"A collaborative project to
develop a universal framework for
encoding and disseminating electronic clinical guidelines"

The SAGE Project

Standards-Based Sharable Active Guideline Environment

"A collaborative project to develop a universal framework for sharing health knowledge in the form of computable clinical practice guidelines"

AMIA 2003 Symposium: Partnerships in Innovation

Session S88

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Agenda for Today's Talk

I. SAGE: A Partnership in Innovation

A round-table overview of the vision, objectives, and collaborative approach of the SAGE Project

II. Illustration of SAGE Technology

A walk-through illustration of working SAGE prototypes – from guideline encoding to execution of guideline content via functions of a clinical information system.

III. SAGE: Where are we going from here?

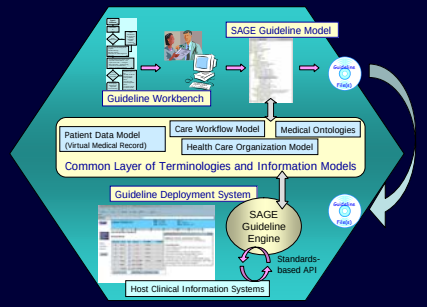
An overview of project futures and implications for delivery of health care

Agenda for Today's Talk

I. SAGE: A Partnership in Innovation

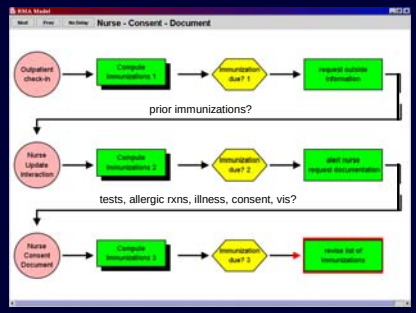
A multi-faceted overview of the vision, objectives, and collaborative approach of the SAGE project

Overview of the SAGE Infrastructure



II. Illustration of SAGE Technology

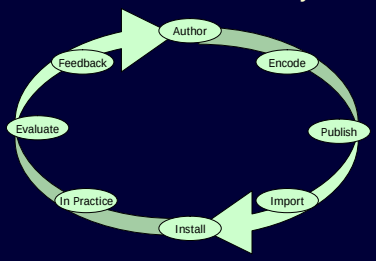
A walk-through illustration of working SAGE prototypes – from guideline encoding to execution of guideline content via functions of a clinical information system



III. SAGE: Looking Forward

An overview of project futures and implications for delivery of health care

The SAGE Guideline Lifecycle



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I. Partnership in Innovation

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I. SAGE: A Partnership in Innovation

- Guy Mansfield, PhD (IDX)
  - SAGE vision, project objectives, collaborative approach
- Sidna Scheitel, MD (Mayo Clinic, Rochester)
  - Use case requirements, usability analysis
- Samson Tu, MS (Stanford Medical Informatics)
  - Guideline modeling, guideline representation
- Jim McClay, MD (University of Nebraska Medical Center)
  - UNMC, interoperability, guideline context modeling
- Roberto Rocha, MD, PhD (Intermountain Health Care)
  - Standard information models, alignment with standards
- Tony Wieda, PhD (Apelon, Inc.)
  - Integration of controlled medical terminologies

The SAGE Project

Standards-Based Sharable Active Guideline Environment

Guy Mansfield, PhD

Director, Health Informatics

IDX Systems, Seattle

Guy_Mansfield@idx.com

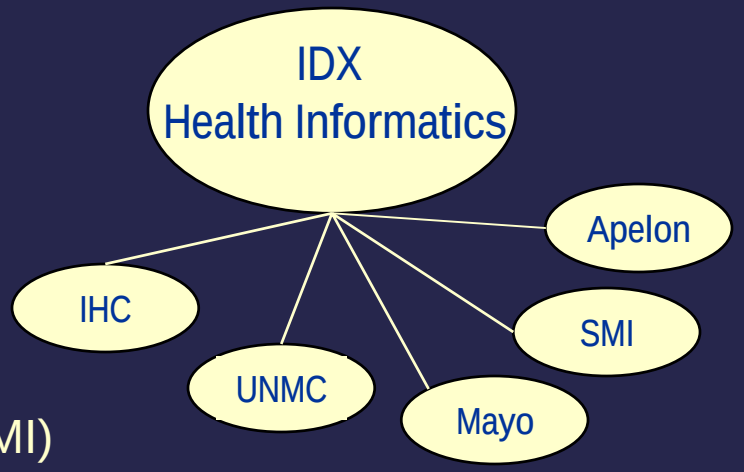
- SAGE Project Vision
- Key Objectives
- Collaborative Approach

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Project Overview

Standards-based **S**harable **A**ctive **G**uideline **E**nvironment

- An R&D consortium to develop the technology infrastructure to enable computable clinical guidelines, that will be shareable and interoperable across multiple clinical information system platforms
- Scope: 3 year, $18 M, multi-site, collaborative project
- Partners in the project are:
  - IDX Systems Inc.
  - Apelon, Inc.
  - Intermountain Healthcare (IHC)
  - Mayo Clinic
  - Stanford Medical Informatics (SMI)
  - University of Nebraska Medical Center (UNMC)



- Funded in part by: NIST Advanced Technology Program

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Guidelines Maximize Cancer Pain Control

Thu 16 October, 2003 19:16 BST

By Karla Gale

NEW YORK (Reuters Health) - Measures to reduce severe pain experienced by some cancer patients are most effective when doctors follow science-based guidelines rather than more traditional approaches, researchers report.

Dr. David B. Matchar and others at Duke University Medical Center in Durham, North Carolina, analyzed three pain-management strategies and their costs. The three approaches were guideline-based care, oncology-based care, and "usual care."

With guideline-based care, round-the-clock long-acting opioids are used along with short-acting opioids and non-opioid painkillers for breakthrough pain. Opioid side effects are recognized and treated appropriately.

Oncology-based care prescribes long-acting opioids half as often, and short-acting opioids and non-opioid analgesics two thirds as often.

Usual care involves sporadic assessment of pain and infrequent treatment with opioids.

As they report in the American Journal of Managed Care, the investigators found that fo every 100,000 cancer patients, 205 will have cancer pain.

Approximately 80 percent of those who receive guideline-based care would experience effective pain control -- a reduction in usual pain level to no more than 3 on a 0-to-10 scale -- the team estimates

That compares with 55 percent of those treated with oncology-based care and 30 percent receiving usual care.

Wider seats

Rugby World Cup REUTERS .co.uk

NEW COMPANY FUNDAMENTAL REPORTS

"Measures to reduce severe pain experienced by some cancer patients are most effective when doctors follow science-based guidelines rather than more traditional approaches, researchers report.

improved technology

advances in medical science

evidence-based guidelines

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Medical Care Often Not Optimal, Study Finds
Failure to Treat Patients Fully Spans Range of What Is Expected of Physicians and Nurses
By David Brown
Washington Post Staff Writer
Thursday, June 26, 2003; Page A02
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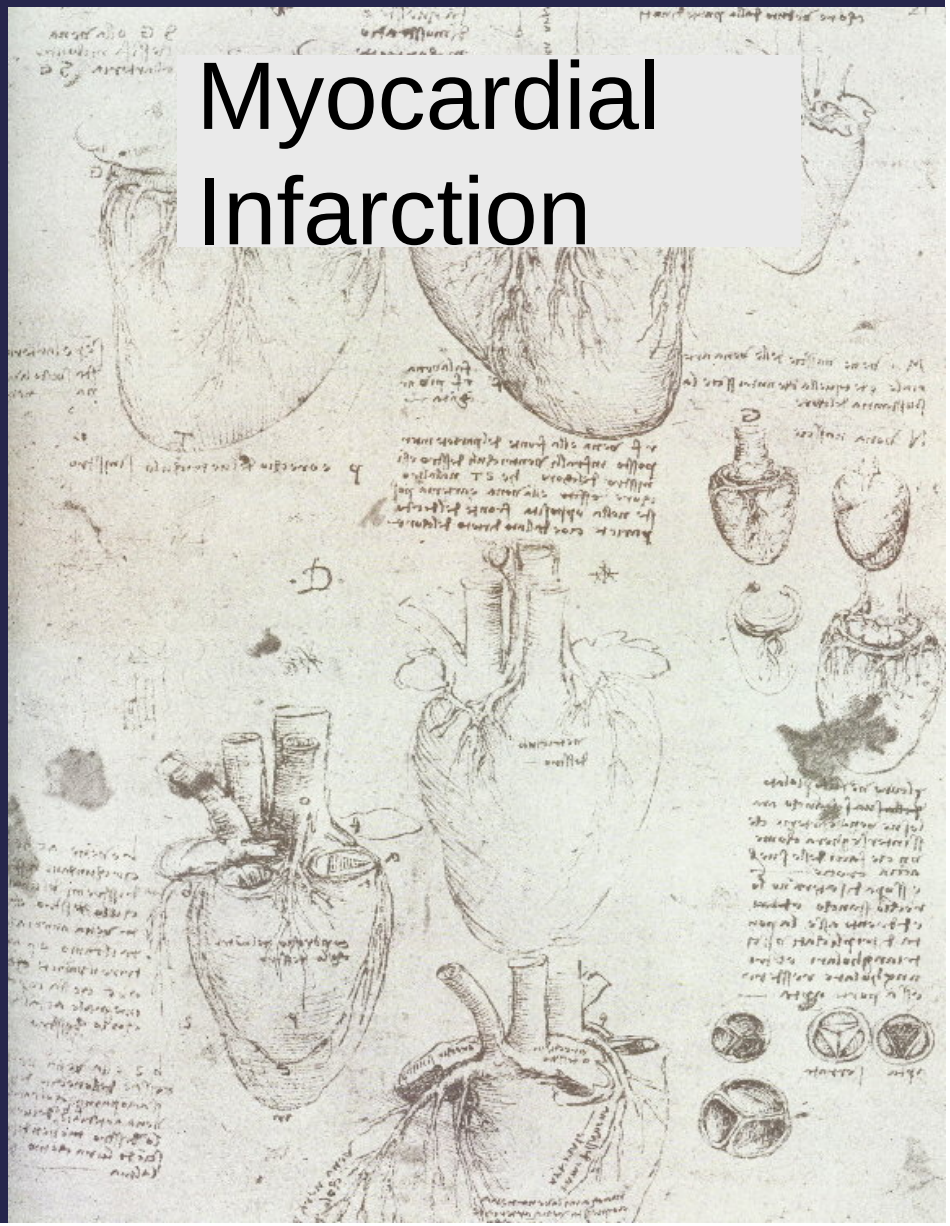
Americans have a slightly better than 50-50 chance their medical problems will be addressed in an optimal way when they visit a doctor's office or enter a hospital, according to a new survey.
The failure to do the right thing -- or, more precisely, all the right things -- extends across the spectrum of activities physicians are expected to perform.
Recommended "best practices" were followed about two-thirds of the time in diagnostic testing, prescribing drugs for acute and chronic illnesses, and monitoring patients' long-term health. In the area of counseling and health education, there was a 1-in-5 chance patients would get everything experts say they should.
The quality of treatment differed markedly by disease, with the best performances seen in breast cancer, certain forms of heart disease and low back pain. For pneumonia, bladder infections, diabetes and peptic ulcers, however, fewer than half of the recommended best practices were followed. Most of the time, the problem was that physicians and nurses did not do or ask enough. But with some conditions, such as migraine headaches, patients were overtreated.
The study, being published today in the New England Journal of Medicine, sketches a dark and disturbing portrait of American health care. It adds to the rapidly growing body of research showing a huge gap between what is known by medical scientists and what is done by medical practitioners.
"Everyone is at risk of failing to get care that they need to live a longer and healthier life," said Elizabeth A. McGlynn, a researcher at Rand, a consulting
Experience a richer, deeper Internet. Sign up online for Verizon Online DSL with MSN 8, and get your first month free!
Make progress every day
"Americans have a slightly better than 50-50 chance their medical problems will be addressed in an optimal way"
over use
"Everyone is at risk of failing to get the care that they need"
under use
practice variation

The SAGE Project
Standards-Based Sharable Active Guideline Environment

A knowledge-processing problem

"Current medical practice relies heavily on the unaided mind to recall a great amount of detailed knowledge – a process which, to the detriment of all stakeholders, has repeatedly been shown unreliable"

Crane and Raymond
The Permanente Journal
Winter 2003 Volume 7 No.1
Kaiser Permanente Institute for Health Policy



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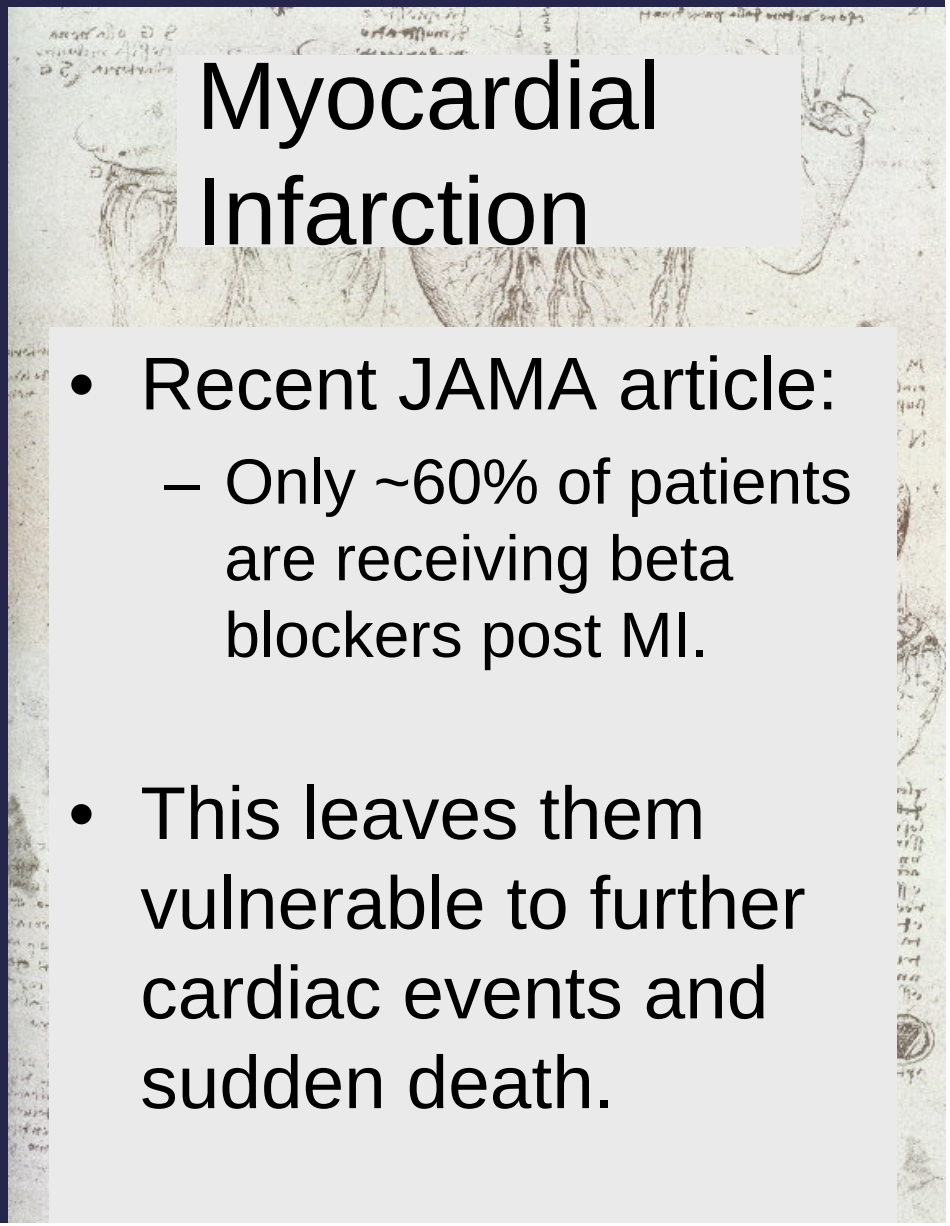

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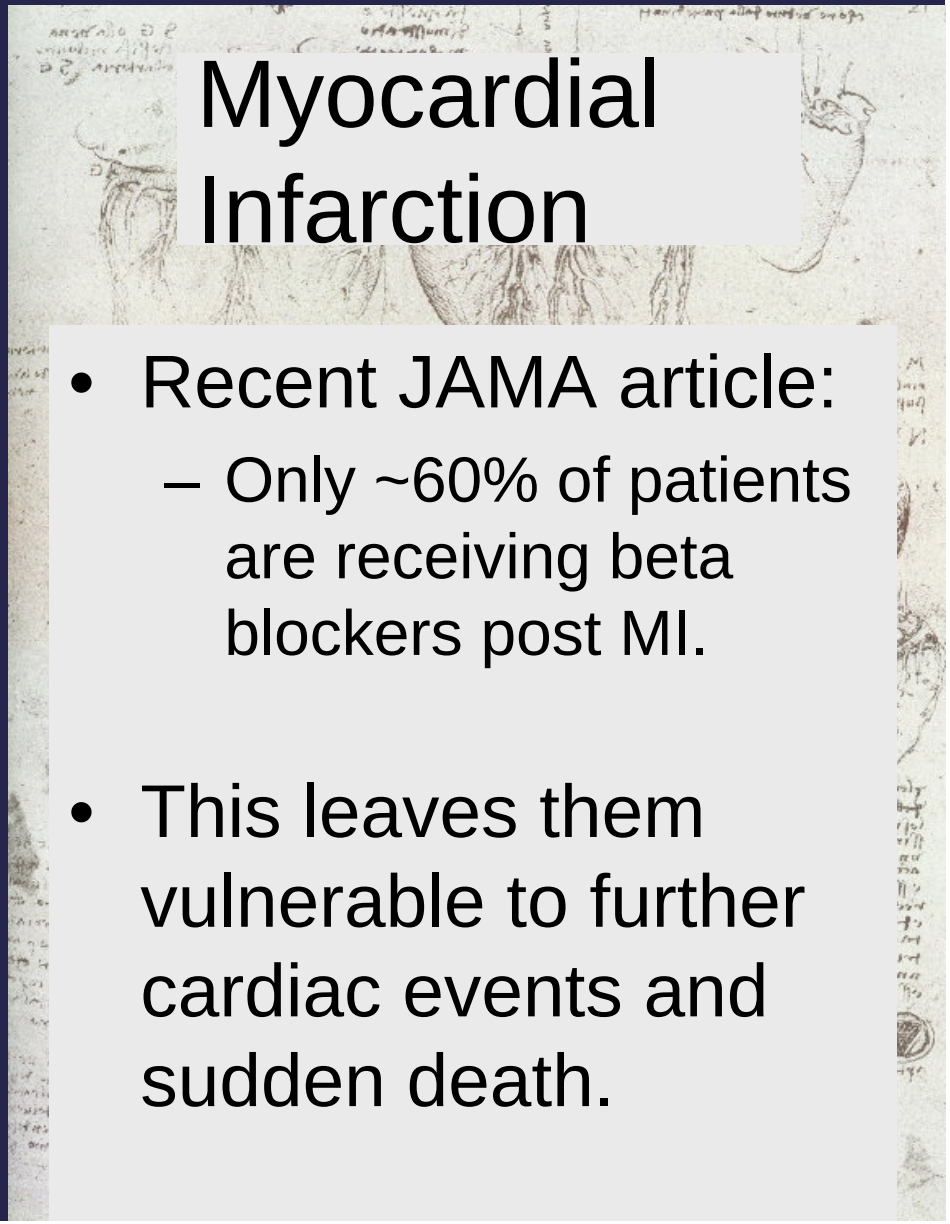
Not just recall:
- Analysis
- Processing
- Application of knowledge to each patient



Myocardial Infarction

- Recent JAMA article:
  - Only ~60% of patients are receiving beta blockers post MI.
- This leaves them vulnerable to further cardiac events and sudden death.

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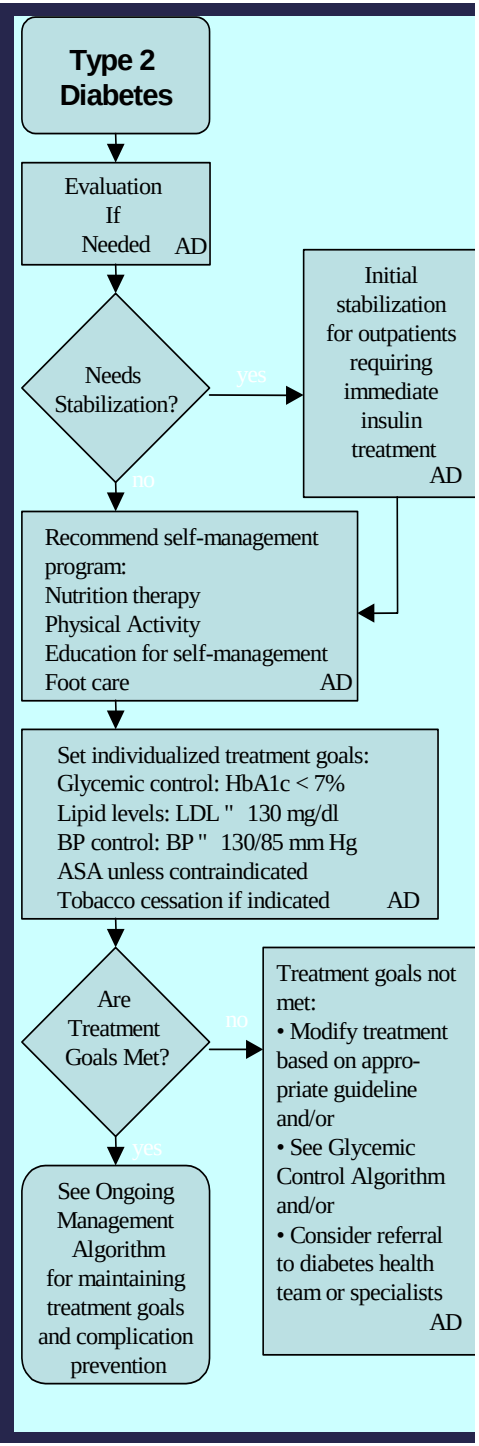
What if . . . ?

Guideline content became active, offering targeted, relevant guidance at the point of care?

Patients were evaluated against <u>proven</u> guidelines - *automatically?*

Key data were presented at critical decision points - *automatically?*

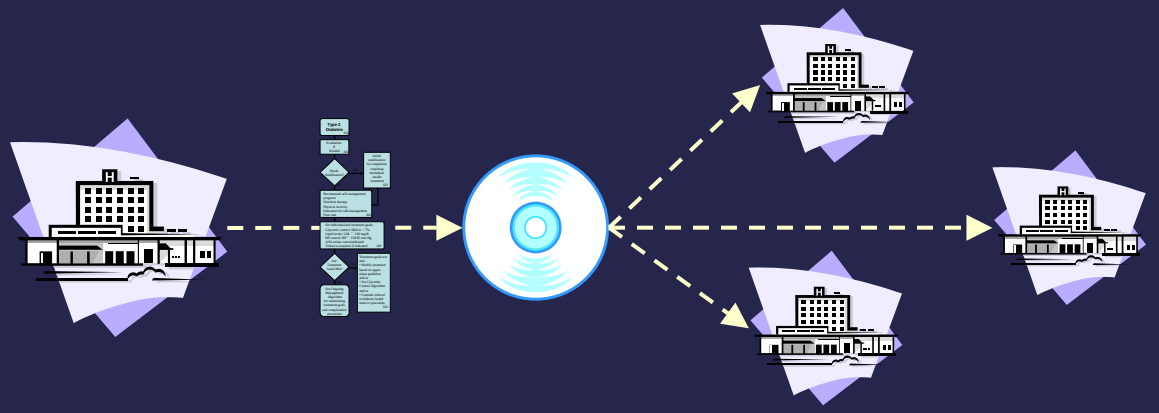


The SAGE Project
Standards-Based Sharable Active Guideline Environment

SAGE Project Goals

The primary goal: Develop a Standards-Based Sharable Active Guideline Environment with which:

- Health experts can author and encode clinical practice guidelines in a standard computable format, and
- Health care organizations throughout the nation can deploy those guidelines easily within any standards-conforming clinical information system.



