

# Modeling Decision Support for Clinical Guidelines Using the SAGE Guideline Workbench and SNOMED CT

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# Introductions

- Who are we?
- Who are you?
  - Training and experience:
    - Clinical understanding
    - Computer science background
  - Interests
    - Guidelines and decision support
    - Interoperation and challenges in deploying standards

# Learning Objectives

1. Appreciate the challenges in formulating guidelines into executable algorithms
2. Understand the standardization challenges to creation of interoperable guideline decision support
3. Understand basic procedures for formulation of decision logic and concept inventory
4. Understand the spectrum of vocabulary services necessary for use of SNOMED CT and other NCVHS vocabularies in a decision support environment
5. Describe the function, capabilities and limitations of reference terminologies including SNOMED CT for use in decision support
6. Appreciate the functional requirements and utilities required for a workbench supporting guideline modeling
7. Understand the issues and tasks required for end-to-end modeling of executable guidelines

# Overview

- Discussion of guidelines and challenges to decision support development

SAGE guideline modeling process:

- Introduction: Modeling the immunization guideline
- Creating the implementation scenarios and assembling decision logic
- Developing concept inventory: employing standard vocabulary
- Specifying information queries
- SAGE guideline model and workbench
- Encoding immunization guideline
- Validating the development
- Demonstration: SAGE at work

# What are Guidelines?

- Guideline(n): a cord or rope to aid passage over a difficult point (Merriam-Webster)
- Systematic statements of evidence-based policy rules or principles to assist clinicians and patients make decisions on healthcare alternatives
- Characteristics
  - May be developed by government agencies at any level, institutions, professional societies, governing boards, or by convening expert panels.
  - May be in narrative, outline, flowchart or tabular forms
  - Need to be formalized to provide computerized clinical decision support at point of care

# Why Study Guidelines?

President's Information Technology Advisory Committee  
“Transforming Health Care through Information Technology” (2001 )

## Findings:

- The U.S. lacks a broadly disseminated and accepted national vision for information technology in health care
- The introduction of integrated decision-support systems that can proactively foster best practices and reduce errors requires enhanced information-technology methods and tools

## Recommendations:

- Develop **guidelines** based on evidences and best practices
- Implement guidelines so that they are usable effectively at the point of care, including **embedded decision support** that is continually updated as new evidence accumulates

# Clinical Decision Support: Comments on a long History

- 1970-80s: Basic studies in expert systems and reminder technology convinced many of CDSS importance
- 1990s:
  - Appearance of practice guidelines as authoritative reference for standard of care
  - Development of SNOMED and Read V3 as reference terminologies for clinical care systems
  - Developing importance of ontologies in scalable systems design

# Clinical Decision Support: Comments on a long History

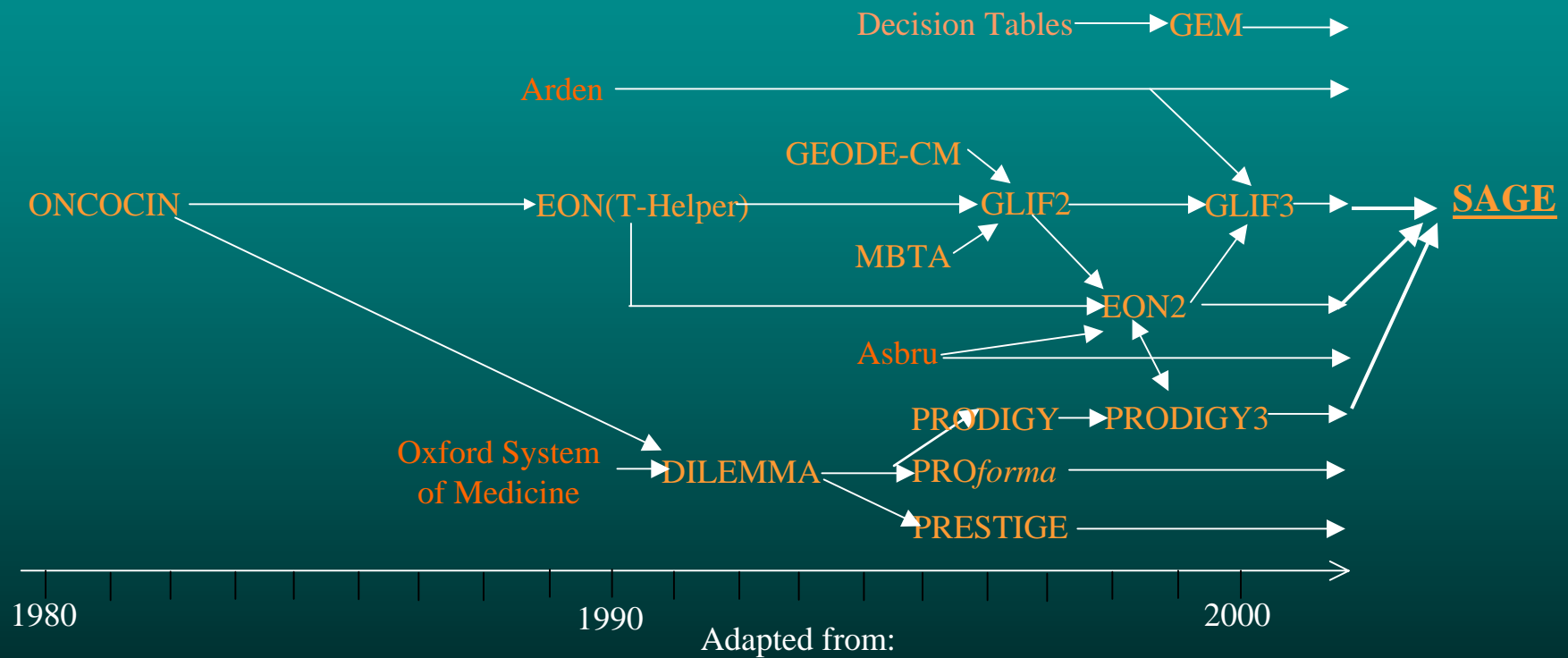
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Musen, M. A. (1999). Scalable Software Architectures for Decision Support. *Methods of Information in Medicine* 38: 229-238.:

**CDSS = domain ontology + problem solving method**



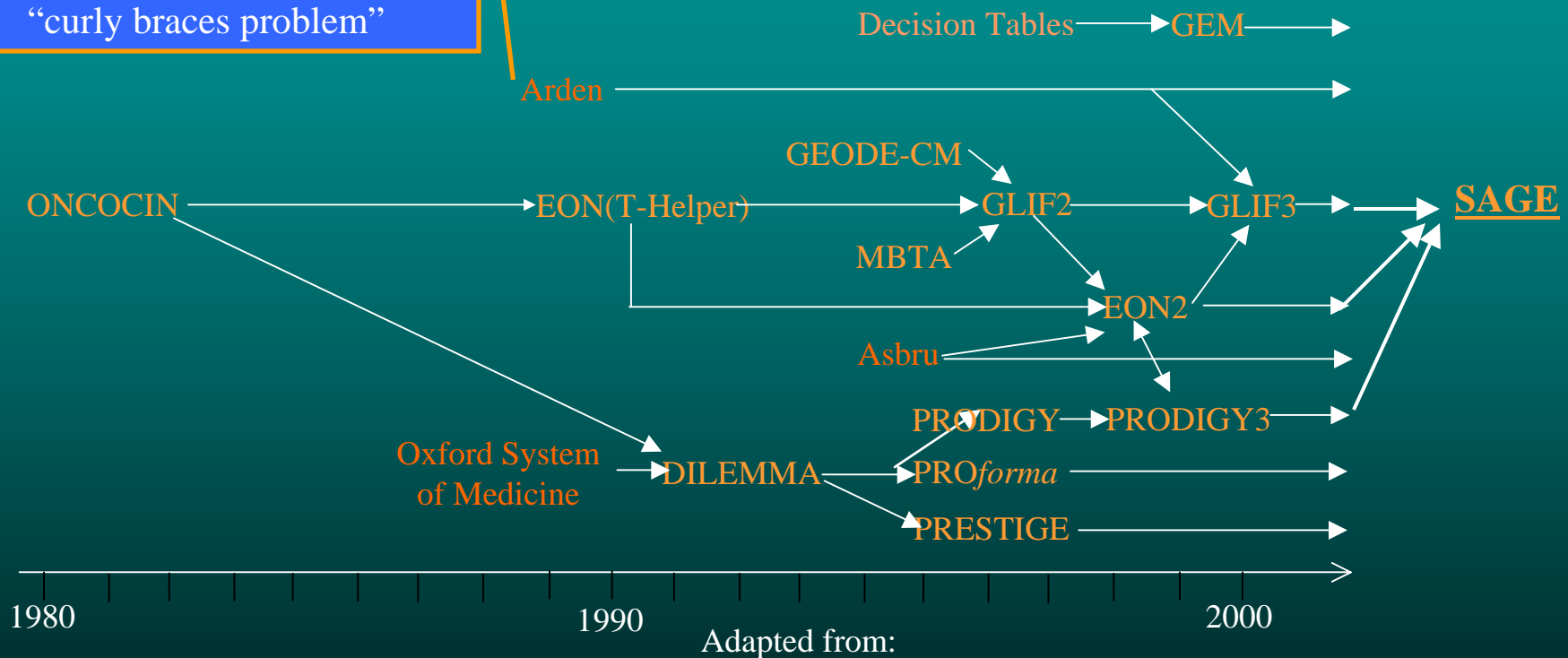
# (Partial) Guideline Model Chronology



P. L. Elkin, M. Peleg, R. Lacson, E. Bernstam, S. Tu, A. Boxwala, R. Greenes, & E. H. Shortliffe.  
Toward Standardization of Electronic Guidelines. *MD Computing* 17(6):39-44, 2000

# (Partial) Guideline Model Chronology

Oriented to single rules; ANSI standard; terminology left to “curly braces problem”

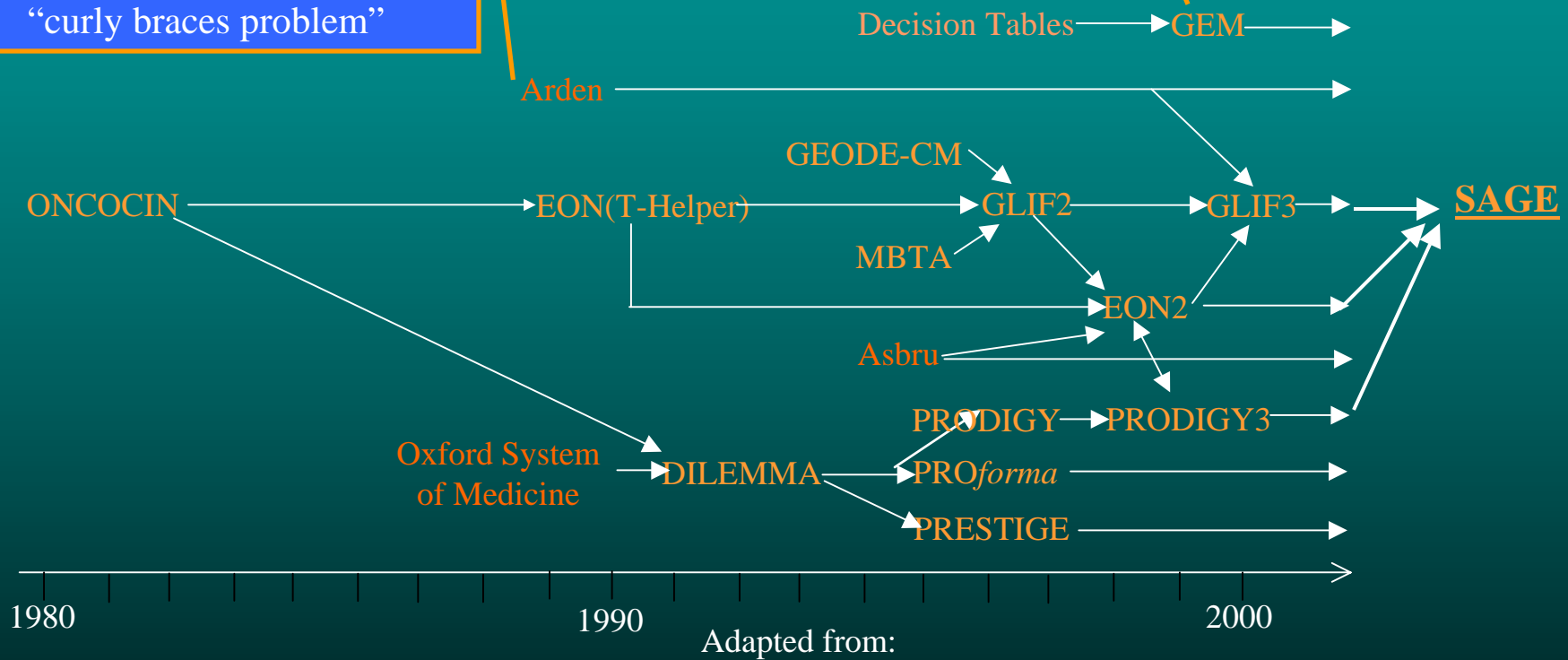


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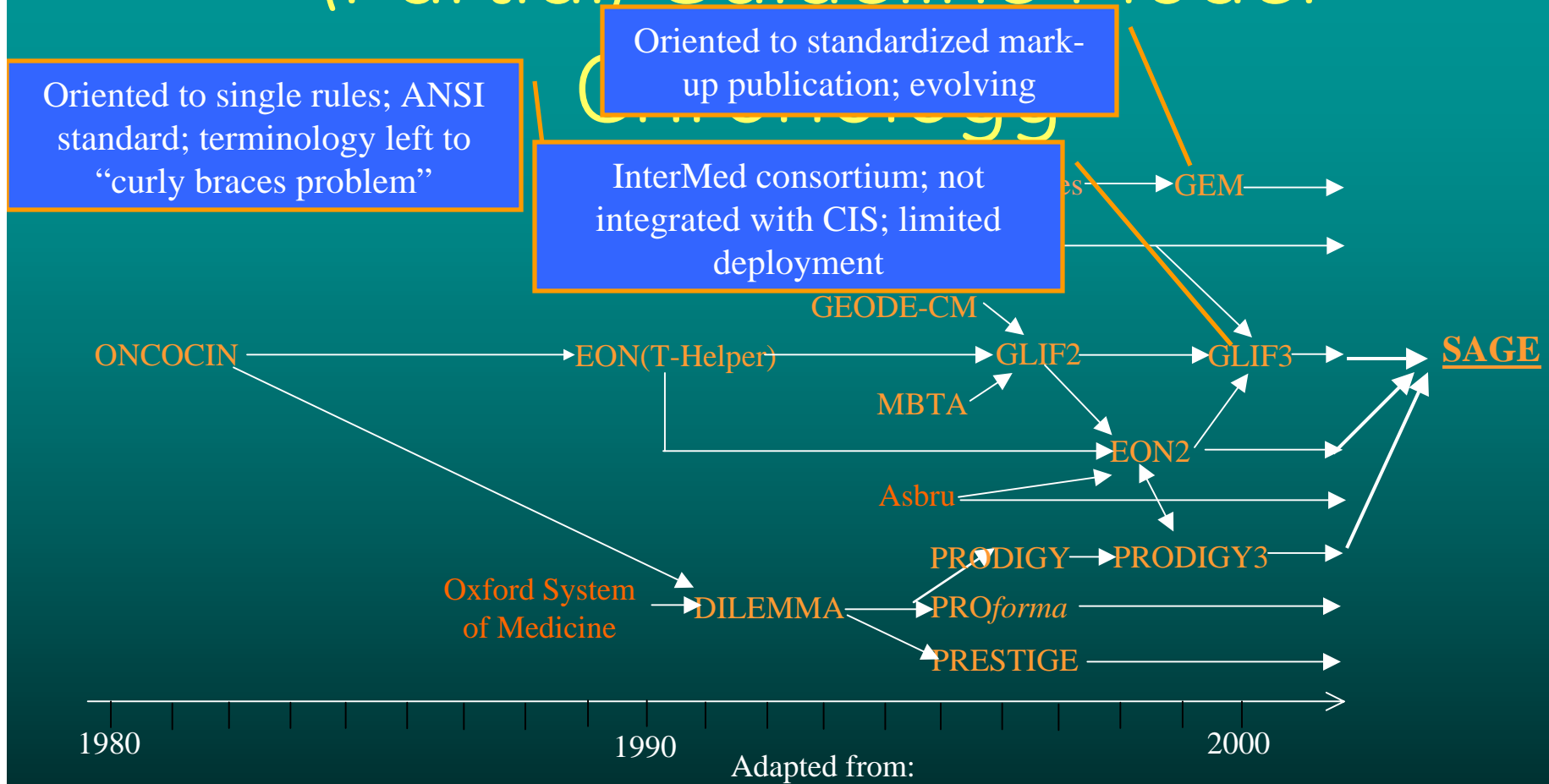
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Oriented to standardized mark-up publication; evolving



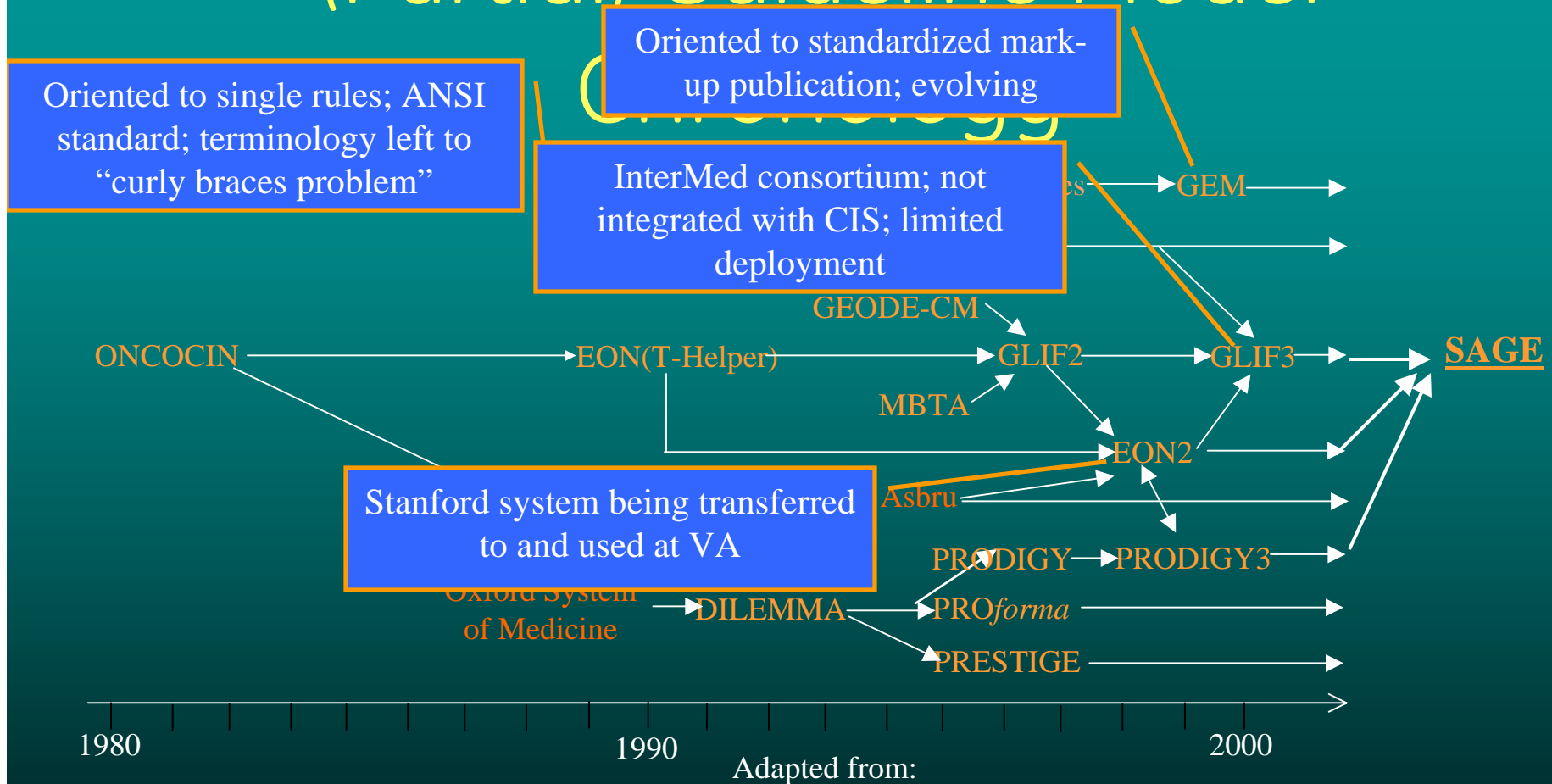
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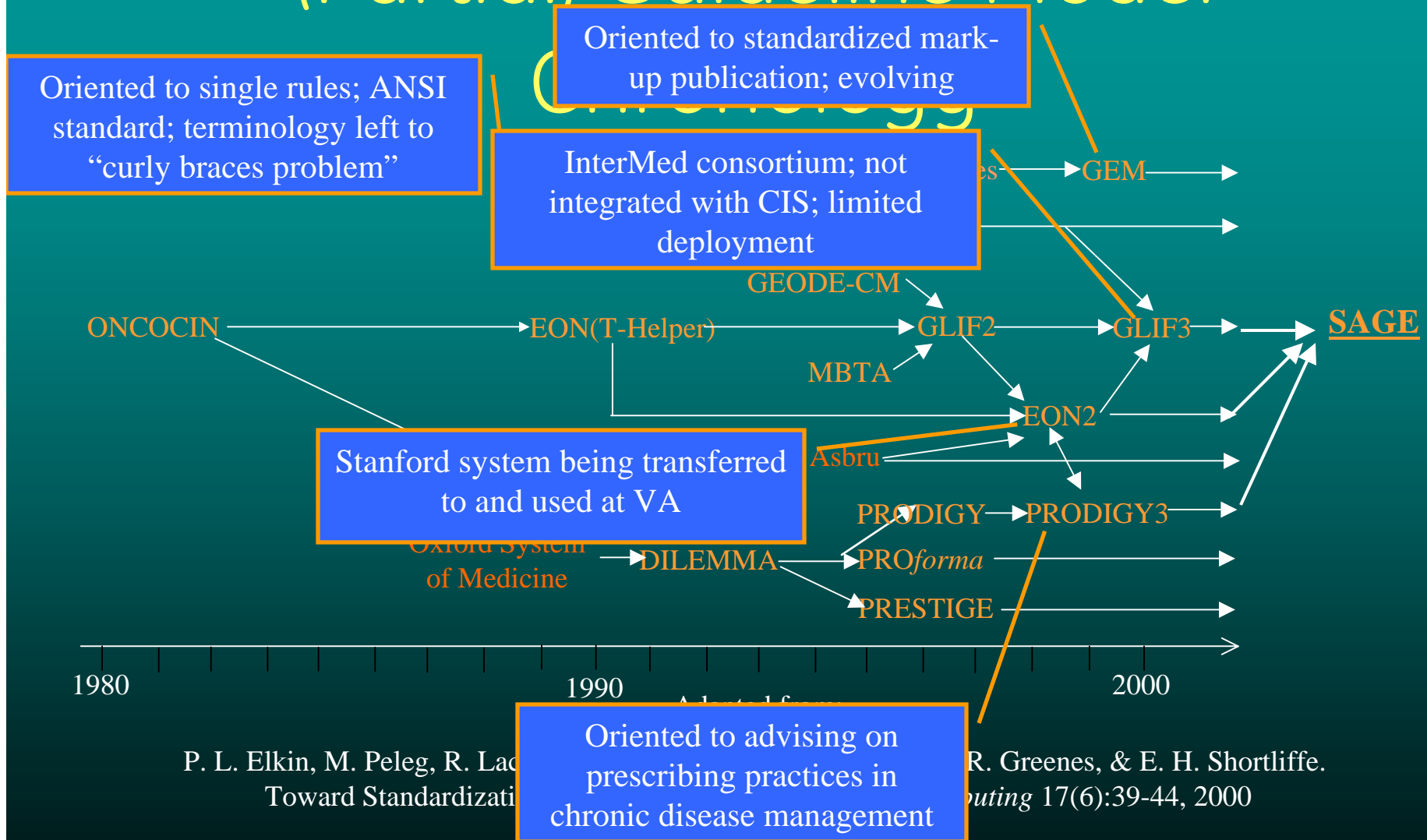
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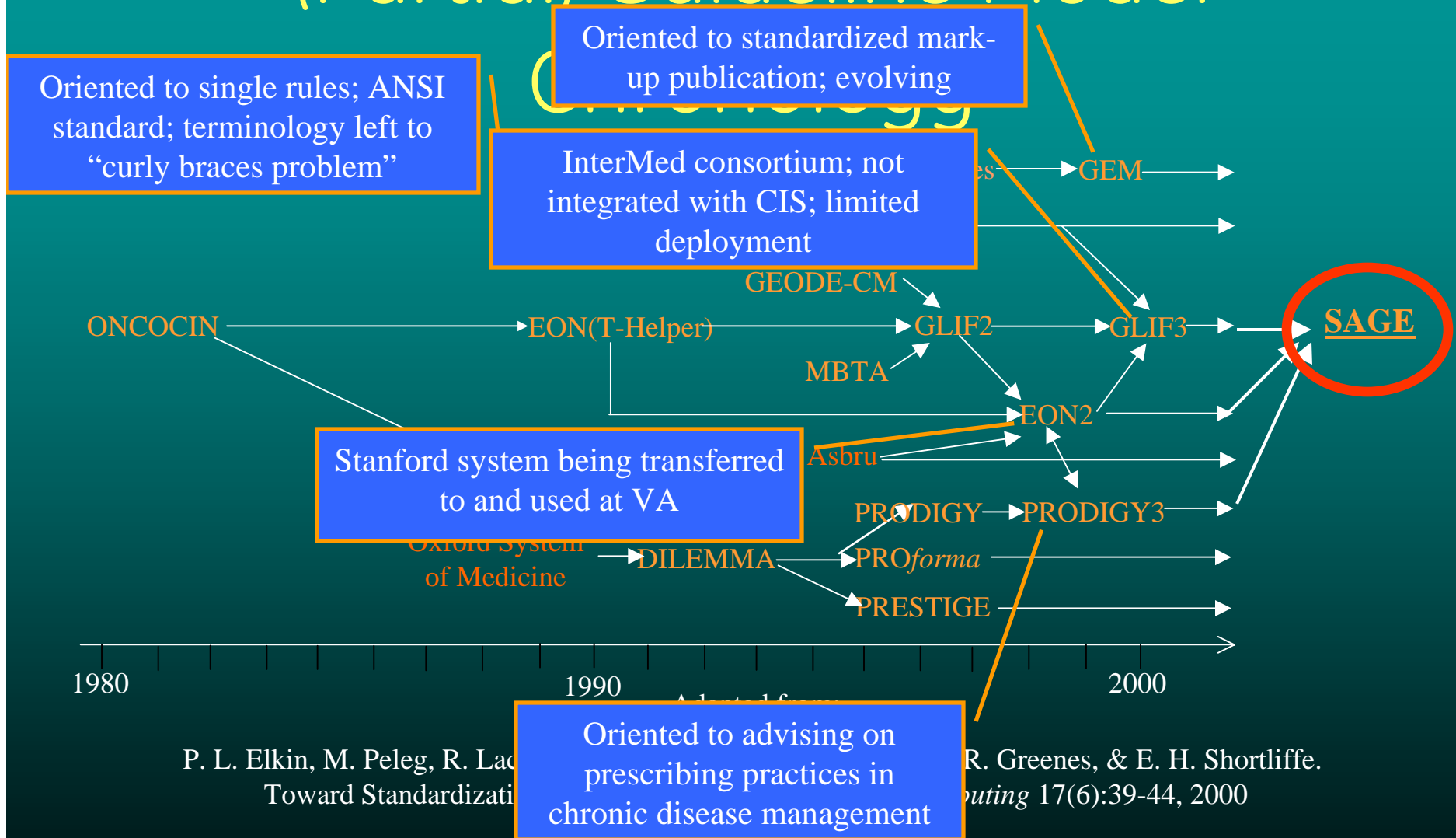


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# (Partial) Guideline Model



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# Requirements of CDSS

- Automated within clinical workflow
- Provision of guidance for care (not diagnoses)
- Timely delivery at point of decision making
- Computer-based decision support; linked with computer patient data base
- Easily encoded and maintained knowledge bases



# Guideline Decision Support Prerequisites

- 1) Identifying an opportunity for clinical process improvement
- 2) Recognizing an authoritative body of recommendations based upon outcomes research (or reputable best practice model)
- 3) Maintaining a data base of reliable and useful clinical data
- 4) Having the tools at hand to organize the knowledge into computable form
- 5) Obtaining support and involvement of the clinical community
- 6) Assuring use of vendor tools for implementing within clinical record software

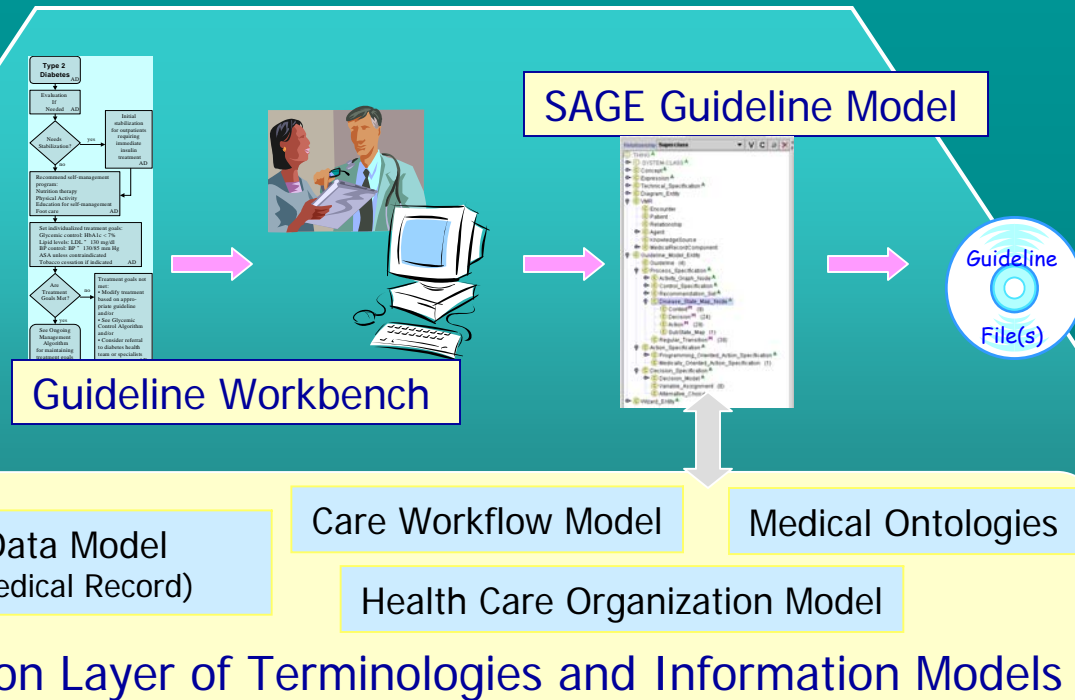
# SAGE Project Overview

- Collaborative research and development project to develop a **standards-based** technology to enable encoding and dissemination of guidelines in executable format.
- Infrastructure will employ informatics standards including Protégé open source workbench, HL7 RIM, SNOMED CT and LOINC, and deployment technology to **support encoding and dissemination of guidelines across vendor platforms** and throughout the spectrum of care
- Guideline deployment technology will present guideline content to clinicians through **active, patient-specific recommendations** surfaced through functions of the local clinical information system, and **integrated into the care workflow**

SAGE is partially supported under a grant from the U.S. Department of Commerce, National Institute of Standards and Technology, Advanced Technology Program, Cooperative Agreement Number 70NANB1H3049.



