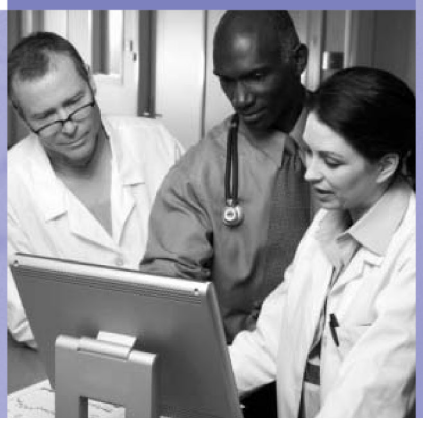
Clinical Decision Support



Driving Quality and Performance Measurement—A Foundation for Clinical Decision Support

A CONSENSUS REPORT

National Quality Forum

The National Quality Forum (NQF) operates under a three-part mission to improve the quality of American healthcare by:

- building consensus on national priorities and goals for performance improvement and working in partnership to achieve them;
- endorsing national consensus standards for measuring and publicly reporting on performance; and
- promoting the attainment of national goals through education and outreach programs.

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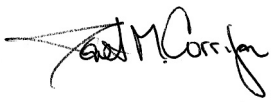
Foreword

INCREASING DEPLOYMENT, ADOPTION, AND MEANINGFUL use of electronic health records (EHRs) and health IT systems in the United States offers great potential to improve the quality, safety, and effectiveness of healthcare. An important means to advance this goal is to measure performance, ensuring that relevant clinical knowledge is available at the point of care and implemented in a manner that promotes optimal care delivery. To do so, EHRs must, at a minimum, capture and make available essential information traditionally found in paper medical records and then match patient information with relevant clinical knowledge, thereby helping users incorporate that knowledge into decisionmaking. Clinical decision support (CDS) is an essential capability in health IT systems that makes this possible. However, achieving this goal requires that CDS users define and understand decision support in the same way, that is, share a common description of CDS. A common description, classification, or "taxonomy" of CDS should assist health IT system developers, system implementers, and the quality improvement community to develop tools, content, and procedures that are compatible and enable comprehensive use of CDS, thereby improving delivery of appropriate, evidenced-based care.

In November, 2009, the National Quality Forum (NQF) convened the CDS Expert Panel, with broad representation from the healthcare community, to develop a taxonomy for CDS. The CDS Expert Panel builds on the work of NQF's Health Information Technology Expert Panel (HITEP), which developed the Quality Data Set (QDS). The QDS is an information model that lays the foundation for automatic, patient-centric, longitudinal quality measurement. This document describes the development of the NQF CDS Taxonomy, the relationship between quality measurement and CDS, and the mapping of the Taxonomy to the QDS Model.

NQF thanks the CDS Expert Panel, the Expert Panel's Chair, Michael Krall, MD, and Vice Chair, Jane Metzger, and NQF members for their contributions to the development of a CDS taxonomy that builds a relationship between quality measurement and clinical decision support.



Janet M. Corrigan, PhD, MBA
President and Chief Executive Officer

Table of Contents

Executive Summary

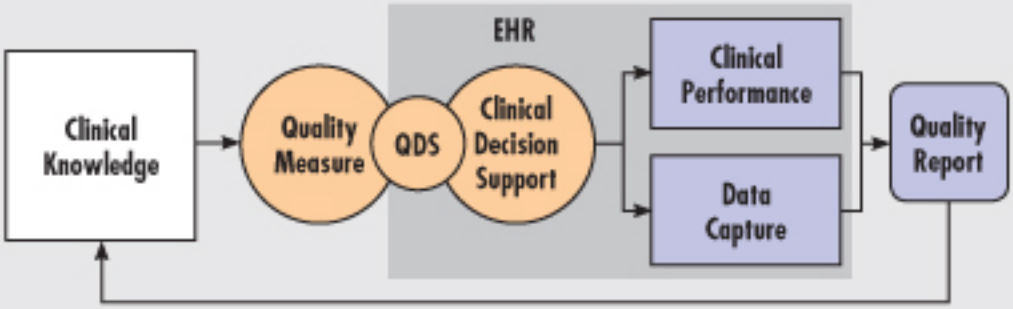
HEALTH INFORMATION TECHNOLOGY (health IT) offers the potential to improve healthcare quality, safety, and effectiveness. To achieve these goals, relevant clinical knowledge represented within quality measures and guidelines of care must be evident at the point of care and implemented in a manner that promotes optimal care. Electronic health records (EHRs) can enable this goal by matching patient information with relevant clinical knowledge, thereby helping users as they incorporate that knowledge into decisionmaking. Properly positioned, clinical decision support (CDS) tools can play an important role.

Clinical decision support can be broadly defined as any tool or technique that enhances decisionmaking by clinicians, patients, or their surrogates in the delivery or management of healthcare. CDS is an essential capability of health IT systems; however, a common classification or taxonomy is necessary to enable health IT system developers, system implementers, and the quality improvement community to develop tools, content, and policies that are compatible and support CDS features and functions.

NQF convened the CDS Expert Panel to develop a classification and categorization of the CDS information necessary for quality improvement, referred to as the CDS Taxonomy. With quality measure developers, clinical system implementers, and vendors communicating more effectively by using a common CDS classification, the expected result is a more effective application of CDS aligned with quality measurement. The CDS Expert Panel's task was to develop or extend a CDS taxonomy that could adequately represent CDS rules and elements, while ensuring concordance of this taxonomy with the Quality Data Set (QDS) Model. The QDS is an information model that describes clinical concepts in a standardized format so individuals monitoring clinical performance and outcomes can communicate necessary quality improvement information clearly and concisely.

Figure 1 provides a high-level overview of the relationship among CDS, quality measures, and the QDS Model. Quality measures, the QDS Model, and CDS work in a parallel effort to deliver clinical knowledge to improve clinical performance and data capture. Clinical research advances the development of clinical knowledge, which is often represented in clinical guidelines of care. The guidelines frequently include algorithms with decision points requiring clinician or patient input. These decision points are often the subject of quality measures and (CDS) rules. The data inputs required to determine whether a specific rule or measure applies to a given patient or user at a specific place and time are defined by the QDS. The CDS rules and interventions promote

Figure 1: Relationship of clinical decision support, quality measures, and the QDS Model



improvements in both data capture and clinical performance. A result is a quality report that indicates the level of performance against quality measures and provides additional knowledge. Figure 1 is not intended to suggest a linear or sequential relationship between quality measures and CDS.

CDS Taxonomy Development and Refinement

Building upon and leveraging existing CDS taxonomy efforts, the Expert Panel agreed to use a taxonomy developed at Partners HealthCare, Inc. (Partners) as a starting point for the NQF CDS Taxonomy. The CDS Expert Panel's taxonomy work group evaluated the Partners' taxonomy to ensure it was sufficient, complete, and represented at the appropriate level of granularity. To assist in this evaluation, other organizations using CDS were engaged. Representatives from the Federal CDS Collaboratory, Intermountain Healthcare, Kaiser Permanente, Regenstrief Institute, the Structural Care Recommendations for CDS Project Team, and the Yale Center for Medical Informatics reviewed the CDS Taxonomy. Ultimately, some taxa in the Partners taxonomy were combined, and others were separated. Additionally, the CDS Expert Panel developed use case scenarios to define and communicate the role of a CDS Taxonomy within the context of workflow "events," including direct patient care, ordering, documentation, and quality reporting.

Following the development of the initial version of the CDS Taxonomy, the CDS Expert Panel's QDS mapping workgroup was charged with defining and explaining the relationship between the NQF CDS Taxonomy and the QDS Model. This exercise clearly demonstrated that the QDS was more expansive and comprehensive than the CDS Taxonomy. Specifically, the QDS by design covers the data elements needed to express the full range of inclusion and exclusion criteria in quality measures.

Description of the NQF CDS Taxonomy

As represented in Figure 2, the NQF CDS Taxonomy is composed of four functional categories that classify and categorize the CDS information necessary for quality improvement: 1) triggers, 2) input data, 3) interventions, and 4) action steps. Each CDS taxonomic category is discussed in further detail in the section entitled *Description of the NQF CDS Taxonomy*.

The Expert Panel designed the taxonomy to be independent of specific implementation, workflow, and design decisions. Additionally, it did not designate specific features or functionality as part of its design, as these are implementation decisions that will vary across regions and individual entities. The taxonomy is intended to be flexible to adapt to local needs and standard practices.

Box 1: Definitions of NQF CDS Taxonomy Categories

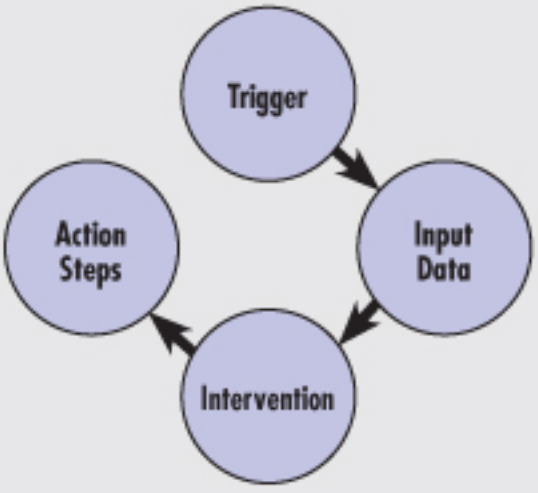
Trigger: events or actions that initiate a CDS rule

Input Data: the additional data, from the patient record or other source, used as background to modify or constrain the CDS rule

Interventions: the possible actions taken by decision support to provide information when the conditions specified in a rule are met

Action Step: any action or event presented to the user of a clinical system that could lead to successful completion (or realization) of the intended mission of the rule

Figure 2: The four functional categories of the NQF CDS Taxonomy



The CDS Taxonomy consists of four functional categories:

1. The *trigger* initiates a CDS rule.
2. The *input data* are represented by the components of the QDS data types.
3. *Interventions* include the possible actions the information system can take to deliver information.
4. The *action steps* are actions a receiver of the information can perform.

In a given cycle of a CDS rule, any input data, intervention, or action step may initiate a new trigger and launch a new CDS rule.

The Expert Panel acknowledged that consumer and caregiver decisionmaking are critical for a safe, effective, patient-centered healthcare system. Patients may increasingly be recipients of CDS via patient portals and secure electronic mail. While not explicitly addressed by the taxonomy presented here, future iterations should be capable of communicating health-related information to patients and caregivers.

Recommendations

The Expert Panel developed the following recommendations for NQF's work and validation of the CDS Taxonomy for use across various healthcare settings:

- continue development and refinement of the CDS Taxonomy;
- incorporate the CDS Taxonomy, using the QDS Model, in real settings that implement CDS;
- educate NQF members and the public on the value and impact of CDS and the NQF CDS Taxonomy;
- work to incorporate the NQF CDS Taxonomy into other ongoing quality and CDS efforts to further the linkage between clinical care, quality measurement, and performance; and
- facilitate sharing across NQF members and key stakeholders regarding application of CDS tools, the NQF CDS Taxonomy, and the QDS Model to real-world implementations of CDS to improve quality.

Moving Forward

The NQF CDS Taxonomy provides a foundation for the description of an electronic infrastructure, bridging quality measurement and health IT. Specifically, the taxonomy will enable quality measure developers, clinical system implementers, and vendors to be more effective in developing, sharing, implementing, and evaluating the effectiveness of different approaches to applying CDS aligned with quality measurement.

