# Clinical Decision Support Consortium


## Dashboard Development Guide

*7/5/2011*

*Principal Investigator:*
*Blackford Middleton, MD, MPH, MSc*
*bmiddleton1@partners.org*

*Organization:*
*The Brigham and Women's Hospital*

# Table of Contents

## PURPOSE OF THE GUIDE

The main goal of this document is to provide a comprehensive guide to address system, data, and reporting requirements needed for developing and implementing a CDS Dashboard from the ground up. The guide will also assist in assessing the implementation process of Clinical Decision Support (CDS) Dashboards in collaborating sites, which would provide an electronic display of CDS performance measures either for healthcare providers or CDS developers. This includes a step-by-step process and a standardized template database/tables and database specifications for collecting the CDS measures data and other Key Performance Indicators (KPI's) to be used in the CDS Dashboard report and for evaluating the effectiveness of the dashboards across sites.

This document will explain in detail how the CDS Dashboards at Partners Healthcare were designed, developed and implemented, with the expectation that it will be a useful tool for different institutions when beginning to establish a dashboard to evaluate the clinical performance and usage of clinical decision support.

The guide will have the following structure:

1. Site Readiness Assessment
   The purpose of this tool is to evaluate a site's readiness to implement a CDS Dashboard in order to identify the barriers and issues that may jeopardize a successful implementation.

2. Generic Specifications
   This part of the guide will discuss in detail the functional and technical specifications of the Dashboards backend. The aspects that were covered during the design phase, including the identification of the target audience, the determination of the Key Performance Indicators (KPI's) and the workflow analysis will be described.

3. Roll-out Phase
   We will explain the chosen approach in which the dashboards were deployed and how the training process took place.

4. Evaluation Phase
   We will present the strategy how a quantitative and qualitative evaluation process turned out. This phase is considered to be crucial in any development process, to guarantee continuous improvement of the tools originally developed and tested under research purposes but that have become standard.

## OVERVIEW

Most healthcare institutions have dashboards of some sort. Many of them are implemented for the executive levels to provide a timely and accurate perspective to certain critical processes inside of the institution. Depending on the level of complexity and the audience that they are targeted to, the level of depth and the presentation of the information can vary widely.

In the context of the Clinical Decision Support Consortium (CDSC), an Agency for Healthcare Research and Quality (AHRQ) funded project, the development of the CDS Dashboards was established as one of the core objectives for the grant. The need to provide feedback to clinicians and developers became a clear requirement to close the loop in the CDS lifecycle. Partners Healthcare has pioneered the effort to understand how decision support has to be evaluated by diverse users and circumstances. At Partners, the Longitudinal Medical Record (LMR) provides an ideal ecosystem to host high level research when it comes to evaluate the process of the design, authoring and performance of knowledge artifacts used for CDS.

These dashboards seek to provide valuable feedback to clinicians and decision support developers, identifying specific moments in the workflow and the corresponding performance attributable to CDS. The displayed information can be used as a performance tracking tool to compare performance with peers and understand how performance is being measured. The same information can facilitate people in leadership positions to identify potential sources of error and eventually implement quality improvement strategies or encourage a better documentation of clinical processes. The developer's version will allow those same people to visualize the activity of the decision support tools, including the end user response to them. Indicators that illustrate the clinician's reaction to the decision support tools and their modification in time will be useful to evaluate the performance of knowledge artifacts and suggest modifications to improve the overall process. Trends in time allow a retrospective evaluation of enhancements and decide their continuity or broader implementation.

The CDS dashboards will serve as a proof of concept with respect to CDS feedback, considering only the rules included for the CDSC project. The dashboards were implemented only in the participating sites, although their development was prepared taking into account the addition of further knowledge artifacts and enterprise-wide implementation to alleviate future scalability efforts. Further research has to be conducted to determine the appropriateness of the proposed KPIs and visual representation.

The implementation of such technologies is sustained by the imperative need of the institutions to have the adequate tools together with quick and reliable information to support change and therefore meaningful decision making.

In CDS, different internal operations need constant refinement and improvement. The internal adjustments may come from:

- Development of additional rules that improve clinician awareness and performance.
- Improvement of actions triggered by the rule engine.
- Redesign of documentation interfaces to improve accuracy of the patient information.
- Clinical workflow analysis to recognize potential sources of error and identify interventions to improve quality of care.

The definition of the target audience for these dashboards determined that there were two primary stakeholders. The primary user was determined to be the CDS designers and developers, considering that this group required proper feedback to evaluate the impact generated by the decision support implemented. Clinicians and providers in leadership positions were considered a secondary stakeholder that would allow evaluating the entire CDS lifecycle up to the end user.

The developer's view seeks to provide sufficient information for a constant improvement cycle. There are several components in the workflow that can be subject of change in order to improve response rates to the alerts and reminders displayed at the point of care. It is of primary importance that these tools provide simple, understandable and trustworthy information to support the development.

Implementing performance feedback tools that present clinical information can also drive to continuous improvement in areas of clinical quality and safety. Empowering the clinician to track his or her own performance and compare with peers is an important piece to improve the clinician's adherence to the clinical guidelines. This integral evaluation allows determining if the rules are relevant and whether the actions are documented adequately.

## SITE ASSESSMENT

### Purpose

To assess a site's ability to build and implement CDS dashboards in a standardized way, which would allow for the collection and comparison of CDS data across other CDS dashboard implementation sites. By completing this assessment, the participating site will be able to identify barriers and issues that may impact dashboard implementation and eventual evaluation, and assess if appropriate resources are available to undertake this task.

### Questions

**Reporting Environment, Development, Publishing and Distributing**

1. Does your site have reporting capabilities (i.e., ability to generate reports, either in-house or via an external vendor, using various data sources)? **y/n**
    a. If yes, the reporting capabilities exist
        i. within the electronic health record (EHR) system **y/n**
        ii. Outside of it as part of an external, separate environment. **y/n**
        iii. Please describe the reporting tool, method, or environment your site utilizes.
    b. If no, does your site use an external vendor to develop reports?
2. Are you able to customize your own reports? **y/n**
3. Are you able to publish reports accessible to providers? **y/n**
    a. If yes, how are these reports disseminated?
4. Are you able to publish reports accessible to developers? **y/n**
    a. If yes, how are these reports disseminated?

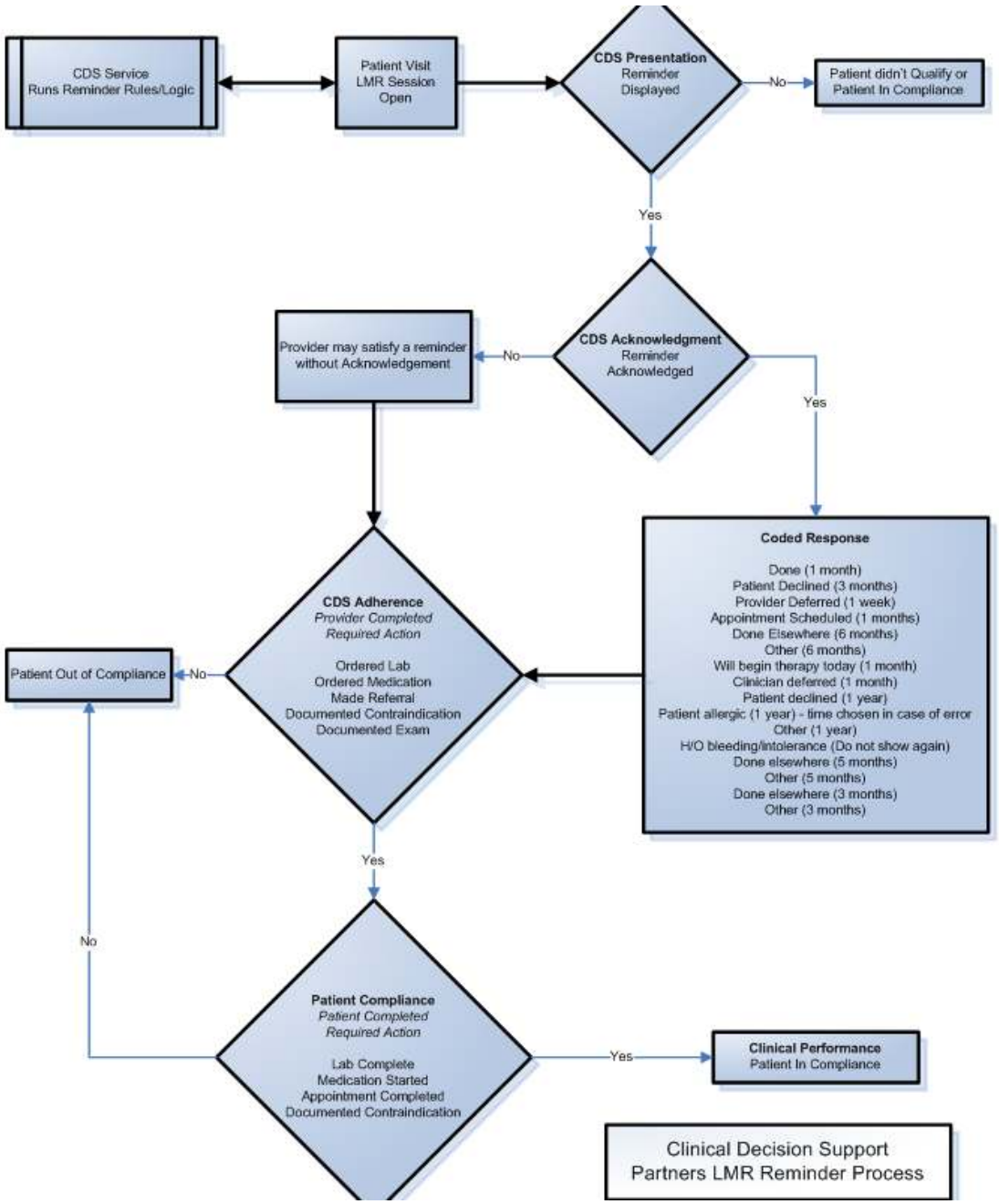
**EHR CDS Interventions: Type, Presentation, Acknowledgement, and Adherence**

5. Does your EHR use CDS reminders and alerts? **y/n**
    a. If yes:
        i. How and when does your EHR present/display reminders and alerts to a provider? (e.g., via the EHR interface, or via email, etc.)
            1. Is the provider **prompted** to view the reminder or alert? **y/n**
            2. Is the provider **required** to review reminders or alerts? **y/n**
        ii. Are your reminders and alerts actionable? (i.e, can they be opened and viewed by the provider and an action can be performed on them, such as selecting a coded response or some other type of acknowledgement?) **y/n**
            1. If yes, what type of acknowledgement options are displayed to the provider?
        iii. Are your reminders and alerts connected to an order entry system? (i.e., a provider can acknowledge a reminder or alert by taking an action such as electronically ordering a lab test) **y/n**
            1. If yes, please describe the workflow from when a reminder or alert appears to the provider to the completion of using the order entry system.
        iv. Does your system allow providers to ignore, suppress, or snooze a reminder or alert? **y/n**

1. If yes, will the alert keep firing and displaying to the provider until it is acknowledged? **y/n**

b. If no, what type(s) of CDS interventions does your EHR utilize, if any? Please describe these interventions and how they function within your EHR in depth.