# SAGE Infrastructure: Guideline Encoding



The diagram illustrates the architecture of the SAGE Guideline Engine. At the bottom, a red box labeled "Host Clinical Information Systems" contains a screenshot of a medical record interface for "Carlos O'KELLY". An arrow points from this system to a yellow box labeled "Guideline Deployment System". This system contains four sub-models: "Patient Data Model (Virtual Medical Record)", "Care Workflow Model", "Medical Ontologies", and "Health Care Organization Model". These models feed into a large yellow box labeled "Common Layer of Terminologies and Information Models". This layer then feeds into the "SAGE Guideline Engine", represented by a yellow oval. The engine interacts with "Guideline File(s)" (represented by CD icons) and a "Standards-based API" (represented by a pink circular arrow). A large blue arrow on the right side of the diagram points from the "SAGE Guideline Engine" towards the "Guideline File(s)" icon at the top right.

# Use of Protégé for Guideline Modeling

- Protégé a good rapid prototyping tool
  - For developing guideline ontologies
  - For encoding instances of guidelines
- Protégé an extensible knowledge-engineering platform
  - Plugin architecture allows SAGE-specific extensions
  - API allows decision-support application to access knowledge base

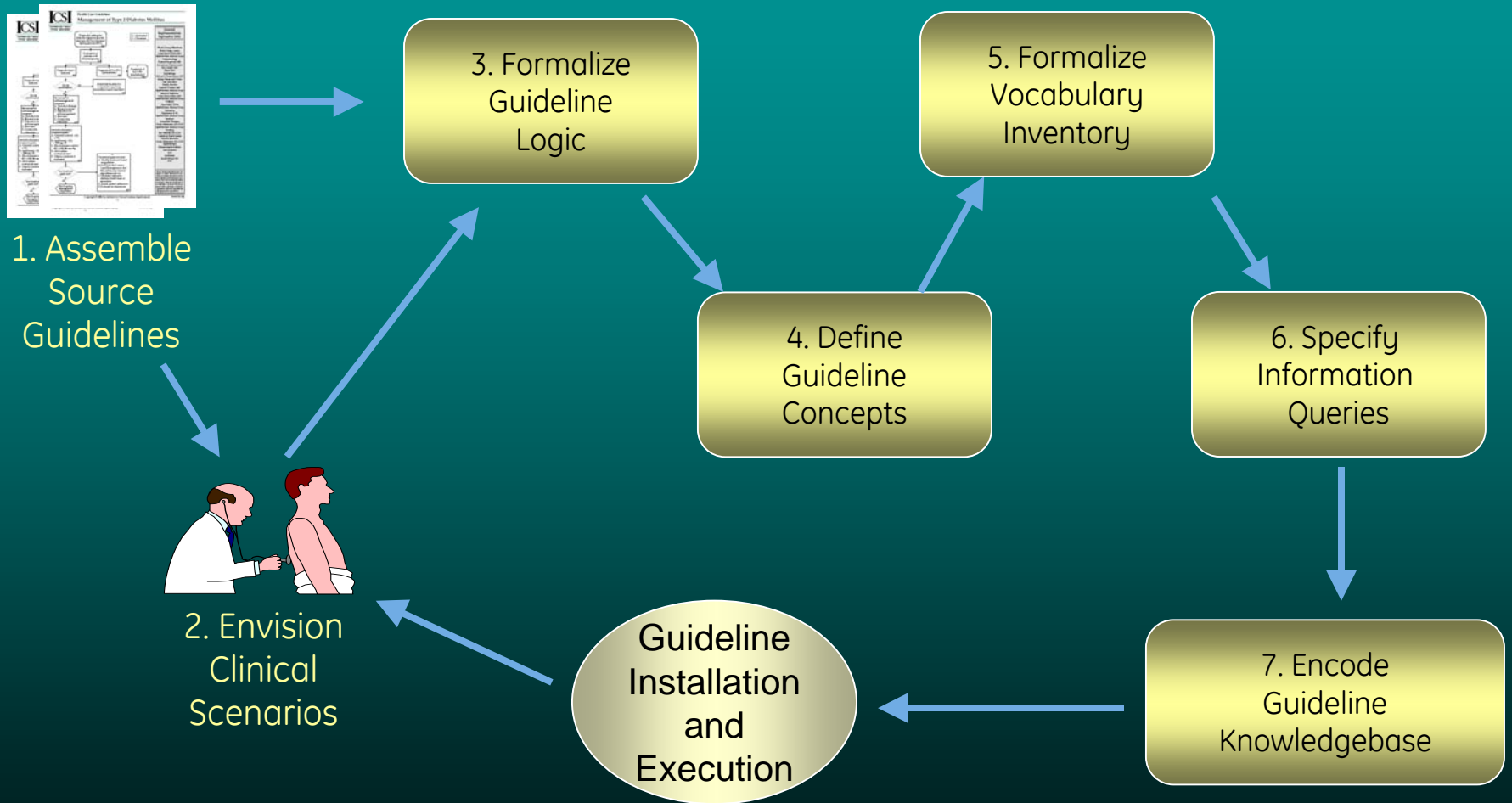
# Overview

- Overview of guidelines and challenges to decision support development

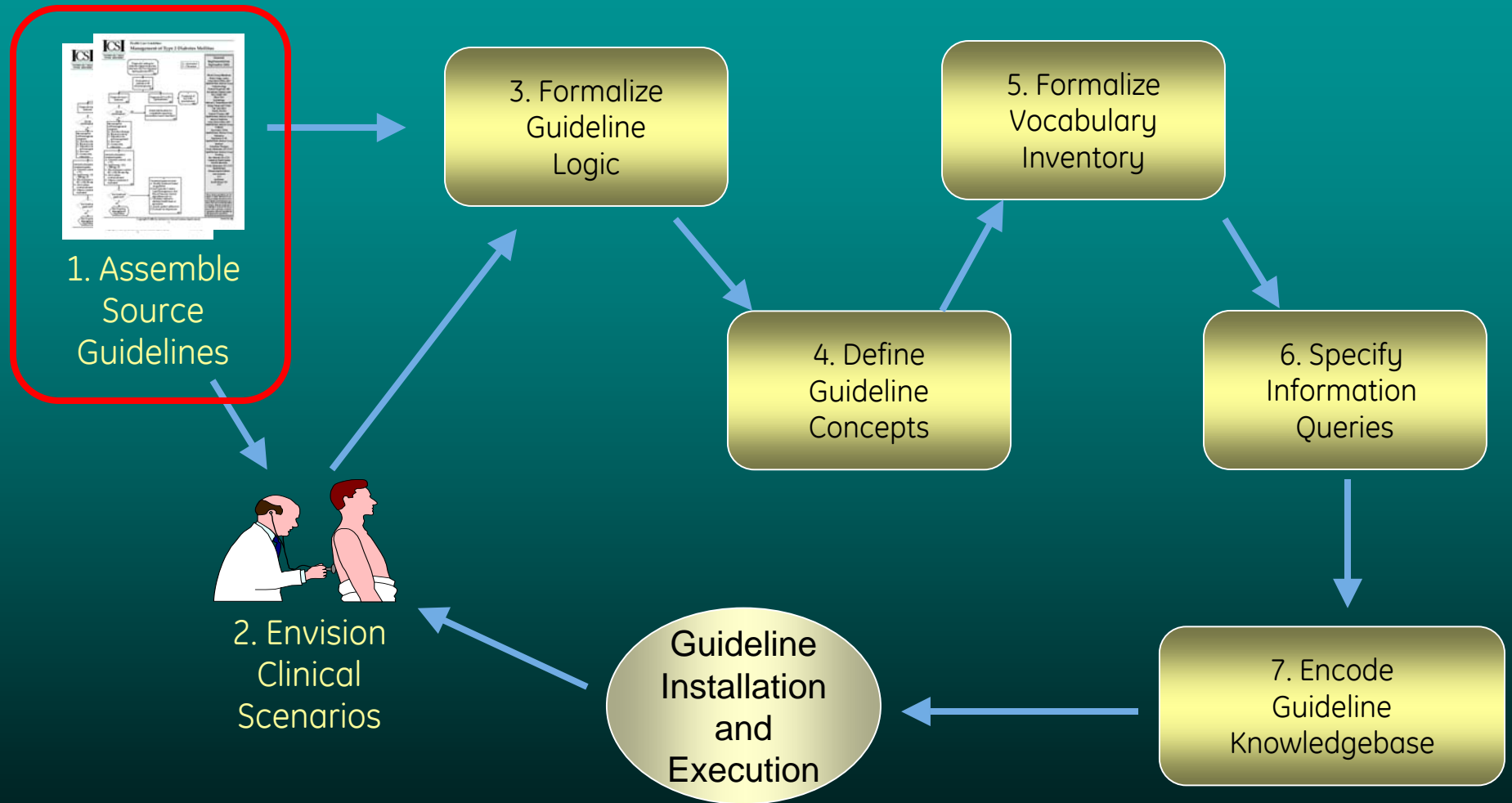
SAGE guideline modeling process:

- **Identifying the source clinical guideline**
- Creating the implementation scenarios and assembling decision logic
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# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process





# Source Guideline: CDC Immunizations

**Recommended Adult Immunization Schedule, by Vaccine and Age Group**  
UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

Vaccine	Age group	10–49 years	50–64 years	≥ 65 years
Tetanus, diphtheria (Td) <sup>1,2</sup>		1 dose booster every 10 yrs		
Measles, mumps, rubella (MMR) <sup>3</sup>		1 dose		
Varicella <sup>4</sup>		1 dose		

**Recommended Childhood and Adolescent Immunization Schedule**  
UNITED STATES • 2006

Vaccine	Age	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	24 months	4–6 years	11–12 years	13–14 years	15–19 years
Poliovirus <sup>1</sup>	Poliovirus <sup>1</sup>	OPV	OPV	OPV	OPV	OPV	IPV							
Diphtheria, tetanus, pertussis <sup>2</sup>	Diphtheria, tetanus, pertussis <sup>2</sup>		DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	Tdap	Tdap	Tdap	
Hepatitis B <sup>3</sup>	Hepatitis B <sup>3</sup>	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs
Measles, mumps, rubella <sup>4</sup>	Measles, mumps, rubella <sup>4</sup>						MMR	MMR	MMR	MMR	MMR	MMR	MMR	MMR
Varicella <sup>5</sup>	Varicella <sup>5</sup>						Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella
MMRV <sup>6</sup>	MMRV <sup>6</sup>						MMRV	MMRV	MMRV	MMRV	MMRV	MMRV	MMRV	MMRV
Pneumococcal <sup>7</sup>	Pneumococcal <sup>7</sup>		PCV	PCV	PCV	PCV	PCV	PCV	PCV	PCV	PPV	PPV	PPV	PPV
Influenza <sup>8</sup>	Influenza <sup>8</sup>						Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)
Hepatitis A <sup>9</sup>	Hepatitis A <sup>9</sup>						Hepatitis A	Hepatitis A	Hepatitis A	Hepatitis A	Hepatitis A	Hepatitis A	Hepatitis A	Hepatitis A

- US Center for Disease Control (CDC): Advisory Committee on Immunization Practices (ACIP) issues vaccination schedules (download)
- Birth-death guideline for all vaccinations advised for US healthcare

# Encoded Guideline: CDC Immunizations

- 75 complex decision rules
- 172 source clinical concepts
- 1200 criteria in run-time logic

**Recommended Adult Immunization Schedule, by Vaccine and Age Group**  
UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

Vaccine	Age group	10–49 years	50–64 years	≥ 65 years
Tetanus, diphtheria (Td) <sup>1,2</sup>		1 dose booster every 10 yrs		
Mumps, measles, rubella (MMR) <sup>1,2</sup>		1 dose	1 dose	
Varicella <sup>3,4</sup>		2 doses (1, 4–8 wk)	2 doses (1, 4–8 wk)	

**Recommended Childhood and Adolescent Immunization Schedule** UNITED STATES • 2006

Vaccine	Age	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	24 months	4–6 years	11–12 years	13–14 years	15–19 years
Hepatitis B <sup>1,2</sup>		HepB		HepB <sup>2</sup>		HepB <sup>3</sup>								
Diphtheria, tetanus, Pertussis <sup>4</sup>		DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP
Hepatitis B <sup>1,2</sup>		HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs	HBs
Poliovirus <sup>5</sup>		IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV
Measles, Mumps, Rubella <sup>6</sup>					MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR
Varicella <sup>7</sup>					Varivax	Varivax	Varivax	Varivax	Varivax	Varivax	Varivax	Varivax	Varivax	Varivax
MMMR <sup>8</sup>					MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR	MMMR
Pneumococcal <sup>9</sup>					PCV	PCV	PCV	PCV	PCV	PCV	PCV	PCV	PCV	PCV
Influenza <sup>10</sup>														
Hepatitis A <sup>11</sup>														

# Pediatric Immunization Sub-guideline Schedule

**Recommended Childhood and Adolescent Immunization Schedule UNITED STATES • 2006**

Vaccine ▼	Age ►	Birth	1 month	2 months	4 months	6 months	12 months	15 months	18 months	24 months	4-6 years	11-12 years	13-14 years	15 years	16-18 years
Hepatitis B <sup>1</sup>		HepB	HepB	HepB <sup>1</sup>	HepB	HepB	HepB	HepB	HepB	HepB Series	HepB Series	HepB Series	HepB Series	HepB Series	HepB Series
Diphtheria, Tetanus, Pertussis <sup>2</sup>			DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	DTaP	Tdap	Tdap	Tdap	Tdap	Tdap
<i>Haemophilus influenzae</i> type b <sup>3</sup>			Hib	Hib	Hib <sup>3</sup>	Hib	Hib	Hib	Hib	Hib	Hib	Hib	Hib	Hib	Hib
Inactivated Poliovirus			IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV	IPV
Measles, Mumps, Rubella <sup>4</sup>						MMR	MMR	MMR	MMR	MMR	MMR	MMR	MMR	MMR	MMR
Varicella <sup>5</sup>						Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella	Varicella
Meningococcal <sup>6</sup>												MCV4	MCV4	MCV4	MCV4
Pneumococcal <sup>7</sup>			PCV	PCV	PCV	PCV	PCV	PCV	PCV	PCV	PPV	PPV	PPV	PPV	PPV
Influenza <sup>8</sup>						Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)	Influenza (Yearly)
Hepatitis A <sup>9</sup>										HepA Series	HepA Series	HepA Series	HepA Series	HepA Series	HepA Series

# Adult Immunization Sub-guideline Schedule

## Recommended Adult Immunization Schedule, by Vaccine and Age Group UNITED STATES, OCTOBER 2005–SEPTEMBER 2006

Vaccine ▼	Age group ►	19–49 years	50–64 years	≥ 65 years
Tetanus, diphtheria (Td) <sup>1*</sup>		1-dose booster every 10 yrs		
Measles, mumps, rubella (MMR) <sup>2*</sup>		1 or 2 doses	1 dose	
Varicella <sup>3*</sup>		2 doses (0, 4–8 wks)	2 doses (0, 4–8 wks)	
--- Vaccines below broken line are for selected populations				
Influenza <sup>4*</sup>		1 dose annually	1 dose annually	
Pneumococcal (polysaccharide) <sup>5,6</sup>		1–2 doses		1 dose
Hepatitis A <sup>7*</sup>		2 doses (0, 6–12 mos, or 0, 6–18 mos)		
Hepatitis B <sup>8*</sup>		3 doses (0, 1–2, 4–6 mos)		
Meningococcal <sup>9</sup>		1 or more doses		

# Guidelines are Dynamic

- Recent provisional recommendations of the Advisory Committee on Immunization Practice (ACIP)
  - Varicella: 2 dose recommendation for all ages (August 2006)
  - HPV: 3 dose series for females ages 9-26 (August 2006)
  - Tdap:
    - use in pregnant women (August 2006)
    - Use in adult population (March 2006)

# Guideline Focus: CDC Adult Pneumococcal Guideline



## **Pneumococcal Polysaccharide Vaccine Recommendations**

- Adults  $\geq 65$  years of age
- Persons  $\geq 2$  years with
  - chronic illness
  - anatomic or functional asplenia
  - immunocompromised (disease, chemotherapy, steroids)
  - HIV infection
  - environments or settings with increased risk
  - cochlear implant

## **Pneumococcal Polysaccharide Vaccine Revaccination**

- Routine revaccination of immunocompetent persons is not recommended
- Revaccination recommended for persons age  $\geq 2$  years at highest risk of serious pneumococcal infection
- Single revaccination dose  $\geq 5$  years after first dose

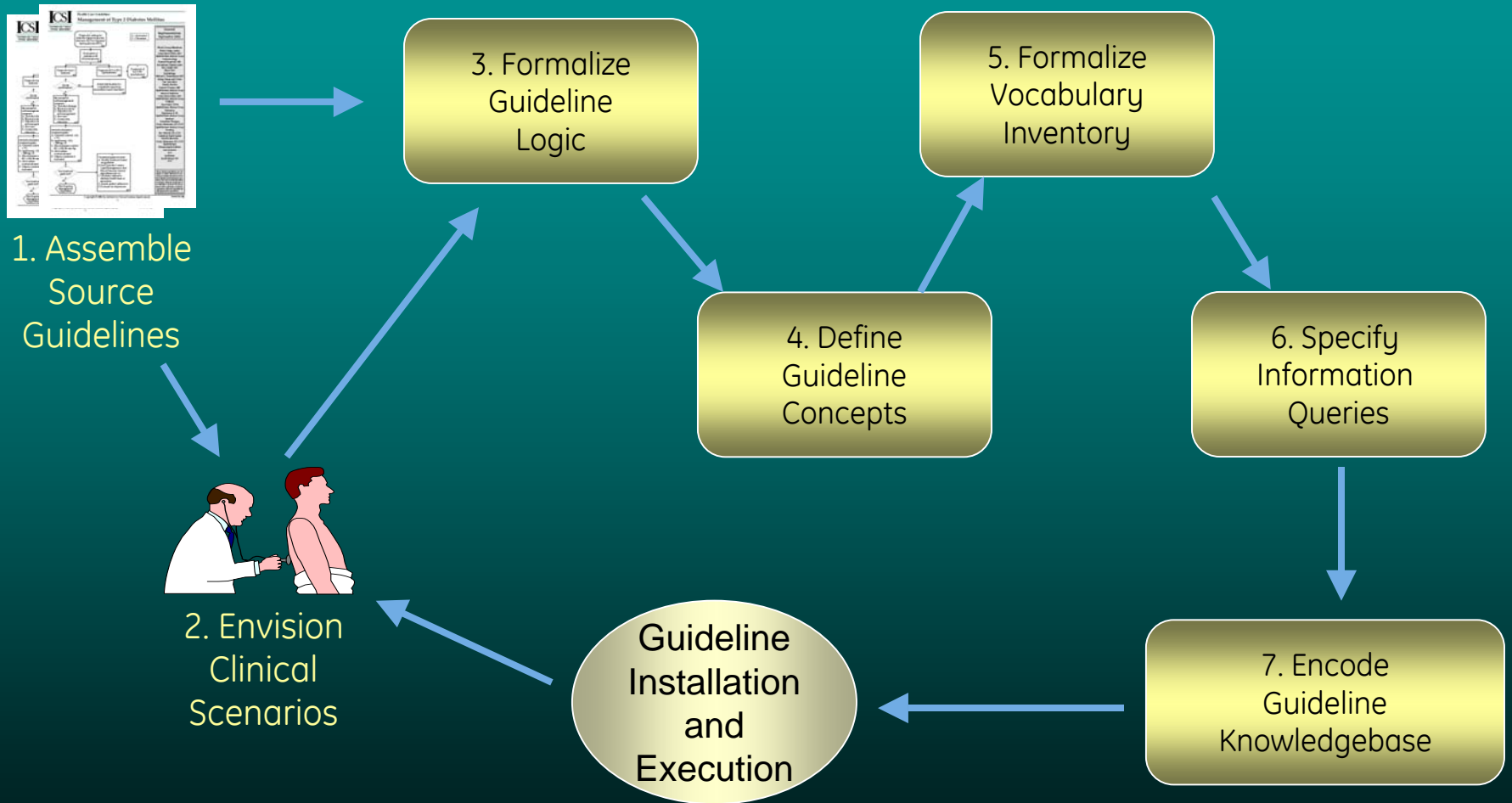
# Overview

- Overview of guidelines and challenges to decision support development

SAGE guideline modeling process: Introduction

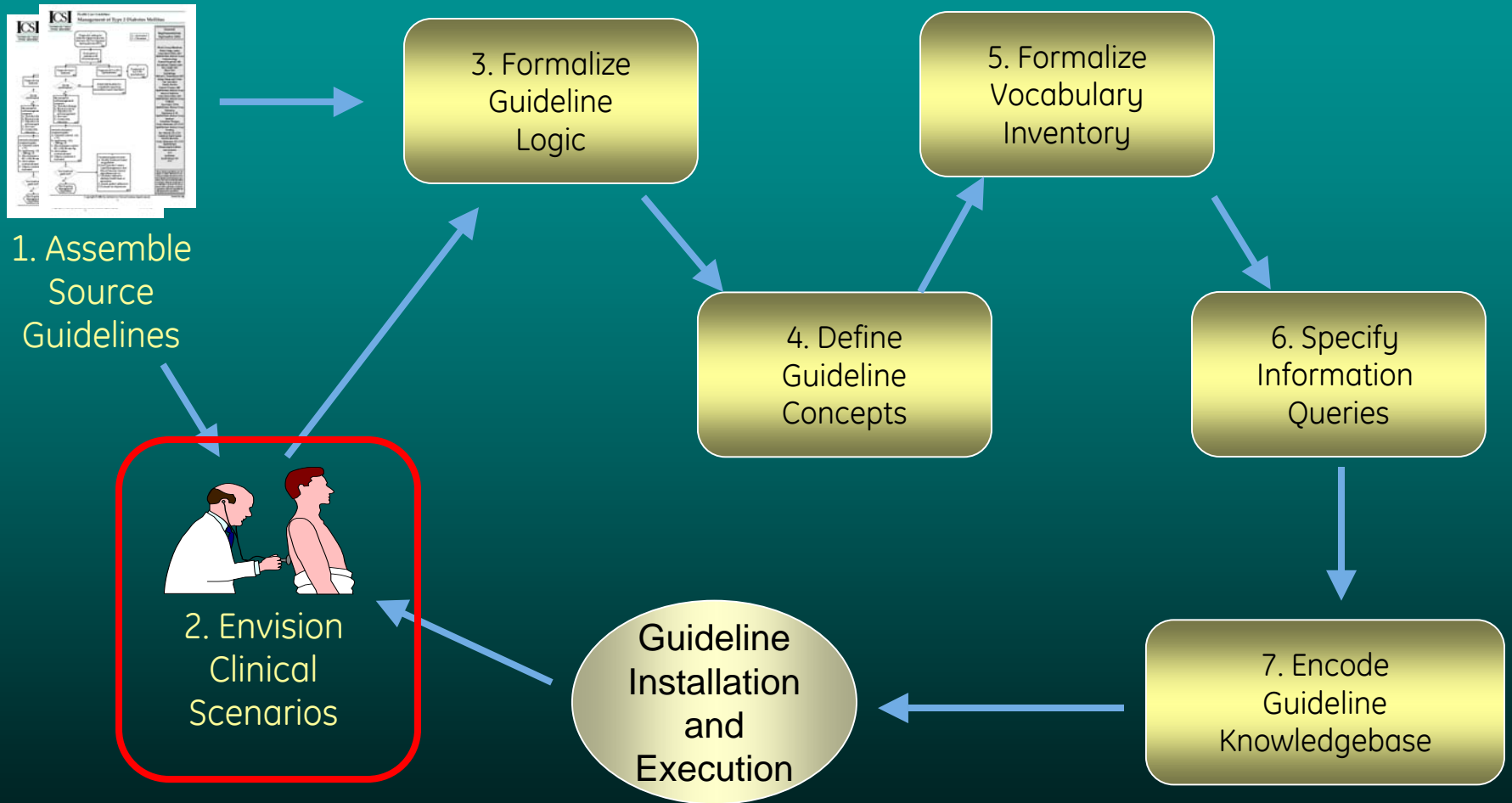
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# SAGE Guideline Encoding Process





# SAGE Guideline Encoding Process



# Envision Clinical Scenarios

“In automating complex guidelines  
... the most difficult (obstacle was)  
related to **workflow integration.**”

Maviglia et al. *J Am Med Inform Assoc.*2003; 10: 154-165

# Creating Guideline Scenarios

- Workflow process that approximates the typical clinical practice
- With an efficient work model that does not control or distort work activities
- Target interactions with the most appropriate individual
- Multi-faceted interventions
- Locally – some need for modifications to match local workflow and CIS capabilities

# Creating Guideline Scenarios

- Focus upon a clinical opportunity
- Have a specified trigger (initiating information event)
- Construct understanding the CDSS and CIS capabilities; digital clinical data available
- Include plans for decision support, recording of data required for good care, and monitoring of CDSS function

# Primary Care Visit Scenario

- Check-in process
  - Patient arrives at primary care office requesting care.
  - The patient is checked in to clinic
- Nurse interaction
  - Patient is called for preparation by the nurse.
  - The nurse logs onto the clinic information system and selects the patient record.
  - Vitals are taken and entered into the CIS
- Physician visit
  - Physician assesses patient and makes recommendations/orders
- Variable check-out process

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CDSS intervention

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CDSS intervention



# Primary Care Visit Scenario

- CDSS is triggered
- Review of patient's record for indication/contraindication:
  - vaccination history
  - problem list
  - procedure history
- Physician notified of due, but contraindicated vaccines
- Nurse informed of eligibility and appropriate vaccination information sheets are printed for the patient or parent to read.
- The nurse is prompted to obtain and document consent and verify that the patient does not have an inter-current illness that would prevent vaccination today.



## CDSS intervention

# Primary Care Visit Scenario

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# Primary Care Visit Scenario

- Clinical record assessed for any known deferral reasons and those vaccines are removed from the list of those to be administered.
- Automated care orders are placed in the system for the vaccines which the patient is to receive.
- The nurse charts against these care orders as she administers the vaccines to the patient, updating the master record.

## CDSS intervention

# Primary Care Visit Scenario

- Clinical record assessed for any known deferral reasons and those vaccines are removed from the list of those to be administered.
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# Population Management Scenario

- Every Sunday at midnight, a batch program starts within the clinical information system for a rural health clinic.
- The program checks each patient record within the practice and reviews the vaccination history and all record data pertinent to indications and contraindications for vaccinations.
- It identifies all patients who have come due for vaccines and issues a report for the clinic manager who coordinates the scheduling for patients who need immunization.

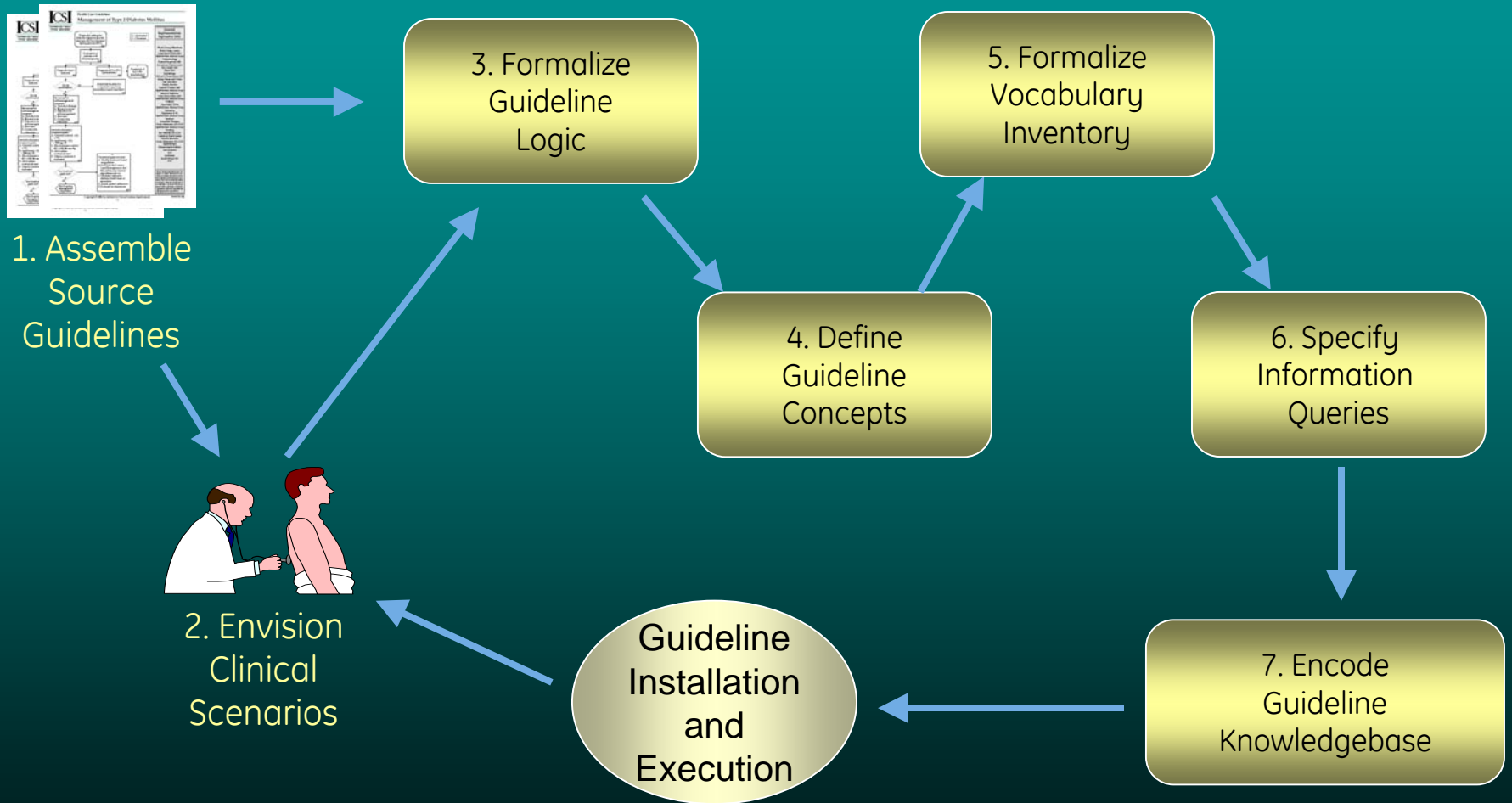
# Neonatal Birth Scenario (Admission to Nursery)

- A baby is admitted to the nursery in a local hospital following birth in the L&D suite. The admission event is tracked by SAGE which checks for eligibility against the child's and mother's clinical records.
- SAGE recommends orders for Hepatitis B vaccine and Hepatitis immune globulin as appropriate.
- Orders for follow-up serologic testing at nine months of age are issued when exposure status is positive or uncertain.
- When mother's serologic status for Hep B is unknown, SAGE issues orders for maternal testing and tracks results until obtained.