Increases in the sheer volume of data for both consumers and providers to use in making informed decisions will require the development, standardization, and integration of additions to the CDS Taxonomy and the QDS Model. NQF anticipates that over time, the CDS Taxonomy will be refined and modified in an open, transparent process and will evolve to keep pace with changes in healthcare delivery, health IT systems, CDS, quality measurement, and the nation's priorities.

Introduction

Overview: Quality and Clinical Decision Support

HEALTH INFORMATION TECHNOLOGY offers the potential to drive quality improvement and directly support the delivery of evidence-based care through real-time measurement and clinical decision support (CDS).[1] Decision support can be broadly defined as any tool or technique that enhances the decisionmaking of clinicians, patients, or their surrogates in the delivery or management of healthcare. CDS includes various functions that deliver knowledge or advice electronically. CDS in electronic health records (EHRs) or other health IT systems can present advice in different ways; examples range from filtered or highlighted electronic information displays to uniquely tailored documentation templates, annotated work lists, order sets, reference information, and messages or alerts.

The public and private sectors are increasingly embracing health IT and CDS as means to achieving the National Priorities as articulated by the National Priorities Partnership: 1) patient and family engagement, 2) population health, 3) safety, 4) care coordination, 5) palliative and end-of-life care, and 6) overuse. Meanwhile, leaders in the quality community have long recognized that widespread EHR use will simplify and ultimately automate processes to achieve these National Priorities. Specifically, health IT will provide electronic information at the point of care, thereby improving clinical performance, data documentation and capture, and the ability to extract and report results and outcomes.

To achieve the vision of improved quality and affordability of care as articulated in the Health Information Technology for Economic and Clinical Health Act (HITECH) in the American Recovery and Reinvestment Act of 2009, there must be widespread adoption and meaningful use of EHRs. Meaningful use, as defined in HITECH, includes meaningful use of a certified EHR, the electronic exchange of health information to improve the quality of healthcare, and, among specific functional requirements, data capture, analysis, and reporting on clinical quality and other measures. To demonstrate the first and third of those requirements, such systems require decision support rules directed to priority conditions and the ability to automatically measure and report quality indicators.

EHRs, however, do not generally support quality measurement concurrent with routine clinical workflow because quality measures have typically not been developed to leverage data captured in EHRs. The HITECH Act, enacted in 2008, is changing that paradigm such that meaningful use requires the capture and reporting of data from the EHR. As a result, a standard taxonomy is needed to manage the collection and reporting of accurate, comparative healthcare quality data instead of the existing complex and burdensome manual process. Standardization of data further supports longitudinal and comparable quality measurement and reporting and the ability to include reusable and reproducible CDS consistently in EHRs.

Evidence Supporting a Quality Improvement and CDS Relationship

There is a direct and important connection between clinical care, quality measurement, and use of CDS to improve care delivery. Studies show CDS contributes to decreasing errors of omission and commission, reducing unnecessary, ineffective, or harmful care, and promoting adherence to evidence-based care.[2,3] CDS enables better care by increasing the provision, documentation, measurement, and reporting of services recommended in quality measures and clinical guidelines. CDS can help deliver "the right information to the right person in the right format through the right channel at the right time."[4]

CDS research has demonstrated improved patient outcomes, although results are not uniform. Generally, alerts and reminders support improved clinician decisionmaking and prevention of errors in routine clinical workflows.[5,6] These improvements are necessary predecessors to greater adherence to evidence-based clinical guidelines and delivery of patient-centered care. CDS can also lead to a reduction of inappropriate care (e.g., overuse and underuse)[7,8] and play an important role in promoting and maintaining good health (e.g., preventive care reminders to providers and patients via EHRs and personal health records [PHRs]).

CDS use, however, has been slowed by a number of challenges related to system design, lack of standardization, provider adoption, and lack of integration into practice across care settings. Common formats around clinical knowledge, vocabularies, and decision support interventions and clinical guideline representation standards do exist;[9] however, the lack of widespread use is a barrier to effective CDS. Workflow interruption, pop-up fatigue, unreliable alerts caused by incomplete information, and insufficient application of "usability" standards or principles have also led users to discontinue use of some decision support tools.[10] Providers, vendors, and other health IT users alike are negatively impacted by these barriers.[11,12]

NQF Health Information Technology Expert Panel and the Quality Data Set

The National Quality Forum (NQF) Clinical Decision Support (CDS) Expert Panel builds on the work of the NQF Health Information Technology Expert Panel (HITEP). With support from the Agency for Healthcare Research and

Quality (AHRQ), NQF convened HITEP to accelerate ongoing efforts defining how health IT can evolve to effectively support quality measurement. HITEP's output, the Quality Data Set (QDS) Model, is an information model that clearly defines concepts used in quality measures and clinical care and is intended to enable quality measurement based on the information available from an EHR.

In 2007, the first HITEP (HITEP I) developed and released a model to facilitate the development, use, and reporting of quality measures from EHR systems. The report that followed, *Recommended Common Data Types and Prioritized Performance Measures for Electronic Healthcare Information Systems,* proposed 11 data categories and 39 data types for a set of 84 high-priority quality measures to enhance capabilities for the electronic capture of data for quality measurement. In its second report, *Health Information Technology Automation of Quality Measurement: Quality Data Set and Data Flow,* the second HITEP (HITEP II) developed the QDS to enable automated, patient-centric, longitudinal, quality measurement. The QDS is intended to serve as a centralized, maintained repository of quality data requirements (concepts, data types, data elements, and code lists) and data definitions that provide unambiguous meaning for each data element in a quality measure.

The HITEP I and II Expert Panels defined a structure for quality measure *data types* and data flow (i.e., the QDS). HITEP used data type to define a concept (e.g., medication) and how it was expected to be used (e.g., administered, ordered). HITEP further defined how that information is captured within a clinical workflow with the *data flow* attributes being: 1) the *source* (the originator of the information, i.e., a clinician, patient, or device); 2) the *recorder* (i.e., a clinician, patient, or device and possibly different than the source); 3) the *setting* (i.e., hospital, home, ambulatory setting); and 4) the *health record field* (location in the EHR where the information should reside). These *data flow* attributes define information about the data captured during the clinical care process to allow for a clear and more specific understanding of the process and to also enable CDS workflows. The QDS Model exists as a dynamic product that will expand and undergo versioning to support future needs for measurement, CDS, and care delivery.

The QDS has been incorporated into the Healthcare Information Technology Standards Panel (HITSP) updates to the Quality Interoperability Specification and the HITSP components to which it refers.[13] The Office of the National Coordinator for Health IT created HITSP in 2005 to promote interoperability and the exchange of information among electronic health systems. HITSP specifically identified an electronic source and a standard code set for each data category and data type in the HITEP report. This allows the QDS to become part of health information exchange standards used by the health IT community.

NQF Clinical Decision Support Expert Panel Objective and Goals

NQF's future vision of a high-performing healthcare system is one in which the use of health IT and quality measurement are inextricably linked to:

- capture the right data;
- provide real-time information necessary for decisionmaking;

- calculate quality measures as a byproduct of health IT use; and
- facilitate the electronic capture of information necessary for quality reporting from the EHR.

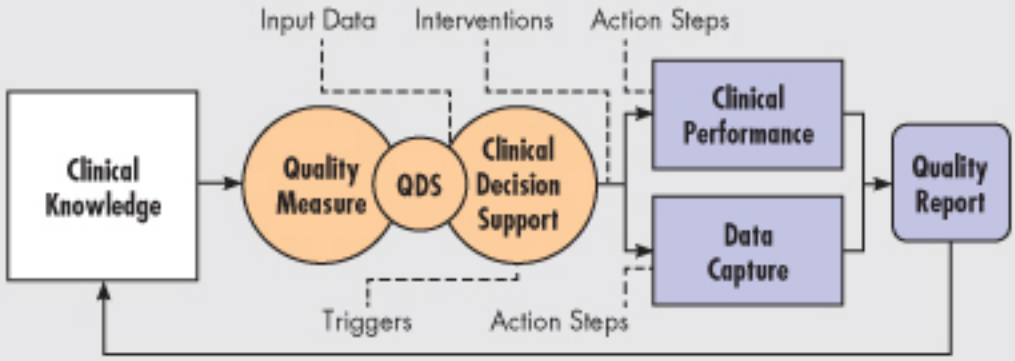
NQF convened the CDS Expert Panel to develop a taxonomy that connects quality measurement and CDS in the EHR and other electronic clinical information systems and to attain several other supporting goals.

The overarching purpose of creating a CDS taxonomy is to increase the adoption of electronic decision support to address national health priorities. The CDS Taxonomy developed by the Expert Panel is a classification and categorization of the CDS information necessary for quality improvement. The taxonomy itself should be independent of specific implementation, workflow, and design decisions, which are the province of developers, vendors, and implementers. The CDS Expert Panel believes it can achieve this purpose by advancing the HITEP I and HITEP II goals of describing unambiguously the clinical information that is needed for all quality measures.

The CDS Expert Panel's goal is to facilitate wider incorporation of CDS into routine EHR clinical workflows *by developing a CDS taxonomy* so that quality measure developers, clinical system implementers, and vendors can "speak the same language," enabling them to develop, share, implement, and evaluate the effectiveness of different approaches to applying CDS aligned with quality measurement.

Figure 3 represents a high-level overview of the relationship among CDS, quality measures, and the QDS Model. Quality measures, the QDS Model, and CDS work in a parallel effort to deliver clinical knowledge to improve clinical performance and data capture. Clinical research advances the development of clinical knowledge, which is often represented in clinical guidelines of care. The guidelines frequently include algorithms with decision points requiring clinician or patient input.

Figure 3: Triggers, Input Data, Interventions, and Action Steps, as part of the relationship of clinical decision support, quality measures, and the QDS Model



These decision points are often the subject of quality measures and (CDS) rules. The data inputs required to determine whether a specific rule or measure applies to a given patient or user at a specific place and time are defined by the QDS. The CDS rules and interventions promote improvements in both data capture and clinical performance. A result is a quality report that indicates the level of performance against quality measures. Figure 3 is not intended to suggest a linear or sequential relationship between quality measures and CDS.

CDS Expert Panel Analysis and Methods

CDS Expert Panel Meeting

The CDS Expert Panel began its work by convening in Washington, DC, on November 11 and 12, 2009 (see Appendix A for the CDS Expert Panel Roster). The two-day meeting provided an overview of HITEP's previous QDS Model work and recommendations, background on CDS and varied CDS systems, and existing information models for CDS implementation. This overview enabled the Expert Panel to review and define the need and goals for the project.

The Expert Panel discussed the lack of a common description of CDS for quality measurement purposes. The Panel endorsed the need to enable better communication about CDS and agreed to create a taxonomy that was sufficiently broad, comprehensive, and adaptable for use across diverse settings and delivery systems using health IT.

To build upon and leverage existing CDS taxonomy efforts, the Expert Panel elected to use a taxonomy developed at Partners HealthCare, Inc. (Partners) as a starting point for the NQF CDS Taxonomy.[14] The Partners' taxonomy identified four basic components in each CDS rule active in its system. Several other CDS models were discussed, but the Expert Panel selected the four-element taxonomy for its simplicity and directness.

The Expert Panel established three workgroups with discrete areas of focus. The NQF CDS taxonomy workgroup evaluated the Partners' taxonomy in detail and performed an environmental scan of CDS implementations in their own organizations. The QDS mapping workgroup reviewed the resulting taxonomy in detail to evaluate the capability of the QDS to support the NQF CDS Taxonomy requirements. The goals workgroup validated the overall goal of the CDS Expert Panel.

