



"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"

Report to HL7

September, 2003

## Agenda for HL7 Update

- Overview of project
  - Objectives and approach
  - Overview of SAGE technology infrastructure
- Update on progress
  - First major integration test of main components
  - Execution of real guideline content in a target CIS
  - Standards layer:
    - Guideline model components (*update from Samson Tu*)
    - VMR (*update from Craig Parker*)
    - Host System Services (*discussion with Craig Parker*)

# The SAGE Project

Standards-Based Sharable Active Guideline Environment



# The SAGE Project

Standards-Based Sharable Active Guideline Environment



“But what about the pirate’s code?”

# The SAGE Project

Standards-Based Sharable Active Guideline Environment



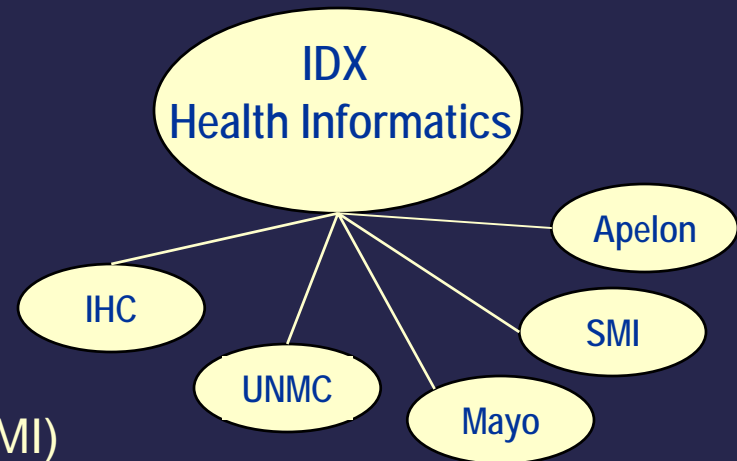
“But what about the pirate’s code?”

“We don’t think of them as rules really,  
*they’re more like guidelines . . .*”

## 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





# Project Approach

- **Interoperability**
  - Deployment across heterogeneous CIS platforms.
  - Reasonable costs to install and use guidelines.
- **Standards-Based Encoding**
  - 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”

Guideline recommendations integrated into a nurse care flowsheet

- View suggested orders
- Process suggested orders

IDX Web Framework - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites History

Links

Address F:\Public\SAGE\Test Screens\ImmScenario1\Frameset-5B.htm

powered by **IDX**

**Carlos O'KELLY**

MRN: 3 303 999  
DOB: 1-22-2003  
SSN: 123-45-6789

Sex: M  
Age: 4 Months  
Phone: (507) 555-1234

Care Support Viewers/Labs Allergies/Immuniz Orders/Meds Problem List/Bill Flowsheets Mgmt Functions

**Care Reminders Flowsheet**

**Immunizations**

Selected	Item	Info	Status	3-17-2003	1-22-2003
<input checked="" type="checkbox"/>	DTaP		Due	Given	
<input checked="" type="checkbox"/>	IPV		Due	Given	
<input checked="" type="checkbox"/>	PCV7		Due	Given	
<input checked="" type="checkbox"/>	Hib		Due	Given	
<input type="checkbox"/>	Hep B		Due 7-22-2003	Given	Given
<input type="checkbox"/>	MMR		Due 1-22-2004		
<input type="checkbox"/>	Varicella		Due 1-22-2004		

Submit Order Back Entry Document Print

**DTaP - Microsoft Internet Explorer**

**Diphtheria, Tetanus, and Pertussis Vaccine**  
2 mo, 4 mo, 6 mo, 12-15 mo, 4-6 yr, 12 yr (adult Td)

**Contraindications:**

- Serious allergic reaction after a previous vaccine dose or to a vaccine component.
- Encephalopathy (e.g., coma, decreased level of consciousness; prolonged seizures) within 7 days of administration of prior dose of DTP or DTaP.
- Progressive neurological disorder, including infantile spasms, uncontrolled epilepsy, progressive encephalopathy: defer DTaP until neurological status clarified and stabilized.

