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Building a two-state learning healthcare system for persons with first episode psychosis☆

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ABSTRACT

The Connection Learning Healthcare System (CLHS) represents a network of academic institutions, state behavioral health systems, and early psychosis specialty care programs in Pennsylvania and Maryland working together to provide the best evidence-based care for persons with first episode psychosis. Developing an integrated, two-state system required unification and harmonization of data collection, training, consultation, research, and dissemination activities. Here we describe the model that supported these efforts and our experience creating an active two-state learning healthcare system. We also review areas of ongoing attention and offer lessons learned.

1. Introduction

Mental health delivery systems have newly turned to the learning health system (LHS) to knit people from multiple organizations together toward a common purpose: coordinating care with a focus on optimizing performance for clients, families, clinicians, and staff. This promise is critically important for programs serving young people experiencing a first episode of psychosis (FEP). Each year, approximately 100,000 adolescents and young adults in the United States (US) experience FEP (Simon et al., 2017), which can derail their social, academic, and vocational development and initiate a trajectory of disability (Hansen et al., 2023). Over the last 15 years, the National Institute of Mental Health (NIMH) has undertaken a research and implementation initiative to identify evidence-based treatment for FEP in the US and make it accessible to young people and families. This initiative identified Coordinated Specialty Care (CSC; Insel, 2016) - a team-based, multicomponent, recovery-oriented service that improves symptoms, functioning, work/school engagement, and quality of life - as the optimal form of treatment for young people with FEP. National CSC implementation with dedicated funding and federal-state partnerships (National Institutes of Health, 2022) has established over 350 CSC programs nationally (Heinssen and Azrin, 2022).

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The NIMH has linked these CSC programs through the Early Psychosis Intervention Network (EPINET; Heinssen and Azrin, 2022; Insel, 2016; NIMH, 2020), a research-to-practice FEP LHS. Its first step has been to support the creation of eight "hubs" of CSC programs across the country that collect a common set of clinical measures. Deidentified data are integrated by the EPINET National Data Coordinating Center to create a dataset that can be used to study and improve CSC. Other key aspects of the LHS, including culture development and system-wide quality improvement initiatives, have been less emphasized to date at the national level.

Connection Learning Healthcare System (CLHS) is an EPINET hub creating a network among four academic institutions, five health care systems, two state behavioral health systems, and 23 CSC programs in Pennsylvania and Maryland. CLHS shows promise to improve care for clients (Bennett et al., 2024; Pagdon et al., 2024; Phalen, Jones et al., 2024a; Phalen, Smith et al., 2024b). For example, rates of suicidality among CLHS clients show significant decline over the first 6 months of treatment (Phalen, Jones et al., 2024a). Developing a two-state LHS required integrating two states' activities via new supportive **structures**, harmonized, expanded **activities**, and a distinct, shared **culture**. Here we describe the model supporting these efforts and our experience creating CLHS. We offer lessons learned and review areas of ongoing attention.

2. LHS background

The National Academy of Sciences, Engineering and Medicine (formerly the Institute of Medicine) defines an LHS as a system that manages knowledge in a rapid, continuous manner to translate the wealth of (internal and external) scientific and clinical information being generated into appropriate care delivery, patient engagement, alignment of payment and policy incentives, and to create and maintain a learning culture that will ultimately improve patient outcomes (Smith et al., 2013). Five active areas of focus exist simultaneously and interact in an LHS (Agency for Healthcare Research and Quality, 2019), as arrayed in our Fig. 1: 1) Using data feedback to identify areas for improvement; 2) Creating a learning culture; 3) Rapidly translating knowledge into practice; 4) Engaging patients and other important stakeholders; and 5) Aligning incentives (including for payment and policies). In a published multiple-case-study report, the Agency for Healthcare Research and Quality (AHRQ; Bindman, 2019; Agency for Healthcare Research and Quality, 2022) emphasized three common LHS traits: investing in data infrastructure; fostering a culture of learning; and valuing the role of staff in continuous improvement. Friedman and colleagues (Friedman, 2022) stressed that LHSs go beyond the cycle of data collection/analysis/using results to support intervention to also include establishing multi-stakeholder learning communities, undertaking "rigorous discovery" before problem solving or implementation activities, and supporting cycles of data collection, learning, practice innovation, and evaluation.

