INNOVATION CENTER PROGRESS REPORT
DECEMBER 2023

CDSiC Innovation Center:
Quarterly Report

PURPOSE

The CDS Innovation Collaborative (CDSiC) Innovation Center prepares a publicly available quarterly progress report to provide a summary of the status of all projects and activities being conducted within the CDSiC Innovation Center's two Cores and Planning Committee during the reporting period.

Table of Contents

Introduction

NORC at the University of Chicago (NORC) is pleased to submit the fourth 2023 quarterly report to the Agency for Healthcare Research and Quality (AHRQ) on the Clinical Decision Support Innovation Collaborative (CDSiC) Innovation Center. This quarterly report provides the first summary of the status of new projects and activities being conducted within the CDSiC Innovation Center in year three. Prior reports cover projects and activities conducted in years one and two.

The CDSiC aims to advance the design, development, dissemination, implementation, use, measurement, and evaluation of evidence-based, shareable, interoperable, and publicly available patient-centered clinical decision support (PC CDS) to improve health outcomes of all patients by creating a proving ground of innovation. Products put forth by the CDSiC will provide innovative solutions that promote the adoption of PC CDS to facilitate whole-person, evidence-based care and improve patients' health and care experience. Ultimately, the CDSiC aims to create a world where patients, caregivers, and clinicians have the information needed to make decisions that improve health and well-being for all individuals.

The CDSiC Innovation Center is the real-world test bed of the CDSiC, leading the development and application of CDSiC tools, learnings, and insights. The Innovation Center consists of a Planning Committee and two Cores:

- **Core 1. Measurement and Value of CDS:** The purpose of this Core is to standardize the measurement of all aspects of PC CDS and demonstrate PC CDS utility through the implementation of safe and effective PC CDS.

- **Core 2. Conducting and Coordinating CDS Projects:** The purpose of this Core is to test PC CDS projects in real-world settings to ascertain best practices for implementation and monitoring to ease last mile implementation challenges.

Status Report

This quarterly report provides a summary of the status of all projects and activities being conducted within the CDSiC Innovation Center from October 2023 through December 2023. Over this period, the Innovation Center has focused on planning and developing four projects for the third year of the CDSiC.

Innovation Center Cores

The Innovation Center Cores are tasked with developing and completing four projects that advance PC CDS research. Based on discussions with AHRQ and the Planning Committee, Innovation Center leadership identified projects aimed at addressing gaps in measuring and monitoring PC CDS performance and using novel technology to facilitate PC CDS. The overarching goals of these projects are to validate a comprehensive performance measurement framework and to develop chatbot

prototypes to help patients, clinicians, and CDS developers understand real-world implementation and measurement considerations for PC CDS and any unintended consequences.

The projects vary in terms of expected length of time to complete based on scope, falling into one of three Levels.

- Level 1 projects are the largest in scope, involving significant effort and multiple modes of research or real-world assessments, with the expectation of tangible results.

- Level 2 projects involve a medium amount of effort and one mode of research or real-world assessment.

- Level 3 projects are shorter-term and may be proof-of-concept ideas or pilots.

Core 1 is undertaking two Level 3 projects and Core 2 is undertaking one Level 2 and one Level 3 project. The projects are being conducted concurrently and in an iterative manner, with findings from one project informing the others to enhance and refine outputs.

## Core 1: Measurement and Value of CDS

Significant gaps exist in the tools, techniques, and standards required to accurately measure and monitor the performance of various forms of PC CDS across the design, development, implementation, and use spectrum. To address these gaps, Core 1 is undertaking two projects: 1) conduct a cross-cutting assessment of PC CDS measurement in the real-world, and 2) evaluate Core 2's prototype PC CDS tools (see details in Core 2 section below).

1. Cross-cutting Assessment of Real-World Experience in PC CDS Measurement

In years one and two of the CDSiC, the Innovation Center developed a new comprehensive PC CDS performance measurement framework that includes key domains, subdomains, and levels of measurement that CDS developers and others should consider when assessing PC CDS interventions (see Exhibit 1). The goal of this framework is to provide a basis for consistent measurement of PC CDS design, development, implementation, use, and evaluation across the structure, process, and outcome spectrum.