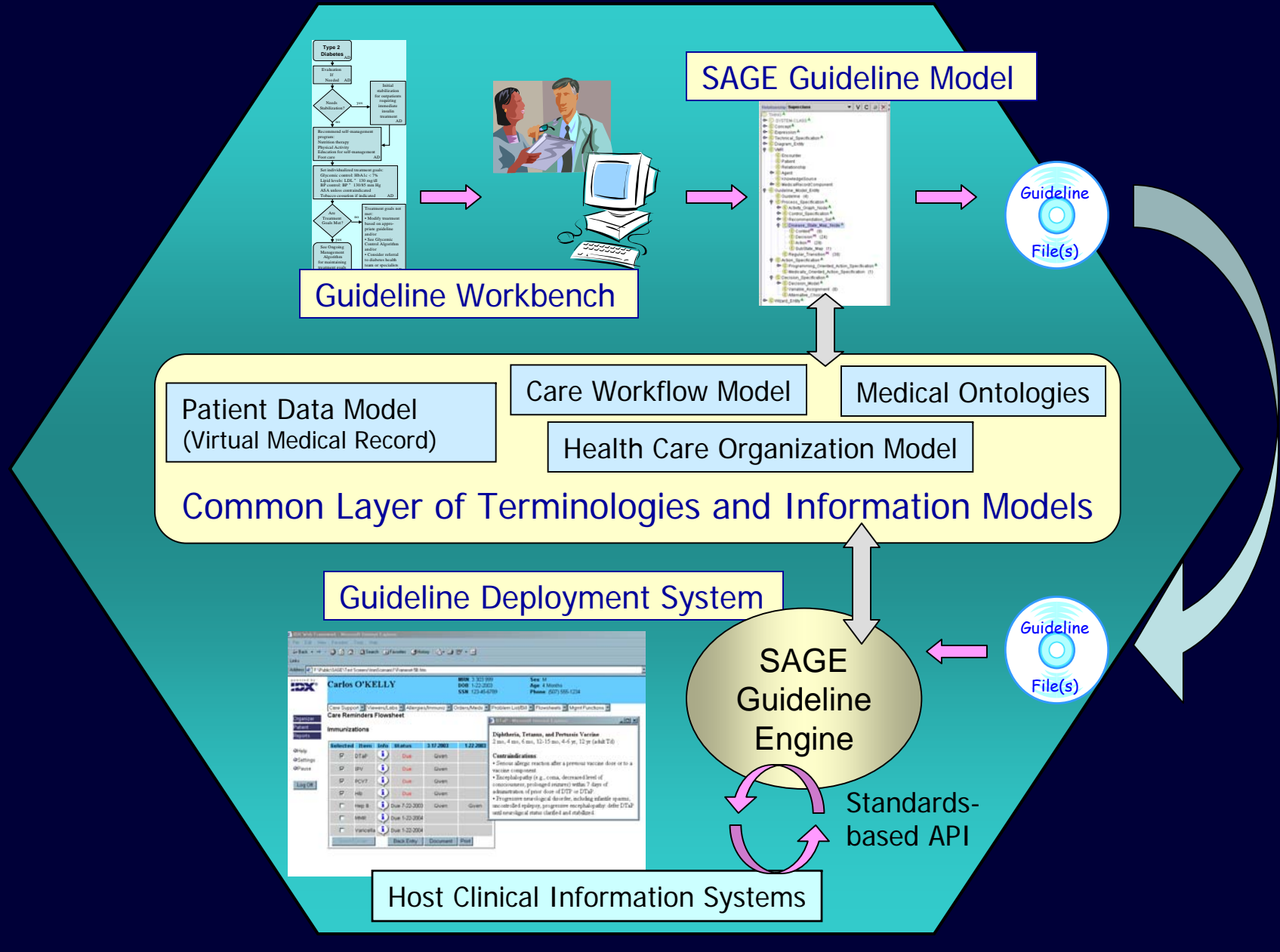
Real time access to reference information