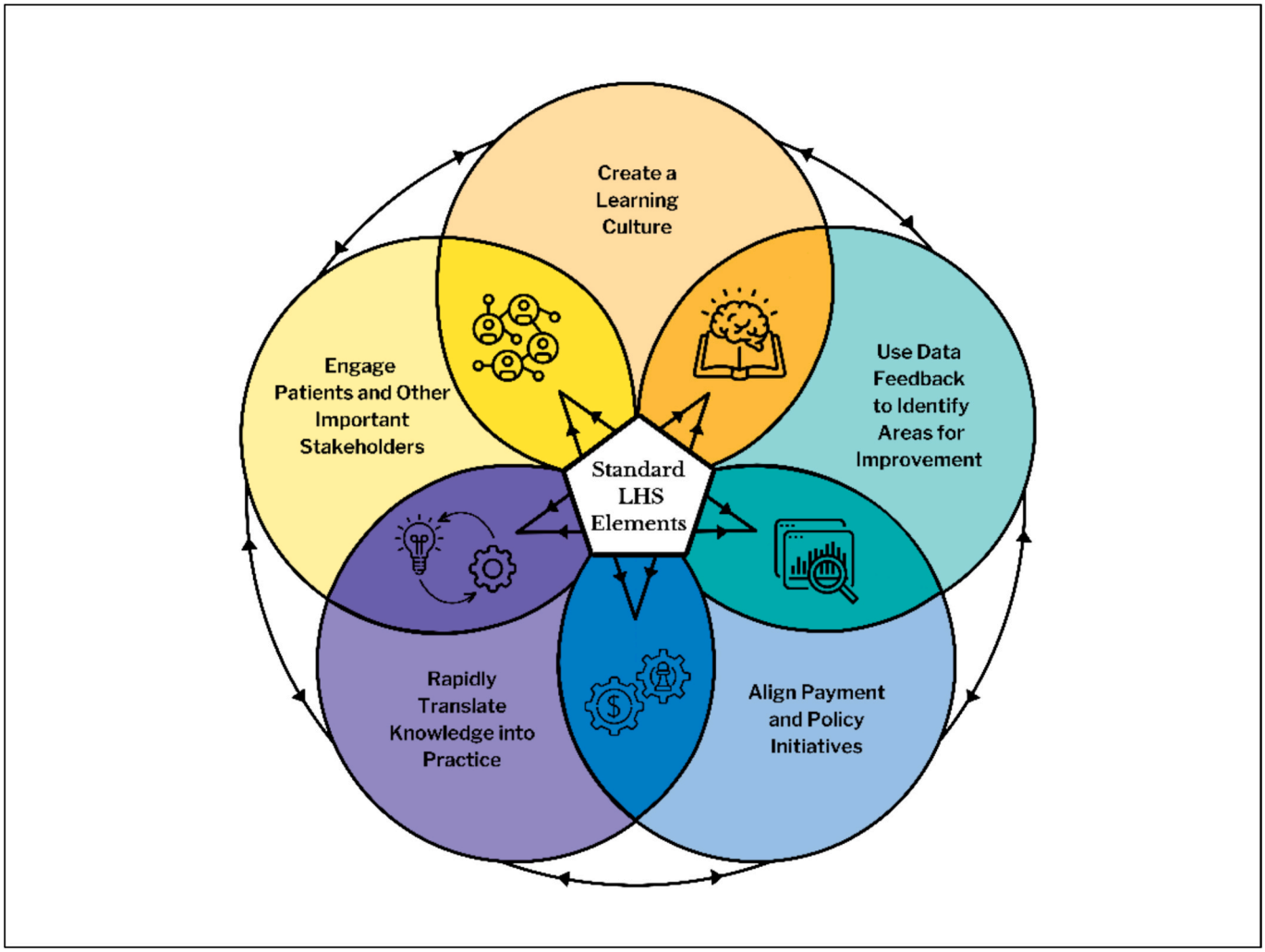

Fig. 1. Interacting Areas of Focus for Connection Learning Healthcare System.

Some early LHS conceptualizations over-emphasized the amassing of big data without sufficient consideration of how those data are translated into care, how patients are engaged, or how organizational culture constrains and facilitates bottom-up and top-down learning (wherein *use* of new information to make decisions is the measure of actual learning). The current LHS model requires strategic alignment of technology, standards, policy, and people, enhancing organizational capabilities by empowering workers and service users as part of system-wide learning (Friedman et al., 2010) to avoid those pitfalls. Unique features of mental health care, including high uncertainty, high risks, strong professional norms, parity struggles, and unique interprofessional working relationships, further shape the formation, success, and maintenance of mental-health focused LHSs (Nembhard et al., 2009). An FEP-focused LHS must pay close attention to multi-level organizational processes underlying the transformation of a healthcare system into a learning system (Cangelosi and Dill, 1965; Fiol and Lyles, 1985; Crossan et al., 1999; Lai et al., 2017; Lapré and Nembhard, 2010). A limited conceptualization of the LHS as only a data-collection enterprise would miss learning and innovation opportunities inherent in collaboration and research-practice iterations that hinge on organizational processes, thoughtful implementation, and learning culture support. We kept these lessons in mind as we worked to create the CLHS.

3. LHS for FEP

Development and implementation of coordinated, multidisciplinary, early interventions for psychosis disorders emerged in the 1990's in Australia, eventually taking hold internationally (McGorry and Mei, 2018). Many integrated care initiatives included multiple programs networked regionally (McGorry et al., 2024) that implemented harmonized care models and gathered common outcomes data to evaluate program efficacy. In the US, several states over the last decade laid the groundwork for FEP learning healthcare by taking stock of all services offered, collecting common data elements across varied programs, and centralizing training and consultation activities to be delivered via a common entity. In California, a broadly diverse set of CSC programs worked to harmonize training and data collection activities to improve the state's ability to evaluate treatment outcomes (Niendam et al., 2019). CSC programs in Massachusetts implemented common data collection to characterize service users and assess change over time, although it was challenging to introduce additional assessments into routine care (Kline et al., 2022). Humensky et al. (2020) described the establishment of OnTrack NY – a FEP LHS in the state of New York that currently represents 29 CSC programs – allowing the state to collaborate with stakeholders, implement ongoing improvements to care, and disseminate knowledge to participating staff. Washington State has developed implementation support for common data-driven components of care in their network of CSC programs that includes training, technical assistance, and processes for evaluation and quality improvement (Oluwoye et al., 2024). Thus, the LHS model is a promising way to bring stakeholders together to monitor, evaluate, and improve quality of CSC.

4. CSC implementation in Pennsylvania and Maryland

Table 1 shows implementation activities occurring in Pennsylvania and Maryland *prior to the CLHS launch*. In Pennsylvania, the STEP program in Pittsburgh opened its doors as early as the 1990s (Wood et al., 2024). The Office of Mental Health and Substance Abuse Services (PA OMHSAS) began funding CSC in 2014; the network now includes 19 programs. In 2017, the state funded the Pennsylvania Early Intervention Center, an umbrella organization now known as HeadsUp, implemented statewide program evaluation, training, technical assistance, outreach support, and fidelity monitoring (Dong et al., 2023a, b; Jumper et al., 2024; Westfall et al., 2021), and these activities have been ongoing following CLHS launch. Program evaluation characterizes CSC programs individually and in aggregate by participant-level characteristics at admission and outcomes at six-month intervals, including variation across programs. The state (via HeadsUp) collects systems-level data on outreach efforts, incoming and outgoing referrals, admissions, discharges, and fidelity of care delivery to the CSC model. CSC programs receive feedback on a regular basis.

Table 1
LHS Elements by Each State Prior to CLHS.

Pennsylvania	Maryland
Use Data Feedback to Identify Areas for Improvement	
• Data collection at all CSC programs. • Annual and ongoing training in data collection. • Ongoing program evaluation that pairs data collection with fidelity monitoring. • Regular site meetings and feedback reports to review and improve data collection.	• Data collection not standardized across programs. • Fidelity monitored for individual practices but not for CSC overall. High ratings lead to higher reimbursement for services.
Create a Reliable Learning Culture	
• Statewide CSC learning collaborative with regular meetings, trainings, and educational opportunities. • Individual site meetings to identify challenges and determine solutions.	• Statewide CSC learning collaborative with regular meetings, trainings, and educational opportunities. • Programs input determines training opportunities. • Ongoing consultation in evidence-based practice offered to all programs.
Rapidly Translate Knowledge into Practice	
• Continuous data collection with regular program and fidelity evaluation to characterize program and participant features and outcomes, and support programs delivery of high-fidelity care.	• National evidence-based practice implementation model: state trainers train service providers with extended consultation as needed for higher level training or corrective action.
Engage Patients and Other Important Stakeholders	
• CSC programs employ Peer Support Specialists. • PA HeadsUp Steering Committee has activities and opportunities for youth and family member involvement.	• CSC programs employ Peer Support Specialists • Maryland Early Intervention Program Advisory Board has activities and opportunities for youth and family member involvement.
Align Payment and Policy Incentives	
• OMHSAS funds HeadsUp to provide the infrastructure to collect program evaluation data. • In quarterly meetings, PA OMHSAS and PEIC/HeadsUp discuss deliverables, progress and goals.	• Payments for IPS Supported Employment and MFG Family Psychoeducation linked to fidelity monitoring.