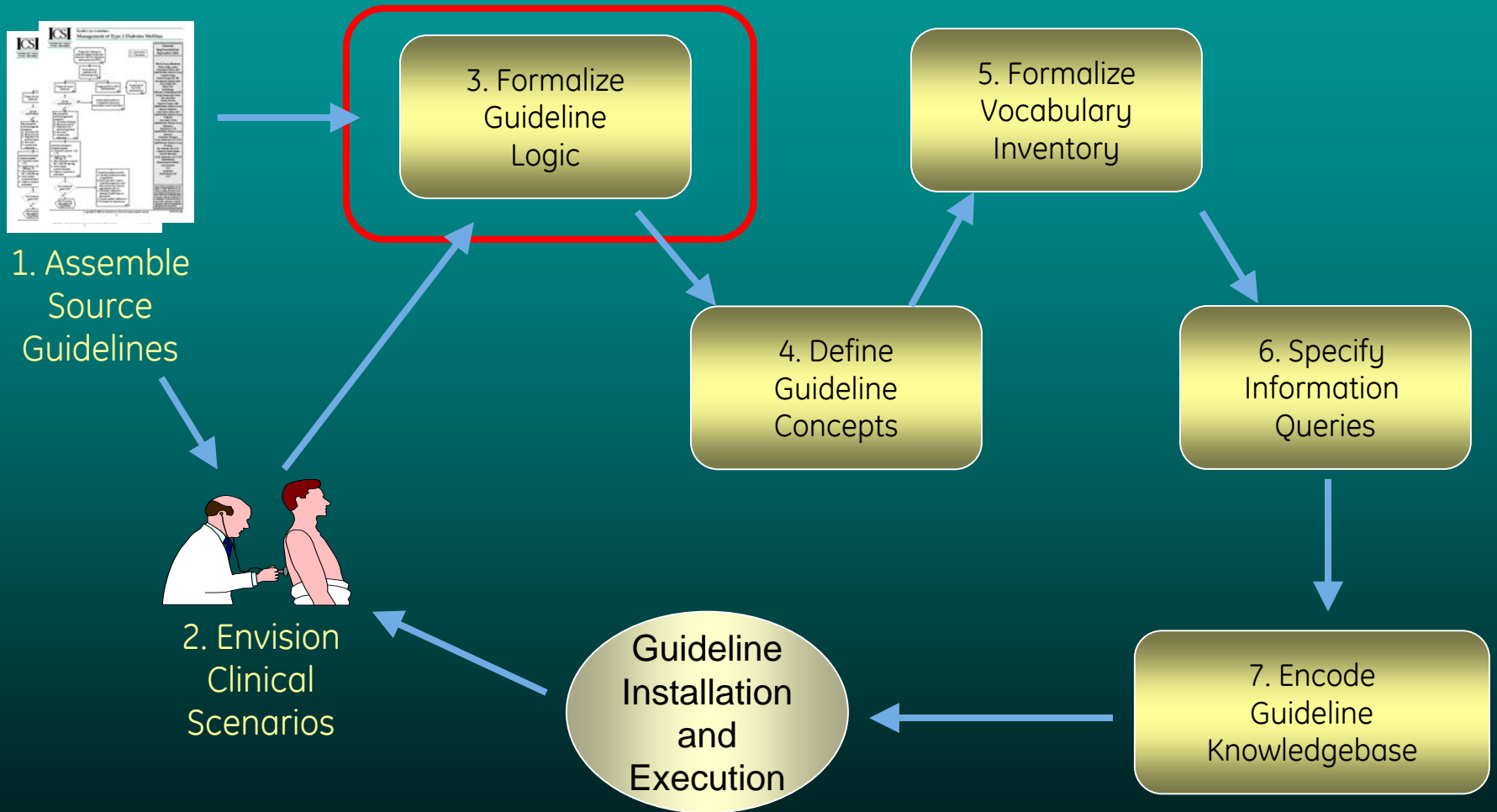
# Alternative Scenarios?

- All patients seeking service in the emergency department or urgent care facility have reminders issued for vaccines
- All patients being discharged from hospital have vaccine requirements reviewed and alerts issued
- The home health visitor has automated alerts generated for the list of scheduled patients who are due for vaccination
- A long term care facility is issued automated orders verifying eligibility for overdue vaccinations

# SAGE Guideline Encoding Process



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# Use Case: CDC Adult Pneumococcal Guideline



## **Pneumococcal Polysaccharide Vaccine Recommendations**

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# Decision Logic Inventory

## **Recommendation set: Adult Pneumococcal polysaccharide vaccine (PPV23)**

Contraindication ::= Anaphylaxis reaction to pneumococcal vaccine

Deferral ::= Moderate or severe current illness  
two weeks prior to chemotherapy or  
radiation therapy

Indication ::=

Immunosuppressed (defined):

- HIV infection
- Leukemia
- Lymphoma (includes Hodgkins)
- Multiple myeloma
- Generalized malignancies
- Congenital immunosuppression
- Immunodeficiency caused by chemotherapy
- Solid organ transplant
- Bone marrow transplant
- Chemotherapy with alkylating agents within last three months
- Antimetabolite therapy
- Long term steroid therapy

Functional and Anatomic Asplenia (defined):

- Splenectomy
- Congenital Asplenia
- Asplenia syndrome
- Functional asplenia
- Hyposplenism

Sickle cell disease

Chronic cardiac disease or

Chronic pulmonary disease excluding asthma or

Diabetes mellitus or

CSF leak or

Hemodialysis patient or

Health care worker or

Emergency response personnel or

Terminal complement component deficiencies or

Chronic liver disease or

Chronic alcoholism

Cochlear implants

Native American

Pregnancy

Chronic transfusion patient (more than 3 transfusions last 6 months)

Nursing home resident

# Decision Logic Inventory

Recommendation set:  
One subset of guideline recommendations that can be implemented in a single work plan

## **Recommendation set: Adult Pneumococcal polysaccharide vaccine (PPV23)**

Contraindication ::= Anaphylaxis reaction to pneumococcal vaccine

Deferral ::= Moderate or severe current illness  
two weeks prior to chemotherapy or  
radiation therapy

Indication ::=

Immunosuppressed (defined):

- HIV infection
- Leukemia
- Lymphoma (includes Hodgkins)
- Multiple myeloma
- Generalized malignancies
- Congenital immunosuppression
- Immunodeficiency caused by chemotherapy
- Solid organ transplant
- Bone marrow transplant
- Chemotherapy with alkylating agents within last three months
- Antimetabolite therapy
- Long term steroid therapy

Functional and Anatomic Asplenia (defined):

- Splenectomy
- Congenital Asplenia
- Asplenia syndrome
- Functional asplenia
- Hyposplenism

Sickle cell disease

Chronic cardiac disease or

Chronic pulmonary disease excluding asthma or

Diabetes mellitus or

CSF leak or

Hemodialysis patient or

Health care worker or

Emergency response personnel or

Terminal complement component deficiencies or

Chronic liver disease or

Chronic alcoholism

Cochlear implants

Native American

Pregnancy

Chronic transfusion patient (more than 3 transfusions last 6 months)

Nursing home resident

# Decision Logic Inventory

Requires review and integration of all decision elements:

- contraindications
- deferrals
- indications

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Contraindication := Anaphylaxis reaction to pneumococcal vaccine

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Nursing home resident

# Decision Logic Inventory: Which Vaccine to Administer?

Rule 1: Adult First Dose PPV23

IF NO CONTRAINDICATION

AND

NO REASON FOR DEFERRAL

AND

NUMBER OF PPV23 VACCINE DOSES = 0

AND

INDICATION FOR PNEUMOCOCCAL VACCINE OR (AGE ≥ 65 YEARS)

THEN

ADVISE ADMINISTRATION OF PPV23 VACCINE

Rule 2: Adult Second dose PPV23

IF NO CONTRAINDICATION

AND

NO REASON FOR DEFERRAL

AND

NUMBER OF PPV23 VACCINE DOSES = 1

AND

((SUBGROUP INDICATIONS FOR REVACCINATION))

OR

((AGE > 65 YEARS) AND (PPV23 VACCINE DOSE GIVEN < AGE 65 YEARS)))

AND

PPV23 ADMINISTERED ≥ 5 YEARS PREVIOUSLY

THEN

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AND

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THEN

ADVISE ADMINISTRATION OF PPV23 VACCINE



# Decision Logic Inventory: Which Vaccine to Administer?

Must specify all  
clinical details  
required for  
complete  
deployment

## Rule 1: Adult First Dose PP V23

IF NO CONTRAINDICATION

AND

NO REASON FOR DEFERRAL

AND

NUMBER OF PP V23 VACCINE DOSES = 0

AND

INDICATION FOR PNEUMOCOCCAL VACCINE OR (AGE ≥ 65 YEARS)

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ADVISE ADMINISTRATION OF PP V23 VACCINE

## Rule 2: Adult Second dose PP V23

IF NO CONTRAINDICATION

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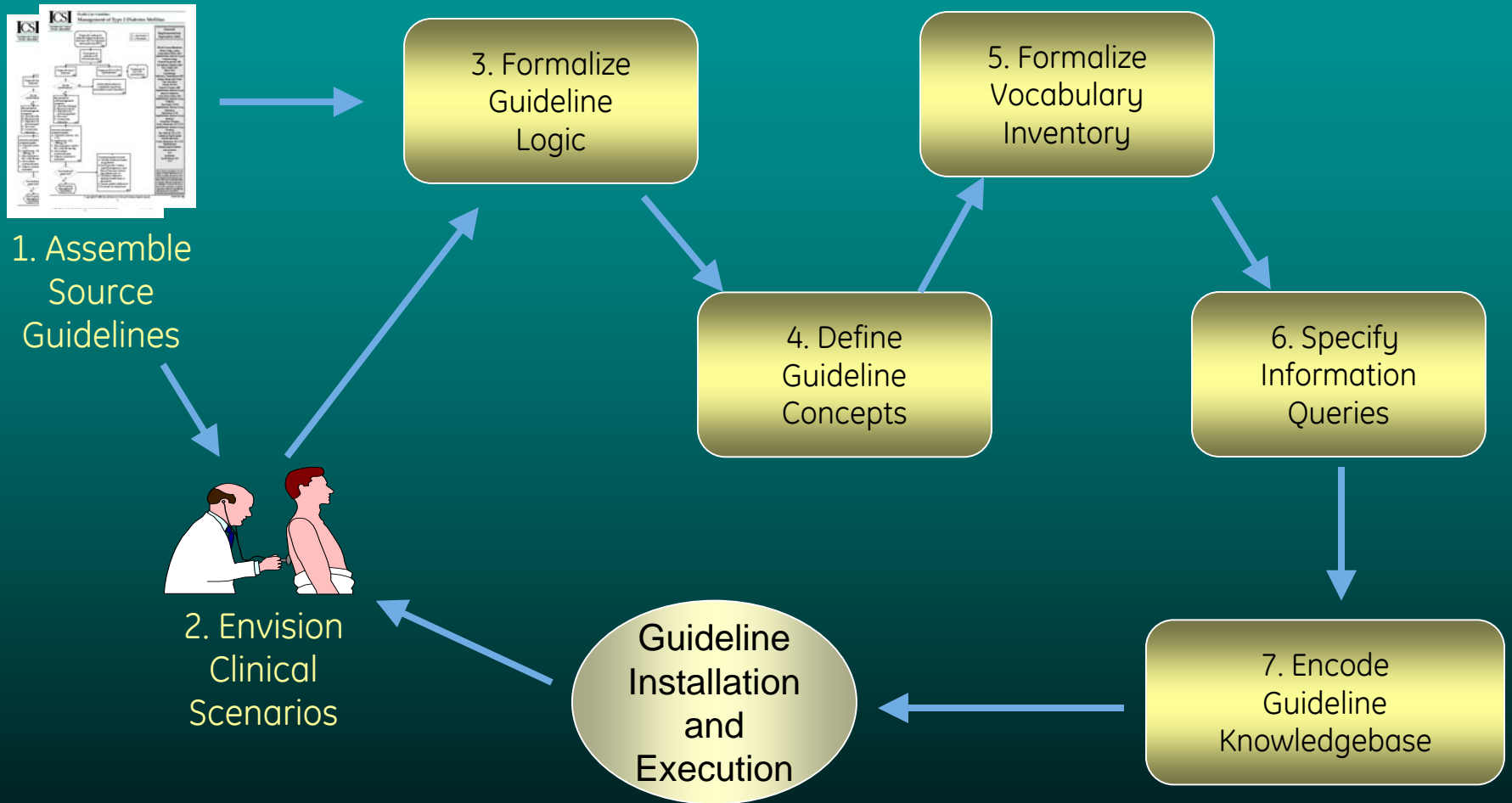
# Overview

- Overview of guidelines and challenges to decision support development

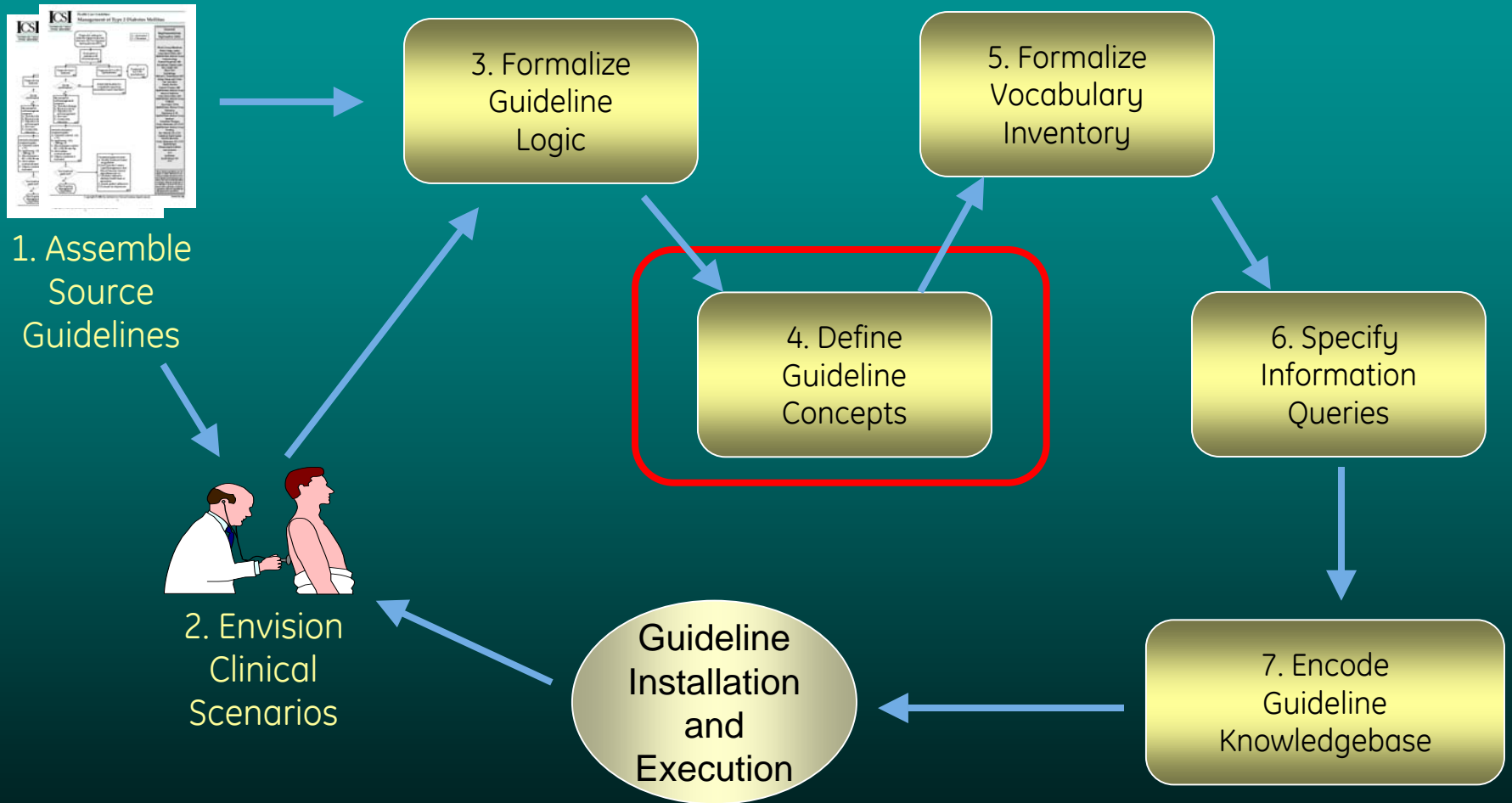
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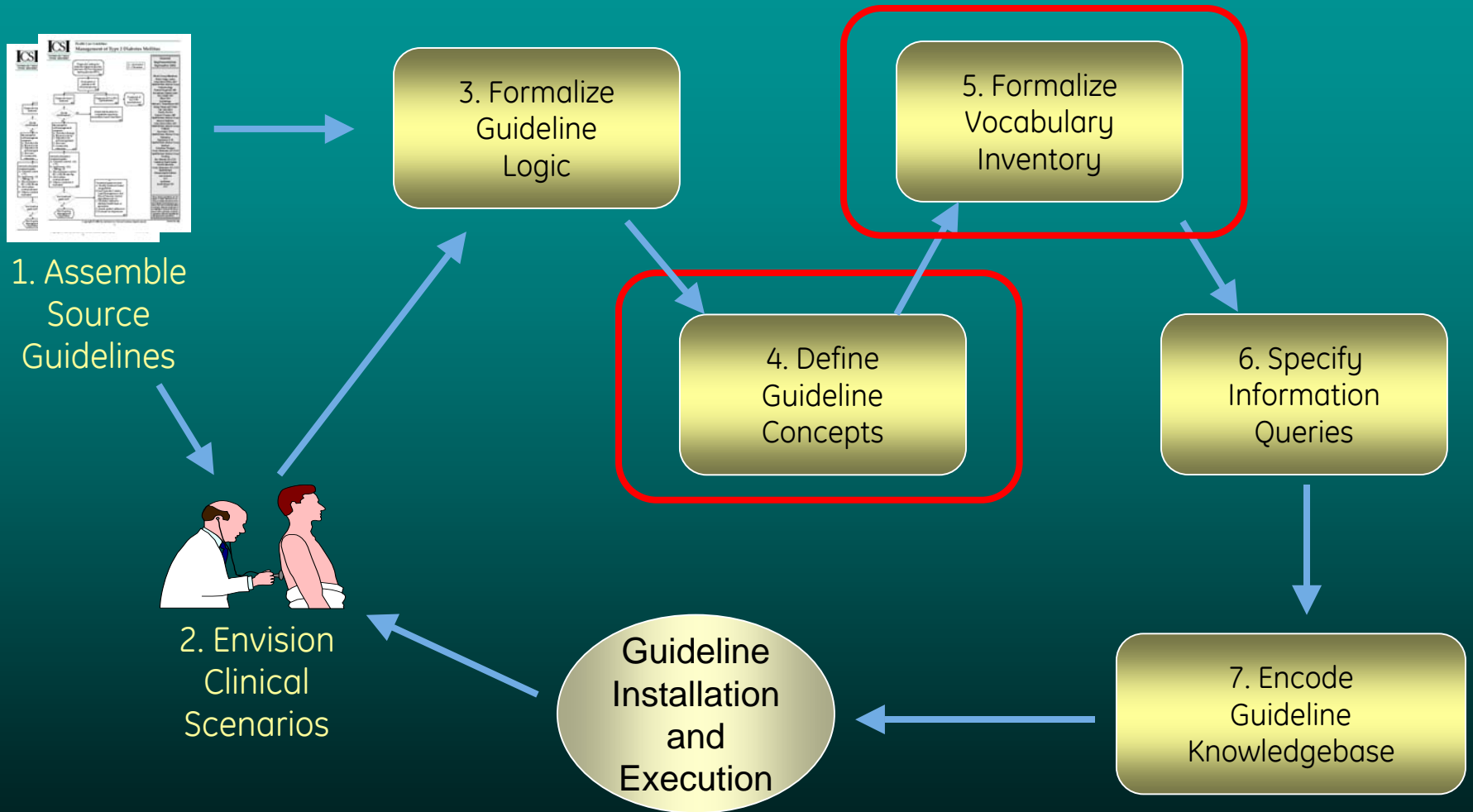
# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process



# Reviewing Concept Inventory: Binding to Standard Vocabulary

- Concepts present in the guideline may require clinical discussion and definition
- Once clarified and matched into information model requirements, meaning must be reviewed against the appropriate vocabulary domain (SNOMED CT, LOINC) to assure that the meaning in the guideline corresponds to the meaning to be retrieved from the patient record

# Clarifying Concept Definition...

- What is a chronic illness?
- Functional or anatomic asplenia?
- Who is an immunocompromised person?

## **Pneumococcal Polysaccharide Vaccine Recommendations**

- Adults  $\geq 65$  years of age
- Persons  $\geq 2$  years with
  - chronic illness
  - anatomic or functional asplenia
  - immunocompromised (disease, chemotherapy, steroids)
  - HIV infection
  - environments or settings with increased risk
  - cochlear implant

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# SNOMED CT<sup>®</sup>

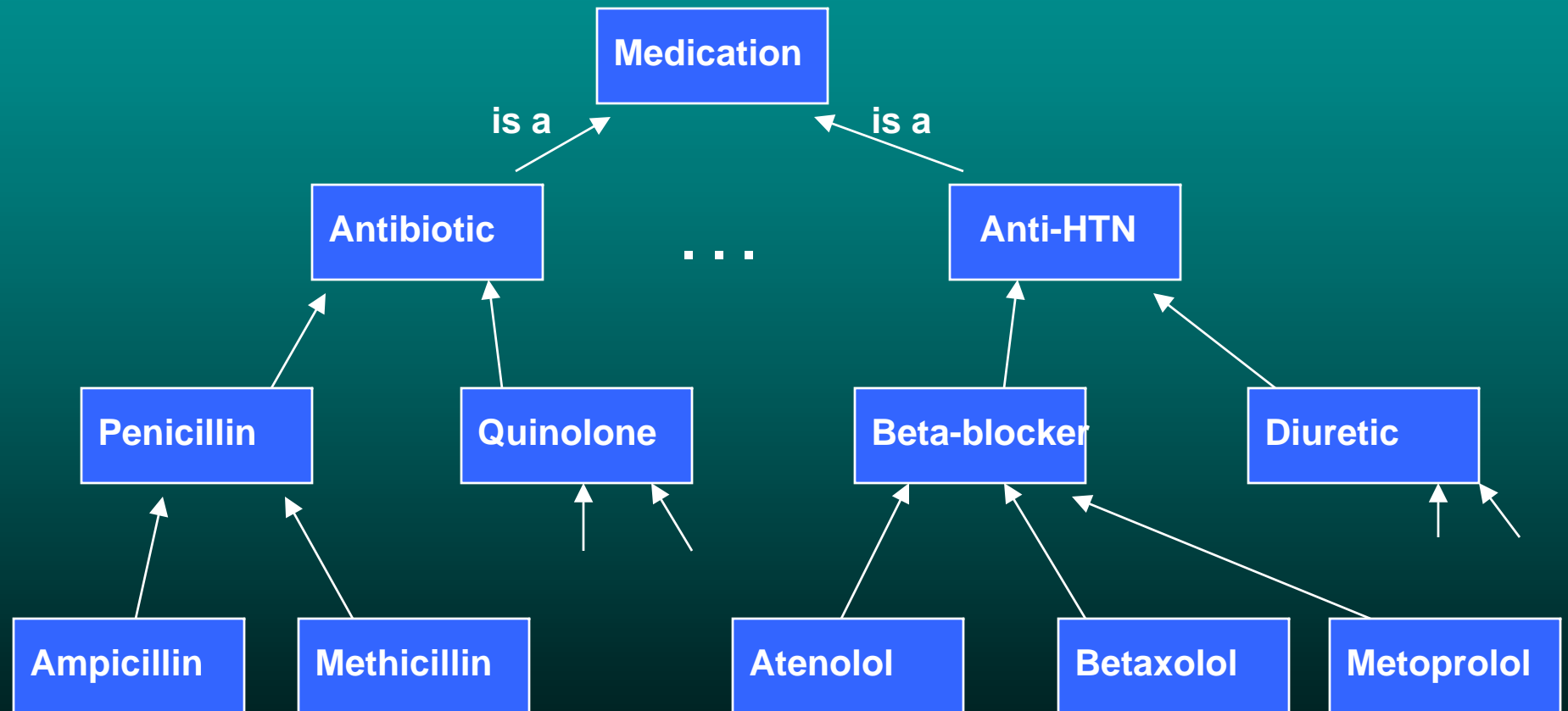
- Under development by the College of American Pathologists since the 1960's
- Provides a disambiguated, polyhierarchical representation of over 350,000 medical concepts, with approximately 1 million descriptions
- Under licensing agreement with the NLM
- Crossmaps to other commonly-used terminologies are built in
- Presently the most complete formal medical ontology in existence

# Why do we need SNOMED CT?

- Synonyms
  - By assigning a unique numeric code to each medical concept, SNOMED CT formalizes clinical terminology.
- Subsumption
  - By representing the complete set of relationships among medical concepts, SNOMED CT automates classification logic.
- Ambiguity
  - By assigning different codes to homonyms, SNOMED CT disambiguates medical language.