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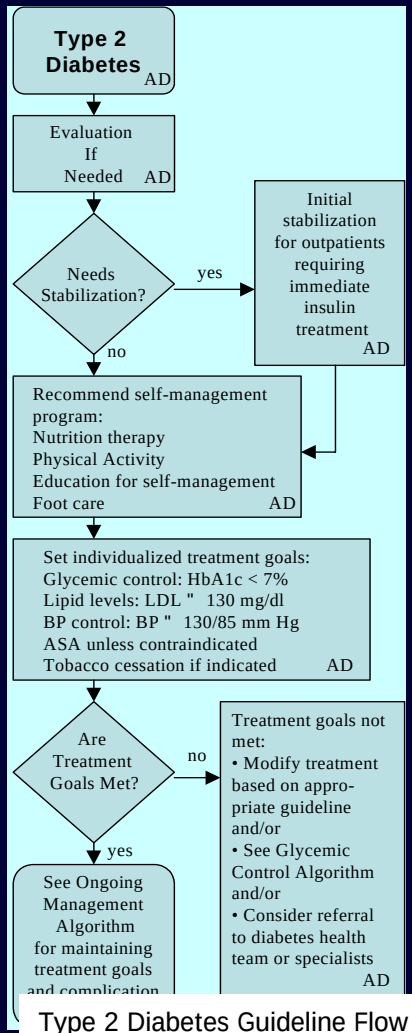
Standards-Based Sharable Active Guideline Environment

SAGE Main deliverables

- An interoperable guideline model – A computable knowledge representation "format" for encoding the content and logic of executable clinical practice guidelines.
- A guideline workbench – A software tool for authoring, encoding, and maintaining guidelines in the format of the SAGE guideline model.
- A guideline deployment system – Software that "decodes" the content of electronic guidelines and surfaces that content via functions of the local clinical information system.
- Controlled resources -- Specification of a common layer of information models and terminologies to mediate guideline content.

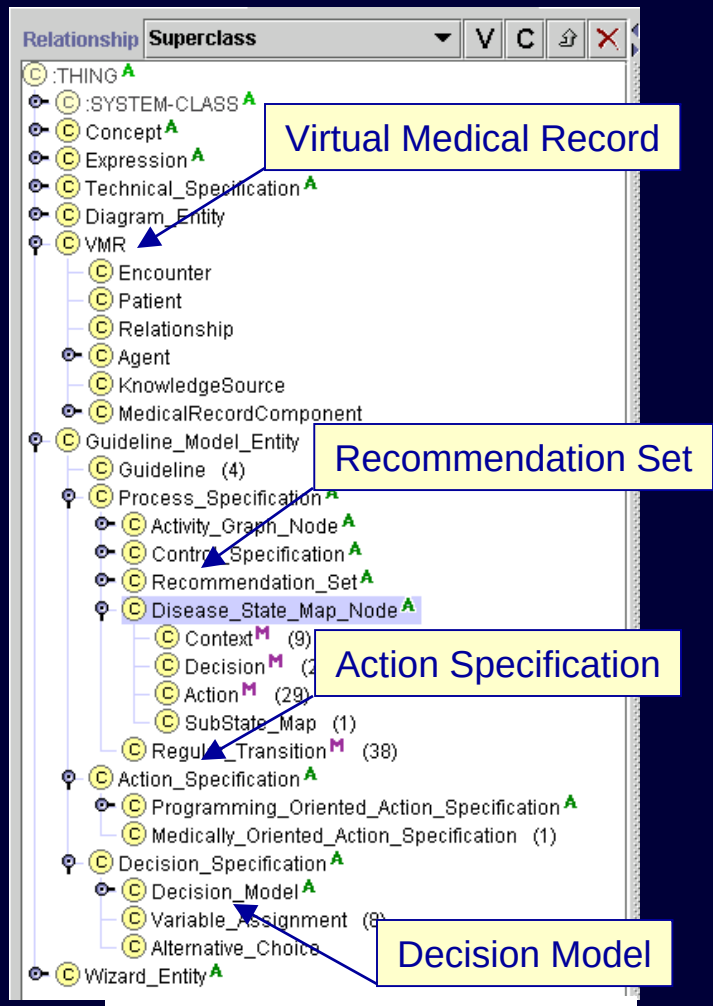
SAGE Interoperable Guideline Model

A standard computable “specification” for representing and encoding the content and logic of clinical practice guidelines



Type 2 Diabetes Guideline Flow Diagram, courtesy of Institute for Clinical Systems Improvement (ICSI)

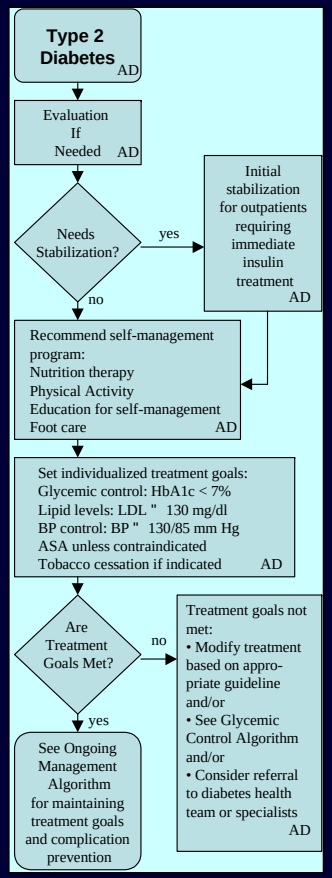
- ✓ Clinical content (criteria, actions)
- ✓ Patient status and eligibility
- ✓ Decision logic
- ✓ Clinical sequencing and workflow
- ✓ Guideline goals and intentions
- ✓ Guideline evidence and references

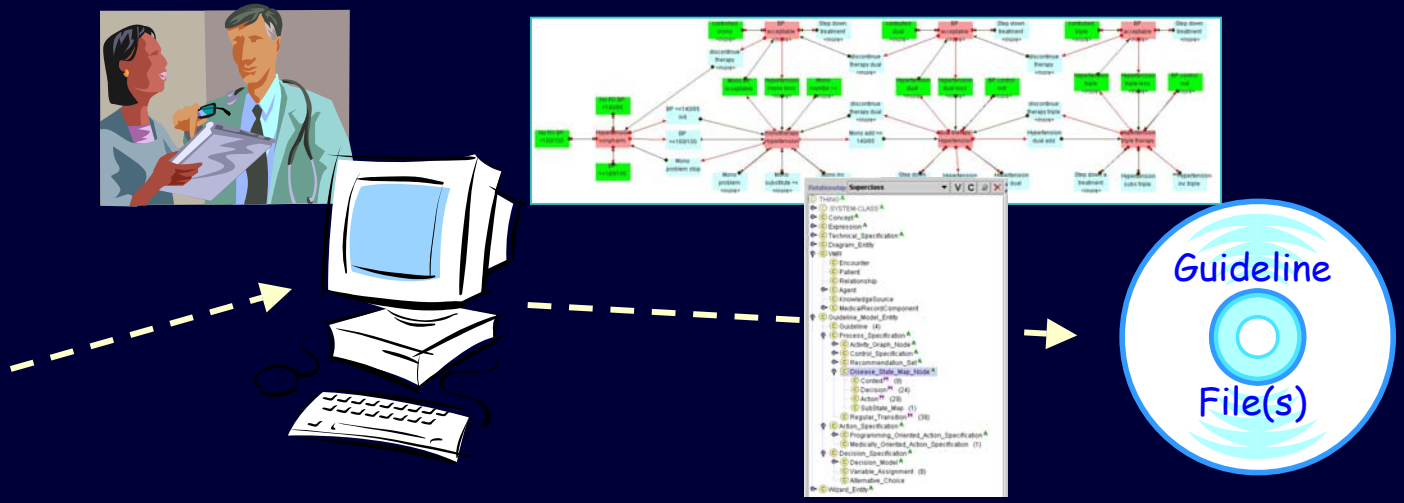


Protégé Guideline Model Knowledge Base, Courtesy Stanford Medical Informatics

Interoperable Guideline Workbench

A software tool for authoring, editing, encoding, and maintaining guidelines in the format of the Guideline Model



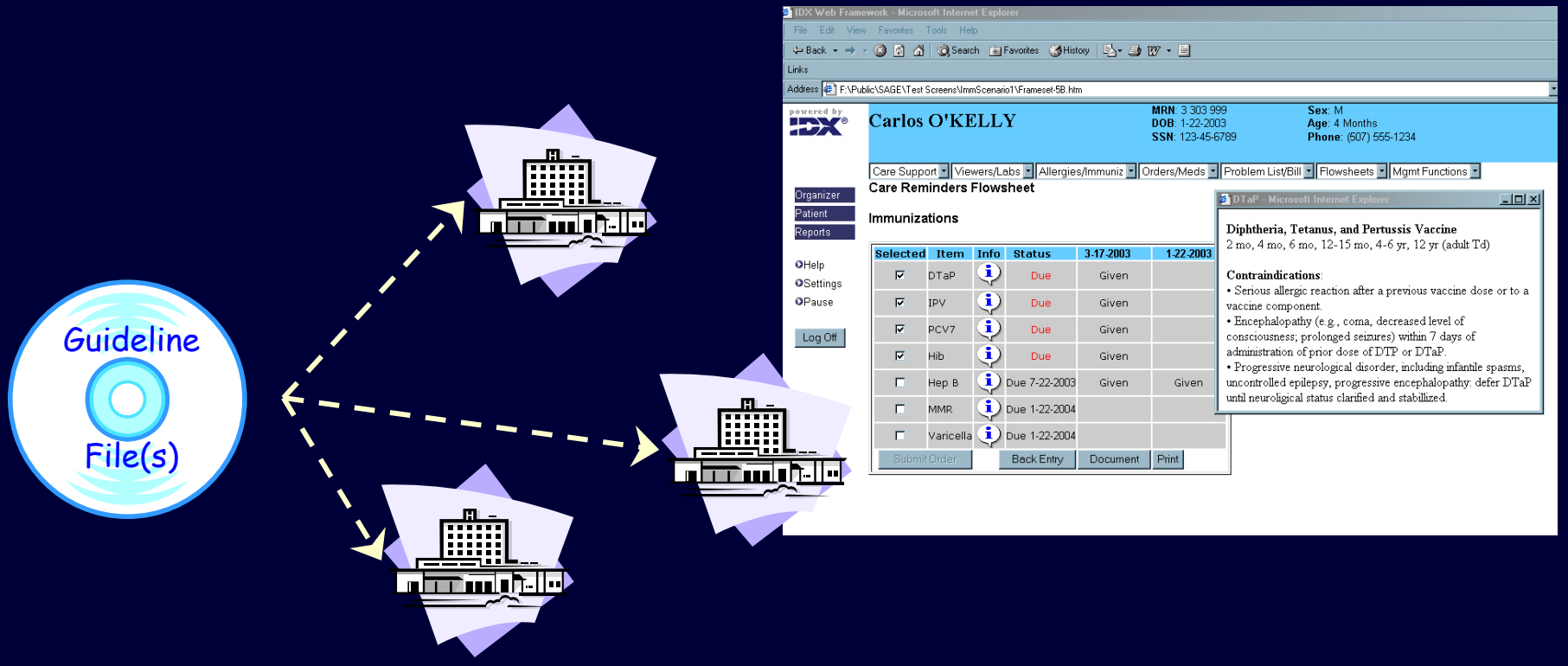


- ✓ Ensure complete ***encoding*** of guideline knowledge
- ✓ Support access to guideline content model
- ✓ Support access to controlled terminologies
- ✓ Support for visualization of guideline logic

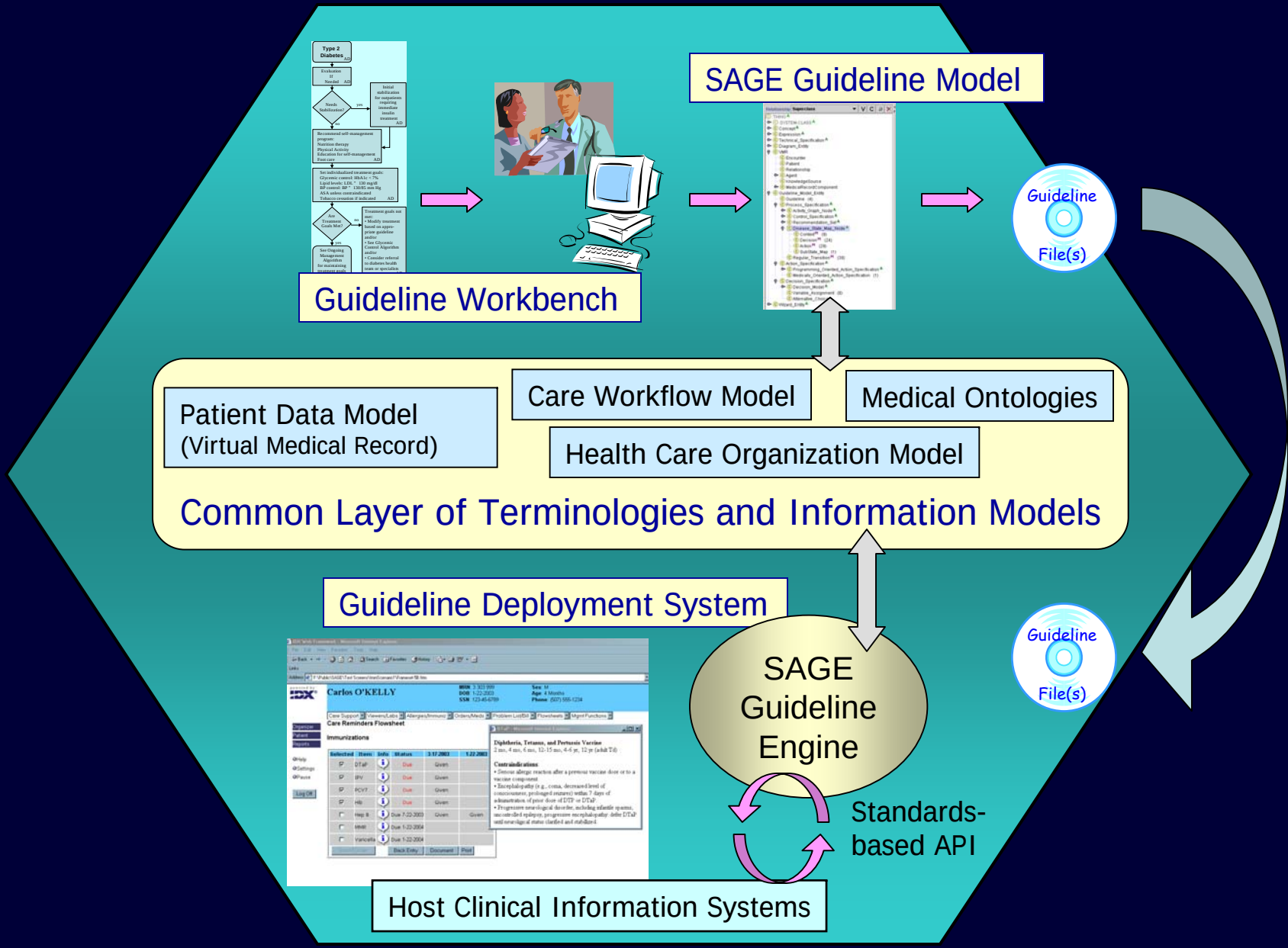
Guideline Deployment System

Software that integrates electronic guidelines with the clinical information system to operationalize the guideline for clinicians

- ✓ Administer: Download, import, store
- ✓ Localize: Clinical edits, local constraints
- ✓ Set Up: Mapping to local terminologies and EMR
- ✓ Execute: Activation of guideline via CIS workflow



Overview of the SAGE Infrastructure



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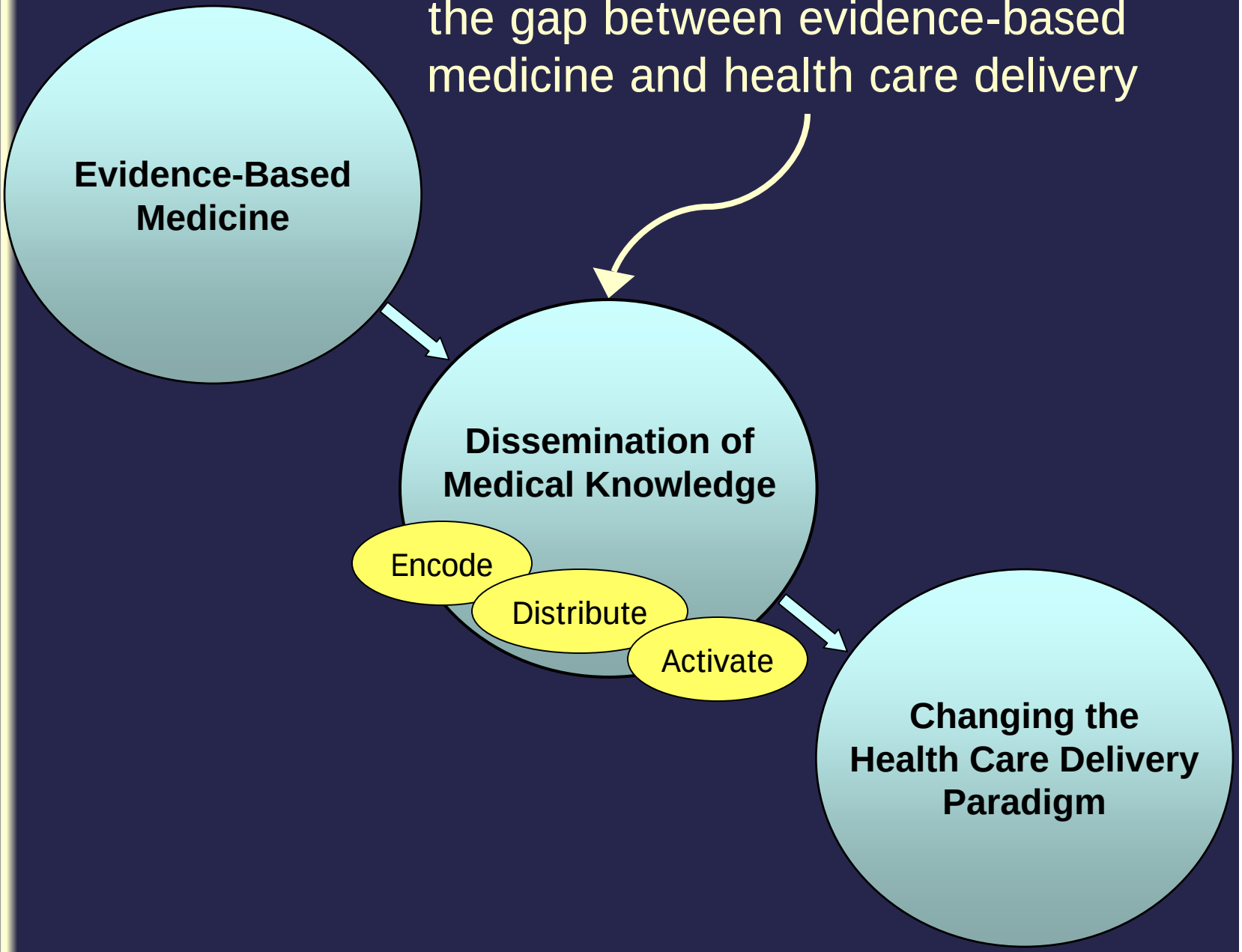
The SAGE Project is about bridging the gap between evidence-based medicine and health care delivery



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Key Problems to Solve:

Functionality

- Represent guideline knowledge in a manner that is both comprehensive and computable.
- Manage complexity during encoding and deployment.
- Activate guideline content via functions of clinical information systems.

Interoperability

- Deploy encoded guideline content widely.
- Semantic interoperability – sharing usable knowledge.
- Install and “map” guideline content at reasonable costs.
- Execute guideline content in multiple HIS environments.

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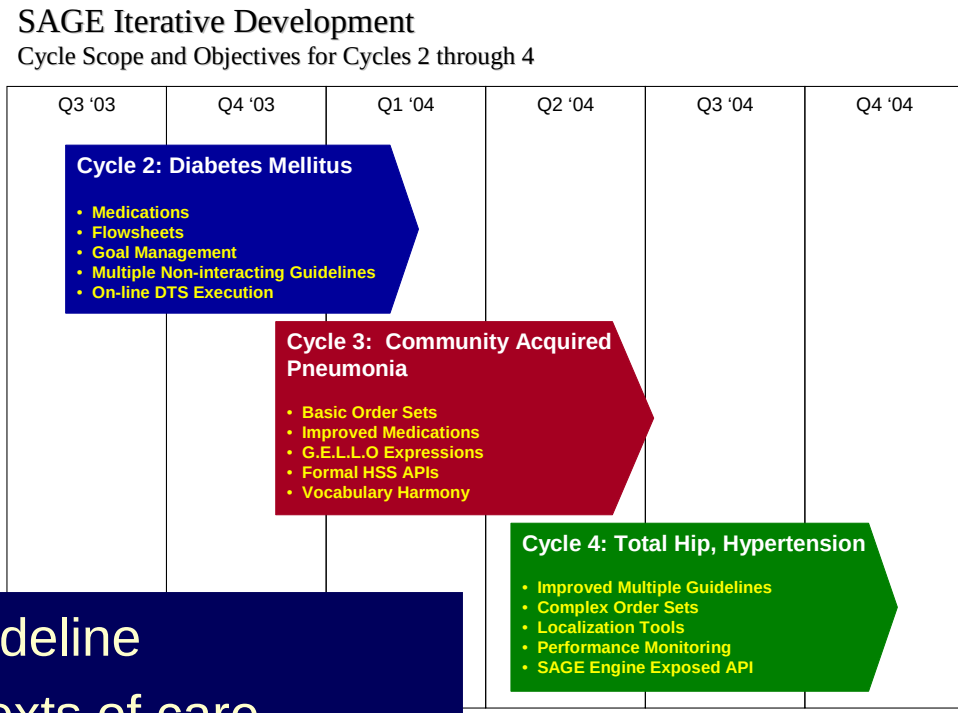
Approach to Solving Problems:

- Build on an invaluable foundation of previous work.
- Requirements analysis employing clinical use cases.
- Usability testing of clinician / guideline interface.
- Organization into cross-partner work teams.
- Alignment with national health information standards.
- Iterative prototyping / development cycles

SAGE Synchronization Cycles:



1. Start with "generic" text-based guideline
2. Define scenarios for specific contexts of care
3. Perform usability analysis and UML modeling
4. Specify guideline content at computable level
   (Decision logic, information models, terminology use)
5. Encode scenario content into SAGE guideline model
6. Specify required actions of the CIS
7. Update execution engine / API technology
8. Install and bind guideline to test CIS
9. Test execution of guideline contents via CIS

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Key Technical Considerations:

- Interoperability
  - Deployment across heterogeneous CIS platforms.
  - Reasonable costs to install and use guidelines.
- Standards-Based Encoding
  - Employ standard terminologies and information models.
  - Collaboration with leading SDOs (e.g., HL7).
  - Alignment with national health information standards.
- Active Deployment of Guideline Content
  - Active use of patient EMR data by clinical decision support.
  - Patient-specific recommendations.
  - Integrate recommendations with care workflow.