In the third year of the CDSiC, the Core 1 team will begin testing the framework by examining how current AHRQ-funded projects are evaluating and measuring real-world PC CDS projects. The four aims of the projects are to: 1) identify process and outcome measures being used to assess PC CDS projects; 2) gather perceptions on the measures used, limitations, and challenges; 3) understand factors that drive PC CDS adoption and use and how they impact measurement; and 4) develop an action plan for advancing the development and use of PC CDS measures.

Exhibit 1. The Patient-centered Clinical Decision Support Performance Measurement Framework
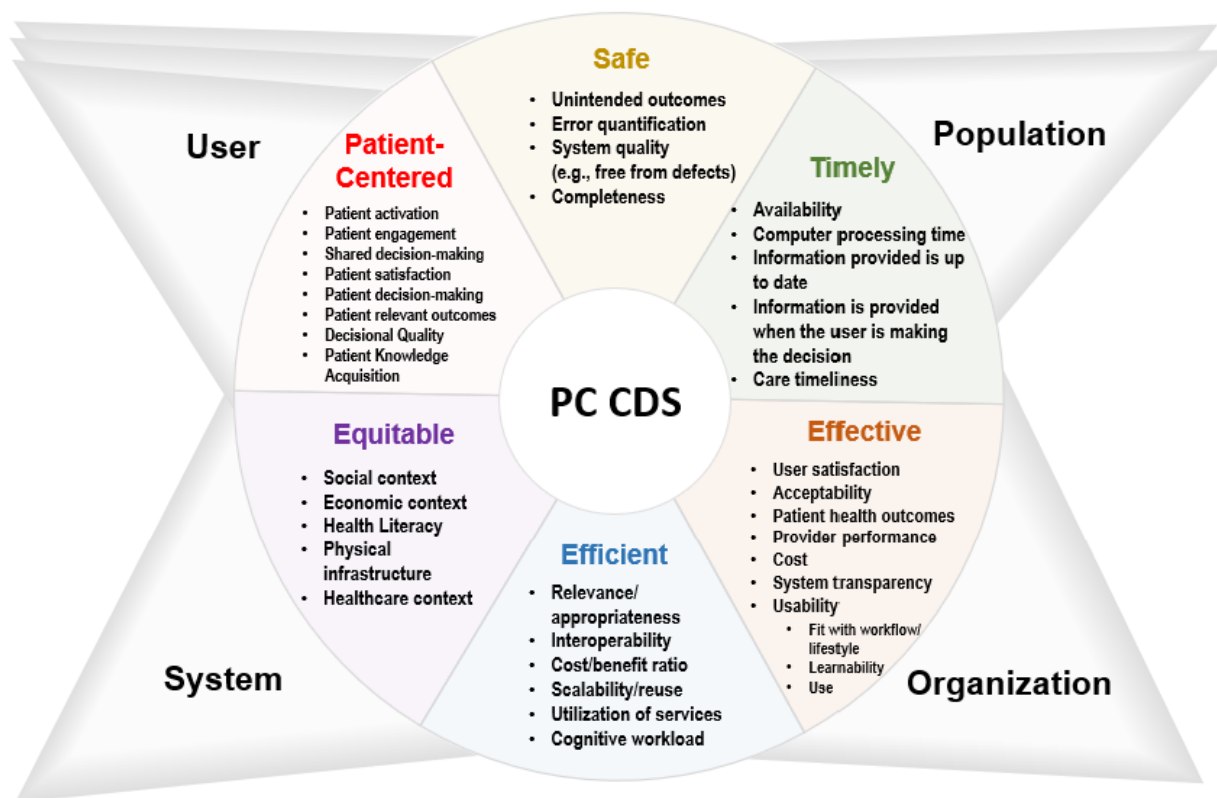
In Q4, the Core 1 team reviewed PC CDS projects funded under AHRQ's R18 (Utilizing Health Information Technology to Scale and Spread Successful Practice Models Using Patient-Reported Outcomes)[1] and U18 grants (Implementation and Evaluation of New Health Information Technology Strategies for Collecting and Using Patient-Reported Outcome Measures),[2] as well as projects in the Digital Healthcare Research Program: 2022 Year in Review.[3] Inclusion criteria included projects that would be completed by 2024, have a PC CDS component, and have an evaluation component.

The team identified 20 projects to include in the assessment. Projects varied by types of data and technology leveraged as well as the user population and condition addressed (see Exhibit 2).