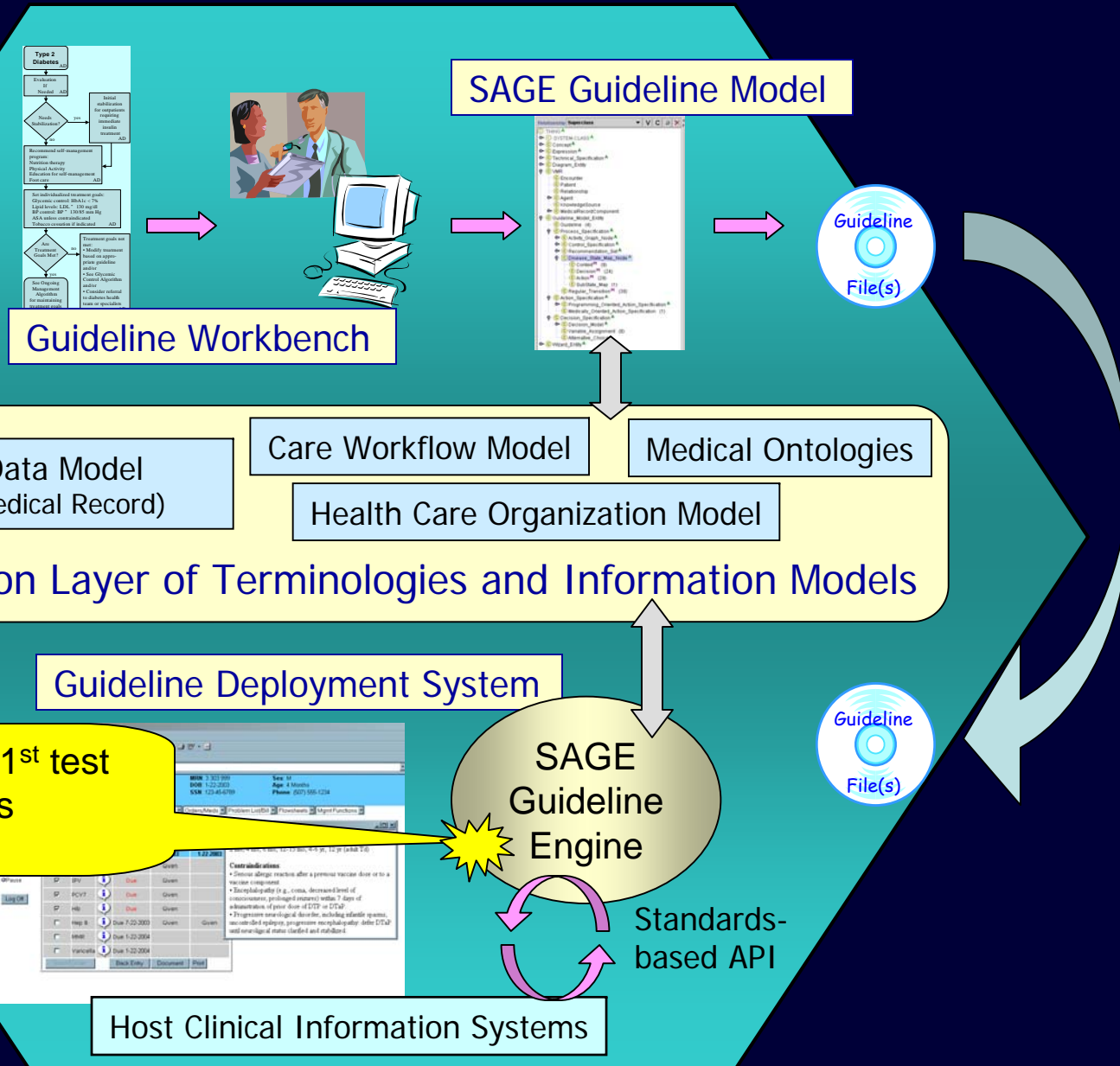
## SAGE Main deliverables

- **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.

# Overview of the SAGE Infrastructure



# SAGE Updates to HL7





## Update on Progress

### First integrated test of SAGE components

- Exemplar guideline (immunizations) as use case
- Develop and encode executable “scenarios”
- Using Protege-2000 as encoding workbench
- Represented in SAGE Guideline Model
- Interpret guideline content via prototype SAGE guideline engine
- Surfaced real guideline content through functions of target CIS (test system)

# SAGE Exemplar Guidelines

Guideline	Clinical Domain
<b>Immunizations</b>	Routine health maintenance, in both outpatient and inpatient settings.
Diabetes Management	Chronic disease monitoring and treatment. Acute exacerbation of chronic disease. Chronic disease as a comorbidity.
Community Acquired Pneumonia	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	Surgical guideline. Comprehensive pre-op workup, inpatient plan of care, and post-op outpatient management.

## Guideline Scenario: Neonatal Orders for Immunization

Baby Boy Jones is a newborn admitted to the neonatal nursery. Triggered by this admission, guideline decision logic evaluates the infant's birth date/time, weight, immunization history/status, and the mother's hepatitis B serologic status:

If patient age < 7 days AND (weight is over 2 kg OR if mother's hepatitis status is positive), a communication will be sent to the nurse to check for immunization contraindications, review immunization history, and obtain vaccination consent.

After speaking with the mother, the nurse uses the CIS to update the patient's record. These updates might include the mother's hepatitis B serology status, infants weight, and presence of contraindications. These updates to the patient's EMR trigger a second round of decision logic that then recommends appropriate immunizations.

Guideline-recommended immunizations are instantiated in the CIS as orders (or ordersets) that can be approved, processed, charted, etc. via normal CIS patient care functions.