"Activating Guideline Content"

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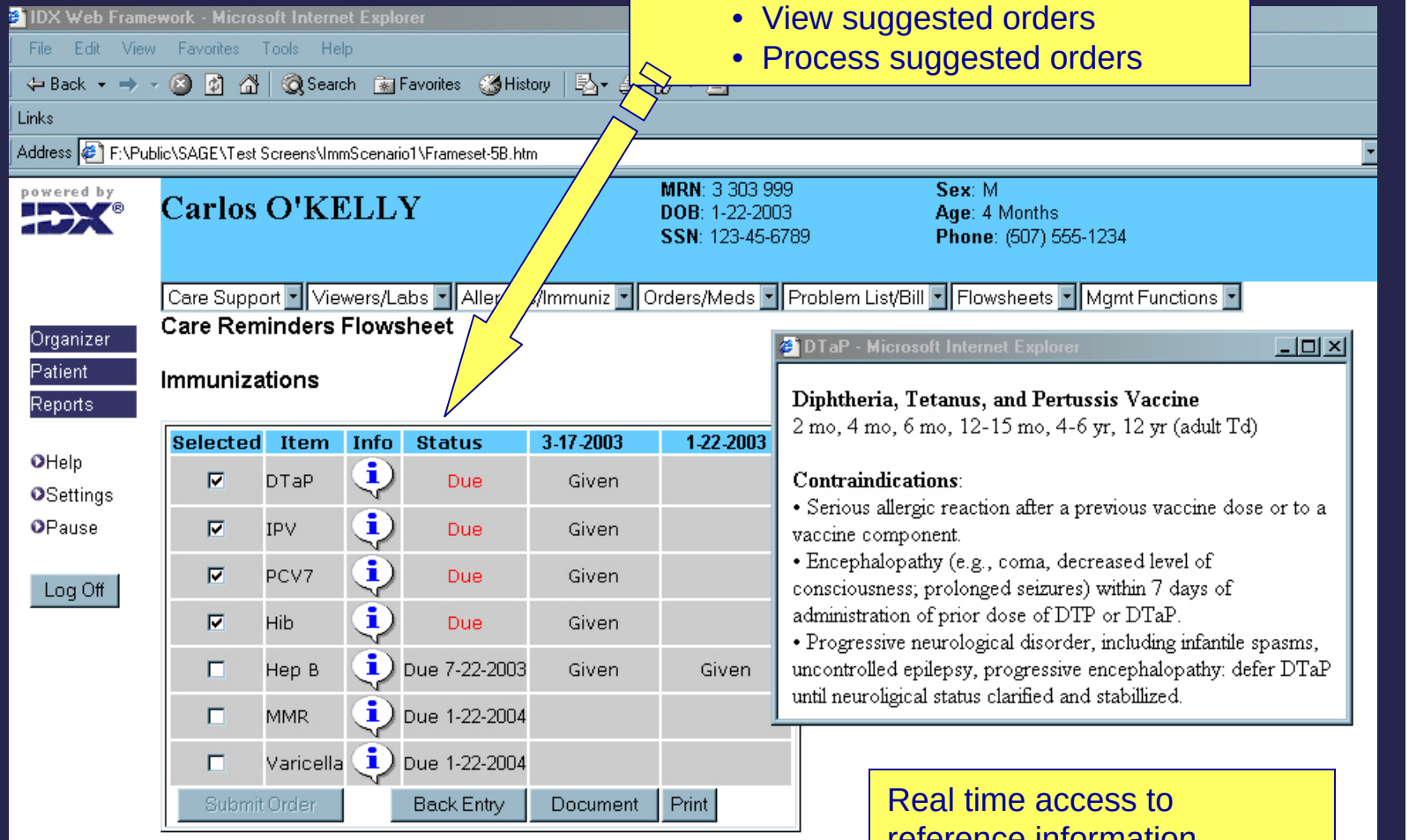
Guideline recommendations integrated into a nurse care flowsheet
- View suggested orders
- Process suggested orders



Real time access to reference information

IDX Systems Corporation – Proprietary and Confidential

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The pirate's code of ethics

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The pirate's code of ethics

"But what about the pirate's code?"

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The pirate's code of ethics

"But what about the pirate's code?"

"We don't think of them as rules really, *they're more like guidelines* . . ."

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Sidna M. Scheitel, MD, MPH

Assistant Professor of Medicine

Mayo Medical School

Scheitel.sidna@mayo.edu

- Use Case Requirements
- Usability Assessment

Problem Focus: Understanding the requirements integrating active guideline recommendations into the care workflow – via functions of the clinical information system

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Selecting Exemplar Guidelines

Exemplar Guideline	Clinical Domain
Diabetes Management (DBM)	Chronic disease monitoring and treatment. Acute exacerbation of chronic disease. Chronic disease as a comorbidity.
Immunizations (IMM)	Routine health maintenance, in both outpatient and inpatient settings.
Community Acquired Pneumonia (CAP)	Emergency room evaluation and diagnosis. Outpatient treatment of acute disease. Inpatient and ICU treatment of acute disease. Follow-up of acute disease.
Total Joint Replacement (TJR)	Surgical guideline. Comprehensive pre-op workup, inpatient plan of care, and post-op outpatient management.

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Guideline Use Cases

- Clinical Scenarios where clinician workflow is documented

- Guideline use case examples for immunization
  - Neonatal, uncomplicated
  - Routine pediatric, uncomplicated
  - Pediatric with unknown/uncertain immunization history
  - Pediatric with known, out-of-date immunization history
  - Pediatric with permanent contraindications
  - Adult with transitory contraindications
  - Adult with risk factors
  - Population-based patient survey

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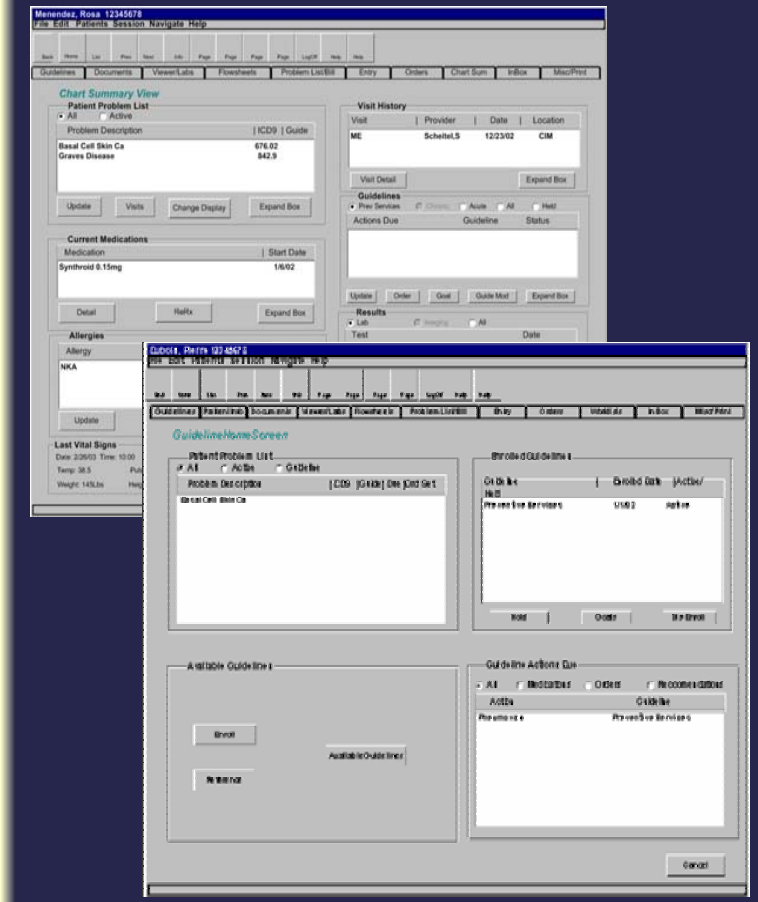
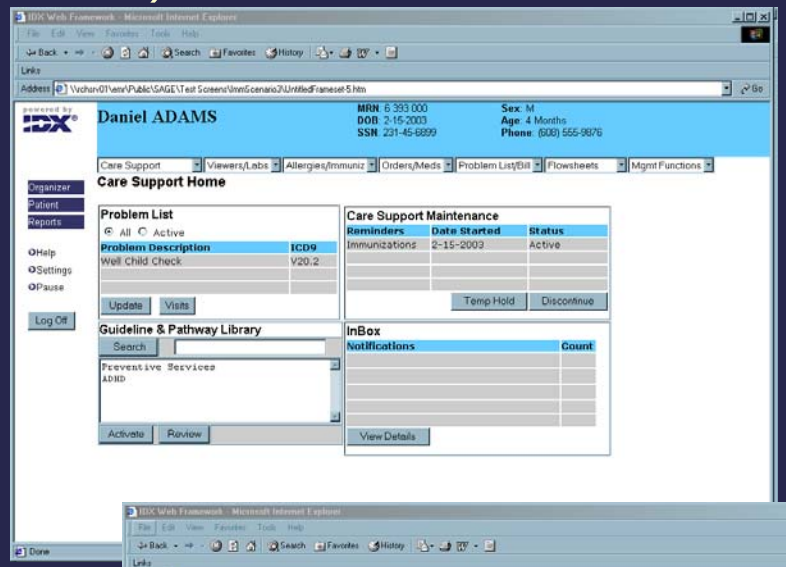
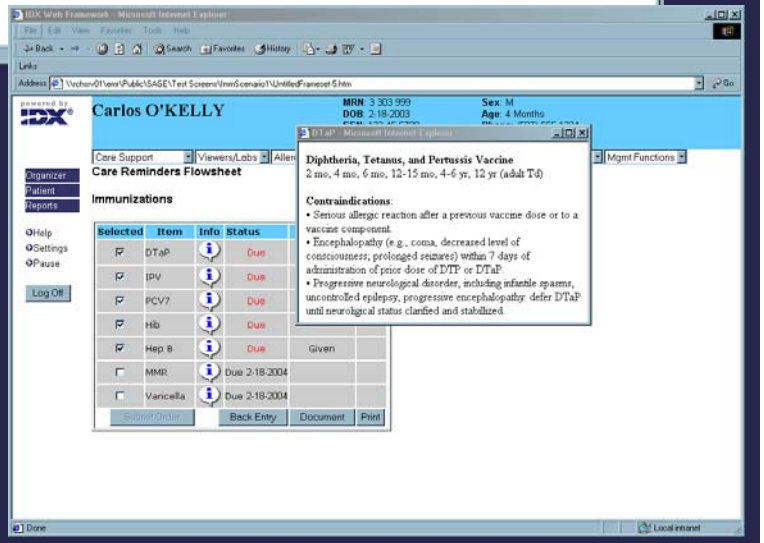
System Prototyping

- Using low fidelity (cheap and quick tools) to develop prototypes (VISIO, Dreamweaver)







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Mayo Usability Lab

- Observers behind one way mirror
  - 2-5 per session
  - Notes taken during testing
  - Debriefing by lab facilitator after each session.
- Participants
  - nurses (LPN, RN)
  - physicians (primary care, specialists)
- Scenarios with EMR screens

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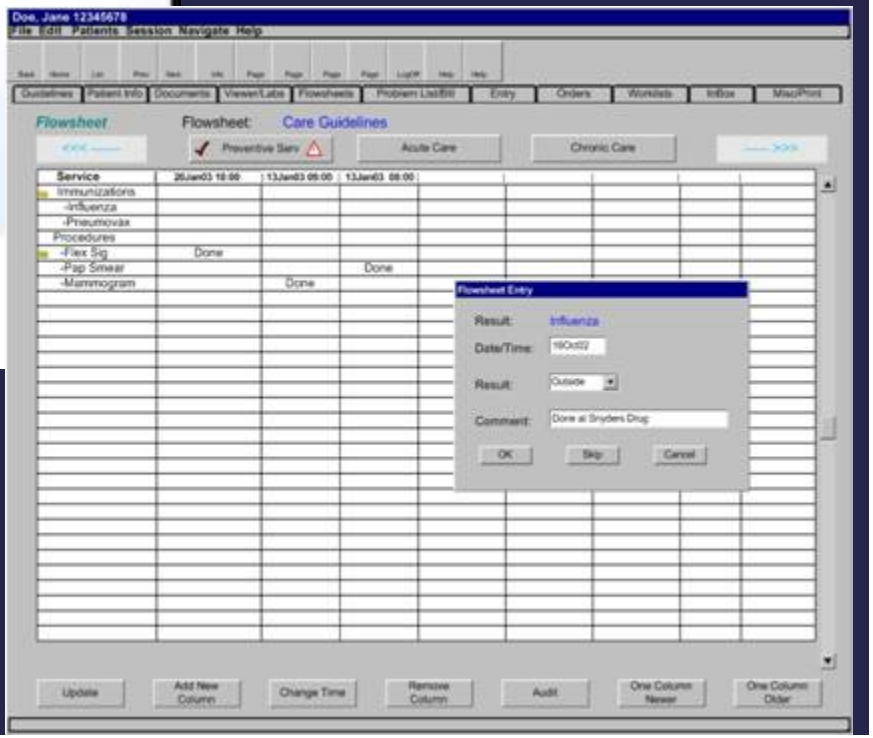
Mayo Usability Lab

- Prototypes tested by physicians



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Guidelines are Seamlessly Integrated

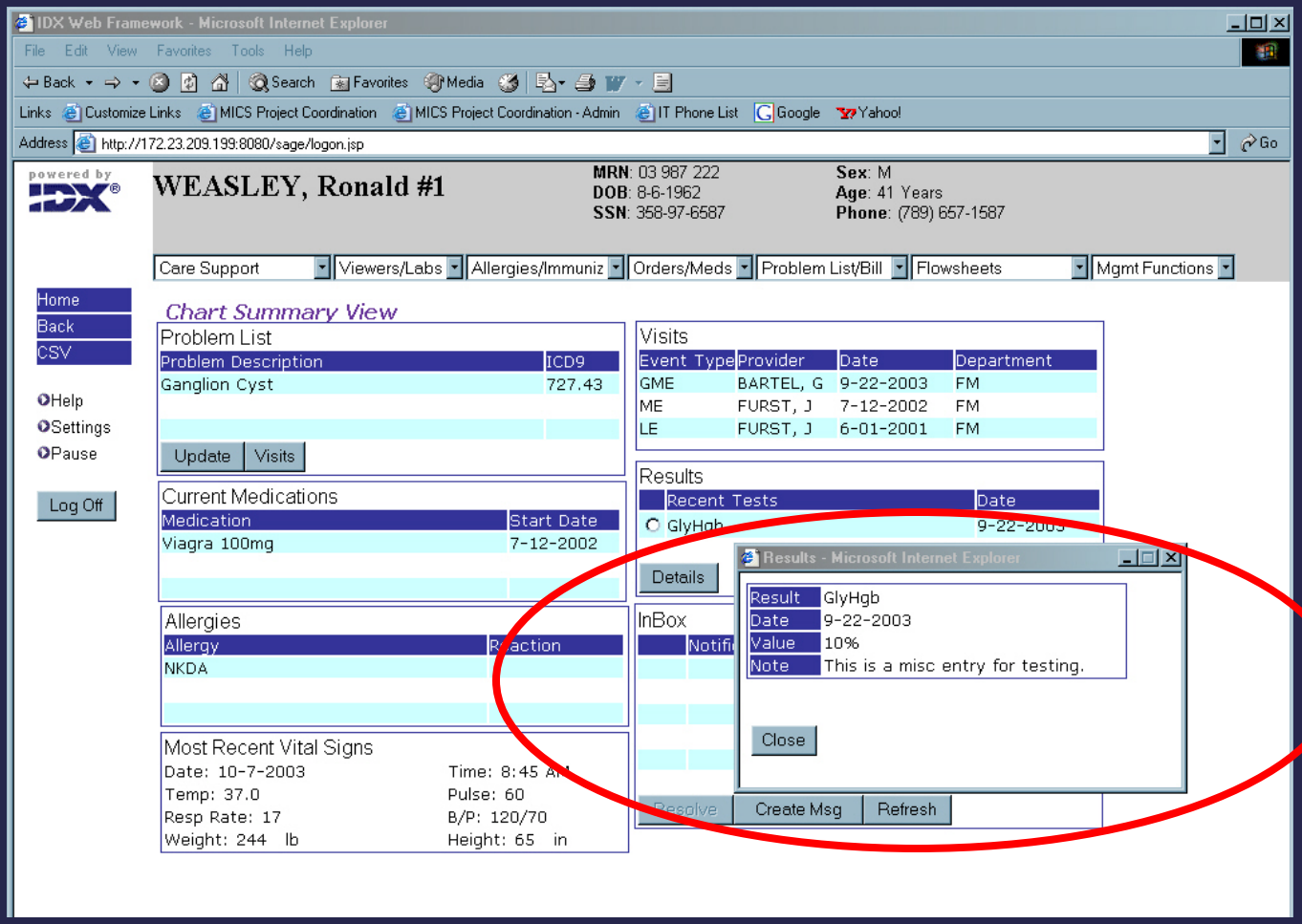

Chart Summary View

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Initial Usability Lab Findings

- Guideline alert reminders
  - Desire to be information dense
  - Configurable presentations (pop-up, in-box)
  - Ability to target to specific clinician role.
  - Meaningful, don't alert if recommendation is pending or ordered.
  - Don't want multiple pop-up alerts for each guideline
  - Ability to respond to alert with minimal amount of clicks

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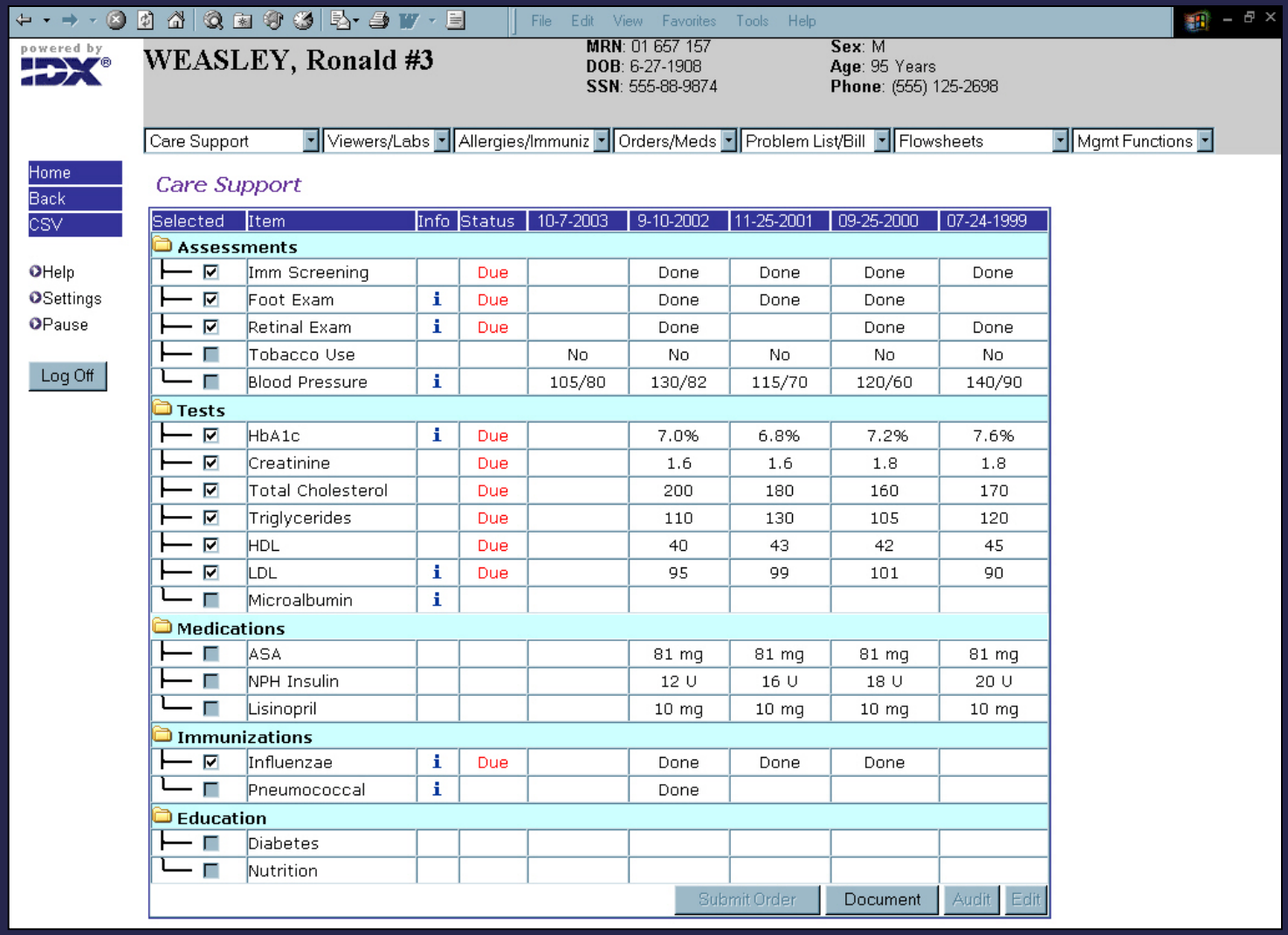
Flowsheets



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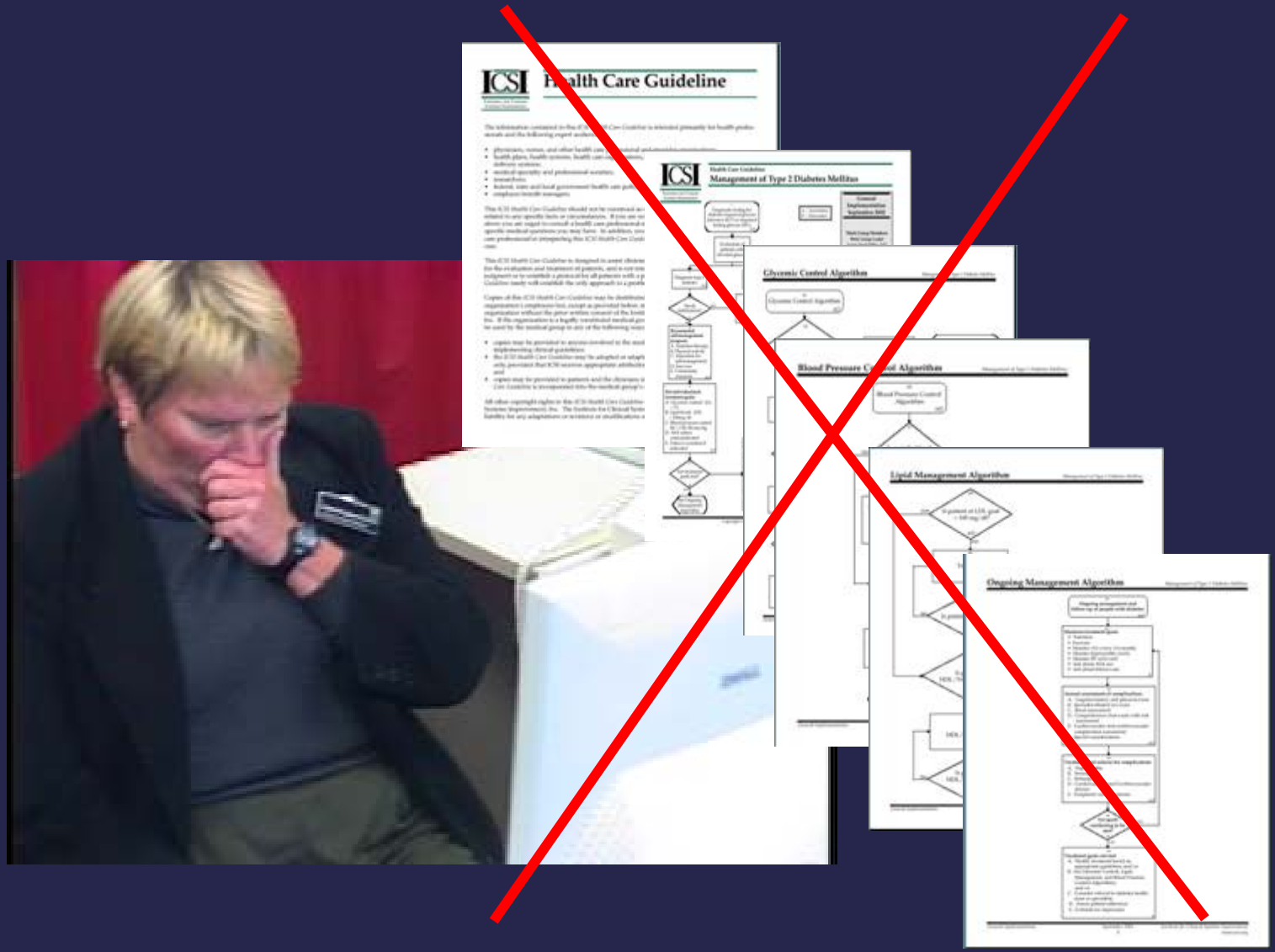
Rationale For Recommendations