The Expert Panel identified the following issues as outside the focus of its work:

- local or particular CDS implementation and adoption issues;
- measurement of CDS effectiveness;
- the details of coded value sets and terminology in CDS or EHRs overall;
- local site requests to external third-party systems for electronic information necessary for CDS logic and performance analysis;
- methods for managing intellectual property of CDS content;
- structure of CDS (formalisms) for sharing requirements and storage;
- considerations related to effective decision support timing in the clinical workflow;

- use and structure of context-specific links from one information system to some other knowledge resource that returns information relevant to the initial context (e.g., "Infobuttons");
- incentives and changes in the payment system to encourage adoption of CDS; and
- legal ramifications regarding the use of CDS.

The Taxonomy Foundation: Partners HealthCare, Inc. Taxonomy

In 2007, a Partners team of CDS researchers published a functional taxonomy that represented the CDS workflow processes that occur during care delivery and allow for the integration of CDS within the EHR.[15] This taxonomy was based on analysis and classification of the more than 7,000 CDS rules, classified into 181 rule types, that were in use at any of Partners' 9 sites at that time. Given that Partners is a large and fully operational healthcare setting with a long history of computer-based point-of-care decision support, the Expert Panel felt this taxonomy was "reality tested," although the extent to which it could be generalized to other operational systems was initially unclear.

Partners' work identified four basic components in each CDS rule active in the Partners clinical information system and defined them as:

- *"Triggers:* the events that cause a CDS rule to be invoked. Examples include prescribing a drug, ordering a laboratory test, or entering a new problem on the problem list.
- *Input data:* the data elements used by a rule to make inferences. Examples include laboratory tests, patient demographics, or the problem list.
- *Interventions:* the possible actions a decision support module can take. These include such actions as sending a message to a clinician, showing a guideline, or simply logging that an event took place.
- *Offered choices:* many decision support events require users of a clinical system to make a choice. For example, a rule that fired because a clinician entered an order for a drug the patient is allergic to might allow the clinician to cancel the new order, choose a safer alternative drug, or override the alert and keep the order as written but provide an explanation."

Use Case Scenarios

The next stage of the CDS Expert Panel's analysis involved developing use case scenarios to more clearly define and communicate the nature and role of a CDS taxonomy. For each use case, the related care delivery workflow "events" were specified, including direct patient care, ordering, documentation, and subsequent quality reporting. The use cases were not intended to be comprehensive or representative of the full spectrum of the taxonomy but rather to demonstrate how the draft taxonomy will address the CDS workflows.

Four illustrative use cases were defined:

1. The EHR user records patient information (trigger) such as a problem or diagnosis that is used to define the population criteria for one or more NQF-endorsed® quality measures. CDS accesses essential data defined in the rule (input data); however, a required element is missing. The CDS facilitates documentation of the information by notifying the EHR user (intervention). The EHR user documents the information via one or more facilitated mechanisms (offered choices).

2. A test result returns (trigger) confirming a condition used to define the population criteria for one or more NQF-endorsed quality measures. Utilizing data captured and recorded elsewhere in the system (input data), the CDS exposes that the patient meets criteria for an intervention (such as the prescription of a medication) and facilitates adherence to the quality measure by notifying the EHR user (intervention) with a pre-staged order and qualifying contraindications, which the EHR user evaluates and acts upon (offered choices).
3. The EHR user is recording patient information such as an encounter or a diagnosis (trigger) that is used to define population criteria for one or more NQF-endorsed quality measures. Accessing other patient data (input data), a CDS application notifies another member of the care team (intervention) about disease management and health behavior change education for which the patient meets criteria. The system provides the identified member of the healthcare team with tools or utilities to address the need (offered choices).
4. Based on a user's action or request, *a predefined event, or the absence of a predefined event at a predetermined time* (trigger), the EHR collates required information (input data) for an individual or a panel of patients. The CDS system analyzes the input data to determine if expected performance or outcomes have been satisfied and provides a recommendation (intervention). The intervention can provide an actionable option for an end user (offered choice) such as presenting individual or batch orders, letters, role-specific education, or other forms of outreach.

Review and Extension of the CDS Taxonomy

The Expert Panel's CDS taxonomy workgroup surveyed the CDS landscape to understand the current level of activity and approach to CDS in organizations around the nation. The workgroup wanted to gauge the applicability and relevance of the taxonomy to other settings actively using CDS. The CDS taxonomy workgroup selected the Federal CDS Collaboratory, Intermountain Healthcare, Kaiser Permanente, Regenstrief Institute, the Structural Care Recommendations for CDS Project Team, and the Yale Center for Medical Informatics to review the CDS Taxonomy (for more information, please see Appendix B—CDS Taxonomy Review Organizations). Representatives were asked to:

- consider whether the proposed taxonomy was sufficient to describe the CDS used in their EHRs;
- consider the semantics employed, the level of granularity, and the completeness in light of their CDS experience; and
- identify any important missing attributes or characteristics.

The feedback received contributed to two CDS Taxonomy modifications. First, the name of the fourth category, *offered choices,* implied the necessary involvement of a person making an active choice following a CDS intervention. Because an intervention can be executed and completed without a person necessarily making a "choice," modification of this name was recommended. The term *action steps* replaced *offered choices*, as it most closely describes the CDS information workflow whereby a system or a human user can complete the process

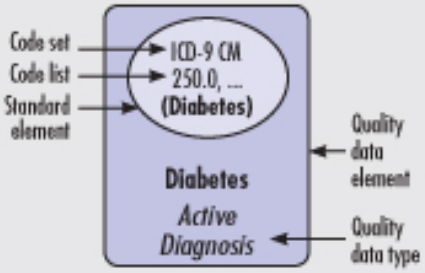
by acting upon an intervention. Second, in response to reviewer input, the workgroup emphatically agreed with the need to emphasize that CDS interventions include more than just interruptive "pop-up" alerts. Accordingly, the taxonomy should support a broad range of interventions, including enhanced display of information (such as flow sheets, reports, or graphics), order sets, documentation templates, non-obtrusive advisories, and more.[16] The CDS taxonomy workgroup sought to develop the taxonomy to an optimal level of detail, or granularity. It was acknowledged that the "right" level will be somewhat dependent on the intended use and that intended uses will vary. Ultimately, the workgroup combined some taxa in the Partners taxonomy and separated ("split") others. It was understood that actual use of the taxonomy would inform this process and that further evolution will be required with use over time.

Mapping the NQF CDS Taxonomy to the QDS Model

Following the development of the initial version of the CDS Taxonomy, the CDS Expert Panel's QDS mapping workgroup was charged with defining and explaining the relationship between the NQF CDS Taxonomy and the QDS Model. The QDS Model is a classification system that describes clinical information so that it may be used to express data needed for quality measurement, clinical research, and public health reporting—all of which repurpose information recorded in the EHR during clinical care. Specifically, the QDS defines the types of data that are necessary to develop standardized, consistent, and comparable common terminology for quality measurement. Each measure is constructed with QDS elements that contain all of the electronic information required to calculate the measure. Each QDS data element is composed of the context in which the information is expected (*data type*) combined with the list of codes (*code list*) in an applicable existing taxonomy or terminology. The code list for any specific item is called a *standard concept.*

In Figure 4, the standard concept, diabetes, is defined by a set of ICD-9 codes, a terminology used to classify information about diagnoses such as diabetes. To identify the measure's context for diabetes, the standard concept is assigned a data type, for example, "*diabetes active.*" Other data type examples for a given diagnosis standard concept are inactive and resolved (past history). The combination of the

Figure 4: The QDS Model "building blocks"



The data "building blocks" of the QDS Model help ensure that quality measures are defined in a standard way. Meanwhile, accomplishing alignment of CDS with quality measurement requires that the rules constructed for CDS support the logic in measures.

standard concept "diabetes" and the data type "active" creates the quality data element "diabetes, active." For more information on the QDS, please refer to the HITEP II report, *Health Information Technology Automation of Quality Measurement: Quality Data Set and Data Flow* and the Quality Data Set on the NQF website at **http://qualityforum.org/Projects/h/QDS_Model/Quality_Data_Set_Model.aspx**.

To ensure the QDS Model and the CDS Taxonomy enable comprehensive measurement, reporting, and use by different stakeholders, the taxonomy's input data (that express patient-specific content in the EHR) must be appropriately aligned with the QDS Model and relevant data elements. However, the other taxonomy categories—triggers, interventions, and action steps—do not require tight linkage to the QDS because they do not generally define eligible populations, but rather describe functions used to integrate the CDS within the EHR clinical workflow.

To further explore the relationship between CDS Taxonomy input data and the QDS Model, the input data were mapped to the QDS Model. It was not initially clear that all of the identified data elements in the taxonomy were included in the QDS.

The QDS mapping workgroup focused its efforts on mapping the CDS Taxonomy to the QDS to understand and define the interrelationship. During the mapping exercise, it became clear that the QDS was more expansive and comprehensive than the CDS Taxonomy. Specifically, the QDS by definition covers the data elements needed to express the full range of inclusion and exclusion criteria in quality measures. Therefore, the focus of mapping was shifted to identifying any gaps in the QDS *were it to be employed as the input data of the CDS Taxonomy*. Refer to Appendix C for the results of mapping input data to the QDS Model. The Expert Panel acknowledged but did not attempt to resolve future requirements that will likely occur as a result of developments in areas such as personalized and genomic medicine and patient-focused CDS.

During the process, the QDS mapping workgroup identified "intervention" and "preference" as standard categories and added them to QDS Version 2.1. The workgroup's efforts also led to the standard inclusion of data types across their relevant categories. For example, in QDS Model Version 2.1, the data type "encounter" can and should be applied to the categories "encounter performed" and "encounter ordered."

Several other considerations highlighted the advantages of using the QDS Model to define the master set of input data:

- The QDS Model was developed to provide direction to measure developers, EHR vendors, and other stakeholders on how to define, without ambiguity, requirements for measure-related data in the EHR. The QDS data types become the standard for measure developers (and CDS rule developers) to define what is needed clinically for measures or rules. Similarly EHR vendors can identify how each data type can be consistently found within their applications so that the required information defined within quality measures or CDS rules can be accessed. Moreover, the QDS data element *code list* component provides a standard to enable greater semantic interoperability among health IT systems, measure developers, and CDS rule developers.

- As the QDS Model continues to evolve, code lists will be specified for each QDS data element, providing the level of granularity needed to achieve uniformity in measurement across EHRs and provider organizations.
- Processes are already in place to accomplish ongoing updates to the QDS Model and the NQF CDS Taxonomy and to make them publicly available (please see the section "Issues, Future State and Work, and Next Steps").
- Other current CDS-related initiatives[17] are referencing, incorporating, or leveraging the QDS.

Description of the NQF CDS Taxonomy

The CDS Expert Panel's task was to develop a CDS taxonomy that could adequately represent CDS rules and elements while ensuring concordance of this taxonomy with the QDS Model. Today, CDS tools and systems are used primarily in EHRs and directed to clinicians and other members of the care team in hospital and ambulatory settings. CDS rules may also be directed toward a clinical application, such as a computer, a monitoring device, or an application on a smart phone.

The CDS Taxonomy classifies and categorizes the CDS information necessary for quality improvement, as well as other secondary uses such as public health reporting and clinical effectiveness research. The taxonomy is composed of four functional categories: 1) triggers, 2) input data, 3) interventions, and 4) action steps. Each CDS Taxonomy category is shown in Figure 5 and described below.

The Expert Panel acknowledged that consumer and caregiver decisionmaking are critical for a safe, effective, patient-centered healthcare system and that patients may increasingly be recipients of CDS via patient portals and secure electronic mail. While not explicitly addressed by the taxonomy presented here, future iterations should be capable of communicating health-related information to patients and caregivers.

