Scaling, Measurement, and Dissemination of CDS Workgroup: Approaches to Measuring Patient-Centered CDS Workflow and Lifeflow Impact Executive Summary

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PURPOSE

The Clinical Decision Support (CDS) Innovation Collaborative (CDSiC) Scaling, Measurement, and Dissemination of CDS Workgroup is charged with identifying measures of patient-centered clinical decision support (PC CDS) adoption, implementation, and use that can be used to scale safe and effective CDS tools beyond initial implementation sites. The Workgroup is comprised of 12 experts and stakeholders representing diverse perspectives related to CDS. This report is intended to be used broadly by those interested in advancing the understanding and evaluation of PC CDS impacts on care team workflows and patient/caregiver lifeflows.

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Executive Summary Overview

This report provides clinical decision support (CDS) developers, informaticians, evaluators, researchers, and others with a broad survey of how care team workflow and patient activity (lifeflow) effects of patient-centered CDS (PC CDS) are assessed in the literature. Here, we present and answer four key questions that can help users of this resource think about how to apply these findings to their work:

- *How does PC CDS intersect with patient lifeflows and the care team workflows?*
- *What types of approaches and measures have been used to assess PC CDS workflow and lifeflow impacts?*
- *What do we know about the effects of PC CDS on care team workflows and patient lifeflows?*
- *What measurement gaps remain and how do we move forward?*

In addressing these questions, this report provides a foundation for ongoing efforts to optimally measure and improve PC CDS—especially dimensions related to their workflow and lifeflow impacts—through:

- A framework for PC CDS developers, researchers, implementers, evaluators, and others to think about how PC CDS affects care team workflows and patient or caregiver lifeflows, which can inform the design, development, and assessment of PC CDS.
- A summary of the current state of the literature on workflow and lifeflow measurement, including key measurement concepts that can inform researchers and PC CDS implementers who want to consider and improve workflow impacts, and evaluators who want to assess these impacts.
- A list of gaps and recommendations that serve as a starting ground for the research community to consider in thinking through next steps needed to advance the study of workflow and lifeflow impacts.

How Does PC CDS Intersect with Patient Lifeflows and Care Team Workflows?

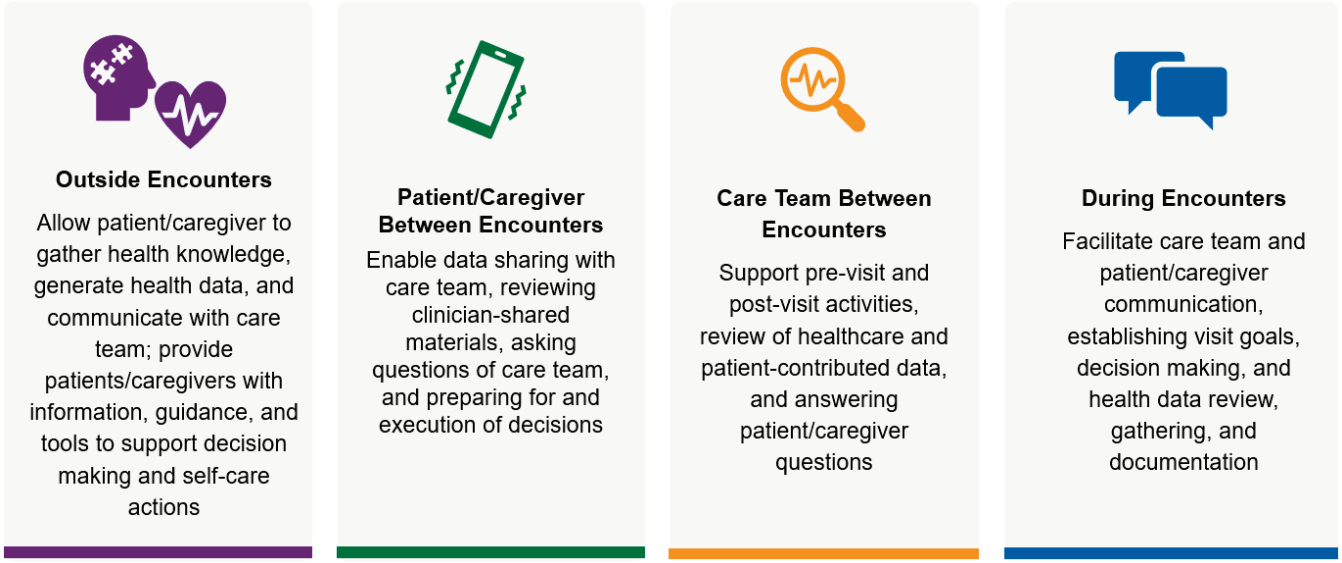
Understanding how patients and care teams interact with PC CDS and how those interactions influence their own and each other's workflows/lifeflows is important to advancing the measurement of PC CDS workflow and lifeflow impacts. By recognizing where and when interactions occur, we can develop and field measures and measurement approaches that better assess interventions' impacts on users, and ultimately develop more effective and user-friendly PC CDS tools.