6. Develop a process flow defining how your CDS system works. The CDS system at Partners Healthcare is shown below.




- Items to be aware of when defining your CDS system:

- Check how End Of Visit (EOV) works and see where and how it fits in satisfying a reminder, what information is electronically collected.
- Insert numbered data collection points, such as when the patient record is opened and alert is fire. The alert can fire multiple times a day. This is an issue. At Partners, we resolved this issue by rolling the alerts up by provider/day.
- Evaluate CDS data collection points:
  - **Service - response object**
    - Whats the action? (example: patient record opened)
    - Whats the data? (service notified and response object received)
    - What makes the data unique? (day/provider/patient/location/time)
    - Data has multiple instances, single or none?
    - Data collected automatically or manually or not at all
  - **EHR-Patient - alert status**
    - Data displayed to provider
    - Automatically prompted
    - Provider self prompts
  - **EHR-Alert data display**
    - Who receives alert?
    - All providers/ Specialty Providers/ PCP
    - How is the alert displayed?
    - Prompt/report/email /EOV screen/Order Entry/Coded entry screen
  - **Provider action**
    - Immediately/active
    - View/passively
    - Whats the outcome?
    - Ignore
    - Snooze
    - Coded Response
    - Action completed
  - **Patient action**
    - Multiple Actions/Single Action
  - **Alert satisfied**
    - When does an alert display/fire?
    - How often is the alert displayed?
    - Does satisfying the reminder stop the alert from displaying?

**CDS, Clinical, and Administrative Data Collection, Storage, and Accessibility**

7. Does your site currently collect and store data related to CDS activity? **y/n**
   a. If yes:
      i. Where and how is this CDS data stored?
      ii. Do you have access to this data? **y/n**
         1. If yes, please describe the process of obtaining this data.
         2. If no, please go to the next question.
      iii. What CDS data is captured and stored? More specifically, is data related to CDS reminder and alert activity captured and stored?
      iv. Does your EHR collect and track data for provider's actions in response to CDS reminders and alerts (i.e., acknowledgements, ignore/suppress/snooze, etc.)? **y/n**
8. Does your site currently collect and store electronic clinical and administrative data? **y/n**
   a. If yes:
      i. Where and how is this clinical data stored?

ii. Where and how is the administrative data stored?
iii. Do you have access to this data? **y/n**
    1. If yes, please describe the process of obtaining this data.
    2. If no, please go to the next question.
iv. Do you have access to and the ability to extract the following types of data?
    1. Administrative:
        a. Patient demographics
        b. Patient visits (schedule data)
        c. Provider information
    2. Clinical:
        a. Medications, including audit history
        b. Notes and Narratives
        c. Health Maintenance Data
        d. Problem List
        e. Vital Signs
        f. Laboratory values

9. What type of physician performance data is electronically collected? Is it accessible for reporting?

**Resources**

10. Does your site currently have the time, resources and expertise to:
    a. Build a database and develop datasets and queries for CDS Dashboards?
    b. Locate and load required data for CDS Dashboards?
    c. Design and publish Provider and Developer CDS Dashboards?
    d. Disseminate CDS Dashboards to providers and developers?

## GENERIC SPECIFICATIONS

*The following is an outline of a functionality specification required for a healthcare data warehouse team to create, design and develop the CDS dashboard.*

### Introduction

This document is a generic (non-site-specific) dashboard specification to serve as a functional guide. This specification will describe the visual user interface and also describe the measure logic needed to design a CDS dashboard.

### Business Requirements/General Description

#### *What is to be developed?*

The purpose of developing CDS dashboards is to allow providers and site clinical quality staff review adherence to CDSC guidelines. The dashboards propose to inform end users and CDS developers about clinical performance and usage of clinical decision support (reminders).

A dashboard is simply a report. It is a visual display that provides users with information about key performance metrics or indicators—in this case the performance metrics relate to the display, acknowledgement, and effectiveness of reminders. In general, dashboards may have some or all of several distinguishing characteristics including:

1. Provide summary of the user's performance for key indicators or metrics
2. Provide comparison of the user's performance with other users or reference benchmarks
3. Provide capability to view details underlying the indicators

In this project, your data warehouse team will serve as the data source for CDS dashboards. The dashboards will be displayed within a reporting environment.

#### *Dashboards to be Developed*

The CDS dashboard will include a provider dashboard which will allow physicians to see their clinical performance for the conditions addressed by the Consortium (hypertension, diabetes, and coronary artery disease) and a CDS designer dashboard which will allow developers to understand how reminders are being displayed and used and to assess

1. **Designers View ~ "How well are the reminders working?"**
   - One reminder analyzed at a time
   - Display performance over time, as well as detailed performance for one month period (time period can be changed as needed)
     - #Displays (Total per patient-provider-month)
     - #Acknowledgements (physician responded within 30 days of the last reminder to fire in the month timeframe)
     - Clinical performance (Total, as well as with and without reminder display)
     - Reminder performance
     - Acknowledgement performance
     - Number needed to remind (NNTR) - The denominator is the count where performance followed a reminder within 30 days of the end of the reporting period.

The numerator is the cumulative count of all reminders per patient in each month (Total) or only counts a patient with a reminder once per month (1X per month).

2. **Clinician/Provider View ~ "How is the clinician doing"?**
   - Provides information on clinical performance measures and feedback on your response to EMR (electronic medical record) reminders.
   - Focus is on total clinical performance for a clinical condition, as well as the clinician's performance for relevant reminders.
   - The patient populations for the CDS Dashboards is measured for performance for the current patient panel as defined in your data warehouse.
   - Reminder performance is calculated for patients where the clinician/provider has been displayed a reminder during the Reporting period.

**Data Requirements Needed to Develop the Dashboards**

Data for the dashboards will come from the data warehouse team and will be refreshed as per the warehouse's refresh schedule.

Within the warehouse, data necessary to assess reminder performance include:

- **Patient**
  - Patient Demographics
- **EMR**
  - Providers
  - Medications, including audit history
  - Narratives
  - Health Maintenance Data
  - Reminders – displays, acknowledgements, logic
  - Problem List
  - Vital Signs
- **Clinical Data Repository**
  - Laboratory values
- **Patient Visits**

**Business Users of the Dashboards**

Business users of the CDS dashboards include:

- Clinicians – nurse practitioners, physician assistants, etc.
- Physicians
- Group practice managers
- Developers
- CDSC members

**Functional Requirements**

***Assumption***

The CDSC Dashboards will have the following characteristics:

- Reminders associated with each guideline. Types of reminders used to include:
  - Pt with DM, overdue for HbA1c
  - Pt with DM, almost due for HbA1c

    - Pt with DM, Order A1c Now (Recent poor diabetes control)
    - Pt with DM, overdue for eye exam
    - Pt with DM, overdue for foot exam
    - Proteinuria screening (no established renal disease and no recent microalb/creat ratio)
    - Start Anti-Platelet Therapy
    - Start ACE-I or ARB in DM pt
    - Assess Blood Pressure
- Specify counts and measures for each of the reminders
    - # Displays
    - # and % Acknowledgement
    - # and % Performance – with and without reminder display
    - Number needed to remind (NNTR)
- Identify and obtain data sources (to define or calculate measures)
    - Reminder Rules
    - Reminder Displays
    - Reminder Acknowledgements (coded responses)
    - Clinical Performance
- Data design
    - Identify and load activity data for reminders – displays, acknowledgements
    - Roll up reminder activity at the provider-day level
    - Define performance for each reminder in terms of data available to us
    - Create new concepts (tables) for measures and associated denominators
    - Reminders are mapped to measures (and to conditions)
    - Keep things simple:
        - Ignore timing
        - Ignore patient population issue (previous slide)
        - Use one-month measurement periods
        - Look for acknowledgement/performance within 30 days of the reminder display. If more than one display, then use the last reminder in a time period.

**Guidelines to Implement**

Patients are pulled from the general patient population based on whether or not they fit the criteria for a reminder to fire, regardless of compliance. Then patients are marked as active if they have any fact data in the EMR from the past 2 years. The 4 denominators used are:

1. Diabetic, 18+ years of age
2. Diabetic w/ Renal Disease, 18+ years of age
3. CAD, 18+ years of age or Male 45-79 or female 55-79
4. Patients 18+ for routine blood pressure readings

***Disease definitions used to create the Dashboards***

*Diabetic*

- Snomed codes: 46635009, 73211009, 44054006, 420422005
- Modifiers not pertaining to: family history, question/chronic, rule out, possible

*Diabetic w/ Renal Disease*

- Snomed codes: 46635009, 73211009, 44054006, 420422005
- Modifiers not pertaining to: family history, question/chronic, rule out, possible
- Lab entry w/ Microalbumin/Creatinine and value > 30 (ever)

*CAD*

- Snomed codes: 22298006, 194828000, 232717009, 11101003, 53741008
- Modifiers not pertaining to: family history, question/chronic, rule out, possible

*Hypertension Screening*

Patients 18+ years old with a valid vital signs entry for blood pressure

**Metrics**

This reference table within the warehouse holds information on the different metrics that are measured in the performance tables. The metrics are:

1. HBA1C completed in the past 6 months for diabetics
2. HBA1C completed in the past 3 months for diabetics w/ poor diabetes control
3. Microalbumin completed in the past year for diabetics
4. Ophthalmologic exam in the past year for diabetics
5. Podiatry exam in the past year for diabetics
6. 18+ years old and blood pressure entry in the past year
7. CAD and aspirin is on the med list (and patient is not allergic to aspirin)
8. Diabetics w/ Microalb/Creat ratio > 30 (renal disease) and on ACE meds.
9. Diabetics w/ Microalb/Creat ratio > 30 (renal disease) and on ARB meds.

