

# Using Clinical Decision Support to Make Informed Patient Care Decisions

**September 19, 2008**

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# Clinical Decision Support Demonstrations

**Jon White, MD**  
**Agency for Healthcare Research and Quality**

# Background

- Clinical decision support has been applied to
  - increase quality and patient safety
  - improve adherence to guidelines for prevention and treatment
  - avoid medication errors
- Systematic reviews have shown that CDS can be useful across a variety of clinical purposes and topics

# Definitions

- Shortliffe, 2006: “A computer-based system that assists physicians in making decisions about patient care”
- Dr. Robert Hayward of the Centre for Health Evidence; “Clinical Decision Support systems link health observations with health knowledge to influence health choices by clinicians for improved health care”

# Clinical Decision Support

- AMIA CDS Roadmap (2006)
  - “Clinical decision support (CDS) provides **clinicians, staff, patients** or other individuals with **knowledge** and **person-specific** information, intelligently **filtered** or presented at **appropriate times**, to **enhance health and health care.**”
  - CDS encompasses a variety of tools and interventions
    - Computerized alerts and reminders
    - Clinical guidelines
    - Order sets
    - Patient data reports and dashboards
    - Documentation templates
    - Diagnostic support
    - Clinical workflow tools

# Barriers

Current adoption of advanced clinical decision support is limited due to a variety of reasons, including:

- Limited implementation of EMR, CPOE, PHR, etc.
- Difficulty developing clinical practice guidelines
- Lack of standards
- Poor support for CDS in commercial EHRs
- Challenges in integrating CDS into the clinical workflow
- Limited understanding of organizational, and cultural issues relating to clinical decision support

# AHRQ's Goals for Advancing Clinical Decision Support

- To facilitate the development, adoption, implementation and evaluation of best practices using CDS.
- To further enhance the nation's efforts to make evidence-based clinical knowledge more readily available to health care providers.

# CDS Demonstration Projects

## *Objective*

To develop, implement, and evaluate projects that advance the understanding of how best to incorporate CDS into health care delivery.

## *Overall goal*

Explore how the translation of clinical knowledge into CDS can be routinized in practice and taken to scale in order to improve the quality of healthcare delivery in the U.S.

## *Funding*

\$1.25 million per project per year for up to five years

# Key Demonstration Goals

- Incorporate CDS into EHRs certified by the Certification Commission for Health IT (CCHIT).
- Demonstrate cross-platform utility.
- Establish lessons learned for CDS implementation across the health IT vendor community.
- Assess potential benefits and drawbacks of CDS.
- Evaluate methods for creating, storing, and replicating CDS elements across multiple clinical sites and ambulatory practices.
- Translate clinical guidelines and outcomes related to preventive health care and treatment of patients with chronic illnesses.

# AHRQ Guidelines Into Decision Support (GLIDES)

**Richard Shiffman, MD, MCIS  
Yale University School of Medicine**





# A Systematic and Replicable Approach to Development of Ambulatory Decision Support

## **GLIDES PROJECT**

### **GuideLines Into DEcision Support**

sponsored by  
the Agency for Healthcare Research and Quality



# Overview

- Goals
- Knowledge transformation
  - Define clinical objectives
  - Markup: Guideline Elements Model (GEM)
  - XSL transforms for process documentation
  - Action-types
  - Preview of user interface

SYSTEMATIC AND REPLICABLE



**GLIDES PROJECT**  
GuideLines Into DEcision Support



Agency for Healthcare Research and Quality  
Advancing Excellence in Health Care • [www.ahrq.gov](http://www.ahrq.gov)

**AHRQ**  
Project Officer - White  
Contracting Officer - Zuhlke

**Project Director - Shiffman**

**GLIDES Steering Group**

Project Director - Shiffman  
Project Mgr - Dixon  
Nemours Lead - Nathanson  
YNHH IS&T - Burns  
Nemours CIO - Milov  
Evaluation Leaders:  
Horwitz  
Ramirez

**Guideline Transformation Group**

Group Leader - Shiffman  
Project Manager - Dixon  
XML Programmer - Michel  
Informatics Fellow - Lomotan  
IS&T Chief - Burns  
**Clinical Experts:**  
Bazzy-Asaad  
Tolomeo  
Fenick  
Banasiak  
Werk  
Fenick  
Bilskis  
Cunningham

**YNHH Implementation Group**

Group Leader  
Project Manager - Dixon  
**Technical Sub-Group**  
IS&T Chief - Burns  
Centricity Team Leader - Simonette  
Programmers: Bonilla, Atamanuk  
**Clinical Sub-Group**  
Bazzy-Asaad  
Tolomeo  
Fenick  
Banasiak  
Bilskis  
Cunningham  
Residents  
CMIO - Hsiao

**Nemours Implementation Group**

Group Leader - Nathanson  
Project Manager - Dixon  
**Technical Sub-Group**  
Chief, Medical Informatics - Milov  
Epic Team Leader  
Programmer  
**Clinical Sub-Group**  
Nathanson  
Werk  
Hassink  
User(s)/Tester(s)

**Evaluation Group**

Group Leader - Horwitz  
Project Manager - Dixon  
Yale Evaluation Lead - Horwitz  
Nemours Evaluation Lead - Ramirez  
Nemours Evaluation Coordinator(s)  
Yale Research Asst -  
Evaluation Consultant - Justice

**Finance**

Eileen Soto  
John Beecher  
Nemours Finance  
Yale G&C Finance

# Yale New Haven Hospital

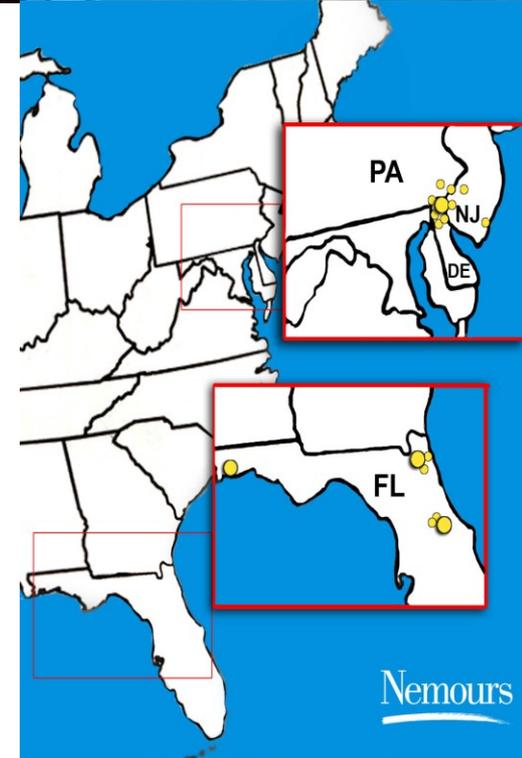


- 966 bed tertiary care hospital includes YNHCH and Primary Care Center
- Major teaching affiliate of Yale School of Medicine
- Pediatric Primary Care Center provides care for 8,000 inner-city patients in 28,000 visits annually

# Nemours



- Healthcare system dedicated to children
- >400 MDs and 4100 staff
- Multi-specialty practice sites in
- Wilmington, DE; PA, NJ;
- Orlando, Jacksonville, Pensacola
- In 2006, 924,000 encounters
  - 238,569 children received care