The Expert Panel designed the taxonomy to be independent of specific implementation, workflow, and design decisions. The Panel also did not designate specific features or functionality as part of its design, as these are implementation decisions that will vary across regions and individual entities. The taxonomy is intended to be flexible to adapt to local needs and standard practices and is designed to be capable of two-way communication between applications (e.g., computer, a monitoring device, or an application on a smart phone).

Triggers

Triggers are events or actions that initiate a CDS rule. Examples include ordering a drug or laboratory test for a patient or system receipt of a result or finding. The CDS Expert Panel consolidated the categories into four types of triggers on the basis of similar themes, or actions, as shown in Table 1 on the following page.

Figure 5: The four functional categories of the NQF CDS Taxonomy

The CDS Taxonomy consists of four functional categories:

1. The trigger (*solicit, update, act, and time*) initiates a CDS rule.
2. The input data are represented by the components of the QDS data types.
3. Interventions (*log, display, and notify*) include the possible actions the information system can take to deliver information.
4. The action steps (*collect information, request, acknowledge, communicate, and document*) are actions a receiver of the information can perform.

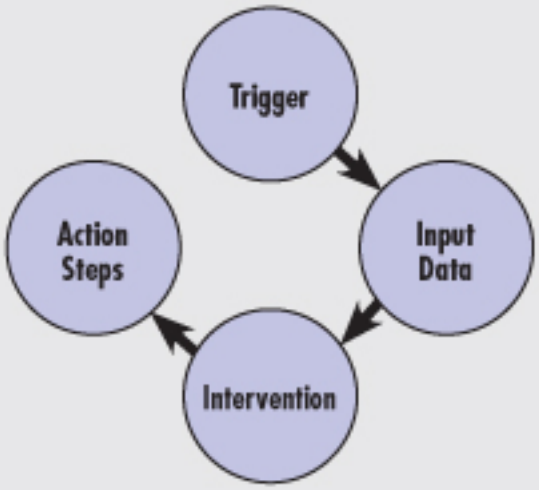


Table 1: NQF CDS Taxonomy Triggers

NQF CDS TAXONOMY: TRIGGERS	
Triggers	**Trigger Examples**
1. Solicit A user *solicits* or requests assistance from a CDS system, rather than having it presented automatically. A wide range of solicited CDS can be embedded in a system.	• Solicit a medication dosing recommendation based on renal function (provider) • Solicit a list of available treatments and their inherent risks based on a diagnosis (consumer) • Solicit links to relevant clinical knowledge or research results, pre-configured compilations of related data or templates, orders or order sets available for the user to select, or analyses of prior performance for individual treatment options
2. Update *Update* represents changes or updates to any patient information documented and recognizable in electronic form.	• Record any new observation, result, condition, or finding (e.g., laboratory test result, imaging study result, patient allergy, existing problem, diagnosis, condition, symptom, physical exam or assessment finding, physiologic measurement such as weight, blood pressure, volume of input/output, temperature, patient or family healthcare or health history, and patient-reported information) • Modify, or *update* any patient-specific information to trigger a rule

more

Table 1: NQF CDS Taxonomy Triggers *(continued)*

NQF CDS TAXONOMY: TRIGGERS	
Triggers	**Trigger Examples**
3. Act *Acts* represent interactions with the EHR. Any initiating function is included, for example, opening a specific patient record, ordering a medication or procedure, and documenting clinical events. *Act* triggers are necessarily workflow dependent. Based on pre-determined local rules, an information system can generate an *act*. System or clinician user interactions apply equally to the *act* trigger type.	• A user signs on to the EHR • A user opens patient record • A user begins an electronic task (e.g., request order, select template to document, request work list) • An electronic task is completed (e.g., sign order, note, assessment) • A user begins or completes an electronic subtask (administer medication, plan of care portion of encounter note) • A user places an order (e.g., admission, discharge, consult or referral, diagnostic study such as laboratory test, CT scan, or pulmonary function test, and treatments including medicine, blood products, diet, surgery, respiratory therapy, information therapy, and nursing care)
4. Time *Time* is the fourth type of trigger. A rule can be set to trigger at a specific, predetermined time, or at a relative time.	• Specific, predetermined time is used to trigger rules for individuals, populations or groups of patients. For example, a rule can be set to trigger nightly to identify all women in a target population age 40 or older to determine if a mammogram (input data) has been performed within the past 24 months • Time is used to trigger rules in relationship to another event. For example, a rule could be set to trigger on post-op day 1 or post-op day 2 • Time can be used to determine the presence or absence of one or more other events. For example, the occurrence of an event (mammography result posts to a database) within a predetermined elapsed time of another trigger occurring (mammography ordered) can determine if the expected process or outcome has been achieved. In the example, the mammography result is the input data to the CDS rule. Its presence allows one intervention (notify the provider and patient to review and follow up); its absence allows a different intervention (notify the provider and the patient to schedule the study)

Input Data

Input data are the additional data, from the patient record or other source, used as background to modify or constrain the CDS rule. Examples include medications, problem lists, allergy, or laboratory values. The CDS Taxonomy Input Data category uses the QDS Model to define all of the data elements for rules inference engines. As shown in Table 2, the structure of the QDS Model defines data categories as general concepts (e.g., medication), further divided into data types that provide additional meaning by highlighting a specific context about those concepts (e.g., medication administered, medication allergy, etc.). A QDS data element combines the data type with a specific code list (or value set) to very specifically provide the information required to calculate a quality measure or process a CDS rule.

Table 2: NQF CDS Taxonomy Input Data

NQF CDS TAXONOMY: INPUT DATA	
QDS Standard Categories	**QDS Data Types (QDS Model Version 2.1)**
Care experience	• Patient care experience • Provider care experience
Care plan	• Care plan
Communication	• Communication from provider to provider • Communication from provider to patient • Communication from patient to provider
Condition/Diagnosis/Problem	• Diagnosis, active • Diagnosis, family history • Diagnosis, inactive • Diagnosis resolved
Device	• Device, adverse event • Device, allergy • Device, applied • Device, intolerance • Device, order
Diagnostic study	• Diagnostic, study adverse event • Diagnostic, study intolerance • Diagnostic, study order • Diagnostic, study result • Diagnostic, study performed

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Table 2: NQF CDS Taxonomy Input Data *(continued)*

NQF CDS TAXONOMY: INPUT DATA	
QDS Standard Categories	**QDS Data Types (QDS Model Version 2.1)**
Encounter	• Encounter, order • Encounter, performed
Functional status	• Functional status, order • Functional status, performed • Functional status, result
Individual characteristic	• Patient characteristic • Provider characteristic
Intervention	• Intervention, adverse event • Intervention, intolerance • Intervention, order • Intervention, performed • Intervention, result
Laboratory test	• Laboratory test, adverse event • Laboratory test, intolerance • Laboratory test, order • Laboratory test, performed • Laboratory test, result
Medication	• Medication, active • Medication, administered • Medication, adverse effects • Medication, allergy • Medication, dispensed • Medication, intolerance • Medication, order
Negation rationale	• Communication, not done • Device, not done • Diagnostic study, not done • Encounter, not done • Functional status, not done

more

Table 2: NQF CDS Taxonomy Input Data *(continued)*

NQF CDS TAXONOMY: INPUT DATA	
QDS Standard Categories	**QDS Data Types (QDS Model Version 2.1)**
Negation rationale *(continued)*	• Laboratory test, not done • Medication, not done • Physical exam, not done • Procedure, not done • Substance, not done
Physical exam	• Physical exam, finding • Physical exam, order • Physical exam, performed
Preference	• Patient preference • Provider preference
Procedure	• Procedure, adverse event • Procedure, intolerance • Procedure, order • Procedure, performed • Procedure, result
Risk category/Assessment	• Risk category/assessment
Substance	• Substance, administered • Substance, adverse event • Substance, allergy • Substance, intolerance • Substance, order
Symptom	• Symptom, active • Symptom, assessed • Symptom, inactive • Symptom, resolved
System characteristic	• System characteristic
Transfer of care	• Transfer from • Transfer to

Interventions

Interventions describe the possible actions taken by decision support to provide information when the conditions specified in a rule are met. Examples include sending a message to a clinician, showing a guideline, or logging that an event (including an alert) took place. The NQF CDS Expert Panel analysis identified three taxa of interventions, as shown in Table 3. These categories reflect the many vehicles besides "pop-up" alerts available to make advice accessible and actionable in the clinical workflow.

Table 3: NQF CDS Taxonomy Interventions

NQF CDS TAXONOMY: INTERVENTIONS	
Interventions	**Intervention Examples**
1. Notify	• Send message • Flag patient on list or whiteboard • Escalate notification • Notify with choices (for example, choices in form of defaults and pick lists, or template, advisory message, alert with embedded choices for response) • Notify informational (description of recommendation contraindication)
2. Display	• Relevant patient information (e.g., laboratory result) • Relevant clinical knowledge or research • Relevant tool such as calculator • Reference • Guidelines • Order set
3. Log	• Work or reference lists for clinical care, research, or other purposes

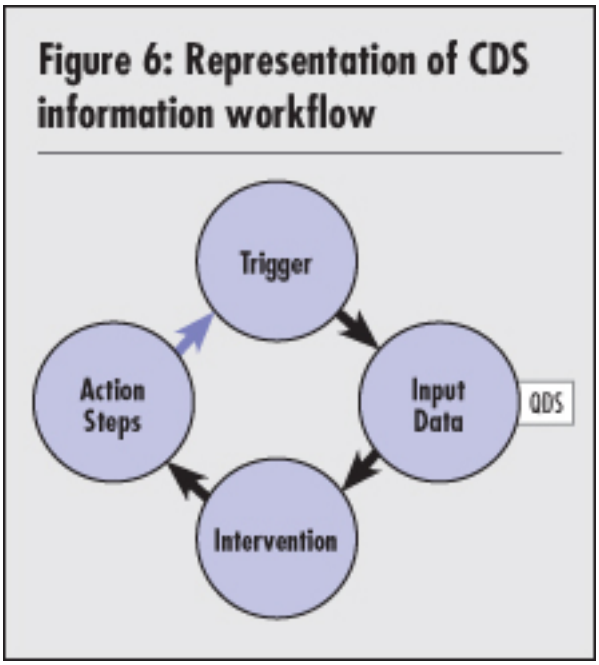
Action steps

Responses to a CDS intervention are defined by the action steps (referred to as "realization option" in the draft report for public comment and modified by the CDS Expert Panel based on comment period feedback). As CDS includes many options, the Expert Panel chose the term "action step" for this portion of the taxonomy, i.e., any action or event presented to the user of a clinical system that could lead to successful completion (or realization) of the intended mission of the rule. For example, a rule that is triggered because a clinician entered an order for a drug to which the patient is allergic might allow the clinician various acceptable options (cancel the new order, choose a safer alternative drug, or override the alert and keep the order as written but provide an explanation). The action steps "communicate" and "document" allow the clinician other options, such as communicating to the patient relevant clinical knowledge or research displayed as an intervention in the CDS taxonomy or documenting the communication.

Table 4: NQF CDS Taxonomy Action Steps

NQF CDS TAXONOMY: ACTION STEPS	
Interventions	**Action Step Examples**
1. Collect information	• Request a reason for overriding an alert • Collect acknowledgement • Collect discrete data • Collect free text
2. Request	• Any type of order (e.g., medication, diagnostic study, etc.) • Modify or cancel order being written or current order • Schedule
3. Acknowledge	• Acknowledge receipt • Respond (e.g., override, delegate, postpone) • Bypass or ignore
4. Communicate	• Recipients including clinicians, other staff, and patients • Communication methods including message, letter, e-mail • Content including patient education materials, template-based communication
5. Document	• Enter new patient information, including rationale for patient exclusion from guideline • Update existing patient information • Completion of care-related task

As depicted in Figure 6, the completion of any action step from one CDS rule may trigger the next rule in a set.



