INNOVATION CENTER PROGRESS REPORT

SEPTEMBER 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.

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Introduction

NORC at the University of Chicago (NORC) is pleased to submit the third 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 a summary of the status of all projects and activities being conducted within the CDSiC Innovation Center.

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 July 2023 through September 2023. Over this period, the Innovation Center has focused on finalizing deliverables for three projects and preparing for the new project year.

Innovation Center Cores

The Innovation Center Cores are tasked with developing and completing three projects in the first two years of the CDSiC that advance PC CDS research. Based on discussions with AHRQ and the Planning Committee, Innovation Center leadership identified three projects aimed at addressing gaps in measuring and monitoring PC CDS performance. The overarching goals of these projects are to develop a comprehensive performance measurement framework along with measurement and

monitoring 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 one Level 1 project 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 each project being incorporated as relevant into 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 three activities: the development of 1) a PC CDS lifecycle diagram; 2) a PC CDS workflow execution model; and 3) a performance measurement framework.
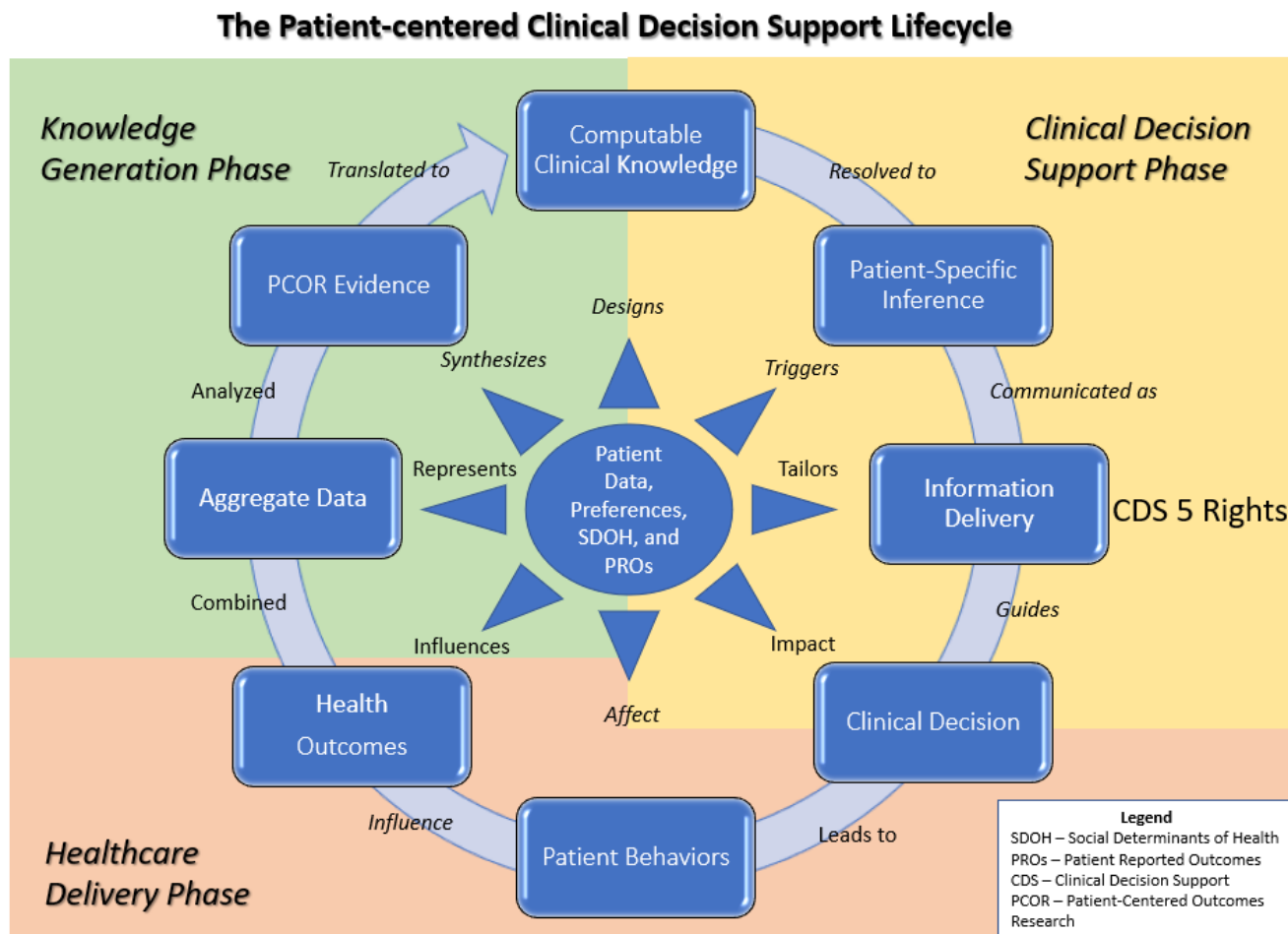
1. PC CDS Lifecycle Diagram

