Reference Taxonomy of Clinical Workflows

The Reference Taxonomy of Clinical Workflows provides a common set of terms to CDS designers and implementers to support communication about CDS and its use in clinical workflows.

- *CDS designers* can use the taxonomy to identify points in the workflow when CDS can be used and design a CDS tool to fit that context. Designers can then tag the CDS tools with terms from the taxonomy to inform practices about the intended use of the CDS.
- *CDS repositories* can create tags based on the taxonomy to enable workflow-related organization and searches.
- *CDS implementers* can refer to the taxonomy when developing maps of the workflows and can use the terms to improve communication with their CDS vendor.

Introduction

Workflow is one of the most important factors to consider during CDS implementation. Studies have shown that the same CDS system - when implemented in two different workflows - can produce very different effects.(1) CDS that is intelligently-filtered to reach the right person at the right point in the workflow leads to more successful implementations and improves healthcare quality more that CDS tools that do not account for workflow.(2, 3)

As demand for CDS tools increases, there is need to disseminate CDS in a scalable way that incorporates information about important environmental factors like workflow. Centralized repositories are a promising solution for the widespread dissemination of CDS tools. CDS knowledge repositories like the one maintained by the Clinical Decision Support Consortium, funded by the Agency for Healthcare Research and Quality, and proprietary knowledge management systems maintained by commercial EHR vendors, have developed libraries of more robust CDS interventions.(4) It is important that practices who use these repositories have the ability to choose CDS tools that fit their workflow and that help them meet their clinical objectives.

A standard set of terms related to clinical workflow could help CDS designers, repositories, and implementers to communicate better, resulting in more successful CDS implementations. This reference taxonomy of clinical workflows can be leveraged by different stakeholders to support CDS design, organize CDS artifacts and enable end-users of CDS repositories to map their workflows and select tools that are relevant to their needs.

Reference taxonomy of workflows

The workflow taxonomy describes thirteen common clinical workflows from the inpatient and outpatient settings and matches them to actors and CDS tools that can potentially support the given tasks (Appendix 1). There is no universally agreed upon definition of the term "workflow", but for the purposes of this taxonomy, we defined clinical workflow as "a modular sequence of tasks, with a distinct beginning and end, performed for the specific purpose of delivering clinical care" (5-7). Workflows are specified at up to four levels of detail: 1) clinical workflow, 2) phase, 3) task & action, and 4) sub-action.

Workflows in the real world are considered to be emergent phenomena and the same workflow may differ based on the individual's preferences and the current needs of the clinical encounter. Workflow models are abstract representations of real-world workflows and are created for the purpose of planning and communicating about real-world workflows. Workflows in our taxonomy appear as task lists for ease of presentation, but the order of the list is not intended to be a linear or comprehensive depiction of the workflow sequence. Tasks within a given workflow may be omitted or happen in a different order based on the circumstance.

User guide

This workflow taxonomy provides standard language that can be used by multiple stakeholders including CDS designers, managers of CDS repositories, and implementers to communicate about workflow. Examples of how each group can use the taxonomy are provided below.

CDS designers & knowledge management repositories

Designers can use the taxonomy to identify opportunities in the workflow where CDS tools might be useful. The workflow taxonomy takes individual tasks and actions and puts them in context with other actions and the actors who complete them. This context is useful for informing the design of CDS tools and may help designers create tools that are more easily integrated into a workflow.

For instance, a designer can use the workflow taxonomy to identify when and how information about obesity treatment recommendations appears in the workflow. An EHR system with CDS could generate obesity treatment recommendations virtually any time after the patient's height and weight are documented; however, it is the designer's goal to ensure that obesity treatment recommendations reach the right person at the right time. To this end, a CDS designer could scan the workflow taxonomy

and find a task that could accommodate obesity treatment recommendations including nutritional counseling. In this care, "patient counseling" (see Row 17 of the taxonomy) is a good match for nutritional counseling. The CDS designer could then look across the row and see that a suggested mode of delivery for recommendations to perform counseling is through and alert during the clinician assessment.

Once a CDS tool has been developed, the designer or repository manager can tag it with terms from the taxonomy. These workflow-related tags can be used to organize the CDS in repositories and enable end-users of CDS (i.e., practices) to efficiently search and select tools that are relevant to their workflows.

Implementers

Implementers can use the workflow taxonomy to map their practice-specific workflows, and they can use the terms and language from the taxonomy to communicate with their vendors about when they want CDS to appear in the workflow. Implementers can use the taxonomy to identify when CDS can be inserted into the workflow, who should be the recipient of the CDS, and what types of CDS tools are available for a given task. Table 1 provides an example outpatient workflow

Many implementers view CDS as a tool for practice transformation and not just a way to automate a manual process. The transition from manual and paper-based processes to a redesigned workflow with new CDS tools can require multiple steps. The most successful organizations approach workflow redesign as an iterative process for continual improvement. The workflow taxonomy can be used to support workflow redesign at all phases of implementation. Table 2 provides an example of how to map a workflow using terms from the taxonomy.