- **Clinician/Care Team Workflows.** While there is no single, broadly accepted definition for clinical workflow,[1] we define clinical workflow as the steps needed (or taken) to perform a clinical activity or task.[2] Clinical workflows are changing, often complex, and reflect the interdependencies between clinical tasks. Additionally, they are influenced by behavioral, organizational, and societal factors.[3]
- **Patient/Caregiver Lifeflow.** We consider the patient "lifeflow" to be patient activities both within and external to a healthcare encounter that influence an individual's health. There are seven key activities in the patient lifeflow that could involve or intersect with PC CDS: 1) engage in daily

activities, 2) generate health data, 3) gather health knowledge, 4) make health decisions, 5) take self-care actions, 6) have healthcare encounter, and 7) communicate with the care team.[4]

PC CDS can support patient lifeflows and clinician workflows outside, between, and during healthcare encounters (Exhibit 1).[4]

Exhibit 1. Uses of PC CDS Outside of, Between, and During Healthcare Encounters



- **Unified PC CDS Workflow Diagram.** PC CDS can be 1) patient-facing, 2) clinician-facing, or 3) patient- and clinician-facing (i.e., CDS that supports shared decision making between patients or caregivers and their care team):
    - **Patient-facing CDS:** CDS deployed to, viewed by, and whose information is used by a patient or caregiver.
    - **Clinician-facing CDS:** CDS deployed to, viewed by, and whose information is used by a clinical care team member to make clinical decisions.
    - **Shared decision making CDS:** CDS that supports shared decision making conversations or interventions between a patient/caregiver and a member or multiple members of their clinical care team.

Our unified workflow diagram (Exhibit 2) provides a visual framework for understanding necessary contextual factors of patients' lives when developing patient-facing, clinician-facing, and/or shared decision making PC CDS for use outside, between, and during healthcare encounters. The diagram reflects the relationship between clinician workflows and the seven steps of the patient lifeflow, which are based on the AHRQ Patient Journey and Service Blueprint and the Veterans Administration-funded Learning Health System Collaborative Health Service Blueprint.[4,5]