The Innovation Center leadership has developed a new comprehensive model that outlines three phases of the PC CDS lifecycle (see Exhibit 1).[a] The goal of this new, expanded model is to highlight the myriad stages in the PC CDS lifecycle that must be adequately negotiated by all participants in the healthcare delivery system, including patients and their caregivers, to achieve the desired changes in behavior and the resulting improvements in personal health and lifestyle, societal health and happiness, and economic outcomes.

In 2022, the Core 1 team developed a report that was approved by AHRQ describing the development of the lifecycle framework and describing the eight stages within the three phases. They then submitted a Viewpoint manuscript to the Journal of the American Medical Informatics Association (JAMIA). The manuscript titled, "A lifecycle framework illustrates eight stages necessary for realizing the benefits of patient-centered clinical decision support" was published in JAMIA in July 2023.[1] Since then, the article has been cited as a "most read article" on JAMIA's homepage in August 2023 and has received 1,673

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[a] A detailed description of the model can be found in the Q1 2022 report.

views, 24 reactions on Twitter/X,[2] and one citation.[b] When JAMIA posted the article on their LinkedIn page, it received 56 likes, 14 reposts, and two comments.[3, b]

Exhibit 1.   The Patient-centered Clinical Decision Support Lifecycle

The Patient-centered Clinical Decision Support Lifecycle

Dissemination Activities:

- AHRQ began dissemination activities for the JAMIA manuscript on August 30, 2023. The NORC team has been promoting AHRQ's dissemination.

2. PC CDS Workflow Execution Models

To summarize the processes for defining, managing, and executing system-level tasks required to generate and deliver PC CDS interventions, the Core 1 team developed PC CDS workflow execution models that describe the following three generic types of PC CDS workflows:

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[b] Metrics as of September 11, 2023

1. *Collection and use of patient-reported outcomes (PRO) data*

2. *Collection and use of patient-generated health data (PGHD)*

3. *Encouragement or facilitation of a shared decision-making session*

In Q2 2023, Core 1 finalized a report approved by AHRQ that provides PC CDS designers and developers with an overview of the workflow components (i.e., both those performed by humans and computers) necessary to create and use PC CDS interventions. The models also provide a basis for describing the types of measures that are relevant to both developers and users of these interventions, such as whether the interventions are working as designed, being used as expected, and generating the expected results. Additionally, they provide an overview of the new policies and procedures that healthcare systems and technology companies will need to develop and manage to support these new workflows and tools.

In Q3 2023, Core 1 began drafting a manuscript of the workflow execution models based on the AHRQ report for submission to a peer-reviewed journal. The manuscript will focus on the challenges and opportunities identified from the models for advancing PC CDS. The aim is to inform future policies and procedures for healthcare delivery systems.

Dissemination Activities:

- Core 1 will present a poster presentation about the workflow execution models at AMIA's Annual Symposium in November 2023. The team began drafting poster presentation materials on the lessons learned from the development of the models.

3. PC CDS Performance Measurement Framework

The Core 1 team developed and finalized a framework for measuring PC CDS performance in Q2 2023 that outlines domains and subdomains of measurement that CDS developers, clinical informaticians, clinical leaders, and others should use to assess PC CDS performance across the PC CDS lifecycle. The framework is based on literature review findings, inputs from the Innovation Center Planning Committee, and six key informant interviews with CDS measurement experts and individuals with experience implementing and measuring PC CDS in health systems. The framework is intended to serve as a basis for consistent measurement and evaluation of PC CDS design, development, implementation, use, and evaluation. The aim is for the framework to be extensible and adaptable to different health care settings, patient populations, and PC CDS developers.