Nemours | Nemours  
Health Clinic

Nemours

Alfred I. duPont  
Hospital for Children

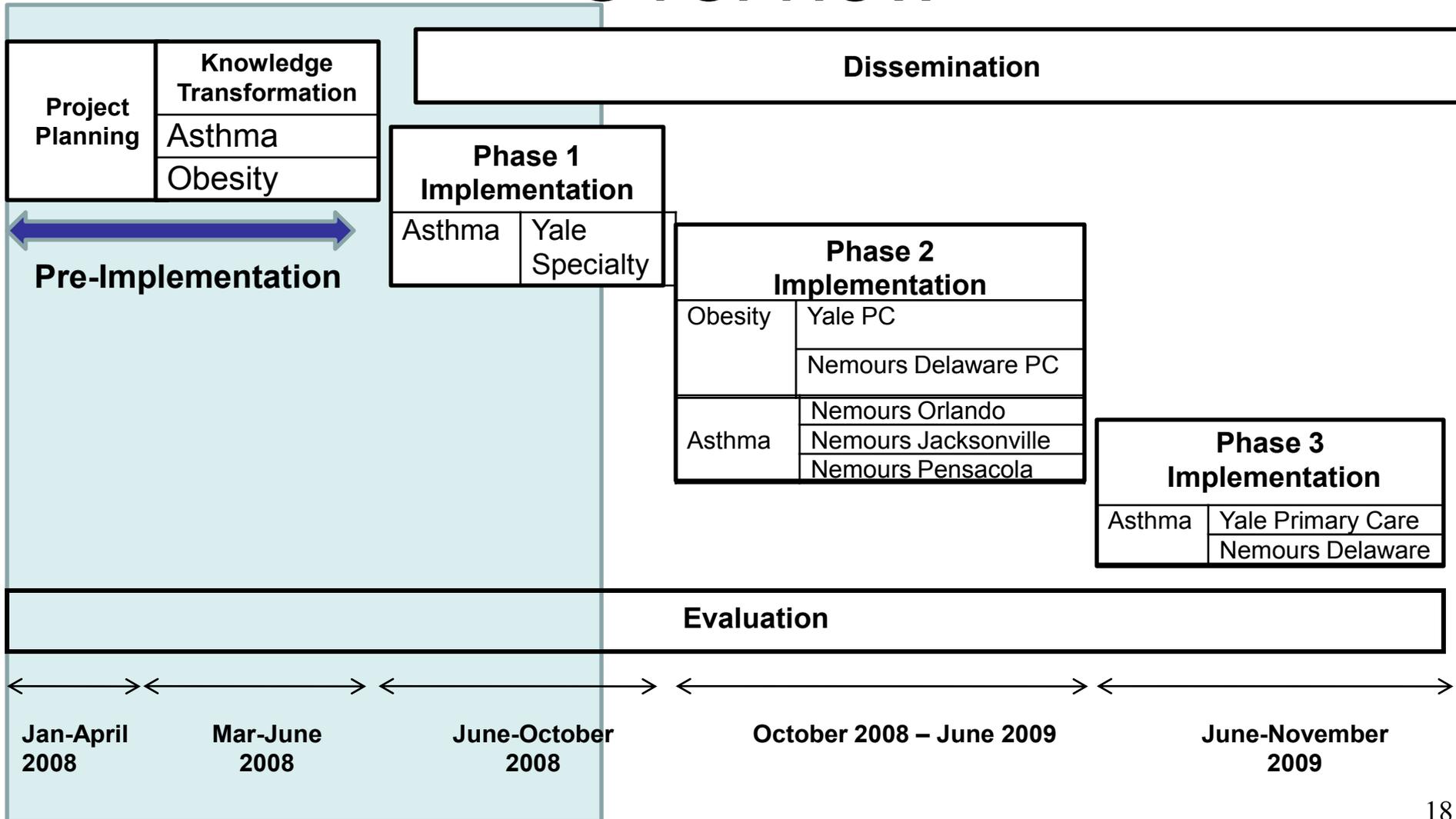
Nemours  
Children's Clinic

# Goals of the GLIDES Project

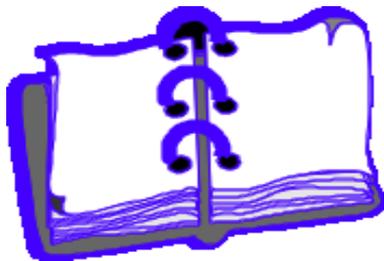
1. Implement evidence-based guideline recommendations that address prevention of pediatric obesity and chronic management of asthma.
2. Apply GEM and its associated tools to systematically and replicably transform the knowledge contained in these guidelines into a computable format.
3. Deliver the knowledge via electronic decision support at ambulatory sites that employ GE's Centricity EMR at Yale and EPIC's EpicCare at Nemours.
4. Evaluate the fulfillment of these goals and the effectiveness of the decision support tools in improving the quality of health care.



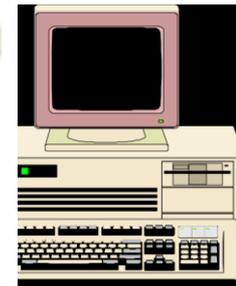
# Project Timeline Overview



# Challenge of Representing Guideline Knowledge Electronically



**Published Guide**



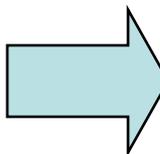
**Computer-Based  
Guideline Implementation**

# Translation of Guideline Knowledge for Decision Support

- Collaborators at Stanford, Harvard and Columbia
- Task: Knowledge engineers individually encode guidelines for vaccine administration and for workup of breast mass
- Test: Submit standardized patients
- Outcome: **Different recommendations** would be given **for the same patient**

Patel VL. JAMIA 1998

**Black Box**



**Narrative Guideline**

**Semi-structured**

**Semi-formal**

**Formal**

# Clinical Objectives

(Osheroff, Sittig, et al. 2005)

- Prevent errors
  - Commission
  - Omission
- Optimize decision making
  - Choice of individual tests or treatments
  - Improve appropriateness of workup/treatment plan
- Improve care processes
  - Improve documentation
  - Improve patient education, empowerment, satisfaction
  - Improve communication among caregivers

# Select Relevant Guideline and Recommendations

- Teleconference to define objectives
- 3 criteria
- Pertinent recommendations identified

Addressed by GL  
Facilitated by IT  
Evaluable  
**Recommend**

<b>Recognize high-risk behaviors</b>	Screen time (TV computers)	Y	Y	Y	245 1c
	Nutritional	Y	Y	Y	179, 186 6
	Lack of exercise	Y	Y	Y	179, 186 7
<b>Counseling (Energy balance: Nutrition-Activity)</b>	Limit sugar sweetened beverages	Y	Y	Y	245 1a
	Encourage fruits and vegetables	Y	Y	Y	245 1b
	Breakfast daily	Y	Y	Y	245 1d
	Limit fast food	Y	Y	Y	245 1e
	Encourage family meals	Y	Y	Y	245 1f
	Limit portion sizes	Y	Y	Y	245 1g
	5210: (fruits & vegetables, max screen time, physical activity, juice intake)	Y	Y	Y	245 1

# COGS Checklist

Ann Intern Med 2003; 139:493-8.

Topic	Description
1. Overview material	Provide a structured abstract that includes the guideline's release date, status (original, revised, updated), and print and electronic sources.
2. Focus	Describe the primary disease/condition and intervention/service/technology that the guideline addresses. Indicate any alternative preventive, diagnostic or therapeutic interventions that were considered during development.
3. Goal	Describe the goal that following the guideline is expected to achieve, including the rationale for development of a guideline on this topic.
4. Users/setting	Describe the intended users of the guideline (e.g., provider types, patients) and the settings in which the guideline is intended to be used.
5. Target population	Describe the patient population eligible for guideline recommendations and list any exclusion criteria.
6. Developer	Identify the organization(s) responsible for guideline development and the names/credentials/potential conflicts of interest of individuals involved in the guideline's development.
7. Funding source/sponsor	Identify the funding source/sponsor and describe its role in developing and/or reporting the guideline. Disclose potential conflict of interest.
8. Evidence collection	Describe the methods used to search the scientific literature, including the range of dates and databases searched, and criteria applied to filter the retrieved evidence.
9. Recommendation grading criteria	Describe the criteria used to rate the quality of evidence that supports the recommendations and the system for describing the strength of the recommendations. Recommendation strength communicates the importance of adherence to a recommendation and is based on both the quality of the evidence and the magnitude of anticipated benefits or harms.
10. Method for synthesizing evidence	Describe how evidence was used to create recommendations, e.g., evidence tables, meta-analysis, decision analysis.
11. Pre-release review	Describe how the guideline developer reviewed and/or tested the guidelines prior to release.
12. Update plan	State whether or not there is a plan to update the guideline and, if applicable, an expiration date for this version of the guideline.
13. Definitions	Define unfamiliar terms and those critical to correct application of the guideline that might be subject to misinterpretation.
14. Recommendations and rationale	State the recommended action precisely and the specific circumstances under which to perform it. Justify each recommendation by describing the linkage between the recommendation and its supporting evidence. Indicate the quality of evidence and the recommendation strength, based on the criteria described in 9.
15. Potential benefits and harms	Describe anticipated benefits and potential risks associated with implementation of guideline recommendations.
16. Patient preferences	Describe the role of patient preferences when a recommendation involves a substantial element of personal choice or values.
17. Algorithms	Provide (when appropriate) a graphical description of the stages and decisions in clinical care described by the guideline.
18. Implementation considerations	Describe anticipated barriers to application of the recommendations. Provide reference to any auxiliary documents for providers or patients that are intended to facilitate implementation. Suggest review criteria for measuring changes in care when the guideline is implemented.