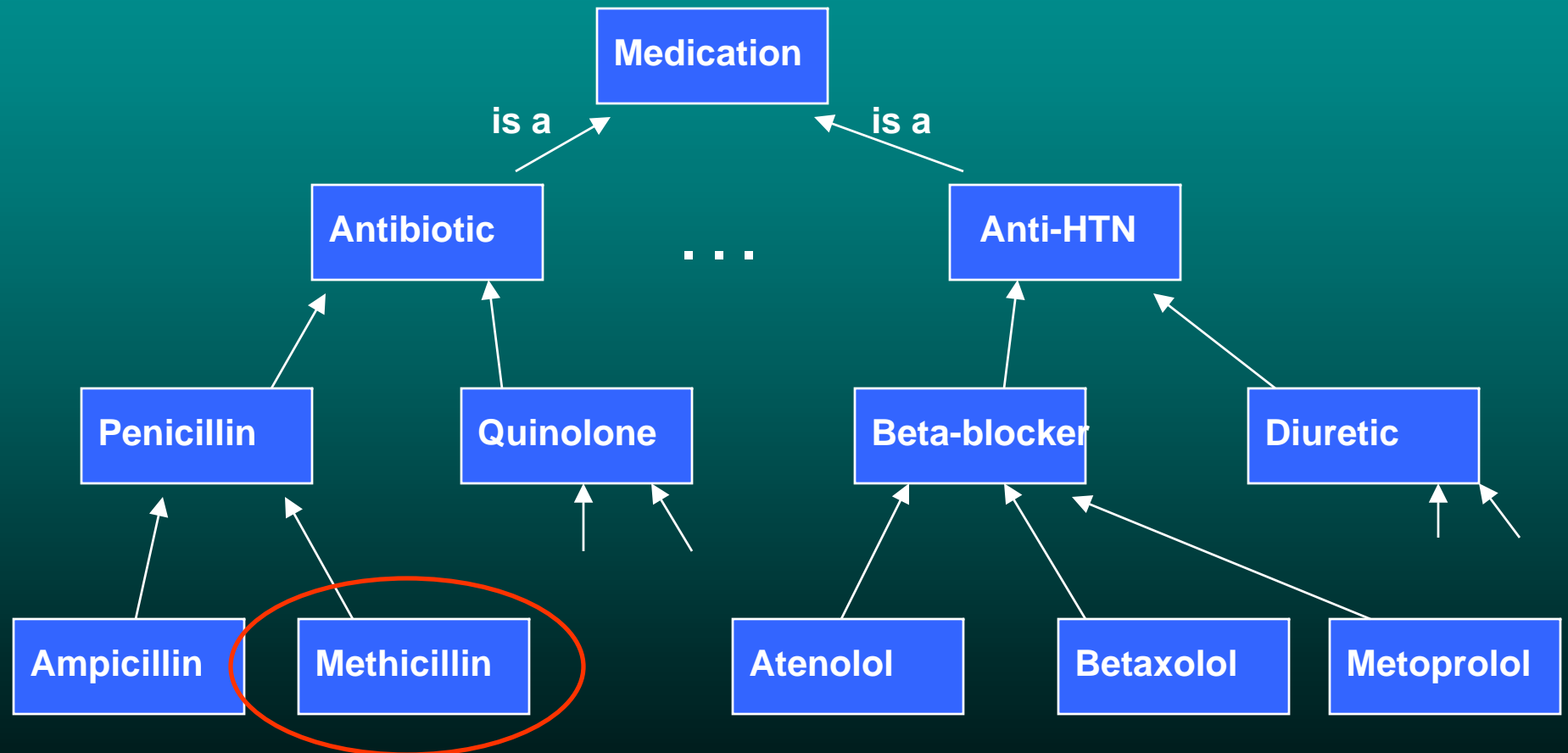
# The Inheritance Hierarchy

Concepts are arranged in a tree hierarchy



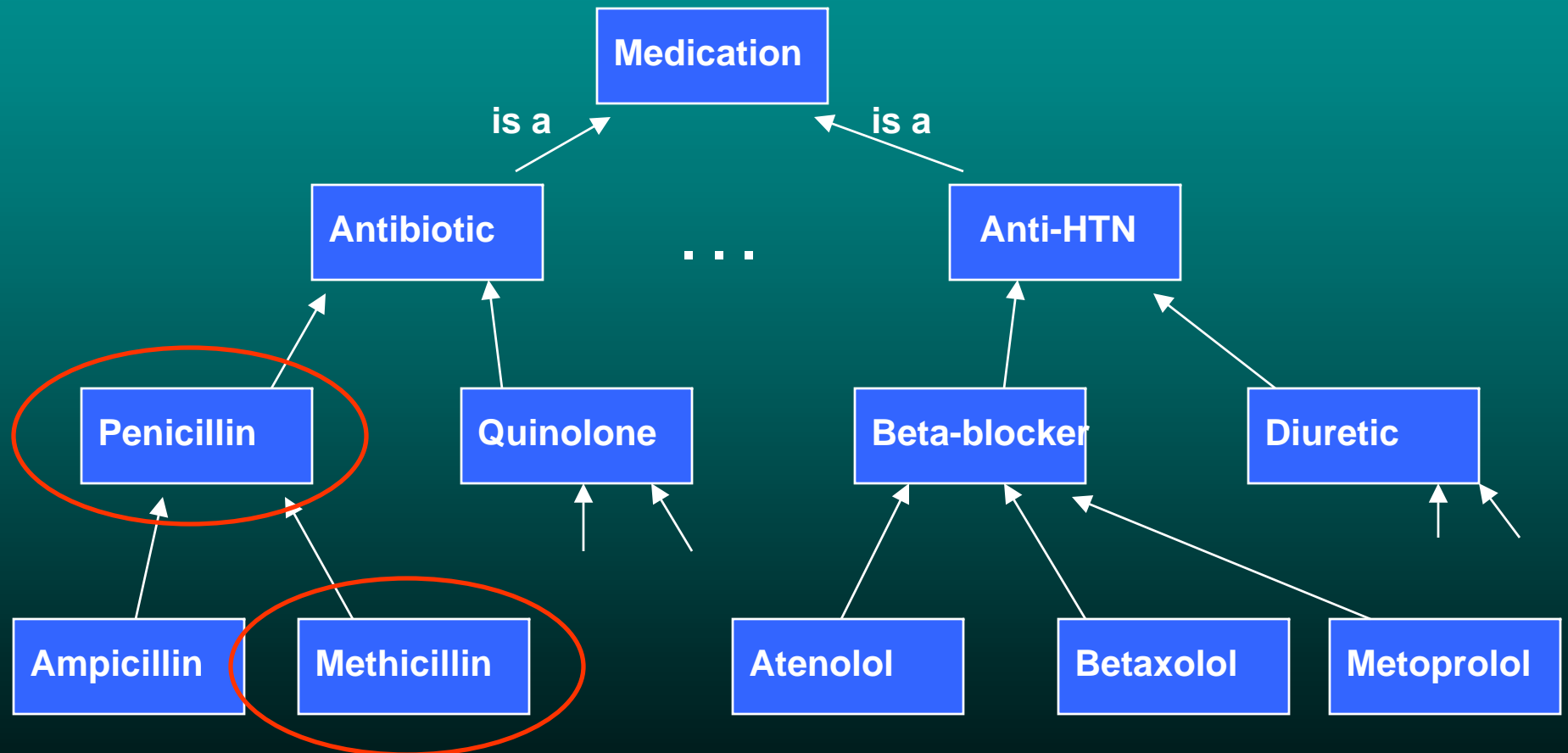
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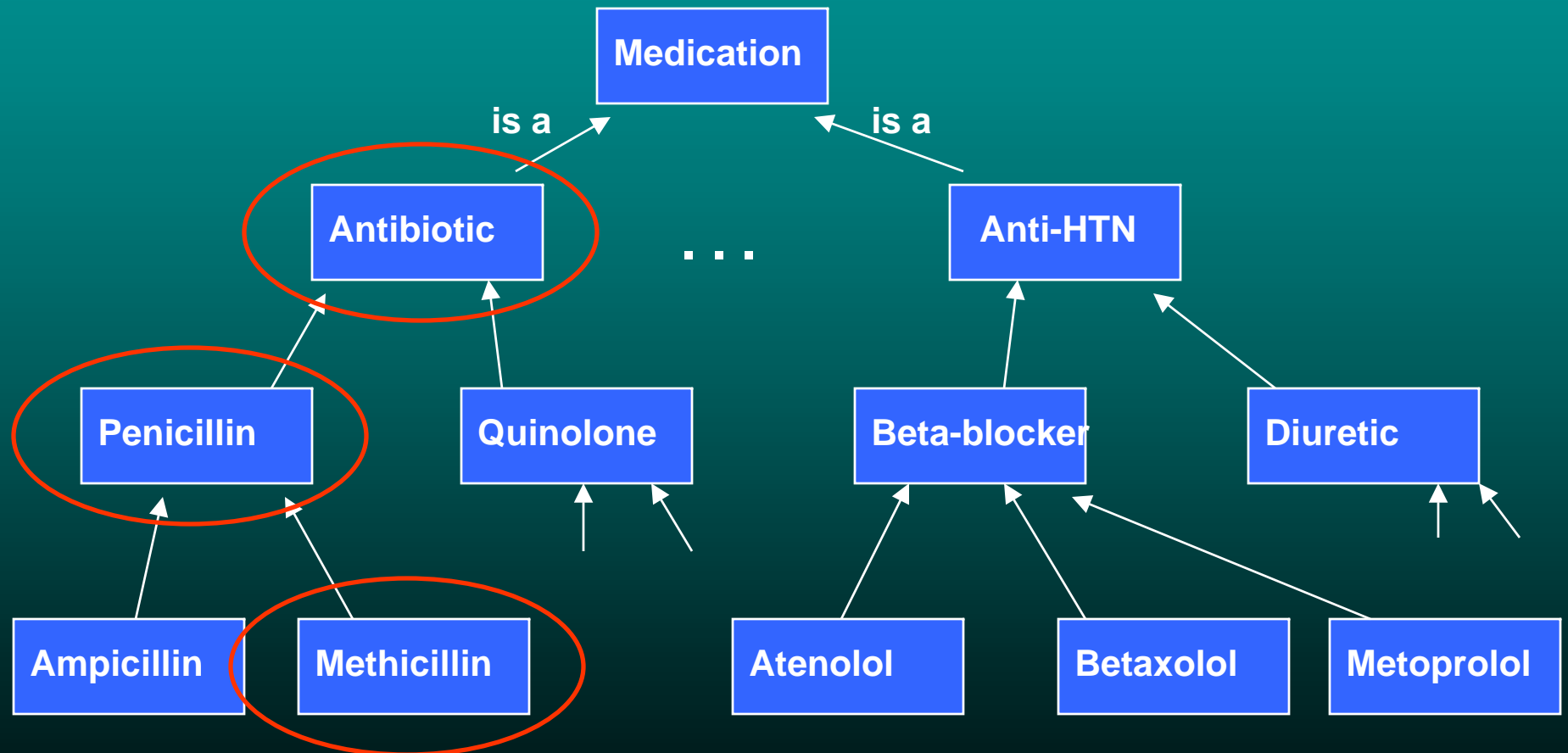
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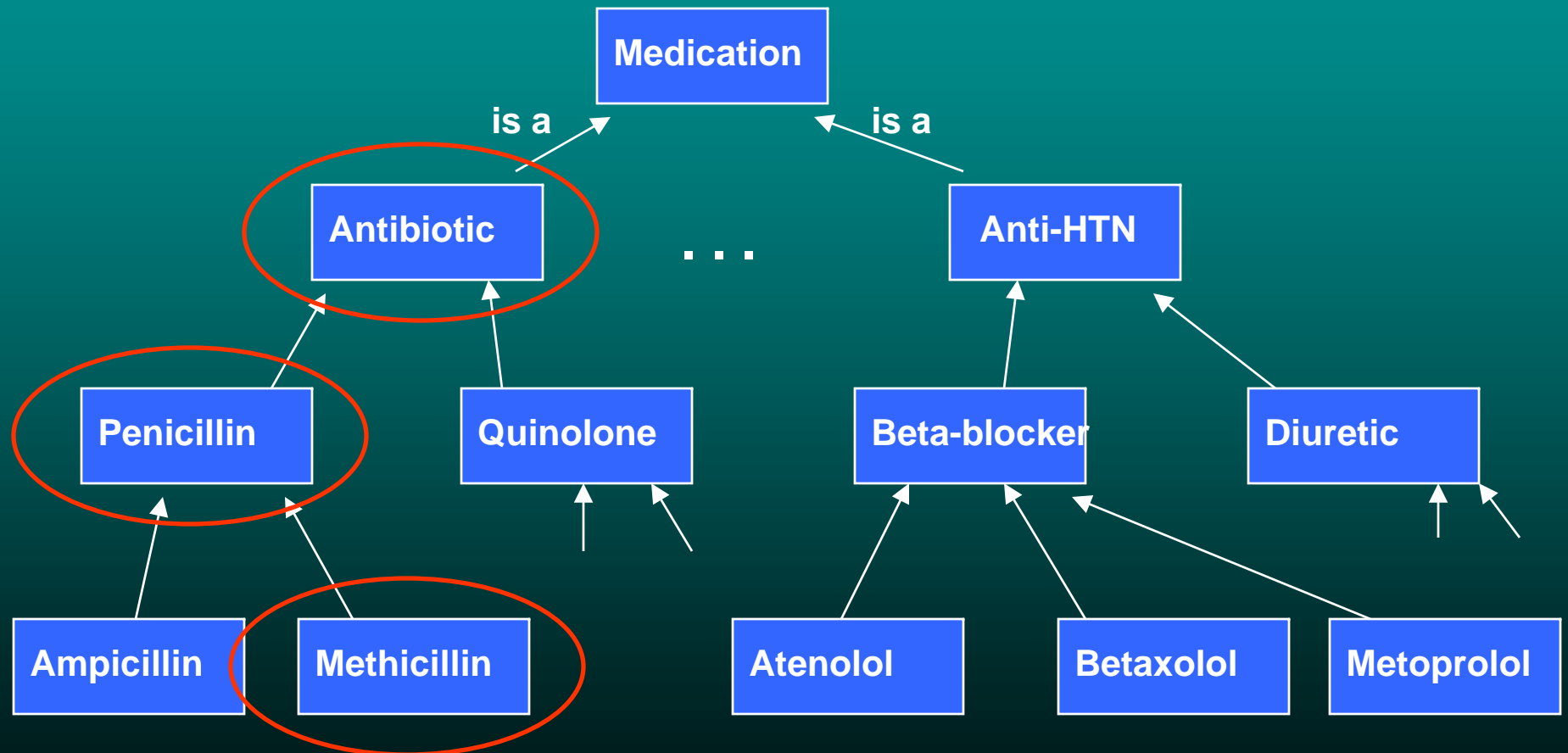
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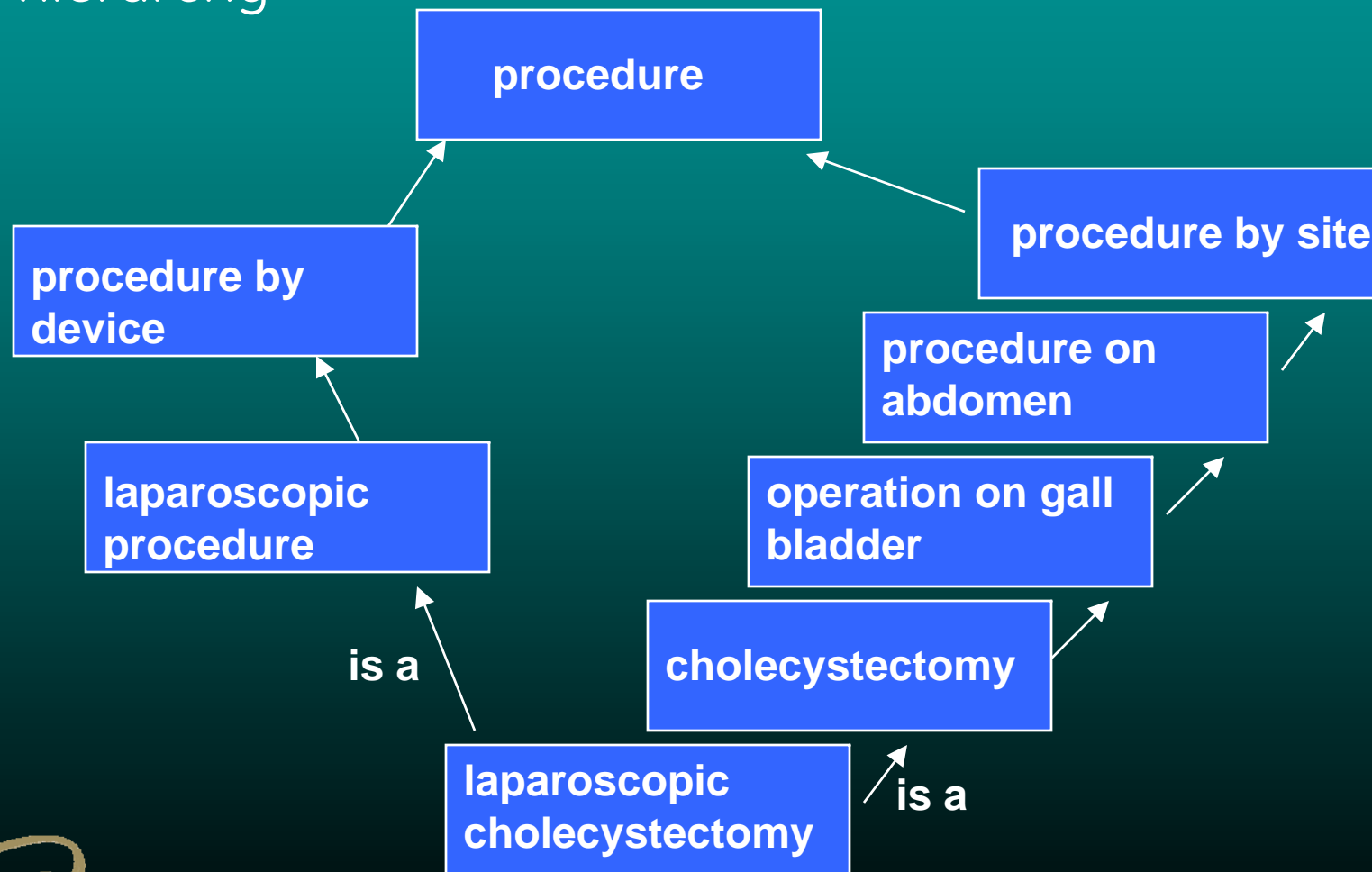
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**Antibiotic subsumes Penicillin and Methicillin**

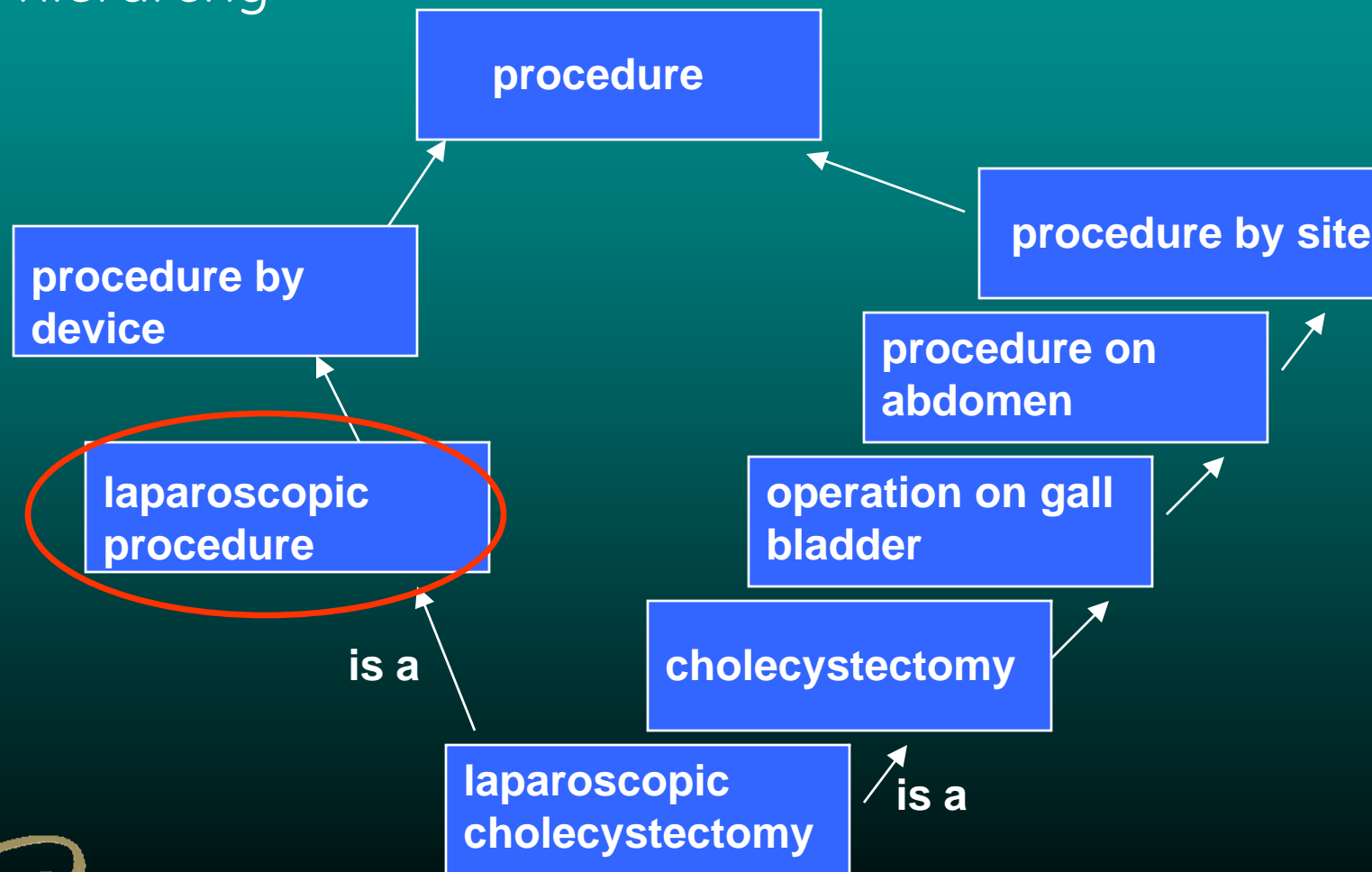
# Polyhierarchical Structure

A concept may have more than one parent in the hierarchy



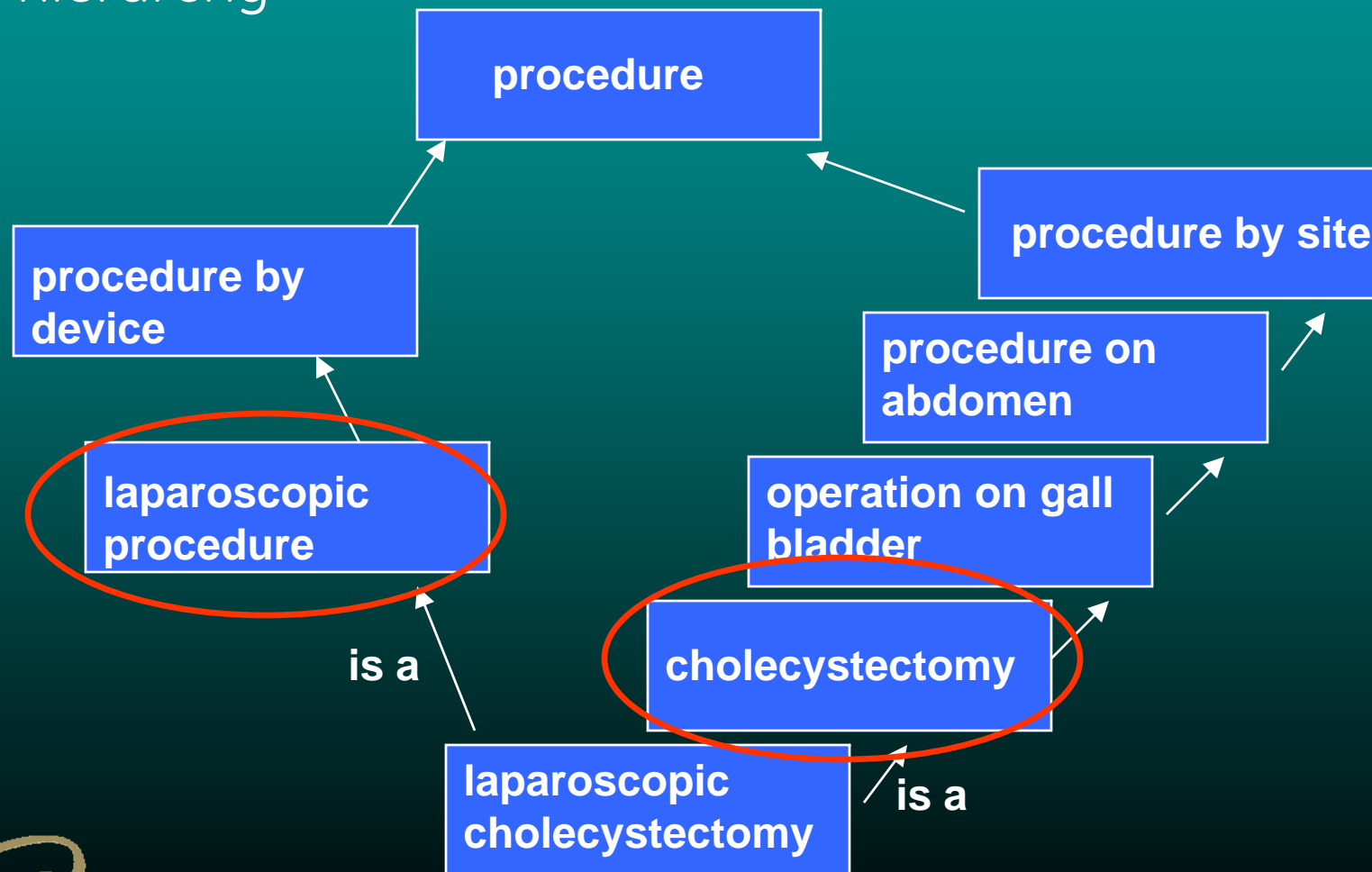
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# Pre- and Post-Coordination

Suprarenal Artery Embolus  
297143008

or

Is_a	Occlusion of Artery	2929001
	Associated Morphology	116676008
	Embolus	55584005
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# Vocabulary Formalization: Overview

- Once a concept from the guideline is clear and has an understandable meaning, it is compared against SNOMED-CT or other vocabulary concepts in the assigned domain:
  - Is it pre-coordinated?
  - Is the SNOMED definition and all children consistent with the scope of guideline meaning?
  - Can it be defined within standard vocabularies or is it outside the scope of standards and require an extension?

# Example...

## **Pneumococcal Polysaccharide Vaccine Recommendations**

- Adults  $\geq 65$  years of age
- Persons  $\geq 2$  years with
  - chronic illness
  - anatomic or functional asplenia
  - immune compromised (disease, chemotherapy, steroids)
  - HIV infection
  - environments or settings with increased risk
  - cochlear implant

# “Functional or anatomic asplenia”

- **Clinical Definition**

- Congenital asplenia
- Congenital hypoplasia of spleen
- Splenectomy
- Splenic atrophy
- Sickle cell disease

- **SNOMED CT Concept**

- 93030006
- 93292008
- 234319005 (Procedure)
- 82893001
- 127040003 (Hemoglobin S disease)

# “Functional or anatomic asplenia”

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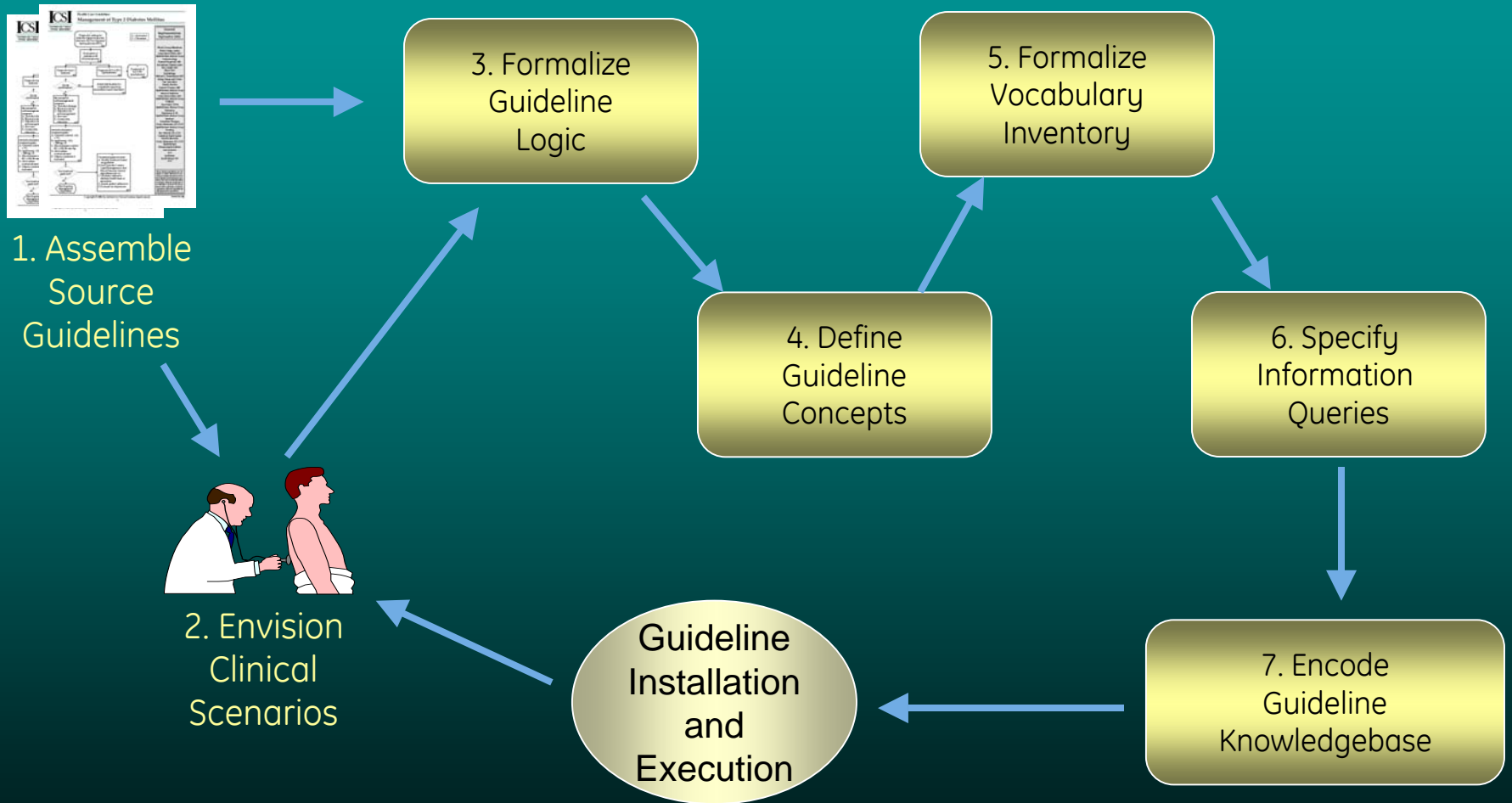
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- Overview of guidelines and challenges to decision support development

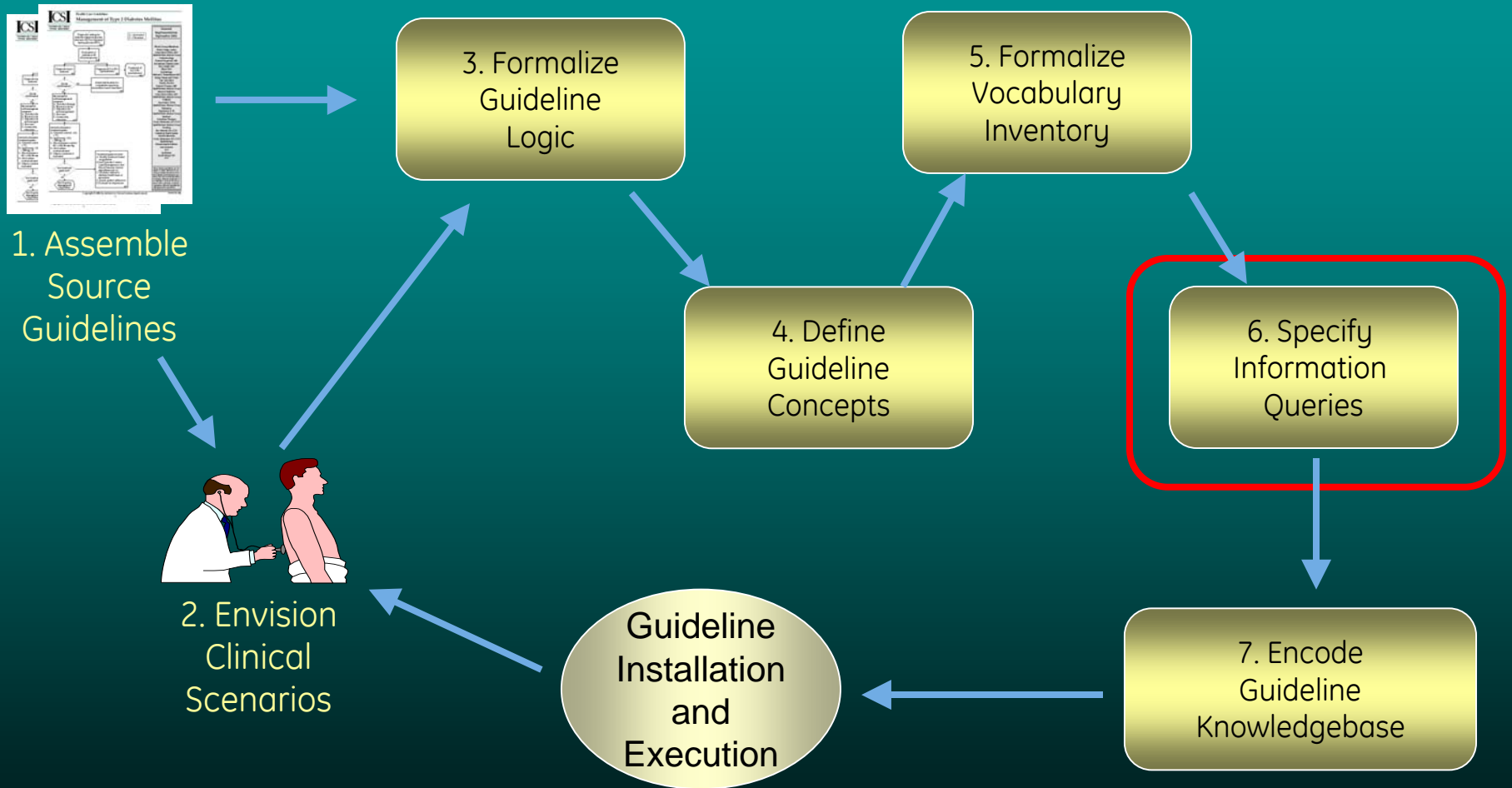
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# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process



# Why do we need to specify Information Queries?

- The CDSS must obtain patient data from the CIS to perform logic
- Every CIS represents patient data differently
  - Physical model
    - Object-oriented vs. Relational
  - Logical Model
    - Variation in patient data components

## Example



# Possible Documentations of a Patient's "Diabetes Mellitus"

- Entry on Problem List
  - Diabetes Mellitus type II
- Observation
  - Lab Value of Fasting Glucose > 125 mg/dL or
  - Lab value for two-hour 75-g oral glucose tolerance test > 200 mg/dL
- Entry in Diagnoses & Procedures list
  - Diabetes Mellitus type II

# Implications of Representation Variability

- Guideline logic needs to consider
  - Looking for different types of information
    - Observations, Problem list, procedures, etc.
    - May need to combine multiple queries to get one logical conclusion
- Need a common representation of:
  - The places to look
    - CIS information model
  - The data we'll find
    - Standard terminology