NQF CDS Taxonomy: Linking Quality Measures and CDS

NQF envisions CDS as the health IT-enabled link between clinical practice and quality performance, improvement, and measurement. The NQF CDS Taxonomy, together with the QDS Model serves as the link between CDS and quality measures, and this linkage is primarily achieved via input data. Four examples are provided below to illustrate how the NQF CDS Taxonomy provides a foundation for the description of an electronic infrastructure that bridges quality measurement and health IT.

Each example begins with the measure and the specific data elements used to determine patients satisfying and eligible for the measure (the "numerator" and "denominator," respectively) and demonstrates how users might employ triggers, interventions, and action steps to deliver measure-related content within the EHR workflow. A pre-condition for each measure is that the data elements specified in the measure match or can be mapped to elements stored in the EHR or other clinical systems.

For each measure, the examples demonstrate how users might employ triggers, interventions, and action steps to deliver measure-related content within the EHR workflow. A sequence of tables identify the "taxon," the singular element of the taxonomy, used by the workflow example and the "follow on user action" that describes the corollary action to the particular CDS taxon utilized in the workflow scenario.

Measurement of CDS effectiveness was out of scope for the CDS Expert Panel. However, in a related effort, in 2010, NQF's Health IT Utilization Expert Panel developed the Health IT Utilization Assessment Framework[18] that defined a method for expressing data that can be captured by health IT systems to understand and measure their usage. The Panel evaluated potential methods to measure CDS usage, which requires identification of:

- *actor:* a person or electronic system that performs actions;
- *content:* the concept on which an action is taken; and
- *action:* something a measure recommends to a person or a computer programmed by a person.

For each measure example accompanying figures represent the *actor, content,* and *action* for each of the CDS taxonomy components.

As described earlier in the report, the CDS Taxonomy is purposefully independent of specific implementation, workflow, and design decisions. Local implementation teams may select and apply the taxonomy based on their individual care models, the specific design of the software employed, and their specific experience with when and how to most effectively integrate clinical knowledge into workflow.

However, these examples illustrate how a local implementer might use the CDS Taxonomy to manage the clinical workflow for CDS within an EHR to improve quality concurrent with routine clinical workflow. Based on evidence-based clinical quality measures, these examples further show how the QDS Model is able to provide input data, identical to the information required by the measure, to enhance care delivery.

These examples are not intended to be either exhaustive or prescriptive.

Example 1: Discharge Medications for Patients with Heart Failure (HF)

The measure expects that all patients with left ventricular systolic dysfunction (LVSD) are prescribed one of two medication classes, angiotensin-converting enzyme inhibitors (ACEI) or angiotensin receptor blockers (ARB), at hospital discharge. One CDS application for this measure might involve a pre-configured order set to be used by the provider when writing discharge orders. This form of CDS, shown as the first example below, is one of the most commonly deployed and effective methods for integrating clinical recommendations at the point of ordering. Well-configured order sets are effectively evidence-based clinical "check lists." Because order sets are not always used or may not enforce comprehensive documentation of inclusion and exclusion criteria, other forms of CDS may be required.

Facilitated access to knowledge resources is an intervention that can be integrated throughout an EHR workflow. Links to "context-sensitive" reference materials are included in both of the first two applications of CDS illustrated below.

The Measure: Heart Failure—ACEI or ARB for LVSD

Measure Steward: Centers for Medicare & Medicaid Services (NQF # 0162)

- **Description of the Measure:** Heart failure patients with left ventricular systolic dysfunction (LVSD) who are prescribed an angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB) at hospital discharge. For purposes of this measure, LVSD is defined as chart documentation of a left ventricular ejection fraction (LVEF) less than 40 percent or a narrative description of left ventricular systolic (LVS) function consistent with moderate or severe systolic dysfunction.
- **Numerator Statement:** Heart failure patients who are prescribed an ACEI or ARB at hospital discharge.
- **Denominator Statement:** Heart failure patients with LVSD.

Measure Inclusion Criteria Mapped to QDS Model (Example 1)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Diagnosis/condition/problem	Diagnosis active	Diagnosis of heart failure
Diagnostic study	Diagnostic study result	LVEF result value
Diagnosis/condition/problem	Diagnosis active	LVSD in chart documentation
Medication	Medication order	ACEI or ARB prescribed at discharge
Encounter	Encounter	Admission date
Individual characteristic	Patient characteristic	Birth date

Measure Exclusion Criteria Mapped to QDS Model (Example 1)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Procedure	Procedure order	LVSD or heart transplant during hospital stay
Individual characteristic	Patient characteristic	Clinical trial (relevant to heart failure)
Individual characteristic	Patient characteristic	Comfort measures only
Encounter	Encounter	Discharge date
Transfer of care	Transfer to	Transferred for inpatient care, to federal health facility, or to hospice
Individual characteristic	Patient characteristic	Expired
Encounter	Encounter	Left against medical advice
Medication	Medication allergy	Allergy to ACEI
Medication	Medication allergy	Allergy to ARB
Medication	Medication order	Documented other medical or patient reason for no ACEI or ARB prescribed

Clinical workflow options for CDS (Example 1: a-c):

a. Ordering clinician prepares to write discharge orders

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	On request	User selects a discharge order set for patients with heart failure. The system may suggest an applicable order set based on input data
Input data elements	Condition/diagnosis/ problem; others	User selects appropriate order set. User performs matching of patient condition with the availability of a condition-specific order set
Intervention	Notify with choices	Order set is displayed, including ACEI and ARB as possible discharge medications and possible reasons for not prescribing to this patient
	Show guidelines	Order set includes one-click access to clinical recommendations regarding discharge medications
Action step	Write order	Clinician selects order for ACEI, along with other orders appropriate to the patient, then signs orders

b. Clinician writes discharge order

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	User selects a discharge order for this patient
Input data elements	Condition/diagnosis/ problem; medication orders; others	A rule fires and identifies lack of documentation of discharge medication orders conforming to recommendations or substantiation that the recommendation does not apply to this patient
Intervention	Notify with choices	Message presents recommendations regarding discharge medications for patients with heart failure, offering choices of ordering either of the medication classes or documenting reason for not ordering
	Show guidelines	Order set provides one-click access to clinical recommendations regarding discharge medications
Action step	Document	Clinician documents other clinical reason for not prescribing either of the recommended discharge medications

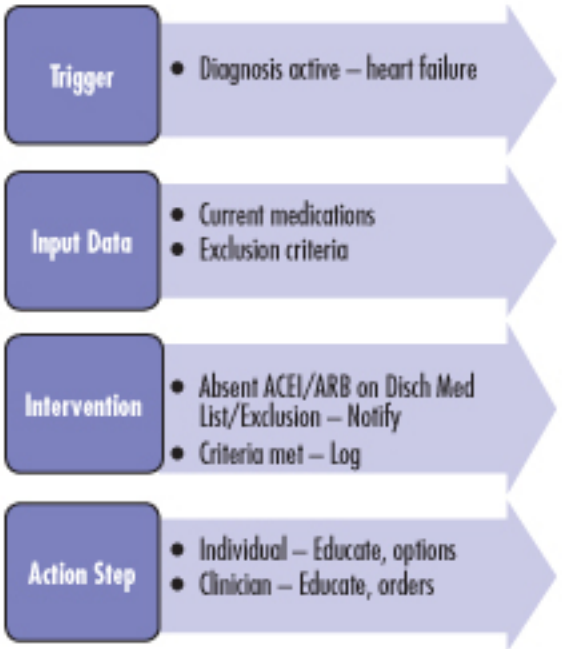
c. Nurse reviews discharge medications

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	Nurse initiates discharge process
Input data elements	Condition/diagnosis/ problem; discharge medications	The rule fires and identifies lack of documentation of discharge medication orders conforming to recommendations or substantiation that the recommendation does not apply to this patient
Intervention	Notify informational	Message presents recommendations regarding discharge medications for patients with heart failure and message also lets the nurse know that an automatic message is being sent to the clinician
	Notify with choices	Message sent to clinician advises of apparent gap in care and provides quick access to order one of the two recommended medications or appropriate exclusions
	Log; place on list	Patient placed on dashboard list for subsequent quality review
Action step	Document	Clinician writes order for ACEI

Figure 7 shows how the CDS Taxonomy and the Health IT Utilization Assessment Framework can be used in concert to display and enable expected actions. The measure tests if patients meeting the criteria have received an order for ACEI or ARB at discharge, or if the medications are present on the discharge medication list.

Figure 7: Display and Enablement of Expected Actions in Example 1

CDS TAXONOMY



HEALTH IT UTILIZATION ASSESSMENT FRAMEWORK

Action	Content	Actor (a) Individual (b) System
Calculate	• Age ≥18 years • Diagnosis active – mod to severe LVSD • Ejection fraction <40	b) System – (clinical application)
Access	• Discharge meds: ACEI, ARB • Allergy: ACEI & ARB • Clinical trial (HF)	b) System – (clinical application)
Notify	• Notify – Individual – Clinician	b) System – (EHR)
Case 1: – Request – Communicate	• Individual – Education link – Ask preference • Clinician – Education link – Order/document	a) Individual (Individual consumer, clinician)

This example provides a brief explanation about how the same information, using the QDS Model to find all required data elements (as also defined in the measure), might be used to address CDS from the perspective of two different users. The clinician might address the screening by means of an order or accessing clinician-directed educational materials to determine the appropriateness of each medication for the individual patient. The individual (or consumer) perspective might focus more on education and understanding the reasons for ACEI or ARB medications and the pros and cons of various options, allowing the expression of his or her preferences in decisionmaking. This single CDS "rule" could start with notifying the individual and then trigger a different rule based on the individual's entry of preference to intervene with an action step that meets the patient's preference.

Example 2: Discharge Education for Patients with Stroke

This next measure example requires that all of the elements of the recommended discharge education are specifically documented for all ischemic or hemorrhagic stroke patients. Nurses would be the most likely recipients of this decision support. The optimal time to insert decision support in the EHR workflow is locally determined; one option is when the responsible nurse is viewing a display of the education component of the discharge plan. The inclusion here of an option for quick access to patient education materials is another example of a CDS intervention. The second example involves a quality nurse as a backup strategy invoked when documentation of the recommended education has not been recorded.

The Measure: Stroke Education

Measure Steward: The Joint Commission (NQF #0440)

- **Description of the Measure:** Ischemic or hemorrhagic stroke patients or their caregivers who were given educational materials during the hospital stay addressing all of the following: activation of emergency medical system, need for follow-up after discharge, medications prescribed at discharge, risk factors for stroke, and warning signs and symptoms of stroke.
- **Numerator Statement:** Ischemic or hemorrhagic stroke patients with documentation that they or their caregivers were given educational material addressing all of the required elements.
- **Denominator Statement:** Ischemic stroke or hemorrhagic stroke patients discharged home.