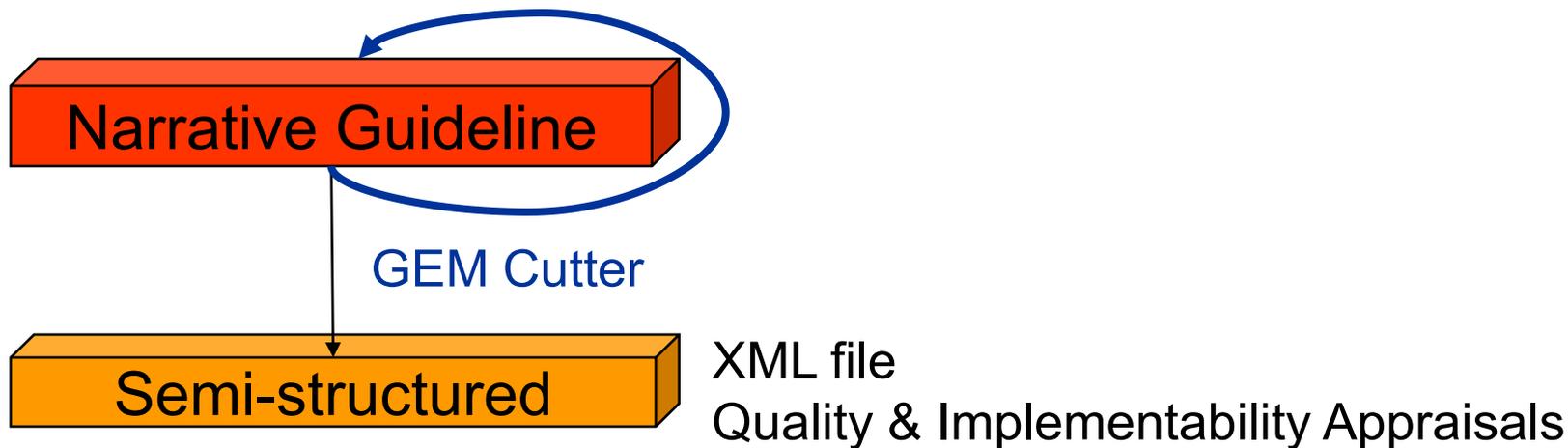
## Identify Obstacles to Implementation

- GuideLine Implementability Appraisal (& eGLIA)
- Provides feedback to guideline *authors* to anticipate and address obstacles before a draft guideline is finalized
- Assists *implementers* in guideline selection and targeting attention toward anticipated obstacles
- <http://gem.med.yale.edu/glia>

# Guideline Challenges

- EPR3 (NHLBI's Asthma 2007) is massive
  - Effort at recording evidence quality and recommendation strength is commendable
  - Redundancies, irregular editing
  - Ambiguity: “Children 0-4”
  - Some choices not mutually exclusive, not exhaustive, not well defined
  - Interference with normal activity: None, Minor limitation, Some limitation, Extremely limited
- Pediatric Obesity 2007 (from AMA, HRSA, CDC, et al)
  - Major methodological deficiencies
    - No recommendation strength

# Narrative to Semi-Structured

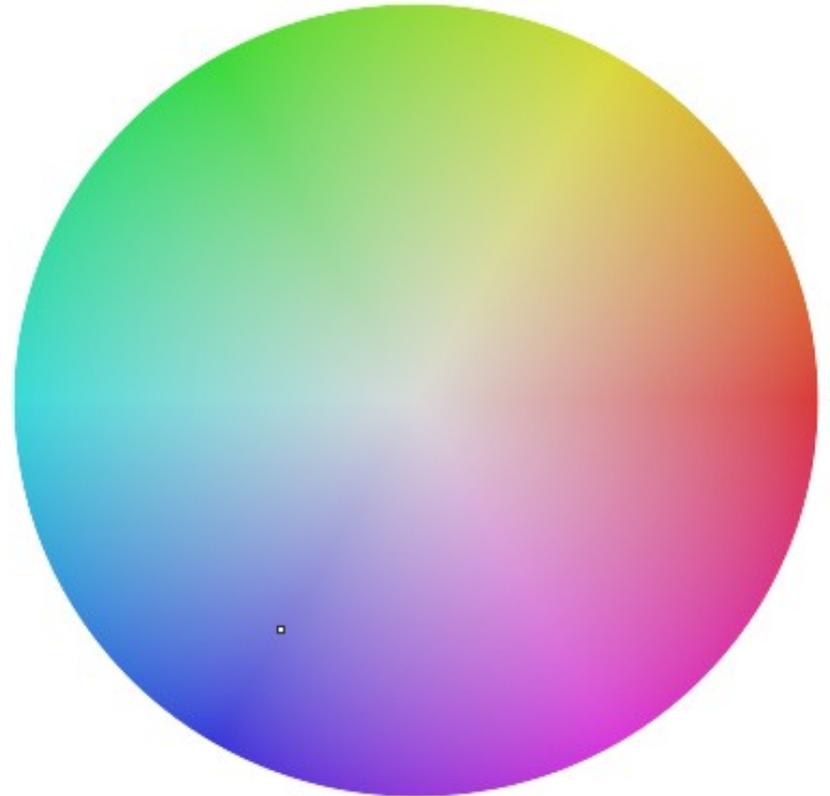


# Logical Analysis with Highlighters

- UTI Recommendation 3

If an infant or young child **2 months to 2 years of age** with **unexplained fever** is assessed as being **sufficiently ill to warrant immediate antimicrobial therapy**, a urine specimen should be obtained by SPA or bladder catheterization; the diagnosis of UTI cannot be established by a culture of urine collected in a bag. (Strength of evidence: good) Urine obtained by SPA or urethral catheterization is unlikely to be contaminated...

# XML: From a small number of discrete colors to an unlimited palette



# XML

- Multi-platform, Web-based, open standard
- “Tags” **enclose** and **describe** text

`<inclusion.criterion>hematuria</inclusion.criterion>`

- Human-readable, yet can be processed by machine
- Markup can be performed by non-programmers



QuickTime™ and a  
TIFF (LZW) decompressor  
are needed to see this picture.