Table 1. Example workflow for an outpatient encounter with actors and potential CDS tools

Phase	Task	Action	Sub-action(s)	Actor(s)	Alerts/ Reminders	Order sets	Info Buttons	Data display	Doc. templates
Intake and Nurse assessment	Check in	Document	1.16 (Access patient demographic data), 7.6 (Document date of birth), 7.9-12 (Document ethnicity, gender, growth chart, height), 7.14 (Document insurance type), 7.25 (Document preferred language), 7.28 (Document race), 7.34(Document smoking status), 7.8(Document encounter)	Registration Clerk	x				x
	Measure, record vital signs	Document	7.40(document vital signs); 7.41(document weight)	Medical Assistant; Nursing	x				x
	Med review	Review	1.10-12(Access mediation allergy history, medication history, active medication list)	Medical Assistant; Nursing				x	
	Handoff	Notify	2.2(acknowledge receipt of clinical summary), 19.5(transmit clinical summary), 12.13(receive patient summary allergy record from other providers)	Medical Assistant; Nursing; Physician		x			x
Clinician assessment	Review charts	Review	1.1-28 (Access - all information in medical record) 17.13 (Review quality measure results)	Physician				x	
	Interview patient	Perform		Physician; Nursing; Medical Assistant	x				x
	Take history	Document	7.1(Document a progress note for each encounter)	Physician; Nursing; Medical Assistant					x
	Diagnose and plan	Perform		Physician			x		x
	Review prior test results		17.1-2(review all information for a lab test report, clinical lab tests received with LOINC codes)						x
	Order lab test	Order	10.4(order lab study)	Physician	x	x	x	x	x
	Prescribe	Order	10.1(Order medication), 10.5-7 (Order medication generic-, new), 19.6 (transmit prescription)	Physician	x	x	x	x	x
	Make a referral	Order	10.10 (Order provider referral)	Physician		x			x
	Treatment	Perform		Physician; Nursing					

	Patient counseling	Perform		Physician; Nursing	x				x
Check out	Give out instructions	Document	2.1(Acknowledge education receipt)	Medical Assistant; Nursing	x			x	x
	Schedule next appointment	Create	15.1-2 (Remind patient per patient preference for follow-up, preventive care)	Registration Clerk					

Table 2. Example workflows for chronic heart failure (CHF) treatment during an outpatient encounter, pre- and post CDS implementation

Pre-CDS implementation	Post-implementation of CDS with interventions for CHF patients

- Intake & nurse's assessment (pt. 1 of 2)
    - Check-in
- Clinician assessment (pt. 1 of 2)
    - Review chart & interview patient → physician notes this is a CHF patient
    - Handoff for additional data collection to support CHF care
    - Begin next patient encounter
- Intake & nurse's assessment (pt. 2 of 2)
    - Measure & record vital signs
    - Medication review
    - Interview patient (e.g., record diet journal)
- Clinician assessment (pt. 2 of 2)
    - Return to patient encounter
    - Review weight and adherencechart
    - Diagnose and plan
    - Prescribe
    - Patient counseling
- Check out
    - Give instructions → patient- or condition-specific handout suggestions
    - Schedule next appointment (e.g., in 3 days)

- Intake & nurse's assessment
    - Check-in → **alert that this is a CHF patient**
    - Measure & record vital signs; including weight → alert if significant change from prior readings
    - Perform nursing assessment for CHF patients
        - Interview patient (e.g., record diet journal)
        - Medication review; when appropriate, make recommendation for prescription
        - Patient counseling
- Physician assessment
    - Review chart & interview patient → data display alerts about key data changes (e.g. weight)
    - Diagnose and plan → alerts for care protocols or pathways
    - Prescribe → alerts for drug-drug interactions, drug-symptom interactions; infobutton for Rx dosing guidelines
    - Document encounter → patient- or condition-specific documentation templates
- Check out
    - Give instructions → patient- or condition-specific handout suggestions
    - Follow up → Alert to schedule next appointment (e.g., in 3 days) or other referral (e.g., dietary counseling)

Development of this reference taxonomy

Structure of the taxonomy

The workflow taxonomy was informed by two targeted searches of the peer-reviewed and grey literature and was supplemented by subject matter experts on the development team. The first literature search focused on the definition of "clinical workflow" and other category headings that organize the taxonomy. The key words while searching included: clinical workflow, flowchart, standard procedures, collaborative tasks, sequence, communication, work practices, sub-processes. The names and definitions of the category headings were iteratively refined by the team and were used to provide structure to the taxonomy.

Based on the goals for this taxonomy and considering the definitions used by the field, we defined clinical workflow as "a modular sequence of tasks, with a distinct beginning and end, performed for the specific purpose of delivering clinical care". (5-7) The beginning and end of a workflow is determined based on the goals of the person or clinical situation that triggers the activity.

