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

“The SAGE Project
Standards-Based Shareable 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*)
“But what about the pirate’s code?”
“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 **Sharable Active Guideline Environment**

- 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

Cooperative Agreement Number 70NANB1H3049
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.
Guideline recommendations integrated into a nurse care flowsheet

- View suggested orders
- Process suggested orders

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

- **Patient Data Model (Virtual Medical Record)**
- **Care Workflow Model**
- **Medical Ontologies**
- **Health Care Organization Model**
- **Common Layer of Terminologies and Information Models**
- **Guideline Workbench**
- **SAGE Guideline Model**
- **Guideline Deployment System**
- **SAGE Guideline Engine**
- **Standards-based API**
- **Host Clinical Information Systems**

### Type 2 Diabetes Evaluation

If Needed

- **yes**
  - Recommend self-management program:
    - Nutrition therapy
    - Physical Activity
    - Education for self-management
    - Foot care

- **no**
  - Treatment goals not met:
    - Modify treatment based on appropriate guideline
    - See Glycemic Control Algorithm
    - Consider referral to diabetes health team or specialists

- **Treatment Goals Met?**
  - **yes**
    - See Ongoing Management Algorithm for maintaining treatment goals and complication prevention
SAGE Updates to HL7

Type 2 Diabetes Evaluation If Needed

- yes
- no

Recommend self-management program:
- Nutrition therapy
- Physical Activity
- Education for self-management
- Foot care

Set individualized treatment goals:
- Glycemic control: HbA1c < 7%
- Lipid levels: LDL ≤ 130 mg/dl
- BP control: BP ≤ 130/85 mm Hg
- ASA unless contraindicated
- Tobacco cessation if indicated

- no

Treatment goals not met:
- Modify treatment based on appropriate guideline
- See Glycemic Control Algorithm
- Consider referral to diabetes health team or specialists

Are Treatment Goals Met?
- yes
  - See Ongoing Management Algorithm for maintaining treatment goals and complication prevention
- no

Initial stabilization for outpatients requiring immediate insulin treatment

AD AD AD AD

Guideline File(s)

Common Layer of Terminologies and Information Models
- Patient Data Model (Virtual Medical Record)
- Care Workflow Model
- Medical Ontologies
- Health Care Organization Model

Guideline Workbench

SAGE Guideline Model

Guideline Deployment System

• Guideline execution 1st test
• Host system services

SAGE Guideline Engine

Standards-based API

Host Clinical Information Systems
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

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Clinical Domain</th>
</tr>
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<tbody>
<tr>
<td><strong>Immunizations</strong></td>
<td>Routine health maintenance, in both outpatient and inpatient settings.</td>
</tr>
<tr>
<td>Total Joint Replacement</td>
<td>Surgical guideline. Comprehensive pre-op workup, inpatient plan of care, and post-op outpatient management.</td>
</tr>
</tbody>
</table>
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: A specialized workflow process model for specifying clinical and computational content of a care guideline.
Activity Graph:

Neonatal Orders for Immunization

- Newborn in hospital
- Invoke decision logic to determine whether Hep B immunization is due
- First Hep B dose maybe due?
- Place nurse work items: gather immunization information; conditional order
Neonatal Orders for Immunization

A Decision Map
Immunization Decisions: DTaP

- DTaP Deferred
- DTaP Indicated and can be given
- DTaP Not due or contraindicated

- Top
  - Child
  - Child / Adult
  - Adult
Our 1st (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)
Neonatal Orders for Immunization

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.
Guideline content will be executed by the SAGE Guideline Engine, interacting with the CIS via standards-based interfaces.
SAGE Guideline Execution:
Execution Log and Execution Monitor
SAGE Guideline Execution: Neonatal Orders for Immunization

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

- Newborn’s Age
- Newborn’s Weight
- Immunization Hx
- Mother’s HBsAG
- Consent obtained?
SAGE Guideline Execution: Neonatal Orders for Immunization

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

- 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
SAGE Engine has caused 4 pending orders to be created in the CIS.
SAGE Engine has caused 4 pending orders to be created in the CIS.
CIS order processing screen for an order created by SAGE
Agenda for Today’s Update

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• 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
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.