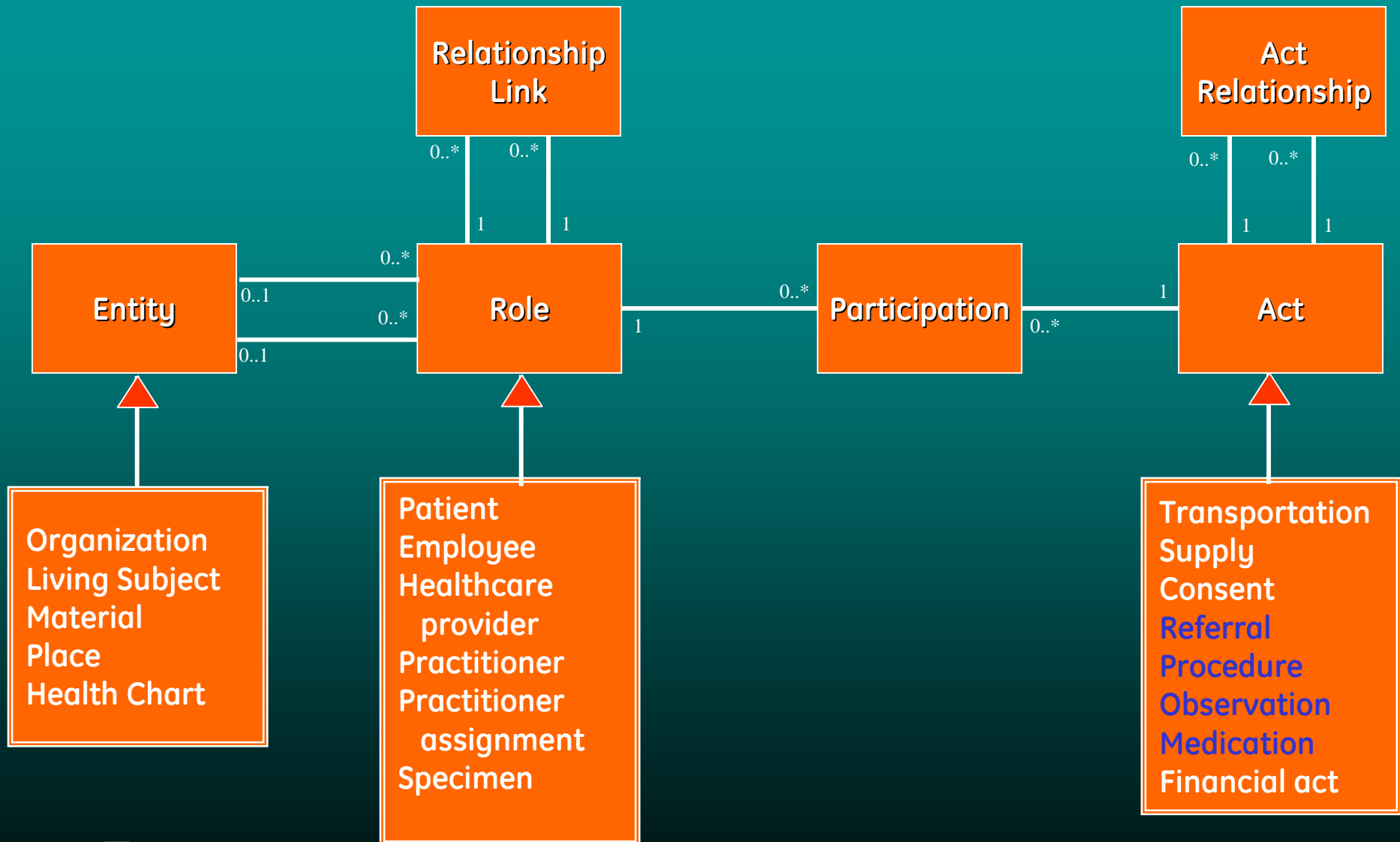
# A Common Representation of Queries

- Must be able to interact correctly with any vendor information model
- Since we cannot tell CIS vendors how to structure their systems, the SAGE approach to interoperability is to use a standard information model and then have each vendor build their own translation from the standard to their system

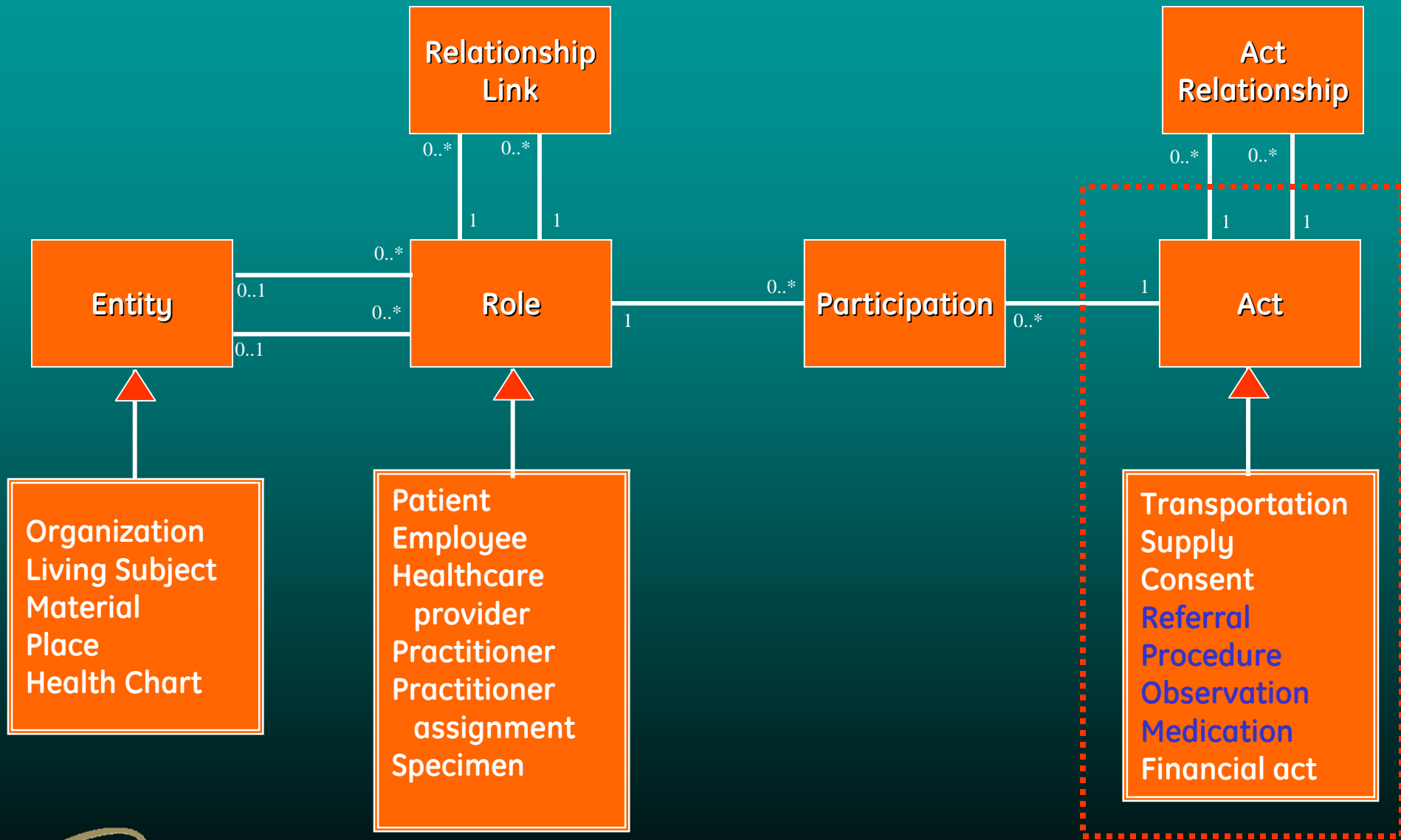
# The vMR..

- Virtual Medical Record
  - Standardized way of representing the CIS information model
  - Created based on the Health Level 7 v3 Reference Information Model (HL7 RIM)
    - Clinical Decision Support Technical Committee
    - Clinical Statements Model
  - Defines an idealized information model
    - “things that can be recorded about patients”
      - Problems, Observations, Medications, etc.
  - Our standard terminologies populate the slots
- An “interlingua” for representing Clinical data

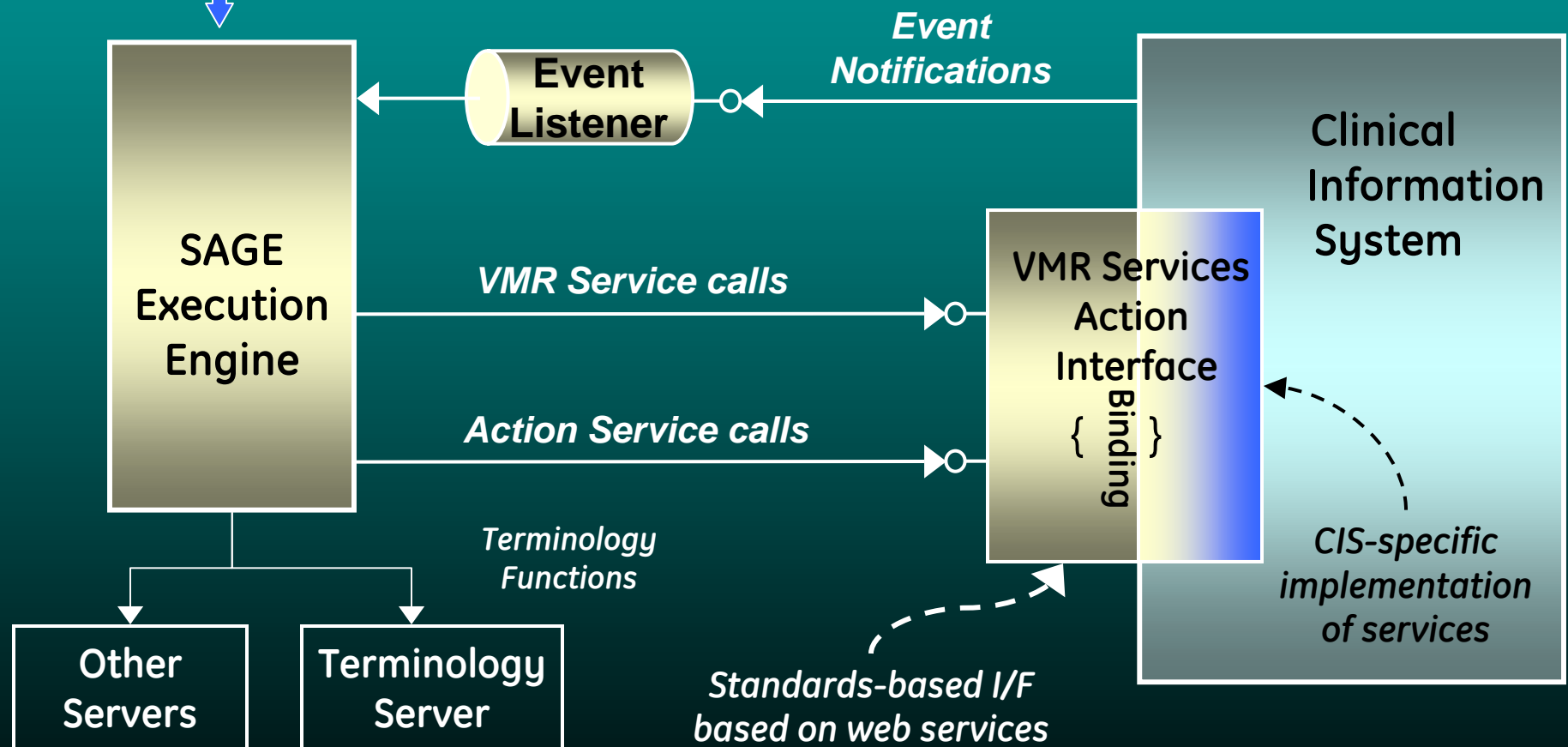
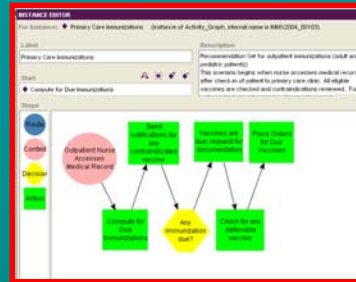
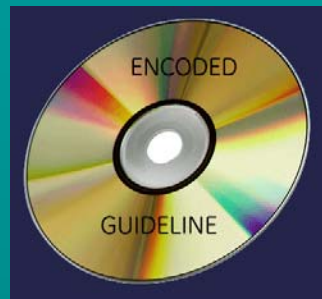
# RIM Core Classes



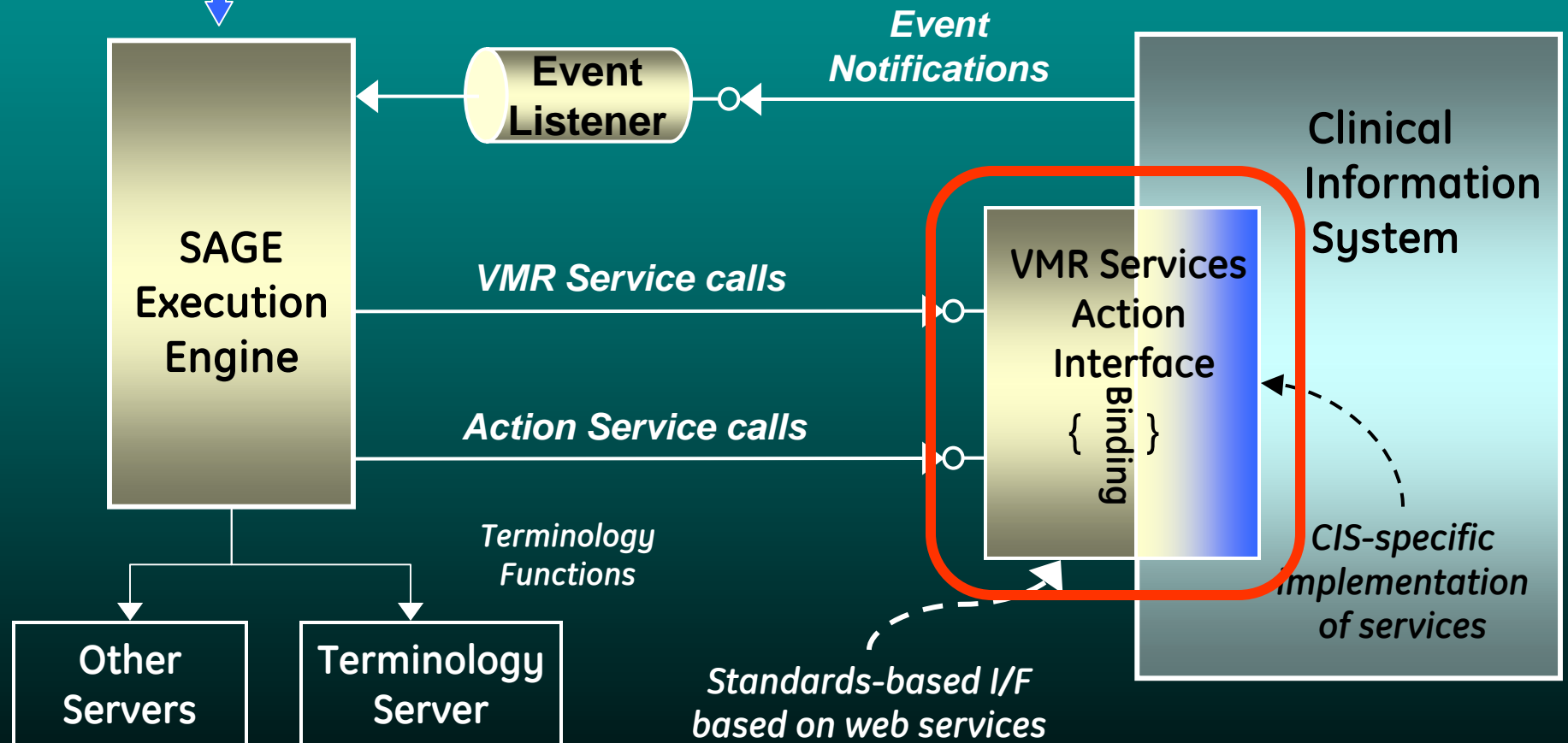
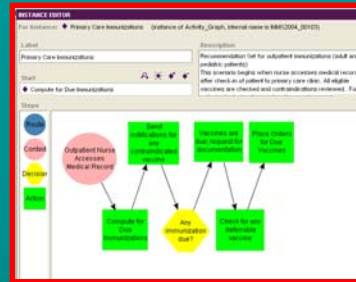
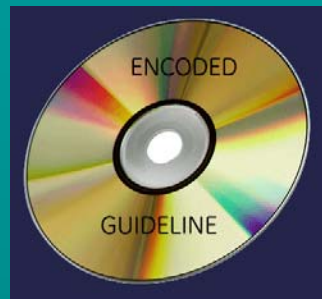
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# SAGE Guideline Deployment System Execution Architecture



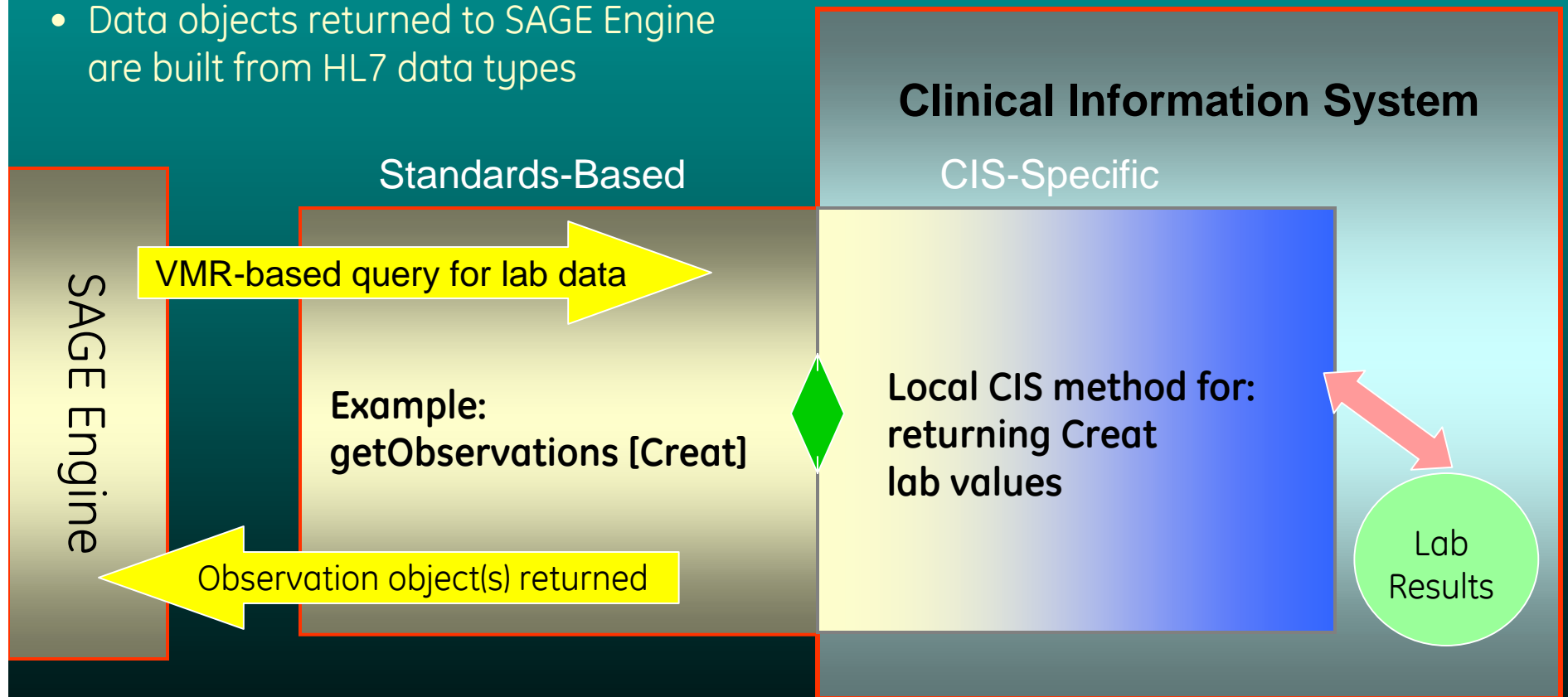
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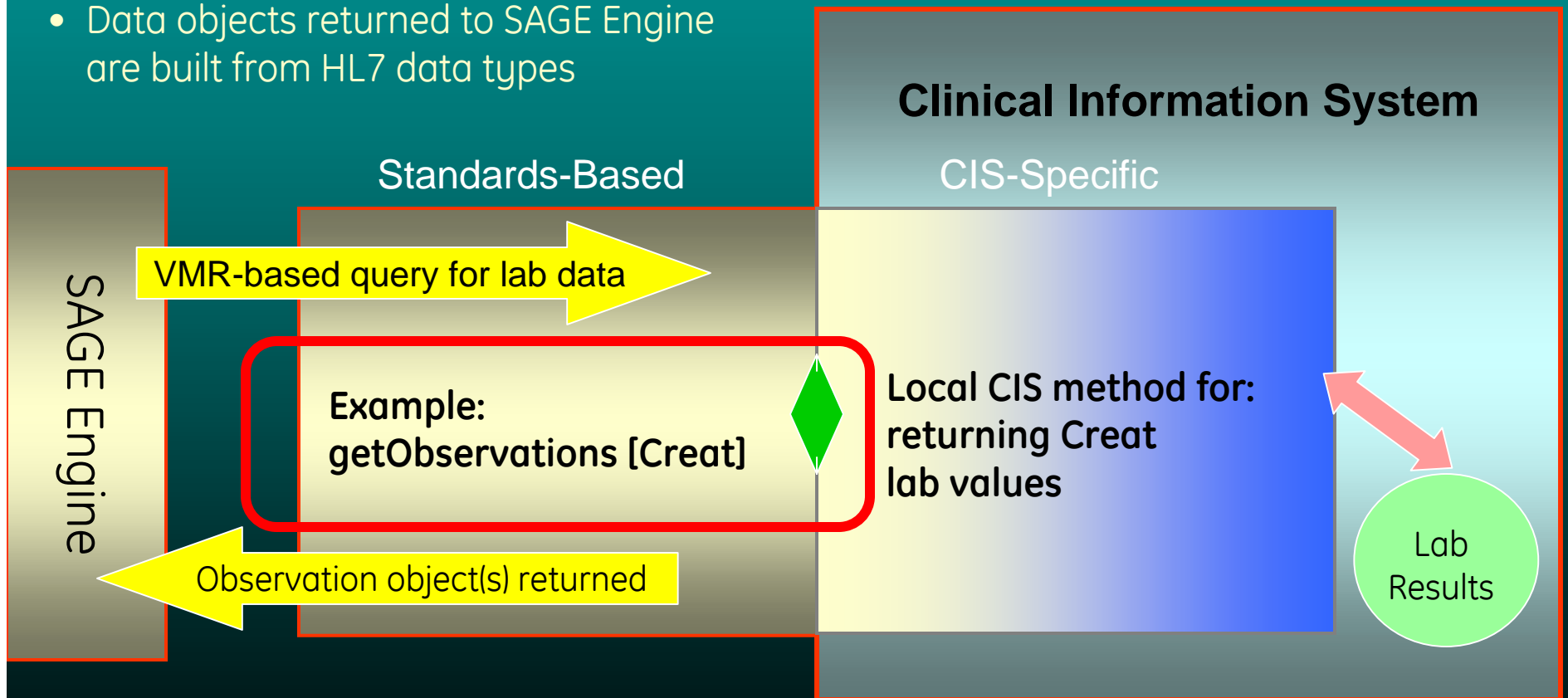
# VMR Services Interface

- In the guideline model, patient data concepts are represented using VMR classes
- Queries for patient data are represented using standard VMR-based methods
- Patient data queries are processed via VMR Service web service
- Generic methods are “mapped” to CIS-specific methods
- Data objects returned to SAGE Engine are built from HL7 data types



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# Virtual Medical Record Objects (SAGE Idealized Information Model)

- Substance administration
- Referral
- Procedure
- Problem
- Order (non-medication)
- Medication order
- Observation
- Goal
- Encounter
- Appointment
- Adverse reaction
- Agent
- Alert

# Virtual Medical Record Objects (SAGE Idealized Information Model)

- Substance
- Observation

Observation where

code is 'HEPATITIS B VIRUS SURFACE AG:ACNC:PT:SER:ORD: [LOINC]'

value is 'Positive (qualifier value) [SNOMED CT]'

- Procedure
- Problem
- Order (non-medication)
- Medication order
- Appointment
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# Interaction of vMR and Vocabulary

- “Family history of colon cancer”
  - Observation: code = 275937001|“family history of colon cancer”
  - Observation: code = 363406005|“colon cancer”, subject = 303071001|“family member”
- “Elevated blood sugar”
  - Observation: code = 166892002|“random blood sugar raised”
  - Observation: code = 2339-0|“Blood glucose”, value = 250mg/dl

# Inter

Overlap of terminology and information model semantics

# lary

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2. Is this on the problem list?

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Data and information co-exist in the CIS

1. Already interpreted information?
2. Raw data

# Pragmatics of Clinician Use

- Is encounter data reliably recorded? When is it available?
- Does nursing staff record vital signs and I&O real-time?
- Who places orders in the system? When are they recorded?
- When do lab results cross the interface and appear in the CIS?
- Do the physicians use the problem list?
- Are procedures recorded as they are billed?



# Questions?

- **BREAK**
- **Part 2:**
  - SAGE Guideline model and Protégé Workbench
  - Encoding the immunization guideline
  - Validation and localization of the guideline
  - DEMONSTRATION: Execution of the encoded guideline within clinical information system

# Overview

- Overview of guidelines and challenges to decision support development

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# Model-Based Approach to Encoding Guidelines

- Model: a simplified abstraction of a system (guideline), aimed at understanding and/or explaining aspects of interest
- Templates for specifying computer-interpretable guideline knowledge
- Guideline: “...systematically developed statements to assist practitioner and patient **decisions** about **appropriate health care** for specific **clinical circumstances**” (Field, 1990)

## Simple Guideline Model

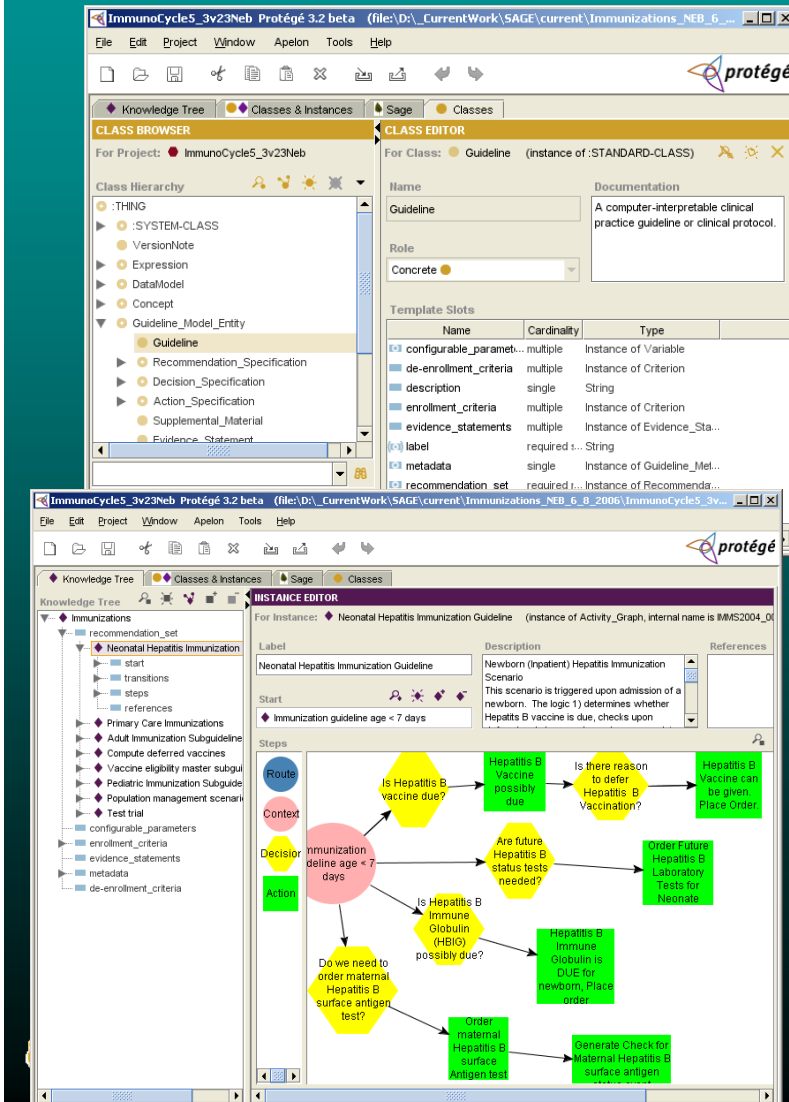
Clinical  
circumstances

*Decision: Criteria for choosing  
among alternatives*

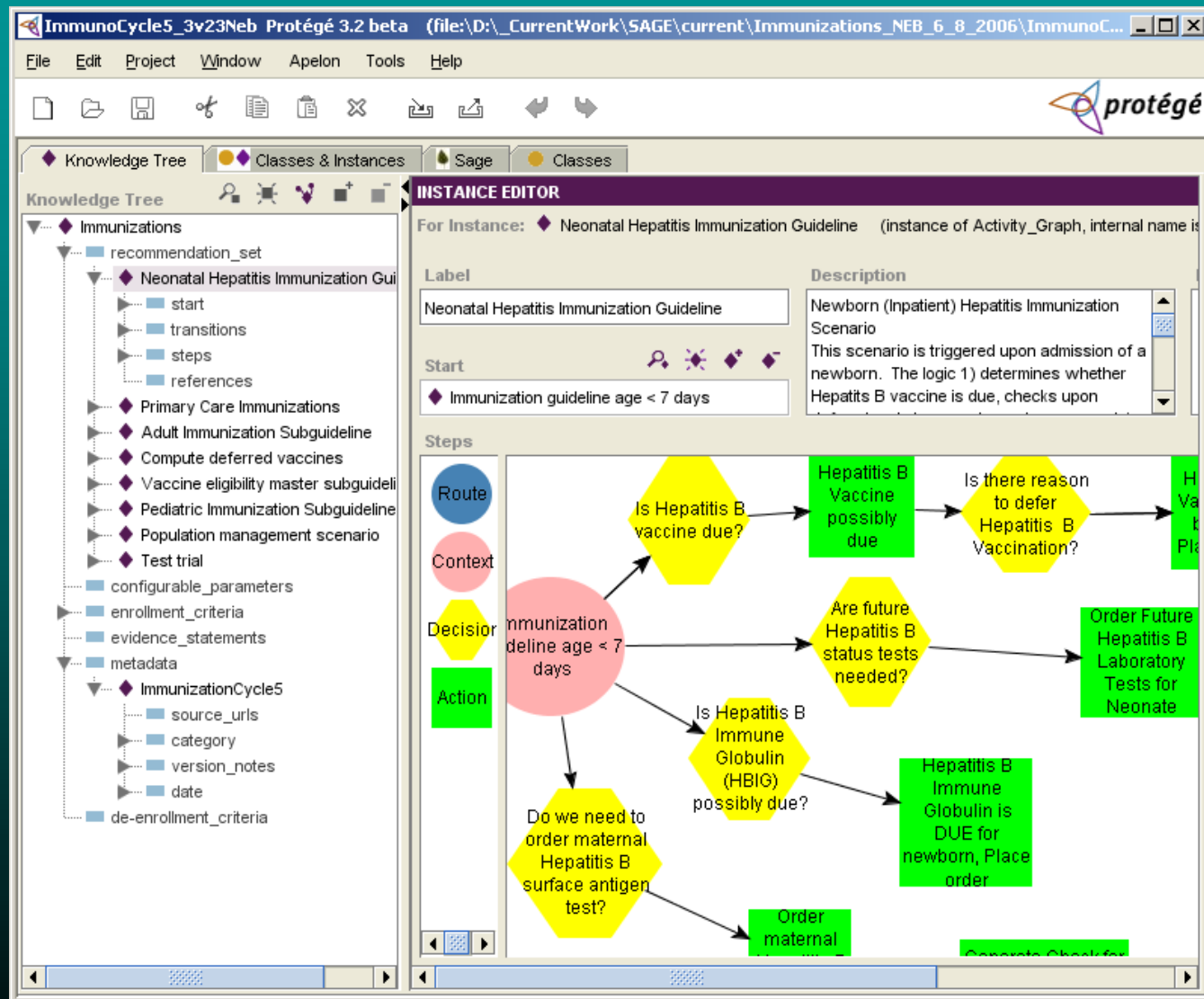
Healthcare  
action

# SAGE Guideline Model and Modeling Environment

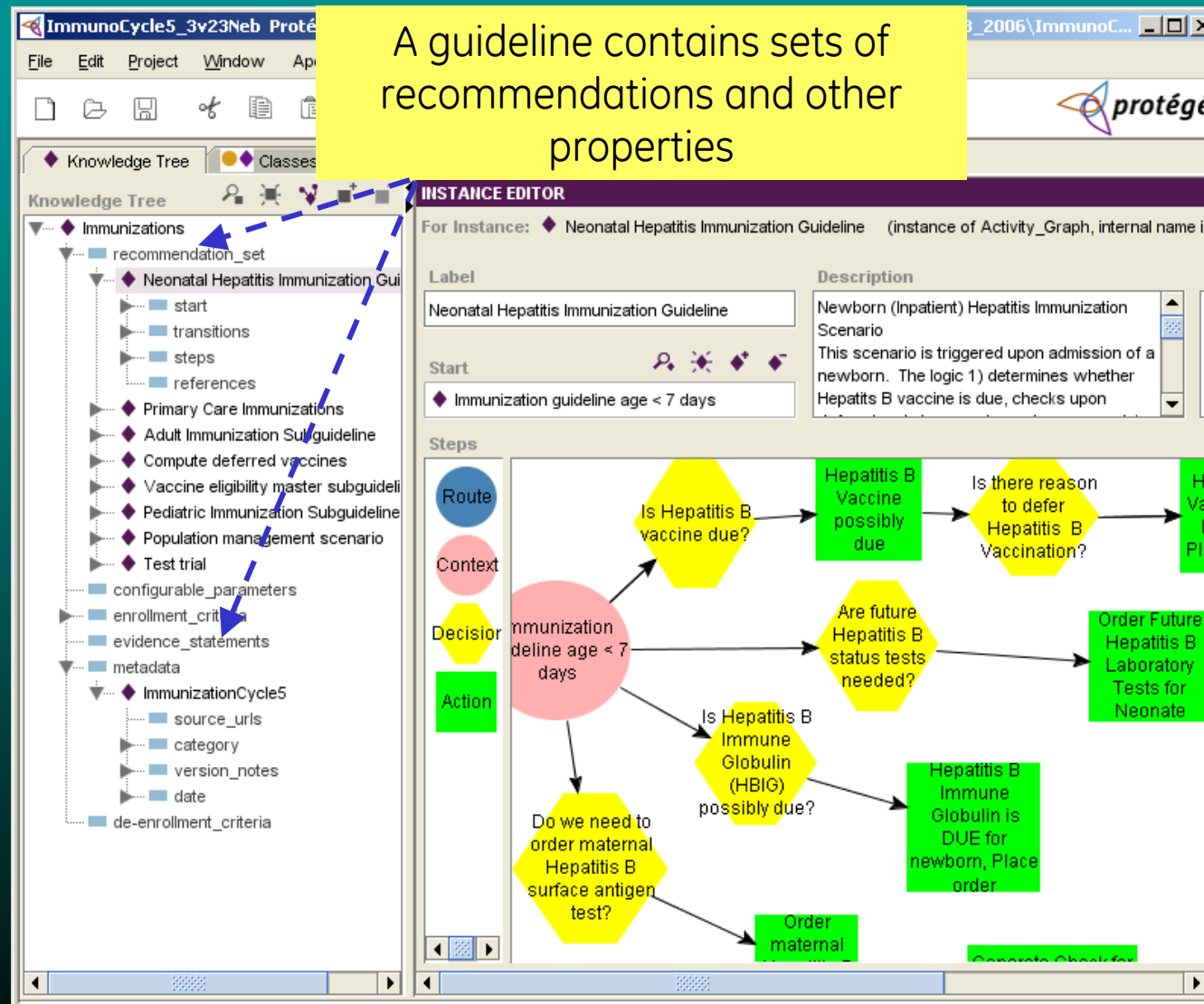
- Use Protégé as guideline modeling and encoding environment
- Guideline model represented as a collection of **classes** and **relationships** among them
- Encoding a guideline (e.g. immunization guideline) means **creating instances** of these classes