Exhibit 2. Characteristics from Review of AHRQ-funded PC CDS Projects

Category	Characteristics
Types of Data	Biometric/physiological, patient preferences, PROs, social determinants of health (SDOH)
Types of Technology	Artificial intelligence (AI), electronic health record (EHR) dashboards, mobile/web applications, patient portals, wearable technology
User Population	Caregiver, patient, provider, pharmacist

Category	Characteristics
Medical/Social Condition	Attention-deficit/hyperactivity disorder (ADHD), asthma, cancer, COVID-19, dental pain, dementia, diabetes, depression, HIV, intimate partner violence, multiple chronic conditions, osteoarthritis, preconception risks

Next, the Core 1 team reviewed the published materials for each project (e.g., final reports, manuscripts, presentations) to gather information regarding the phase of PC CDS (i.e., design, development, implementation, use, evaluation), the measures used, and the challenges described related to measurement. The team categorized measures into domains and subdomains of the PC CDS performance measurement framework and noted areas of saturation and gaps in the framework.

Finally, the Core 1 team selected 9 projects to include in key informant interviews based on a variety of data types, technology, phases, measures, user populations, and conditions represented. They began developing the discussion guide and conducting outreach for interviews that will be held in January 2024.

Deliverables Submitted in Q4:

- A Project Outline & Timeline that describes the aims, scope, methods, deliverables, and timeline for the cross-cutting assessment.

Dissemination Activities

- Core 1 presented planned project ideas to the Innovation Center Planning Committee in October and the CDSiC Steering Committee meeting in December.

- Core 1 presented a poster presentation about the prior year's workflow execution models at the American Medical Informatics Association (AMIA)'s Annual Symposium in November.

2. Evaluation of Core 2's Prototypes

To build upon the findings from the cross-cutting assessment, Core 1 will conduct two evaluations of Core 2's prototype tools. The team will leverage the PC CDS performance measurement framework and any additional findings from the cross-cutting assessment to determine measurement domains and subdomains for each project evaluation. Further details about each project's evaluations can be found in the next section.

Core 2: Conducting and Coordinating CDS Projects

Artificial intelligence (AI) can facilitate the collection and use of patient information for PC CDS to provide summative, distilled information to clinicians, leaders and patients making health care decisions. In recent years, large language models (LLMs) like OpenAI's ChatGPT[4] have been increasingly utilized in health care applications, namely in the areas of education, triage, and contextual question-answering.[5, 6] The evidence reported has been mostly positive in terms of effectiveness and user satisfaction, with evaluators indicating some responses from chatbots to be more empathetic and

higher quality compared to those from physicians.[7] However, there are several considerations for the use of AI in decision support tools, and more studies are needed exploring patient and provider perspectives on the subject. To address these gaps, Core 2 is undertaking two projects: 1) design, develop, and implement a chatbot prototype to support medication adherence; and 2) design and develop a chatbot prototype to support patient-provider communication.

1. Design, Development, and Implementation of Chatbot Prototype to Support Medication Adherence

In this project, Core 2 will co-design, develop, and implement a pilot study of a text-messaging application (app) to help patients improve adherence to medication for a chronic disease. Working with a health system partner, the app will leverage an AI-based tool called "Quartz" to text patients who have recently started medication treatment or whose medications were modified to ensure that a) patients begin and continue taking their medications as prescribed, and b) the medications have the desired effect. Quartz will ask questions in the patient's preferred language but will not provide medical advice. Quartz will be integrated with the electronic health record (EHR) using Substitutable Medical Applications and Reusable Technologies (SMART) on Fast Healthcare Interoperability Resources (FHIR®)[8] to allow providers to monitor the patient's medication use between visits and intervene if necessary.

The Core 1 team will conduct a mixed methods evaluation of the Quartz intervention. The team will use a combination of qualitative input from the implementation and clinical care teams involved in the pilot, as well as gather patient input via key informant interviews. Quantitative metrics related to usage and engagement will also be collected and assessed. Overall, the evaluation will assess 1) the technical feasibility of the design, development, and implementation of the chatbot; 2) the appropriateness of the chatbot in clinical use; and 3) the post-implementation impacts and acceptability of the chatbot.

In Q4, the Core 2 team completed the necessary background research to draft a Specifications & Requirements document for Quartz. The team reviewed existing literature on AI-based CDS interventions, patient-facing medication adherence interventions, and published PROs and instruments for medication adherence to gather design and development protocols and considerations for implementation.[9,10,11] The submitted Specifications & Requirements document outlines the background research for the project, the technical approach, and model conversations for various scenarios. The Core 2 team also began conversations with potential health system partners about serving as a pilot site.

