et al., 2016) |
| I3. Integrates results of qualitative and quantitative analyses. Triangulates qualitative and quantitative data. |
| J3. Uses qualitative data to clarify study design and elucidate the results of a quantitative data analysis e.g., electronic medical record (EMR) data. |

Back to Domain 3, Competency 4.

(D3.4P) Demonstrate knowledge of how to assess multilevel determinants of health and health care disparities when designing studies.

Evidence of Proficient Skills

| K3. Conducts research that executes analyses that adjusts for multi-level factors that influence outcomes (e.g., genetic, patient, family, health system, and societal levels). |
| L3. Integrates and applies theories and models to measure multi-level factors and executes analyses that integrate multi-level factors that influence intervention outcomes. |
| M3. Integrates multi-level factors in analyses to understand and address heterogeneity and disparities in patient outcomes from health system interventions. |

Back to Domain 3, Competency 5.
(D3.5P) Demonstrate the ability to select and interpret appropriate clinical, financial, and patient-centered outcomes of interest based on the concepts they measure and their measurement properties.

| Evidence of Proficient Skills |
|-------------------------------|
| □ N3. Designs a study that includes measures that address multi-level analyses including genetic, clinical, behavioral, social, health system, and economic factors. |
| □ O3. Integrates valid, reproducible, and standardized clinical, utilization, cost, and patient-centered outcomes in health systems research. |
| □ P3. Integrates valid outcome measures that address the perspectives of diverse stakeholders, including patients, caregivers, and families. |

Back to Domain 3, Competency 6.

(D3.6P) Demonstrate the ability to apply the principles of hypothesis testing and statistical inference to data collected routinely through the course of care as well as supplemental data from patients, providers, and health systems.

| Evidence of Proficient Skills |
|-------------------------------|
| □ Q3. Defines supplemental standardized data capture to augment real-world data and to assure valid research analyses. |
| □ R3. Apply methods for data imputation to improve data completeness and quality in research based on real-world data. |
| □ R3. Conducts research assuring adequate sample size through both efficient enrollment and retention S3. Leads completion of a statistical analysis plan, in collaboration with a biostatistician where indicated, that assures complete interpretation of the data. |
| □ S3. Leads completion of a statistical analysis plan, in collaboration with a biostatistician where indicated, that assures complete interpretation of the data. |

Back to Domain 4.

Domain 4: Informatics -- Proficiency

(D4.1P) Demonstrate the ability to use data derived from electronic health records and other clinical information sources for research and quality improvement.

(D4.2P). Demonstrate knowledge about additional data sources that can be linked to health system clinical data in order to augment exposure and outcome ascertainment.

| Evidence of Proficient Skills |
|-------------------------------|
| □ A3. Scales a study to involve more sites and/or more data. Assesses strengths and limitations of data for appropriateness, quality and scalability. Ensures data provided will answer the research question. Able to negotiate with data analytics teams, suggesting alternative approaches and defending decisions. |
### Evidence of Proficient Skills

| Evidence | Proficiency Details |
|----------|---------------------|
| B3.      | Understands the data source to identify data strengths/weaknesses, data relevance, missing data. Understands how to provide the appropriate standardized terminology codes for the pseudocode. |
| C3.      | Communicates effectively with key system stakeholders who influence data capture and informatics processes to optimize data quality. Translates the research question into the specifications that the data analytics team can execute by providing clinical and research context. |
| D3.      | Integrates EHR data with claims and other novel sources of data to expand the measures available (e.g., area-level data on environmental influences of health linked via geocodes). Able to see patterns in data and patterns across systems and across designs. (Forrest et al., 2018) |
| E3.      | Collects data prospectively from patients and other stakeholders (e.g., patient-reported outcomes and care experience) in consultation with stakeholders to minimize burden on respondents and clinical care processes. (Forrest et al., 2018) |

**Back to Domain 4, Competency 3.**

(D4.3P). Demonstrate the ability to assess data quality and apply data quality assurance processes, including error prevention, data cleaning, data monitoring, documentation, and relevant data standards.

| Evidence of Proficient Skills |
|------------------------------|
| F3. | Considers and questions assumptions about data so that data meet quality standards and data are meaningful. |
| G3. | When data are missing, asks questions to determine why data are missing to assess whether they are missing randomly or whether some type of bias is at play. |
| H3. | Identifies ways to improve the quality of data entered in the EHR at the point of care. (Forrest et al., 2018) |