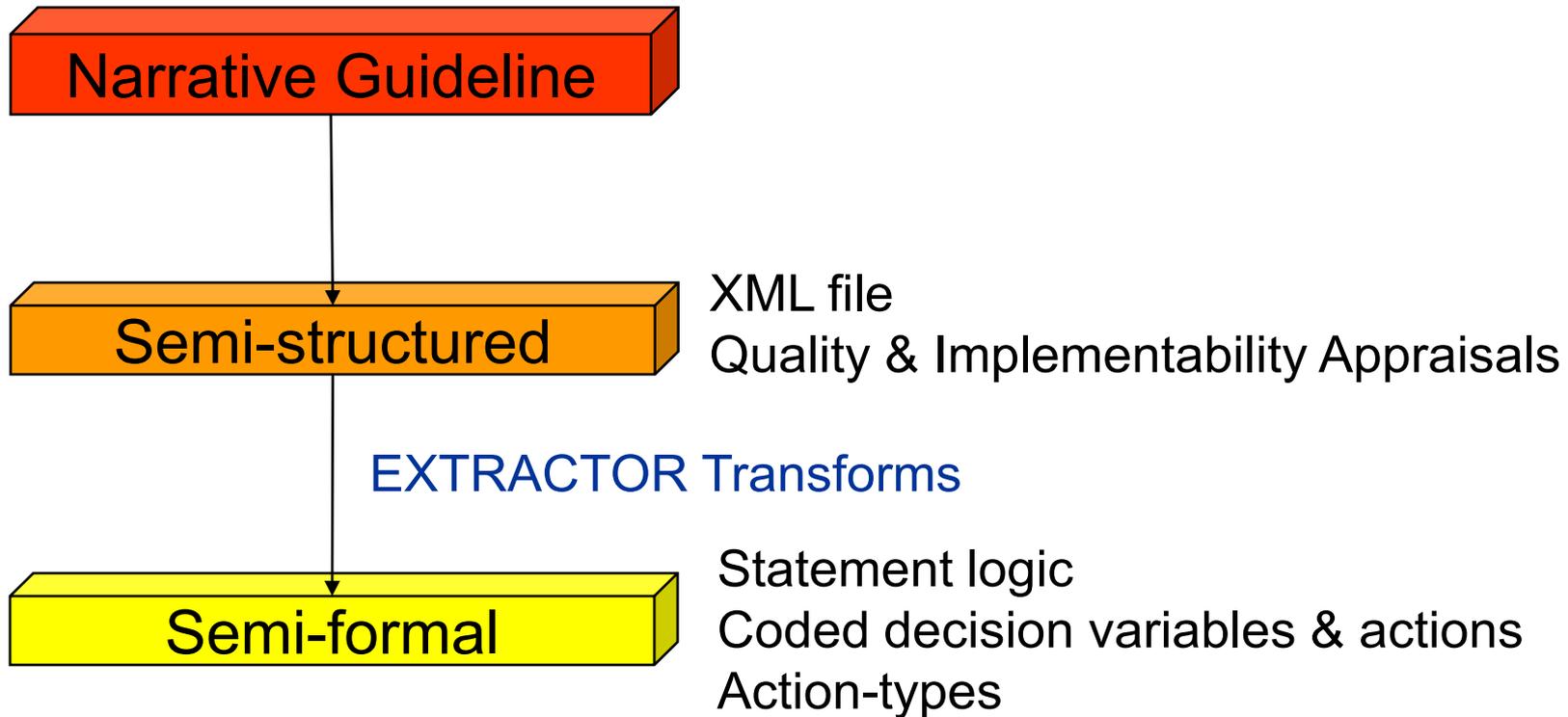
# GEM

- Knowledge model for guideline documents
- GEM adopted as a standard by ASTM in 2002; GEM II updated and re-standardized in 2006
- Models heterogeneous information contained in guidelines
  - Multi-level hierarchy (>100 elements)

# Markup Guideline

- GEM Cutter II
  - Parses guideline text into components of the Guideline Elements Model
  - “GEMifying”
  - Creates XML files
  - Available at <http://GEM.med.yale.edu>

# Semi-Structured to Semi-Formal



# EXTRACTOR: Decision Variables

- Removed from guideline context and presented in a list.
- Opportunity to judge vagueness, underspecification, and decidability
- Comprehensive list of *trigger items* for decision support activities
- Measurable starting points for evaluation

# Decision Variables

0–4 Years of Age

Rec\_1: Cond\_1: DV\_1

four or more episodes of wheezing in the past year that lasted more than 1 day and affected sleep

Rec\_1: Cond\_1: DV\_2

parental history of asthma

Rec\_1: Cond\_1: DV\_3

a physician diagnosis of atopic dermatitis

Rec\_1: Cond\_1: DV\_4

evidence of sensitization to aeroallergen

Rec\_1: Cond\_1: DV\_5

evidence of sensitization to foods

Rec\_1: Cond\_1: DV\_6

# Categorize Action-types

- Test (Inquire, Examine)
- Monitor
- Conclude
- Prescribe
- Perform Procedure
- Refer/consult
- Educate/counsel
- Document
- Dispose
- Prepare
- Advocate

# Action-Type Pattern: Prescribe

- Drug information
- Safety alerts (allergy, drug-drug, drug-disease, drug-lab)
- Formulary check
- Dosage calculation
- Pharmacy transmission
- Patient education
- Corollary orders

Narrative Guideline

Semi-structured

Semi-formal

Formal

Statement logic

Coded decision variables & actions

Action-types

*Local workflow & barrier analysis  
(technical, people, organizational)*

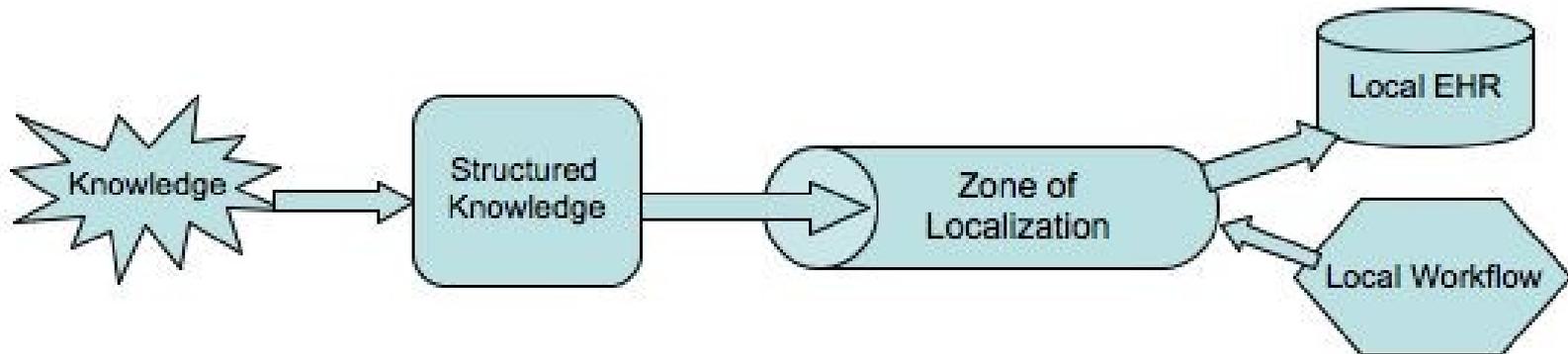
*Local codes*

*Origins/insertions*

Local EHR scripting language

User interface design

# Knowledge Pipeline



# How Decision Support May Be Delivered

Static



- Documentation templates (prompts)
- Relevant data presentation (display of relevant lab when ordering)
- Order creation facilitators (order sets, guided dosing algorithms, calculators)
- Reference information (infobutton)
- Reminder (appropriate care)
- Alerts (drug allergy, interaction, critical test notification)

Dynamic



CLASSIFYING COMPONENTS OF ASTHMA SEVERITY AND INITIATING TREATMENT

	----- Intermittent ----->		<----- Persistent ----->			
		Mild	Moderate	Severe		
<b>Impairment</b>	Cough	<input type="checkbox"/> None	<input type="checkbox"/> <=2days/wk	<input type="checkbox"/> >2days/wk	<input type="checkbox"/> Daily	<input type="checkbox"/> All Day
	Wheezing	<input type="checkbox"/> None	<input type="checkbox"/> <=2days/wk	<input type="checkbox"/> >2days/wk	<input type="checkbox"/> Daily	<input type="checkbox"/> All Day
	Chest tightness	<input type="checkbox"/> None	<input type="checkbox"/> <=2days/wk	<input type="checkbox"/> >2days/wk	<input type="checkbox"/> Daily	<input type="checkbox"/> All Day
	Shortness of breath	<input type="checkbox"/> None	<input type="checkbox"/> <=2days/wk	<input type="checkbox"/> >2days/wk	<input type="checkbox"/> Daily	<input type="checkbox"/> All Day
	Nighttime awakening	<input type="checkbox"/> None	<input type="checkbox"/> <=1 month	<input type="checkbox"/> 1-2x/month	<input type="checkbox"/> 3-4x/month	<input type="checkbox"/> >1x/week
	SABA use (not for EIB)	<input type="checkbox"/> None	<input type="checkbox"/> <=2days/wk	<input type="checkbox"/> >2days/wk but not daily	<input type="checkbox"/> Daily	<input type="checkbox"/> Several times per day
	Reduction in school/ play/work activities	<input type="checkbox"/> None		<input type="checkbox"/> Mild	<input type="checkbox"/> Moderate	<input type="checkbox"/> Severe
<b>Risk</b>	Urgent/ ER visit(s) due to asthma	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> >=4
	Hospitalizations due to asthma	<input type="checkbox"/> 0	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> >=4
	Exacerbations requiring oral systemic corticosteroids	<input type="checkbox"/> <=1 year	<input type="checkbox"/> >=2 exacerbations in 6 months requiring oral systemic corticosteroids, or >=4 wheezing episodes/1 year lasting >1 day AND risk factors for persistent asthma			
<b>DOCUMENTATION</b>	Treatment-related adverse effects	<b>Medication Adverse Effect</b> <input type="checkbox"/> Thrush <input type="checkbox"/> Palpitations <input type="checkbox"/> Jitteriness <input type="checkbox"/> Sleep Disturbances <input type="checkbox"/> Decreased Growth <input type="checkbox"/> Other			<b>Comments</b> <div style="border: 1px solid gray; height: 100px;"></div>	