Measure Inclusion Criteria Mapped to QDS Model (Example 2)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Diagnosis/condition/problem	Diagnosis active	Diagnosis of ischemic or hemorrhagic stroke
Transfer of care	Transfer to	Discharged to home or home care or discharge/transfer to court/law enforcement
Communication	Communication provider to patient	Education addresses activation of emergency medical system
Communication	Communication provider to patient	Education addresses follow-up after discharge
Communication	Communication provider to patient	Education addresses medications prescribed at discharge
Communication	Communication provider to patient	Education addresses risk factors for stroke
Communication	Communication provider to patient	Education addresses warning signs and symptoms of stroke
Encounter	Encounter	Admission date
Individual characteristic	Patient characteristic	Birthdate

Measure Exclusion Criteria Mapped to QDS Model (Example 2)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Procedure	Procedure order	Elective carotid intervention
Individual characteristic	Patient characteristic	Clinical trial (relevant to stroke)
Individual characteristic	Patient characteristic	Comfort measures only
Encounter	Encounter	Discharge date

Clinical workflow options for CDS (Example 2: a-b):

a. Nurse conducts discharge education

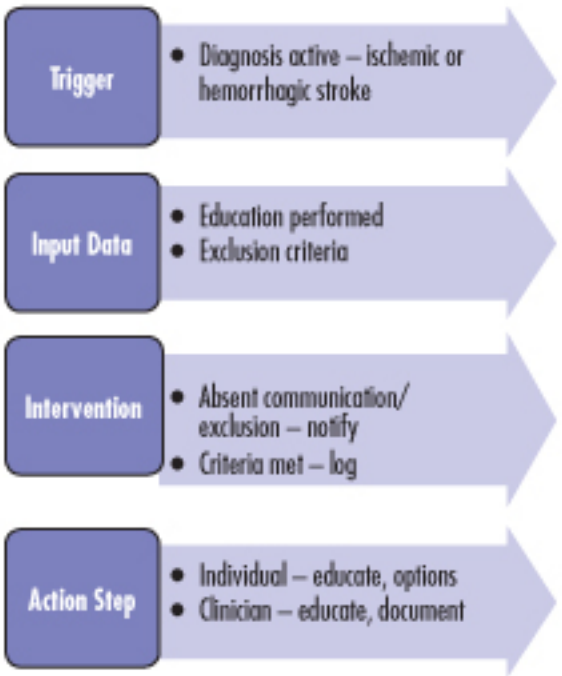
CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	User initiates discharge process
Input data elements	Condition/diagnosis/ problem; other	The rule fires, matches the patient with the recommendations
Intervention	Notify with choices	Discharge plan displayed includes elements of discharge education recommended for this patient and method for documenting completion of communication to patient of each element
	Show guidelines	Display includes icon providing one-click access to patient education materials for patient
Action step	Document	Nurse documents completion of education

b. Quality nurse reviews patients to be discharged the next day to identify any apparent gaps in care

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	User requests patient tracking report for all patients due to be discharged and with targeted conditions including ischemic or hemorrhagic stroke
Input data elements	Condition/problem/ diagnoses; educational components	Logic employed to create the report screens all patients with ischemic or hemorrhagic stroke to identify lack of documentation of recommended discharge education
Intervention	Notify with choices	Patient tracking display lists every identified patient and provides opportunity to attach a quality flag to each patient's entry on electronic white board maintained for patients on each nursing unit
Action step	Communicate	Nurse selects option to flag patients still lacking recommended discharge education

Figure 8 shows how the CDS Taxonomy and the Health IT Utilization Assessment Framework can be used in concert to display and enable expected actions.

Figure 8: Display and Enablement of Expected Actions in Example 2



HEALTH IT UTILIZATION ASSESSMENT FRAMEWORK

Action	Content	Actor (a) Individual (b) System
Calculate	• Age ≥18 years • Diagnosis active – ischemic or hemorrhagic stroke	b) System – (clinical application)
Access	• Communication: all 5 elements • Clinical trial (HF) • Comfort measures only	b) System – (clinical application)
Notify	• Notify – Individual – Clinician	b) System – (EHR)
Case 1: – Request – Communicate	• Individual – Education link – Ask preference • Clinician – Education link – Document	a) Individual (Individual consumer, clinician)

The measure tests if patients meeting the criteria (admission for ischemic or hemorrhagic stroke) received education at discharge. In this example, the clinician might address patient education through communication (education) and related documentation, or accessing clinician-directed educational materials to determine the rationale. The individual (or consumer) approach to education might consider the actions a patient and caregiver should take with respect to safety and follow up. Note that this single CDS "rule" could start with notifying the individual and then trigger a different rule based on the individual's entry of preference to intervene with the clinician with an action step that meets the patient's preference.

Example 3: Colorectal Cancer Screening in Ambulatory Care

This measure requires evidence that one of four types of colorectal cancer screening was performed and documented in the medical record for all patients aged 50 to 80 years. Orders for the procedures by themselves are not sufficient; each must have been performed at the respective interval. The first CDS application illustrated—automatic display of guidelines-based care gaps in one section of a patient summary screen whenever the patient record is opened—is a common design feature in ambulatory EHRs. One possible application of CDS that is not included in this set of examples is a message sent to the clinician or designee pointing out the gap in preventive care. Delivering a message every time a CDS rule identifies a possible gap in care interrupts clinician workflow and becomes impracticable with a large number of guidelines and related measures. For this reason, implementers may rely on asynchronous interventions (i.e., interventions that are not tied to specific clinician actions).

The Measure: Preventive Care and Screening—Colorectal Cancer Screening

Measure Steward: National Committee for Quality Assurance (NQF # 0034)

- **Description of the Measure:** Patients aged 50 through 80 years who received the appropriate colorectal cancer screening.
- **Numerator Statement:** Patients aged 50 through 80 years who received
  - Fecal occult blood test (FOBT) during the one year reporting period,
  - Flexible sigmoidoscopy during the reporting period or the four years prior to the reporting period,
  - Colonoscopy during the reporting period or the nine years prior to the reporting period,
  - Double contrast barium enema during the reporting period or four years prior to the reporting period.
- **Denominator Statement:** Patients aged 50 through 80 years who had one face-to-face encounter during the measurement period and no documented medical or patient reason for not performing screening.

Measure Inclusion Criteria Mapped to QDS (Example 3)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Individual characteristic	Individual characteristic	Birth date
Laboratory test	Laboratory test ordered	Fecal occult blood test
Laboratory test	Laboratory test performed	Fecal occult blood test date/ time
Diagnostic study	Diagnostic study performed	Flexible sigmoidoscopy
Diagnostic study	Diagnostic study performed	Flexible sigmoidoscopy date/ time
Diagnostic study	Diagnostic study performed	Colonoscopy
Diagnostic study	Diagnostic study performed	Colonoscopy date/time
Diagnostic study	Diagnostic study performed	Double contrast barium enema
Diagnostic study	Diagnostic study performed	Double contrast barium enema date/time

Measure Exclusion Criteria Mapped to QDS Model (Example 3)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Individual characteristic	Personal characteristic	Birth date
Encounter	Encounter	Encounter type
Encounter	Encounter	Encounter date/time
Diagnosis/condition/problem	Diagnosis active	Colorectal cancer
Procedure	Procedure performed	Total colectomy
Preference	Patient preference	Coded patient reason for not participating in screening
Transfer of care	Transfer to	Transferred to hospice
Individual characteristic	Patient characteristic	Expired

Clinical workflow options for CDS (Example 3: a-b):

a. Clinician opens patient record

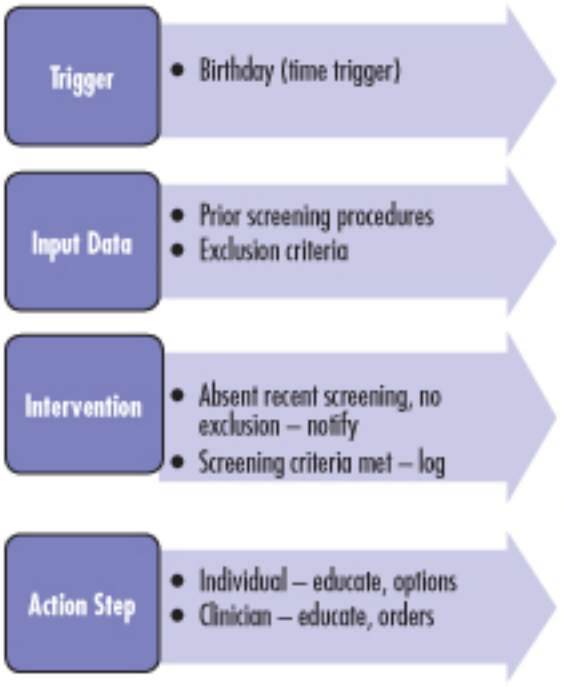
CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	Clinician opens patient ambulatory record
Input data elements	Patient age; prior diagnostic procedures; condition/problem/ diagnosis	The rule fires, matches the patient with the recommendations, and identifies that none of the recommended screening procedures has been documented during the relevant time periods for each type of screening
Intervention	Notify with choices	Patient summary screen displayed includes information about health maintenance recommendations that are overdue with one-click access to responses
	Notify with information	Screen header that includes patient name, birth date, and other information includes indication of overdue health maintenance care
Action step	Write order	Clinician takes advantage of the link option to order appropriate screening

b. Clinician writes electronic encounter note

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	Clinician initiates encounter note, selecting template based on reason for visit
Input data elements	Condition/problem/ diagnosis; past procedures	The rule fires, matches the patient with the recommendations, and identifies that none of the recommended screening procedures has been documented during the relevant time periods in the measure
Intervention	Notify with choices	Plan section of template displayed is auto-matically updated to include possible orders for overdue health maintenance care, in this case the colorectal cancer screening
Action step	Write order	Clinician selects appropriate screening procedure to include in the interventions being ordered at the end of the encounter

Figure 9 shows how the CDS Taxonomy and the Health IT Utilization Assessment Framework can be used in concert to display and enable expected actions.

Figure 9: Display and Enablement of Expected Actions in Example 3



HEALTH IT UTILIZATION ASSESSMENT FRAMEWORK

Action	Content	Actor (a) Individual (b) System
Calculate	• Age (current date – birth date =>= 50 years)	b) System – (clinical application)
Access	• Last: colonoscopy sigmoidoscopy FOBT • History: colectomy	b) System – (clinical application)
Notify	• Notify – Individual – Clinician	b) System – (EHR)
Case 1: – Request – Communicate	• Individual – Education link – Ask preference • Clinician – Education link – Order	a) Individual (Individual consumer, clinician)

The measure tests if patients meeting the criteria have screening procedures on established schedules (every 10 years for colonoscopy, every 5 years for flexible sigmoidoscopy, and every year for fecal occult blood testing <FOBT>). The measure has been converted, or "retooled," to assess clinical data within electronic health records. The clinician might address the screening by means of an order, or accessing clinician-directed educational materials to determine the appropriateness of each action for the individual patient. The individual (or consumer) might approach education on the pros and cons of various options, allowing the individual to express his or her preferences to share in decisionmaking. As described in previous examples, this single CDS "rule" could start with notifying the individual and then trigger a different rule based on the individual's entry of preference to intervene with the clinician with an action step that meets the patient's preference.

Example 4: Use of High-Risk Medications in the Elderly

This measure example illustrates how the NQF CDS Taxonomy can be used to describe a common application of CDS in both inpatient and ambulatory EHRs: screening of medication orders to detect potential contraindications and other safety issues. The particular measure involves an extensive list of medications deemed inappropriate in patients 65 years of age and older. The measure involves two calculations: the number of eligible patients with one prescribed inappropriate medication and the number of eligible patients with two or more such prescriptions during the measurement period. For purposes of illustration, these are combined because the same application of decision support is applicable in both cases.