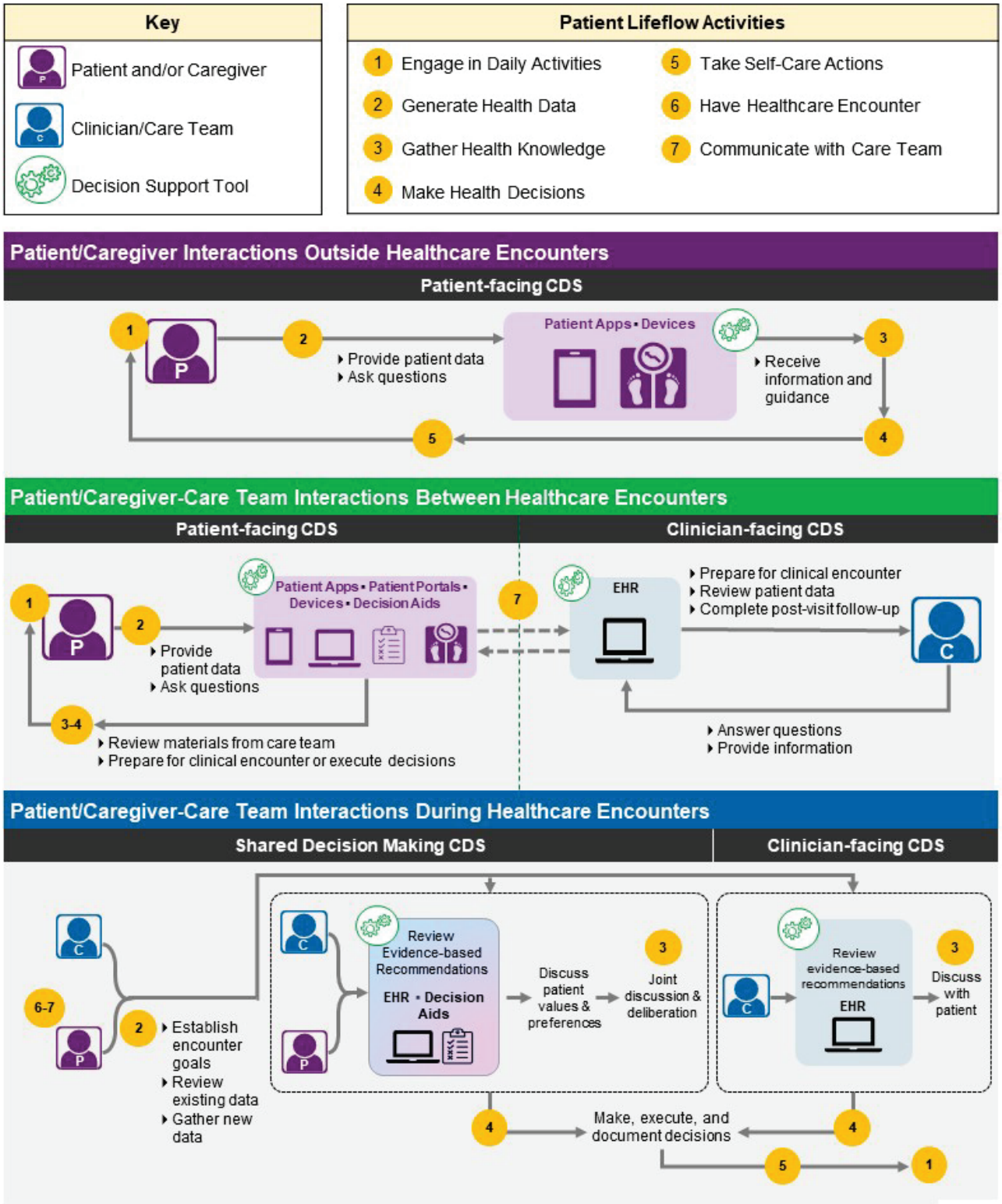
- **Patient/Caregiver Interactions Outside Healthcare Encounters**: Patients and/or caregivers interact with PC CDS tools such as patient apps and personal devices in their daily lives. The flow

of information provided by these patient-facing CDS tools gives patients the guidance needed to support health-related decisions and self-care actions. This can also inform patient/caregiver interactions with their care team between and during healthcare encounters, as these data can provide a fuller picture of their patient's health, including patterns and trends that may influence health.

- **Patient/Caregiver-Care Team Interactions Between Healthcare Encounters:** Patient-facing CDS and clinician-facing CDS both support health-related activities between healthcare encounters. Patient-facing CDS enables patients to share health data with their care team, ask questions of their care team, review materials shared by clinicians, and prepare to and make health-related decisions. Clinician-facing CDS can support the care team's pre-visit activities and post-visit follow-up by allowing them to review patient-contributed data and answer patient questions between healthcare encounters to support ongoing care management and patient decision making.
- **Patient/Caregiver-Care Team Interactions During Healthcare Encounters:** During the clinical encounter, PC CDS can be used by clinicians and patients together (i.e., to support shared decision making) or just by clinicians (e.g., to support ordering or documentation). Both PC CDS intervention types can support patients/caregivers and their care teams in negotiating encounter goals, reviewing existing data, gathering new data, reviewing evidence-based guidance, making decisions, executing decisions, and documenting data, decisions, and actions.

This diagram can help identify interactions between care teams and patients and caregivers and the PC CDS intervention, or "trigger points" within the clinical workflow and the patient lifeflow that can indicate the optimal point for a PC CDS tool deployment in a patient's lifeflow.