# Activity Graph for Neonatal Immunizations

**Classes & Instances** | **Classes** | **Slots** | **Forms** | **Instances** | **Queries** | **Sage**

**Relationship** | **Superclass** | **V** | **C** | **+** | **-** | **Class**

**Class**

Activity\_Graph

**Direct Instances** | **V** | **C** | **+** | **-** | **X**

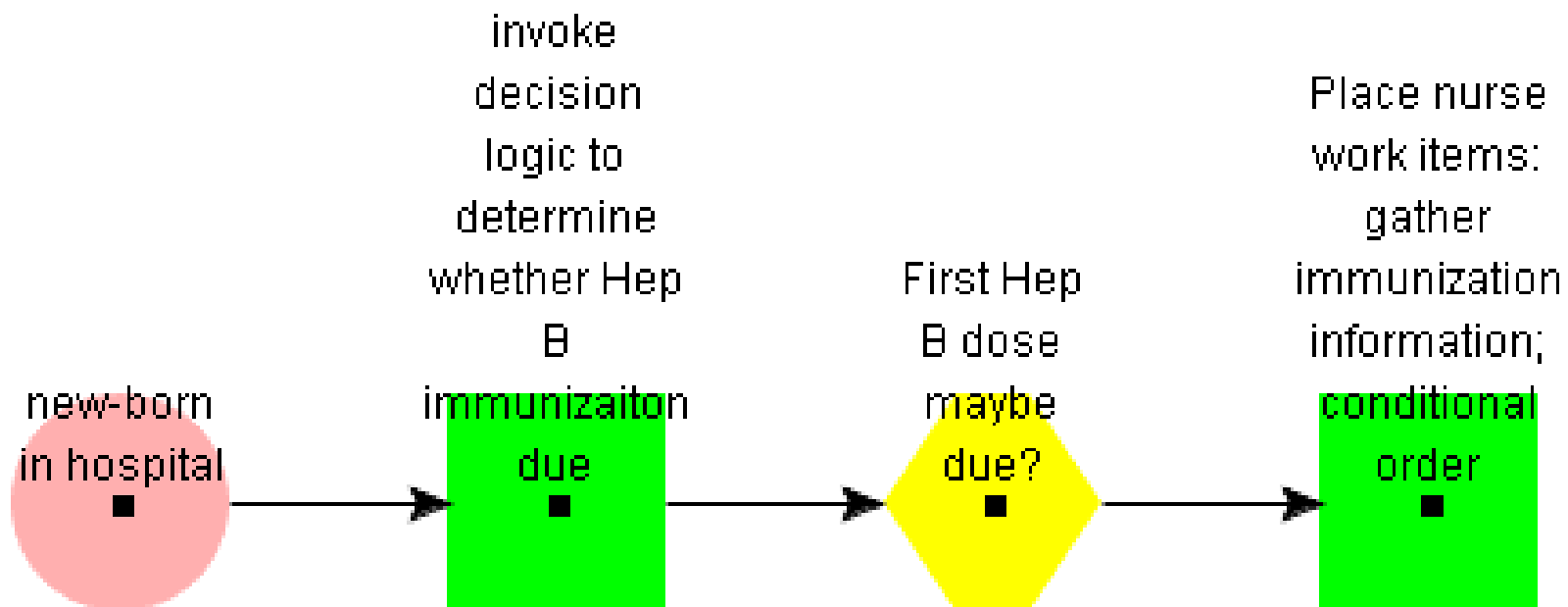
- Compute Immunization decisions
- Example Activity Graph
- Neonatal orders for immunization immediately after birth
- Population-based reminders to patients or providers
- Primary care immunization with standard care protocols