**Back to Domain 4, Competency 4.**

(D4.4P). Demonstrate knowledge of population health informatics, including disease surveillance, monitoring of community health, assessment of social and behavioral determinants of health, and geographic information systems.

| Evidence of Proficient Skills |
|------------------------------|
| I3. | Understand how public health data sources can be leveraged for tracking and assessing the health of a population. With Informatics support, able to integrate and interpret disparate data sources to answer questions that require more than one data set. Facile with GIS and sources of social determinant data (e.g., income, walkability etc.). |

**Back to Domain 4, Competency 5.**

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(D4.5P). Demonstrate knowledge of clinical information systems, including electronic health records, clinical documentation, computerized physician order entry (CPOE), clinical decision support systems, electronic prescribing, medical imaging, and clinical/population dashboards.

| Evidence of Proficient Skills |
|------------------------------|
| J3. Able to apply these key informatics components to enable a variety of research projects such as intervention trials (e.g., clinical and pragmatic trials for apps, drugs.). Uses clinical decision support tools with input from clinician and patient stakeholders to enhance usefulness to clinicians and stakeholders. (Forrest et al., 2018) |
| K3. In an ML or AI intervention, able to determine if ML/AI is being used in the right context, identify sources of bias, and identify potential ethical framework challenges. |
| L3. Identifies and incorporates data from the rapidly expanding digital traces that patients provide from personal wearable and home sensors. |

Back to Domain 5.

Domain 5: Ethics of Research and Implementation in Health Systems – Proficiency

(D5.1P) Demonstrate the ability to apply ethical principles in the engagement of health systems, including issues of business ethics and the importance of publishing both positive and negative findings in the public domain.

(D5.2P) Demonstrate knowledge of what activities constitute research as opposed to quality improvement activities and seek appropriate oversight for each.

(D5.3P) Demonstrate knowledge of specific Health Insurance Portability and Accountability Act (HIPAA) requirements associated with varied data sources used in health systems research activities and seek appropriate approvals.

(D5.4P) Demonstrate the ability to identify and minimize potential conflicts of interest in the design, conduct, and reporting of research conducted in health systems.

(D5.5P) Demonstrate knowledge of ethical and legal considerations when engaging in multi-system studies.

| Evidence of Proficient Skills |
|------------------------------|
| A3. Collaborates with IRB to develop options to address ethical concerns and develop solutions for the conduct of research. |
| B3. Asks key questions to identify ethical issues in advance and build time into the planning process to address ethical issues, including actively addressing stakeholder issues. Narrows defensible options to those that are equally justifiable. |
| C3. Takes appropriate action to address anticipated ethical and regulatory issues, including HIPAA guidelines. |
| D3. Defines and maintains ethical oversight for research and quality improvement studies. |
### Evidence of Proficient Skills

|   |   |
|---|---|
| ☑️ E3. Recognizes that different stakeholders will have different conflicts of interest by virtue of their roles, and actively seeks to identify and respond to conflicts of interest among stakeholders. |

**Back to Domain 6.**

### Domain 6: Improvement and Implementation Science – Proficiency

(D6.1P) Demonstrate the ability to employ specific quality improvement methods to reduce avoidable variation and improve performance in clinical processes and outcomes in routine practice.

|   |   |
|---|---|
| ☑️ A3. Applies the best available guidance by conducting a thorough review of current practice and, with a team, evaluates and selects options to improve care delivery and measures most appropriate to advance the study of a specific process or outcome. |
| ☑️ B3. Leads a rapid cycle improvement initiative from analyzing the causes of variation in practice through defining changes / improvements to implementation and change management and measuring change over time. |
| ☑️ C3. After identifying potentially avoidable variation or suboptimal performance in care delivery, identifies stakeholders, collaborates to establish team charter and measures longitudinal practice change. Utilizes team process to achieve measurable objectives and assure sustained improvement in outcomes. |

**Back to Domain 6, Competency 2.**

(D6.2P) Demonstrate the ability to employ specific implementation science or quality improvement methods to study and promote systematic uptake of research findings and other clinical evidence into routine practice.