Exhibit 2. The Unified PC CDS Workflow and Lifeflow Diagram



What Types of Approaches and Measures Have Been Used to Assess PC CDS Workflow and Lifeflow Impacts?

Researchers, CDS implementers, evaluators, and others use various measurement approaches to assess the impacts of interventions on workflows and lifeflows. Measurement approaches can be distinguished by:

- **What types of measures are used:** Workflow studies tend to assess distal or proxy measures, such as time spent using the electronic health record (EHR), clinician performance, guideline compliance, and patient outcomes, rather than make direct assessments of changes to workflows, such as the completion of a set task or the order in which tasks are completed. However, there have been growing efforts to shift the field towards a focus on direct assessments of workflows.[3]
- **How the data are collected:** Workflow and lifeflow impacts can be measured through both qualitative and quantitative measures. Quantitative methods can include numeric study observations, scores derived from participant-completed scales, EHR historical log data or other documentation, screen capture software data, and eye-tracking data. Qualitative methods include open-ended questionnaire responses, ethnographic observation of real-world or simulated care, focus groups, and interviews.
- **Who reports the data:** Data can be observer-reported, user-reported, or software/sensor observational data.
- **What Measurement Concepts Are Used to Measure PC CDS Workflow and Lifeflows Impacts?** Workflow and lifeflow impacts can be categorized into four workflow-related intervention dimensions:

    1. **Workflow context:** The source of data inputs for the CDS logic. For example, decision support triggers are based on pertinent activities that provide the clinical context for the CDS intervention.
    2. **Uptake:** The initiation or adoption of the intervention. For example, the frequency with which the intervention is seen/used or given opportunities to do so.
    3. **Use:** Changes in knowledge, behavior, or action due to tool use. For example, the specific workflow task/decision the intervention is designed to support and the intervention's effects on decisions and actions (such as time to complete a specific task).
    4. **Subjective value:** The user's perceptions of how the intervention impacted them. For example, change in satisfaction or burden with the workflow/lifeflow as modified by the CDS intervention.

Through a scoping review of the literature, we documented 75 unique measures related to clinician workflow impacts and patient/caregiver lifeflow impacts. While our findings are not an exhaustive list of workflow and lifeflow impact measures, they inform our understanding of common measurement concepts. The measures fit within 18 measurement concepts that describe the general categories of workflow/lifeflow-related outcomes captured in the literature. Exhibit 3 lists these measure concepts by the workflow-related intervention dimension.

Exhibit 3. Measure Concepts

Measure Concept	Definition
Workflow Context	
PC CDS design characteristics	The underlying design principles (i.e., theoretical frameworks, conceptual models) and processes (i.e., providing user training) of the PC CDS tool design.
PC CDS format	PC CDS intervention type (e.g., alert, flowsheet, order set, info button).
Workflow/lifeflow integration	PC CDS elements and how the intervention was deployed to integrate within existing clinical workflows and patient lifeflows.
Patient participation/involvement	The degree to which patients were involved in decision making about care and level of patient/provider communication (e.g., care planning).
Uptake	
Frequency shown/displayed to end-user	How often the PC CDS intervention was shown to the end-user.
Patient adoption	Documentation of patient adoption of the PC CDS tool and details of its reach.
Care team adoption	Documentation of care team adoption of the PC CDS tool and details of its reach.
Care team acceptance	Care team acceptance of the information / recommendations provided.
Use	
Knowledge	Changes in knowledge about a disease/condition, risks and benefits, treatment options, and clinical guidelines.
Efficiency	Assessment of efficiency of using the PC CDS tool, changes in the time or number of steps needed to complete a task, and time required to understand the information presented by the PC CDS tool.
Change in workflow appropriateness	The tool's support of and effect on clinicians' completion of guideline-recommended care.
Change in workflow timing and coordination	Changes in temporal aspects of workflows and teamwork.
Patient decision making	The resulting impacts from patients' involvement in decision-making processes, user-rated assessments of decision-making aids, and support for patients' decision making that aligns with their goals.
Subjective Value	
Change in user satisfaction	User satisfaction with the PC CDS tool and processes supported by the tool.
Perceived utility	Users' perceptions of the tool's usefulness for supporting key healthcare decisions and actions.
Alert fatigue/burnout	User perception of the tool's impact on alert fatigue and/or feelings of burnout.
Mental workload	The cognitive load or burden associated with using the PC CDS tool or changes in user-rated cognitive load/burden when completing a workflow task or activity as a result of using the PC CDS tool.
Patient decision quality	Aspects related to the patient's satisfaction, certainty, and confidence in their decision and their decision's alignment with their values.