Documentation Templates

Prev Form (Ctrl+PgUp)

Next Form (Ctrl+PgDn)

Close

Asthma Severity

Steps

Recommended Step for Initiating Therapy

<b>Intermittent Asthma</b>	<b>Persistent Asthma: Daily Medication</b> Consult with asthma specialist if step 4 care or higher is required. Consider consultation at step 3.				
<b>Step 1</b>  Preferred: SABA PRN	<b>Step 2</b>  Preferred: Low-dose ICS  Alternative: Cromolyn, LTRA, or Nedocrilil or Formoterol + Theophylline	<b>Step 3</b>  Preferred: Low-dose ICS+ either LABA, LTRA, or Theophylline  OR Medium-dose ICS	<b>Step 4</b>  Preferred: Medium-dose ICS + LABA  Alternative: Medium-dose ICS+ either LTRA or Theophylline	<b>Step 5</b>  Preferred: High-dose ICS + LABA  Alternative: High-dose ICS+ either LTRA or Theophylline	<b>Step 6</b>  Preferred: High-dose ICS + LABA + oral systemic corticosteroid  Alternative: High-dose ICS+ either LTRA or Theophylline+ oral corticosteroid

ORDER MEDS

Relevant Data Presentation

<<==== Step down if possible  
( and asthma is well controlled  
at least 3 months )

Assess  
control

====>> Step up if needed  
(check adherence, inhaler  
technique, and environmental control)

- adherence
- inhaler technique
- environmental control
- comorbid conditions

Step up if needed click here >>>>>

**Patient Education, Environmental Control, and Management of comorbidities at Each Step**  
Quick-Relief Medication for All Patients

^ SABA as needed for symptoms. Intensity of treatment depends on severity of symptoms: up to 3 treatments at 20-minute interval as needed. Short course of oral systemic corticosteroids may be needed.  
^ Caution: Increasing use of SABA or use >2 days a week for symptom relief (not prevention of EIB) generally indicates inadequate control and the need to step up treatment.

**Problems**

ABNORM, CERVIX PREG, OTH,  
DELIVERED (ICD-654.61)  
ADD (ICD-314.00)  
WARTS, VIRAL (ICD-078.1)  
ASTHMA, MODERATE PERSISTENT  
(ICD-493.00)

Update Problems

**Medications**

Update Meds

**Allergies**

Update Allergies

**SYSTEM ASSESSMENT**

**Severity Classification:** Moderate Persistent  
**Impairment:** Mild  
**Risk:** Moderate

Add Dx of Mod Persistent to Prob List

**Alert**

**Documentation Template**

Adherence:  good  fair  poor  
Inhaler technique:  correct  incorrect  
Envir. control:  adequate  inadequate  
Provider Classification:  Intermittent  Mild Persistent  Moderate Persistent  Severe Persistent  
Current level of control is:  Well Controlled  Not Well Controlled  Very Poorly Controlled

**Active Problems List:**

- ABNORM CERVIX PREG
- OTH
- DELIVERED (ICD-654.61)
- ADD (ICD-314.00)
- WARTS VIRAL (ICD-078.1)

Copy Selected Problems to Comments

**Additional Diagnosis**

OTH, DELIVERED (ICD-654.61)

**Assessment**

ASTHMA, MODERATE PERSISTENT (ICD-493.00)

Prev Form (Ctrl+PgUp)

Next Form (Ctrl+PgDn)

Close

ASTHMA MEDICATION: DIORDERS ACTEST

Problems	Medications	Allergies
ABNORM, CERVIX PREG, OTH, DELIVERED (ICD-654.61) ADD (ICD-314.00) WARTS, VIRAL (ICD-078.1) ASTHMA, MODERATE		
<a href="#">Update Problems</a>	<a href="#">Update Meds</a>	<a href="#">Update Allergies</a>

Selected Treatment Step : 6

### Quick-Relief

Short acting B-2 agonist  [ORDER](#)

### Long Term Control

**Preferred** Patient's Weight in (kg)   
High-dose inhaled steroid  [ORDER](#)  
**+ either**  
LABA  [ORDER](#)

OR

Montelukast  [ORDER](#)

**And, if needed, Oral Corticosteroids:** *tabs or syrup long term (2mg/kg/day, don't exceed 60 mg/day).  
Attempt to reduce systemic corticosteroids and maintain control with high does inhaled corticosteroids.)*

SPECIFY:  **Dose:**  **Instructions:**   
**Duration:**  **Unit:**  **Qty:**  **Refills:**  [ORDER](#)

- 1 mg tab
- 2.5 mg tab
- 5 mg tab
- 10 mg tab
- 20 mg tab

Consider O  patients who have allergies

[Back to Steps](#)

[Prev Form \(Ctrl+PgUp\)](#)

[Next Form \(Ctrl+PgDn\)](#)

[Close](#)

Order Facilitator

# Thank you!

[GEM.med.yale.edu/glides](http://GEM.med.yale.edu/glides)

[richard.shiffman@yale.edu](mailto:richard.shiffman@yale.edu)



# AHRQ Clinical Decision Support Consortium

**Blackford Middleton, MD, MPH, MSc  
Partners Healthcare System**



# CDS Demonstration Project

## *Objective*

To develop, implement, and evaluate projects that advance the understanding of how best to incorporate CDS into health care delivery.

## *Overall goal*

Explore how the translation of clinical knowledge into CDS can be made routine in practice and taken to scale in order to improve the quality of healthcare delivery in the U.S.

## *Funding*

\$1.25 million per project per year for two years.



# CDS Consortium: Member Institutions

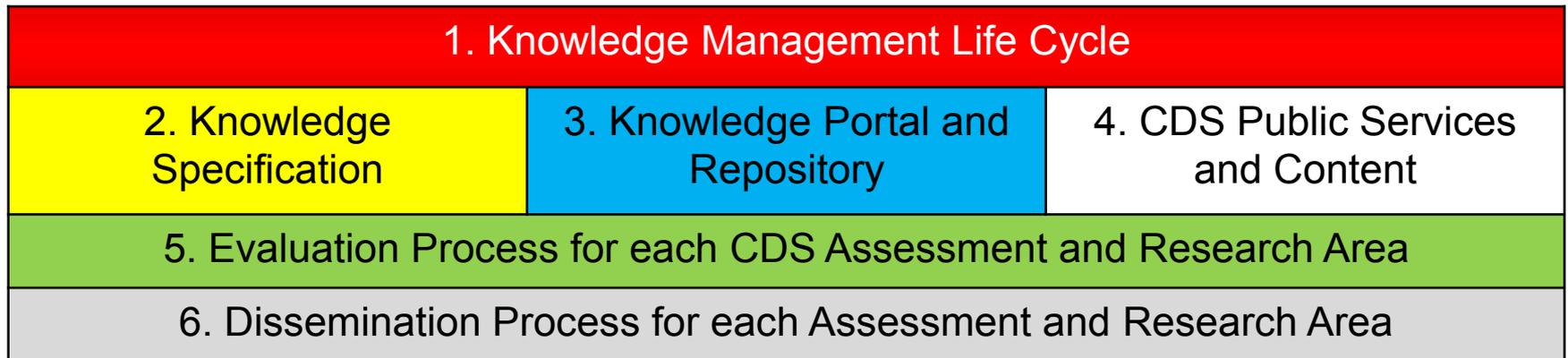
- Partners HealthCare
- Regenstrief Institute
- Veterans Health Administration
- Kaiser Permanente Center for Health Research
- Siemens Medical Solutions/NextGen
- GE Healthcare
- Masspro
- Oregon Health and Science University
- University of Texas, Houston

# The CDS Consortium Primary Goal

To **assess, define, demonstrate, and evaluate** best practices for knowledge management and clinical decision support in healthcare information technology at scale – across multiple ambulatory care settings and EHR technology platforms.