The Measure: Drugs to be Avoided in the Elderly

Measure Steward: National Committee for Quality Assurance (NQF # 0022)

- **Description of the Measure:** Patients 65 years of age and older on one high-risk medication; Patients 65 years of age and older on two or more high-risk medications.
- **Numerator Statement:** Patients aged 65 years or more with one or more prescriptions for a designated high-risk medication [list provided in measure specification] during the measurement year.
- **Denominator Statement:** Patients aged 65 years of age and older who had one face-to-face encounter during the measurement period.

Measure Inclusion Criteria Mapped to QDS (Example 4)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Individual characteristic	Individual characteristic	Birth date
Medication	Medication order	Medication name
Medication	Medication order	Medication order date/time

Measure Exclusion Criteria Mapped to QDS Model (Example 4)

QDS Model Data Category	QDS Model Data Type	QDS Model Data Element
Individual characteristic	Individual characteristic	Birth date
Encounter	Encounter	Encounter type
Encounter	Encounter	Encounter date/time

Clinical workflow options for CDS (Example 4: a-b)

a. Clinician writes prescription

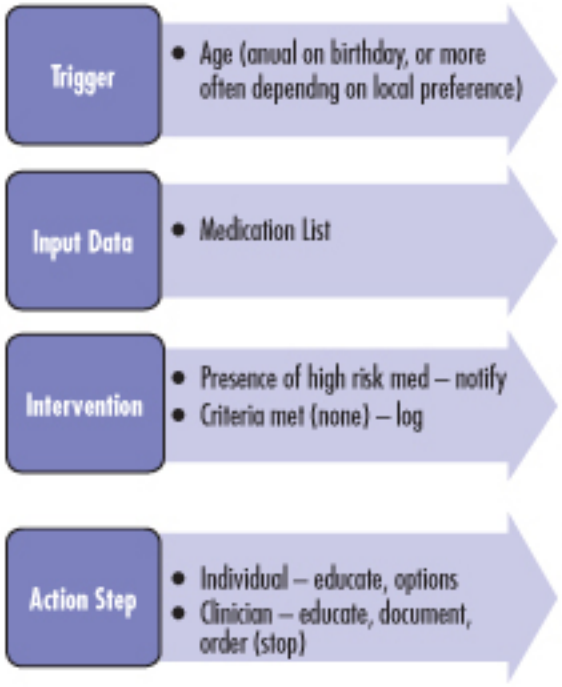
CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	Clinician writes a medication order and selects one of the designated high-risk medications
Input data elements	Age; active medication list	The rule fires and checks patient age and medication list
Intervention	Notify with information	In patients greater than or equal to age 65, the CDS notifies clinician that medication is high-risk for patients 65 years and older
Action step	Acknowledge notification; cancel prescription	Clinician has option to select a different medication or to override the advisory with documentation of reason

b. Medication reconciliation is completed, including the addition of several new medications the patient indicates have been prescribed outside the confines of the EHR

CDS Functional Category	CDS Taxon	Follow-on user actions
Trigger	Workflow	Clinician performs medication reconciliation, updating the medication list maintained in the EHR
Input data elements	Patient age; medication list	The rule fires and checks patient age and the list of designated high-risk medications
Intervention	Notify with information	A message is provided to ordering clinician that this particular medication is on the "do not prescribe" list for patients 65 years and older
Action step	Write order; acknowledge	Clinician has option to discontinue medication on medication list or provide documentation of review and rationale for continuing

Figure 10 shows how the CDS Taxonomy and the Health IT Utilization Assessment Framework can be used in concert to display and enable expected actions.

Figure 10: Display and Enablement of Expected Actions in Example 4



HEALTH IT UTILIZATION ASSESSMENT FRAMEWORK

Action	Content	Actor (a) Individual (b) System
Calculate	• Age ≥65 years	b) System – (clinical application)
Access	• Presence of any "medication to be avoided in the elderly" on med list	b) System – (clinical application)
Notify	• Notify – Individual – Clinician	b) System – (EHR)
Case 1: – Request – Communicate	• Individual – Education link – Ask preference • Clinician – Education link – Stop/document	a) Individual (Individual consumer, clinician)

The measure tests if patients 65 years and older receive any medication included in the high-risk category. The measure has been converted, or "retooled," to assess clinical data within electronic health records. The clinician might address the screening with an order to stop the medication and consider alternatives, or accessing clinician-directed educational materials to determine the appropriateness of each action for the individual patient. The individual (or consumer) perspective might consider education about the reasons for high-risk medication use and alternative pros and cons, allowing the expression of preferences and sharing in decisionmaking with the clinician. This single CDS "rule" could start with notifying the individual and then trigger a different rule based on the individual's entry of preference to intervene with the clinician with an action step that meets the patient's preference.

NQF CDS Expert Panel Recommendations

NQF should support refinement, validation, and implementation of this CDS Taxonomy by encouraging its use across various healthcare settings. The Expert Panel identified the following activities and areas of focus for future work:

1. Continue development and refinement of the CDS Taxonomy in the following potential areas:
   a. add standard representations for specific types of triggers, interventions, and action steps to further enhance descriptions of CDS applications;
   b. maintain and extend both the CDS Taxonomy and the QDS Model in the public domain to meet new data requirements (such as meaningful use, clinical guidelines);
   c. explore QDS mapping to clinical knowledge sources and research to extend the CDS Taxonomy beyond the application to quality measures;
   d. clarify what is addressed in each data category and data type so that it will become more applicable beyond the initial intended use in development and maintenance of quality measures;
   e. ensure "direct mapping" of QDS and CDS elements. Specifically, add additional CDS elements to the QDS Model to address any gaps demonstrated through application of the QDS Model to real-world system implementations; and
   f. encourage further investigation of the areas listed as outside of the scope of this version of the NQF CDS Taxonomy, and determine a list of potential or real CDS limitations.
2. Incorporate the CDS Taxonomy using the QDS Model in real settings that implement CDS in the following potential areas:
   a. coordinate implementation of meaningful use quality measures with CDS to enhance performance concurrently; and
   b. enable sharing of rules within and across settings through use of a common taxonomy to describe CDS components and the QDS as a standard method to organize and express different types of rules' concepts and their context of use.
3. Educate NQF members and the public on the value and impact of CDS and the NQF CDS Taxonomy.
4. Work to incorporate the NQF CDS Taxonomy into other ongoing quality and CDS efforts to further the linkage between clinical care and quality measurement and performance. Possible opportunities include:
   a. pilot test the use of the QDS Model and the NQF CDS Taxonomy;
   b. extend the Healthcare Quality Measure Format, or the eMeasure, to make CDS action steps actionable in the clinical workflow;
   c. connect Structuring Care Recommendations for CDS logic statements to NQF CDS Taxonomy components;
   d. integrate the NQF CDS Taxonomy within the NQF Health IT Utilization Expert Panel so CDS is included in the measurement of effective utilization of health IT; and
   e. use the NQF CDS Taxonomy to describe CDS applications in a consistent manner in efforts to measure the effectiveness of CDS.

5. Facilitate sharing across NQF Members and key stakeholders regarding application of CDS tools, the NQF CDS Taxonomy, and the QDS Model to real world implementations of CDS to improve quality.
   a. hold NQF or member-sponsored webinars and conduct directed discussions with the NQF User Group about the applicability of the CDS Taxonomy to quality improvement initiatives based on implementation experience. The NQF User Group, launched in September 2010, is a means to bring stakeholders (EHR users, vendors, quality measurement community) together to create a constructive virtual forum for shared learning around components of the quality infrastructure, including the NQF CDS Taxonomy.

Issues, Future State and Work, and Next Steps

NQF anticipates that public review, comment, and use of the NQF CDS Taxonomy will lead to modifications and improvements over time. Input from additional stakeholders and stakeholder communities should enhance the richness and usefulness of the taxonomy and help to further develop use cases. Health IT, CDS, quality measurement, national priorities, and medicine itself continue to evolve, and the NQF CDS Taxonomy and QDS Model will need to change to keep pace. Further development and use of health IT in personal health records, mobile and novel devices, and new media will likely drive new CDS opportunities and potential paradigm shifts.

CDS will continue to advance with new capabilities for making inferences, performing predictive modeling, accessing guidelines and other knowledge representations, and handling large amounts of complex data and data types, some that may be entirely new. Genomic and personalized medicine, information therapy (Ix), and more effective representation and consideration for patient preferences and values will greatly increase the amount of data and number of data types that are available and increase the number and complexity of inferences that will need to occur in making care decisions. The sheer amount of available data and number of choices will make CDS imperative for both consumers and practitioners to be able to make informed decisions. Furthermore, priorities and areas of concern for consumers, payers, and providers of healthcare will likely evolve, and the focus of quality measurement and reporting will likely follow. Many of these changes will require the development, standardization, and integration of additions to the CDS Taxonomy and QDS.

Though not explicitly addressed in the current version, future iterations of the NQF CDS Taxonomy should include patients, families, and consumers as potential users. In the future, in addition to EHRs, PHRs, patient portals, and secure e-mail will be potential access points for CDS. As a result, components of the taxonomy may be even more important (e.g., interventions and action steps are especially important to target directly to these users) and worthy of future work.

Notes

1. Chaudry B, Wang J, Wu S, et al., Systematic review: impact of health information technology on quality, efficiency, and costs of medical care, *Ann Int Med*, 2006; 144(10):742-752.
2. Eslami S, bu-Hanna A, de Keizer NF, Evaluation of outpatient computerized physician medication order entry systems: a systematic review, *JAMIA*, 2007;14(4):400-406.
3. Wolfstadt J, Gurwitz J, Field T, et al., The effect of computerized physician order entry with clinical decision support on the rates of adverse drug events: a systematic review, *J Gen Intern Med*, 2008;23(4):451-458.
4. Osheroff, JA, *Improving medication use and outcomes with clinical decision support: a step-by-step guide*. Chicago, IL: The Healthcare Information and Management Systems Society; 2009.
5. Eslami S.
6. Wolfstadt J.
7. Teich JM, Merchia PR, Schmiz JL, et al., Effects of physician order entry on prescribing practices, *Arch Int Med*, 2000;160(18):2741-2747.
8. Bates DW, Kuperman GJ, Wang S, et al., Ten commandments for effective clinical decision support: making the practice of evidence-based medicine a reality, *JAMIA*, 2003;10(6):523-530.
9. Arden Syntax and GLIF are examples of common formats to represent clinical knowledge. Arden Syntax, a formal procedural language that represents medical algorithms in clinical information systems, was developed by the HL7 Arden Syntax Special Interest Group and the CDS Technical Committee. GLIF (Guideline interchange format), is a format for sharing clinical guidelines through computer-interpretable language for modeling and executing clinical practice guidelines.
10. Van der Sijs, H, Aarts J, Berg M, Overriding of drug safety alerts in computerized physician order entry, *JAMIA*, 2006;13:138-147.
11. Krall, MA, DF Sittig, Clinician's assessments of outpatient electronic medical record alert and reminder usability and useful requirements. Proceedings from the AMIA Symposium 2002: pp. 400-404.
12. Bates, DW.
13. HITSP Component, *Data Dictionary*, HITSP/C154. Review Copy 20100131 V1.0.1. 2009.
14. Wright A, Goldberg H, Hongsermeier T, et al., A description and functional taxonomy of rule-based decision support at a large integrated delivery network, *JAMIA*, 2007;14(4):489-496.
15. Ibid.
16. For more information on the range of CDS interventions, please refer to Osheroff JA, Pifer EA, Teich JM, et al., *Improving Outcomes with Clinical Decision Support: An Implementers' Guide*, Chicago: HIMSS Press; 2005.
17. The AHRQ-funded Structuring Care Recommendations for CDS project is developing *eRecommendations*, widely accepted clinical recommendations expressed as coded logic statements made freely available via the Internet. These statements will be structured in a standard fashion and use standard codes to identify patients for whom the recommendation applies and the actions that should be taken. Such logic statements can then be further adapted by clinical information system suppliers and care providers to generate automated reminders for specific clinicians and/or patients within deployed systems.
18. NQF, Health IT Utilization Expert Panel Draft Report: Driving Quality: A Model to Measure Electronic Health IT Use, Washington, DC; 2010. Available at **http://www.qualityforum.org/Projects/HIT_Utilization.aspx**. Last accessed October 2010.