Maryland's first early psychosis program was established in 2003. In 2008, as part of the NIH Recovery After Initial Schizophrenia Episode (RA1SE) initiative, researchers developed and implemented a team-based CSC approach at one site and studied its impact (Dixon et al., 2015; Kreyenbuhl et al., 2016; Lucksted et al., 2015; Lucksted et al., 2018), later offering training materials, dissemination processes, and policy and funding solutions to support implementation (Dixon et al., 2018; Essock et al., 2015a, b; Lieberman et al., 2013; Goldman et al., 2013). In 2013, the Maryland Behavioral Health Administration (MD BHA) funded the Maryland Early Intervention Program (EIP) to provide CSC training, technical assistance, and implementation support across the state. Since 2014, the state has funded additional CSC programs, bringing the network in Maryland to six programs. In related efforts, the MD BHA monitors all Maryland public mental health programs in Individual Placement Supported Employment and in Multifamily Group Psychoeducation using a standardized fidelity tool. High-fidelity programs receive a higher level of reimbursement; low-fidelity programs

receive further training until they meet full criteria. This model integrates training and fidelity assessment (by the state rather than the CLHS) to guide quality improvement.

5. CLHS model

We approached creating CLHS with a plan to employ **structures, activities, and culture** to achieve LHS goals. We used strategies from implementation science to harmonize and expand best practices from both states and ideas from High Reliability Organizing to operationalize the concept of a learning culture. As shown in Table 1, each state had strong elements of its organization prior to CLHS, as well as growth areas relative to what is possible for an LHS. To build a unified, integrated and improved "Version 2.0," (Table 2), we sought to harmonize the two systems by adopting best practices from each and expanding activities to enhance our overall match to LHS domains. For example, Pennsylvania's prior development and implementation of a common assessment battery, including measure selection, computerization, and staff training (Westfall et al., 2021), provided the basis for the rollout of common assessments across CLHS. Maryland's long-time use of ongoing site-by-site consultation on evidence-based practices and their implementation also became a CLHS-wide activity. State leaders, researchers, and frontline representatives in each state tapped into their years of practice in the separate systems to identify barriers to achieving a joint LHS. Based on these anticipated challenges, we employed evidence-based implementation science strategies, which focus on how to motivate programs to adopt desired behaviors and practices, to support LHS activities across all programs in both states. These select strategies fit identified needs, including: 1) local needs assessment to address variation across programs; 2) audit and feedback to provide actionable information to programs; 3) practice facilitation to share knowledge across programs; 4) remote collaborative learning sessions with training, data review and group problem solving to build skills and a sense of community; and 5) designation of LHS points of contact in each program to connect leadership with CSC programs and guide local change (Michie et al., 2013; Powell et al., 2015; Chambers et al., 2016).

Another critical step was building a shared learning culture across both states. To help guide culture-building, we turned to concepts from High Reliability Organizations (HROs), which maintain performance in complex environments using approaches that facilitate continuous learning (Sutcliffe et al., 2017). HROs exhibit five features that characterize learning: 1) preoccupation with failure (being on alert for glitches which point to ways to promote smooth functioning); 2) reluctance to simplify (being inquisitive and digging in for deeper explanations); 3) sensitivity to operations (gathering data and understanding trends at the point of care); 4) commitment to resilience (learning from things that go wrong); and 5) deference to expertise (making decisions based on data and expert perspectives including those with lived experience of psychosis and CSC rather than based on authority or hierarchy) (Weick and Sutcliffe, 2015). These features offered us mechanisms to operationalize a learning culture.

Zurynski et al., 2020 highlighted that structure and governance were barriers and facilitators to LHS development and implementation. Below we describe the organizational **structure** of CLHS (Fig. 2) and how CLHS **activities** meet each of the five LHS domains (Institute of Medicine, 2013), including **culture**. In each area, we describe the implementation science strategies or HRO principles used to activate the CLHS.

6. CLHS structures

CLHS is structured around committees with integrated objectives (Fig. 2). The central organizing ***Planning Committee*** is comprised of research investigators and service providers who provide oversight, planning, and timeline and milestone review, and contribute their knowledge of the field to guide CLHS's functioning and growth. Members of it co-lead additional committees that oversee specific aspects of

Table 2
Activities to Achieve a Harmonized CLHS.

LHS 2.0 Activity	Brief Description	Sample Activities	Implementation Strategies*
Use Data Feedback to Identify Areas for Improvement			
Collection of CLHS CAB	Supports standardized CSC program data collection.	CLHS CAB is harmonized with measures selected for EPINET; has additional domains of interest to stakeholders in each state.	DC
Hub-based infrastructure for data collection	Standard data collection protocol, central support for data collection, hub/site data review, dedicated staff to support data collection at some programs.	CSC programs collect and enter CAB data.	DC
Create a Reliable Learning Culture			
Monthly collaborative meetings	Staff from 23+ CSC programs come together to share experiences and provide input on best practices.	*May 2020: Program representatives shared experiences connecting with clients and families during the COVID19 pandemic.	LNA, RCL
Quarterly evidence-based practice didactics and discussion	Didactic presentations focused on topics relevant to FEP and its treatment	Sample topics: racial disparities in early psychosis, addressing problem substance use in FEP, and engaging natural supports for long-term recovery	LNA, RCL
Quarterly site overviews and case presentations	Programs describe their programs, staffing, and populations served; share case presentations for discussion	Sample case topic: case formulation using Cognitive Behavioral Therapy for psychosis	LNA, RCL
Quarterly communities of practice and interest groups	Program members meet with their counterparts across programs/states in regularly scheduled community of practice calls.	Recent interest meetings on preventing CSC disengagement, enhancing services for families.	LNA, RCL, PF
Bi-annual data feedback and discussion	Presenters describe findings from CLHS or national EPINET data and lead discussion about implications for clinical practice.	Sample topics: CLHS researcher presented CAB data to illustrate best practices for reducing suicidality in FEP; clinician described his use of Tableau to visualize CAB data for measurement-based care.	RCL, DLC
Information Sharing	Regular information to programs on upcoming learning opportunities; archived trainings,	CLHS website; cloud-based SharePoint site; weekly email listing of upcoming trainings and presentations.	PF, RCL