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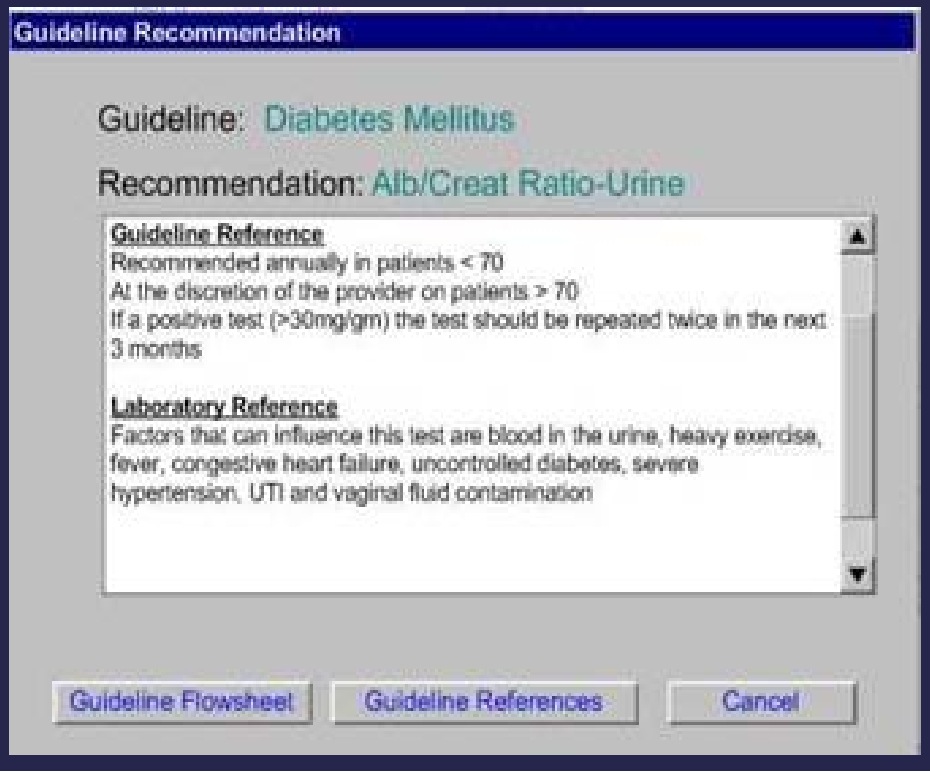
Rationale For Recommendations

- Liked pull not push presentation
- Like succinct summaries
- Present at appropriate time in workflow
- If full guideline referenced desired bookmark

Guideline
Reference Box



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General Findings

- Enrollment
  - What is it and when is someone “enrolled” ?
    - Prev Services – at birth or first contact
    - Chronic – Diagnosis of disease
    - Diagnostic, Acute Illness– No answer yet
- Miscellaneous Embedded Tools
  - Calculators with pre-filled data elements eg. Goal setting – LDL Cholesterol
  - Level of care – eg. Community Acquired Pneumonia
  - Establishment of diagnosis – Disease criterion

The SAGE Project
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General Findings

- Use of Order Sets
  - Critical for efficient use of guidelines and CIS
- Diagnostic, Acute Illness guidelines are problematic
  - When is enrollment done?
  - Workflow issues

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Stanford Medical Informatics in SAGE Project

Samson W. Tu, Ravi Shankar, Mark A Musen (PI)
Stanford Medical Informatics
Stanford University School of Medicine

- About SMI
- Guideline Modeling
- Guideline Workbench

Problem Focus: Solving the challenge of comprehensive, interoperable, and computable representation and encoding of guideline content

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Stanford Medical Informatics

- History of guideline modeling and execution projects
  - ONCOCIN, T-Helper, InterMed, PRODIGY, EON, ATHENA
- Protégé national resource
  - Robust and extensible knowledge-engineering environment
  - Basis for SAGE guideline workbench

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Guideline Modeling Goal

- Create a guideline model that
  - Is sufficient to encode guideline knowledge needed to provide situation-specific decision support
  - Uses standardized components that allow interoperability with the standard services of vendor clinical information systems.
  - Includes organizational knowledge to capture workflow information and resources needed to provide decision-support in enterprise setting

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Guideline Modeling Overview

- Scenario-driven modeling
  - Clinical scenario: Patient arrives for visit with primary physician. At check-in, SAGE checks for immunizations that are due and prints consents and information sheets. Nurse then reviews any other shots received, updates the record, and records immunizations given that day in CareCast

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Guideline Modeling Overview

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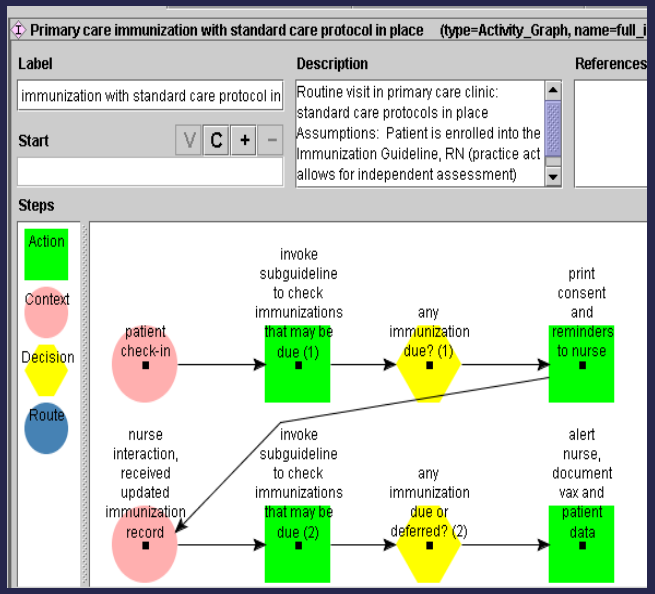
  - Clinical scenario: Patient arrives for visit with primary physician. At check-in, SAGE checks for immunizations that are due and prints consents and information sheets. Nurse then reviews any other shots received, updates the record, and records immunizations given that day in CareCast



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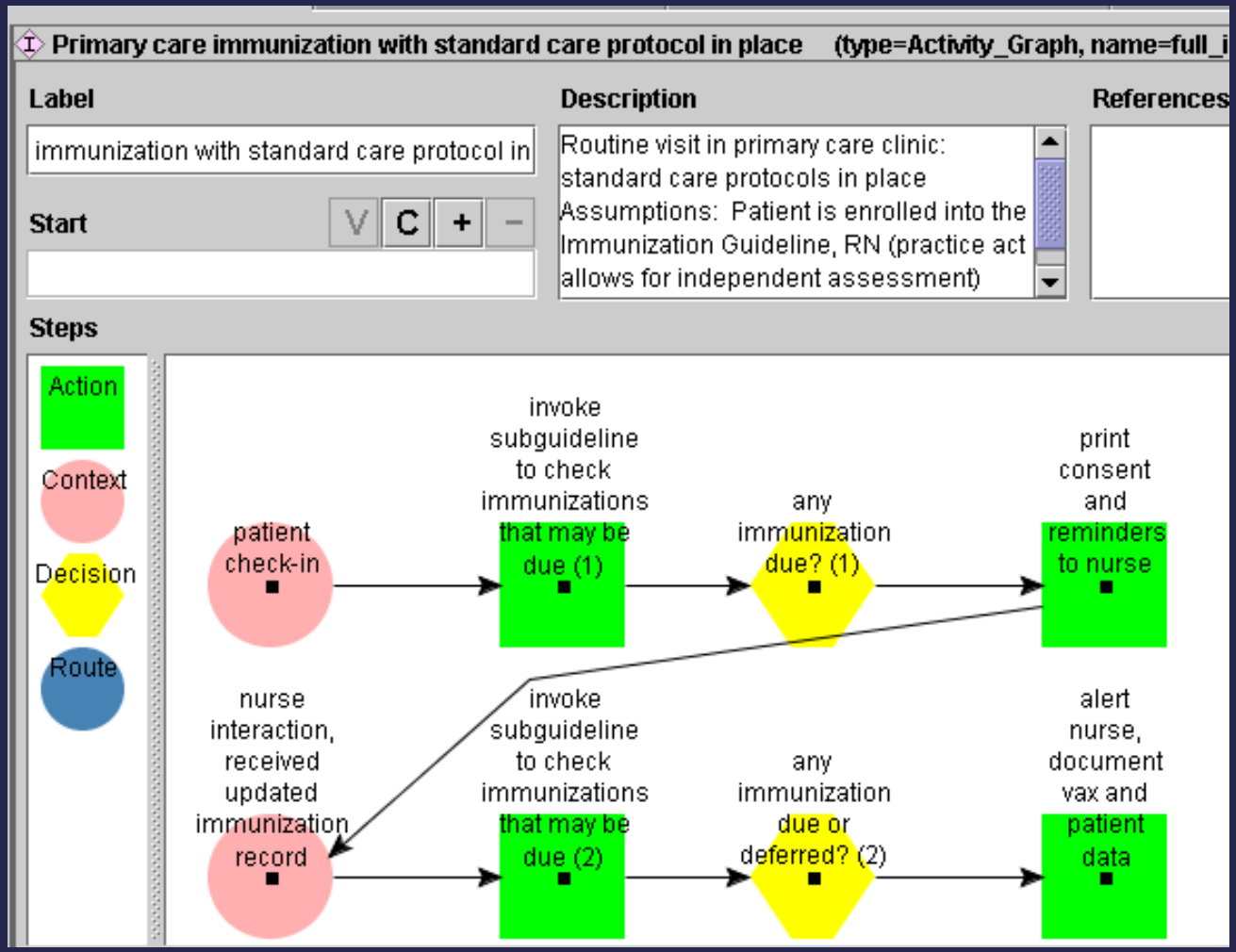
Top-Level Workflow-Aware Process



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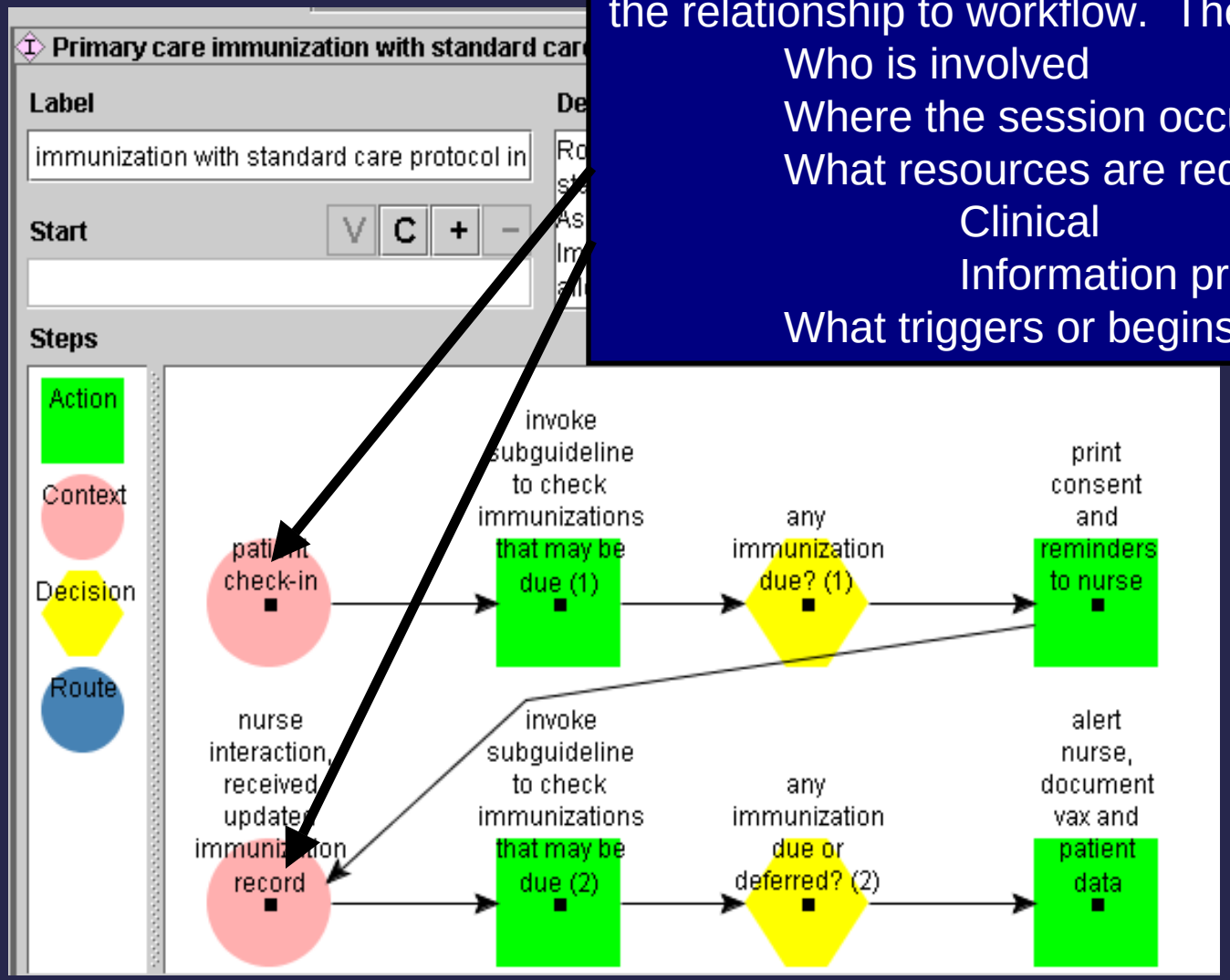
SAGE Context Model: Workflow Specification and Sharing

Context nodes organize and specify the relationship to workflow. They record:

- Who is involved
- Where the session occurs
- What resources are required
  - Clinical
  - Information processing
- What triggers or begins session



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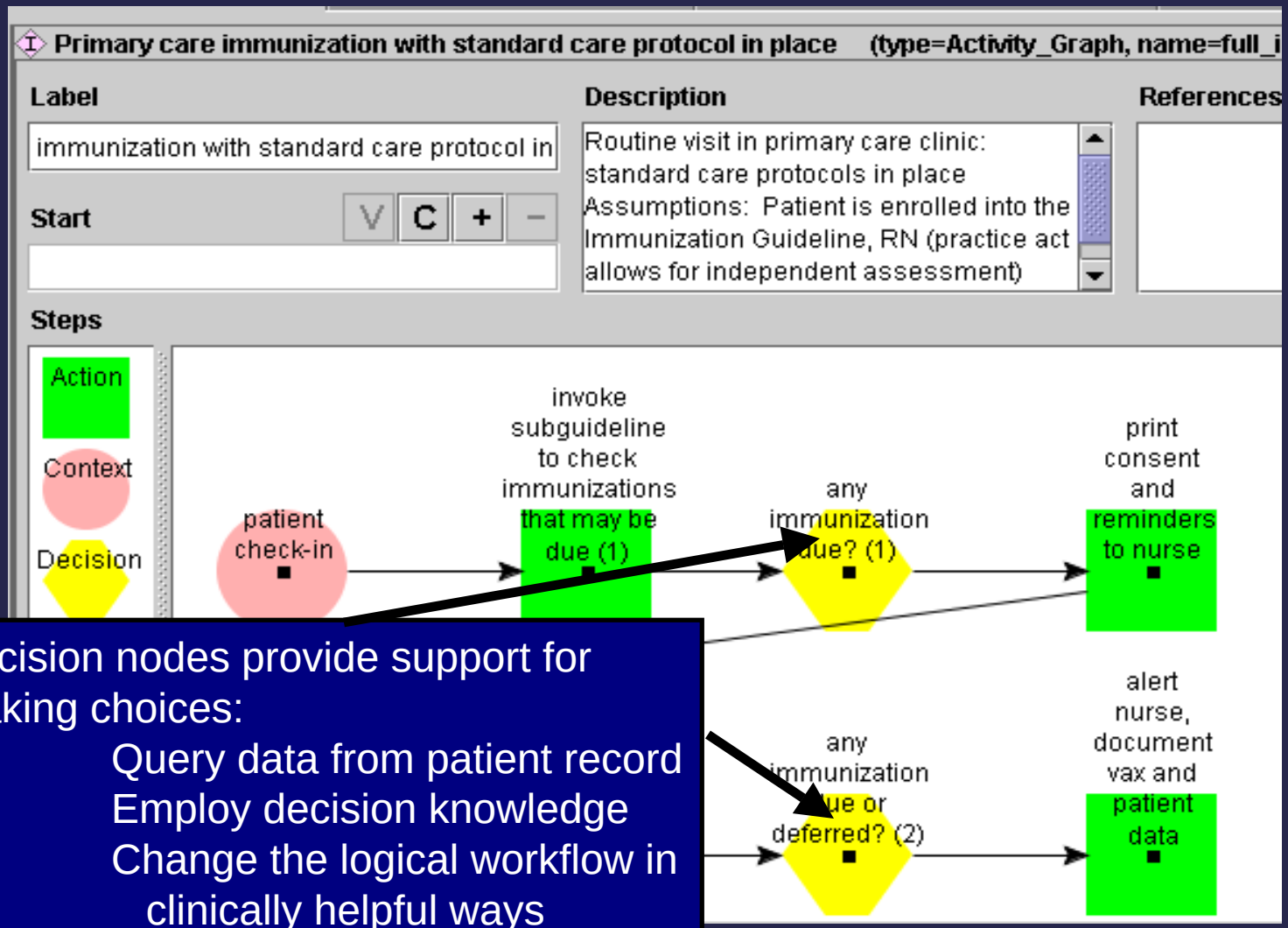
SAGE Decision Model: Clinical Decision Making



Decision nodes provide support for making choices:

- Query data from patient record
- Employ decision knowledge
- Change the logical workflow in clinically helpful ways

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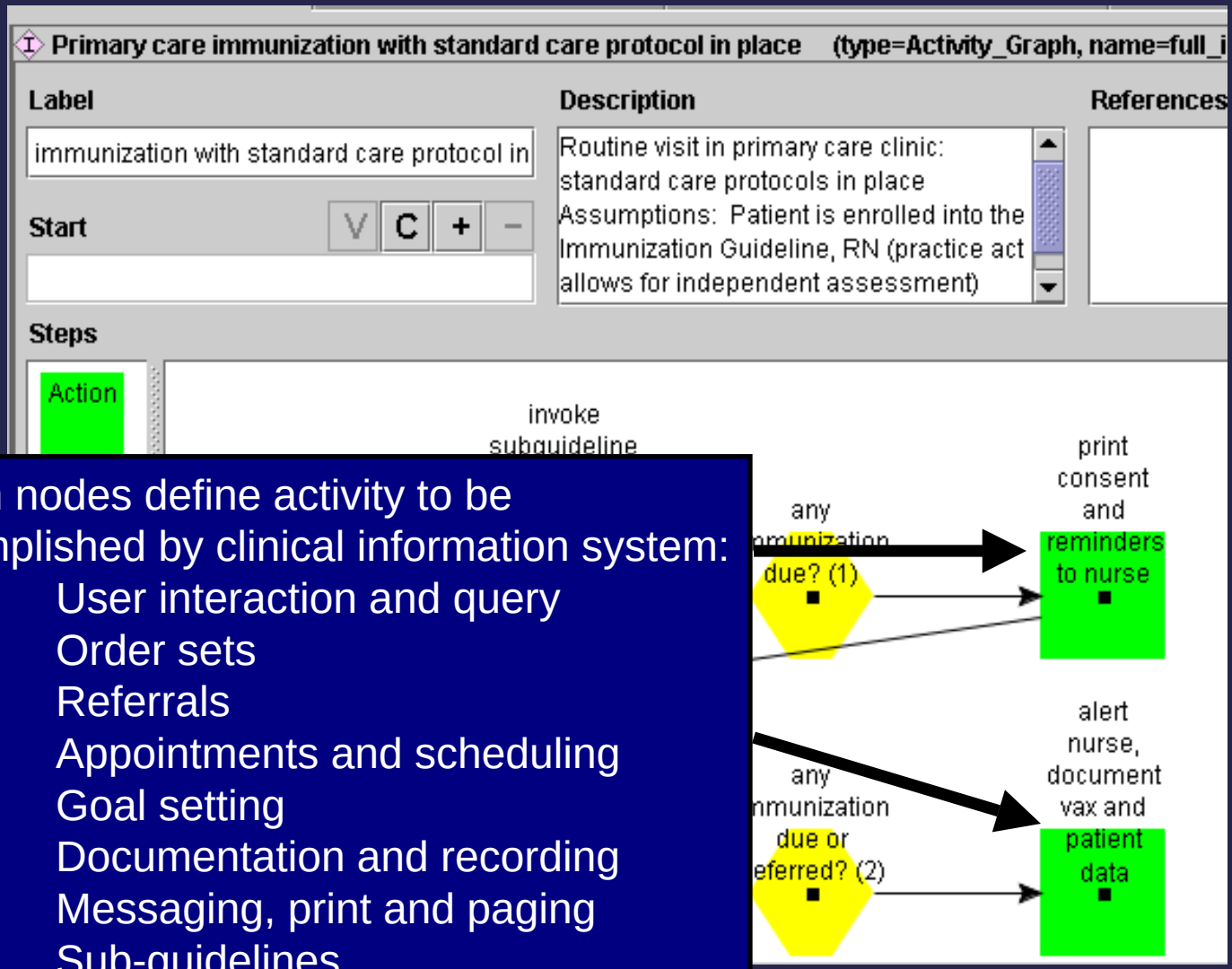
SAGE Action Model: Creating Interventions for Favorable Outcomes



Action nodes define activity to be accomplished by clinical information system:

- User interaction and query
- Order sets
- Referrals
- Appointments and scheduling
- Goal setting
- Documentation and recording
- Messaging, print and paging
- Sub-guidelines

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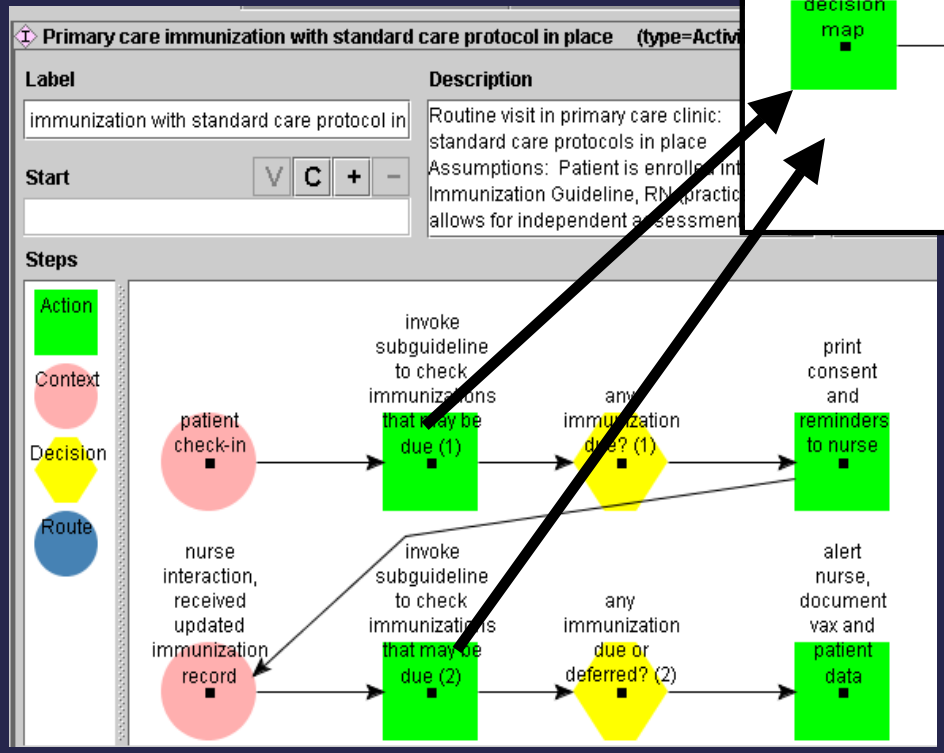
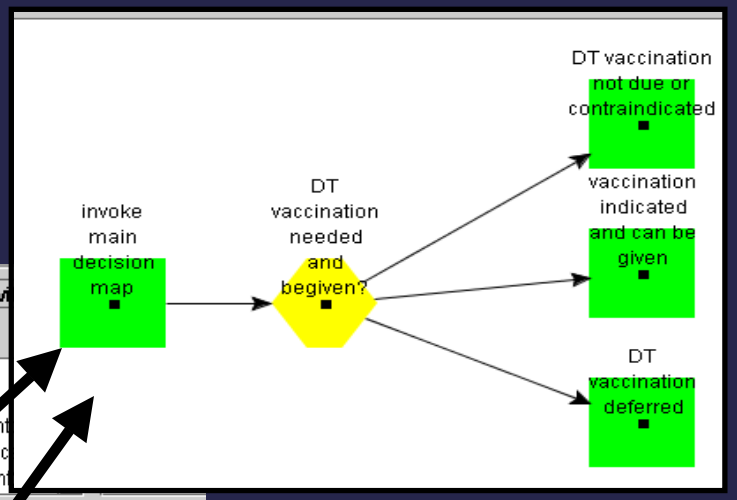
Sub-guidelines