|   |   |
|---|---|
| ☑️ D3. Fosters increased local readiness to change and leads translation of new research and best practice evidence to improve care. |
| ☑️ E3. Convenes, engages, leads local health system leaders and clinicians to plan and implement system changes to translate new research evidence to improved care delivery. |
| ☑️ F3. Selects, designs or tailors change management strategies such as behavioral and organizational (e.g., IT, policies) systems to support implementation and sustainment of improved processes and outcomes. |

**Back to Domain 6, Competency 3.**

(D6.3P) Demonstrate knowledge regarding when and how to mount larger efforts to scale-up, spread, and sustain successful interventions based on strength of clinical evidence and organizational and provider readiness for change.
## Evidence of Proficient Skills

|   |   |
|---|---|
| G3. | Assembles multi-institutional or national team of health system leaders and clinicians to plan and implement system changes to translate new research evidence to improve care practices. |
| H3. | Implements generalizable behavioral and organizational (e.g., IT, policies) changes to support implementation, maintenance, and scaling of new clinical practices to improve health outcomes in diverse healthcare settings. |
| I3. | Analyzes practice change initiatives across diverse healthcare systems and tailors strategies to reduce variation and improve outcomes. Monitors and adapts to sustain practice improvement across broad populations. |
| J3. | Identifies barriers to scaling and sustaining practice change and disseminates generalizable strategies to spur implementation and sustain practice change. |

### Back to Domain 7.

### Domain 7: Engagement, Leadership and research Management – Proficiency

**D7.1P** Demonstrate the ability to build and lead research teams with diverse health system stakeholder representation.

**D7.4P** Demonstrate the ability to conduct effective team-based project management, employing skills in leadership, communication, negotiation, consensus building, and problem-solving.

**D7.7P** Demonstrate knowledge of participatory research approaches that foster participation and engagement of vulnerable populations.

## Evidence of Proficient Skills

|   |   |
|---|---|
| A3. | Manages meetings in a way that engages the entire group of stakeholders, enabling consensus building and facilitating group-level problem solving. |
| B3. | Demonstrates flexibility when conversing with stakeholder teams. Proactively tailors conversation to engage diverse stakeholder perspectives, elicits their needs, respects communication styles, facilitates consensus and synthesizes all voices. Can “read the room” and engage accordingly. |
| C3. | Defines research objectives that meet personal and stakeholder goals and needs. |

### Back to Domain 7, Competencies 5,6.

**D7.5P** Demonstrate the ability to develop protocols consistent with health systems needs and timelines, employing patient and clinician engagement, and using a mix of conventional and alternative funding sources.

**D7.6P** Demonstrate the ability to implement protocols aligned with health systems operations and integrated into clinical settings, including engaging clinicians in the research process.

### Evidence of Proficient Skills

|   |   |
|---|---|
| D3. | Develops shared vision for the partnership by including all partners |
### Evidence of Proficient Skills

|   |   |
|---|---|
| E3. Engagement involves an exchange of information between researchers and stakeholders. Communication is bidirectional and includes discussion and deliberation to refine the research procedures, elicit needs and priorities and learn how stakeholders make decisions. |
| F3. Roles and decision-making authority of all research partners, including the patient and other stakeholder partners, are defined collaboratively and clearly stated. Major decisions are made inclusively and communicated to all stakeholders. |
| G3. Engages stakeholders (including patients) in defining the study design and dissemination plan and actively engages stakeholders in identifying opportunities to present information about the study. |
| H3. Time and contribution of patient and other stakeholder partners are valued and demonstrated in fair financial compensation, as well as in reasonable and thoughtful requests for time commitment by patient and other stakeholder partners. |

Back to Domain 7, Competencies 2,3.

(D7.2P) Demonstrate knowledge of the values and communication mechanisms used by stakeholder groups involved in research in health systems.

(D7.3P) Demonstrate the ability to translate, disseminate, and communicate the value proposition and business case for research to diverse health system stakeholders.

|   |   |
|---|---|
| I3. Leads meetings to encourage respectful, transparent, and equal engagement of all stakeholders and their perspectives. |
| J3. Assures team learning opportunities to foster balanced information that will support equal engagement in decisions and discussions. |

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