**Superclasses** | **+** | **-**

Recommendation\_Set

## Activity Graph:

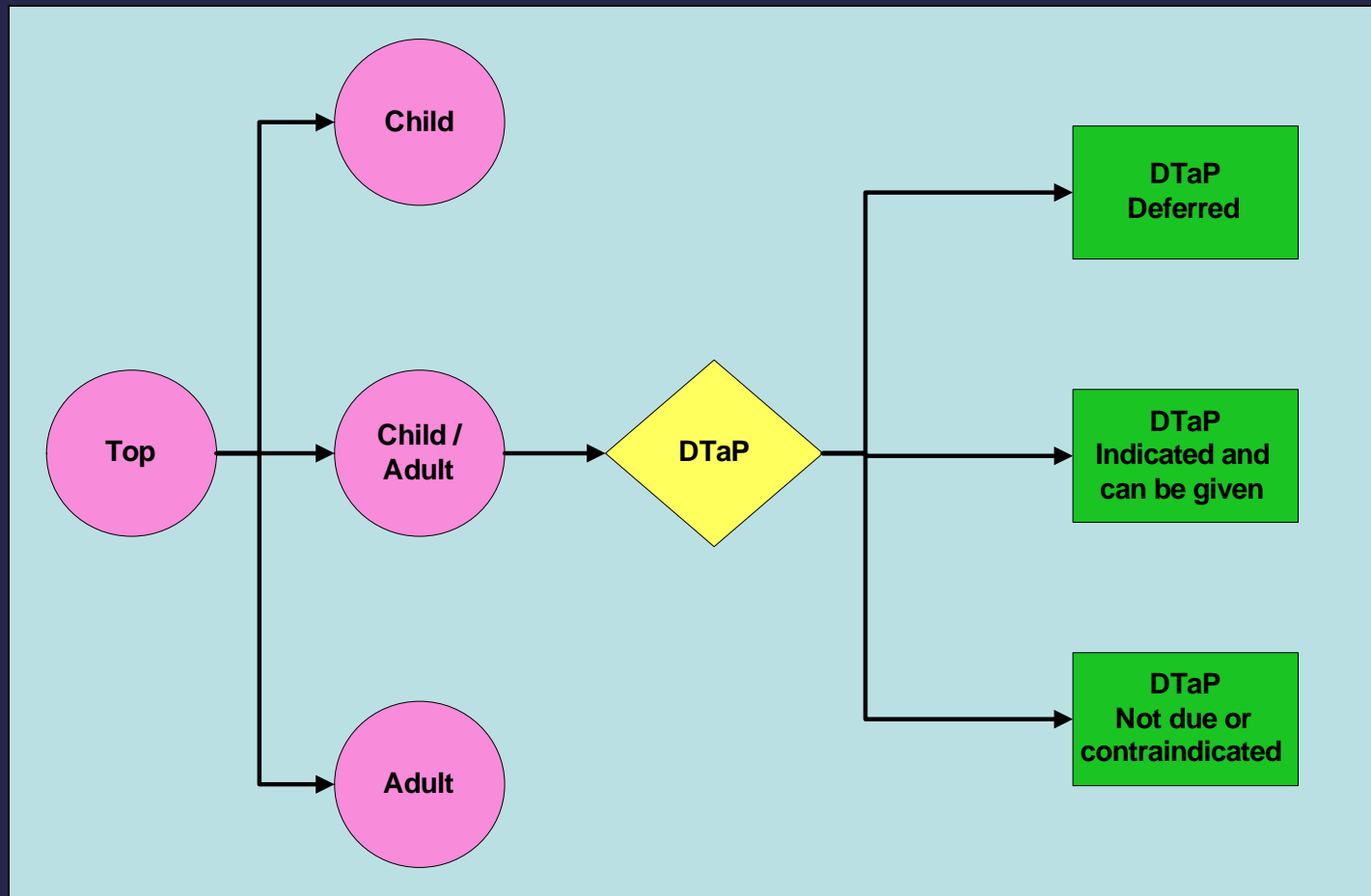
# Neonatal Orders for Immunization



# A Decision Map

The screenshot shows the Sage software interface with the 'Classes & Instances' tab selected. The left pane, titled 'Relationship', shows a hierarchy of classes. The 'Decision\_Map' class is highlighted in blue. The right pane, titled 'Class', shows the 'Direct Instances' of 'Decision\_Map'. The instance 'Immunization decisions (except DT)' is highlighted in blue, and a yellow arrow points to it. The bottom pane, titled 'Superclasses', shows the 'Recommendation\_Set' class.

# Immunization Decisions: DTaP



# Our 1<sup>st</sup> (virtual) Patient

## (1) Baby Boy Jones

- ✓ 2229 gram
- ✓ 34 week gestation neonate
- ✓ delivered by emergency C-section due to placental abruption
- ✓ His 20 year old mother received no prenatal care.
- ✓ Mother's urine drug screen was positive for methamphetamines.
- ✓ Mother's HBsAg serology was positive.
- ✓ Problem listed: "newborn exposure to Hepatitis B"



# Baby Boy Jones

## Expected SAGE Behavior (4 orders):

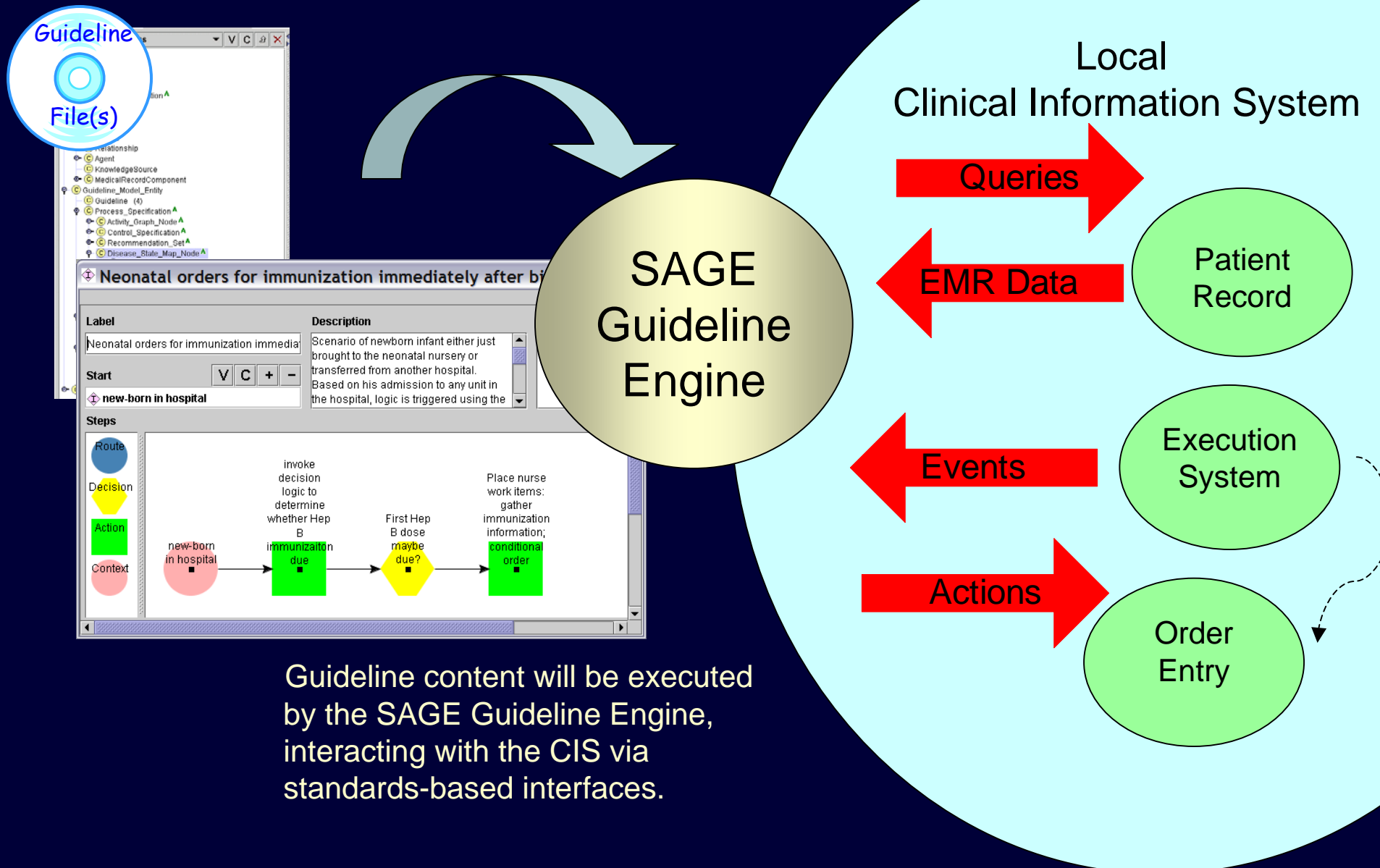
- **2 Substance administrations**  
due immediately
  - Hepatitis B vaccine injection
  - Hepatitis B Immune Globulin (HBIG)
- **2 Serologic tests**  
due 9 months in the future
  - Hepatitis B core antibody levels (anti-HBc)
  - Hepatitis B surface antigen levels (HBsAg)