Can be thought of as reusable subsets of guideline logic (much like subroutines) for repeated use within a recommendation set





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SAGE Guideline Workbench

- Protégé-2000 as foundation
  - Extensible with custom plug-ins (e.g. Apelon terminology service plug-in)
  - Knowledge-acquisition (KA) GUI generated from guideline ontology
- Kwiz: Protégé application to improve KA process
  - Chunk work into discrete steps
  - Create alternative views
  - Reuse components from guideline knowledge repository
  - Improved navigation and search

The SAGE Project
Standards-Based Sharable Active Guideline Environment

James McClay, MS, MD

Assistant Professor

University of Nebraska Medical Center

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- Guideline Interoperability
- Guideline Context Specification

Problem Focus: Specifying the guideline modeling and encoding requirements for interoperable active deployment of guideline recommendations via actions of the clinical information system

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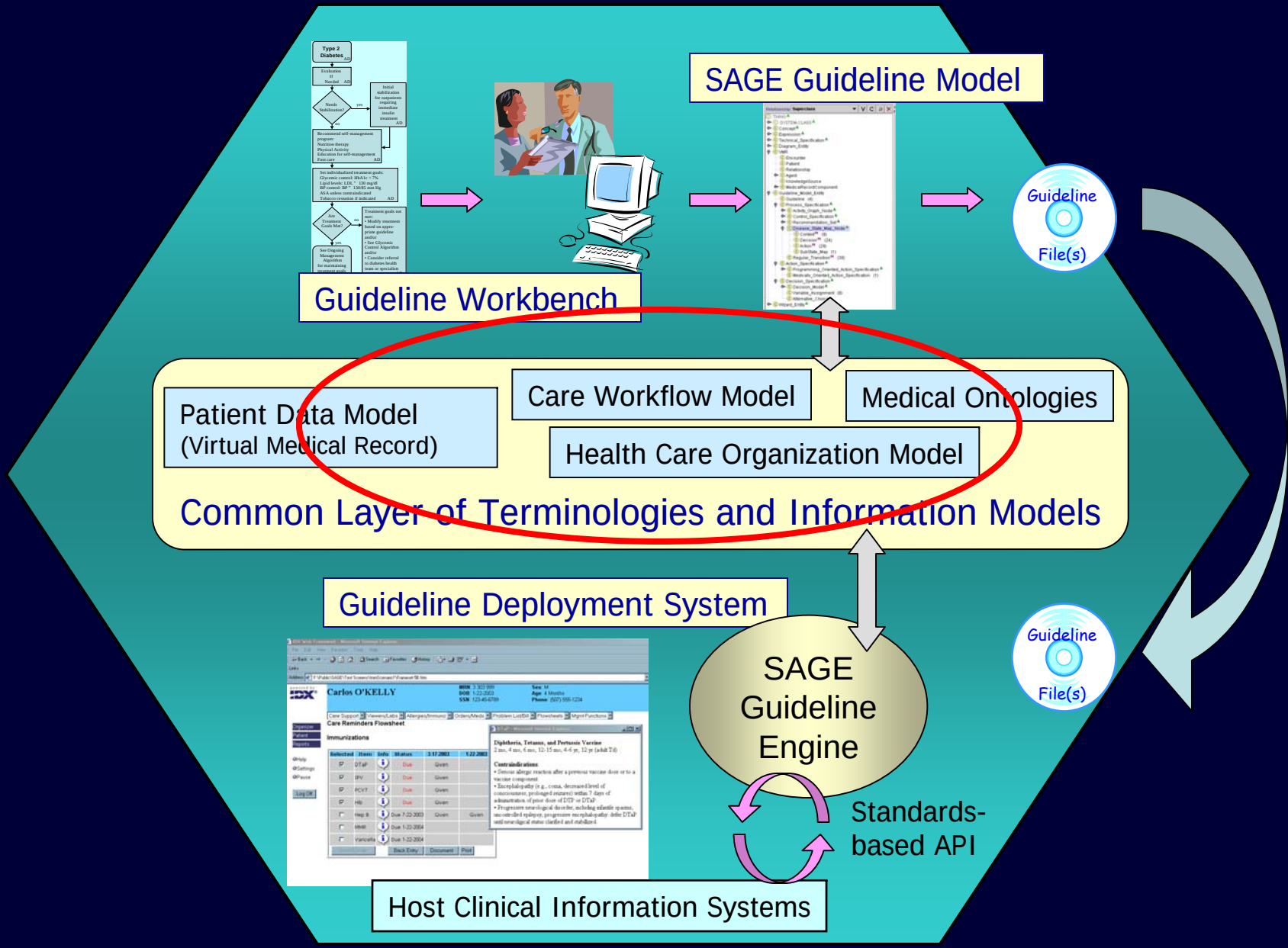
SAGE Enhances Memory

Sage herb "can boost memory"

Centuries-old theories that the herb sage can improve memory appear to be borne out by modern research.

BBC News Published: 2003/08/28 23:15:38 GMT

Overview of the SAGE Infrastructure



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Interoperability

- In common terms, interoperability is “plug-and-play” functionality, in this case – for clinical knowledge and decision support
- Requires that the software employs the same terminology, models knowledge using the same constructs, and is applied only in comparable clinical environments
- Allows different institutions to share software and knowledge bases
- Required if we want to achieve economies of scale in clinical decision support

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SAGE: Transactional and Semantic Interoperability

- Create all SAGE sharable guideline data strictly adhering to SNOMED CT, LOINC, RxNorm standards requirements
- Explicitly model guideline context and workflow assumptions for translation to local settings
- Vendor-specific process translates SAGE data sets to their local terminologies and information models
- Create a virtual medical record (vMR) model in dialogue with standards developers including HL7 RIM and College of American Pathologists
- A guideline execution engine employs the SAGE data, supplementing their clinical information system, and delivering the guideline decision support during ordering sessions

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Interoperability: Computer systems freely sharing data and programs for a common purpose

- 1) Functional: physical link
- 2) Transactional: sharing data
- 3) Semantic: sharing data meaning
- 4) Procedural: sharing executable process
- 5) Ergonomic: software employed within a shared work plan

- 1) OSI layers 1-2: physical connectivity
- 2) OSI 3-6: transport and messaging
- 3) OSI layer 7: data content standards
- 4) OSI 7: software and knowledge-based standards
- 5) OSI 7+: workflow coalition and others

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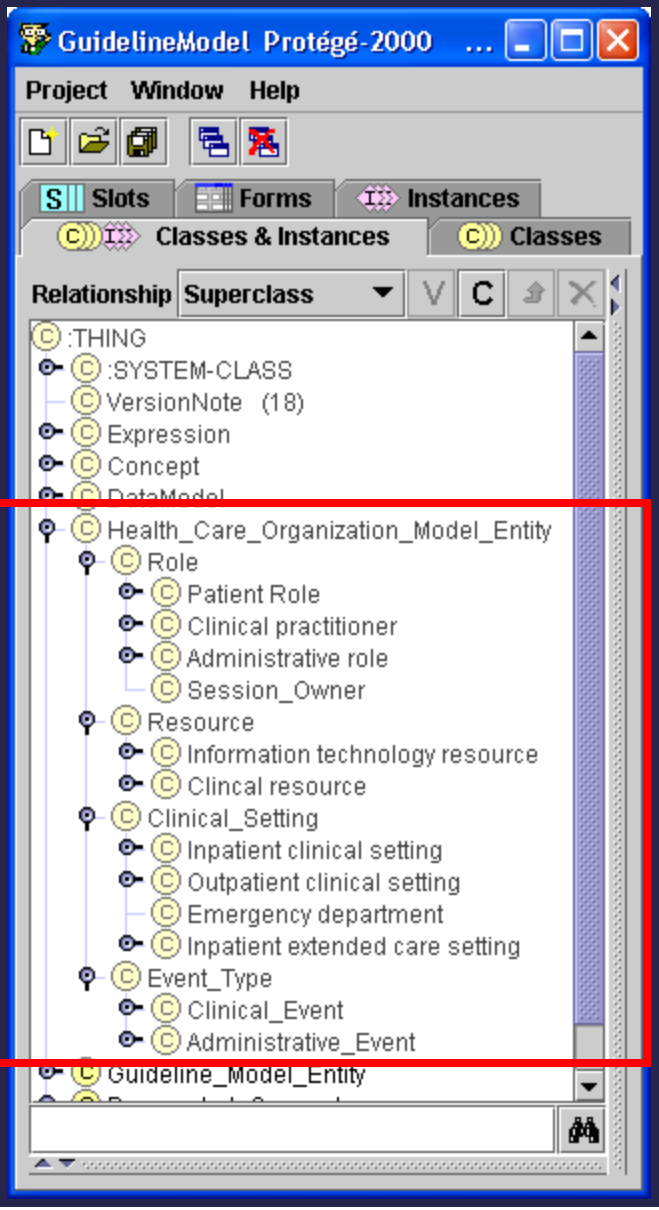
Standardizing The Clinical Context



- Organizational Model
  - Roles
  - Resources
  - Settings
  - Events

Based on workflow management coalition specifications

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Organizing Workflow Around Problem-indexed Session-based Order Sets

- Order sessions are defined by points in the care process when decision making or change in care plan occur
- Goal setting and outcomes documentation integrated with charting
- Integrated problem list management
- Order sets and subsets:
  - Navigation within large list (2-3,000) of order sets by diagnosis or procedure
  - Co-morbidity order sets for managing complex patients
  - Identification of “units of work” as nested sets for editorial maintenance

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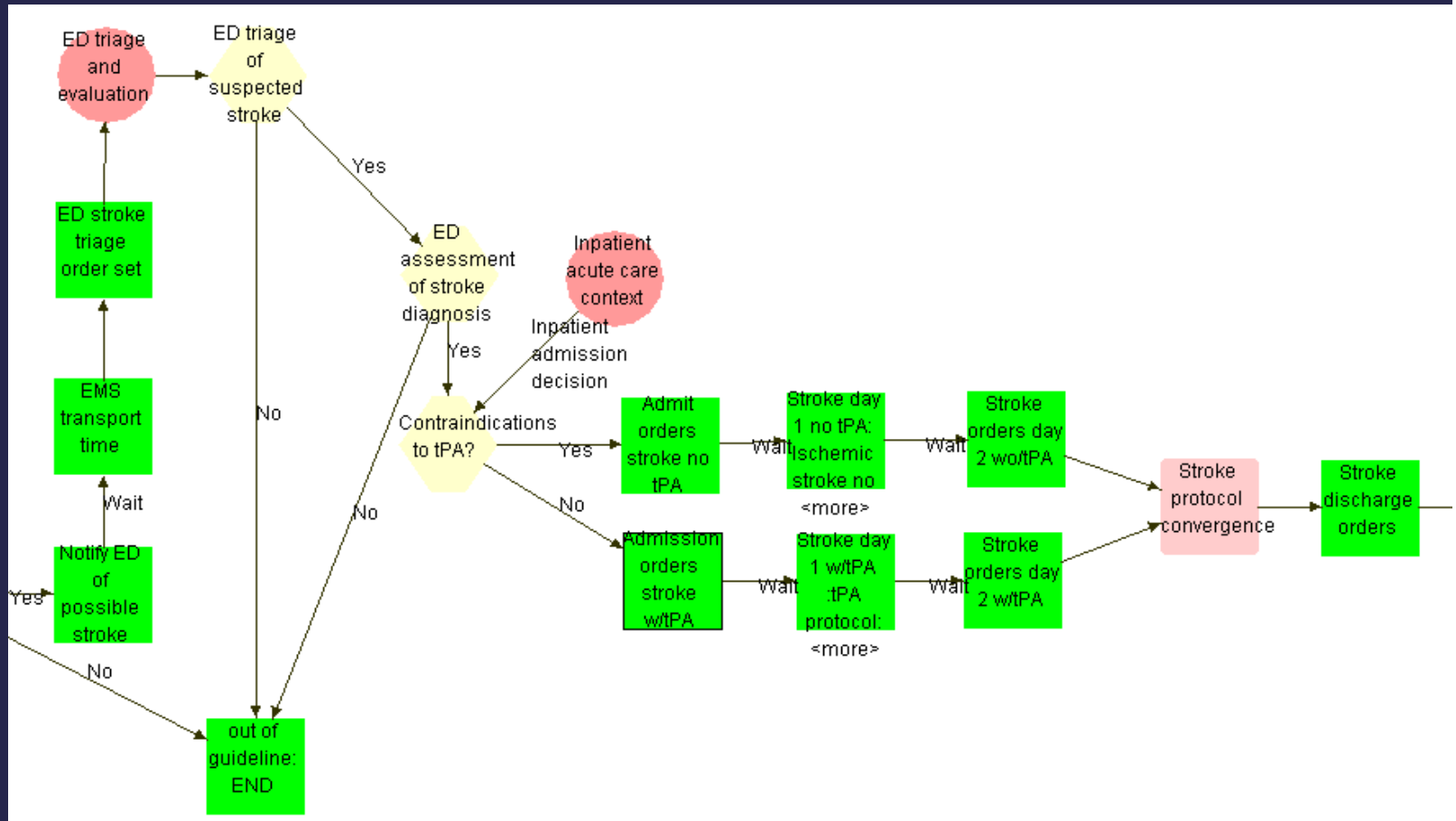
How will it work?
1) Specify the clinical scenario for support
2) Model the decisions and actions for specific guideline clinical scenarios



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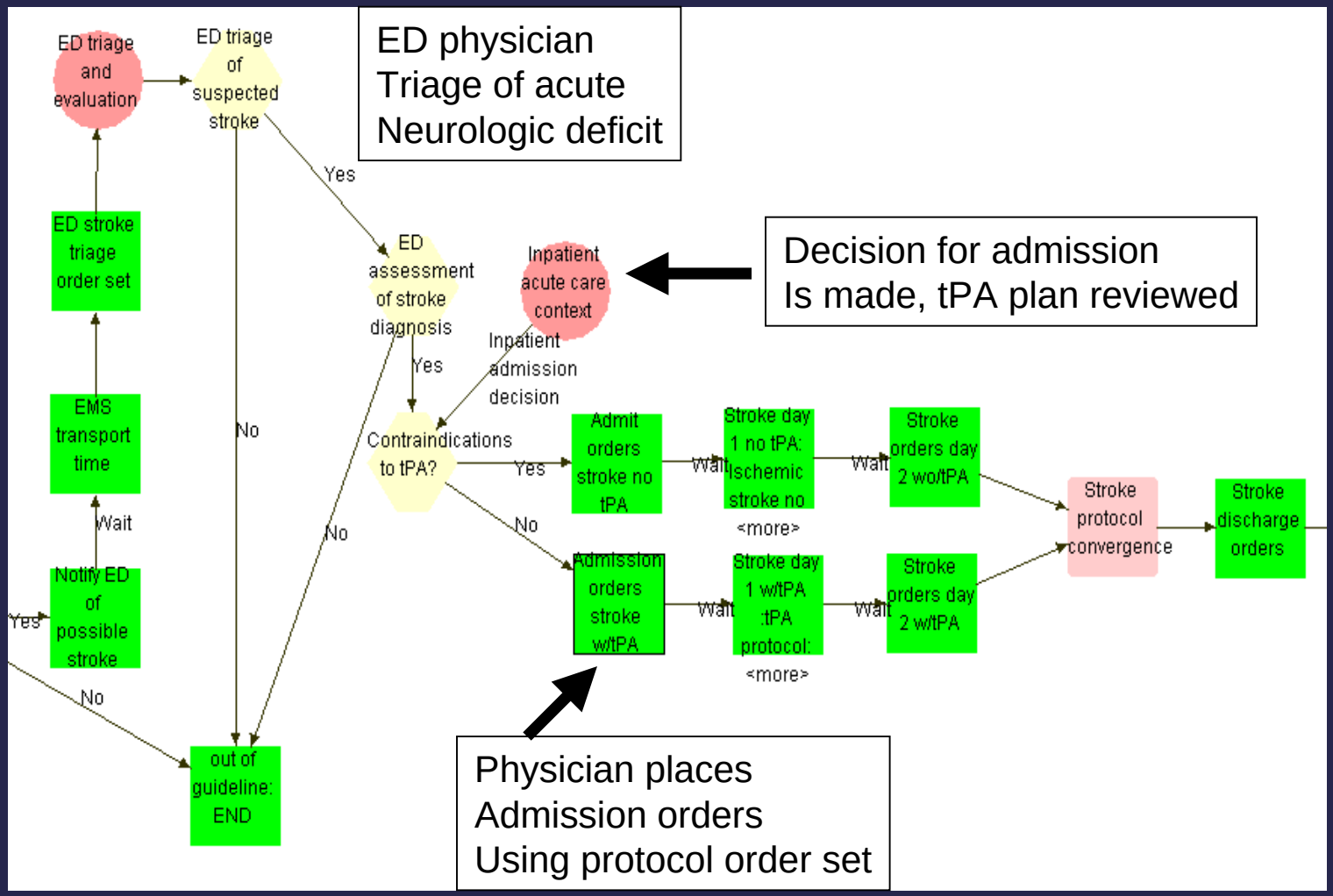
How will it work?
3) Link the model to an 'ideal enterprise' workflow and supporting software tools



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UNMC Goal: Expanding Institutional Memory

- **Content development for CPOE too expensive for one institution**
- **Integration of nursing care plans and institutional workflow into guideline model**
- **Clinical context specification**

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Standards-Based Sharable Active Guideline Environment

Roberto A. Rocha, MD, PhD

Senior Medical Informaticist, Intermountain Health Care

Assistant Professor, University of Utah

roberto.rocha@ihc.com

- Standard information models
- Alignment with standards organizations

Problem Focus: Designing and specifying the standards-based information models required to mediate the encoding and deployment of guideline content

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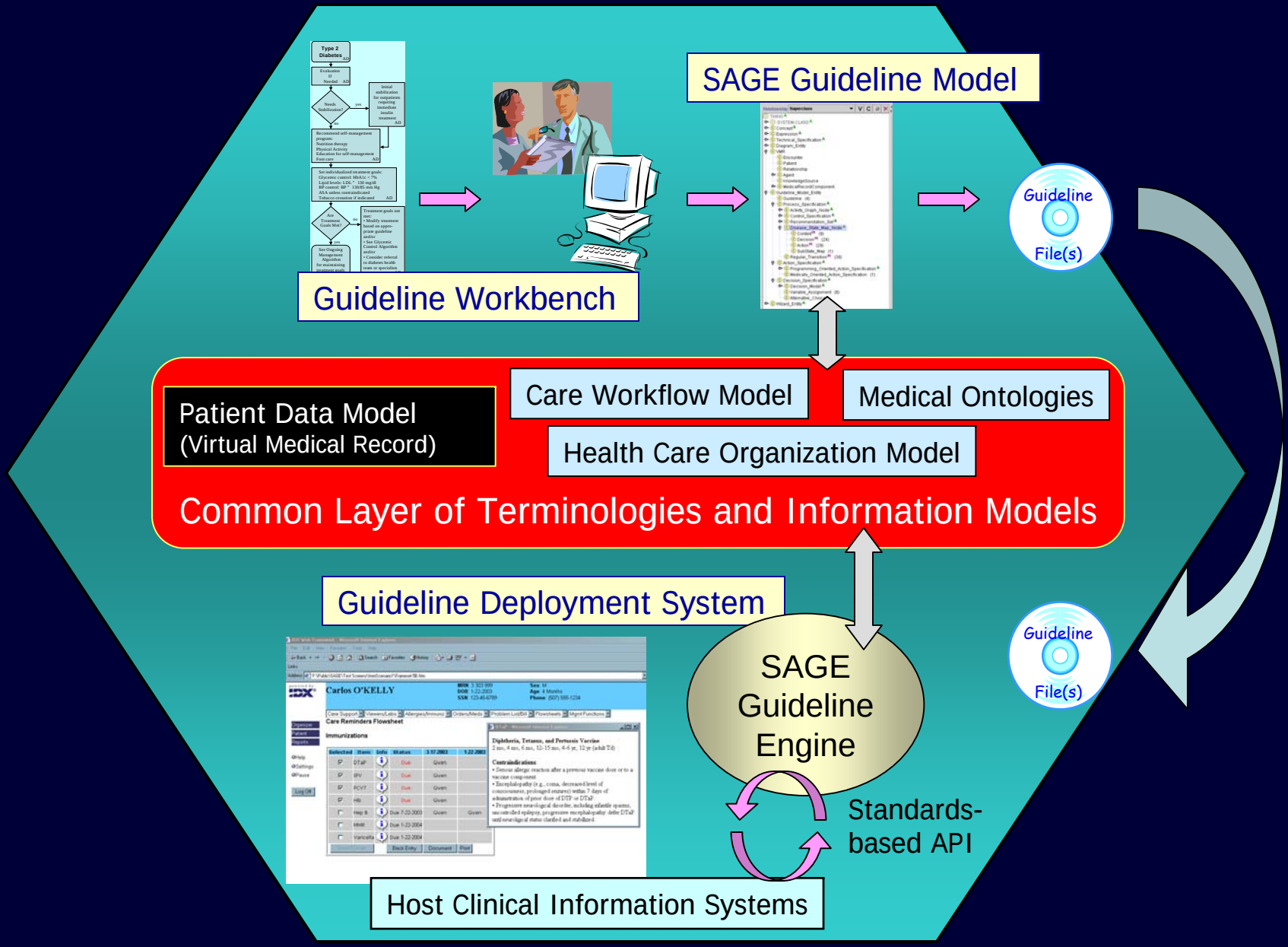
Information models

- Interoperability with:
  - EMR
    - Virtual Medical Record (VMR)
  - Hosting CIS
    - Host System Services (HSS)

Overview of the SAGE Infrastructure



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Assumption

- Sharable, executable guidelines…
  - All patient data referenced in a guideline MUST be defined by a base information model which is coupled to standard terminologies
    - VMR is a ***standard layer*** that enables interoperability between different systems (models)

Adapted from Harold Solbrig

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SAGE VMR

- Set of broad classes of clinical information → generic information model
  - Classes that a decision support system would need to read and write data to/from an electronic patient record
  - Model designed to be implementation independent, but with sufficient expressiveness to allow guideline execution

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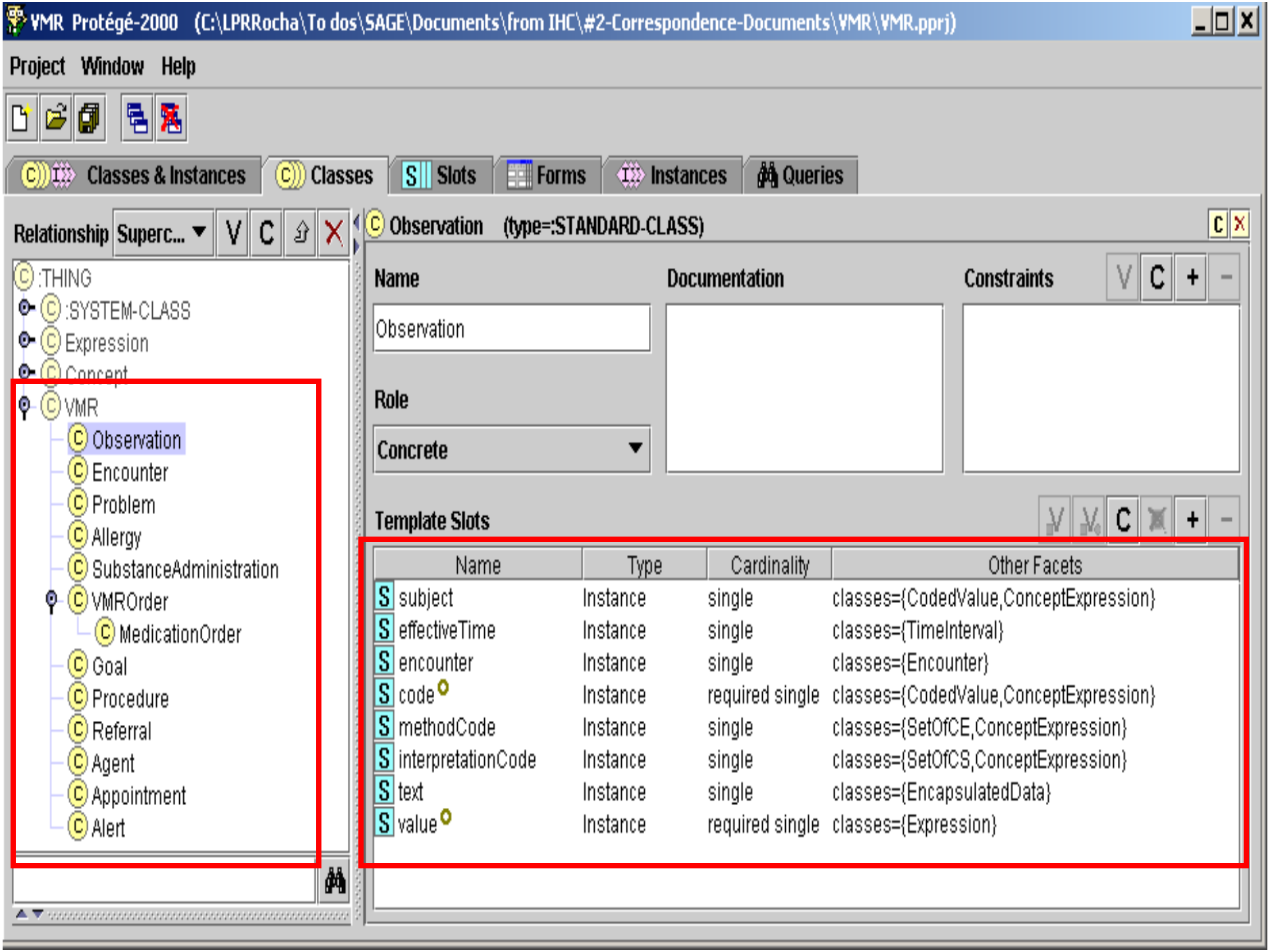
SAGE VMR Strategy