***Risks/Constraints***

- Relying on the source data being available on an ongoing basis
- Does your site have the reminder data needed to measure?
- Site may not be able to reliably know when some reminders are acknowledged. This may hamper our ability to evaluate the acknowledgement of all reminders.

**CDSC and Clinical Performance Measures**

| CDS Concept | Description | Count | Measure |
|---|---|---|---|
| **CDS Reminder** | Description of the reminder alert | | |
| **CDS Recommendation** | Description of the recommended action to be taken by physician | | |
| **CDS Reminder Logic** | Description of the criteria used in the rule | | |
| | | | |
| **Suggested Prevalence based on CDS Services Logic** | Clinically eligible population, patients with a qualified clinical state, who had an OV in one of the Intervention Sites and was evaluated by the CDS Service for guideline adherence. Patients must meet all inclusion/exclusions | # Patients with eligible Clinical State who can be assessed by decision support | |
| | | | |
| **CDS Presentation** | Presentation of the reminder to the user Multiple displays of the reminders are rolled up into 1 instance by patient, day, and physician. | # Times reminder displayed to the user (for a specified time frame) | |
| **CDS Acknowledgement (coded responses)** | User clicks on reminder and chooses a response | # Times user clicks on the reminder and chooses a response | |
| **CDS Performance** | Of times CDS presented, how often the correct action was taken (directly or indirectly) | # Times correct action taken (for a specified time frame) | CDS Performance / CDS Presentation |
| **CDS Timing** | How long after CDS presented was correct action taken (directly or indirectly) - each instance of presentation is associated with a time interval. | #Time between CDS presentation and correct action taken | # Days between CDS Presentation and Clinical Performance |
| | | | |
| **CDS Adherence (Physician Adhered to Recommendation)** | Physician adheres to CDS recommendation, does the required action, irrespective of CDS presentation and/or acknowledgment | # Patients in the eligible population where the physician adhered to the recommendation during the measurement time period | CDS Adherence / Prevalence |
| **Clinical Performance (Patient Compliance)** | Patients get the "right" action, irrespective of CDS presentation and/or acknowledgement | # Patients in the eligible population who get the correct action taken during the measurement time period | Clinical Performance / Prevalence |
| **Clinical Outcome** | Patients get the "right" clinical result, irrespective of CDS presentation and/or acceptance | # Patients with "right" result (patient is in compliance) | Clinical Outcome / Prevalence |

**Samples of Tables to be Used**

***Main Tables***

**CDS_Denom_Desc**

This table holds reference data for each patient denominator. The 4 denominators used are:

- Diabetic
- Diabetic w/ Renal Disease
- CAD
- Hypertension

**CDS_Denom_Patients**

This table holds data for each patient that falls into one or more of the denominator categories in CDS_Denom_Desc. The 5 denominators used are:

- Diabetic, 18+ years of age
- Diabetic w/ Renal Disease, 18+ years of age
- CAD, 18+ years of age or Male 45-79 or female 55-79
- Hypertension – No data yet

**CDS_Metric_Desc**

This reference table holds information on the different metrics that are measured in the performance tables. The metrics are:

- HBA1C completed in the past 6 months for diabetics
- HBA1C completed in the past 3 months for diabetics w/ poor diabetes control
- Microalbumin completed in the past year for diabetics
- Ophthalmologic exam in the past year for diabetics
- Podiatry exam in the past year for diabetics
- 18+ years old and blood pressure entry in the past year
- CAD and aspirin is on the med list (and aspirin in not on patient's allergy list)
- Diabetics w/ Microalb/Creat ratio > 30 (renal disease) and on ACE/ARB meds.
- Diabetics w/ Microalb/Creat ratio > 30 (renal disease) and on ACE meds.
- Diabetics w/ Microalb/Creat ratio > 30 (renal disease) and on ARB meds.

**CDS_Reminders**

This table matches rules with patient denominators and metric IDs.

**CDS_ReminderActivity**

This table houses performance and acknowledge statistics for reminders that have fired in the EMR for the rules in CDS_Reminders. Reminders are group by patient/provider/day (i.e. multiple firings for a patient by a providers login on the same day are ignored). Reminders are only counted if they have a display value of 1 (which means a provider saw the reminder). The time periods for measurements are by month for each patient, going back to 1/1/2008 (arbitrary start date for the dashboard). Each monthly entry has a start date and end date which is used when tracking acknowledgement and performance. Each grouping of reminder has a "displayfirstdate" and "displaylastdate" which is the first and last time that reminder fired in the monthly timeframe (grouped, as stated above, by provider/day)

The **performance** values are then set as positive if the following criteria is met:

• For a given reminder, there is an appropriate action documented that has a service date > the start date of the monthly time period, and the service date < 30 days past the last display date of the reminder in the monthly period.

At this point, all performance values are set to negative if they do not meet the criteria above. The **acknowledgement** data is then set to positive if the following criteria is met:

• For a given reminder, there is an acknowledgement (coded response), and the provider ids match up, that has a service date > the start date of the monthly time period, and the service date < 30 days past the last display date of the reminder in the monthly period.

At this point, all acknowledgement values are set to negative if they do not meet the criteria above.

**CDS_Performance**

This table houses performance statistics for patients who fit into the various denominator and metric buckets. The idea of this table is to be able to point out patients who have always been in performance, as well as those who fall into a performance bucket at some point. As with the Reminder Activity table, performance by patient is broken out into monthly timeframes.

Patients are placed in the table w/ monthly ranges, from the denominators:

• 4 - Patient with DM, microalbumin/creatinine ratio >30 and not on ACE/ARB Meds
• 6 - Diabetes for HBA1C Testing (every 6 months)
• 7 - CAD for Aspirin on Med List
• 8 - Diabetes for MicroAlbumin Lab (yearly)
• 9 - Diabetes for Ophthal Exam (yearly)
• 10 - Foot exam completed in the past year
• 11 - Patient with DM, microalbumin/creatinine ratio >30 and not on ACEI
• 12 - Patient with DM, microalbumin/creatinine ratio >30 and not on ARB
• 13 - Patient has not had a blood pressure reading in the past year
• 14 - Patient has CAD and aspirin is not on the med list, Male 45-79 or Female 55-79
• 15 - Diabetes for HBA1C testing for poor diabetes control patients (every 3 months)

Performance over time is then measured as:

• 4 – Patient has an ACEI/ARB Med on their med list before the period start date and there is no stop date on the med entry that is before the period end date
• 6 – Patient has an HBA1C entry entered < than the period end date and > than 6 months before the period start date
• 7 – CAD patient has aspirin on their med list before the period start date and there is no stop date on the med entry that is before the period end date
• 8 - Patient has a “MALBCRE” entry entered < than the period end date and > than 12 months before the period start date
• 9 - Patient has an “Ophthal Exam” entry entered < than the period end date and > than 12 months before the period start date
• 10 - Patient has a “Podiatry Exam” entry entered < than the period end date and > than 12 months before the period start date

• 11 - Patient has an ACEI Med on their med list before the period start date and there is no stop date on the med entry that is before the period end date
• 12 - Patient has an ARB Med on their med list before the period start date and there is no stop date on the med entry that is before the period end date
• 13 - Patient has a vital signs entry for blood pressure in the past year
• 14 - Patient has aspirin on their med list before the period start date and there is no stop date on the med entry that is before the period end date
• 15 – Patient has an HBA1C entry entered < than the period end date and > than 3 months before the period start date

All entries not in compliance are then marked as not performed.

***Reporting/Pre-Aggregated Tables***

**CDS_ReminderAckEntries**

This table simply holds all acknowledgement values (coded responses) for easier reporting.

**CDS_ReminderCountsbyMeasure**

This table pre-aggregates counts of patients, displayed physicians, total display counts, acknowledgement counts, and performance totals, and then sums up the combination of all values. Sample code for the combination counts:

```
sum((CASE WHEN Performance='1' and displayFlag='1' THEN 1 ELSE 0 END)) as wRemPerf,
sum((CASE WHEN Performance='0' and displayFlag='1' THEN 1 ELSE 0 END)) as wRemNoPerf,
sum((CASE WHEN Performance='0' and (displayFlag='0' or displayFlag is null) THEN 1 ELSE 0
END)) as NoRemNoPerf,
sum((CASE WHEN Performance='1' and (displayFlag='0' or displayFlag is null) THEN 1 ELSE 0
END)) as NoRemPerf,
-- other 8 options
sum((CASE WHEN Performance='1' and displayFlag='1' and AcknFlag='1' THEN 1 ELSE 0 END)) as
wRemwAckPerf,
sum((CASE WHEN Performance='1' and displayFlag='1' and (AcknFlag='0' or AcknFlag is null)
THEN 1 ELSE 0 END)) as wRemNoAckPerf,
sum((CASE WHEN Performance='0' and displayFlag='1' and AcknFlag='1' THEN 1 ELSE 0 END)) as
wRemwAckNoPerf,
sum((CASE WHEN Performance='0' and displayFlag='1' and (AcknFlag='0' or AcknFlag is null)
THEN 1 ELSE 0 END)) as wRemNoAckNoPerf,
sum((CASE WHEN Performance='0' and (displayFlag='0' or displayFlag is null) and
AcknFlag='1'  THEN 1 ELSE 0 END)) as NoRemwAckNoPerf,
sum((CASE WHEN Performance='0' and (displayFlag='0' or displayFlag is null) and
(AcknFlag='0' or AcknFlag is null) THEN 1 ELSE 0 END)) as NoRemNoAckNoPerf,
sum((CASE WHEN Performance='1' and (displayFlag='0' or displayFlag is null) and
AcknFlag='1' THEN 1 ELSE 0 END)) as NoRemwAckPerf,
sum((CASE WHEN Performance='1' and (displayFlag='0' or displayFlag is null) and
(AcknFlag='0' or AcknFlag is null) THEN 1 ELSE 0 END)) as NoRemNoAckPerf
```

**CDS_ProviderPerf**

This table contains performance summaries by provider/clinic/period/metric/reminder groupings. Summary columns included are:

categorypatients (count of distinct patients)
totaldisplayedphysicians (count of distinct displays)
totalcountdisplayed (count of total displays)

wRemPerf (count of performance = 1 and display = 1)
wRemNoPerf (count of performance = 0 and display = 1)
NoRemNoPerf (count of performance = 0 and display = 0)
NoRemPerf (count of performance = 1 and display = 0)
totalperfsum (count total performances)
totalpatsum (count total patient performances)

Note: This table summarizes each provider by their current panel.