Appendix A
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Appendix B
Acknowledgements and CDS Taxonomy Review Organizations

The National Quality Forum appreciates the input and contribution of:

- The chair, vice chair, members, and federal liaisons of the CDS Expert Panel, for their expertise in clinical decision support and quality measurement;
- Partners HealthCare, Inc., for providing a CDS taxonomy foundation to build the NQF CDS Taxonomy; and
- The representatives from institutions with CDS expertise, who reviewed the NQF CDS Taxonomy for its relevance and applicability to current CDS adoption and use:

Review Organizations	Description of Review Organizations
Federal CDS Collaboratory	The CDS Federal Collaboratory is a community of professionals employed by a variety of federal agencies and who share an interest in advancing the availability, efficacy, and use of CDS to improve the quality, safety, and value of healthcare services. The CDS Federal Collaboratory serves to foster collaboration and synergy in federally supported activities focused on advancing CDS.
Intermountain Healthcare	Intermountain Healthcare is a nonprofit health system based in Salt Lake City, Utah, with 22 hospitals, over 750 physicians and clinicians in the Intermountain Medical Group, a broad range of clinics and services, and health insurance plans. Intermountain Healthcare is a recognized leader in clinical decision support.

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Review Organizations	Description of Review Organizations
Kaiser Permanente	Founded in 1945, Kaiser Permanente is the nation's largest not-for-profit health plan, serving more than 8.6 million members nationwide. With headquarters in Oakland, CA, it comprises: • Kaiser Foundation Health Plan, Inc., • Kaiser Foundation Hospitals and their subsidiaries, and • The Permanente Medical Groups. Kaiser Permanente is a leader in electronic medical record technology, implementation, and decision support and currently operates the largest nongovernmental electronic health record (EHR) system in the nation.
Regenstrief Institute	Regenstrief Institute, Inc., an internationally recognized informatics and healthcare research organization, is dedicated to the improvement of health through research that enhances the quality and cost-effectiveness of healthcare. Established in 1969 by philanthropist Sam Regenstrief on the campus of the Indiana University School of Medicine in Indianapolis, the Institute is supported by the Regenstrief Foundation and closely affiliated with the Indiana University School of Medicine and the Health and Hospital Corporation of Marion County, Indiana.
Structuring Care Recommendations for CDS	Structuring Care Recommendations for CDS is an AHRQ-funded initiative that is providing a template and contents for structured, coded logic statements (referred to as "eRecommendations"). eRecommendations are intended to speed, improve and broaden efforts by Eligible Professionals and Eligible Hospitals (to use Meaningful Use terms), and others including information system suppliers, to successfully deploy CDS rules that improve care delivery.
Yale Center for Medical Informatics	The Center focuses on the creative use of computers in clinical medicine, molecular biology, neuroscience, and other areas of biomedical research. They conduct research, provide support, and coordinate collaborative projects involving Medical School faculty, Yale-New Haven Hospital, and faculty in other departments at Yale, such as computer science. The Center also serves as a focal point for training in biomedical informatics with a Postdoctoral Fellowship Program and the affiliated Informatics Fellowship Program at the West Haven VA.

Appendix C
Results of Mapping Input Data Elements in the NQF CDS Taxonomy to the QDS Model

NQF CDS Taxonomy		QDS Model	
Input Data Element	**Examples**	**Extent of Coverage**	**Data Categories of Overlap/ Identified Gaps**
Care setting	Includes: • ambulatory • inpatient (e.g., hospital unit—ICU, ED, OR, PACU, medical/surgical, Team A, etc.) • primary care/specialty	Complete	Encounter
Diagnostic result	Includes • declined • numeric (e.g., total protein or calorie intake) • non-numeric • trend in result/observation • diagnostic result/procedure (e.g., laboratory, imaging, pathology, endoscopy, etc., with more complex results structure)	Complete	Diagnostic Study Laboratory Test
Medication list	Includes: • active medication • historical medication • dose • frequency • route Note: extends to over the counter (OTC) medications and nutritional supplements	Complete	Medication

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NQF CDS Taxonomy		QDS Model	
Input Data Element	**Examples**	**Extent of Coverage**	**Data Categories of Overlap/ Identified Gaps**
Problem list	Includes: • active problem • historical problem	Complete	Diagnosis/ condition/ problem
Time	Includes: • absolute • relative • elapsed time • after/before some designated time	Complete time/date is implicit in any QDS data element, but not an explicit term	A derived element in the logic based on time/dates of identified QDS data elements
Diagnosis/ problem	Includes: • active • relative • primary	Complete	Diagnosis/ condition/ problem
Age	Likely to be birth date-based	Complete	Individual characteristic
Orders list	Includes: • procedure list (laboratory, imaging, nursing, physical therapy, respiratory therapy, occupational therapy communication, etc.) • active and historical orders • admission, discharge, transfer orders • consult orders	Partial	Medication Substance Procedure (assuming non-procedure interventions)
History	Includes: • family history (except for diagnosis) • surgical history (e.g., surgical procedures) • social history, behavioral health history • medical history	Partial, but probably covered well enough for the time being	Encounter procedure diagnosis/ condition/ problem medication laboratory diagnostic study

more

NQF CDS Taxonomy		QDS Model	
Input Data Element	**Examples**	**Extent of Coverage**	**Data Categories of Overlap/ Identified Gaps**
Allergy list	Includes: • active allergy • historical allergy • allergen (medication, food, environment) • type/severity of reaction (rash, severe anaphylaxis) • true allergies • contraindications, • intolerances • unknown/undetermined reaction	Complete (considers pollen, cat dander, etc., as substances)	Medication substance device
Observation	Includes: • physiological observations • general observations • fall risk	Complete	Physical exam care goal health risk assessment (Braden, etc.)
Visit history	Includes: • well child care visits • required number of behavioral health visits • pregnancy visits	Complete	Encounter
Presenting complaint	Includes: • presenting problem • chief complaint/symptom • reason for admission/seeking care	Complete	Diagnosis/ condition/ problem symptom
Patient Demographic Profile	Includes: • race • ethnicity • language spoken • preferred language • payment source • gender • DOB/DOD/cause • advance directive	Complete	Individual characteristic
Other	Includes: • research study participation	Complete	Patient characteristic

Appendix D
Report Glossary

Alert: To make someone aware of a possible danger or difficulty.

Clinical Decision Support Taxonomy: A classification system, based on the Quality Data Set (QDS) Model and existing studies of clinical decision support implementations, used to trigger alerts and activate guidelines to enable providers with the "right information, at the right time, for the right patient."

Clinical practice guidelines: Systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances.

Code set: The codes belonging to a specific value set. See Value set.

Data flow attributes: The third of three QDS Model levels; descriptions of the authoritative source for the information that is required to represent any given quality data element. Data flow attributes include the data source, recorder, setting, and health record field.

Data types: A grouping of information that indicates the circumstance of use for any individual standard data type.

Health Information Technology Expert Panel (HITEP): An Agency for Healthcare Research and Quality-funded panel convened by NQF.

Health Information Technology Standards Panel (HITSP): A cooperative partnership between the public and private sectors, formed in 2005 for the purposes of harmonizing and integrating standards that will meet clinical and business needs for sharing information among organizations and systems.

HL7 (Health Level 7): A standards-developing organization that provides standards for the exchange, integration, sharing, and retrieval of electronic health information that supports clinical practice and the management, delivery, and evaluation of health services.

Input data: The additional data, from the patient record or other source, used as background to modify or constrain the CDS rule.

Intervention: The possible actions taken by decision support to provide information when the conditions specified in a rule are met.

Meaningful use: The American Recovery and Reinvestment Act authorizes the Centers for Medicare & Medicaid Services (CMS) to provide a reimbursement incentive for physician and hospital providers who are successful in becoming "meaningful users" of an electronic health record (EHR). These incentive payments begin in 2011 and gradually phase down. Starting in 2015, providers are expected to have adopted and be actively utilizing an EHR in compliance with the "meaningful use" definition, or they will be subject to financial penalties under Medicare.

Quality Data Set (QDS) Model: An information model that describes clinical concepts in a standardized format so individuals monitoring clinical performance and outcomes can communicate necessary quality improvement information clearly and concisely.

Quality data elements: The second of three QDS Model levels; a combination of a standard element and a quality data type that is used in quality measures to describe part of the clinical care process. Examples include active diabetes diagnosis, diabetes family history, diabetes medication dispensed, and diabetes medication administered. Quality data elements and their components can be reused by other measures, clinical guidelines, and clinical decision support (CDS) developers.

Quality data type: Information that can be applied to a standard element to indicate the circumstance, or context, in which the standard element is used in a quality measure. Examples include active diagnosis, inactive diagnosis, family history of diagnosis, and medication ordered.

Quality measure: A quality measure is a quantitative tool that provides an indication of an individual's or organization's performance in relation to a specified process or outcome via the measurement of an action, process, or outcome of clinical care. Quality measures are often derived from clinical guidelines and are designed to determine whether the appropriate care has been provided given a set of clinical criteria and an evidence base.

Action step: Responses to a CDS intervention.

Standard element: The first of three QDS Model levels; a clinical concept defined by a list of standard codes (e.g., "diagnosis of heart failure" or "medication"). Each standard element has a standard category (e.g., diagnosis), a code set (ICD-10), and a code list (also known as a value set) of one or more codes. Standard elements are given additional meaning when used in conjunction with a specific quality data type (e.g., diagnosis active) to form a quality data element.

Structured rules: Widely accepted clinical recommendations expressed as coded logic statements made freely available via the Internet, developed by the AHRQ-funded Structuring Care Recommendations for CDS project. These statements, or *eRecommendations*, will be structured in a standard fashion and use standard codes to identify patients for whom the recommendation applies and the actions that should be taken. Such logic statements can then be further adapted by clinical information system suppliers and care providers to generate automated reminders for specific clinicians and/or patients within deployed systems.

Taxonomy: Generally, a model with hierarchy and classification assembled with a descriptive purpose.

Trigger: Events or actions that initiate a CDS rule.

Value set: A set or collection of concepts from one or more vocabulary code systems and grouped tougher for a specific purpose. A value set is a uniquely identifiable set of valid concept representations. A value set may be a simple flat list of concept codes drawn from a single code system, or it might be constituted by expressions drawn from multiple code systems (a code system is a system consisting of designations and meanings, for example LOINC, SNOMED-CT, ICD-10, or ISO 639 Language Codes).

THE NATIONAL QUALITY FORUM (NQF) is a private, nonprofit, open membership, public benefit corporation whose mission is to improve the American healthcare system so that it can be counted on to provide safe, timely, compassionate, and accountable care using the best current knowledge. Established in 1999, NQF is a unique public-private partnership having broad participation from all parts of the healthcare industry. As a voluntary consensus standard-setting organization, NQF seeks to develop a common vision for healthcare quality improvement, create a foundation for standardized healthcare performance data collection and reporting, and identify a national strategy for healthcare quality improvement. NQF provides an equitable mechanism for addressing the disparate priorities of healthcare's many stakeholders.

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