# What will happen now?

1. **Triggering event:** SAGE engine detects newborn admission.
2. **“Automatic enrollment”:** SAGE enrolls new patient.
3. **Context node:** Obtain and check patient age.
4. **Decision node:** Compute vaccinations that are due.
  - a. Evaluate for all immunizations.
  - b. Query child’s record re: # of past immunizations.
  - c. Mother’s HBsAG status (CEM)
5. **CEM-based query:** Has consent been obtained?
6. **CEM-based query:** Obtain child’s weight.
7. **Concept Expression:** e.g., “progressive encephalopathy”
8. **SAGE-initiated action:** Non-active orders sent to CIS.
9. **SAGE-initiated action:** Notification sent to clinician Inbox.

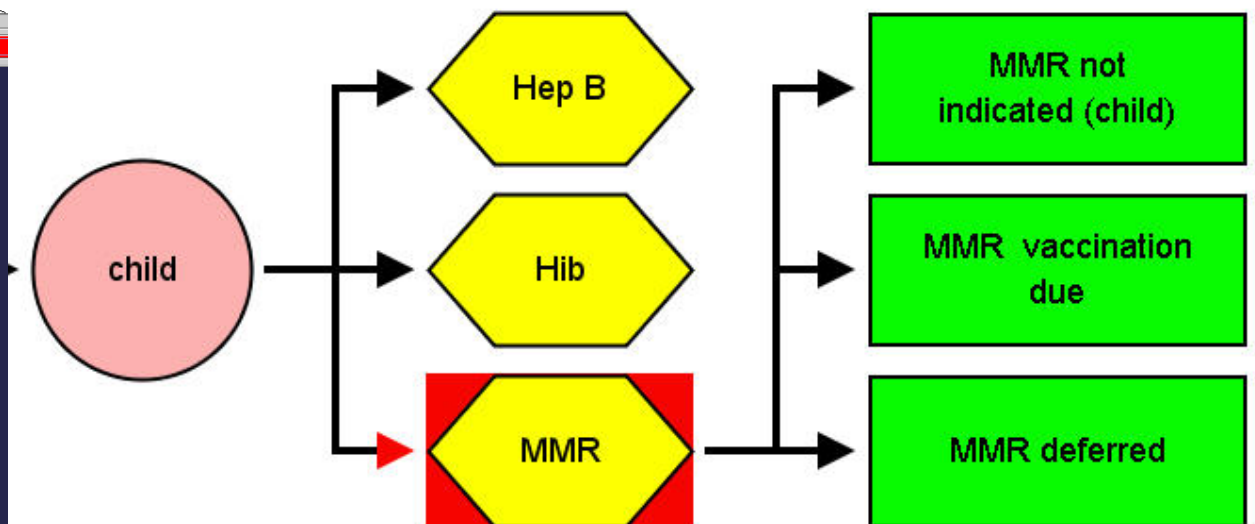
# SAGE Guideline Execution: Deployment Concepts