In Q2 2023, the Core 1 team developed a report describing the development of the framework, the measurement domains and subdomains, how to use the framework, limitations of the framework, and areas for future research. The report was finalized and approved by AHRQ in June 2023.

In Q3 2023, the Core 1 team began drafting a manuscript of the framework based on the AHRQ report to be submitted to a peer-reviewed journal. The manuscript will focus on presenting the development of the framework, the measurement domains subdomains, and applications of the framework for the advancement of PC CDS.

Core 2: Conducting and Coordinating CDS Projects

Clinical dashboards provide real-time feedback to healthcare providers and leaders, as opposed to a retrospective summary of care activities. Data visualization techniques can lead to a more effective decision-making process by reducing cognitive load and improving summarization of patient data. However, there are several considerations that can impact their performance, such as data sources and availability, the design of visualizations, level of user experience and expertise, individual cognitive factors, or device being used (i.e., PC or mobile device).[4]

Core 2 developed two types of data visualizations intended to operationalize the PC CDS measurement framework developed by Core 1. The visualizations—one a set of dashboards and the other a software toolkit with demonstration apps—seek to create easy-to-use, succinct views of metrics related to the measure domains and subdomains outlined in the framework. The dashboards are focused on presenting aggregate data to a clinical leader or informatician to facilitate a better understanding of PC CDS performance and use. The demonstration apps are focused on presenting individual patient data to support patient and clinician shared decision-making.

Project 1: PRO Performance Measurement Dashboards. While the use of patient-reported outcomes (PROs) is well-established and validated within the research setting, their incorporation into routine clinical care for the purpose of informing healthcare decisions is relatively new.[5,6] For PROs to be useful for clinical decision-making, research in this area suggests there must be full integration and real-time synergy with clinician workflows so the data is easily retrievable at the point of care.[7,8] Even still, knowing how to interpret the PRO data and incorporate the results into care plans can be a barrier for clinicians, further limiting the usefulness of PROs.[8] Developing PC CDS driven by PROs creates a valuable opportunity to utilize this rich patient-centered data while providing clinicians an automated interpretation and potentially actionable, evidence-based care responses that are timely and appropriate to patient needs.

The team developed two dashboards focused on different types of PRO data. One dashboard visualizes PROs and PC CDS metrics involving use of the Patient Health Questionnaire (PHQ-9), a screening tool for depression in Vanderbilt University Medical Center's pediatric rheumatology department. The second dashboard visualizes PROs for Vanderbilt University Medical Center's Inflammatory Bowel Disease (IBD) Clinic. The dashboards are intended to present aggregate-level data only to support clinical director-level personnel and informaticians/developers. The intent is for the dashboards to improve quality and patient safety of PC CDS interventions associated with the PROs collected.

The Core 2 team completed usability testing for both dashboards, which included a heuristic evaluation and think-aloud assessments with five representative potential end users. The team developed an evaluation report describing findings from the usability assessment, which was finalized and approved by AHRQ in Q2 2023.

In Q3 of 2023, the Core 2 team developed a demonstration slideshow describing the dashboards and how to use them. The slideshow uses hypothetical data to show aggregate views of questionnaire completion flow, responses to items on the questionnaire, overall assessment scores, and data

stratified by gender, race, disability, and non-English speaking status. The slideshow also shows the dashboard graphs for various decision support alerts and patient-level data for questionnaire responses and actions taken. The goal is to post the final product on the public facing CDSiC website after AHRQ review and approval.

Deliverables Submitted in Q3:

- Core 2 submitted the draft PRO dashboard demonstration slideshow to AHRQ in August and again in September 2023 for review. The team finalized the slideshow based on feedback and posted it to the CDSiC website in September 2023.

Dissemination Activities:

- Core 2 will participate in a panel presentation about the PRO performance dashboards at AMIA's Annual Symposium in November 2023. The team began drafting panel presentation materials on the lessons learned from developing the dashboards and conducting the usability assessment.

Project 2: PGHD Software Toolkit. PC CDS clinical dashboards that integrate PGHD could support informed and shared decision-making processes. PGHD, including continuously measured physiologic parameters such as blood pressure or glucose, presents unique issues for integration into, and presentation during, clinical decision-making tasks due to limited availability and use of interoperability standards, the potential volume of data, and the variable circumstances in which the data is obtained and reported. On the other hand, the use of PGHD to inform clinical decisions can improve engagement and connectedness with patients,[9] which can lead to better health outcomes, increase patient satisfaction, and improve self-management.[10] PGHD can provide a holistic picture for continuous care.[11] Currently, there is a dearth of knowledge on optimal ways to integrate and visualize PGHD so that it informs care processes and integrates into provider workflows.