# Six Specific Research Objectives

- Knowledge management lifecycle
- Knowledge specification
- Knowledge Portal and Repository
- CDS Knowledge Content and Public Web Services
- Evaluation
- Dissemination



# Office of the National Coordinator of Health IT: 2008 Strategic Plan

- ONC's strategic plan Strategy 1.3.3 is:
  - *“Incorporate EHR functionalities into health IT certification that provide clinical decision support at the point of care.”*
- Milestone 1.3.3 is:
  - *“By 2010, certified EHRs include clinical decision support.”*

**We are on the right path!**

# Clinical Focus Areas

- **Diabetes:** Glycemic control including medication management and HbA1c testing and screening for complications.
- **Coronary Artery Disease:** Anti-platelet therapy in high-risk populations.
- **Preventive Care:** Hypertension screening.

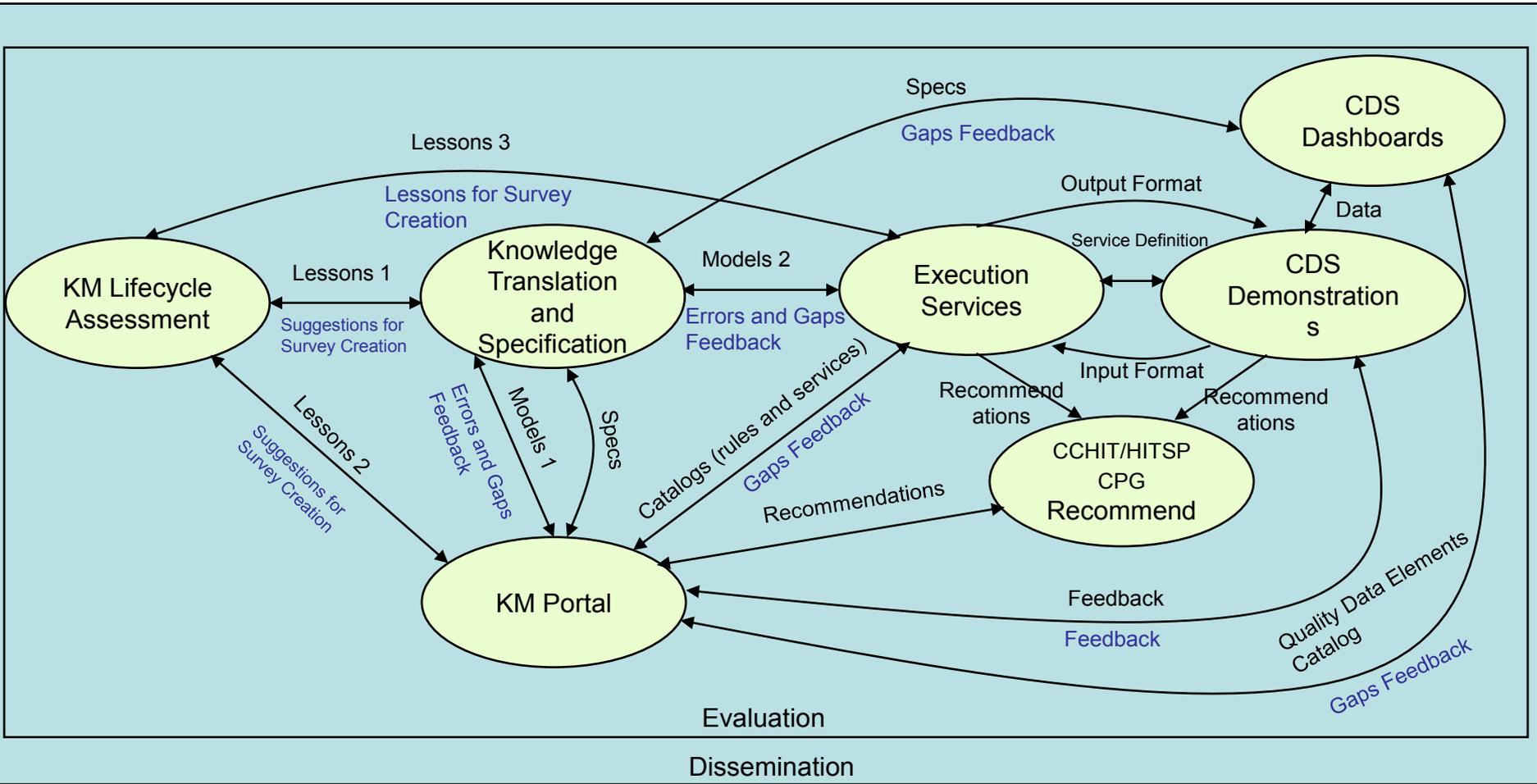
# Consortium Teams

1. **Knowledge Management Lifecycle Assessment Team:** This team will conduct surveys and site visits at the CDSC member institutions to assess their clinical decision support activities and practices both before and after the CDSC activities.
2. **Knowledge Translation and Specification Team (KTS):** This team is charged with selecting guidelines to use in consortium activities and translating these guidelines into the multi-layered knowledge representation format for use in the service and demonstration projects.
3. **Knowledge Management Portal and Repository Team:** This team will develop and implement collaborative knowledge management tools for use in the development, review, publication, cataloging and archival of knowledge specifications in human and machine readable forms.
4. **Vendor Generalization and CCHIT Recommendations Team:** This team will assess state-of-the-art methods for clinical decision system support and the results from CDSC best practices development, and make a series of recommendations to vendors, content vendors, and regulatory and certification authorities, about best practices and capabilities for decision support.

# Consortium Teams, Cont.

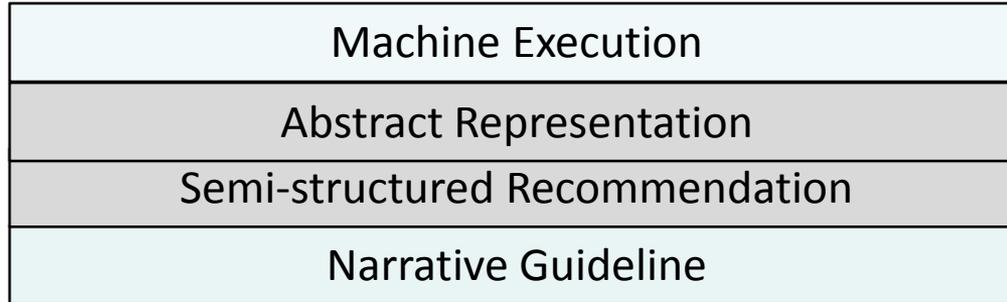
5. **CDS Services Team:** This team will take the decision support knowledge representation and knowledge prepared by the KTS team and develop publicly available web services that implement the content for use in information systems among the CDS Consortium.
6. **CDS Demonstrations Team:** This team, in conjunction with site demonstration teams, will perform analysis, development and implementation of decision support interventions using the content and services developed in the CDS Consortium.
7. **CDS Dashboards Team:** This team will develop performance reporting tools and clinical decision support dashboards so that providers and site clinical quality staff can review adherence to Consortium guidelines.
8. **CDS Evaluation Team:** This team will lead and coordinate evaluation activities across all projects performed by the CDS Consortium.
9. **Dissemination Team:** This team will coordinate sharing and publication of the clinical decision support content and best practices developed by the Consortium.
10. **Joint Information Modeling Team:** This team is a joint subcommittee of the KTS and CDS Services team and coordinates information models and terminology across all Consortium projects.