What Do We Know About the Effects of PC CDS on Care Team Workflows and Patient Lifeflows?

The findings from our literature review of the effects of PC CDS interventions on clinician workflows and patient lifeflows can support researchers, informaticians, CDS developers, evaluators, and others in understanding where there is emerging consensus in the literature and where additional work is needed. Exhibit 4 summarizes the current state of the literature on studying the effects of PC CDS on clinician workflows and patient lifeflows.

Exhibit 4. Summary of Key Findings on PC CDS Effects on Care Team Workflows and Patient Lifeflows

Key Findings
Overall State of the Literature
The study of workflow and lifeflow impacts resulting from PC CDS interventions is an emerging field with evolving evidence.
We found that there is not yet a robust body of evidence across settings to indicate that a particular type of PC CDS intervention could be predictably expected to yield a specific, positive workflow or lifeflow impact.
Clinician Workflows
The majority of literature related to workflow and lifeflow impacts focuses on impacts of clinician-facing CDS on care team workflows.
Alert fatigue and clinician burnout are common primary outcomes of clinician workflow studies. PC CDS interventions have been found to both reduce alert fatigue and burnout, but also can increase these outcomes due to workflow fragmentation and increased inefficiency.
Patient Lifeflows
Literature on patient lifeflows mainly focuses on shared decision making interventions deployed in the context of healthcare encounters, with the majority focusing on patient decision aids. There were a few studies assessing the impacts of mobile application and patient portal interventions on patient lifeflows.
Decisional conflict, patient knowledge, and patient engagement or involvement in care were frequently assessed outcomes; however, there were no standardized approaches for measuring these outcomes and the findings were mixed on the impact of PC CDS interventions on these outcomes.

What Measurement Gaps Remain and How Do We Move Forward?

We identified measurement gaps in three areas and corresponding recommendations to advance understanding of the impact of PC CDS interventions on workflows and lifeflows (Exhibit 5):

1. Fundamental gaps in conducting workflow studies.
2. Gaps related to the quality of evidence.
3. Gaps related to specific measures and outcomes.

Exhibit 5. Workflow and Lifeflow Impact Measurement Gaps and Recommendations

Gap	Recommendation
Conducting and Reporting Workflow Studies	
Workflow Definition: Inconsistent definition of clinical workflow used in research. This presents challenges in understanding the purpose and findings of workflow research.	• Develop a precise definition of workflow—or context-specific definitions—to support study design. Using such definitions in study reporting will help others understand and build on the research's purpose and impact. • The Workflow Elements Model provides a conceptual model of clinical workflows that can be used by researchers designing and reporting on workflow studies to better define and study workflows.[1]
Reporting Impact: Limited information available about the impact of interventions on existing clinical workflows and adaptations required for successful deployment and use of CDS tools – and how these should be reported.	Measure and report effects of CDS on temporal aspects of workflow to understand impacts related to workflow integration and fragmentation, such as when the appropriate time to elicit patient preferences is, or how the results of decision support tool activities fit within the patient care team dialogue.[6] Reporting should also include descriptions of variation in workflows from the standardized workflow to better understand variations in outcomes.[3]
Measuring Impact: Identifying clinical workflow aspects that are important to study and can be reliably measured is an ongoing challenge to studying workflows. Currently, most studies do not directly assess workflow impacts, but use proxy measures of the performance of the workflow.	Develop and use methods to directly study workflow and clinician workarounds during and following implementation of PC CDS interventions. Workflow measures should directly capture the completion of a set of necessary tasks and the order in which they were completed. [3]
Reporting Consistency: Large degree of inconsistency in how workflow studies report study design and results, which makes cross-study synthesis very difficult, diminishing the ability to accumulate knowledge as a field.	Develop reporting guidelines to improve consistency in how methods and findings are reported for workflow studies. For example, the STAMP (Suggested Time and Motion Procedures) Checklist is a potential resource that can support better reporting of workflow studies utilizing time-motion methods.[7]
Patient-facing PC CDS: Limited number of studies exist on the impact of CDS tools on patient activities outside of healthcare encounters context, with the majority focusing on patient portal usage. Further, patient portal studies are limited and present inconsistent results, often due to the use of non-standardized terminology related to portal features and implementation and limited analysis of patient portal usage data.	• Use standardized evaluation frameworks and measures to strengthen comparisons of patient portal implementation and outcomes.[8] For example, a taxonomy of patient portal functionalities could support standardized description of portal features and terminology, which can enable comparing and aggregating results across interventions.[9] • Analyze patient portal usage to identify relationships between portal usage and patient outcomes to understand what qualifies as meaningful portal usage.[10]
Lifeflow Analysis: The majority of workflow studies fails to consider the relationship and gaps between patient health-related activities in patients' daily lives and activities within the clinical	• Conduct workflow studies that are patient-oriented, include both clinical and daily living settings, and include both process and structure measures.