**CDS_Clinic_Perf**

This is a view which is created to summarize all providers into total performance within their local practices for the provider level report. The data is summarized by adding all patients by provider and all performing patients by provider into the value for the practice. It is summarized by cliniccode, metricID, and PeriodStartDate

View Code:

```
select cliniccode, metricID, PeriodStartDate, sum(totalperfsum) as
totalperf,sum(totalpatsum) as totalpat
 from CDS_ProviderPerf group by cliniccode, metricID, PeriodStartDate
```

**Table Creation Scripts**

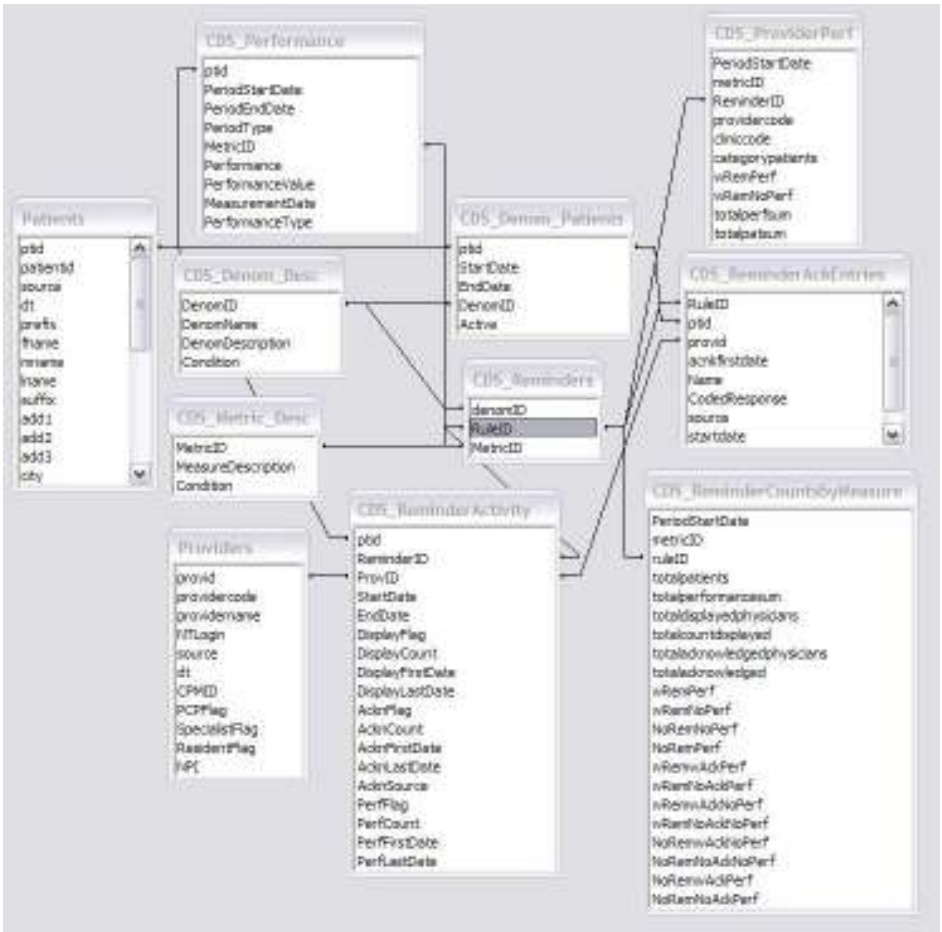
(SQL Server based code to follow)

```
/****** Object:  Table [dbo].[CDS_Denom_Desc]******/

CREATE TABLE [dbo].[CDS_Denom_Desc](
        [DenomID] [int] NULL,
        [DenomName] [varchar](50) NULL,
        [DenomDescription] [varchar](1000) NULL,
        [Condition] [varchar](100) NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_Denom_Patients]******/

CREATE TABLE [dbo].[CDS_Denom_Patients](
        [ptid] [bigint] NOT NULL,
        [StartDate] [datetime] NULL,
        [EndDate] [datetime] NULL,
        [DenomID] [int] NULL,
        [Active] [varchar](2) NULL
) ON [PRIMARY]


/****** Object:  Table [dbo].[CDS_Metric_Desc]******/

CREATE TABLE [dbo].[CDS_Metric_Desc](
        [MetricID] [int] NULL,
        [MeasureDescription] [nvarchar](255) NULL,
        [Condition] [nvarchar](255) NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_Performance]******/

CREATE TABLE [dbo].[CDS_Performance](
        [ptid] [bigint] NOT NULL,
        [PeriodStartDate] [datetime] NULL,
        [PeriodEndDate] [datetime] NULL,
        [PeriodType] [varchar](50) NULL,
        [MetricID] [int] NULL,
        [Performance] [smallint] NULL,
        [PerformanceValue] [varchar](100) NULL,
        [MeasurementDate] [datetime] NULL,
        [PerformanceType] [varchar](100) NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_ProviderPerf]******/

CREATE TABLE [dbo].[CDS_ProviderPerf](
        [PeriodStartDate] [datetime] NULL,
        [metricID] [int] NULL,
        [ReminderID] [int] NULL,
        [providercode] [varchar](50) NOT NULL,
        [cliniccode] [varchar](44) NOT NULL,
        [categorypatients] [int] NULL,
        [wRemPerf] [int] NULL,
        [wRemNoPerf] [int] NULL,
        [totalperfsum] [int] NULL,
        [totalpatsum] [int] NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_ReminderAckEntries]******/
```

```
CREATE TABLE [dbo].[CDS_ReminderAckEntries](
        [RuleID] [smallint] NULL,
        [ptid] [bigint] NULL,
        [provid] [bigint] NULL,
        [acnkfirstdate] [datetime] NULL,
        [Name] [varchar](100) NULL,
        [CodedResponse] [varchar](100) NULL,
        [source] [varchar](20) NULL,
        [startdate] [datetime] NULL,
        [enddate] [datetime] NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_ReminderActivity]******/

CREATE TABLE [dbo].[CDS_ReminderActivity](
        [ptid] [bigint] NULL,
        [ReminderID] [int] NULL,
        [ProvID] [bigint] NULL,
        [StartDate] [datetime] NULL,
        [EndDate] [datetime] NULL,
        [DisplayFlag] [varchar](1) NULL,
        [DisplayCount] [smallint] NULL,
        [DisplayFirstDate] [datetime] NULL,
        [DisplayLastDate] [datetime] NULL,
        [AcknFlag] [smallint] NULL,
        [AcknCount] [smallint] NULL,
        [AcknFirstDate] [datetime] NULL,
        [AcknLastDate] [datetime] NULL,
        [AcknSource] [varchar](50) NULL,
        [PerfFlag] [smallint] NULL,
        [PerfCount] [smallint] NULL,
        [PerfFirstDate] [datetime] NULL,
        [PerfLastDate] [datetime] NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_ReminderCountsbyMeasure]******/

CREATE TABLE [dbo].[CDS_ReminderCountsbyMeasure](
        [PeriodStartDate] [datetime] NULL,
        [metricID] [int] NULL,
        [ruleID] [int] NULL,
        [totalpatients] [int] NULL,
        [totalperformancesum] [int] NULL,
        [totaldisplayedphysicians] [int] NULL,
        [totalcountdisplayed] [int] NULL,
        [totalacknowledgedphysicians] [int] NULL,
        [totalacknowledged] [int] NULL,
        [wRemPerf] [int] NULL,
        [wRemNoPerf] [int] NULL,
        [NoRemNoPerf] [int] NULL,
        [NoRemPerf] [int] NULL,
        [wRemwAckPerf] [int] NULL,
        [wRemNoAckPerf] [int] NULL,
        [wRemwAckNoPerf] [int] NULL,
        [wRemNoAckNoPerf] [int] NULL,
        [NoRemwAckNoPerf] [int] NULL,
        [NoRemNoAckNoPerf] [int] NULL,
        [NoRemwAckPerf] [int] NULL,
        [NoRemNoAckPerf] [int] NULL
) ON [PRIMARY]



/****** Object:  Table [dbo].[CDS_Reminders]******/
```

```
CREATE TABLE [dbo].[CDS_Reminders](
        [denomID] [int] NULL,
        [RuleID] [int] NULL,
        [MetricID] [int] NULL
) ON [PRIMARY]


/****** Object:  Table [dbo].[CDS_RemindersRules]******/

CREATE TABLE [dbo].[CDS_RemindersRules](
        [RuleID] [int] NOT NULL,
        [RuleCategory] [varchar](255) NULL,
        [PrimaryClinicalArea] [varchar](50) NULL,
        [SecondaryClinicalArea] [varchar](50) NULL,
        [RuleTitle] [varchar](255) NULL,
        [OtherRelatedRules] [varchar](50) NULL,
        [RiskGroupDefinition] [text] NULL,
        [RiskGroupSpecification] [text] NULL,
        [DisplayedMessage] [varchar](255) NULL,
        [DataElementsUsed] [text] NULL,
        [TextComments] [varchar](255) NULL,
        [ActiveFlag] [varchar](2) NOT NULL,
        [ProposedForRetirement] [bit] NOT NULL,
        [PatientOverdueText] [text] NULL,
        [PatientUTDText] [text] NULL
) ON [PRIMARY] TEXTIMAGE_ON [PRIMARY]
```

**Database Model**



Note: Master tables used to calculate performance (e.g. Laboratory Tests, Vital Signs, Medications, etc) and the Problem List were not included to improve clarity of the model.