The team will engage patients in co-designing Quartz to ensure the tool is designed and developed with patient needs around medication adherence in mind. In Q4, the team reviewed the CDSiC's patient partners and identified two candidates whose experiences as patients and work in patient advocacy would be valuable for informing the tool. The team conducted outreach to these individuals and began discussions with them about their involvement in the co-design process.

Deliverables Submitted in Q4:

- A Project Outline & Timeline that describes the aims, scope, methods, deliverables, and timeline for the medication adherence chatbot prototype.

- The Quartz Specification & Requirements document that describes the background, technical approach, and model conversations for the app.

Dissemination Activities:

- Core 2 presented planned project ideas to the Innovation Center Planning Committee in October and the CDSiC Steering Committee meeting in December.

- Core 2 presented a poster presentation about the prior year's visualization apps for patient-generated health data (PGHD) at AMIA's Annual Symposium in November.

- Core 2 supported AHRQ and CDSiC-wide dissemination activities (e.g., LinkedIn posts, newsletter distribution) for a manuscript developed in year two on PGHD visualization that was published in the Applied Clinical Informatics Journal (ACI). AMIA also featured the manuscript in an email distribution to members.

2. Design and Development of Chatbot Prototype to Support Patient-Provider Communication

In this project, Core 2 will co-design and develop an interactive LLM-powered prototype that will serve as an intermediary between patients and providers via the patient portal, called PAIGE: Patient Artificial Intelligence Guided E-messages. They will partner with Vanderbilt University Medical Center® (VUMC) to extract a sample of patient portal message and provider responses as well as traditional triage handbooks to train ChatGPT to ask similar clarifying questions on the providers' behalf. They will also integrate additional medical information from the EHR (e.g., current medication lists, recent laboratory test results) to conditionally tailor the questions and responses to each patient. They will conduct laboratory testing to assess the quality and completeness of the LLM-generated summaries and assess patient and provider perceptions of the prototype. The team expects to see improved accuracy and efficiency of provider responses and strengthened communication between patients and providers.

The Core 1 team will conduct an evaluation of PAIGE. The evaluation will focus on patient and provider perspectives of the system within relevant domains of the PC CDS performance measurement framework (e.g., efficiency, safety, patient-centeredness). The team will assess the design and development of the chatbot, the laboratory testing of the chatbot with providers, and the comparative performance of the chatbots responses versus those generated by providers.

In Q4, the Core 2 team conducted the background research for design and development protocols and considerations. The team reviewed the existing literature on chatbot interventions and LLM-powered CDS. They also held discussions with providers and researchers on using AI in this setting. They began drafting the Specifications & Requirements document that is due to AHRQ next quarter.

The team will also engage patients in co-designing PAIGE to ensure the tool is designed and developed with patient needs around chatbot messaging in mind. In Q4, the team reviewed the CDSiC's patient partners and identified two candidates whose experiences as patients and work in patient advocacy would be valuable for informing the tool. The team conducted outreach to these individuals and secured their involvement in the co-design process.

Deliverables Submitted in Q4:

- A Project Outline & Timeline that describes the aims, scope, methods, deliverables, and timeline for the patient-provider chatbot prototype.

Dissemination Activities:

- Core 2 presented planned project ideas to the Innovation Center Planning Committee in October and the CDSiC Steering Committee meeting in December.

Innovation Center Deliverables

In Exhibit 3, we outline each Core's project deliverables to date, as well as the future deliverables in progress.

Exhibit 3. Summary Table of Deliverables

Project	Status
Innovation Center	
Project Outline and Timeline	Complete
Revised Charter	Complete
Revised Operational Framework	Complete
Core 1	
Cross-cutting Assessment Report	In Progress
Patient-Provider Prototype Evaluation Report	Not Started
Medication Adherence Prototype Evaluation Report	Not Started
Core 2	
Medication Adherence Prototype	
Specification & Requirements Document	Under AHRQ Review
Medication Adherence Prototype	In Progress
Patient-Provider Communication Prototype	
Specification & Requirements Document	In Progress
Patient-Provider Prototype Demonstration	In Progress

Planning Committee

The Planning Committee met once during this quarterly reporting period on October 12, 2023. During the meeting, members were asked for input on the four planned project ideas outlined above. First, each Co-Lead presented the project ideas, including the medical significance, aims, methods, and final products. After each project presentation, Co-Leads provided at least 10 minutes of Question & Answer for the Planning Committee members to provide feedback.