(continued on next page)

Table 2 (*continued*)

LHS 2.0 Activity	Brief Description	Sample Activities	Implementation Strategies*
	readings, meeting notes, etc. so that programs can refer to them as needed.		
Rapidly Translate Knowledge into Practice			
Data visualization tools	Programs receive licenses data visualization software and training in its use.	Standard tables and graphs show state-, program- and participant-specific outcome data; programs can request customized views.	LNA, PF
Data analysis and discussion	Hub leaders and CLHS committees analyze CAB data and provide results to the CSC program programs.	Data snapshots, individual site meetings for data review, data feedback presentations, consultation with data analysis experts.	LNA, PF
Training resources for as-needed learning	Web-based training videos support training and prepare new hires for participation in monthly training/ consultation activities.	Sample topics: clinician assessments to measure psychiatric symptoms and role functioning.	PF, RCL
Training and implementing new practices through research participation	CLHS supports research projects that collect data on FEP clinical care topics.	Sample topics: brief intervention for cannabis use, understanding barriers to engagement for Black clients and families, exploring young adults' preferences and needs for school and work support.	PF, RCL
Individual Program Consultation and Problem Solving	Trainers are available to engage with any CSC program interested in implementing a new practice in their setting.	Sample topic: Training in and implementation of Social Skills Training protocol.	LNA, RCL, PF
Engage Patients and Other Important Stakeholders			
Stakeholder participation in CLHS committees	State partners and CSC staff are invited to attend and actively engage in all CLHS committees and learning activities.	LHS Committee includes CSC staff who actively contribute to planning LHS activities to ensure they are responsive to programs' needs.	LNA, RCL
Advisory Board presentations with feedback	State initiatives include an advisory board that is kept informed of the LHS and actively contributes via regular meetings and input in between meetings.	*State advisory boards include time at all meetings for CLHS updated and solicitation of ideas and input using data presentations.	LNA, RCL
Stakeholder-specific workgroups	Groups dedicated to imbuing a specific stakeholder group's perspective into CLHS activities.	Lived Experience, Family Member, and Staff/Clinician Collectives.	LNA, RCL
Diversity and disparities workgroup	Provides guidance on the use of related data in research project and thought leadership on issues related to diversity and disparities within CLHS.	Wrote a call-to-action published in mental health services journal focused on Justice, Equity, Diversity, and Inclusion in CSC (Pagdon et al., 2024).	DC, LNA, RCL, PF
Align Payment and Policy Initiatives			
State partner collaborative meetings	Meet with state funders to discuss progress, review outcomes, and make changes as needed.	State partners meet with state FEP CSC leadership and with counterparts in the other state through breakout sessions in Community of Practice meetings.	IP
Ongoing program evaluation	Assess outcomes of interest to programs and state partners in line with the FEP outcome literature.	Infrastructure for live capture of data in a Redcap interface across the network that is used for program evaluation and state reporting.	IP, AF
CSC Fidelity Assessment and Feedback	Evaluate CSC Fidelity using a known and validated tool.	Data are used for fidelity monitoring and to provide feedback with consultation/ remediation as needed.	IP, AF
EBP Fidelity Assessment and Feedback	Evaluate fidelity of individual EBPs on which programs receive training; use fidelity assessment and feedback to improve practice.	Maryland programs are trained by state trainers in IPS Supported Employment and in MFG in Family Psychoeducation. Fidelity is monitored by state fidelity-monitors that generates a formal feedback report. Pennsylvania programs can take part in training activities for these practices if desired.	IP, AF

* DC=Data Collection; LNA = Local Needs Assessment; AF = Audit and Feedback; PF=Practice Facilitation; RCL = Remote Collaborative Learning; DLC=Designation of Local Champions.

the LHS: ***Data Assessment Committee*** (select and adapt measures, train program staff to collect data, monitor data collection; and problem-solve to safeguard the data collection process); ***Data Management and Analysis Committee*** (oversees the computerized data collection interface and data management systems, analyzes data, presents accessible findings to CSC programs, aggregates and submits data to the EPINET National Data Coordinating Center); ***Practice-Based Research Committee*** (reviews requests to use CLHS data to answer research questions and provides input on practice-improvement projects); and ***Learning***

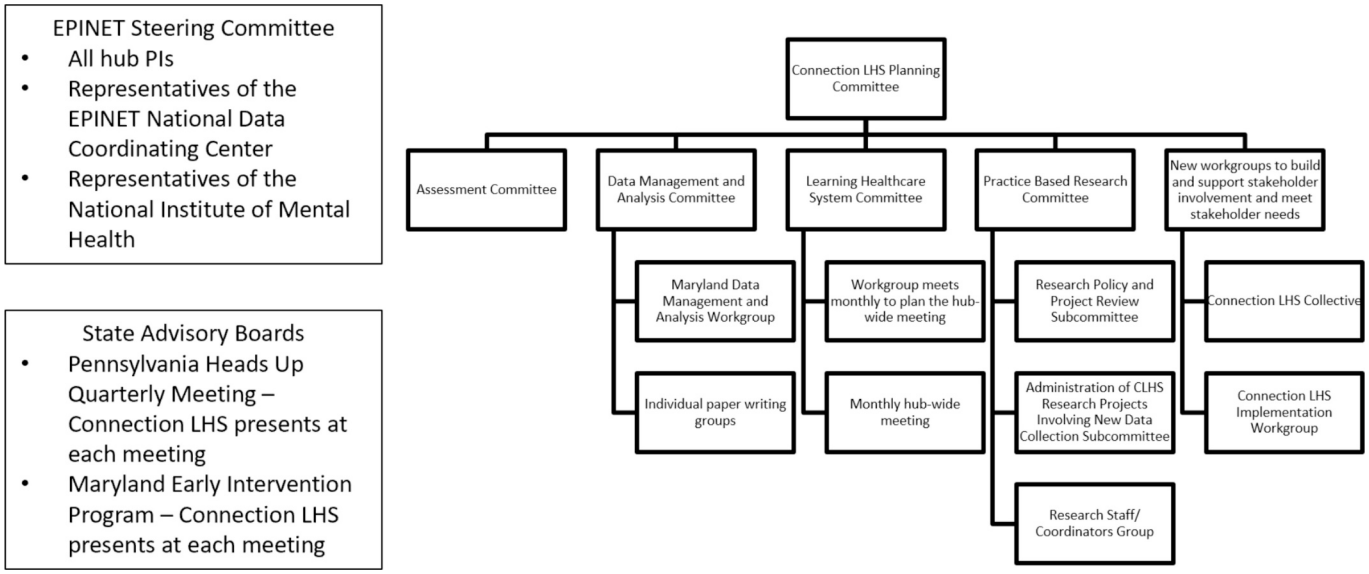

Fig. 2. Organizational Structure of Connection Learning Healthcare System.