**Samples of Data**

*Main Tables*

| Table | Column | Sample Values |
|---|---|---|
| CDS_Denom_Desc | Condition | Diabetes |
| CDS_Denom_Desc | Condition | CAD Female 55-79 |
| CDS_Denom_Desc | Condition | CAD Male 45-79 |
| CDS_Denom_Desc | DenomID | 1 |
| CDS_Denom_Desc | DenomID | 2 |
| CDS_Denom_Desc | DenomID | 3 |
| CDS_Denom_Desc | DenomName | Diabetic and age > 18 with Renal Disease |
| CDS_Denom_Desc | DenomName | Diabetic and age > 18 |
| CDS_Denom_Desc | DenomName | Coronary Artery Disease |
| CDS_Denom_Patients | Active | Y |
| CDS_Denom_Patients | Active | N |
| CDS_Denom_Patients | DenomID | 2 |
| CDS_Denom_Patients | DenomID | 7 |
| CDS_Denom_Patients | DenomID | 3 |
| CDS_Denom_Patients | Ptid | 206967 |
| CDS_Denom_Patients | Ptid | 206977 |
| CDS_Denom_Patients | Ptid | 207015 |
| CDS_Denom_Patients | StartDate | Aug 7 2008 12:00AM |
| CDS_Denom_Patients | StartDate | Oct 6 2008 12:00AM |
| CDS_Denom_Patients | StartDate | Apr 29 2008 12:00AM |
| CDS_Metric_Desc | Condition | Diabetes |
| CDS_Metric_Desc | Condition | CAD |
| CDS_Metric_Desc | Condition | Diabetes w Renal Failure |
| CDS_Metric_Desc | MeasureDescription | Diabetes, HbA1C completed in the past 6 months |
| CDS_Metric_Desc | MeasureDescription | Diabetes, Foot exam completed in the past year |
| CDS_Metric_Desc | MeasureDescription | Diabetes with poor management, |
| CDS_Metric_Desc | MetricID | 12 |
| CDS_Metric_Desc | MetricID | 10 |
| CDS_Metric_Desc | MetricID | 11 |
| CDS_Performance | MeasurementDate | Jan 20 2009 12:00AM |
| CDS_Performance | MeasurementDate | Mar 5 2009 12:00AM |
| CDS_Performance | MeasurementDate | Jun 11 2009 12:00AM |
| CDS_Performance | MetricID | 11 |
| CDS_Performance | MetricID | 6 |
| CDS_Performance | MetricID | 8 |
| CDS_Performance | Performance | 0 |
| CDS_Performance | Performance | 1 |
| CDS_Performance | PerformanceType | CAD and Aspirin on med list |
| CDS_Performance | PerformanceType | Diabetes and HBA1C in past 6 months |

| | | |
|---|---|---|
| CDS_Performance | PerformanceType | Diabetes w/ poor management and HBA1C in the past 3 months |
| CDS_Performance | PeriodEndDate | Feb 1 2009 12:00AM |
| CDS_Performance | PeriodEndDate | Sep 1 2009 12:00AM |
| CDS_Performance | PeriodEndDate | Dec 1 2009 12:00AM |
| CDS_Performance | PeriodStartDate | Jan 1 2009 12:00AM |
| CDS_Performance | PeriodStartDate | Sep 1 2009 12:00AM |
| CDS_Performance | PeriodStartDate | Feb 1 2009 12:00AM |
| CDS_Performance | PeriodType | Month |
| CDS_Performance | Ptid | 23732 |
| CDS_Performance | Ptid | 18625 |
| CDS_Performance | Ptid | 14022 |
| CDS_ReminderActivity | AcknCount | 0 |
| CDS_ReminderActivity | AcknCount | 1 |
| CDS_ReminderActivity | AcknFirstDate | Dec 16 2008 12:00AM |
| CDS_ReminderActivity | AcknFirstDate | Jan 31 2008 12:00AM |
| CDS_ReminderActivity | AcknFirstDate | Nov 3 2008 12:00AM |
| CDS_ReminderActivity | AcknFlag | 1 |
| CDS_ReminderActivity | AcknFlag | 0 |
| CDS_ReminderActivity | AcknSource | Rem |
| CDS_ReminderActivity | AcknSource | HM |
| CDS_ReminderActivity | AcknSource | NR |
| CDS_ReminderActivity | DisplayCount | 3 |
| CDS_ReminderActivity | DisplayCount | 2 |
| CDS_ReminderActivity | DisplayCount | 1 |
| CDS_ReminderActivity | DisplayFirstDate | Aug 4 2008 9:40AM |
| CDS_ReminderActivity | DisplayFirstDate | Dec 21 2009 1:39PM |
| CDS_ReminderActivity | DisplayFirstDate | Apr 6 2009 11:01AM |
| CDS_ReminderActivity | DisplayFlag | 1 |
| CDS_ReminderActivity | DisplayLastDate | Aug 22 2009 10:20AM |
| CDS_ReminderActivity | DisplayLastDate | Aug 31 2009 10:41AM |
| CDS_ReminderActivity | DisplayLastDate | May 24 2008 12:19AM |
| CDS_ReminderActivity | EndDate | Jul 1 2008 12:00AM |
| CDS_ReminderActivity | EndDate | May 1 2009 12:00AM |
| CDS_ReminderActivity | EndDate | Mar 1 2009 12:00AM |
| CDS_ReminderActivity | PerfCount | 0 |
| CDS_ReminderActivity | PerfCount | 1 |
| CDS_ReminderActivity | PerfFirstDate | Jan 11 2008 12:50PM |
| CDS_ReminderActivity | PerfFirstDate | Oct 28 2009 2:04PM |
| CDS_ReminderActivity | PerfFirstDate | Jun 3 2008 10:51AM |
| CDS_ReminderActivity | PerfFlag | 0 |
| CDS_ReminderActivity | PerfFlag | 1 |
| CDS_ReminderActivity | ProvID | 7105 |
| CDS_ReminderActivity | ProvID | 8147 |
| CDS_ReminderActivity | ProvID | 3893 |
| CDS_ReminderActivity | Ptid | 24728 |
| CDS_ReminderActivity | Ptid | 24822 |
| CDS_ReminderActivity | Ptid | 24432 |
| CDS_ReminderActivity | ReminderID | 164 |
| CDS_ReminderActivity | ReminderID | 175 |

| | | |
|---|---|---|
| CDS_ReminderActivity | ReminderID | 267 |
| CDS_ReminderActivity | StartDate | Apr 1 2008 12:00AM |
| CDS_ReminderActivity | StartDate | Sep 1 2008 12:00AM |
| CDS_ReminderActivity | StartDate | Feb 1 2008 12:00AM |
| CDS_Reminders | denomID | 2 |
| CDS_Reminders | denomID | 1 |
| CDS_Reminders | denomID | 3 |
| CDS_Reminders | MetricID | 11 |
| CDS_Reminders | MetricID | 12 |
| CDS_Reminders | MetricID | 10 |
| CDS_Reminders | RuleID | 175 |
| CDS_Reminders | RuleID | 176 |
| CDS_Reminders | RuleID | 164 |

**Aggregate/Reporting Tables**

| | | |
|---|---|---|
| CDS_ProviderPerf | Categorypatients | 1 |
| CDS_ProviderPerf | Categorypatients | 17 |
| CDS_ProviderPerf | Categorypatients | 21 |
| CDS_ProviderPerf | Cliniccode | 100 |
| CDS_ProviderPerf | Cliniccode | 120 |
| CDS_ProviderPerf | Cliniccode | 158 |
| CDS_ProviderPerf | metricID | 4 |
| CDS_ProviderPerf | metricID | 6 |
| CDS_ProviderPerf | metricID | 7 |
| CDS_ProviderPerf | NoRemNoPerf | 0 |
| CDS_ProviderPerf | NoRemNoPerf | 1 |
| CDS_ProviderPerf | NoRemNoPerf | 2 |
| CDS_ProviderPerf | NoRemPerf | 0 |
| CDS_ProviderPerf | NoRemPerf | 17 |
| CDS_ProviderPerf | NoRemPerf | 20 |
| CDS_ProviderPerf | PeriodStartDate | Feb 1 2009 12:00AM |
| CDS_ProviderPerf | PeriodStartDate | Jan 1 2009 12:00AM |
| CDS_ProviderPerf | PeriodStartDate | Mar 1 2009 12:00AM |
| CDS_ProviderPerf | Providercode | 1022325 |
| CDS_ProviderPerf | Providercode | 1035333 |
| CDS_ProviderPerf | Providercode | 1061526 |
| CDS_ProviderPerf | ReminderID | 175 |
| CDS_ProviderPerf | ReminderID | 178 |
| CDS_ProviderPerf | ReminderID | 179 |
| CDS_ProviderPerf | Totalcountdisplayed | 1 |
| CDS_ProviderPerf | Totalcountdisplayed | 13 |
| CDS_ProviderPerf | Totalcountdisplayed | 70 |
| CDS_ProviderPerf | totaldisplayedphysicians | 1 |
| CDS_ProviderPerf | totaldisplayedphysicians | 10 |
| CDS_ProviderPerf | totaldisplayedphysicians | 35 |
| CDS_ProviderPerf | Totalpatsum | 17 |
| CDS_ProviderPerf | Totalpatsum | 2 |
| CDS_ProviderPerf | Totalpatsum | 22 |

| | | |
|---|---|---|
| CDS_ProviderPerf | Totalperfsum | 17 |
| CDS_ProviderPerf | Totalperfsum | 2 |
| CDS_ProviderPerf | Totalperfsum | 20 |
| CDS_ProviderPerf | wRemNoPerf | 0 |
| CDS_ProviderPerf | wRemNoPerf | 1 |
| CDS_ProviderPerf | wRemNoPerf | 15 |
| CDS_ProviderPerf | wRemPerf | 0 |
| CDS_ProviderPerf | wRemPerf | 10 |
| CDS_ProviderPerf | wRemPerf | 20 |
| CDS_ReminderAckEntries | Acnkfirstdate | Feb 3 2009 12:00AM |
| CDS_ReminderAckEntries | Acnkfirstdate | Mar 25 2008 12:00AM |
| CDS_ReminderAckEntries | Acnkfirstdate | Sep 10 2009 12:00AM |
| CDS_ReminderAckEntries | CodedResponse | Ordered |
| CDS_ReminderAckEntries | CodedResponse | Other |
| CDS_ReminderAckEntries | CodedResponse | Patient is not diabetic |
| CDS_ReminderAckEntries | Enddate | Apr 1 2008 12:00AM |
| CDS_ReminderAckEntries | Enddate | Oct 1 2009 12:00AM |
| CDS_ReminderAckEntries | Enddate | Sep 1 2009 12:00AM |
| CDS_ReminderAckEntries | Name | BLIN |
| CDS_ReminderAckEntries | Name | M-alb/creat ratio |
| CDS_ReminderAckEntries | Name | OTHR |
| CDS_ReminderAckEntries | Provid | 180165 |
| CDS_ReminderAckEntries | Provid | 45580 |
| CDS_ReminderAckEntries | Provid | 93118 |
| CDS_ReminderAckEntries | Ptid | 123 |
| CDS_ReminderAckEntries | Ptid | 188 |
| CDS_ReminderAckEntries | Ptid | 2 |
| CDS_ReminderAckEntries | RuleID | 164 |
| CDS_ReminderAckEntries | RuleID | 175 |
| CDS_ReminderAckEntries | RuleID | 176 |
| CDS_ReminderAckEntries | Source | CR |
| CDS_ReminderAckEntries | Source | HM |
| CDS_ReminderAckEntries | Source | Narr |
| CDS_ReminderAckEntries | Startdate | Aug 1 2009 12:00AM |
| CDS_ReminderAckEntries | Startdate | Mar 1 2008 12:00AM |
| CDS_ReminderAckEntries | Startdate | Sep 1 2009 12:00AM |
| CDS_ReminderCountsbyMeasure | metricID | 10 |
| CDS_ReminderCountsbyMeasure | metricID | 11 |
| CDS_ReminderCountsbyMeasure | metricID | 12 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckNoPerf | 10039 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckNoPerf | 10146 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckNoPerf | 10286 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckPerf | 10123 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckPerf | 10269 |
| CDS_ReminderCountsbyMeasure | NoRemNoAckPerf | 10407 |
| CDS_ReminderCountsbyMeasure | NoRemNoPerf | 10039 |
| CDS_ReminderCountsbyMeasure | NoRemNoPerf | 10146 |
| CDS_ReminderCountsbyMeasure | NoRemNoPerf | 10286 |
| CDS_ReminderCountsbyMeasure | NoRemPerf | 10123 |
| CDS_ReminderCountsbyMeasure | NoRemPerf | 10269 |