- Identify classes and sets of attributes from standard reference models
  - Classes from artifacts of the **HL7 Reference Information Model** (RIM)
    - Attributes needed for decision support are selected
    - Use more general RIM artifacts if no specific ones are available
  - Data models from other systems
- *Keep the VMR as simple as is practical*


VMR Protégé-2000 (C:\LPRRocha\To dos\SAGE\Documents\from IHC\#2-Correspondence-Documents\VMR\VMR.pprj)
Project Window Help
Classes & Instances
Classes
Slots
Forms
Instances
Queries
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:THING
:SYSTEM-CLASS
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VMR
Observation
Encounter
Problem
Allergy
SubstanceAdministration
VMROrder
MedicationOrder
Goal
Procedure
Referral
Agent
Appointment
Alert
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Observation
Documentation
Constraints
Role
Concrete
Template Slots
Name
Type
Cardinality
Other Facets
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Instance
single
classes={CodedValue,ConceptExpression}
effectiveTime
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classes={TimeInterval}
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classes={Encounter}
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classes={CodedValue,ConceptExpression}
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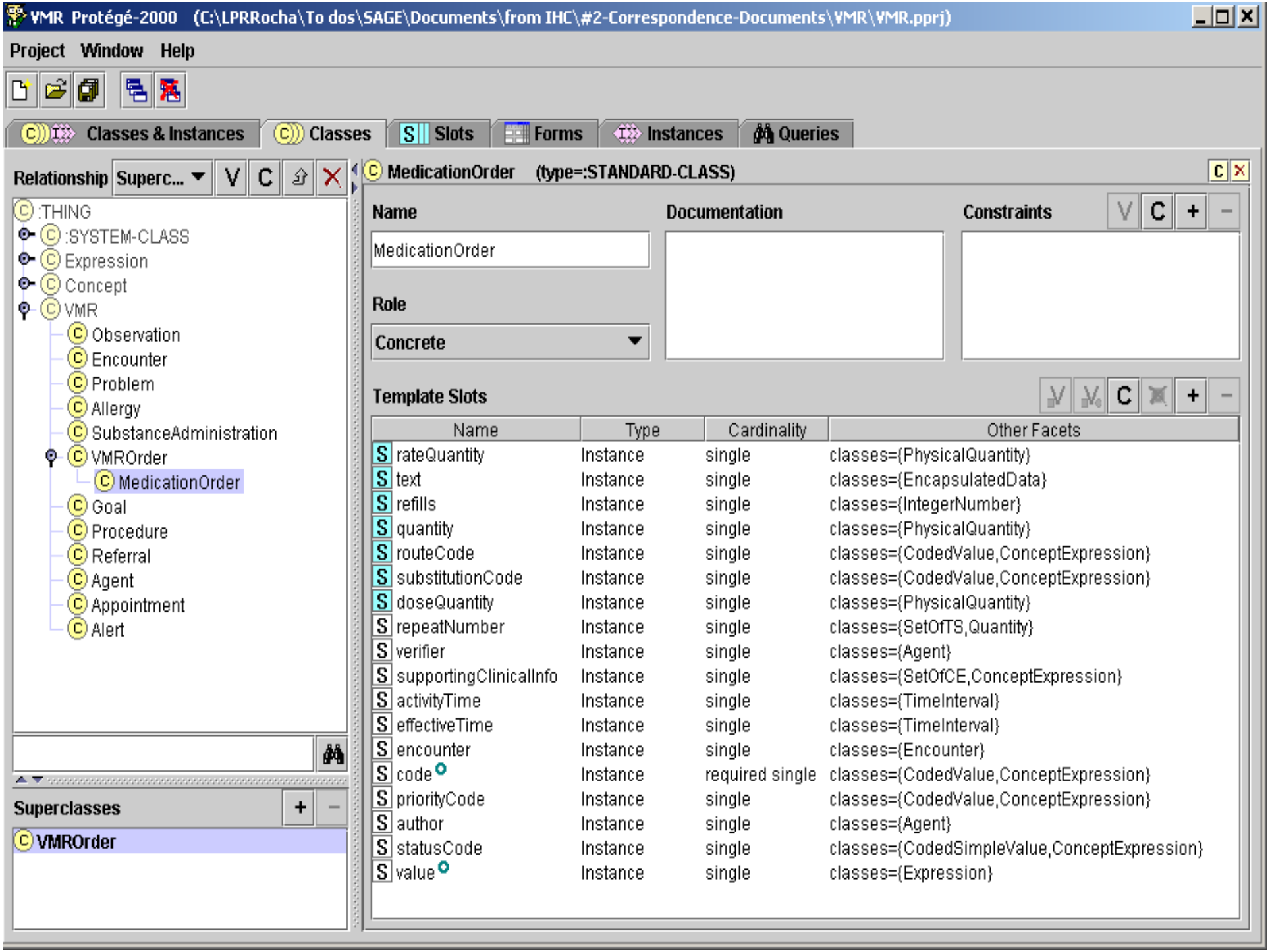
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Agent
Appointment
Alert
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VMROrder
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Documentation
Constraints
Role
Concrete
Template Slots
Name
Type
Cardinality
Other Facets
rateQuantity Instance single classes={PhysicalQuantity}
text Instance single classes={EncapsulatedData}
refills Instance single classes={IntegerNumber}
quantity Instance single classes={PhysicalQuantity}
routeCode Instance single classes={CodedValue,ConceptExpression}
substitutionCode Instance single classes={CodedValue,ConceptExpression}
doseQuantity Instance single classes={PhysicalQuantity}
repeatNumber Instance single classes={SetOfTS,Quantity}
verifier Instance single classes={Agent}
supportingClinicalInfo Instance single classes={SetOfCE,ConceptExpression}
activityTime Instance single classes={TimeInterval}
effectiveTime Instance single classes={TimeInterval}
encounter Instance single classes={Encounter}
code Instance required single classes={CodedValue,ConceptExpression}
priorityCode Instance single classes={CodedValue,ConceptExpression}
author Instance single classes={Agent}
statusCode Instance single classes={CodedSimpleValue,ConceptExpression}
value Instance single classes={Expression}

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Reconcile with RIM

- Three approaches:
  1. Use existing v3 messages
  2. Create VMR specific v3 messages based on existing DMIMS/RMIMs
  3. Create VMR DMIM

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Proposed Approach

- #2 - VMR specific messages based on existing DMIMs/RMIMs
  - Define guideline information needs in terms of existing, higher-level v3 artifacts.
    - Estimate ¾ already exist
  - Propose Message Types based on VMR needs (focused scope)
    - Create all of the HMDs and MTs

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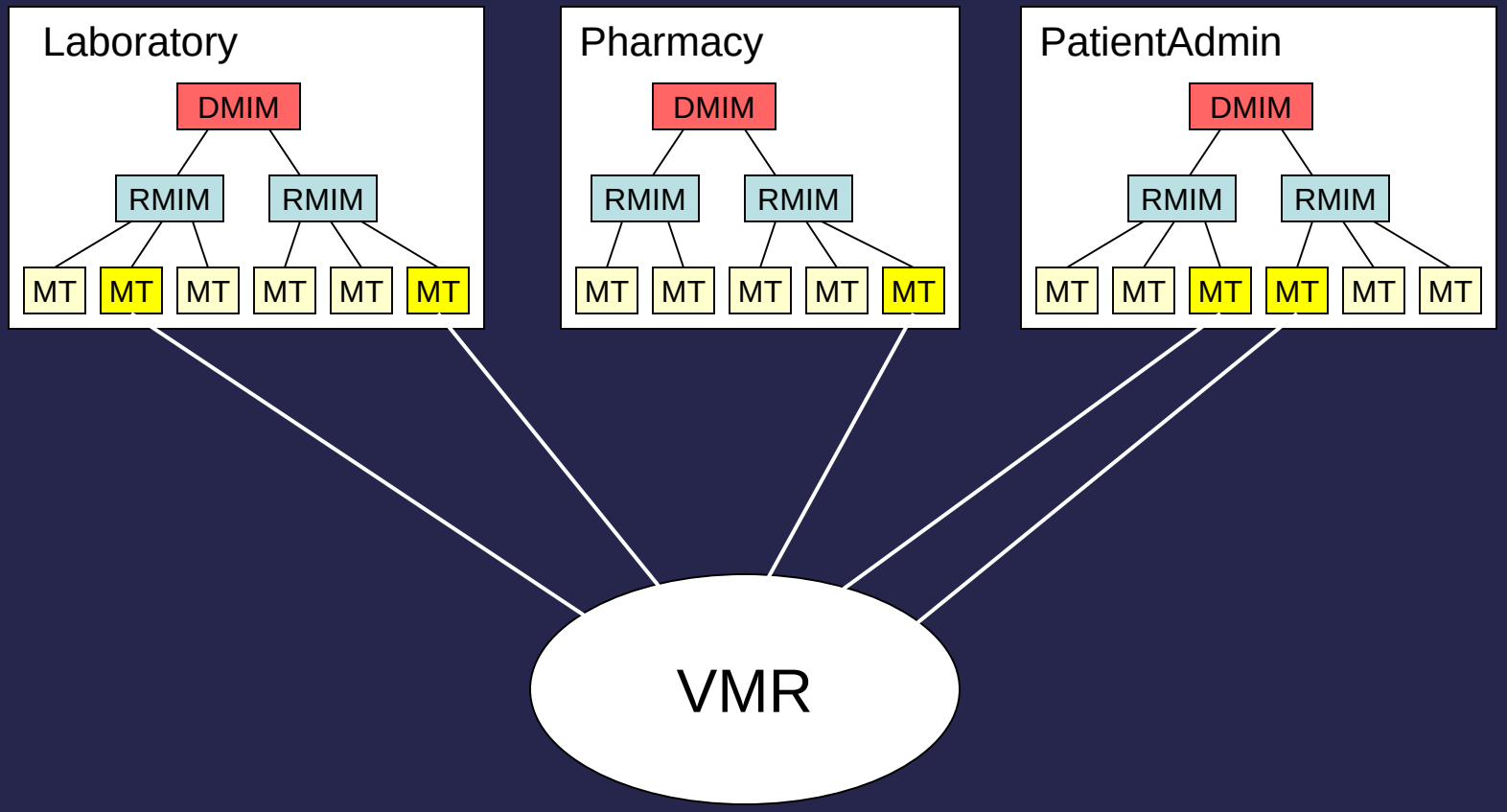
VMR Specific Messages



Define new message types specifically for the VMR.

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VMR Specific Messages

- Pros:
  - Leverage existing higher-level models
  - Leverage efforts of other TCs and SIGs
  - Messages tailored to VMR needs
- Con:
  - Dependent on other TCs and SIGs

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VMR: Current SAGE Plans

- Iteratively:
  - Create implementation (4 guidelines)
  - Refine model based on gathered experience (supporting documentation)
  - Reconcile with existing/new R/DMIMs
- Open collaboration with interested parties
  - Formalize within HL7 (SIGs and TCs)

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Detailed Clinical Models

- Created by restricting aspects of the VMR classes
  - Representation of concepts from clinical guidelines
  - Common model of information that implementers will map to their local data representations
- *"Clinical Expression Models" (CEMs)*

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CEM Example

```
<cem vmrClass="Observation">
   <restrict>
      <field>code.code</field>
      <value>271649006</field>
      <!--"Systolic Blood Pressure"-->
   </restrict>
   <restrict>
      <field>code.codeSystemName</field>
      <value>SNOMED-CT</value>
   </restrict>
   <restrict>
      <field>value.unit</field>
      <value>mmHg</value>
   </restrict>
</cem>
```

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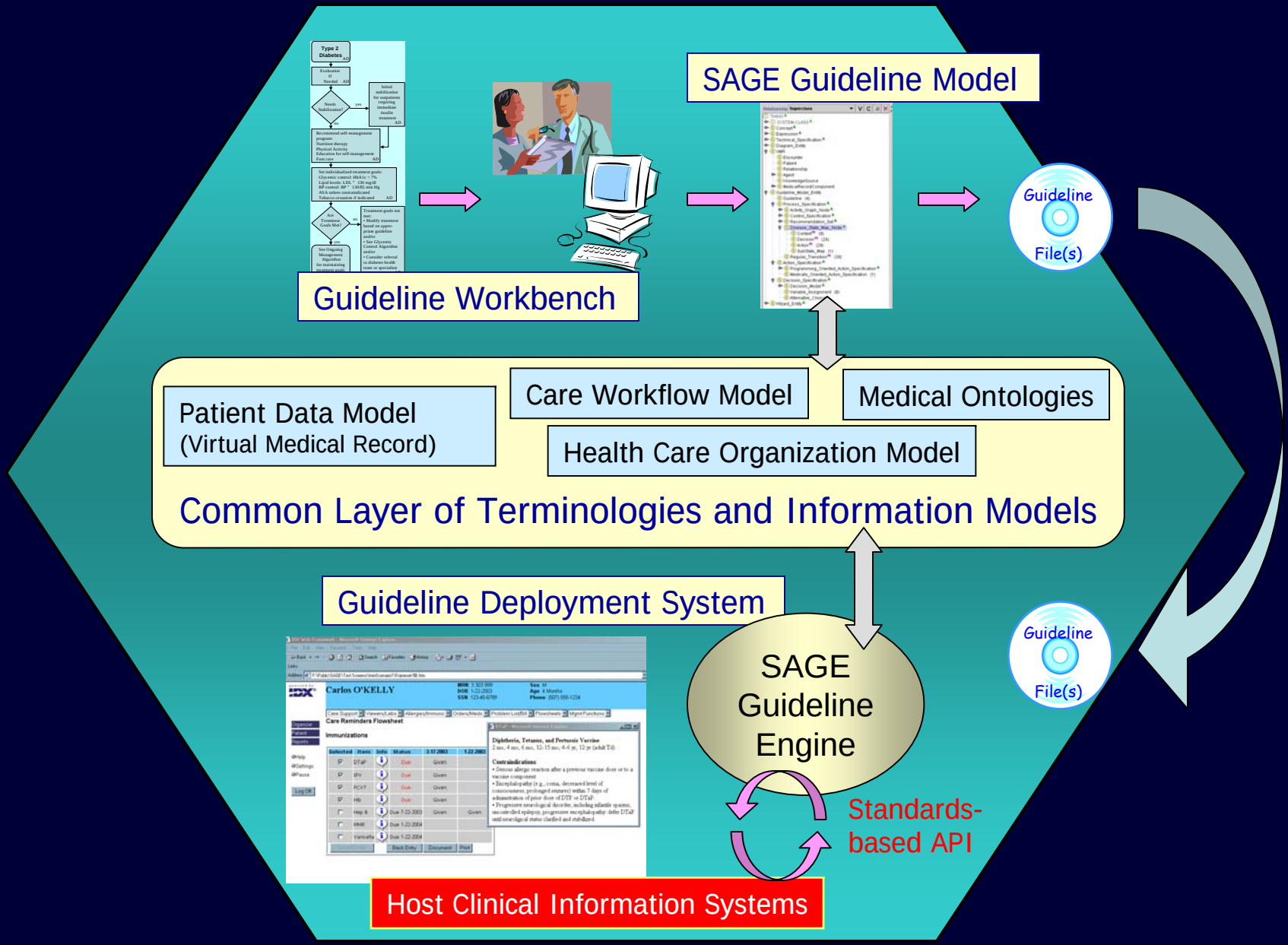
CEM: Current SAGE Plans

- Iteratively:
  - Create necessary CEMs for each implementation (4 guidelines)
- *Close collaboration with HL7's VMR and Template projects*
  - Propose a method for creating and sharing detailed clinical models

Overview of the SAGE Infrastructure



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Host System Services

- Services provided by a clinical information system (“host”) to a guideline execution environment
  - These services complement and interoperate with those provided by the guideline execution environment

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Identified HSS

- Order an action or a service
- Route a message
- Schedule an event
- Collect data from a person
- *Access (retrieval) of clinical data*
- *Store clinical data*
- Create relationships to patient
- CIS event publishing

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HSS Scope

- How far do HSSs go?
  - e.g. For an Alert Service do we:
    - specify a level of priority?
    - specify a delivery time range?
    - specify a delivery modality?
    - specify message formatting?
      - e.g. put the text “critical” in bold.
- Mapping to “guideline-defined activities”

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HSS: Current SAGE Plans

- Iteratively:
  - Define services for next guideline implementations
    - EHR initiative
  - Implement the APIs
- Open collaboration with interested parties
  - Formalize service definitions within HL7 (SIGs and TCs)
    - Provide reference implementations?

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Tony Weida, PhD

- Director, Emerging Applications
- Apelon, Inc.
- weida@apelon.com

- Integration of standard medical terminologies

Problem Focus: Specifying and automating the integration of controlled medical terminologies in guideline modeling and guideline deployment

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Apelon

- Products
  - Terminology Development Environment
  - Distributed Terminology System
  - Concept Based Indexing and Retrieval
  - TermWorks Web Services
- Services
  - Terminology development, integration and applications

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Terminology-powered Guidelines

- Make guidelines easier to
  - Author
  - Explain and understand
  - Publish and retrieve
  - Customize
  - Localize
  - Execute

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Apelon's SAGE Contributions

- Modeling
  - Terminology plug-in
  - Guideline registry
  - Concept expressions
- Execution
  - Terminology server
  - CTS specification
- Further directions …

Apelon

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DTS Plug-in

- Terminology services
  - Browse, search and inspect concepts
    - Standards: SNOMED, LOINC
    - Emerging terminologies: NDF-RT
    - Extensions proposed by SAGE
  - Map selected concepts to Protégé slots

The SAGE Project
Standards-Based Sharable Active Guideline Environment

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Protégé

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DTS Plug-in

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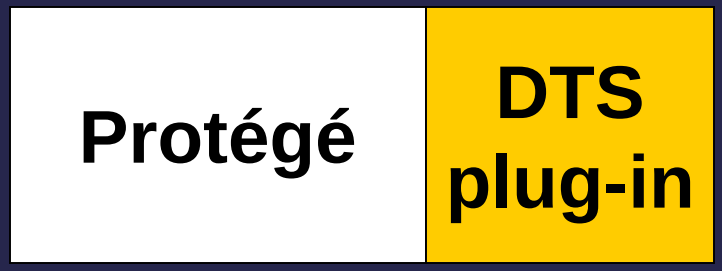