Healthcare System Committee (offers evidence-based learning and other implementation strategies to build an LHS culture and collaboration among CSC programs). This last committee, comprised of program representatives and researchers from partnering academic institutions, assesses proposed LHS activities, structures, and implementation strategies and adapts them to fit CSC program needs. This group plans LHS training and collaboration activities that take place at ***Monthly Hub-Wide Meetings*** and evaluates how well the LHS is serving its participants.

7. CLHS activities

These structures provide the scaffolding of CLHS, from which we implement activities to achieve harmonization, generate collaboration, and inspire expanded use of best practices in care. Table 2 summarizes LHS domains and the CLHS activities we use to realize each, described in greater detail below. Table 2 also summarizes the implementation strategies reflected in these activities. The domain "Creating a learning culture" has its own section in the text but is included in Table 2.

7.1. LHS domain: Using data feedback to identify areas for improvement

CLHS collects data and provides feedback to its constituent CSC programs using a Core Assessment Battery (CAB; Calkins et al., (n.d.) under review) collected using Research Electronic Data Capture (REDCap; Harris et al., 2009). The CLHS CAB is based on the battery previously implemented in Pennsylvania, harmonized with measures selected for EPINET to support common CSC data collection nationally, with additional domains of interest to researchers, state partners, and other stakeholders. Participant-level data are collected on background characteristics, pathways to care, psychiatric symptoms, instrumental and social role functioning, physical health, medication use, and medication adherence. Of note, some domains (e.g., psychiatric symptoms, medication side effects, treatment engagement) are collected via both clinician ratings and service-user self-reports to capture both perspectives.

A key consideration is integrating data collection into clinical service without unduly burdening service providers. Integrating the CAB with each site's electronic health record might have been easiest for CSC staff. However, because CLHS spans several academic centers and hospital systems with no common electronic health record system, that was not possible. CLHS, in collaboration with HeadsUp, supports CAB data collection and reduces burden via: 1) a standard data collection protocol with associated training; 2) points of contact that programs can access with questions; 3) regular meetings with CLHS staff to review data, address challenges, and identify ways programs can use CAB data for required reporting and measurement-based care; and 4) dedicated staff at Maryland programs to assist in tracking assessment due dates, sending measures via email links to the site staff who collect them, and collecting self-report assessments from service users. CAB data collection has consistently increased since we began in January 2021; CAB completions by timepoint are summarized in Calkins et al., (n.d.) under review. As of January 2025, over 1600 participants are represented in the CLHS CAB dataset. CLHS itself measures compliance with CAB collection (one type of fidelity) and shares this information with CSCs.

7.2. LHS domain: Rapidly translating knowledge into practice

Using data to improve practice is the goal of a successful LHS and the primary mission of EPINET. CLHS has created mechanisms to support knowledge translation.

7.2.1. Data visualization tools for measurement based care

All the CSC programs in our MD-PA hub receive licenses for Tableau (www.tableau.com), a data visualization software, and training in its use. We created standard tables and graphs allowing programs to see state-, program- and participant-specific outcome data; programs can request customized views based on their needs and interests. In this way we encourage programs to use data to inform measurement-based care and programmatic decision-making.

7.2.2. Analysis and discussion of CAB data

CLHS committees analyze CAB data and provide results to the programs in several ways: 1) Data snapshots - 1-page visualizations of data focused on a particular clinical topic – are publicized via a weekly dissemination email and posted on the CLHS website. 2) Hub leaders meet with individual programs to review their experiences collecting CAB data, share data patterns, and suggest ways to use their data as a part of clinical care. 3) Twice a year, data feedback presentations and related discussions take place within the CLHS Monthly Hub-Wide Meeting (discussed further below). These offer the opportunity to share data and discuss clinical questions of highest interest to CSC programs. 4) Consultation with the Data Management and Analysis Committee is available to researchers, clinicians, and program staff to

brainstorm ways to apply findings. 5) The Practice-Based Research Committee regularly discusses research findings and their clinical application.

7.2.3. Access to web-based training resources for as-needed learning

Web-based videos can support training and prepare new hires for participation in monthly training/consultation activities. Both Pennsylvania HeadsUp and the Maryland EIP provide on-line, web-based trainings on a wide array of recovery-oriented best practices such as Recovery Oriented Cognitive Therapy; introduction to Motivational Interviewing; safety planning; and stigma intervention for young people with psychosis. All are available on-demand to all in CLHS.

7.2.4. Program-to-program discussion and consultation

CLHS has a regular schedule of workgroups and meetings that allow programs to communicate and share practice innovations. The CSC Staff and Clinician Collective (fully described below) is a place where programs share ideas. For example, in its recent meeting, a Peer Support Specialist from Maryland shared an initiative they are developing for future implementation focused on celebrating treatment milestones with service users. Staff and clinicians from various programs provided input, asked for progress updates, and expressed interest in future implementation in their locales. Some programs have written papers about their experiences as a way of disseminating their knowledge to CSC programs in CLHS and beyond (Sepahpour et al., 2023; Wood et al., 2024).

7.2.5. Training in new practices and practice implementation through research participation

CLHS supports new research projects that collect data on FEP clinical care topics. These projects have separate funding and currently focus on 1) cannabis use; 2) understanding barriers to engagement for Black clients and families; 3) exploring preferences and needs for school and work support; and 4) piloting a group recovery-oriented intervention for family members to better support their loved ones' recovery. Focus areas were identified by listening to CSC program, client, and family needs. For example, improving conversations about cannabis came out of a clinician survey asking what issues they found the most challenging. Because cannabis use topped the list, researchers built a study to better understand the dynamics of use and helpful ways to talk about cannabis from the perspectives of services users, family members, and clinicians. As this project has progressed, CLHS has fed findings of each stage back to the programs, which have provided ideas for moving findings into practice.

Such projects provide opportunities and guidance for pilot implementation of new evidence-based or evidence-informed practices. For example, the cannabis project produced a manual and training seminar for clinicians to learn the new conversation guide in their practice. Another study trained interested programs in providing a family group intervention and collected data from staff and family member participants on their experiences to refine implementation. In both examples, training remains available to interested clinicians, who then offer information about their experience using these new skills in their work.