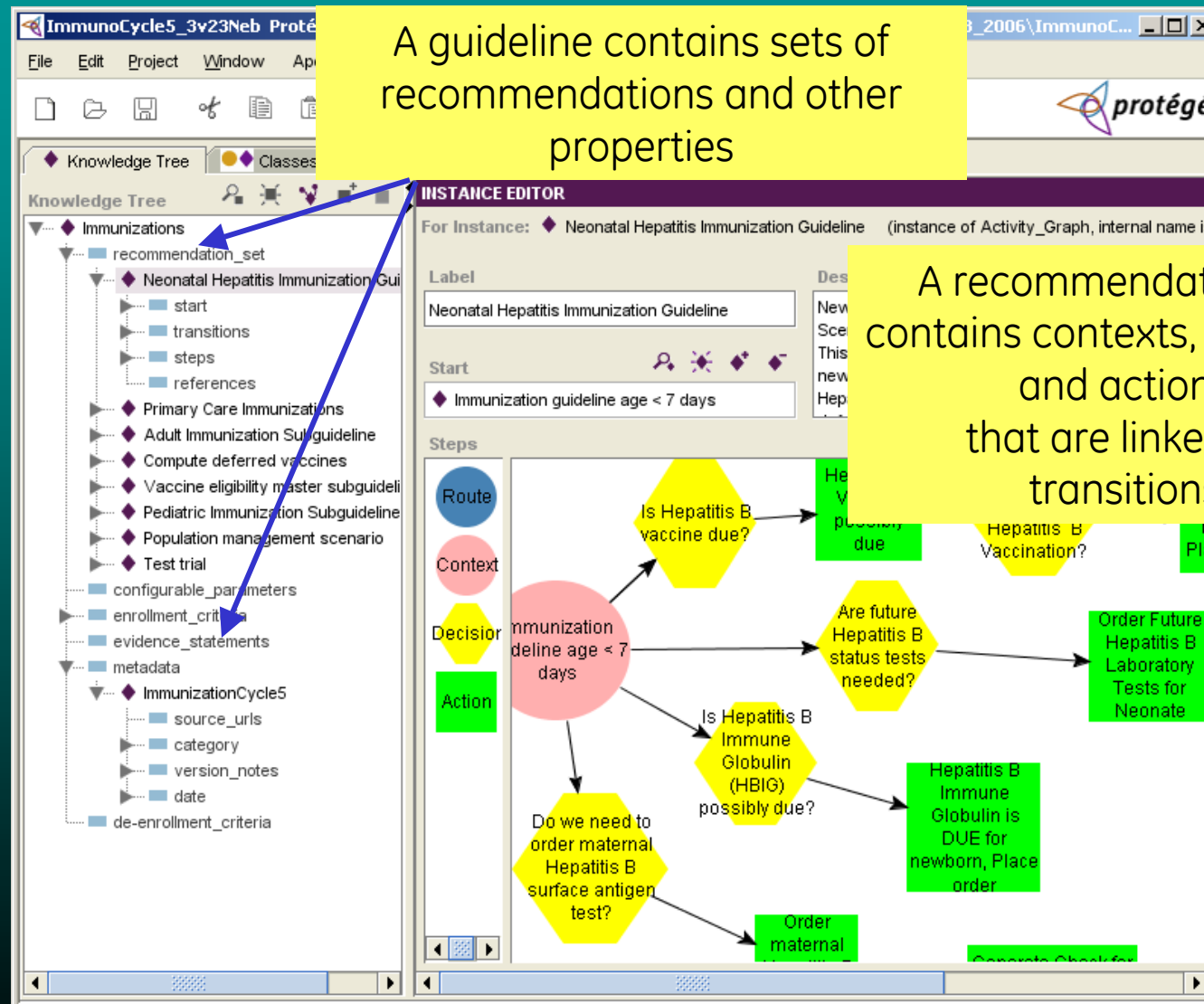
# Structure of a SAGE Guideline



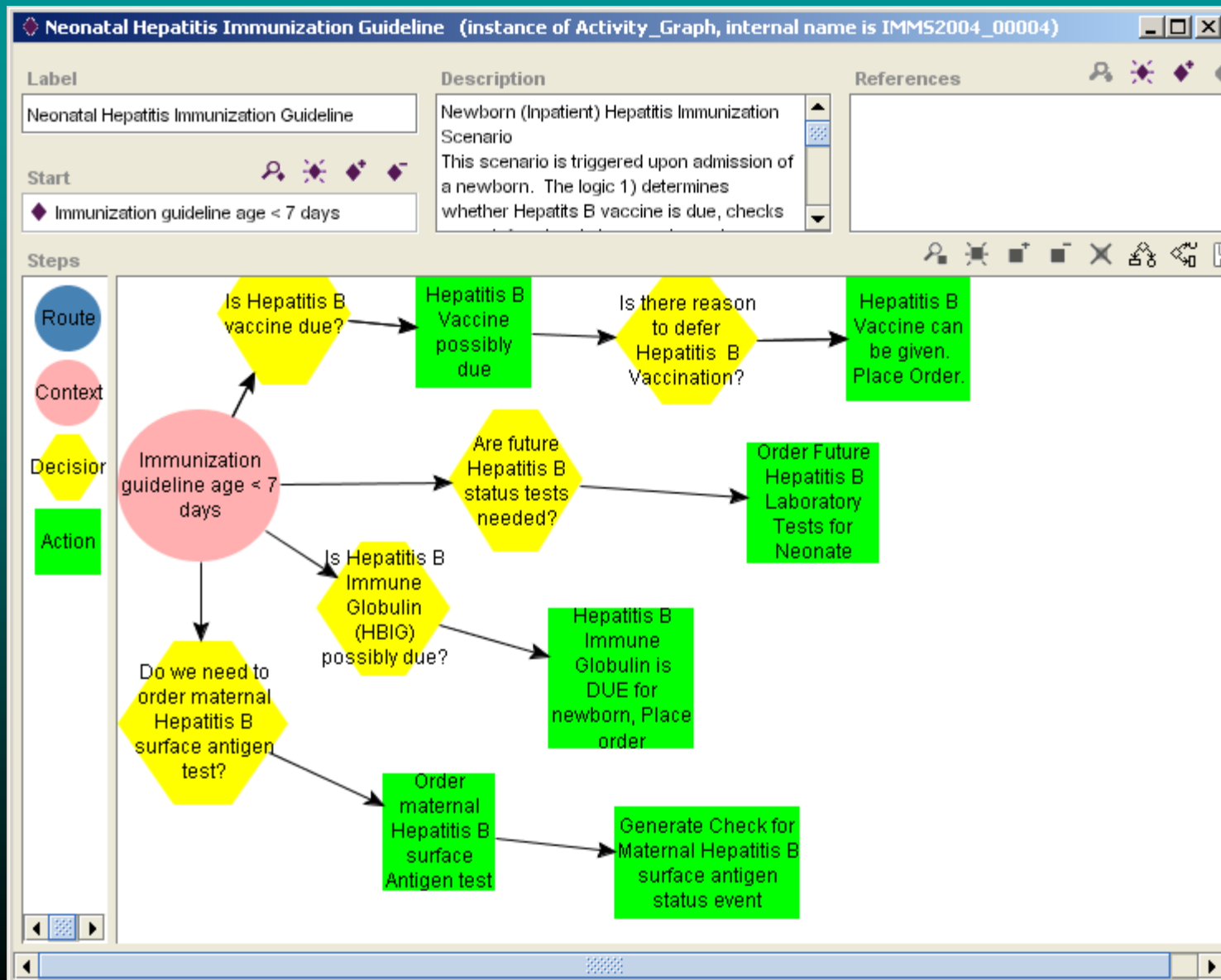
# Structure of a SAGE Guideline



# Structure of a SAGE Guideline



# A Guideline Recommendation: Basic Components

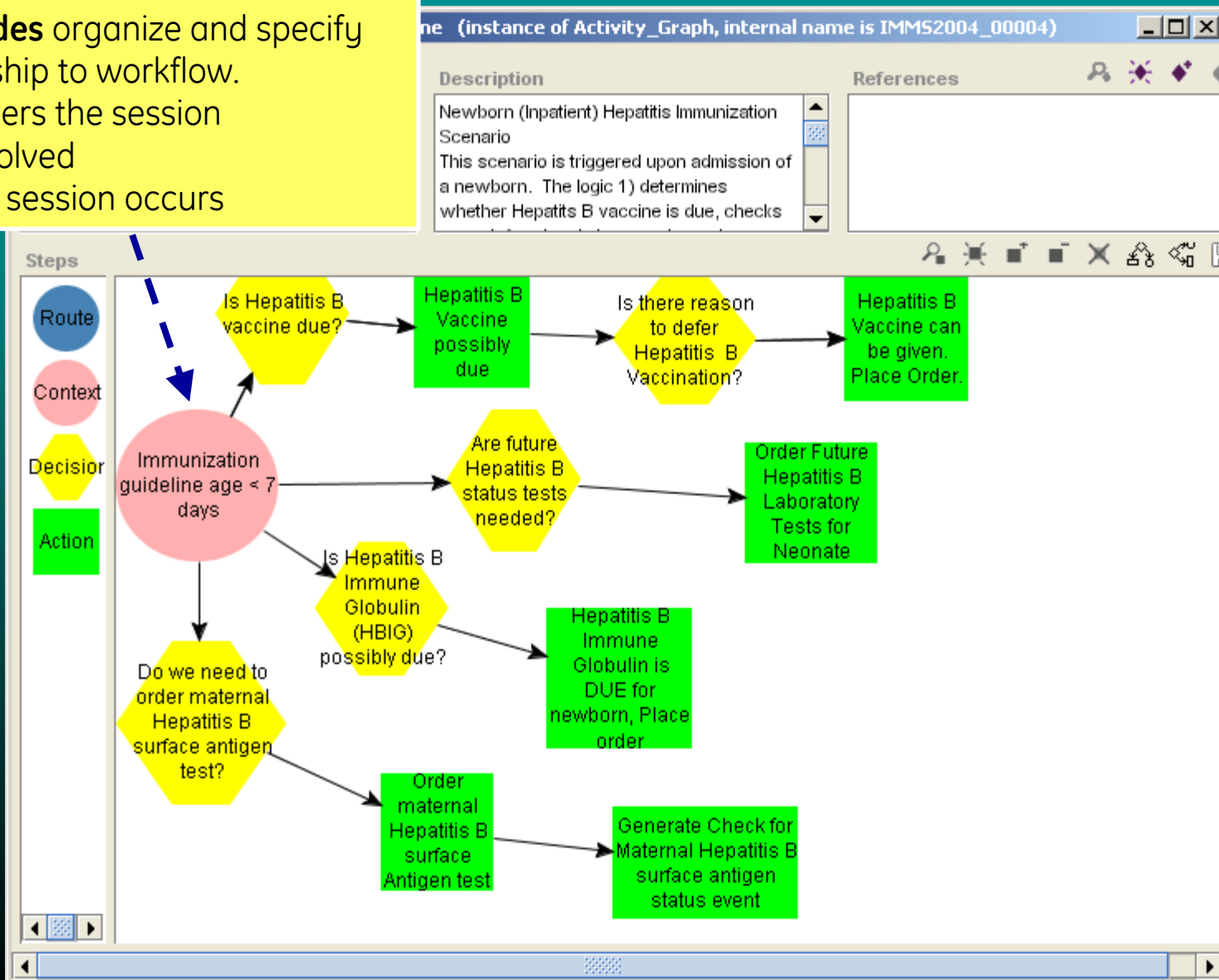




# A Guideline Recommendation: Basic Components

**Context Nodes** organize and specify the relationship to workflow.

- What triggers the session
- Who is involved
- Where the session occurs



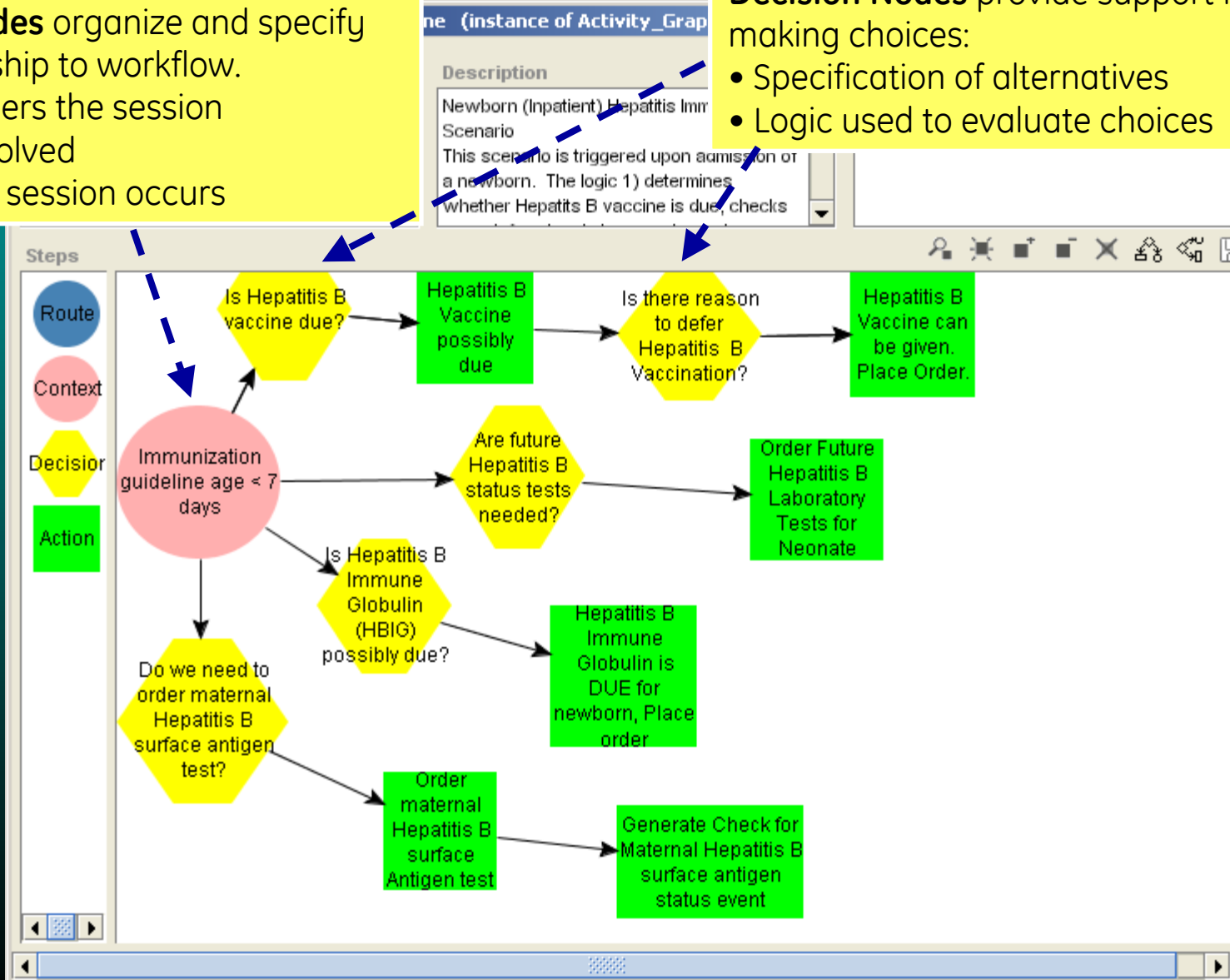
# A Guideline Recommendation: Basic Components

**Context Nodes** organize and specify the relationship to workflow.

- What triggers the session
- Who is involved
- Where the session occurs

**Decision Nodes** provide support for making choices:

- Specification of alternatives
- Logic used to evaluate choices



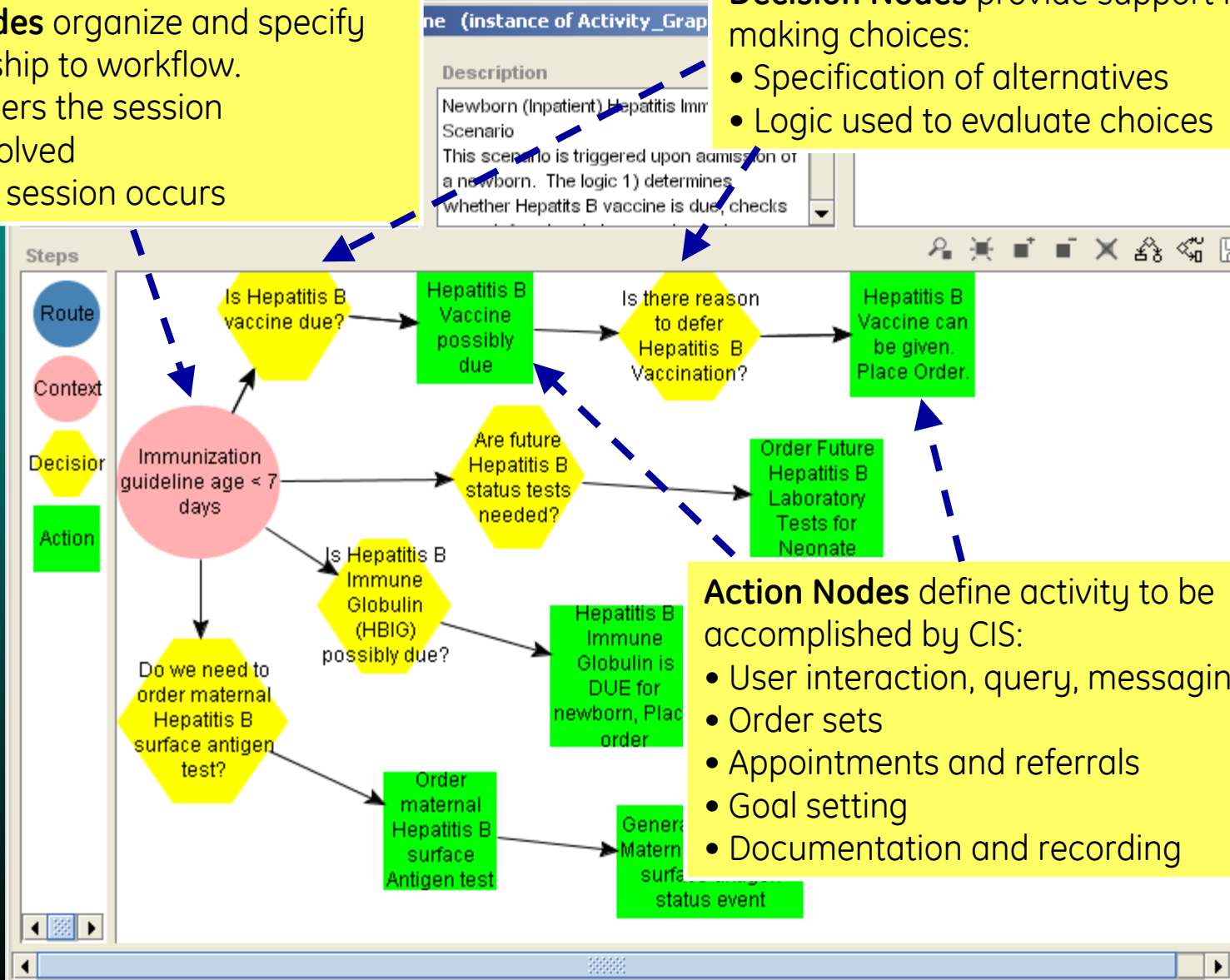
# A Guideline Recommendation: Basic Components

**Context Nodes** organize and specify the relationship to workflow.

- What triggers the session
- Who is involved
- Where the session occurs

**Decision Nodes** provide support for making choices:

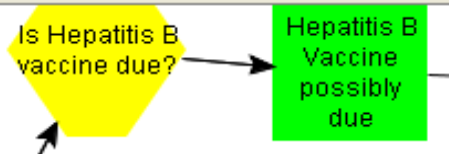
- Specification of alternatives
- Logic used to evaluate choices



**Action Nodes** define activity to be accomplished by CIS:

- User interaction, query, messaging
- Order sets
- Appointments and referrals
- Goal setting
- Documentation and recording

# A Decision Node contains reasons for choosing each alternative



Is Hepatitis B vaccine due? (instance of Decision, internal name is IMM52...)

Label: Is Hepatitis B vaccine due?

Triggering Even

Scheduling Constraint

Decision Model (1 values)

Alternatives

- ◆ Hepatitis B Vaccine possibly due

Transition R

- ◆ AND join A

Automation

- ◆ automatic

Hepatitis B Vaccine possibly due (instance of Alternative\_Choice, internal...)

Alternative

- ◆ Hepatitis B Vaccine possibly due

Recommendation Threshold

1

Strict Rule Out

- ◆ Patient received Hep B or has current order

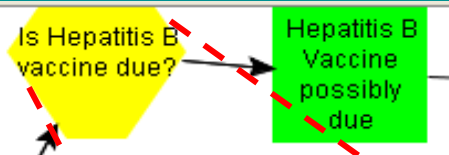
Strict Rule In

- ◆ Mother is HBsAg POSITIVE OR (HBsAg unkn
- ◆ Weight (of baby) >= 2 kg

Rule Out

Rule In

# A Decision Node contains reasons for choosing each alternative



Is Hepatitis B vaccine due? (instance of Decision, internal name is IMM52...)

Label  
Is Hepatitis B vaccine due?

Triggering Even

Scheduling Constraint

Decision Model (1 values)

Alternatives

- Hepatitis B Vaccine possibly due

Transition R

Automation

automatic

Hepatitis B Vaccine possibly due (instance of Alternative\_Choice, internal...)

Alternative

- Hepatitis B Vaccine possibly due

Recommendation Threshold

1

Strict Rule Out

- Patient received Hep B or has current order

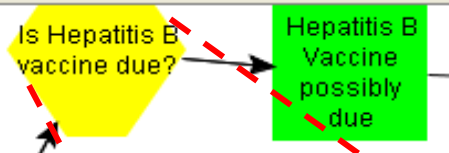
Strict Rule In

- Mother is HBsAg POSITIVE OR (HBsAg unkn
- Weight (of baby) >= 2 kg

Rule Out

Rule In

# A Decision Node contains reasons for choosing each alternative



Rule-in and rule-out criteria determines whether an alternative is recommended

Is Hepatitis B vaccine due? (instance of Decision, internal name is IMM52...)

Label  
Is Hepatitis B vaccine due?

Scheduling Constraint

Decision Model (1 values)

Alternatives

- Hepatitis B Vaccine possibly due

Transition R

Automation

automatic

Hepatitis B Vaccine possibly due (instance of Alternative\_Choice, internal...)