| | | |
|---|---|---|
| CDS_ReminderCountsbyMeasure | NoRemPerf | 10407 |
| CDS_ReminderCountsbyMeasure | NoRemwAckNoPerf | 0 |
| CDS_ReminderCountsbyMeasure | NoRemwAckPerf | 0 |
| CDS_ReminderCountsbyMeasure | PeriodStartDate | Apr 1 2009 12:00AM |
| CDS_ReminderCountsbyMeasure | PeriodStartDate | Aug 1 2009 12:00AM |
| CDS_ReminderCountsbyMeasure | PeriodStartDate | Dec 1 2009 12:00AM |
| CDS_ReminderCountsbyMeasure | ruleID | 164 |
| CDS_ReminderCountsbyMeasure | ruleID | 175 |
| CDS_ReminderCountsbyMeasure | ruleID | 176 |
| CDS_ReminderCountsbyMeasure | Totalacknowledged | 0 |
| CDS_ReminderCountsbyMeasure | Totalacknowledged | 1 |
| CDS_ReminderCountsbyMeasure | Totalacknowledged | 101 |
| CDS_ReminderCountsbyMeasure | totalacknowledgedphysicians | 0 |
| CDS_ReminderCountsbyMeasure | totalacknowledgedphysicians | 1 |
| CDS_ReminderCountsbyMeasure | totalacknowledgedphysicians | 101 |
| CDS_ReminderCountsbyMeasure | Totalcountdisplayed | 0 |
| CDS_ReminderCountsbyMeasure | Totalcountdisplayed | 101 |
| CDS_ReminderCountsbyMeasure | Totalcountdisplayed | 102421 |
| CDS_ReminderCountsbyMeasure | totaldisplayedphysicians | 0 |
| CDS_ReminderCountsbyMeasure | totaldisplayedphysicians | 1000 |
| CDS_ReminderCountsbyMeasure | totaldisplayedphysicians | 1034 |
| CDS_ReminderCountsbyMeasure | Totalpatients | 10028 |
| CDS_ReminderCountsbyMeasure | Totalpatients | 10166 |
| CDS_ReminderCountsbyMeasure | Totalpatients | 10331 |
| CDS_ReminderCountsbyMeasure | Totalperformancesum | 10123 |
| CDS_ReminderCountsbyMeasure | Totalperformancesum | 10269 |
| CDS_ReminderCountsbyMeasure | Totalperformancesum | 10407 |
| CDS_ReminderCountsbyMeasure | wRemNoAckNoPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemNoAckNoPerf | 10158 |
| CDS_ReminderCountsbyMeasure | wRemNoAckNoPerf | 10297 |
| CDS_ReminderCountsbyMeasure | wRemNoAckPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemNoAckPerf | 1 |
| CDS_ReminderCountsbyMeasure | wRemNoAckPerf | 1003 |
| CDS_ReminderCountsbyMeasure | wRemNoPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemNoPerf | 1005 |
| CDS_ReminderCountsbyMeasure | wRemNoPerf | 10196 |
| CDS_ReminderCountsbyMeasure | wRemPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemPerf | 1 |
| CDS_ReminderCountsbyMeasure | wRemPerf | 1000 |
| CDS_ReminderCountsbyMeasure | wRemwAckNoPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemwAckNoPerf | 1 |
| CDS_ReminderCountsbyMeasure | wRemwAckNoPerf | 10 |
| CDS_ReminderCountsbyMeasure | wRemwAckPerf | 0 |
| CDS_ReminderCountsbyMeasure | wRemwAckPerf | 1 |
| CDS_ReminderCountsbyMeasure | wRemwAckPerf | 10 |

**Screenshots & Technical Specifications of Report Central at Partners HealthCare**

***Provider-level view:***

CDS Dashboard - Provider View
Reporting period: 1/1/08 to 6/1/09
Test Clinic
Test Provider

Generated by: Test Provider
Test Clinic
BWH
Generated on: 01/14/2010

This report provides information on clinical performance measures and feedback on your response to LMR reminders. The patient population measured for performance is your current patient panel as defined in Report Central (see the My Panel report). Reminder performance is calculated relative to patients where you have been displayed a reminder during the reporting period.

Current performance rate is the performance on the clinical measure for the last measurement month.

Performance trend is a display of the performance value by month in a graph for the overall report time frame

Reminder Historical Performance shows the denominator (Times displayed) as total patients over the report time period where reminders have been shown to you in LMR for this measure. If the patient was in compliance of the measure within 30 days of the reminder then they appear in the numerator (Times performed). The same patient may appear across multiple months in the total.

| Condition | Measure | Current Patients* | Number in Compliance** | My Rate | My Clinic Rate | My Performance Trend | Reminder for this measure | Times displayed | Times Performed |
|---|---|---|---|---|---|---|---|---|---|
| Diabetes | Diabetes, HbA1C completed in the past 6 months | 85 | 47 | 55.3% | 62.7% | | | | |
| | | | | | | | Diabetic overdue for HbA1C | 479 | 267 |
| | | | | | | | Diabetic almost due for HbA1C | 216 | 141 |
| Diabetes | Diabetes, MicroAlb completed in the past year | 85 | 35 | 41.2% | 52.8% | | | | |
| | | | | | | | Diabetes overdue for Microalb/creat ratio | 731 | 266 |
| | | | | | | | Diabetes almost due for Microalb/creat ratio | 359 | 269 |
| Diabetes w Renal Failure | Diabetes, microalbumin/creatinine ratio >30 and on ACEI, ARB | 23 | 21 | 91.3% | 92.5% | | | | |
| Diabetes | Diabetes, Opthal exam completed in past year | 85 | 0 | 0.0% | 4.8% | | | | |
| | | | | | | | Diabetic overdue for ophthal exam | 1,812 | 33 |
| | | | | | | | Diabetic almost due for ophthal exam | 160 | 7 |
| CAD | Patient has CAD and aspirin is on the med list | 60 | 30 | 50.0% | 63.1% | | | | |
| | | | | | | | CAD and no ASA | 18 | 18 |
| Hypertension Screening | Patient has had a blood pressure reading in the past year | 1,383 | 1,110 | 80.3% | 82.1% | | | | |

Generated by: Test Provider on 1/14/10

* Based on Report Central panel definition

** Based on evaluation during the last month as the reporting period

Reporting period: 01/01/2008 TO 06/01/2009

*Page 1 of 1*

**Provider Level Report**

Data in this report is limited to the available data set for the date ranges available in the CDS_ProviderPerf table as defined by the minimum and maximum values of the periodstartdate. The report is based on the underlying data relating to the provider's panel at the time the report data was calculated and thus may not be the accurate population for the provider.

The fields are generated as follows:

Condition: CDS_Metric_Desc.Condition
Measure: CDS_Metric_Desc.MeasureDescription

The following three fields are for the last reporting period

- Current Patients: CDS_ProverPerf.totalpatsum
- Number in compliance: CDS_ProverPerf.totalperfsum
- My rate: 100*({CDS_ProviderPerf.totalperfsum}/{CDS_ProviderPerf.totalpatsum})
- My clinic rate: 100*({CDS_ClinicPerf.totalperf}/{CDS_ClinicPerf.totalpat})
- (Note that the clinic is summarized in the view discussed at an earlier point in this document)

***Graph***

My performance trend: This graph is generated across time periods as a sparkline. Each date is a CDS_ProvderPerf.PeriodStartDate. Each point is the value for {CDS_ProviderPerf.totalperfsum}/{CDS_ProviderPerf.totalpatsum} which is the ratio of patients who are "performing" for the measure divided by the total patients who are in the denominator for the measure.

***Reminder Level Data***

Data in this report includes information both at the measure level and the reminder level. This is because a single measure may have multiple reminders associated with it. For example – there is both an HbA1C reminder for almost due and overdue patients. But there is only one measure for HbA1c performance. The fields relating to reminder level data are measured across periods so a single patient may have the same reminder appear across more than one month. The summaries work across months.

Reminder for this measure: CDS_RemindersRules.ruleTitle . This field is from the Partners knowledge management system. The official rule title is included as the output.

- Times displayed: The sum across all periods in the report for {CDS_ProviderPerf.wRemPerf}+{CDS_ProviderPerf.wRemNoPerf} for the patient population.
- Times with performance: The sum across all periods in the report for the field CDS_ProviderPerf.wRemPerf

**Designer View**

**Report:** CDS Dashboard - Reminder Designer View
**Report Run For:** [redacted]
**Today's Date:** 02/19/2010
**Reporting Period:** From 1-09 thru 1-10.

## Multiple time period view

**Condition:** CAD
**ReminderID:** 164-CAD and no ASA
**Measure:** Patient has CAD and aspirin is on the med list

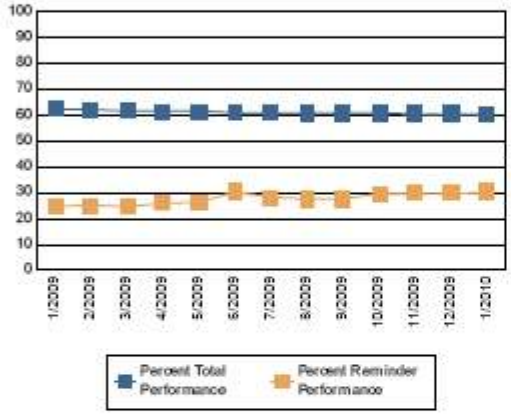
**Reminder:** Patient has CAD-equivalent on problem list and aspirin is not on the med list. Recommend aspirin.