PGHD Data Visualization Apps. The Core 2 team developed a software toolkit to enable presentation of selected types of PGHD (e.g., patient-collected, physiologic measurements like blood pressure readings) in support of PC CDS. The core component of the toolkit is an open-source library for creating visualizations of PGHD. The library was used to create two additional components in the toolkit: (1) a demonstration app featuring a dashboard of PGHD shared by a patient that can be used by clinicians to review and interpret PGHD and in shared decision-making scenarios ("clinician app"); and (2) a demonstration app that can be used by patients to contribute PGHD and to visualize their historical data ("patient app"). Both apps integrate with the EHR system using the Substitutable Medical Applications, Reusable Technologies (SMART) on Fast Healthcare Interoperability Resources (FHIR) standards.[12] The open-source library can be used by other developers and innovators to embed visualizations of PGHD in their own apps.

The team conducted usability testing of the clinician and patient app prototypes, which included a heuristic evaluation for both apps as well as think-aloud assessments for the clinician dashboard app with three representative potential end users. The team developed a report describing findings from the usability assessment, which was finalized in Q2 2023.

Dissemination Activities:

- Core 2 published the software toolkit on Elimu Informatics' GitHub page[13] in November 2022 and has been continuously maintaining the page for contributions. In September 2023, the toolkit was linked to AHRQ's CDS Connect Github page.[14]

- Core 2 will present a poster presentation about the PGHD visualization apps at AMIA's Annual Symposium in November 2023. The team began preparing poster presentation materials on the design, development, and lessons learned from the usability evaluation of the clinician-facing app.

PGHD Data Visualization Manuscript. As a first step in developing the toolkit, the Core 2 team completed a scoping literature review of existing patient-collected, physiological measurements and visualization techniques and drafted a manuscript summarizing best practices and challenges for presentation of this data. In Q3 of 2023, the team continued working with AHRQ on revisions to the manuscript based on reviewer feedback from the Journal of Applied Clinical Informatics (ACI).

Deliverables Submitted in Q3:

- The Core 2 team first submitted the manuscript to ACI in May 2023. The team received feedback from reviewers in July and revised and resubmitted the manuscript in August 2023. The manuscript was accepted for publication in September 2023.

Dissemination Activities:

- The team will work with AHRQ to conduct dissemination activities once the manuscript is published by ACI.

In Exhibit 2, we outline each Core's project deliverables to date, as well as the future deliverables in progress.

Exhibit 2. Summary Table of Deliverables

Project	Status
Core 1	
PC CDS Lifecyle Manuscript	Complete
PC CDS Workflow Execution Models Report	Complete
PC CDS Performance Measurement Framework	Complete
Core 2	
PRO Dashboard	
Dashboard Design Considerations Document	Complete
Dashboard Usability Evaluation Report	Complete
Dashboard Demonstration Slideshow	Complete
PGHD Dashboard	
PGHD Visualization Literature Review Manuscript	Complete
Design Considerations Document	Complete
Dashboard Usability Evaluation Report	Complete
Dashboard Software	Complete

Planning Committee

The next Planning Committee meeting is scheduled for October 12, 2023. It will focus on discussing project ideas for the upcoming year.

Next Steps

This quarterly report marks the end of the first two years of the CDSiC and the Innovation Center's first set of projects. Both Cores will continue to work on finalizing manuscripts stemming from their respective projects. Core 1 will revise and finalize manuscripts for the Workflow Execution Model and Performance Measurement Framework and submit to peer-reviewed journals. Core 2 will work with AHRQ to disseminate the publication of the PGHD literature review manuscript in ACI and finalize the PRO dashboard demonstration slideshow. Both Cores will also finalize and present their projects at the AMIA Annual Symposium in November 2023. Lastly, to begin preparing for the third year of the CDSiC, the Cores will begin brainstorming new projects that build upon the successes and lessons learned from the first two years and continue testing and advancing the projects already developed.

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[14] Charts on FHIR. Agency for Healthcare Research and Quality. GitHub. Accessed September 8, 2023. https://github.com/AHRQ-CDS/charts-on-fhir