Alternative

- Hepatitis B Vaccine possibly due

Recommendation Threshold

1

Strict Rule Out

- Patient received Hep B or has current order

Rule Out

Strict Rule In

- Mother is HBsAg POSITIVE OR (HBsAg unkn...
- Weight (of baby) >= 2 kg

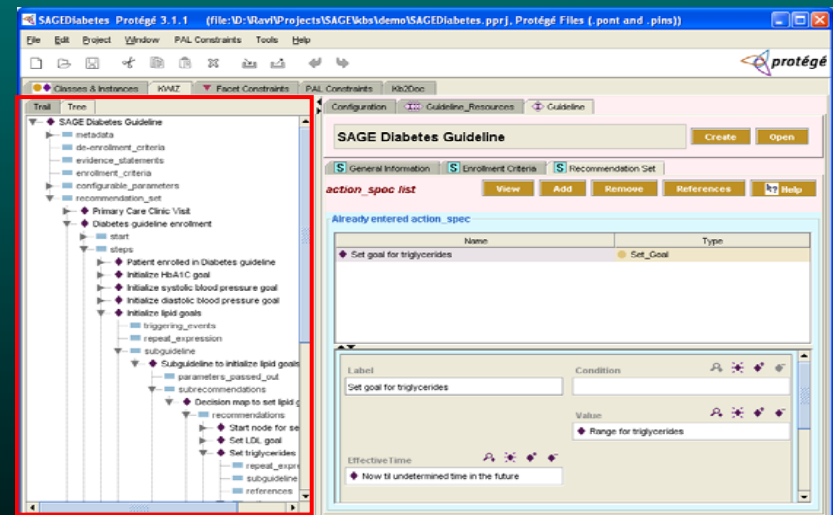
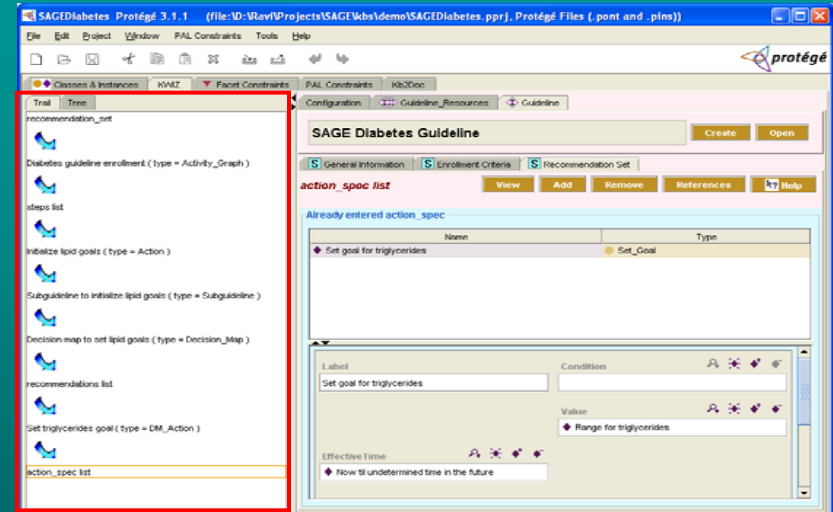
Rule In

# Features of SAGE Protégé Workbench

- Navigation and search: KWIZ tab
- Generation of XML/HTML: kb2doc tab
- Constraint checking: FacetConstraint tab & PALConstraint tab
- Terminology service: Apelon DTS plugin
- Case-based testing: SAGE tab

# Kwiz

- Alternative navigation
- Enhanced Search
- Re-use of instances from other projects





# XML/HTML Guideline View

- Uses a separate Protégé knowledge base to specify how XML should be generated from instances
- Uses XSLT to transform XML to HTML

**Immunizations**

SAGE Cycle 5 Immunization guideline All patients eligible for vaccination regardless of age and clinical condition

- meta\_data:
  - Guideline\_Metadata ()
    - identifier: ImmunizationCycle5
    - title: Immunization master guideline
    - version: ImmunoCycle5
    - category: Prevention
    - date: 2005/11/11
    - developer: Rob McClure Samson Tu Karen Hrabak Jim Campbell
  - enrollment\_criteria: true
  - recommendation set:
    - [Neonatal Hepatitis Immunization Guideline](#)
    - [Primary Care Immunizations](#)
    - [Adult Immunization Subguideline](#)
    - [Compute deferred vaccines](#)
    - [Vaccine eligibility master subguideline](#)
    - [Pediatric Immunization Subguideline](#)
    - [Population management scenario](#)
    - [Test trial](#)

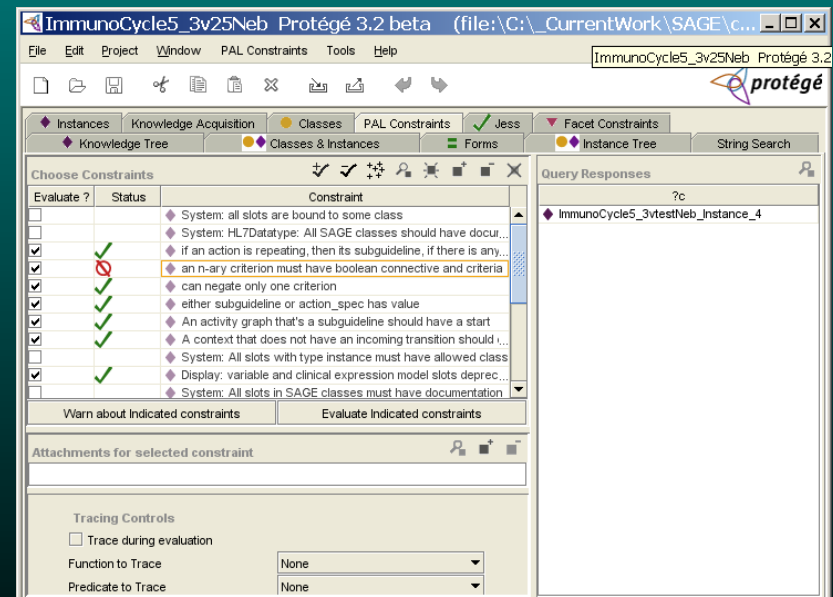
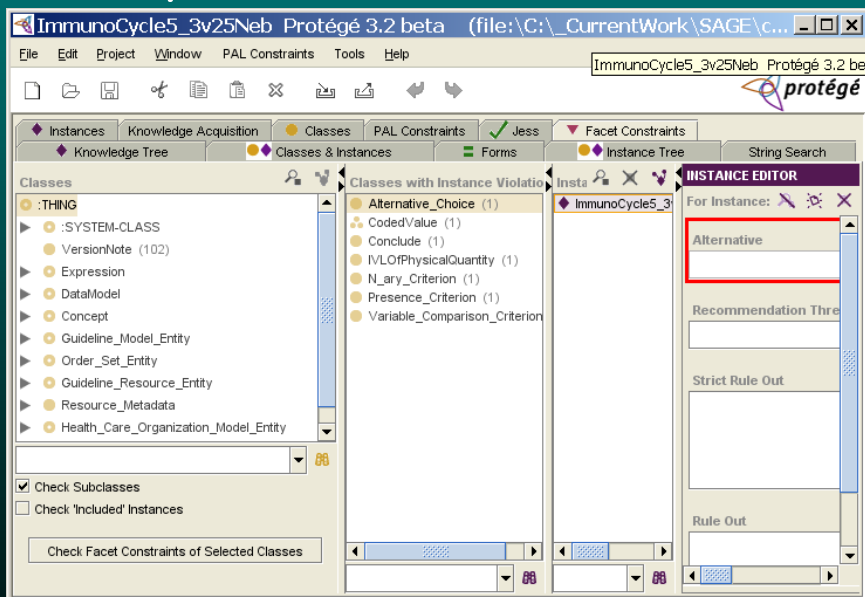
**Recommendation Set (Activity Graph): Neonatal Hepatitis Immunization Guideline**

Newborn (Inpatient) Hepatitis Immunization Scenario This scenario is triggered upon admission of a newborn. The logic 1) determines whether Hepatitis B vaccine is due, checks upon deferral and places orders when appropriate. 2) Orders followup testing at nine months of age for infants at risk 3) Determines whether Hepatitis B Immune Globulin is due and places order 4) Checks maternal record for information of Hepatitis B status. If these cannot be found, orders are placed for maternal testing and time drive event is set for 12 hour rechecks until receipted or the baby is more than 24 hours old.

```
graph LR
    A{Is Hepatitis B vaccine due?} --> B[Hepatitis B Vaccine possibly due]
    B --> C{Is there reason to defer Hepatitis B Vaccination?}
    C --> D[Hepatitis B Vaccine can be given, Place Order]
```

# Constraint Checking: PAL and Facet Constraint Tabs

- PALConstraint tab: Learning curve
- FacetConstraint tab: Problems with performance



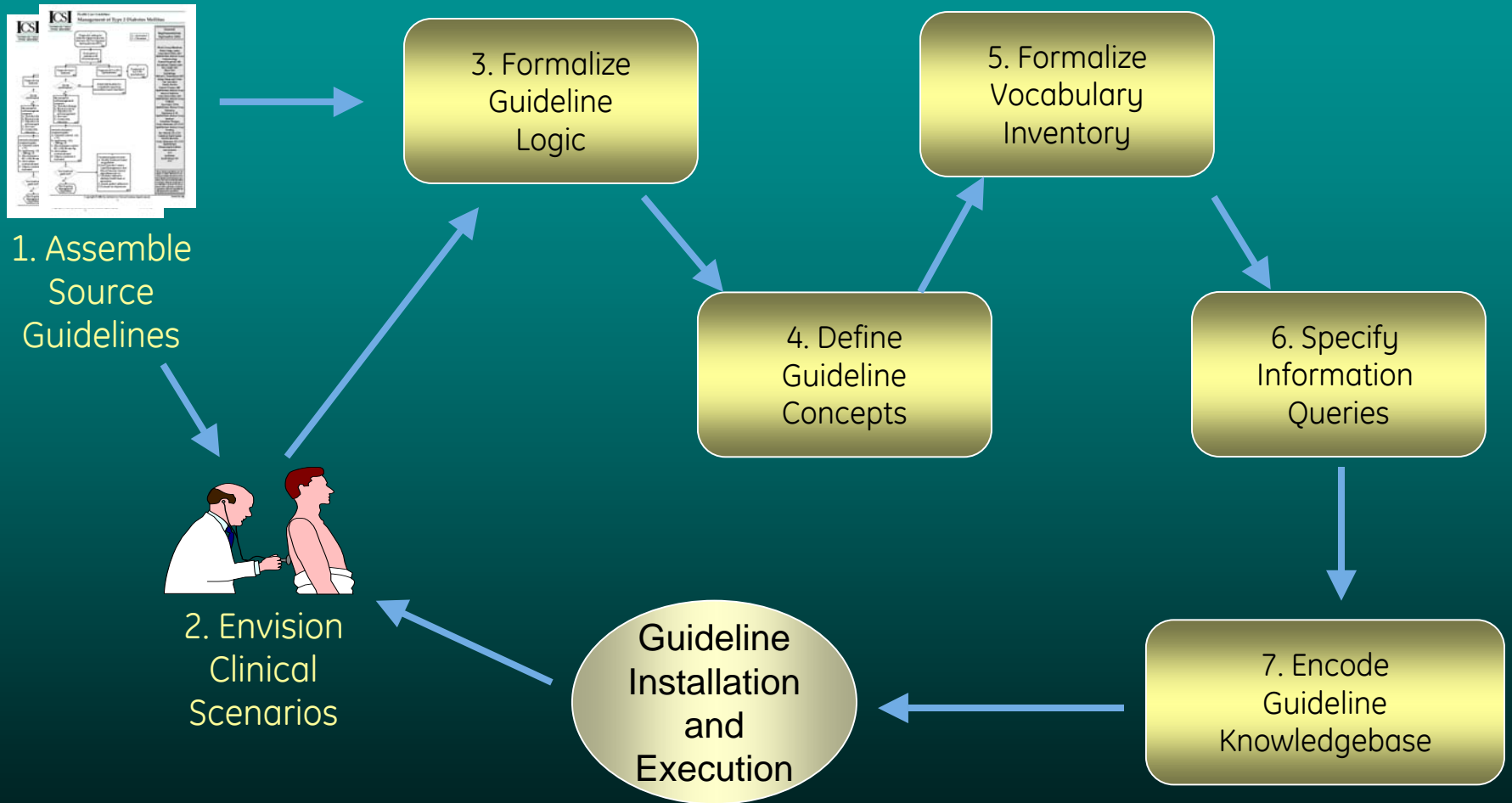
# Overview

- Overview of guidelines and challenges to decision support development

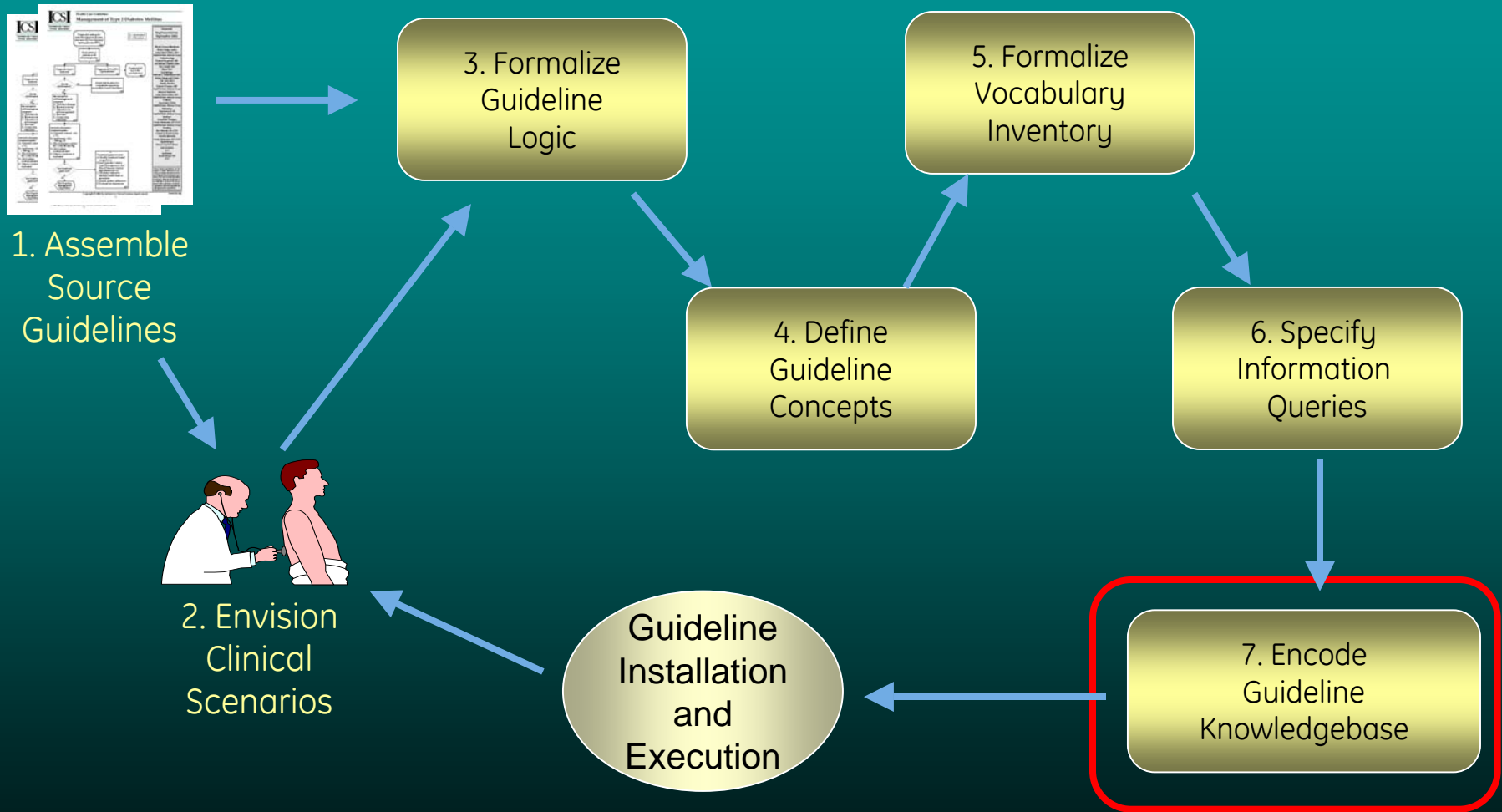
SAGE guideline modeling process:

- Identifying the source clinical guideline
- Creating the implementation scenarios and assembling decision logic
- Developing concept inventory: employing standard vocabulary
- Specifying information queries
- SAGE guideline model and workbench
- **Encoding the immunization guideline**
- Validating the development
- Demonstration: SAGE at work

# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process



# Demo of Encoding Exercise: Adult Pneumococcal Vaccine

# Guideline Logic

Rule 1: Adult First Dose PPV23

IF NO CONTRAINDICATION

AND

NO REASON FOR DEFERRAL

AND

NUMBER OF PPV23 VACCINE DOSES = 0

AND

INDICATION FOR PNEUMOCOCCAL VACCINE OR (AGE  $\geq$  65 YEARS)

THEN

ADVISE ADMINISTRATION OF PPV23 VACCINE

Rule 2: Adult Second dose PPV23

IF NO CONTRAINDICATION

AND

NO REASON FOR DEFERRAL

AND

NUMBER OF PPV23 VACCINE DOSES = 1

AND

((SUBGROUP INDICATIONS FOR REVACCINATION))

OR

((AGE  $>$  65 YEARS) AND (PPV23 VACCINE DOSE GIVEN  $<$  AGE 65 YEARS)))

AND

PPV23 ADMINISTERED  $\geq$  5 YEARS PREVIOUSLY

THEN

ADVISE ADMINISTRATION OF PPV23 VACCINE

Recommendation set: Adult Pneumococcal polysaccharide vaccine (PPV)

Contraindication ::= Anaphylaxis reaction to pneumococcal vaccine

Deferral ::= Moderate or severe current illness

Indication::=

Chronic cardiac disease or

Chronic pulmonary disease excluding asthma or

Diabetes mellitus or

CSF leak or

Hemodialysis patient or

Health care worker or

*Emergency response personnel* or

Terminal complement component deficiencies or

Chronic liver disease or

Chronic alcoholism

Cochlear implants

Native American

American Indian

*Pregnancy*

HIV+

Congenital hypoplasia of spleen

Splenic atrophy

Splenectomy

Chronic renal failure

Institutionalized

Sickle cell disease

Nephrotic syndrome

Solid organ transplant

Long term steroid therapy (12 glucocorticoid doses last six months)

Antimetabolite therapy

Chronic transfusion patient (more than 3 transfusions last 6 months)

Immunodeficiency due to chemotherapy)

Functional asplenia

Multiple myeloma

Generalized malignancy

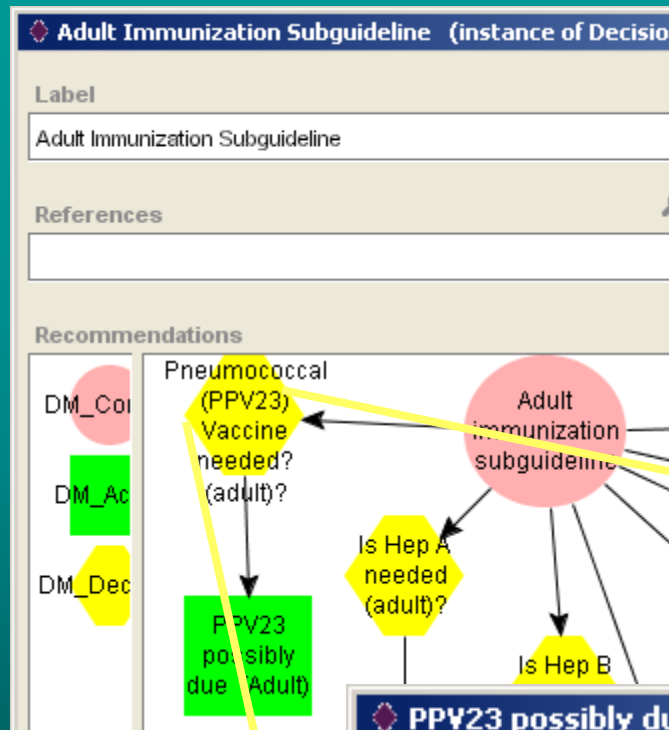
Bone marrow transplant recipient

Congenital immunodeficiency

Chemotherapy with alkylating agents within last 3 months

Nursing home resident

# Encoding example



**PPV23 possibly due (Adult)** (instance of Alternative\_Choice, internal na...

Alternative

◆ PPV23 possibly due (Adult)

Recommendation Threshold

1

Strict Rule Out

◆ # of PPV23 doses  $\geq 2$

Strict Rule In

◆ PPV23 first dose indicated (adult)  
◆ PPV23 second dose (adult)



◆ PPV23 possibly due (Adult) (instance of Alternative\_Choice, internal na...

Alternative

◆ PPV23 possibly due (Adult)

Recommendation Threshold

1

Strict Rule Out

◆ # of PPV23 doses >= 2

Strict Rule In

◆ PPV23 first dose indicated (adult)

◆ PPV23 second dose (adult)

◆ PPV23 first dose indicated (adult) (instance of N\_ary\_Criterion, internal name is ...

Label

PPV23 first dose indicated (adult)

Boolean Connective

AND

Criteria

◆ Number of PPV23 vaccine doses = 0

◆ Age >= 65 OR PPV23 adult indications

PPV23 first dose indicated (adult) (instance of N\_ary\_Criterion, internal name is ...)

Label	Criteria
PPV23 first dose indicated (adult)	<ul style="list-style-type: none"><li>Number of PPV23 vaccine doses = 0</li><li>Age &gt;= 65 OR PPV23 adult indications</li></ul>

Boolean Connector: AND

Age >= 65 OR PPV23 adult indications (instance of N\_ary\_Criteri...)

Label	Criteria
Age >= 65 OR PPV23 adult indications	<ul style="list-style-type: none"><li>Pneumococcal (PPV23) vaccine general indications (adult)</li><li>AGE &gt;= 65 YEAR</li></ul>

Boolean Connector: OR

Pneumococcal (PPV23) vaccine general indications (adult) (instance of N\_ar...)

Label	Criteria
Pneumococcal (PPV23) vaccine general indications (adult)	<ul style="list-style-type: none"><li>Chronic heart disease</li><li>Diabetes</li><li>Hematologic malignancy</li><li>Chronic renal failure</li><li>Institutionalized</li><li>Nephrotic syndrome</li><li>CSF leak</li><li>Terminal complement deficiencies</li><li>Cochlear implant problem history</li></ul>

Boolean Connector: OR

**Pneumococcal (PPV23) vaccine general indications (adult)** (instance of N\_ar...

**Label**  
eumococcal (PPV23) vaccine general indications (adult)

**Criteria**

- ◆ Chronic heart disease
- ◆ Diabetes
- ◆ Hematologic malignancy
- ◆ Chronic renal failure
- ◆ Institutionalized
- ◆ Nephrotic syndrome
- ◆ CSF leak
- ◆ Terminal complement deficiencies
- ◆ Cochlear implant problem history

**Boolean Connective**  
OR

**Chronic heart disease** (instance of Presence\_Criterion, internal name is I...

**Label**  
Chronic heart disease

**Vmr Class**  
● Problem

**Presence**  
true

**Code**  
● Chronic heart disease (disorder) [SNOMED ...]

**Subject**

**Valid Window**

**Pneumococcal (PPV23) vaccine general indications (adult)** (instance of N\_ar...

**Label**  
eumococcal (PPV23) vaccine general indications (adult)

**Criteria**

- ◆ Chronic heart disease
- ◆ Diabetes
- ◆ Hematologic malignancy
- ◆ Chronic renal failure
- ◆ Institutionalized
- ◆ Nephrotic syndrome
- ◆ CSF leak
- ◆ Terminal complement deficiencies
- ◆ Cochlear implant problem history

**Boolean Connective**  
OR

**Chronic heart disease** (instance of Presence\_Criterion, internal name...

**Label**  
Chronic heart disease

**Vmr Class**  
● Problem

**Presence**  
true

**Code**  
● Chronic heart disease (disorder) [SNOMED ...]

**Subject**

**Valid Window**

**invoke Apelon  
DTS plugin**

# Apelon DTS Plugin

The screenshot shows a software interface for selecting a concept from the Apelon DTS plugin. The window is titled "Select Apelon DTS Concept". It has two tabs: "Search" and "Tree". The "Search" tab is active, showing search criteria and results. The search criteria include "Search for:" with radio buttons for "Concepts & Synonyms", "Concepts" (selected), and "Terms"; "Maximum Results:" set to 10; "Search For:" containing "chronic heart\*"; "Namespace:" set to "All"; and "Search By:" set to "Name". The search results show two matches: "Chronic heart disease (disorder) [ SNOMED CT ]" and "Chronic heart failure (disorder) [ SNOMED CT ]". The first result is selected. To the right, the "Focus Concept:" section shows "Chronic heart disease (disorder)" with "View Axis:" set to "Superconcepts / Subconcepts" and "Namespace:" set to "SNOMED CT". Below this, a tree view shows the hierarchy of the selected concept, including "Code: D3-14015", "ID: 128238", "Namespace: SNOMED CT ( Ontology, Subscription, Read-Only )", and folders for "Synonyms", "Properties", "Superconcepts", "Subconcepts", and "Roles". A large white box with the text "Concept details" is overlaid on the right side of the window. At the bottom right, there are "OK" and "Cancel" buttons.

**Select Apelon DTS Concept**

Search   Tree

Search for: ☐ Concepts & Synonyms ☒ Concepts ☐ Terms

Maximum Results : 10   Search

Search For : chronic heart\*

Namespace : All

Search By : Name

Search Results :   Matches Found : 2

- Chronic heart disease (disorder) [ SNOMED CT ]
- Chronic heart failure (disorder) [ SNOMED CT ]

**Focus Concept:** Chronic heart disease (disorder)

**View Axis:** Superconcepts / Subconcepts

**Namespace:** SNOMED CT

- Chronic cardiac valvulitis (disorder)
- Chronic degenerative aortic valve disease (disorder)
- Chronic ectopic atrial tachycardia (disorder)
- Chronic endocarditis (disorder)
- Chronic heart failure (disorder)

**Chronic heart disease (disorder)**

- Code: D3-14015
- ID: 128238
- Namespace: SNOMED CT ( Ontology, Subscription, Read-Only )
- Synonyms
- Properties
- Superconcepts
- Subconcepts
- Roles

OK   Cancel

Search

Concept  
details

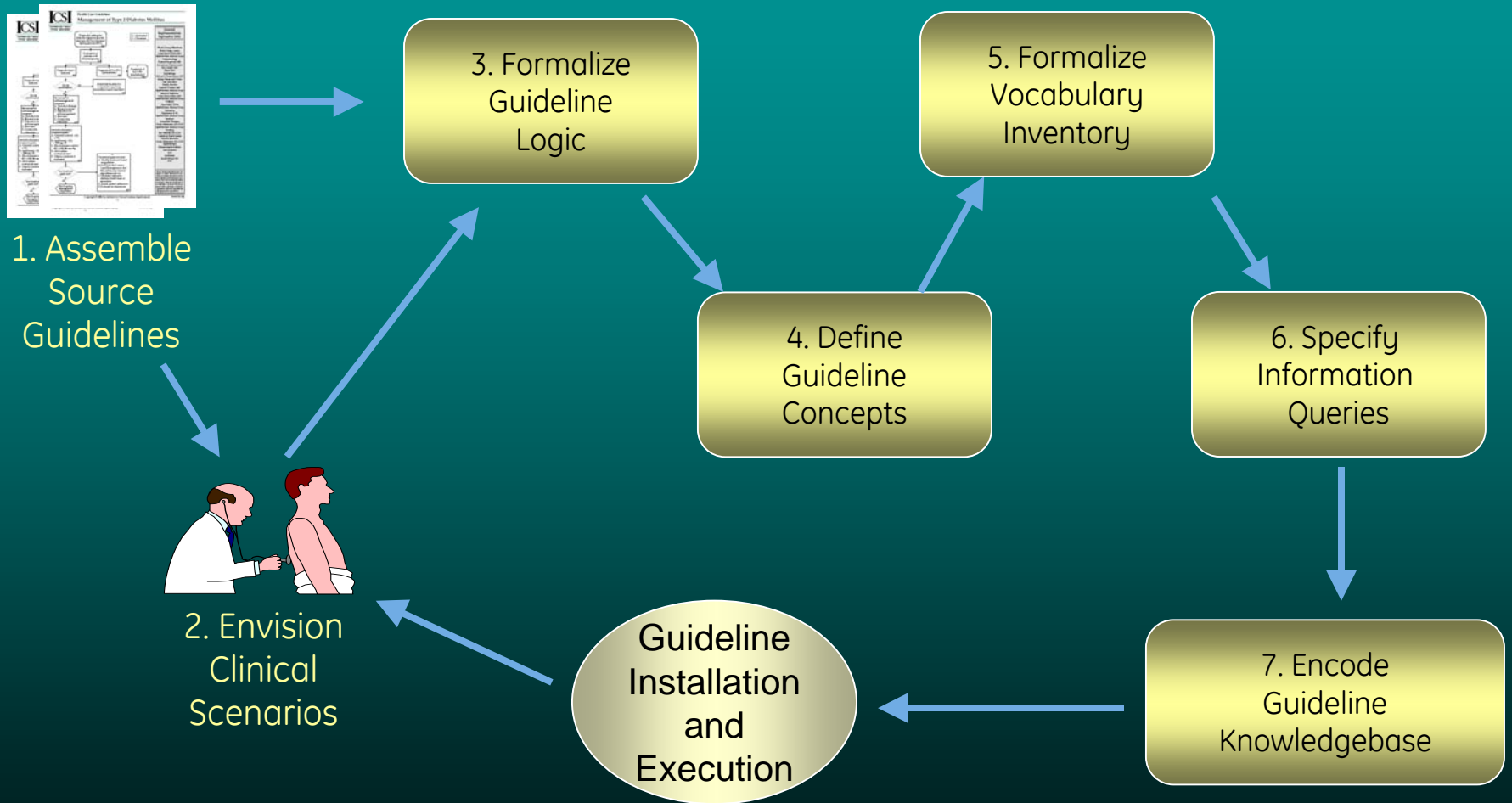
# Overview

- Overview of guidelines and challenges to decision support development

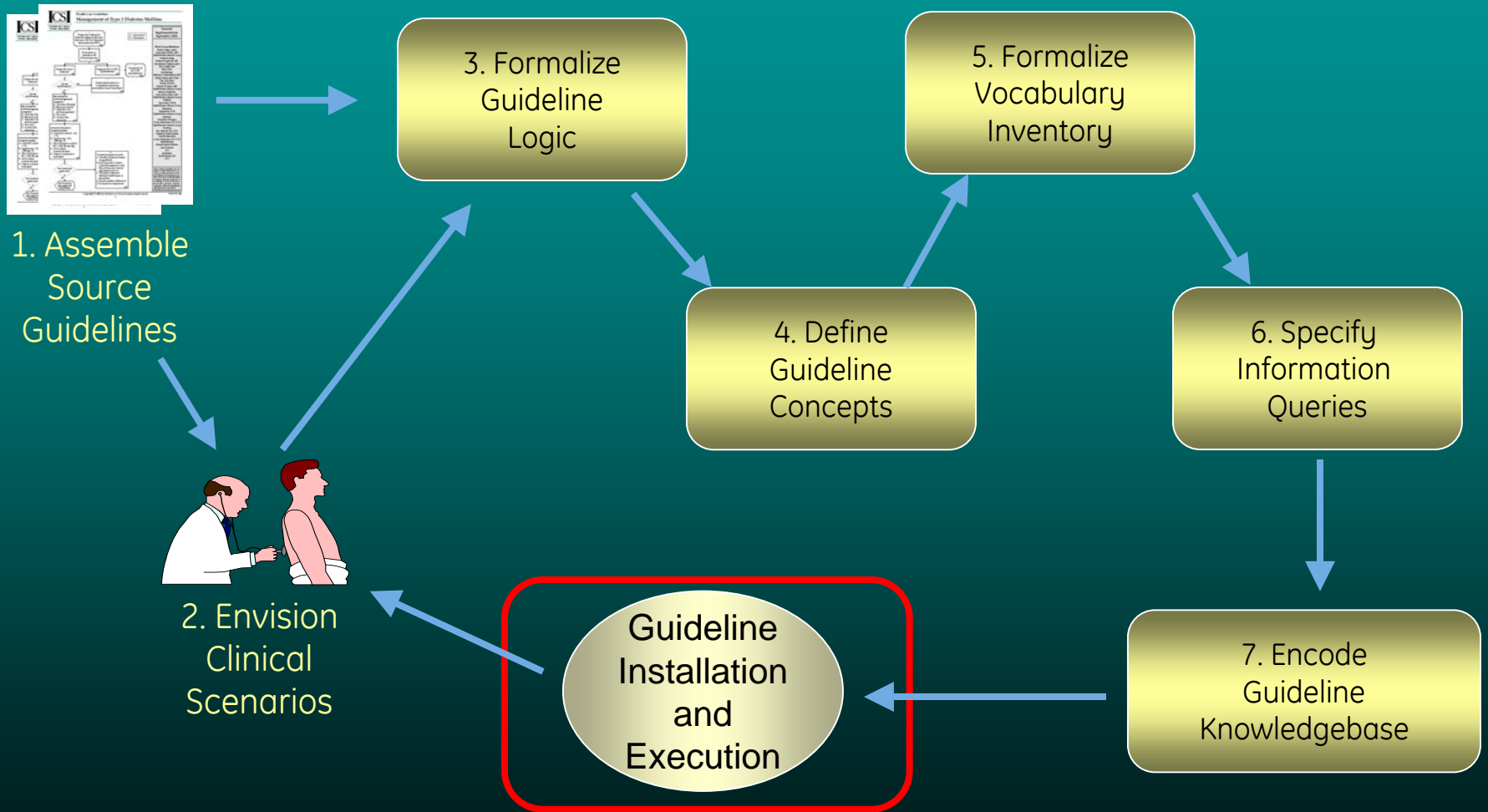
SAGE guideline modeling process:

- Identifying the source clinical guideline
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- Developing concept inventory: employing standard vocabulary
- Specifying information queries
- SAGE guideline model and workbench
- Encoding immunization guideline
- **Validating the development**
- Demonstration: SAGE at work

# SAGE Guideline Encoding Process



# SAGE Guideline Encoding Process





# Guideline Installation and Execution

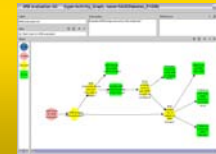
**Download  
Guideline**



**Medical Staff  
Review Guideline**



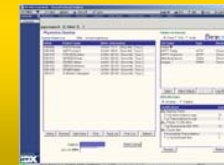
**Edit Guideline for  
Local Conditions**



**Map Standard to  
Local Terminologies**



**Activate  
Guideline**



## Medical Staff Review Guideline



# Guideline Review - Validation

- Guideline workflow logic is often more complicated than simple rules
- With increased scenario complexity, the probability of errors rises geometrically
- CDSS environment should therefore allow for workbench testing
- Internal consistency checking of bindings and data constraints should be integrated within the CDSS workbench