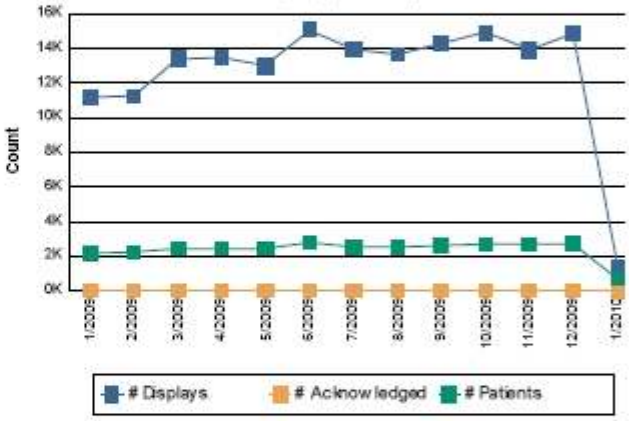
**Data:** All users of LMR. From 1-09 thru 1-10.

**Total Count Displays (across providers):** 164,416
**#Patient (months) with reminders displayed:** 30,947
**#Patient (months) w/ reminder and perf:** 8,630
**#Patient (months) w/ reminder and no perf:** 22,317
**#Reminders acknowledged:** 284
**#Reminders acknowledged and perf:** 150
**#Reminders acknowledged and no perf:** 134

**NNTR (Total):** 19.05
**NNTR (1X per month):** 3.59

NNTR is number needed to remind. The denominator is the count where performance followed a reminder within 30 days of the end of the reporting period. The numerator is the cumulative count of all reminders per patient in each month(Total) or only counts a patient with a reminder once per month (1X per month).



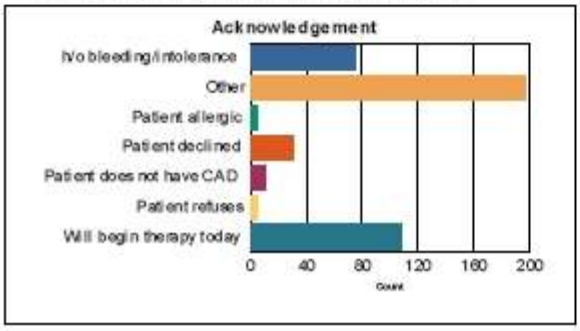

Total Performance is the clinical performance for the measure across all LMR patients in the denominator for that period. The patient is counted in the numerator if the patient record shows compliance with the measure's numerator criteria within 30 days of the reporting period.

Reminder Performance is the performance for patients where a reminder was displayed to a physician during the reporting period. The denominator is reminders (one per provider / day). If the patient clinical data shows that the criteria for the measure is met within 30 days of the period then the performance is counted in the numerator.

# Displays is the count of displays for the reminder during the time period. Note that reminders are counted once per day for each physician such that multiple displays for the same provider on the same day are not counted but multiple providers are counted as separate.

# Acknowledged is the count of displayed reminders where there was an acknowledgement through the LMR reminder tool

# Patients is the total number of patients that reminders were displayed to. Note: When counting patients across months the concept of a "patient(month)" is needed to cover for duplicate patients that appear in more than one period.



***Multiple Time Period View***

This report is based on the previously documented summary table which includes CDS_ReminderCountsByMeasure for all major data and CDS_Reminders, CDS_Metric_Desc, qdrReminderRules to provide meta-data such as descriptions of reminders, ruleIDs, etc. Some summarization of the data provided is incorporated and documented below. The data included in the summary by measure across time periods is not restricted by elements within the Crystal Report query itself. All aggregation of major elements such as which patients to include, which providers to report against, and what a reminder is occurs in the construction of CDS_ReminderCountsByMeasure prior to when the report is run against the table.

There is one constraint on the report for the dates of data to include. This constraint is that the date for data lags the report execution. It runs only for data from through [current date – 40 days] for the field {CDS_ReminderCountsByMeasure.PeriodStartDate} to ensure it does not include a build of data or data sets where no activity has occurred yet. Note that date for that field is the first day of each month given that our summarization is monthly.

Major data assumptions/logic: All sums to summarize data through the report display logic are across the set of records being reviewed. Each record from the table CDS_ReminderCountsByMeasure represents a time period and a measure.

- Condition: CDS_Metric_Desc.Condition
- ReminderID: {CDS_ReminderCounstbyMeasure.ruleID} + - + {CDS_RemindersRules.RuleTitle}
- Measure: {CDS_Metric_Desc.MeasureDescription}
- Reminder: {CDS_RemindersRules.DisplayedMessage}
- Data: Lists the data ranges included automatically based on the start date.
- Total Count Displays (across providers): The sum of the field (note it is scored as 0 or 1) {CDS_ReminderCountsbyMeasure.totalcountdisplayed} across all data in the report.
- #Patient (months) with reminders displayed: The sum of the field {CDS_ReminderCountsbyMeasure.totaldisplayedphysicians}
- #Patient (months) w/reminder and perf: The sum of the field {CDS_ReminderCountsbyMeasure.wRemPerf}
- #Patient (months) w/ reminder and no perf: The sum of the field {CDS_ReminderCountsbyMeasure.wRemNoPerf}
- #Reminders acknowledged: The sum of the field {CDS_ReminderCountsbyMeasure.totalacknowledged}
- #Reminders acknowledged and perf: The sum of the field {Sum CDS_ReminderCountsbyMeasure.wRemwAckPerf}
- #Reminders acknowledged and no perf: The sum of the field {CDS_ReminderCountsbyMeasure.wRemwAckNoPerf}

NNTR is the number needed to remind. The denominator is the count where performance followed a reminder within 30 days of the end of the reporting period. The numerator is the cumulative count of all reminders per patient in each month (Total) or only counts a patient with a reminder once per month (1X per month)

NNTR Total: The calculation is made by the following logic:

- Sum({CDS_ReminderCountsbyMeasure.totalcountdisplayed}/Sum({CDS_ReminderCountsbyMeasure.wRemPerf})
- The sums are to look across the periods being reviewed so each row will have a specific value in it per record per period.

NNTR (1X per month): The calculation is made by the following logic:

- Sum({CDS_ReminderCountsbyMeasure.totaldisplayedphysicians})/Sum(CDS_ReminderCountsbyMeasure.wRemPerf)

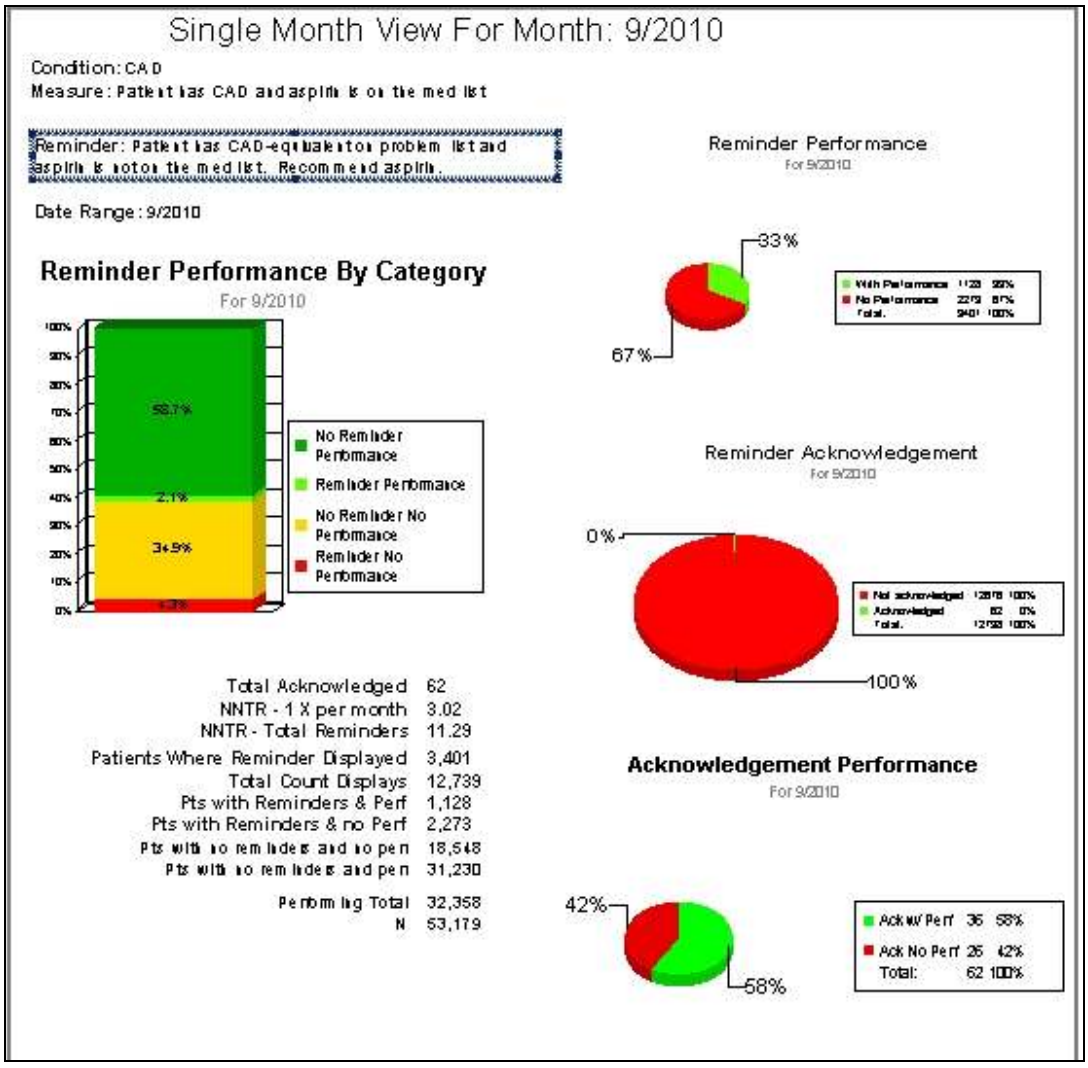
***Graphs***

The graph for Percent Total Performance and Percent Reminder Performance uses the following logic:

- It summarizes the data from the table {CDS_ReminderCountsbyMeasure}. It does so by grouping by the field Periodstartdate for each period and displays only the month for the period.
- The "Percent Total Performance" line is the value of (100*totalperformance/totalpatients) for the period for the measure.
- The "Percent Reminder Performance" line is the value of (100*wRemPerf/(wRemNoPerf+wRemPerf)).