- For the cross-cutting assessment, members discussed the importance of understanding factors that impact PC CDS measurement, such as challenges with patient engagement.

- For the Medication Adherence Prototype, members suggested different workflows and goals for patients based on the severity of their condition and level of adherence. To do this, they suggested incorporating patient-specific information from the EHR, such as psychographics or social needs. They also suggested having plans in place for common barriers to medication adherence, such as transportation, cost, or symptoms.

- For the Patient-Provider Prototype, members felt strongly that providers should not be excluded from the patient interaction, but rather the prototype could provide the triage steps traditionally conducted by care team members.

- For the two prototype evaluations, members emphasized the importance of capturing patient and care team perspectives as well as distinguishing process and outcome goals.

The next Planning Committee meeting is scheduled for February 7, 2024. The Committee will review materials related to Core projects and help raise awareness of Core activities within the broader CDS community.

Next Steps

This quarterly report is the first to provide updates on the Innovation Center's projects in the third year of the CDSiC. Over the next three months, Core 1 will finalize the cross-cutting assessment of AHRQ-funded PC CDS projects by conducting 9 key informant interviews, synthesizing key findings across projects, and submitting the first draft of the report. Core 1 will also begin collecting project materials relevant to the prototype evaluations. Core 2 will continue the co-design and development of the Quartz and PAIGE prototypes by holding discussions with patient advocates and training the prototypes with information gathered in the background research.

References

[1] Department of Health and Human Services. Utilizing Health Information Technology to Scale and Spread Successful Practice Models Using Patient-reported Outcomes (R18). Accessed October 11, 2023. https://grants.nih.gov/grants/guide/pa-files/pa-17-077.html

[2] Department of Health and Human Services. Implementation and Evaluation of New Health Information Technology (IT) Strategies for Collecting and Using Patient-Reported Outcome (PRO) Measures (U18). Accessed October 11, 2023. https://grants.nih.gov/grants/guide/pa-files/PA-17-247.html

[3] Agency for Healthcare Research and Quality. Improving Healthcare Through AHRQ's Digital Healthcare Research Program: 2022 Year in Review. Digital Healthcare Research. Accessed October 6, 2023. https://digital.ahrq.gov/program-overview/research-reports/2022-year-review

[4] OpenAI. "OpenAI: ChatGPT." OpenAI. https://openai.com/chatgpt/

[5] Milnes-Ives M, de Cock C, Lim E, et al. The effectiveness of artificial intelligence conversational agents in health care: systematic review. *J Med Internet Res*. 2020;22(10):e20346. doi:10.2196/20346

[6] Tudor Car L, Dhinagaran DA, Kyaw BM, et al. Conversational agents in health care: scoping review and conceptual analysis. *J Med Internet Res.* 2020;22(8):e17158. doi:10.2196/17158

[7] Ayers JW, Poliak A, Dredze M, et al. Comparing physician and artificial intelligence chatbot responses to patient questions posted to a public social media forum. *JAMA Intern Med.* 2023;183(6):589-596. doi:10.1001/jamainternmed.2023.1838

[8] SMART on FHIR. 2020. Computational health Informatics program. Boston's Children's Hospital. Boston, MA. Accessed October 19, 2023. https://docs.smarthealthit.org/

[9] Chen AM, Kiersma ME, Shepler BM, Murawski MM. Pilot testing of checklists to discern adverse drug reactions and adverse drug events. *J Am Pharm Assoc* (2003). 2013;53(1):61-69. doi:10.1331/JAPhA.2013.11196

[10] McHorney CA. The Adherence Estimator: a brief, proximal screener for patient propensity to adhere to prescription medications for chronic disease. *Curr Med Res Opin.* 2009;25(1):215-238. doi:10.1185/03007990802619425

[11] Svarstad BL, Chewning BA, Sleath BL, Claesson C. The Brief Medication Questionnaire: a tool for screening patient adherence and barriers to adherence. *Patient Educ Couns.* 1999;37(2):113-124. doi:10.1016/s0738-3991(98)00107-4