# Workflow Diagram



# Multilayered model

Precision and executability



Flexibility and adaptability

## Narrative Recommendation layer

## Semi-Structured Recommendation layer

## Abstract Representation layer

## Machine Executable layer

- Knowledge encoded in a format that can be rapidly integrated into a CDS tool on a specific HIT platform

E.g., rule could be encoded in Arden Syntax

A recommendation could have several different artifacts created in this layer, one for each of the different HIT platforms

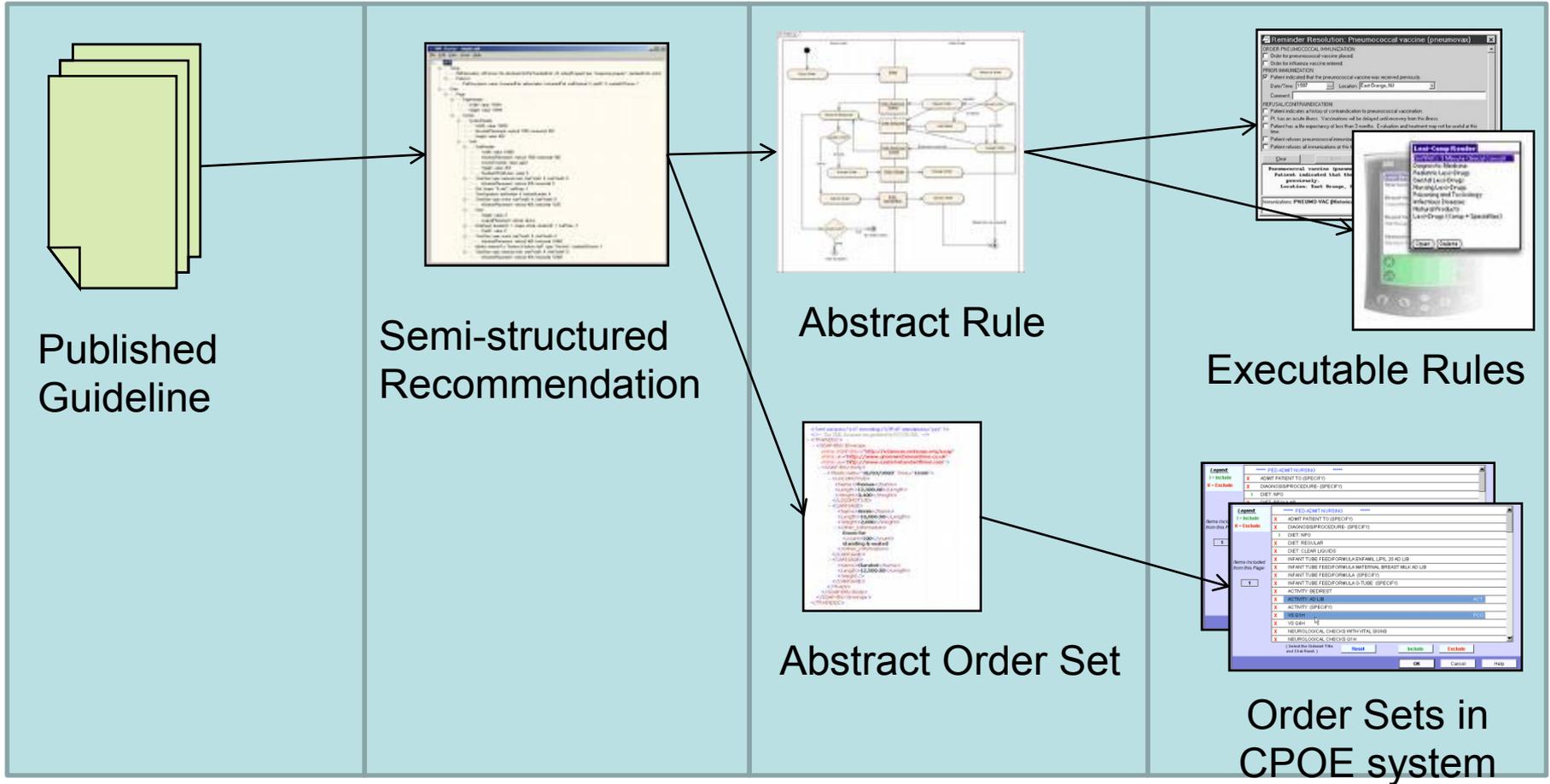
# Knowledge Pack

- For each knowledge representation layer in CDS stack:
  - **Data standard** (controlled medical terminology, concept definitions, allowable values)
  - **Logic specification** (statement of rule logic)
  - **Functional requirement** (specification of IT feature requirements for expression of rule, etc.)
  - **Measure specification** (description of method for CDS impact measurement and report)

# Why Multilayered Representation?

- Allows us to balance between the competing requirements for flexibility in representation for various environments and the ability to deliver precise, executable knowledge that can be rapidly implemented
  - For those who can use an available **Machine Executable level** knowledge artifact, this approach provides for **rapid implementation of the guideline**
  - For others, it might be more appropriate to use an artifact from the **Semi-structured Recommendation or Abstract** layers, to **create rapidly their own executable knowledge**. They can then submit the latter to the KM portal for inclusion as a Machine Executable artifact
- Provides a path to achieve logical consistency from the narrative guideline to the execution layer

# Knowledge Artifacts by Layer



# Complete CDS Knowledge Specification

	Data	Logic	Function	Measure
Narrative				
Semi-structured	<i>A complete functional specification to accommodate and facilitate a variety of implementation methods in HIT.</i>			
Abstract				
Machine interpretable				

# Complete CDS Knowledge Specification

	Data	Logic	Function	Measure		
general	Narrative	<b>If the patient's creatinine</b>	<b>is elevated then avoid metformin.</b>	Ability to show an alert (on screen or paper)	% of metformin pts w/ high Cr.	knowledge
	Semi-structured	Lab value: creatinine	Clinical scenario: Elevated Cr... Action: avoid metformin	Lab results, medication list (database)	Num: all metformin pts Denom: high Cr & metformin	
	Abstract	LOINC 2159-2	if cr > 1.2 mg/dL → Tell user "d/c metformin"	CIS with rule evaluation capability, alerting function	NumSet = {med=metformin} DenomSet = {cr > 1.2}	
specific	Machine interpretable	select * from labs where ID = 2159-2	If(cr>1.2) → print("d/c metformin");	CPOE with lab, meds and alerting capability.	select count(*) where ...	action

# Content Comparison Across CDSC Organizations



Knowledge Management Portal

Keyword search

Site Search:

Home Browse by Topic **Filter-based Search**

## Search Criteria

### Clinical Disciplines

- All Clinical Disciplines
- Anesthesiology/Perioperative Medicine
- Behavioral Medicine
- Burn Management
- Cardiology (Interventional)
- Cardiology (Medical)
- Cardiology (Surgical)
- Emergency Medicine
- Endocrinology
- Gastroenterology
- General Medicine
- General Surgery
- GI Colorectal Surgery
- Hematology and Oncology
- Infectious Disease
- Nephrology
- Neurology
- Neurosurgery
- Newborn/Neonatology
- Obstetrics and Gynecology
- Orthopedic

### Filters

- Entity :**
- All Entities
  - BWH
  - DFCI
- Venue :**
- Acute Care
  - All Venues
  - Ambulatory Care
- Patient Age Group :**
- Adult
  - All Patient Age Groups
  - Geriatric
- Application :**
- All Applications
  - BICS Event Monitor
  - BICS Order Entry

CTRL - click to select multiple choices from the filters

- Content Type :**
- All Content Types
  - Drug Information
  - Expert Dosing
- Patient Safety :**
- Alerts and Notification
  - All Patient Safety
  - Consequent Order/Lab Display
- Disease Management :**
- All Disease Management
  - Coronary Artery Disease
  - Diabetes