Gap	Recommendation
context, prohibiting design of collaborative health technologies that can fill these gaps.	• Develop methods to capture health-related activities across clinical and daily living settings.[11]
Evidence Scope and Quality	
Patient-reported Indicators: Scant attention to measures composed of patient-reported outcomes/items to assess aspects, such as disease activity and functional status, needed to fully convey pertinent patient lifeflows outside and between healthcare encounters.	Conduct research and utilize disease activity and functional status measures that can be adapted for use in telehealth/patient portal settings to support high-quality PC CDS. Conduct research to better understand how these types of measures alleviate gaps in the patient/caregiver lifeflows.[12]
Evidence Quality: The majority of evidence related to PC CDS workflow and lifeflow impacts found was rated as “low quality” or at “high risk of bias” by systematic reviews and meta-analyses.	Conduct rigorous workflow studies employing larger, more representative sample sizes to fill gaps left by current studies that have utilized small, non-generalizable samples.[13]
Contributing Intervention Factors: Insufficient analysis of intervention characteristics or development attributes that are most effective in promoting shared decision making.	Develop studies to test the contributions of individual intervention characteristics on shared decision making outcomes.[14]
Measurement Benchmarks: Benchmarks for workflow and lifeflow impacts have not been established for measures critical to assessing the effectiveness of PC CDS interventions.	Develop standardized measures and validated tools to assess commonly measured workflow/lifeflow outcomes so that results across studies can be compared and workflow/lifeflow impact measures can be prioritized for benchmarking. Focus future measurement research on key areas, including patient and clinician adoption, clinician time spent on clinical tasks, clinician completion of guideline-recommended care, decisional conflict, informed choice, and patient activation and decision making.
Measures	
Cognitive Workload: Clinician cognitive workload is not measured with high validity across studies.	Related concepts of alert fatigue and desensitization can be used as proxy measures of cognitive workload. These measures should be prioritized so they can be leveraged in improving patient safety.[15]
Informed Choice: Informed choice—the extent to which a patient can make a choice that is based on relevant knowledge, consistent with the decision-maker's values, and behaviorally implemented[16]—is not consistently defined in the research or measured in a standard manner.	Conduct research to explore whether it is possible and beneficial to develop a generic scale for informed choice.[16]
Patient Knowledge: Need for a generalized measure of patient knowledge to assess the impact of decision aids on disease-specific knowledge. Addressing this gap would reduce the need for developing study-specific assessment tools and may support intervention efforts to improve knowledge about a disease, and not just knowledge specific to the decision aid content.[17]	Develop validated, intervention- and disease-agnostic scales and questionnaires for assessing patient knowledge outcomes. Additionally, foster consensus on what constitutes “adequate knowledge”.[16]
Tool Acceptance: Inconsistent assessment of CDS acceptance, with a variety of concepts in use to assess user acceptance of CDS tools.	Develop standardized, low-cost, informative measures for determining CDS intervention acceptance.[18]

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