7.2.6. Individual program consultation and problem solving

CLHS trainers engage with any program interested in implementing a new practice. For example, CLHS held a 2-day virtual training workshop in Social Skills Training for Schizophrenia (Mueser et al., 2024), a recovery-oriented, evidence-based group intervention for improving social functioning. Attendees were offered follow-up individual consultation to support site-level implementation. One site engaged in this consultation: over 3 months and with the approval of their supervisor, the trainer met regularly with a Supported Employment and Education Specialist and a Peer Support Specialist at to plan a new Social Group, discuss ways to let clinicians and service users know how to enroll, role play delivering the session content, and review ways to balance skills training and practice within and between each session. After completing the first four group sessions, the staff and trainer held a follow-up call for problem solving and future planning.

7.3. LHS domain: Engage patients and other important stakeholders

CLHS supports engagement of stakeholders impacted by CSC. First, state partners and program staff are invited to attend and engage in all committees and learning activities, which are disseminated in a weekly email blast. For example, the LHS Committee includes program staff who actively contribute to planning to ensure that learning activities are responsive to program needs. Second, CLHS partners with stakeholders through the advisory boards of HeadsUp and the Maryland EIP. Both include standing agenda items for updates from CLHS and opportunities to solicit input on hub activities. CLHS data summaries are regularly presented at these advisory board meetings so that state advisors can participate in using the data to understand and improve services. Third, CLHS has three workgroups - called Collectives – each dedicated to imbuing a specific stakeholder group perspective into CLHS activities, similar to the role of an advisory board. The ***Lived Experience Collective*** is co-facilitated by a CLHS Peer Specialist and a CLHS investigator who has lived experience of psychosis and is comprised of program participants and peer support specialist staff; this group develops initiatives to support the engagement of adolescents and young adults in CLHS activities. Recent areas of focus include developing and disseminating a CLHS Newsletter and creating a youth advisory board. The ***Family Member Collective*** is a meeting for family members of CSC participants, co-led by CLHS staff who are family members of people with mental health conditions. It provides suggestions and critique of CLHS initiatives to integrate family perspectives. Recent topics include how to improve outreach so families in need can more easily find CSC programs and the development of an initiative in which new CSC families are paired with families who have participated for a longer period to offer support. Third, the ***CSC Staff and Clinician Collective*** is clinician-driven, welcomes CSC staff from all positions, and focuses on identifying site-based innovations using data to improve practice, insights from practice to improve data, and communicating these innovations across the hub. Finally, ***the Diversity and Disparities Workgroup*** provides thought leadership on issues related to diversity and disparities within CLHS and offers guidance on the use of CLHS data to examine related issues. A good example of the activities of this workgroup was collaborative writing of a call-to-action focused on Justice, Equity, Diversity, and Inclusion in CSC (Pagdon et al., 2024).

7.4. LHS domain: Aligning payment and policy initiatives

State partners provide CLHS with a policy-oriented view of services. They serve on committees, are invited to all hub activities, and have met in a State Representatives Community of Practice meeting to discuss shared interests related to funding and policy. Both HeadsUp and the Maryland EIP summarize CAB data in reports to state representatives to keep them informed of participant and program outcomes, enabled by state reporting requirements allowing CAB data to be used for this purpose. State representatives have also been involved in CSC fidelity efforts in both states. In Pennsylvania, an adapted fidelity scale and annual site assessment process in place since 2018 has continued since EPINET began (Jumper et al., 2024). HeadsUp provides PA OMHSAS with annual site-specific reports and an aggregate report of CSC program fidelity across Pennsylvania. Similarly, the Maryland EIP collaborates with the MD BHA to develop and implement CSC fidelity monitoring across the state.

8. Creating a reliable learning culture in CLHS

A learning culture makes work more interesting and rewarding (Senge, 1990), bonds CLHS members together via shared values, and

supports sustainment of LHS domains over time (Fernandes et al., 2023). Culture can be built via intentional mechanisms, such as hiring for specific values or use of rituals and institutionalized stories to build shared lore (Schein and Schein, 2016). Cognitive dissonance suggests that beliefs and values will come to match the habits people build to avoid the discomfort of beliefs that are inconsistent with actions (Gruber, 2003; Keiser and Bickle, 1980). Thus, by engaging LHS participants in learning activities within a framework of high reliability principles, we aimed to create a lasting learning culture in CLHS (see Table 3 for examples of high reliability principles and corresponding CLHS activities).

One of the main culture-building approaches of CLHS is the virtual ***Monthly Hub-Wide Meeting***. Using a learning collaborative structure, these broad gatherings serve as an important vessel for communication, collaboration, learning, and feedback. We approach the meeting process as a form of group study aimed to develop and expand LHS characteristics (in leadership, culture, technical infrastructure, evidence-based delivery of care and embedded research) within and across CSC programs.

We invite all clinicians, non-clinician staff (e.g., supported employment and education specialists, peer support specialists), researchers, and state partners to engage in shared learning, review data, offer experiences and challenges for discussion, assess and alter plans for applying what we learn together to clinical decision-making, and adapt practice toward improved CSC services. Attendance between September 2021 and January 2025 averaged around 50 people (range 32–81) (estimated to be about 1/3 of CLHS membership). The LHS Committee identifies meeting topics by asking CSC representatives or via analysis of CAB data and invites guest speakers. Fig. 3 shows the meeting's schedule of activities, which are intentionally designed to support aspects of the LHS.

Table 3
Creating a Learning Culture for the Learning Health System.

HRO Principles (Weick and Sutcliffe, 2015)	Definitions	CLHS Structures and Activities
Preoccupation with failure	Being on alert for glitches to promote smooth functioning	*Planning Committee *LHS Committee *Data Visualization Tools for Measurement Based Care
Reluctance to simplify	Being inquisitive and digging in for deeper explanations	*Practice-Based Research Committee *Data Assessment Committee *Data Management and Analysis Committee *Data Visualization Tools for Measurement Based Care *Analysis and Discussion of CAB Data
Sensitivity to operations	Gathering data and understanding trends at the point of care	*All committees have frontline representation *CSC Staff and Clinician Collective *Lived Experience Collective *Family Member Collective *Diversity and Disparities Workgroup *Data Visualization Tools for Measurement Based Care *Analysis and Discussion of CAB Data
Commitment to resilience	Learning from things that go wrong	*LHS Committee *Implementation Workgroup *Analysis and Discussion of CAB Data *CSC Staff and Clinician Collective *Practice Facilitation
Deference to expertise	Making decisions based on data and expert perspectives rather than based on authority or hierarchy	*All committees have frontline representation *Data Visualization Tools for Measurement Based Care *Analysis and Discussion of CAB Data