## Results

Document Title	Content Type	Entity	Selected Search Filters:
<a href="#">Aortic Surgery Post Op Pathway - BWH</a> <a href="#">View Details</a>	Order Sets and Templates	BWH	<b>Clinical Disciplines</b> • Cardiology (Surgical)
<a href="#">Atrial Fibrillation Protocol - MGH</a> <a href="#">View Details</a>	Order Sets and Templates	MGH	<b>Entity</b> • BWH • MGH
<a href="#">Cardiac SICU Additional Post Op Orders Transplant Patients - MGH</a> <a href="#">View Details</a>	Order Sets and Templates	MGH	<b>Venue</b> • All Venues
<a href="#">Cardiac Surgery Admission Pre-Op - BWH</a> <a href="#">View Details</a>	Order Sets and Templates	BWH	<b>Patient Age Group</b> • All Patient Age Groups
<a href="#">Cardiac Surgery Admission Pre-Op - MGH</a> <a href="#">View Details</a>	Order Sets and Templates	MGH	<b>Application</b> • All Applications
<a href="#">Cardiac Surgery Ellison 8 Front Door Same Day Admit - MGH</a>	Order Sets and Templates	MGH	<b>Content Type</b>



# Partners CDS Services: CAD/DM Smart Form

Smart View:  
Data Display

Smart  
Documentation

Smart  
Assessment,  
Orders, and Plan

Assessment and  
recommendations generated  
from rules engine

- Lipids
- Anti-platelet therapy
- Blood pressure
- Glucose control
- Microalbuminuria
- Immunizations
- Smoking
- Weight
- Eye and foot examinations

## Assessment

No recent LDL measurement

Patient is on anti-platelet therapy

Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)

Patient is due for Pneumovax (older than 65, no record of prior vaccination)

Patient is due for Influenza Vaccine (high risk medical condition)

Patient may be Current Smoker, not thinking of quitting. Last counseled on 10/10/06.

Patient is overweight or obese (BMI 27.1 on 10/31/06, goal < 25)

# CAD/DM Smart Form

Lmrsfest,Cadfive  
 20567889 (BWH) | 01/01/1931 (75 yrs.) M

Select Desktop Pt Chart: Smart Form Oncology Custom Reports Admin Sign Results ? Resource

### Vital Signs

	10/31/06	10/10/06	03/06/06
T (<98.6)		98.5F	
BP (<130/80)	150/75!	110/85!	110/75
HR (50-100)	70	85	
RR	14		
O2 Sat			
W	200lb		165lb
H	72in		
BMI (<25)	27.1!		22.4

### Rules

If patient has DM then goal BP < 130/80  
 If the average of the blood pressure at the last 2 visits (in the last year) is above goal then return..

### Orders, A/P

Execute

#### Assessment

- No recent LDL measurement
- Patient is on anti-platelet therapy
- Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)
- Patient is due for Pneumovax (older than 65, no record of prior vaccination)
- Patient is due for Influenza Vaccine (high risk medical condition)
- Patient may be Current Smoker, not thinking of quitting. Last counsel date is 10/10/06.
- Patient is overweight or obese (BMI 27.1 on 10/31/06, goal < 25)

- Lipid Management
- Antiplatelet Therapy
- Blood Pressure Management
- Immunizations
- Smoking
- Weight/BMI
- Follow-ups

### Procedures

None listed

Save & Exit | Save as Final & Exit | Exit

# CAD/DM Smart Form

Lmrsfest, Cadfive

20567889 (BWH) 01/01/1931 (75 yrs.) M

Log RCT Select Desktop Pt Chart: Smart Form Oncology Custom Reports

SmartView Note Graphs

Filter by  
 CAD  DM  Smoking  
 Detected: CAD,DM,Smoking

Vital Signs

	10/31/06	10/10/06	03/06/06
T (<=98.6)	98.5F		
BP (<=130/80)	150/75!	110/85!	110/75
HR (50-100)	70	85	
RR	14		
O2 Sat			
Wt	200lb	165lb	
H	72in		
BMI (<=25)	27.1!	22.4	

Lab Tests Last Known

- K
- Creatinine
- BUN
- Glucose
- HbA1c (4.4-6.4)

Medication Orders

History of Present Illness  
 75 yo man with CAD, DM, and elevated CK. He is not having any of his medications. I last saw him 3 months ago.

Review of Systems  
 ROS: No F, C, N, V, SOB, cough, CP, palpitations, abd pain, bowel changes, vision changes, hearing changes, MS pain

Lab Orders

CAD-related  
 - Diabetes mellitus type 1  
 - Coronary artery disease

DM-related  
 - Diabetes mellitus type 1

Referrals

Procedures  
 - Onychomycosis  
 - Elevated creatine phosphokinase

Handouts/Education

Save & Exit Save as Final & Exit

### Blood Pressure Management

Blood Pressure is above goal (avg. over last 2 visits 130/80, goal < 130/80)

[Start an Other Anti-Hypertensives \(Help Me Choose\)](#)

- [Adjust Oretic 25 MG \(25MG TABLET take 1\) PO QD](#)
- [Adjust Lisinopril 20 MG \(20MG TABLET take 1\) PO QD](#)
- [Adjust Acebutolol HCL 200 MG \(200MG CAPSULE take 1\) PO QD](#)

Order Chem 7 now

Order Chem 7 in

Referral to Nutritionist

Referral to Cardiac Rehab ([Help Me Choose](#))

Referral to Blood Pressure Specialist ([Help Me Choose](#))

[Print "Control High Blood Pressure"](#)

[Print DASH diet instructions](#)

[Print exercise "prescription"](#)

# Accomplishments to Date

<p><b>KM Lifecycle Assessment Team</b></p>	<ul style="list-style-type: none"> <li>• Completed Knowledge Management and CDS Survey and sent it out to the Consortium sites. PHS and Regenstrief have returned the survey</li> <li>• PHS Site Visit, June 16-20. Interviewed and shadowed Partners physicians about their knowledge management and CDS practices</li> <li>• Site visits to Regenstrief and VA scheduled and shepherds identified</li> </ul>
<p><b>Knowledge Translation and Specification Team</b></p>	<ul style="list-style-type: none"> <li>• Completed semi structured representation and presented work to AHRQ and TEP on July 11, 2008.</li> <li>• Draft clinical action model developed.</li> </ul>
<p><b>KM Portal</b></p>	<ul style="list-style-type: none"> <li>• Delivered eRoom as a collaborative environment for CDSC activities and finalized KM Portal design hardware</li> </ul>
<p><b>Vendor Generalization and CCHIT Team</b></p>	<ul style="list-style-type: none"> <li>• Completed capability reviews of nine EHR systems through customer interviews to assess their decision support features.</li> </ul>
<p><b>CDS Services Development</b></p>	<ul style="list-style-type: none"> <li>• Completed literature review on current service-oriented architectures for clinical decision support.</li> <li>• Beginning service development.</li> </ul>
<p><b>Joint Information Modeling Working Group</b></p>	<ul style="list-style-type: none"> <li>• Patient data model and terminologies selected.</li> <li>• Developing conceptual model.</li> </ul>

# Timeline Overview

Year I		Year II
Knowledge Management Lifecycle Assessment		
Knowledge Translation and Specification		
Knowledge Portal & Repository		
	CDS Web Services Development	
	Vendor Recommendation/CCHIT	
		Demo Phase 1: LMR
Evaluation		
Dissemination		

# Questions & Answers

## Our Panel

Jon White, MD  
Agency for Healthcare Research and Quality

Richard Shiffman, MD, MCIS  
Yale University School of Medicine

Blackford Middleton, MD, MPH, MSc  
Partners Healthcare System

# Save the Date!

## Our Next Event

### **A National Web Conference on Use of Clinical Decision Support and Impact on Workflow**

Second teleconference in our four-part series on Clinical Decision Support

October 27, 2008,  
from 2:30 pm – 4:00 PM Eastern Time

Watch your inbox for information on how to register

# Thank You for Attending

This event was brought to you by the  
AHRQ National Resource Center for Health IT

*The AHRQ National Resource Center for Health IT promotes best practices in the adoption and implementation of health IT through a robust online knowledge library, Web conferences, toolkits, as well as AHRQ-funded research outcomes.*

A recording of this Web conference will be available on the AHRQ National Resource Center Web site in approximately one week.

<http://healthit.ahrq.gov>