We conceptualized workflows in three categories: 1) patient-centric, 2) message-centric, and 3) population management. Patient-centric workflows occur when the patient is on-site and interacts with the staff and clinicians. Patient-centric workflows begin when the patient enters the office or ward and ends when the patient leaves or is discharged. Message-centric workflows include care activities that occur when the patient is not present; they typically begin with a message, may continue over an extended period of time, and end when the message is considered handled. Population management workflows focus on prevention and care management activities that involve pro-active review and outreach to a defined population or to individuals within that population.

Workflow components are specified at up to 4 levels of detail:

1) Clinical workflow: described above
2) Phase: corresponds to the physical location of the patient; used only if the patient changes location during a workflow
3) Task & action:
   - A task is an activity that is relatively short and constitutes a discrete step in the care process. For example, 'measure and record vital signs' is considered a task.
   - In this taxonomy, actions are used to relate tasks to a more general typology of clinical activities. For example, 'document' is the action associated with 'measure and record

vital signs'. Actions were based on the information available in the National Quality

Forum's "Health IT Assessment Framework for Measurement: A Consensus Report" (8);

4) Sub-action: specific activities that constitute or comprise an action. Continuing the example

above, 'Document weight' is a sub-action of 'measure & record vital signs'. The NQF Framework

for Measurement was also used to inform the sub-actions.(8)

A second literature search was conducted to find terms for workflows and other clinical activities that could populate the taxonomy. The team reviewed textbooks, academic literature, reports from non-profit organizations and other grey literature for relevant terms. Workflow terms were then organized under the appropriate headings.

Matching workflow actions to actors and types of CDS

Once the clinical workflows were specified, two additional aspects were added to the taxonomy to provide more context. First, an actor(s) was designated for each workflow action. Actors were selected from the National Quality Forum's "Driving Quality – A Health IT Assessment Framework for Measurement"(8) We selected four actors from the NQF report (i.e., physician, nurse, medical assistant, registration clerk) for use in this taxonomy. Practices can customize their workflow maps with the roles present in their practices or refer to the NQF report for additional types of actors.

Workflow actions were also matched to types of CDS that support or had the potential to support that action. The five types of CDS were used in the taxonomy.

1) Alerts & reminders: Alerts and reminders deliver information at the point of care in a way that

gets the provider's attention. Alerts and reminders can appear as pop-up boxes, strategically

placed reminder lists, or changes in visual presentation (such as font or color).

2) Order sets: Pre-specified bundles of orders grouped by a clinical purpose. For example, a

practice could have standard order sets for diabetes care.

3) Infobuttons: Clickable links to reference information for selected terms or phrases that appear

in the EHR. Providers can seek out information using infobuttons, such as the basis for a clinical

guideline or recommendation, as opposed to alerts and reminders, which automatically deliver

information to the provider.

4) Relevant data displays: An organized set of data elements such as problems, medications, test

results, and trends that are grouped to support a clinical purpose.

5) Documentation templates: structured forms that collect information to assist in diagnosis, care planning, and management.

Expert Panel Review

The workflow taxonomy was reviewed by an expert panel on two occasions. The first round of review focused on the structure of the taxonomy and the content of the clinical workflows. The second round of review addressed the refinements of the workflow taxonomy and the matching of the workflow actions to actors and types of CDS. The expert panel was comprised of representatives from commercial EHR vendors, academia, and other subject matter experts.

References

1. Niazkhani Z, van der Sijs H, Pirnejad H, Redekop WK, Aarts J. Same system, different outcomes: Comparing the transitions from two paper-based systems to the same computerized physician order entry system. Int J Med Inform. 2009 Mar;78(3):170-81.

2. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: A systematic review of trials to identify features critical to success. BMJ. 2005 Apr 2;330(7494):765.

3. Osheroff, JA. Improving Medication Use and Outcomes with Clinical Decision Support: A Step by Step Guide. Chicago: HIMSS; 2009.

4. Clinical Decision Support Consortium [Internet]. Wellesley, MA: Partners Healthcare. Available from: http://www.partners.org/cird/cdsc/

5. Carayon P, Karsh B, Cartmill C, Hoonakker P, Shoofs Hundt A, Krueger D, Thuemling T. Incorporating Health Information Technology Into Workflow Redesign. (Prepared by the Center for Quality and Productivity Improvement, University of Wisconsin–Madison, under Contract No. HHSA 290-2008-10036C). Rockville, MD: Agency for Healthcare Research and Quality; 2010 Oct 2010. Report No.: AHRQ Publication No. 10-0098-EF

6. Niazkhani Z, Pirnejad H, Berg M, Aarts J. The impact of computerized provider order entry systems on inpatient clinical workflow: A literature review. J Am Med Inform Assoc. 2009 Jul-Aug;16(4):539-49.

7. Unertl KM, Novak LL, Johnson KB, Lorenzi NM. Traversing the many paths of workflow research: Developing a conceptual framework of workflow terminology through a systematic literature review. J Am Med Inform Assoc. 2010 May 1;17(3):265-73.

8. National Quality Forum (NQF). Driving Quality—A Health IT Assessment Framework for Measurement: A Consensus Report. Washington, DC: NQF; 2010