8.1. *Quarterly evidence-based practice didactics and discussion*

Didactic presentations reinforce shared understanding and learning culture while supporting continuous service improvement. In January–April 2023 we administered a RedCap survey assessing utility of meeting topics for internal quality improvement purposes. Overall, 97 % of the 50 respondents felt that this series had a moderately or significantly positive impact on their daily practice (6 % missing; no significance testing). Topics include an orientation to the Learning Health System (with 78 % reporting positive impact on daily practice) and issues known to be important to CSC delivery, such as racial disparities in early psychosis (86 % positive), addressing substance use in FEP (82 % positive), and engaging natural supports for long-term recovery (74 % positive). Other presentations highlight issues that are new to CSC with important potential implications for its delivery, such as incorporating spirituality into therapy and sharing experiences connecting with young people and families during the COVID19 pandemic (Dong et al., 2023a, b; Nelson et al., 2022).

8.2. *Quarterly site overview and case presentations*

Over the first two years of CLHS, programs delivered introductory presentations describing their programs, staffing, populations served, example best practices and key challenges. This allowed all programs to familiarize themselves with one another, learn about practice innovations, and initiate collaboration and consultation relationships. Ongoing, programs share anonymized client-case presentations engaging LHS members in discussion about service user needs and practice challenges.

8.3. *Quarterly communities of practice and interest groups*

Breakout groups afford opportunities for staff in the same role across programs to share best practices and jointly problem-solve around key challenges. For example, the Communities of Practice groups include prescribers, non-prescribing clinicians such as counselors, social workers, and psychologists, state funders, Peer Support Specialists and Supported Employment and Education Specialists. Recently, the latter two groups have presented their work to the Hub-wide meeting in a panel format. We also added cross-role interest groups around special topics including diagnostic changes over adolescence/young adulthood, cannabis legalization and its impact on treatment, factors affecting treatment engagement, and psychiatric comorbidities.

8.3.1. *Bi-annual data feedback and discussion meetings*

In these hub-wide sessions, presenters describe findings from CLHS or national EPINET data and lead discussion about implications for clinical practice. For example, a CLHS researcher integrated CAB data on suicidality into a presentation about best practices for reducing suicidality in FEP. A frontline psychologist and LHS Committee member presented on how individual CSC programs can use Tableau to visualize CAB data at their CSC level to generate practice insights (with 92 % of 2023 survey respondents reporting they would be moderately/definitively likely to use CAB data as discussed). The CLHS lead described data from the cannabis research project and led discussion of how CSC

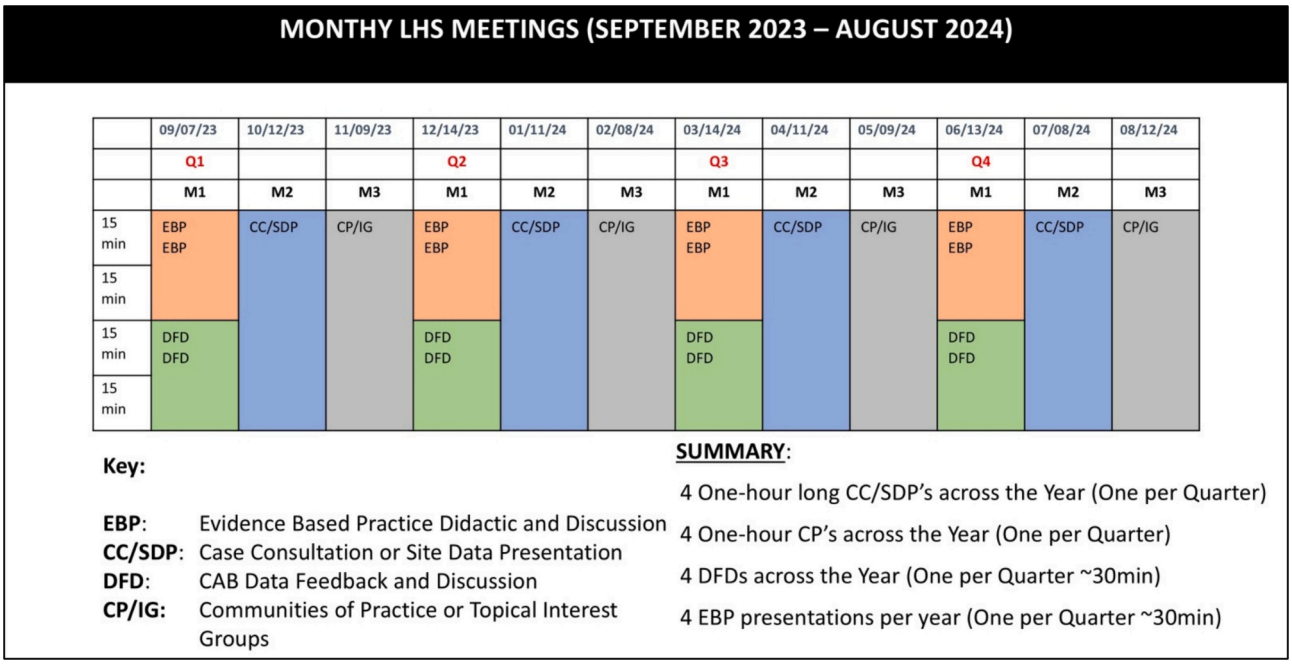

Fig. 3. Sample Schedule of Activities at the CLHS Monthly Hub-Wide Meeting.

programs might use the data to inform their practice (96 % found the presentation moderately/very helpful).

Outside of Hub-wide meetings, each state offers a selection of training workshops that have been opened to the entire CLHS. Examples of these collaborative learning opportunities include an annual virtual week-long training in Recovery Oriented Cognitive Therapy (CT-R; offered by Pennsylvania HeadsUp), twice yearly virtual Social Skills Training for Schizophrenia offered by the Maryland EIP, and the annual Pennsylvania FEP Conference with presentations delivered by clinicians and researchers throughout the hub and programming geared toward both new and continuing team members.