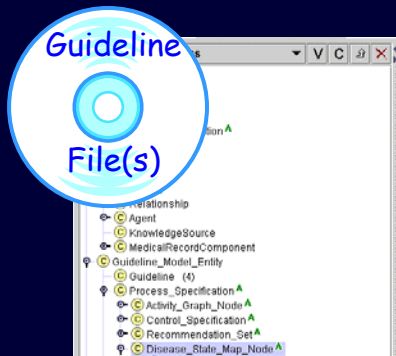
# SAGE Guideline Execution: Execution Log and Execution Monitor

```
SAGE - Log Monitor: server.log
| criterion: Polio vaccine indicated re
| criterion: Polio vaccine not indicate
| decision: Polio vaccination due and can be g
| criterion: DTaP immunization due resu
| action sp: retract Td due conclusion
| action sp: retract Td vaccine to be d
| action: Td vaccination not due or contraind
| action sp: retract varicella due pid=
| action sp: retract varicella vaccine
| action: Varicella vaccination not due or con
| action sp: C
| action: Hep B immun
```

## Compute Immunizations / Decision Map

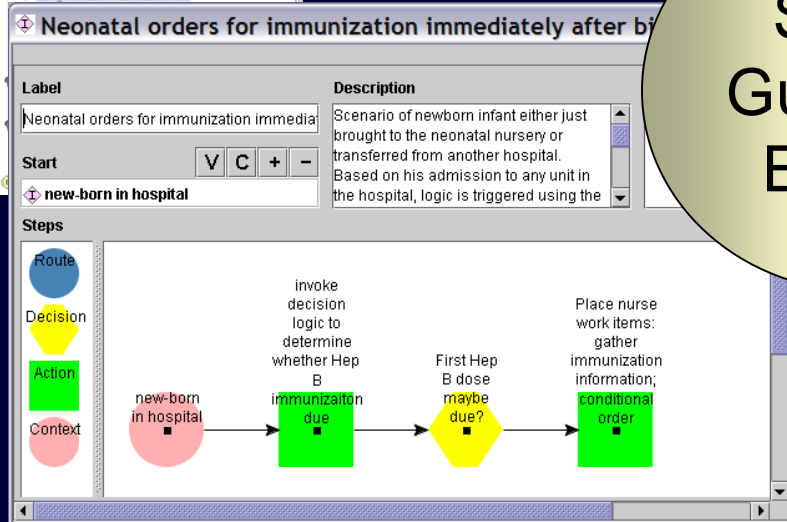


# SAGE Guideline Execution: Neonatal Orders for Immunization



- Newborn's Age
- Newborn's Weight
- Immunization Hx
- Mother's HBsAG
- Consent obtained?

SAGE  
Guideline  
Engine



Guideline content will be executed by the SAGE Guideline Engine, interacting with the CIS via standards-based interfaces.

Local  
Clinical Information System

Queries

EMR Data

Patient  
Record

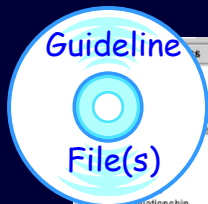
Events

Execution  
System

Actions

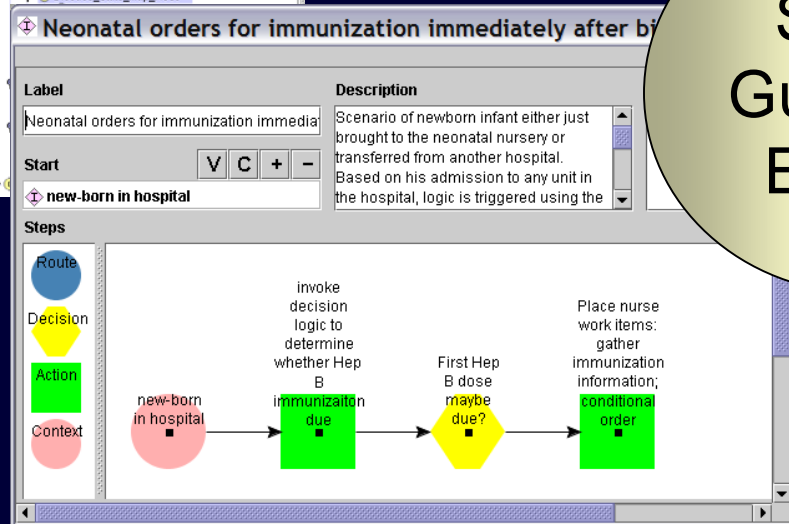
Order  
Entry

# SAGE Guideline Execution: Neonatal Orders for Immunization



- Detect newborn admission
- Detect updates to newborn's EMR

SAGE  
Guideline  
Engine



Guideline content will be executed by the SAGE Guideline Engine, interacting with the CIS via standards-based interfaces.