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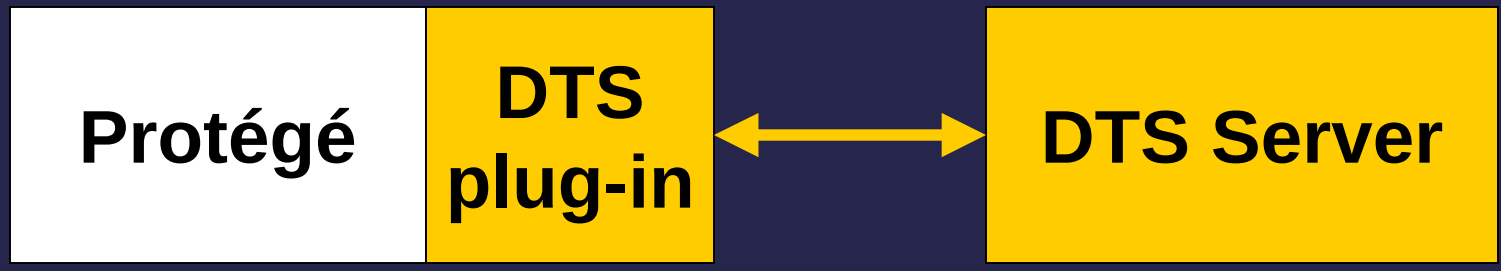
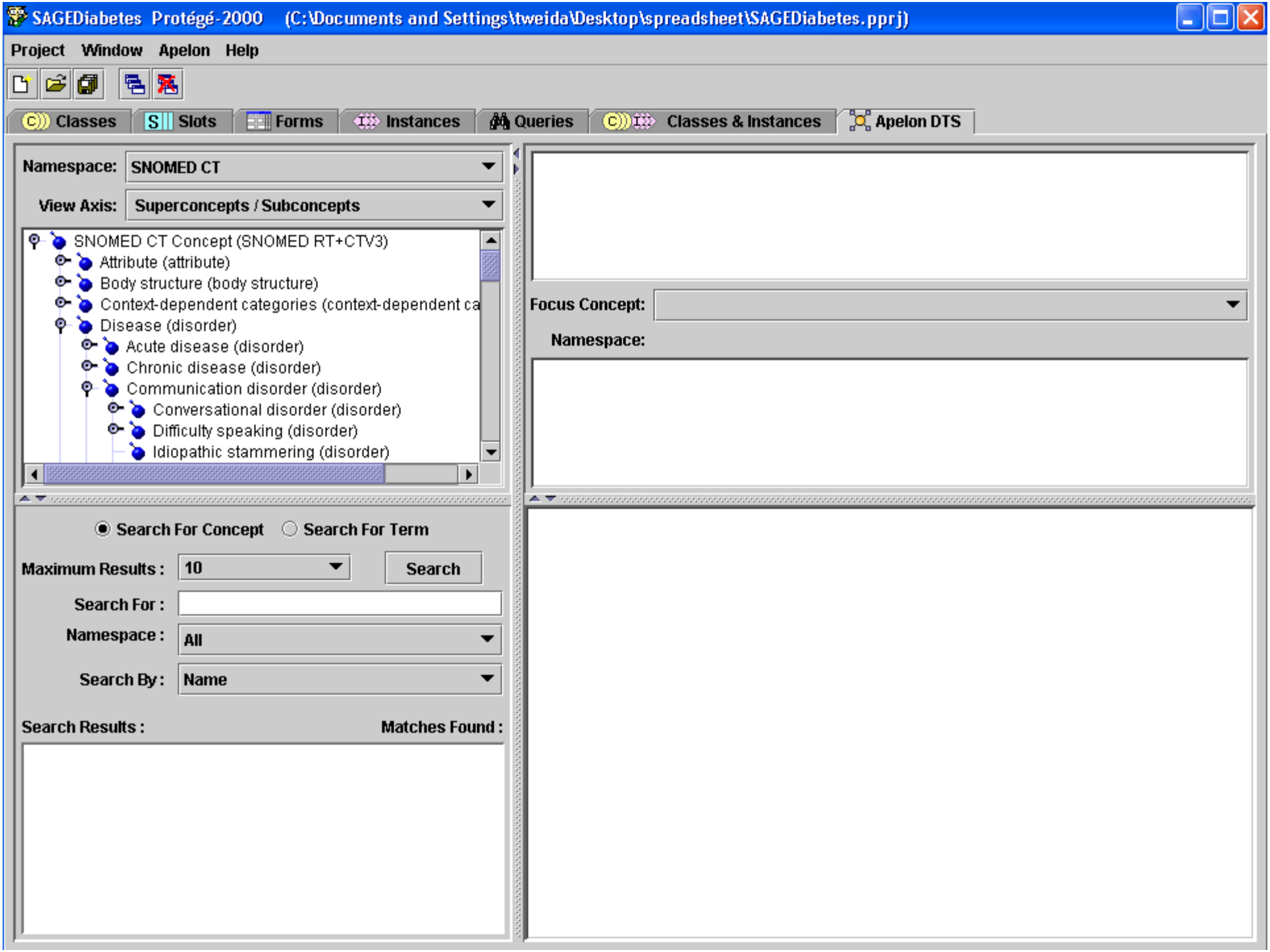
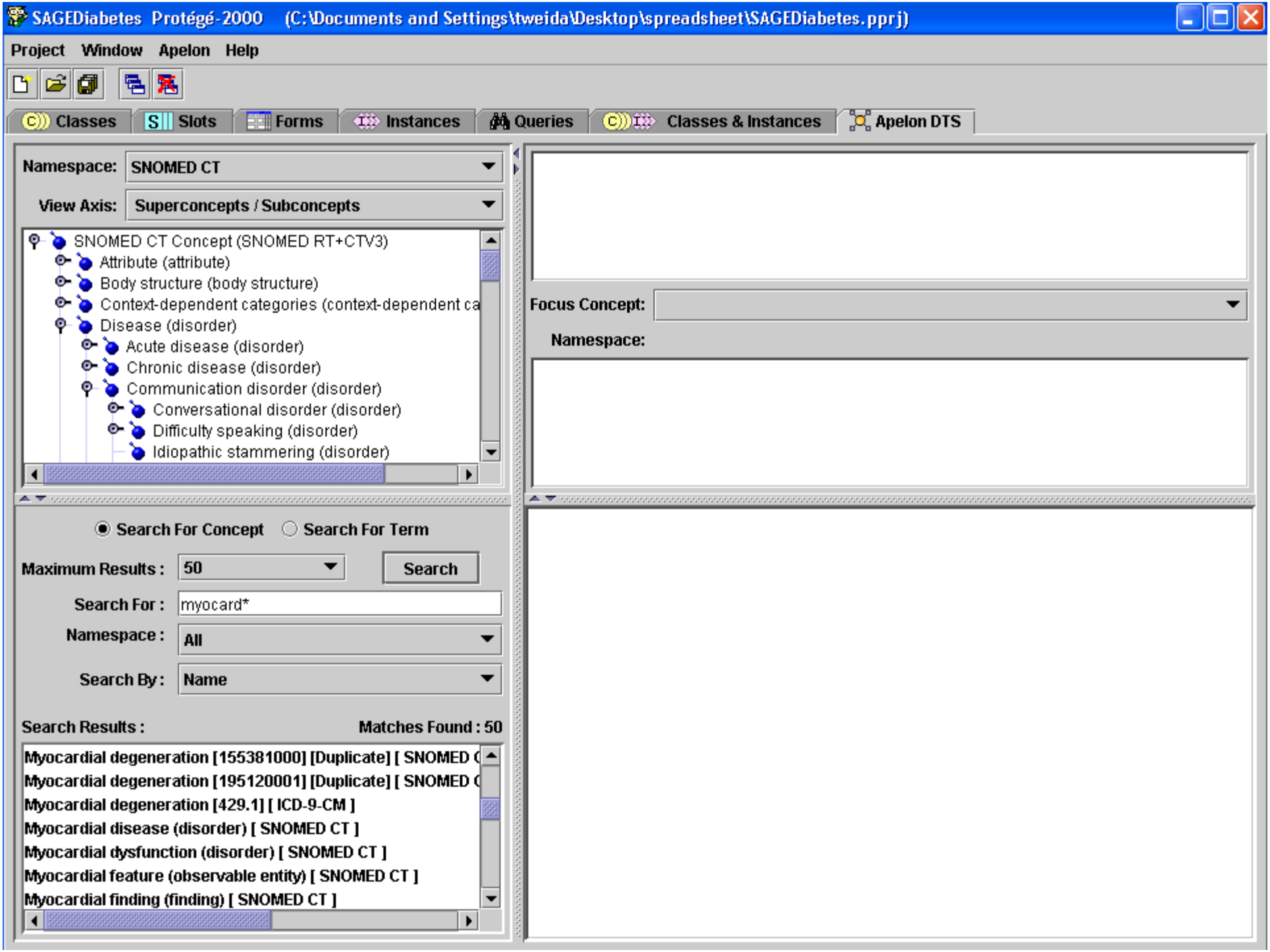



SAGEDiabetes Protégé-2000 (C:\Documents and Settings\tweida\Desktop\spreadsheet\SAGEDiabetes.pprj)
Project Window Apelon Help
Classes Slots Forms Instances Queries Classes & Instances Apelon DTS
Namespace: SNOMED CT
View Axis: Superconcepts / Subconcepts
SNOMED CT Concept (SNOMED RT+CTV3)
Attribute (attribute)
Body structure (body structure)
Context-dependent categories (context-dependent ca
Disease (disorder)
Acute disease (disorder)
Chronic disease (disorder)
Communication disorder (disorder)
Conversational disorder (disorder)
Difficulty speaking (disorder)
Idiopathic stammering (disorder)
Focus Concept:
Namespace:
Search For Concept
Search For Term
Maximum Results : 10
Search
Search For :
Namespace : All
Search By : Name
Search Results :
Matches Found :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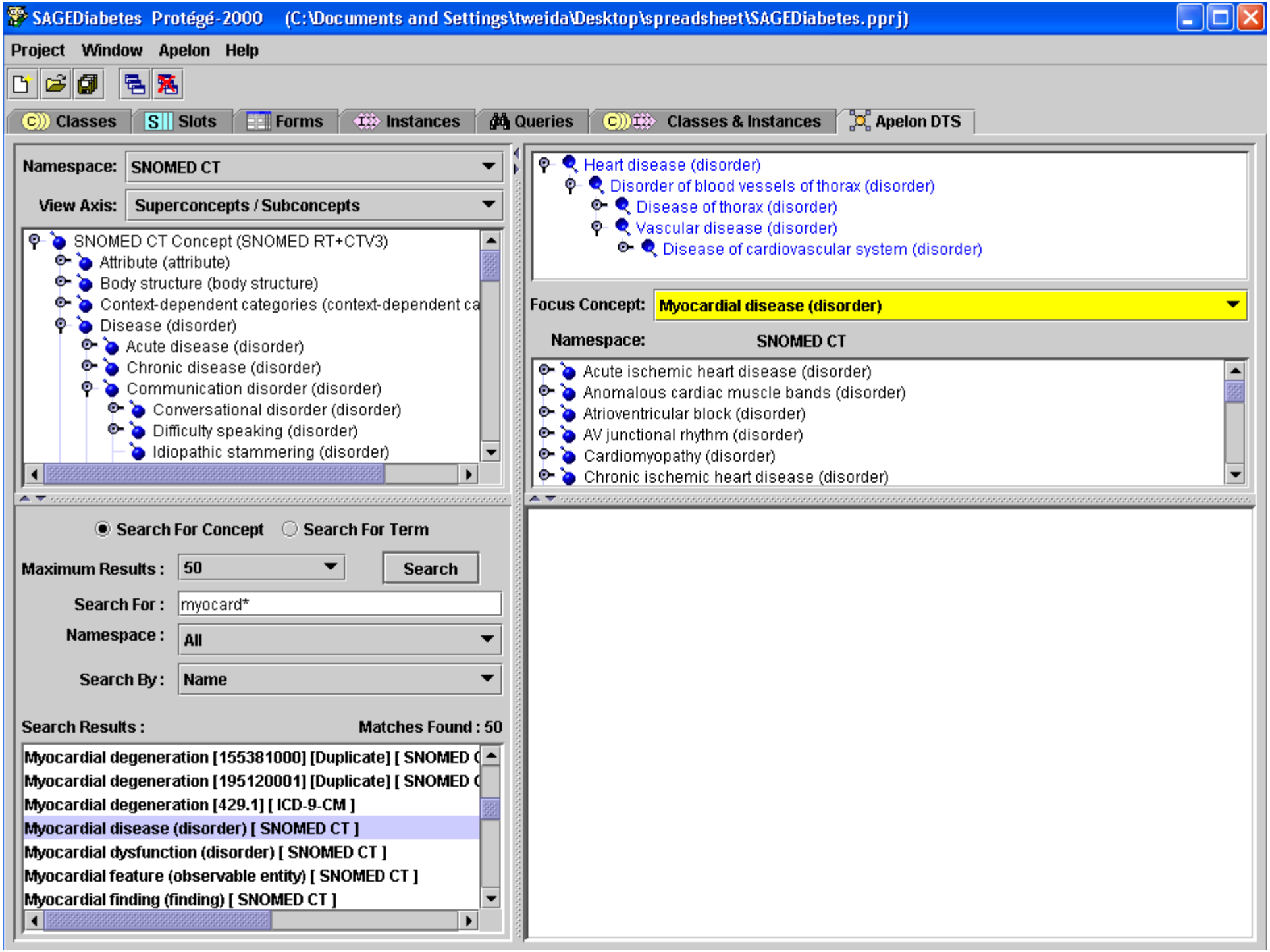
Project Window Apelon Help
Classes Slots Forms Instances Queries Classes & Instances Apelon DTS
Namespace: SNOMED CT
View Axis: Superconcepts / Subconcepts
SNOMED CT Concept (SNOMED RT+CTV3)
Attribute (attribute)
Body structure (body structure)
Context-dependent categories (context-dependent ca
Disease (disorder)
Acute disease (disorder)
Chronic disease (disorder)
Communication disorder (disorder)
Conversational disorder (disorder)
Difficulty speaking (disorder)
Idiopathic stammering (disorder)
Focus Concept:
Namespace:
Search For Concept
Search For Term
Maximum Results : 50
Search
Search For : myocard*
Namespace : All
Search By : Name
Search Results :
Matches Found : 50
Myocardial degeneration [155381000] [Duplicate] [SNOMED C
Myocardial degeneration [195120001] [Duplicate] [SNOMED C
Myocardial degeneration [429.1] [ICD-9-CM]
Myocardial disease (disorder) [SNOMED CT]
Myocardial dysfunction (disorder) [SNOMED CT]
Myocardial feature (observable entity) [SNOMED CT]
Myocardial finding (finding) [SNOMED CT]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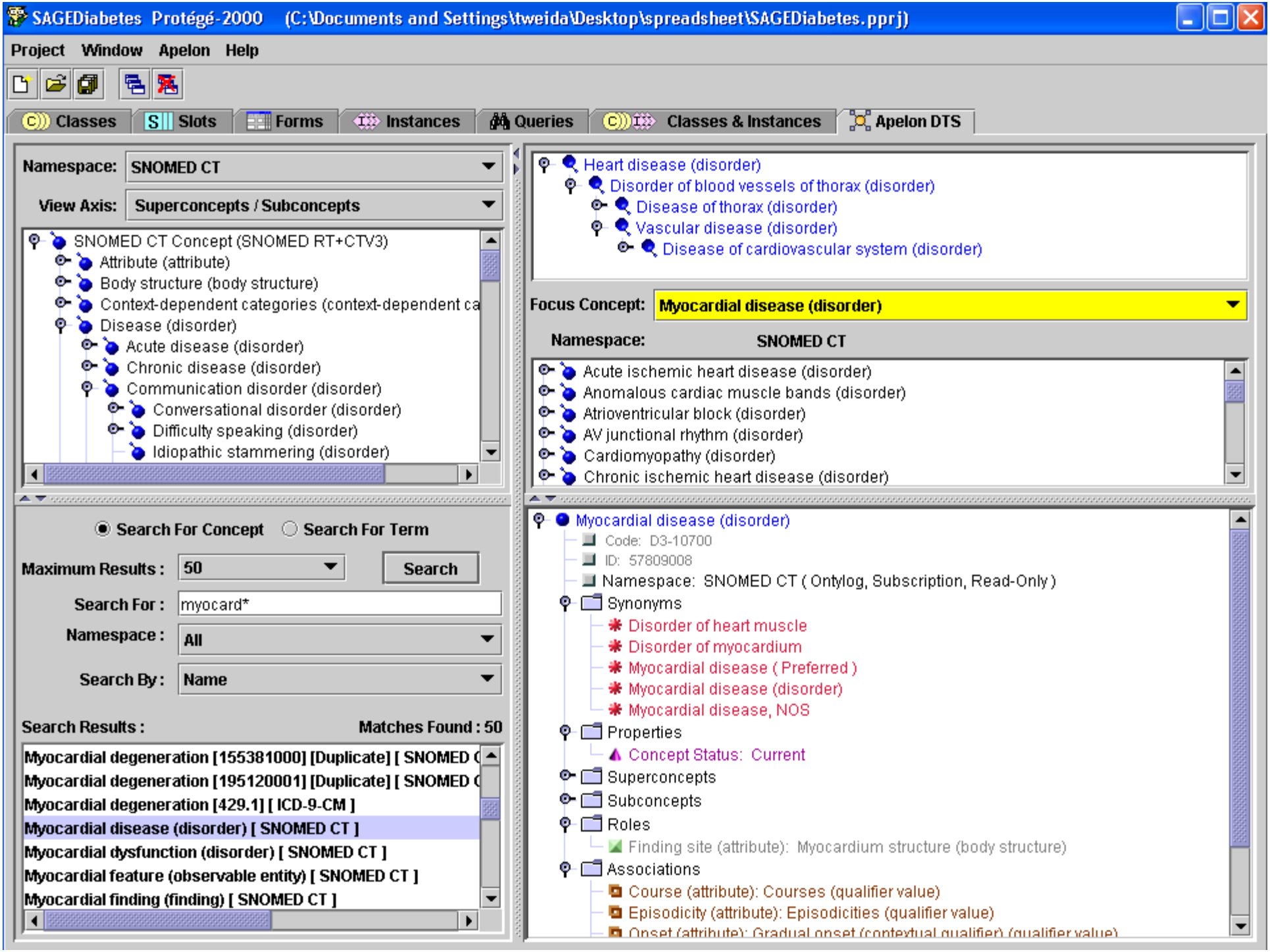
Project Window Apelon Help
Classes Slots Forms Instances Queries Classes & Instances Apelon DTS
Namespace: SNOMED CT
View Axis: Superconcepts / Subconcepts
SNOMED CT Concept (SNOMED RT+CTV3)
Attribute (attribute)
Body structure (body structure)
Context-dependent categories (context-dependent ca
Disease (disorder)
Acute disease (disorder)
Chronic disease (disorder)
Communication disorder (disorder)
Conversational disorder (disorder)
Difficulty speaking (disorder)
Idiopathic stammering (disorder)
Heart disease (disorder)
Disorder of blood vessels of thorax (disorder)
Disease of thorax (disorder)
Vascular disease (disorder)
Disease of cardiovascular system (disorder)
Focus Concept: Myocardial disease (disorder)
Namespace: SNOMED CT
Acute ischemic heart disease (disorder)
Anomalous cardiac muscle bands (disorder)
Atrioventricular block (disorder)
AV junctional rhythm (disorder)
Cardiomyopathy (disorder)
Chronic ischemic heart disease (disorder)
Search For Concept
Search For Term
Maximum Results : 50
Search
Search For : myocard*
Namespace : All
Search By : Name
Search Results :
Matches Found : 50
Myocardial degeneration [155381000] [Duplicate] [SNOMED C
Myocardial degeneration [195120001] [Duplicate] [SNOMED C
Myocardial degeneration [429.1] [ICD-9-CM]
Myocardial disease (disorder) [SNOMED CT]
Myocardial dysfunction (disorder) [SNOMED CT]
Myocardial feature (observable entity) [SNOMED CT]
Myocardial finding (finding) [SNOMED CT]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Project Window Apelon Help
Classes Slots Forms Instances Queries Classes & Instances Apelon DTS
Namespace: SNOMED CT
View Axis: Superconcepts / Subconcepts
SNOMED CT Concept (SNOMED RT+CTV3)
Attribute (attribute)
Body structure (body structure)
Context-dependent categories (context-dependent ca
Disease (disorder)
Acute disease (disorder)
Chronic disease (disorder)
Communication disorder (disorder)
Conversational disorder (disorder)
Difficulty speaking (disorder)
Idiopathic stammering (disorder)
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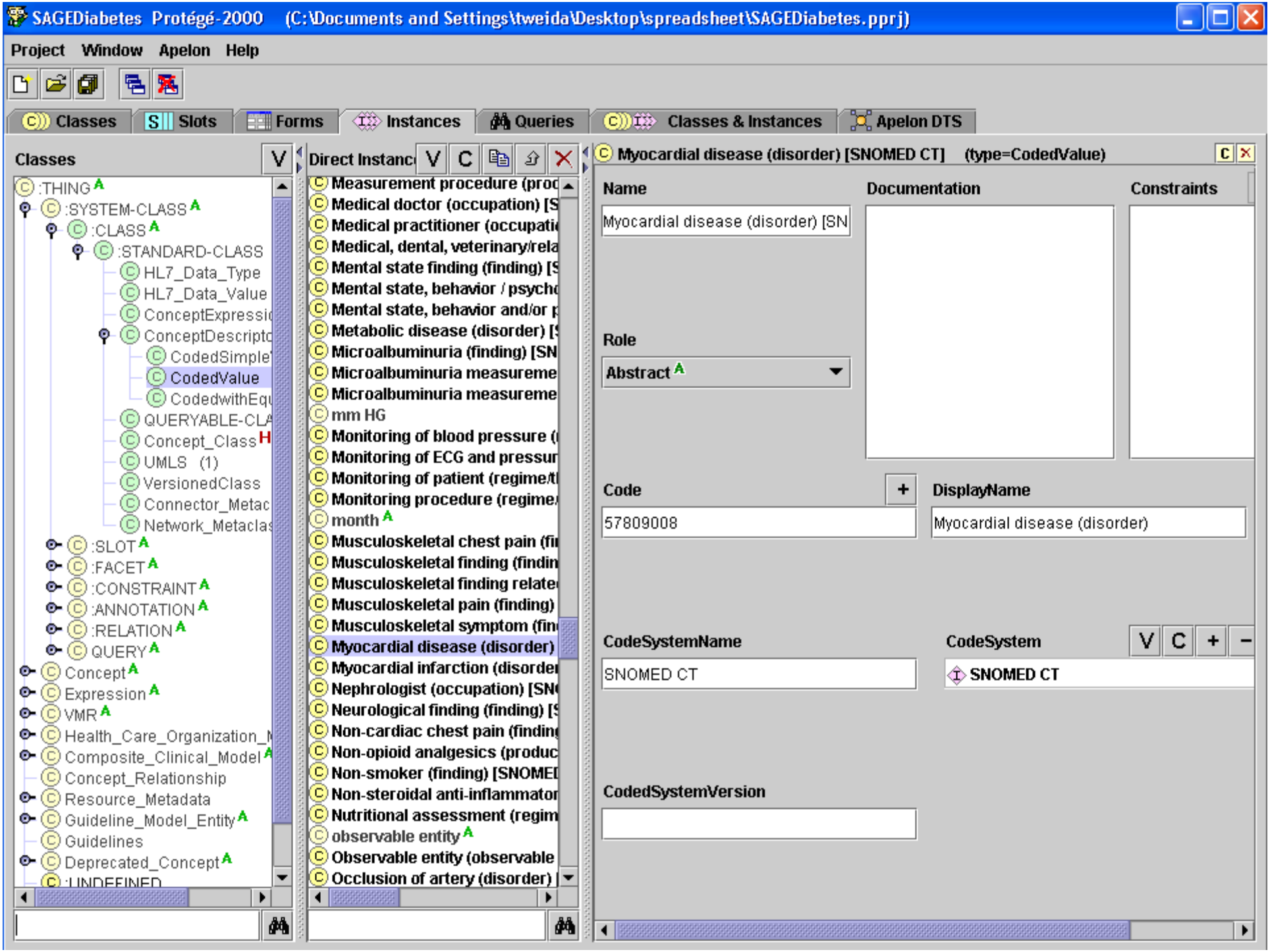
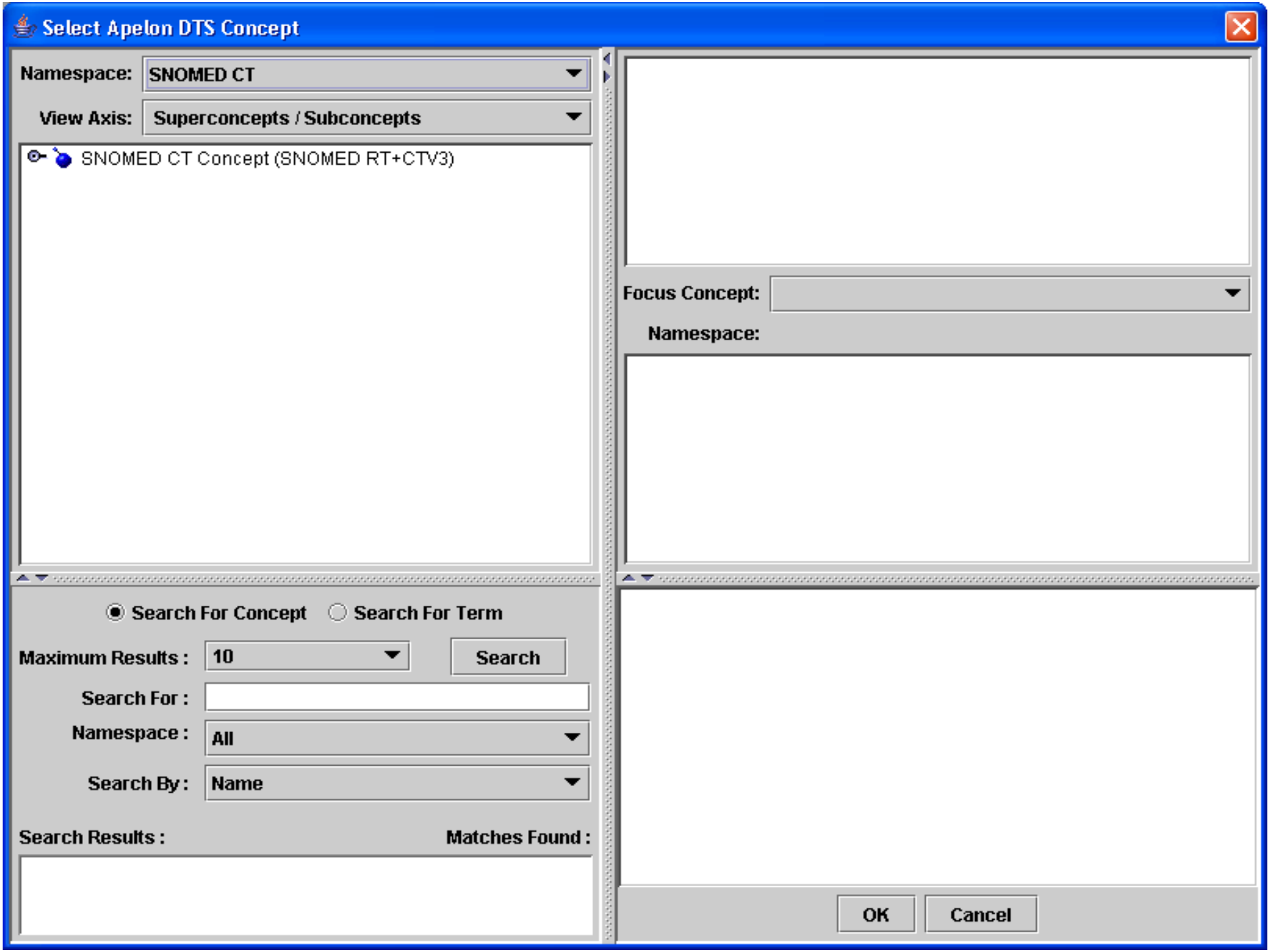
Focus Concept: Myocardial disease (disorder)
Namespace: SNOMED CT
Acute ischemic heart disease (disorder)
Anomalous cardiac muscle bands (disorder)
Atrioventricular block (disorder)
AV junctional rhythm (disorder)
Cardiomyopathy (disorder)
Chronic ischemic heart disease (disorder)
Search For Concept Search For Term
Maximum Results : 50
Search
Search For : myocard*
Namespace : All
Search By : Name
Search Results : Matches Found : 50
Myocardial degeneration [155381000] [Duplicate] [SNOMED C
Myocardial degeneration [195120001] [Duplicate] [SNOMED C
Myocardial degeneration [429.1] [ICD-9-CM]
Myocardial disease (disorder) [SNOMED CT]
Myocardial dysfunction (disorder) [SNOMED CT]
Myocardial feature (observable entity) [SNOMED CT]
Myocardial finding (finding) [SNOMED CT]
Myocardial disease (disorder)
Code: D3-10700
ID: 57809008
Namespace: SNOMED CT (Ontylog, Subscription, Read-Only)
Synonyms
Disorder of heart muscle
Disorder of myocardium
Myocardial disease (Preferred)
Myocardial disease (disorder)
Myocardial disease, NOS
Properties
Concept Status: Current
Superconcepts
Subconcepts
Roles
Finding site (attribute): Myocardium structure (body structure)
Associations
Course (attribute): Courses (qualifier value)
Episodicity (attribute): Episodicities (qualifier value)