We have developed and disseminated a range of resources to support our culture of continuous learning toward reliable outcomes. The ***CLHS website*** (Connection Learning Healthcare System Connection Learning Healthcare System: Regional Hub of the Early Psychosis Intervention Network (EPINET) | University of Maryland School of Medicine) lists contact information for all programs (to assist in reliable referrals to local care) and includes a page for contacting the hub leadership with questions CLHS data can address. For internal LHS use, we created a ***cloud-based SharePoint site*** to archive recordings and materials from all presentations, trainings, and workgroups for use by any CSC staff. The site includes learning resources for clinicians (e.g., materials from trainings on family psychoeducation) and non-clinicians (e.g., resources for developing an Individualized Education Plan from a workshop for Supported Employment and Education Specialists), CAB training resources (e.g., training recordings, practice vignettes), and notes from committee meetings. Through the Data Management and Analysis Committee, all data users have **access to data managers, data analysts, and statisticians** to support the continuous learning mission via research project guidance for non-traditional researchers through specific interest groups, consultations to write papers, present data in clinical or research venues, and complete required reports. Pennsylvania's HeadsUp program also creates and disseminates a **weekly email listing of upcoming training and educational presentations and opportunities** for all CLHS CSC staff, allowing them to keep track of upcoming activities and learn about new ones.

9. Lessons learned and future plans

EPINET afforded the opportunity to integrate two state FEP implementation programs into a single overarching LHS. We have established a collaborative structure within which to participate in non-hierarchical shared learning, launched a shared system for data collection and analysis, and developed mechanisms for using the data to improve services and communicating findings more broadly. As a cross-state LHS, our experience may differ from others described in the literature (Humensky et al., 2020; Niendam et al., 2019; Oluwoye et al., 2024) in having an added layer of complexity from collaborating with two state behavioral health systems, each with its own policies, priorities, and funding structures. Close collaboration with state partners is always essential and likely even more so when integrating activities across two states. It did provide opportunities for each state to learn from the other. For example, Pennsylvania had developed and implemented a CSC fidelity tool prior to the start of CLHS. When Maryland began their fidelity process development effort, CLHS was able to present the Pennsylvania experience as a starting point for thought and idea development. Similarly, Maryland's CSC training infrastructure includes a dedicated Peer Support Specialist Trainer/Consultant who could open training presentations and discussions to peers at Pennsylvania sites, increasing their opportunities for learning and networking. In these ways, each states' experience supported new activities in the other. CLHS can offer its experience as more multi-state, integrated FEP LHSs take shape.

An important lesson learned is that stakeholders face different barriers and facilitators to LHS involvement. For example, while LHS leaders want and invite robust participation from CSC programs and staff, these professionals have full-time, demanding jobs providing mental health services. The NIMH funding supporting the work of CLHS committees does not fund CSC frontline staff time to take part in them, nor in joining in communities of practice and other opportunities that fall outside of CSC program deliverables. Our CLHS constituent CSC programs are also impacted by staff turnover, staffing shortages, and unpredictable clinical needs that limit time available to participate in CLHS activities. In our start-up experience, these abiding factors were exacerbated by the COVID19 pandemic and its disruptions to providing CSC services (Dong et al., 2023a, b; Nelson et al., 2022). While these processes have settled somewhat into a "new normal' including the

widespread use of telehealth services which increase access for service users, CSC sites continue to grapple with challenges that present barriers to site time, buy-in, engagement, and daily involvement in CLHS. Our Staff and Clinician Collective has started to address these issues by identifying ways to reduce obstacles, showcase how LHS involvement has benefitted their programs, and craft procedures for partnering with low-involved programs (site-to-site consultation). One CLHS researcher is conducting in-depth interviews with site staff to learn about challenges collecting data and fully integrating in CLHS. Our goal is to learn about program and staff needs and find ways to address them.

A second lesson has come in determining effective ways to engage service user and family member stakeholders in the LHS. CLHS at first relied on the advisory boards of HeadsUp and the Maryland EIP to reach these stakeholders. While somewhat useful it was unsuccessful in bringing them into active LHS involvement. To more actively solicit participation and input from persons with FEP and their family members, we established the CLHS Lived Experience and Family Member Collectives to support participation of people with lived experience of psychosis and their loved ones in bringing their experiences to bear on ways our CLHS can become more inclusive, accessible, and relevant to their needs and priorities. Our advice to others seeking to establish a similar LHS is to have all stakeholder groups substantially represented from the earliest stages of LHS planning.

Finally, using data to continuously improve clinical care, a hallmark of an LHS, requires creativity, dynamic navigation, and ongoing conversations. Data and findings mean different things to researchers, clinicians, administrators, state partners, young people with FEP, and family members. Programs and staff have varying levels of comfort and experience with data collection, analysis, consuming findings, and integrating them into service delivery. Establishing CAB collection as a routine part of practice at some programs, and garnering interest in how data can be clinically useful to daily service provision, continue to be areas for improvement in our realization of the LHS. We are also working to develop new and creative channels for dissemination of uses for and findings of the data to more CLHS stakeholders. HeadsUp and the Maryland EIP have separately paid special attention to this issue and put time and resources into developing materials that summarize data and findings that are disseminated online and via social media. It will be important for CLHS to capitalize on these resources to promote implementation.

Moving forward, we plan to initiate practical evaluations of several CLHS components. We look forward to designing and implementing a hub-wide project to reduce CSC disengagement – our first research-to-practice initiative to include all CSC programs in both states. We are also planning ways to expand avenues for integrating input from participants with lived experience of psychosis and CSC into all aspects of CLHS. Additionally, we plan to use the RE-AIM framework (Glasgow et al., 2019) to examine implementation outcomes such as Reach (the proportion of an eligible population that receives an evidence-based service), Effectiveness (clinical outcomes of treated patients, including those with diverse backgrounds), Adoption (the uptake of LHS activities and FEP practices), and Maintenance (continuation of activities over time) - to evaluate CLHS success. We also are considering adapting the HRO literature Mindful Organizing Scale (Vogus, 2011) to assess the presence of a learning culture within CLHS. As we identify ways to operationalize measurement of these implementation and culture factors, we are also planning evaluation processes to be ongoing and to iteratively inform our CLHS activities.

10. Conclusion

CLHS brings together clinicians, staff, and researchers from two state systems serving young people with FEP. We have established structures that embody most LHS domains and have made strides toward building a learning culture and engaging young people with FEP, their families, and other stakeholders. We continue to build mechanisms for rapid translation of knowledge into practice in a unified hub-wide initiative. We continue efforts to achieve capability in the five LHS domains to ultimately deliver the most effective FEP services.

CRediT authorship contribution statement

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Declaration of competing interest

Robert W. Buchanan has consulted for Boehringer-Ingelheim; serves on the Data Safety and Monitoring Boards of Roche, Merck and Newron; and has served on the Advisory Boards of Merck, Acadia, Karuna, and Neurocrine. All other authors have no declarations.

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