The graph for displays, acknowledgements, and patients uses the following logic:

- Lines are summarized by counts in the thousands so 1K displays = 1,000 displays with summaries using the field Periodstartdate:
    - #Displays: Sum of totalcountdisplayed
    - #Acknowledged: Sum of totalacknowledgedphysicians
    - #Patients: Sum of totaldisplayedphysicians


Single Month View For Month: 9/2010
Condition: CAD
Measure: Patient has CAD and aspirin is on the med list
Reminder: Patient has CAD-equivalent on problem list and aspirin is not on the med list. Recommend aspirin.
Date Range: 9/2010
Reminder Performance By Category
For 9/2010
58.7%
2.1%
34.9%
4.3%
No Reminder Performance
Reminder Performance
No Reminder No Performance
Reminder No Performance
Total Acknowledged 62
NNTR - 1 X per month 3.02
NNTR - Total Reminders 11.29
Patients Where Reminder Displayed 3,401
Total Count Displays 12,739
Pts with Reminders & Perf 1,128
Pts with Reminders & no Perf 2,273
Pts with no reminders and no perf 18,548
Pts with no reminders and perf 31,230
Performing Total 32,358
N 53,179
Reminder Performance
For 9/2010
33%
67%
Reminder Acknowledgement
For 9/2010
0%
100%
Acknowledgement Performance
For 9/2010
42%
58%
Ack W Perf 36 58%
Ack No Perf 26 42%
Total: 62 100%

***Single Month View***

Note: Condition, Measure, Reminder are the same in the monthly view as in the multiple time period view. Each page represents one month for reminder for one measure.

Unless otherwise specified all fields are derived from the table CDS_ReminderCountsbyMeasure:

- Date Range: PeriodStartDate for the month
- Total Acknowledged: {totalacknowledgedphysicians}
- NNTR – 1 X per month: totaldisplayedphysicians/wRemPerf
- NNTR – Total Reminders: totalcountdisplayed/wRemPerf
- Patients where Reminder Displayed: totaldisplayedphysicians
- Total Count Displays: totalcountdisplayed
- Pts with Reminders & Perf: wRemPerf
- Pts with reminders & no Perf:wRemNoPerf
- Pts with no reminders and no performance: NoRemNoPerf
- Pts with no reminders and performance:NoRemPerf
- Performing total:totalperformancesum
- N:totalpatients

***Charts***

This chart is populated from the fields in the CDS_ReminderCountsbyMeasure.

*Reminder Performance by Category chart*

- wRemNoPerf: Reminder No Performance
- NoRemNoPerf: No Reminder No Performance
- wRemPerf: Reminder Performance
- NoRemPerf: No Reminder Performance

*Reminder Performance (for period)*

- With performance: wRemPerf
- No performance: wRemNoPerf

*Reminder Acknowledgement (for period)*

- Not acknowledged: (totalcountdisplayed-totalacknowledged)
- Acknowledged: totalacknowledgedphysicians

## ROLLOUT PHASE

### Purpose

The purpose of this phase is to provide the end users with detailed training on both the developers and providers' versions of the dashboards. Once the dissemination and training are completed, the end users will be ready to go-live with the CDS dashboards.

### End-User Training

For this stage we decided to start by distributing a personal email to all the users involved in the project to let them know that the CDS dashboards were available for them to use. This communication included the details about how to access the dashboards and an explanation of the KPIs and how to interpret them. This was also done specifically to determine the level of impact that this type of communication has among final users.

Once we realized that there was no significant impact of passive communication that would improve the use of this tool, we conducted the second part of the dissemination phase that consisted of short presentations during the practice monthly meeting where we could explain in detail how to access them and demonstrate in detail its features.

The presence of people with leadership roles in the presentations proved to be of vital importance. Being able to review the provider's performance and compare them all together is one of the most important uses that this dashboards can have. The potential of using this tool to take specific actions on a practice level using updated information allowed quality managers take a closer look at specific processes that could be detrimenting the quality in which patients are being treated. They provide the decision maker a strong background to take specific actions to improve quality. If the source of error is not totally clear, the comprehensive structure of the information will give enough clues to identify the problem and determine the following steps to solve it.

The developer's dashboards were presented separately to the members of the knowledge management team to present the benefits that performance feedback would have when evaluating the implementation of decision support.

## EVALUATION SECTION

### Purpose

The purpose of this phase is to review and monitor the dashboard implementation. This evaluation component seeks to gather the end-user opinion of the reports in general and the impact on the workflow and their usability. It is very important to determine if the dashboard is providing the information for which it was designed and if there are other indicators that would need to be considered.

Once completing the training period, we started monitoring the use of the dashboards. As a quantitative evaluation we looked at the usage reports with raw counts of the daily access per user and aggregated by participating site. The data was collected on a monthly basis from the dashboard logs.

To get a qualitative assessment of the implementation process, we conducted semi-structured interviews with several of the final users of the dashboards both from the clinician and the developers group. We were interested in hearing the users' perspective on the use of quality feedback and the evaluation of their clinical performance associated with decision support. More specifically we asked about the usability and functionality of the CDS dashboards in their current state and whether this would represent a useful tool.

### Questions

1. Please say your name and where you practice.
2. How many sessions do you do per week?
    a. How many patients per each one of them?
    b. Can you roughly estimate on how many patients per week?
3. Do you have any leadership or quality role in your practice?
4. Are you interested in getting feedback on CDS utilization?
    a. Why? / Why not?
    b. What would you like to do with your data?
3. Have you ever used the CDSC Dashboards?
4. How often do you use any report in Report Central?
5. How often do you use the CDSC Dashboards in particular?
6. Do you think that the CDSC Dashboards increase your use of Report Central?
7. Have you felt difficulties in understanding the information presented to you?
8. Are the reports close to your daily clinical practice?
9. Do you feel that your work and effort are reflected in you reports?
10. Do you think that the rule engine used for the CDSC Dashboards is accurate and reliable?
11. Have you felt that the Reporting tools change the way you provide care?
    a. If YES: Change for better or for worse?
12. Have you ever taken specific actions in response of any of your reports?
14. Do you think that the CDSC Dashboards provide enough level of detail that you would like to see?
15. Do you feel being observed or punished for your performance when using reporting tools?
16. How would you change the CDSC Dashboards?
17. For quality or practice leaders only: have you ever used the reports to take specific actions or implement changes on a practice-wide level?

In the middle of the interview we asked the person to access the dashboards to evaluate if the visibility in the system affected the user's ability to actually find the report. Later, we reviewed the first impression generated by the report in terms of what draws the attention at first sight to understand what the user is expecting to see versus what is provided to them. The request to have a look at each one of the metrics presented came last. It is fundamental to hear their explanation of the results displayed. This interpretation can be very subjective or biased by training or interests, but every dashboard should follow the principle

that the simpler and more straightforward the report is, the less explanation or training it will require. There may be people that have different roles in the institution and can switch between different standpoints during the interview. People in leadership positions in healthcare institutions are frequently very supportive of incorporating novel tools that look at the process of clinical care from different perspectives, and thus their input will be extremely valuable.

To conclude, performance reporting tools are intended to provide sufficient information to support the actions to be taken in order to improve outcomes, adding value to the decision making process. Asking about the actions that have been taken or that would be possible to take through to these tools will generate the argument for maintenance and future improvements for any reporting system. The information representation needs to be simple and effective avoiding unnecessary verbosity.

## LESSONS LEARNED

**Define the purpose:** this aspect in the development process has to be considered carefully. The requirements have to be defined considering the final purpose, since in the context of CDS there is not much experience available building these particular types of reports. In an effort to leverage the work in progress there may be a burden to expand the end-user group. This can significantly mislead the original purpose of the dashboard development, and therefore compromise the quality and usability of the final product.

**Identification of target audience:** in order to carry out a successful CDS dashboard implementation, the final user has to be considered as a pivotal element during the entire development process. There needs to be a clear distinction of the different roles inside of the institution to who these reports will be oriented. This can be achieved by clearly defining the profile of the end user and finding somebody that could provide that feedback during the planning and development.

**Source data:** Refinement of the dashboards themselves is a factor that needs to be considered. The capture of unstructured information remains a big issue to be addressed. The quality of the information displayed will always be determined by the way that information is collected. By definition a dashboard needs to use information collected from the processes in order to provide up-to-date feedback to the consumer. Since some of the information may not be documented adequately either because of inconsistent use of suitable modules in the electronic health record or lack of them, the displayed information can be inaccurate, consequently compromising reliability.

Dashboards even can be used as a tool for evaluating the level of completeness of the structured information that is required. Many times end users feel overwhelmed by all the information that has to be entered into the systems. For that reason it is of vital importance a careful planning of the information that needs to be in structured format and the one that is documented in free text format that will most probably not be entirely useful for analysis.

Technologies like natural language processing are in an advanced stage of evolution to extract information from the notes and use it for quality analysis purposes. There is still work to be done in order to obtain reliable results from such techniques to extract relevant information for quality feedback, since they inherently bring some uncertainty to the process.

**Prerelease evaluation:** the development of complex reporting systems is prone to display certain amount of inaccurate information. This happens because they receive pieces of data from very diverse sources that need to be processed in different ways in order to be aggregated in central repositories. The representation of that information is generated by complex logics that do not discriminate the source, manipulating it without making any distinctions. By being further away from the place where information is generated and gathered, an exhaustive revision of the dashboards needs to happen constantly, especially before the dissemination phase. Proving reliable information the first time the dashboards are presented to the final user has proven to be an important aspect for a successful implementation.

## CONTRIBUTING AUTHORS

| Name | Affiliation |
|---|---|
| Christine Kucera | CDSC – Partners Healthcare |
| Zachary Turechek | CDSC – Partners Healthcare |
| Jonathan Einbinder | QDM – Partners Healthcare |
| Ruslana Tsurikova | CDSC – Partners Healthcare |
| Brian Horwitz | QDM – Partners Healthcare |
| Kerry C. Martin | QDM – Partners Healthcare |
| Dan Housman | Recombinant Inc. |
| Esteban Hebel | CIRD – Partners Healthcare |

## LIST OF ACRONYMS

| | |
|---|---|
| **AHRQ** | Agency for Healthcare Research and Quality |
| **CDS** | Clinical decision support |
| **CDSC** | Clinical Decision Support Consortium |
| **EMR** | Electronic medical record |
| **EOV** | End of Visit |
| **KPI** | Key performance indicator |
| **LMR** | Longitudinal Medical Record |
| **NNTR** | Number needed to remind |

**Acknowledgement** This research was funded in part by a contract from the Agency for Healthcare Research and Quality HHHSA29020080010.