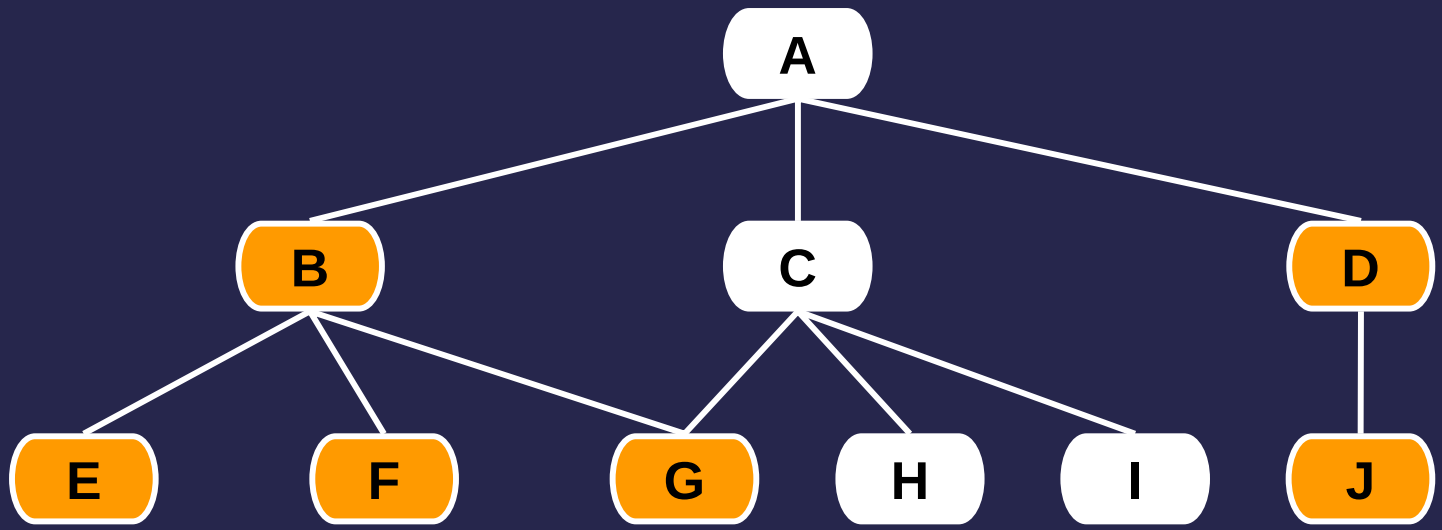

SAGEDiabetes Protégé-2000 (C:\Documents and Settings\tweida\Desktop\spreadsheet\SAGEDiabetes.pprj)
Project Window Apelon Help
Classes Slots Forms Instances Queries Classes & Instances Apelon DTS
Classes
:THING
:SYSTEM-CLASS
:CLASS
:STANDARD-CLASS
HL7_Data_Type
HL7_Data_Value
ConceptExpressi
ConceptDescripto
CodedSimple
CodedValue
CodedwithEqu
QUERYABLE-CLA
Concept_Class
UMLS (1)
VersionedClass
Connector_Metac
Network_Metaclas
:SLOT
:FACET
:CONSTRAINT
:ANNOTATION
:RELATION
QUERY
Concept
Expression
VMR
Health_Care_Organization_M
Composite_Clinical_Model
Concept_Relationship
Resource_Metadata
Guideline_Model_Entity
Guidelines
Deprecated_Concept
:UNDEFINED
Direct Instanc
Measurement procedure (proc
Medical doctor (occupation) [S
Medical practitioner (occupati
Medical, dental, veterinary/rela
Mental state finding (finding) [S
Mental state, behavior / psycho
Mental state, behavior and/or p
Metabolic disease (disorder) [S
Microalbuminuria (finding) [SN
Microalbuminuria measureme
Microalbuminuria measureme
mm HG
Monitoring of blood pressure (
Monitoring of ECG and pressur
Monitoring of patient (regime/t
Monitoring procedure (regime/
month
Musculoskeletal chest pain (fi
Musculoskeletal finding (findin
Musculoskeletal finding relate
Musculoskeletal pain (finding)
Musculoskeletal symptom (fin
Myocardial disease (disorder)
Myocardial infarction (disorder
Nephrologist (occupation) [SN
Neurological finding (finding) [S
Non-cardiac chest pain (findin
Non-opioid analgesics (produc
Non-smoker (finding) [SNOMED
Non-steroidal anti-inflammator
Nutritional assessment (regim
observable entity
Observable entity (observable
Occlusion of artery (disorder)
Myocardial disease (disorder) [SNOMED CT] (type=CodedValue)
Name
Myocardial disease (disorder) [SN
Documentation
Constraints
Role
Abstract
Code
57809008
DisplayName
Myocardial disease (disorder)
CodeSystemName
SNOMED CT
CodeSystem
SNOMED CT
CodedSystemVersion


Select Apelon DTS Concept
Namespace:
SNOMED CT
View Axis:
Superconcepts / Subconcepts
SNOMED CT Concept (SNOMED RT+CTV3)
Focus Concept:
Namespace:
Search For Concept
Search For Term
Maximum Results :
10
Search
Search For :
Namespace :
All
Search By :
Name
Search Results :
Matches Found :
OK
Cancel

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Concept Expressions

- Arbitrary subsets of taxonomies
- Defined with logical operators
- Novel taxonomic interpretation



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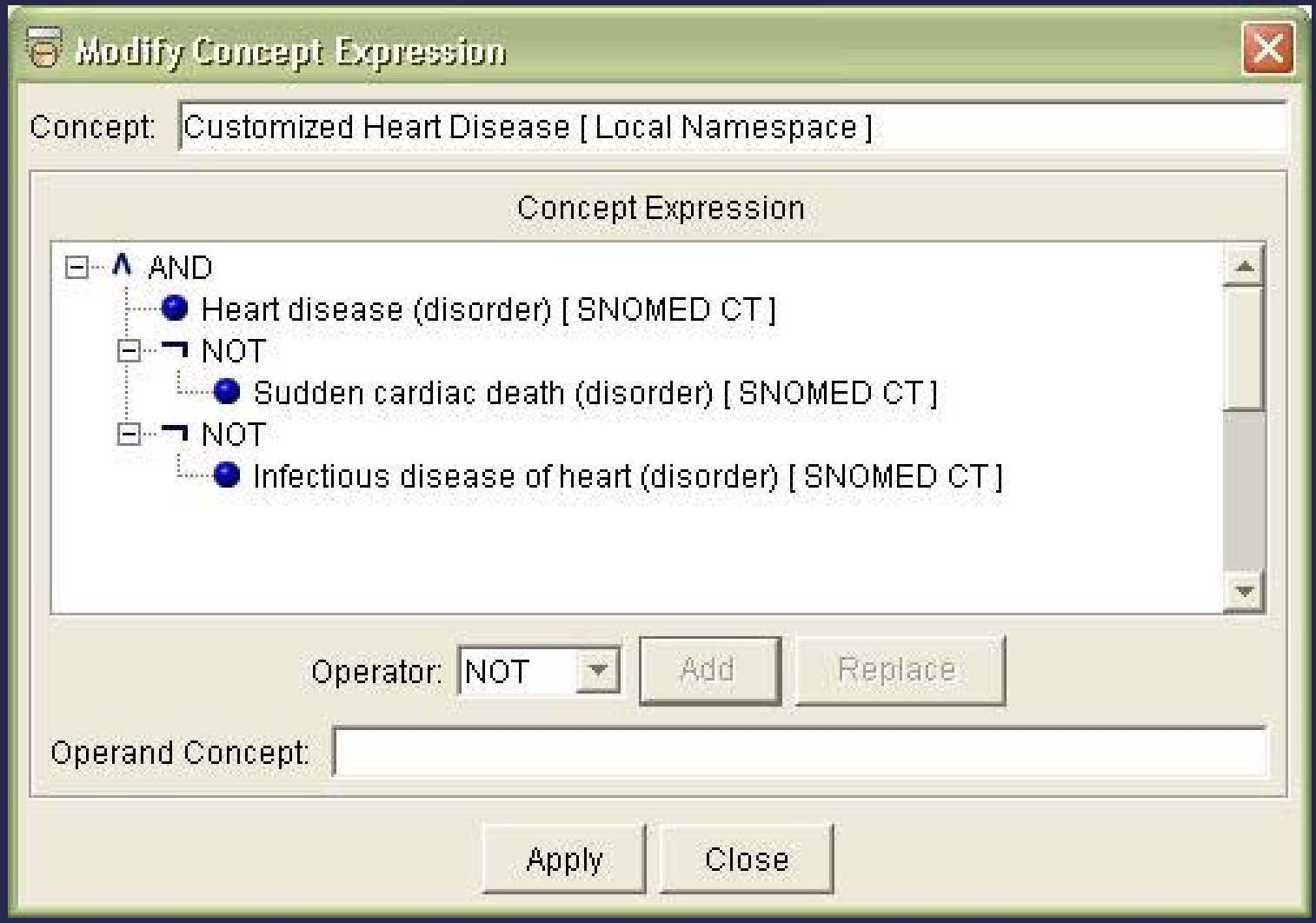
Expression Editor



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Guideline Registry

- Goals
  - Collaborative development
  - Sharing and reuse
  - Lifecycle management
  - Standards-based
  - Terminological metadata

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Standards-Based Sharable Active Guideline Environment

Registry Architecture

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Registry Architecture

Guideline Registry Client

The SAGE Project
Standards-Based Sharable Active Guideline Environment

Registry Architecture

ebXML Registry Server

Guideline Registry Client

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Standards-Based Sharable Active Guideline Environment

Registry Architecture

ebXML Registry Server

Guideline Registry Client

Apelon DTS Server

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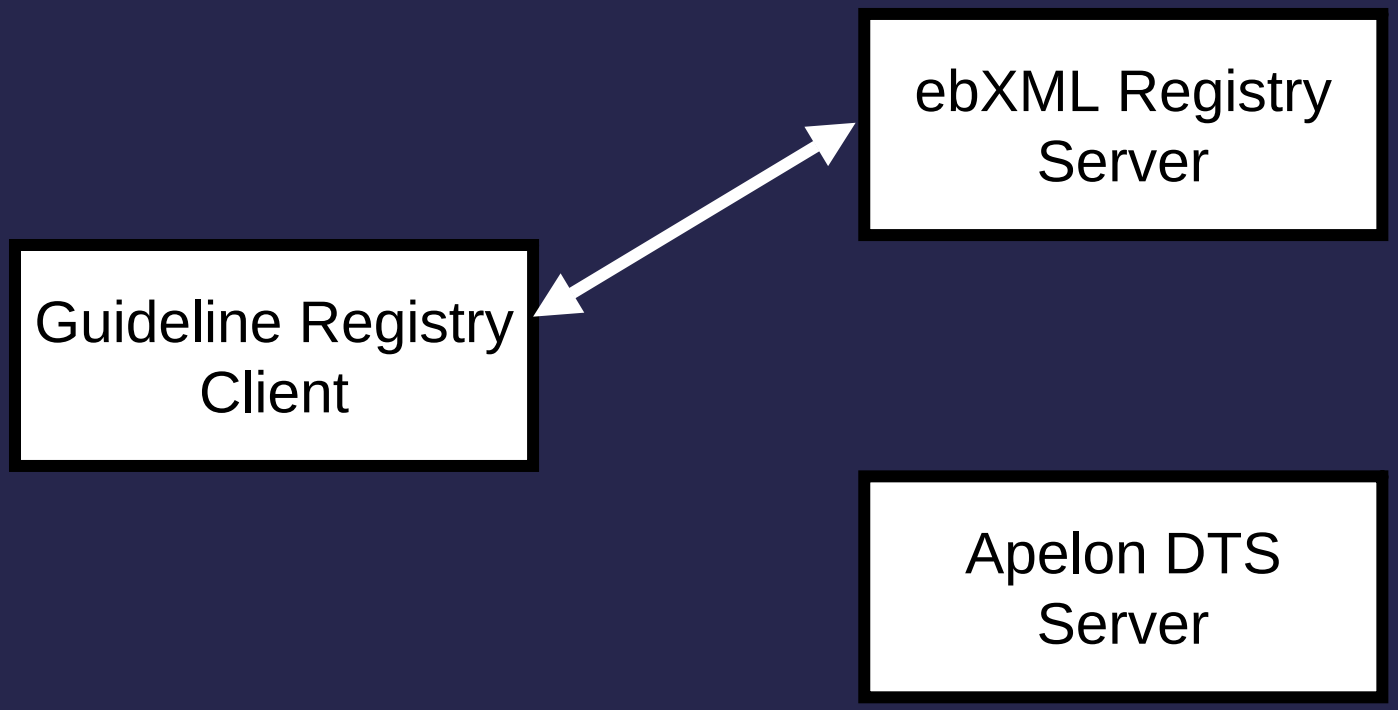
Registry Architecture



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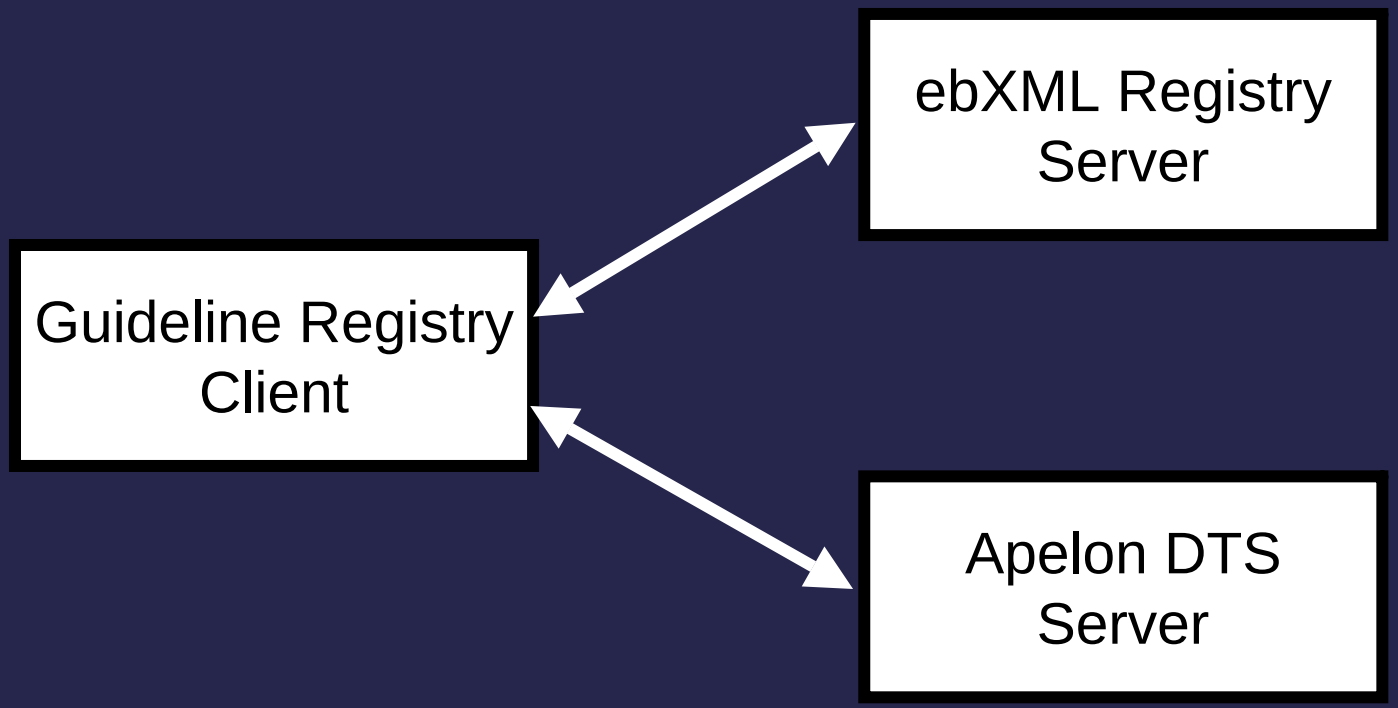
Registry Architecture



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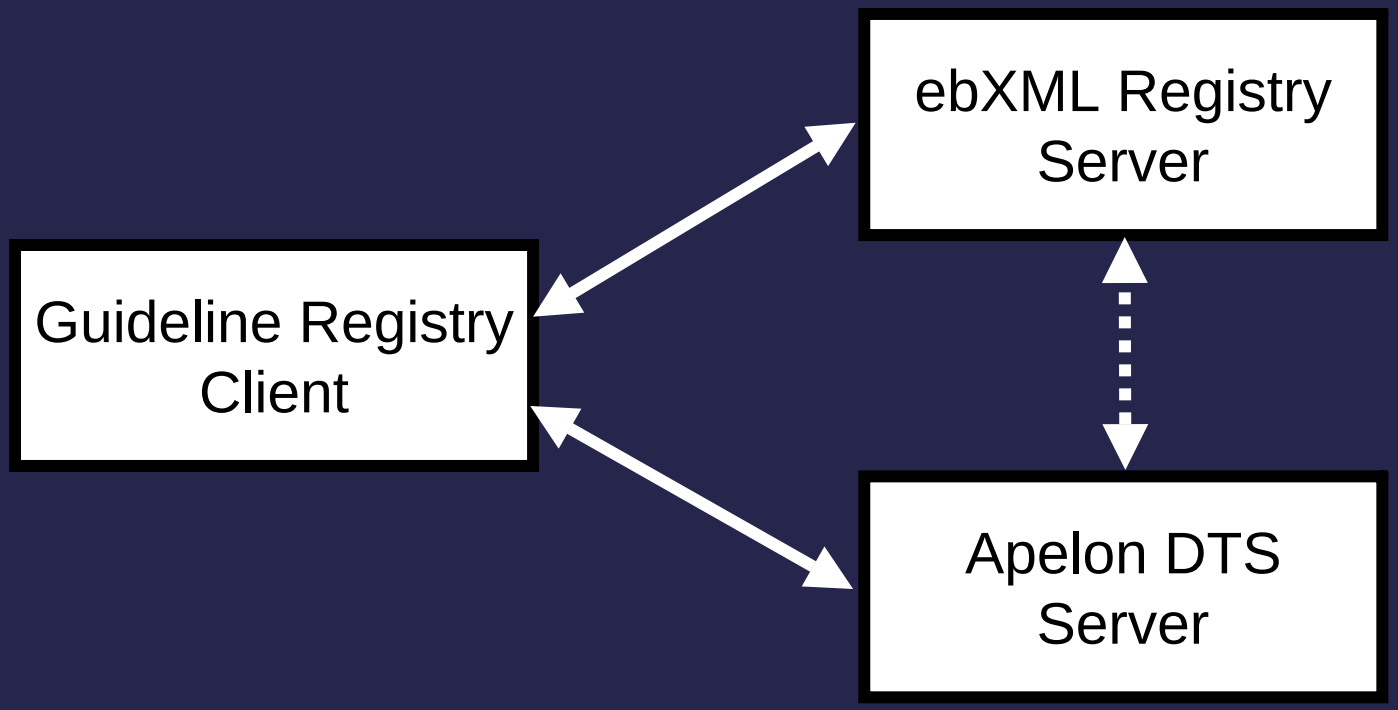
Registry Architecture



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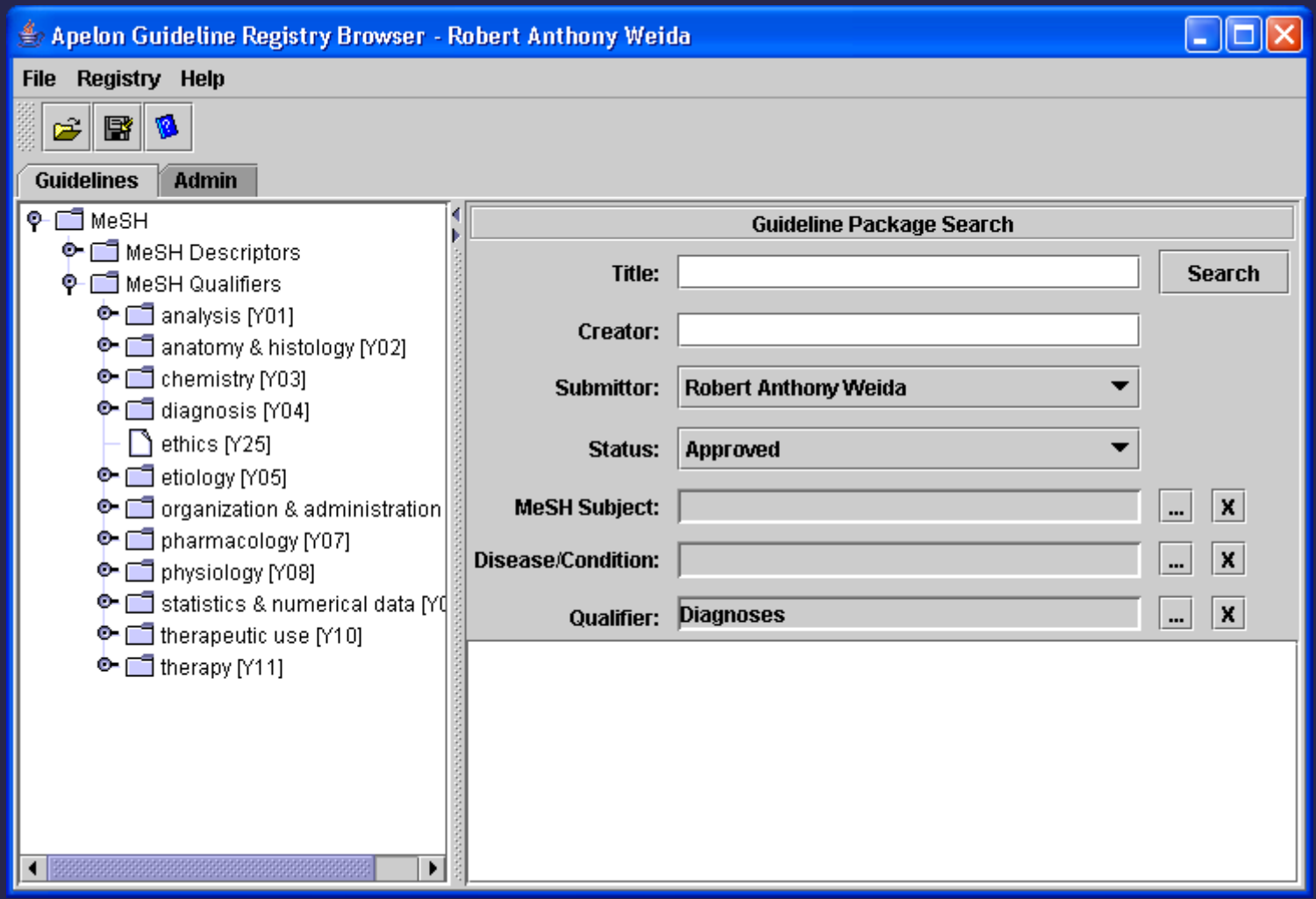
Guideline Registry Client



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Runtime Services

- Hosted DTS Server
- CTS specification

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Further Apelon Directions

- Modeling
  - Terminology extensions
    - Concept expressions
    - Local concept classification with reference to standard terminologies
  - CEMs
- Execution
  - Concept expression support
  - CTS interface prototype