Local  
Clinical Information System

Queries

EMR Data

Patient  
Record

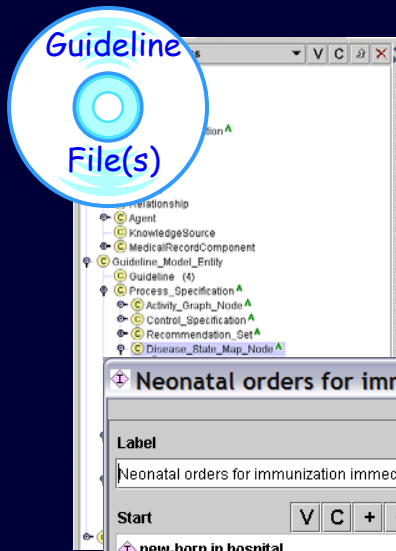
Events

Execution  
System

Actions

Order  
Entry

# SAGE Guideline Execution: Neonatal Orders for Immunization



- Remind nurse to check immunization HX
- Remind nurse to check contraindications
- Remind nurse to obtain consent
- Create recommended (pending) immunization orders in CIS
- Notify physician of new pending orders

Guideline content will be executed by the SAGE Guideline Engine, interacting with the CIS via standards-based interfaces.



Local  
Clinical Information System

Queries

EMR Data

Patient  
Record

Events

Execution  
System

Actions

Order  
Entry





## Desktop

Current Patient List: PERS: Sage Testing Attending, Ray

MRN	Patient Name	Other Information
01005800	ANDERSON, Paige	
01005867	CHAPMAN, Lucy	
01005776	HORNER, Jack	
01005842	JONES, Baby boy	LWGH A401 Attending, Ray
01005784	MCCRAY, Jim	
01005834	SMITH, Suzy	
01005875	STOCK, Marie	
01005883	THOMAS, John	
01005826	TUCKER, Tommy	
01005792	WHITE, Tristan	

SAGE Engine has caused  
4 pending orders to be  
created in the CIS

## Patient List Directory

☒ Freq ☐ Folders ☐ Avail

List Name	Type	Owner
Hotlist		
CAR Service	CNSS	
Sage Testing	PERS	Attending,
TemporaryList	PERS	Attending,

## InBox Messages

☐ All Mine ☒ Patient

Notifications	Count
Unsolicited	
You have saved order sessions	4
Message from SAGE Engine	2

## Command Central

Command:

Active MRN:

LastWord Client

File Patient Session Navigate Help

My Saved Order Sessions

Patient	Mrn	Previous Owner	Save Date Time	Comment
JONES, Baby boy	01005842	ATTENDING, R	15Aug2003 10:41	Hep B surface antige
JONES, Baby boy	01005842	ATTENDING, R	15Aug2003 10:41	Hepatitis B core ant
JONES, Baby boy	01005842	ATTENDING, R	15Aug2003 10:41	Hepatitis B Vac Reco
JONES, Baby boy	01005842	ATTENDING, R	15Aug2003 10:41	Hepatitis B Immune G

SAGE Engine has caused 4 pending orders to be created in the CIS

Activate Details Forward Issue Delete Cancel

DCXSESSQ 252-ADF1 0.1 LWGH



Demog

Orders

Results

Viewer

Allergies

Pathways

Pharmacy

Care Mgmt

Setup

Notes

Med Profile

Microbiology ...

## Patient Problem List

☒ All ☐ ActiveAdd: 

Status	Problem Description	Gde
A	Newborn exposure to maternal h...	

Guidelines

Update Problem

## Patient Order List

Expand

Change Context

Prefs

Save Session

Current Order	ST	Sub ST	Start Date	Problem
Hepatitis B Vac Recombinant Inj inj	U	READY	15Aug2003	

Modify

D/C

Issue

Dept Buttons

Common

Order Sets

Search

Meds

Personal

Prescriptions

Common Orders

MEDICATIONS

CIS order processing  
screen for an order  
created by SAGE

## Order Selection

- ☐ Order is Historical  
☐ Order is Prescription

Select Order

Button Dept: MED

Order Text Search:

## Agenda for Today's Update

- Overview of project
  - Objectives and approach
  - Overview of SAGE technology infrastructure
- Update on progress
  - First major integration test of main components
  - Execution of real guideline content in a target CIS
  - Standards layer:
    - Guideline model components (*update from Samson Tu*)
    - VMR (*update from Craig Parker*)
    - Host System Services (*discussion with Craig Parker*)
- Seeking input on Host System Services
  - Role of host system services
  - Initial catalog of host system services
  - Discussion: Synchronous communication

Thank You!



[www.sageproject.net](http://www.sageproject.net)

# Spare Slides



## SAGE: Frequently Asked Questions

Is the SAGE project developing guideline content ?

No. While we are fully characterizing and encoding a small set of guidelines to be used in our R&D work, the main objective of the SAGE project is to enable a technology infrastructure for encoding and wide-spread dissemination of active guideline content.

Is the SAGE project developing an IDX-specific solution ?

No. We are using IDX *Carecast* as our prototyping CIS environment during the project; however, our goal is a universal infrastructure that will allow activation of guideline content in multiple HIS vendor systems.

Where can I get more information on the SAGE project ?

Our project web site [www.sageproject.net/](http://www.sageproject.net/) is just coming online and will provide increasing detailed project updates in the near future.