## Medical Staff Review Guideline



# Guideline Review

## Medical Staff Review Guideline



# Guideline Review

Protégé Workbench

Document-Oriented  
View

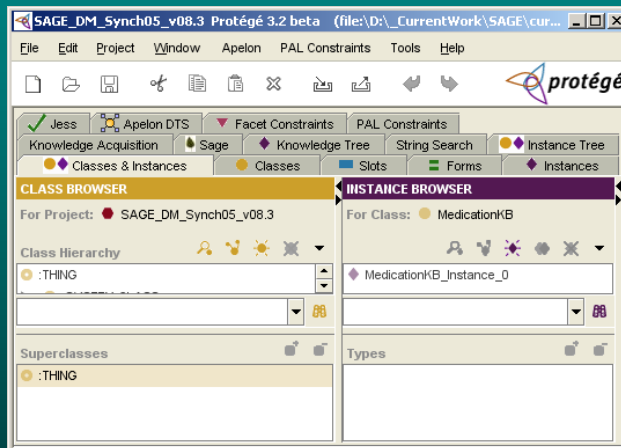
## Medical Staff Review Guideline



# Guideline Review

Document-Oriented  
View

Protégé Workbench

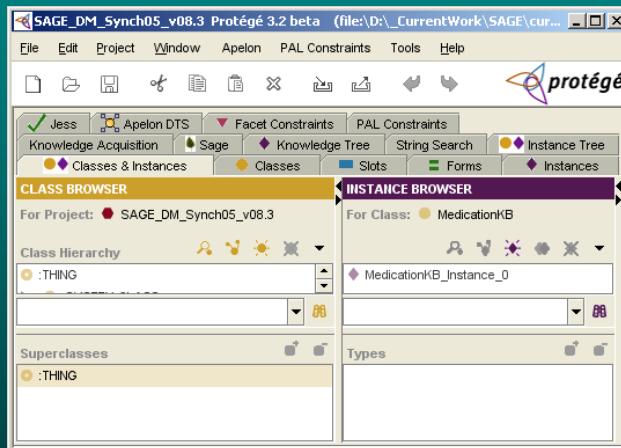


## Medical Staff Review Guideline

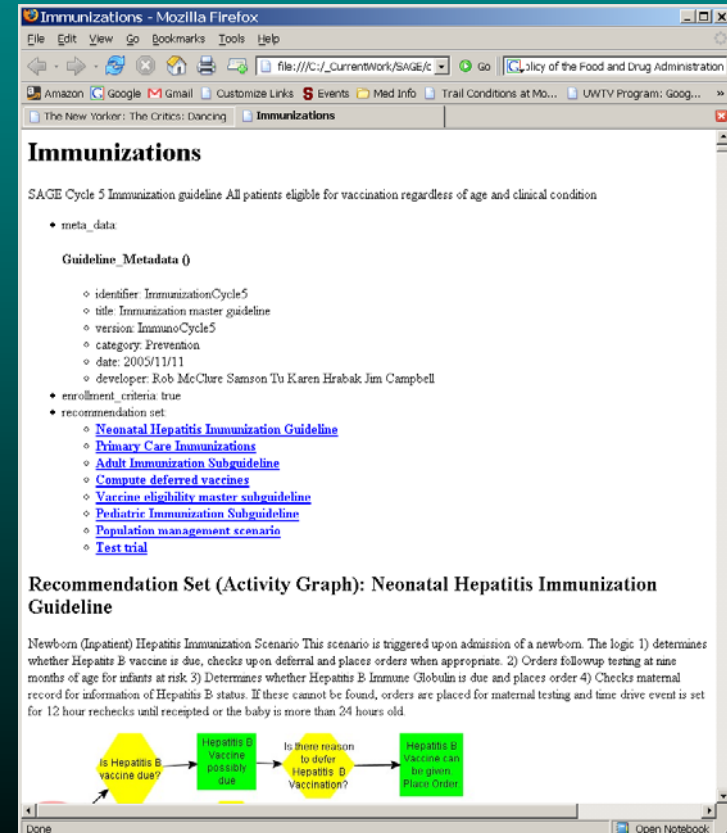


# Guideline Review

Protégé Workbench



Document-Oriented  
View

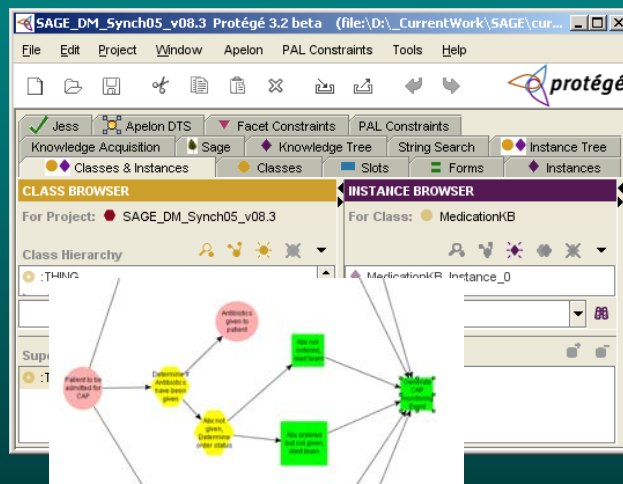


## Medical Staff Review Guideline

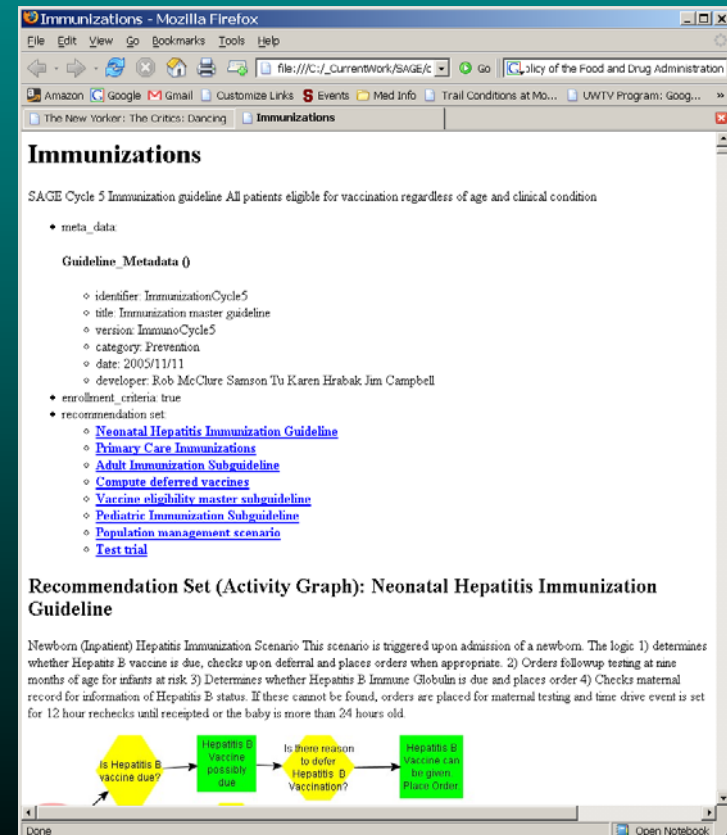


# Guideline Review

## Protégé Workbench



## Document-Oriented View

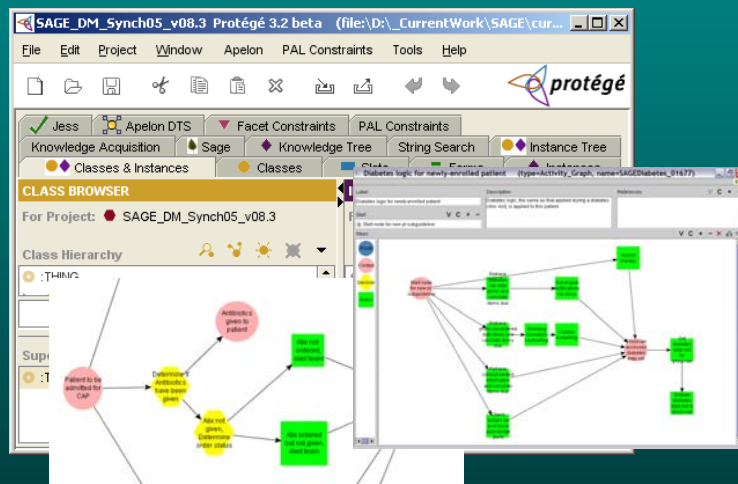


## Medical Staff Review Guideline

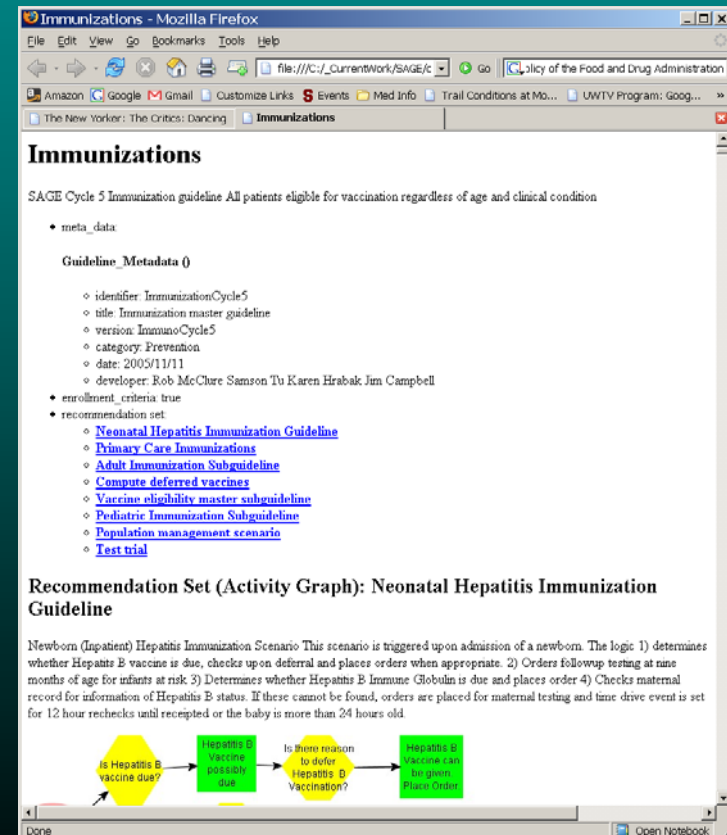


# Guideline Review

## Protégé Workbench



## Document-Oriented View



**Immunizations**

SAGE Cycle 5 Immunization guideline All patients eligible for vaccination regardless of age and clinical condition

- meta\_data
- Guideline\_Metadata ()
  - identifier: ImmunizationCycle5
  - title: Immunization master guideline
  - version: ImmuoCycle5
  - category: Prevention
  - date: 2005/11/11
  - developer: Rob McClure Samson Tu Karen Hrabak Jim Campbell
- enrollment\_criteria: true
- recommendation\_set
  - [Neonatal Hepatitis Immunization Guideline](#)
  - [Primary Care Immunizations](#)
  - [Adult Immunization Subguideline](#)
  - [Compute deferred vaccines](#)
  - [Vaccine eligibility master subguideline](#)
  - [Pediatric Immunization Subguideline](#)
  - [Population management scenario](#)
  - [Test trial](#)

**Recommendation Set (Activity Graph): Neonatal Hepatitis Immunization Guideline**

Newborn (Inpatient) Hepatitis Immunization Scenario This scenario is triggered upon admission of a newborn. The logic 1) determines whether Hepatitis B vaccine is due, checks upon deferral and places orders when appropriate. 2) Orders followup testing at nine months of age for infants at risk. 3) Determines whether Hepatitis B Immune Globulin is due and places order 4) Checks maternal record for information of Hepatitis B status. If these cannot be found, orders are placed for maternal testing and time drive event is set for 12 hours rechecks until receipt or the baby is more than 24 hours old.

```
graph LR
    A{Is Hepatitis B vaccine due?} --> B{Hepatitis B vaccine possible due}
    B --> C{Is there reason to defer Hepatitis B Vaccination?}
    C --> D{Hepatitis B vaccine can be given. Place Order}
```

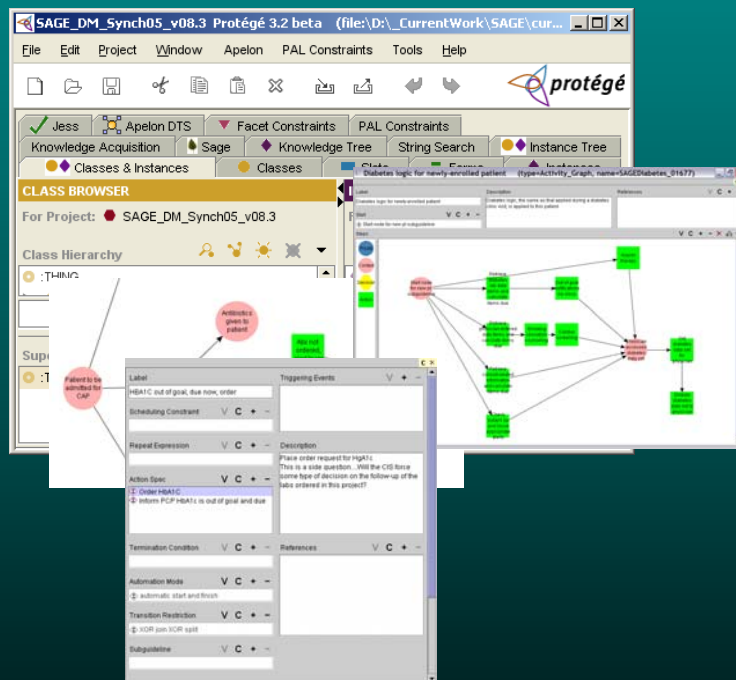


## Medical Staff Review Guideline

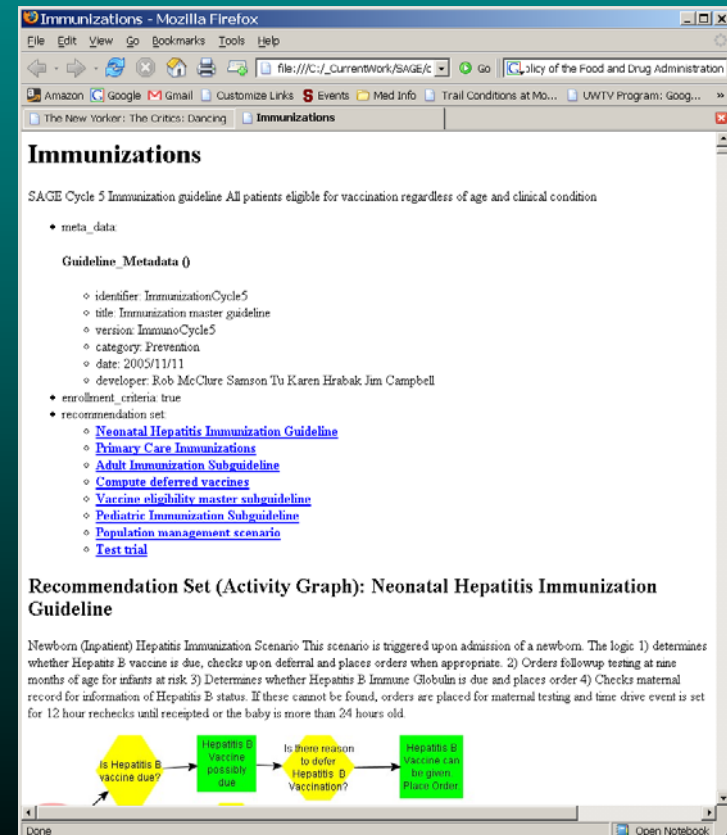


# Guideline Review

## Protégé Workbench



## Document-Oriented View

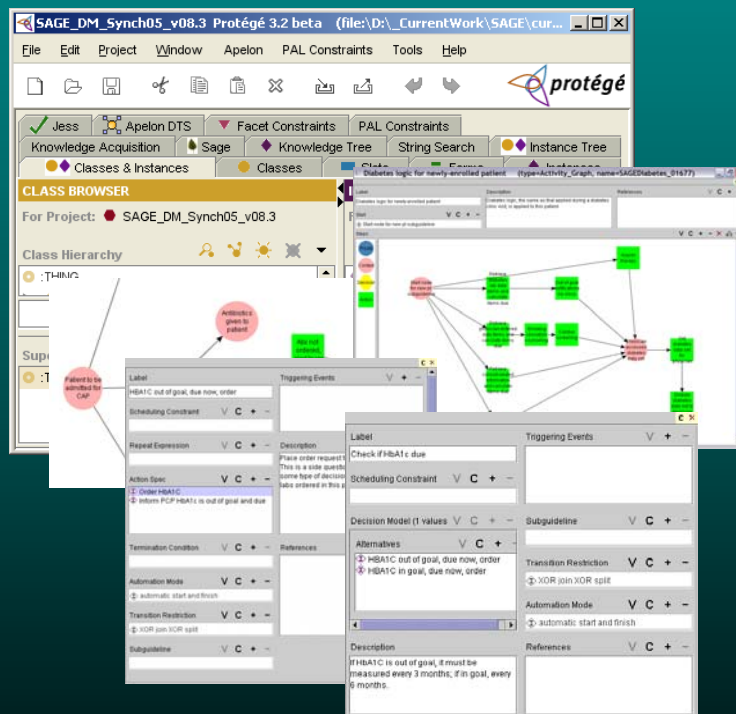


## Medical Staff Review Guideline

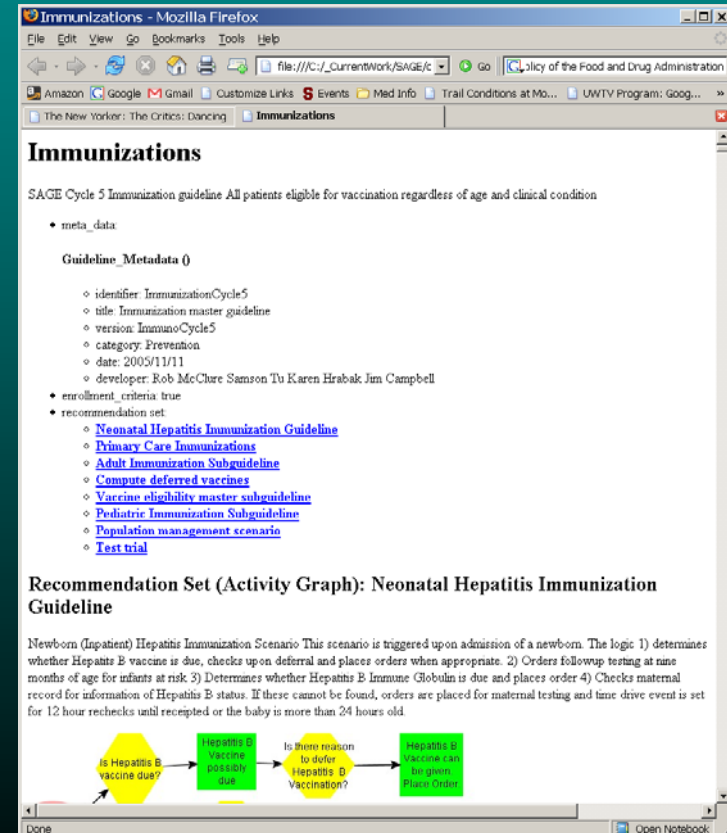


# Guideline Review

## Protégé Workbench



## Document-Oriented View



**Edit Guideline for  
Local Conditions**



# Guideline Localization

## Edit Guideline for Local Conditions



# Guideline Localization

- Local “edits” to guideline content might include:
  - Minor changes (thresholds, formulary, etc.)

## Edit Guideline for Local Conditions



# Guideline Localization

- Major changes (workflow, goals, decisions)

## Edit Guideline for Local Conditions



# Guideline Localization

- Major changes (workflow, goals, decisions)

Edit Guideline for  
Local Conditions



# Guideline Localization

- Major changes (workflow, goals, decisions)

Generic Guideline

Local Care Workflow

Edit Guideline for  
Local Conditions



# Guideline Localization

- Major changes (workflow, goals, decisions)

Generic Guideline

Local Care Workflow

Do A, then B, then C



Edit Guideline for  
Local Conditions



# Guideline Localization

- Major changes (workflow, goals, decisions)

Generic Guideline



Do A, then B, then C

Local Care Workflow

## Edit Guideline for Local Conditions



# Guideline Localization

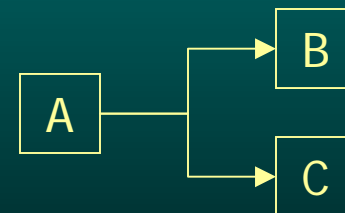
- Major changes (workflow, goals, decisions)

## Generic Guideline



Do A, then B, then C

## Local Care Workflow



## Edit Guideline for Local Conditions



# Guideline Localization

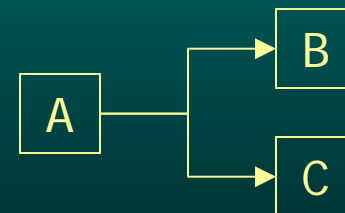
- Major changes (workflow, goals, decisions)

## Generic Guideline



Do A, then B, then C

## Local Care Workflow



Do A, then B and C in parallel

**Edit Guideline for  
Local Conditions**



# Guideline Localization

- Major change -- decisions

Edit Guideline for  
Local Conditions



# Guideline Localization

- Major change -- decisions

## POSITION STATEMENT

### **Standards of Medical Care in Diabetes-2006**

AMERICAN DIABETES ASSOCIATION

**D**iabetes is a chronic illness that requires continuing medical care and

## Edit Guideline for Local Conditions



# Guideline Localization

- Major change -- decisions

### POSITION STATEMENT

## Standards of Medical Care in Diabetes-2006

AMERICAN DIABETES ASSOCIATION

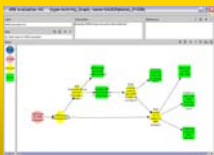
**D**iabetes is a chronic illness that requires continuing medical care and

### Treatment recommendations and goals

In individuals with overt CVD

- All patients should be treated with a statin to achieve an LDL reduction of 30–40%. (A)
- A lower LDL cholesterol goal of <70 mg/dl (1.8 mmol/l), using a high dose of a statin, is an option. (B)

## Edit Guideline for Local Conditions



# Guideline Localization

- Major change -- decisions

### POSITION STATEMENT

## Standards of Medical Care in Diabetes-2006

AMERICAN DIABETES ASSOCIATION

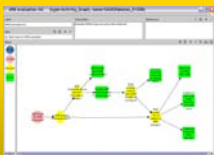
**D**iabetes is a chronic illness that requires continuing medical care and

### Treatment recommendations and goals

In individuals with overt CVD

- All patients should be treated with a statin to achieve an LDL reduction of 30–40%. (A)
- A lower LDL cholesterol goal of <70 mg/dl (1.8 mmol/l), using a high dose of a statin, is an option. (B)

## Edit Guideline for Local Conditions



# Guideline Localization

- Major change -- decisions

### POSITION STATEMENT

## Standards of Medical Care in Diabetes-2006

AMERICAN DIABETES ASSOCIATION

Diabetes is a chronic illness that requires continuing medical care and

### Treatment recommendations and goals

In individuals with overt CVD

- All patients should be treated with a statin to achieve an LDL reduction of 30–40%. (A)
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Notify MD: CVD present so consider lower LDL goal of 70 (instance of Notify...)

Label  
Notify MD: CVD present so consider lower LDL goal of 70

Priority

Subject

Addressee  
☐ Primary care physician

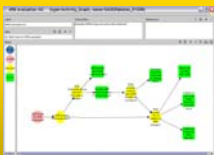
Condition  
☒ Known CVD, but goal LDL not < 70

Communication Mode  
☐ Provider inbox communication protocol

Parameterized String  
☒ Consider lower LDL goal of 70



## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:\C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

File Edit Project Window Apelon PAL Constraints Tools Help

Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

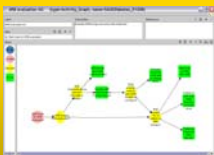
run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

```
criticon 00000ms: LDL value exists result=false pid=00000001 gid=1
criticon 00000ms: LDL within goal result=false pid=00000001 gid=1
evaluate: NOT false
criticon 00010ms: LDL out of goal result=true pid=00000001 gid=1
evaluate: false AND true
criticon 00010ms: LDL value exists and is out of goal result=false pid=00000001 gid=1
action sp: If LDL out of goal, notify MD pid=00000001 gid=1
criticon 00000ms: Acute Myocardial Infarction result=false pid=00000001 gid=1
criticon 00000ms: Coronary arteriosclerosis result=true pid=00000001 gid=1
evaluate: false OR true
criticon 00030ms: Known CVD result=true pid=00000001 gid=1
evaluate: 100 >= 70.0
criticon 00000ms: LDL Goal >= 70 result=true pid=00000001 gid=1
evaluate: true AND true
criticon 00040ms: Known CVD, but goal LDL not < 70 result=true pid=00000001 gid=1
action sp: Notify MD: CVD present so consider lower LDL goal of 70 pid=00000001 gid=1
action 02724ms: Out-of-goal notifications via inbox
Done executing guideline with event Physician accesses the EMR
Received user input
```

## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:\C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

File Edit Project Window Apelon PAL Constraints Tools Help

Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

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criticon 00000ms: LDL value exists result=false pid=00000001 gid=1
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evaluate: 100 >= 70.0
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Done executing guideline with event Physician accesses the EMR
Received user input
```

## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

Log Tab

**SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1** (file: C:\Documents and Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

File Edit Project Window Apelon PAL Constraints Tools Help

Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Query	Value
AdverseReaction: Presence: Allergic drug reaction (disorder) [SNOMED CT]: Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal Value: Diastolic blood pressure (observable entity) [SNOMED CT]: value: most_recent	30.0-80.0
Goal Value: LDL Tests for SAGE DM [SAGE LOINC]: value: most_recent	0.0-100.0
Goal Value: Systolic blood pressure (observable entity) [SNOMED CT]: value: most_recent	90.0-130.0
MedicationOrder: Count: Antihypertensive medications (SAGE DM) [SAGE NDF-RT]: Now: number_of	0
MedicationOrder: Presence: ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder: Presence: Atenolol (product) [SNOMED CT]	false

Steps Log Results Codes

criticon 00000ms: LDL value exists result=false pid=00000001 gid=1  
criticon 00000ms: LDL within goal result=false pid=00000001 gid=1  
evaluate: NOT false  
criticon 00010ms: LDL out of goal result=true pid=00000001 gid=1  
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action sp: Notify MD: CVD present so consider lower LDL goal of 70 pid=00000001 gid=1  
action 02724ms: Out-of-goal notifications via inbox  
Done executing guideline with event Physician accesses the EMR  
Received user input



## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

Log Tab

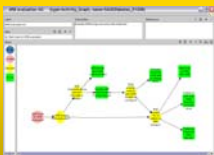
The screenshot shows the Protégé 3.1.1 interface. The 'SAGE' tab is selected in the top toolbar. The main window displays a table with columns 'Query' and 'Value'. Below the table, the 'Log' tab is selected, showing a list of log entries. A red arrow points from the 'Log Tab' text to the 'Log' tab in the interface.

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

```
criticon 00000ms: LDL value exists result=false pid=00000001 gid=1
criticon 00000ms: LDL within goal result=false pid=00000001 gid=1
evaluate: NOT false
criticon 00010ms: LDL out of goal result=true pid=00000001 gid=1
evaluate: false AND true
criticon 00010ms: LDL value exists and is out of goal result=false pid=00000001 gid=1
action sp: If LDL out of goal, notify MD pid=00000001 gid=1
criticon 00000ms: Acute Myocardial Infarction result=false pid=00000001 gid=1
criticon 00000ms: Coronary arteriosclerosis result=true pid=00000001 gid=1
evaluate: false OR true
criticon 00030ms: Known CVD result=true pid=00000001 gid=1
evaluate: 100 >= 70.0
criticon 00000ms: LDL Goal >= 70 result=true pid=00000001 gid=1
evaluate: true AND true
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action sp: Notify MD: CVD present so consider lower LDL goal of 70 pid=00000001 gid=1
action 02724ms: Out-of-goal notifications via inbox
Done executing guideline with event Physician accesses the EMR
Received user input
```

## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

Log Tab

The screenshot shows the Protégé 3.1.1 interface with the SAGE tab selected. The SAGE tab displays a table of queries and their values. The Log tab is also visible, showing a list of log entries. A red box highlights a specific log entry, and a red arrow points to it from the 'Log Tab' text.

Query	Value
AdverseReaction: Presence: Allergic drug reaction (disorder) [SNOMED CT]: Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal: Value: Diastolic blood pressure (observable entity) [SNOMED CT]: value: most_recent	30.0-80.0
Goal: Value: LDL Tests for SAGE DM [SAGE LOINC]: value: most_recent	0.0-100.0
Goal: Value: Systolic blood pressure (observable entity) [SNOMED CT]: value: most_recent	90.0-130.0
MedicationOrder: Count: Antihypertensive medications (SAGE DM) [SAGE NDF-RT]: Now: number_of	0
MedicationOrder: Presence: ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder: Presence: Atenolol (product) [SNOMED CT]	false

Log Tab

Log

Steps

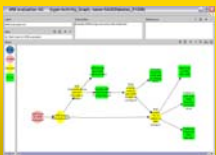
Results

Codes

Done executing guideline with event Physician accesses the EMR  
Received user input



## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

File Edit Project Window Apelon PAL Constraints Tools Help

Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Local CIS

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
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MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

mg/day:

- subject: Notify MD: CVD present so consider lower LDL goal of 70
- message: Patient has known CVD, consider lowering the LDL goal to 70.
- SubjectStr: Sage Mesg.
- AddresseeStr: Primary care physician

Order 00000001

- Name: Fasting lipid profile (procedure) [SNOMED CT]
- From: SNOMED CT:252150008:1.0
- FromDisplayName: Fasting lipid profile (procedure)
- EndDate: Thu Oct 12 22:10:25 CDT 2006
- StartDate: Thu Oct 12 22:10:25 CDT 2006

## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

File Edit Project Window Apelon PAL Constraints Tools Help

Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Local CIS

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
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MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

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- FromDisplayName: Fasting lipid profile (procedure)
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## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

Result  
Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

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Sage Knowledge Tree String Search Instance Tree Jess Apelon DTS Facet Constraints PAL Constraints Classes & Instances Classes Slots Forms Instances Knowledge Acquisition

C:\Documents and Settings\man02\Desktop\Sage Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\DM\_Case\_5.xml

File Guideline

run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Local	CIS
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

mg/day:

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## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

SAGE\_DM\_Synch05\_v08.4 Protégé 3.1.1 (file:C:\Documents%20and%20Settings\man02\Desktop\Sage%20Folder\Diabetes\SAGE\_DM\_Synch05\_v08.3Mayo\SA...

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run reset clear Patient ID: 00000001 Event: Physician accesses the EMR

Local CIS

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

Steps Log Results Codes

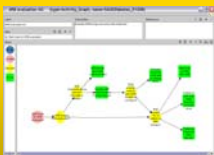
Order 00000001

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- FromDisplayName: Fasting lipid profile (procedure)
- EndDate: Thu Oct 12 22:10:25 CDT 2006
- StartDate: Thu Oct 12 22:10:25 CDT 2006

Result  
Tab

## Edit Guideline for Local Conditions



# Guideline Localization

## Validate using SAGE Tab

Result  
Tab

**Query Results Table:**

Query	Value
AdverseReaction:Presence:Allergic drug reaction (disorder) [SNOMED CT]:Non-steroidal anti-inflammatory agent (product) [SNOMED CT]	false
Goal:Value:Diastolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	30.0-80.0
Goal:Value:LDL Tests for SAGE DM [SAGE LOINC]:value:most_recent	0.0-100.0
Goal:Value:Systolic blood pressure (observable entity) [SNOMED CT]:value:most_recent	90.0-130.0
MedicationOrder:Count:Antihypertensive medications (SAGE DM) [SAGE NDF-RT]:Now:number_of	0
MedicationOrder:Presence:ACE Inhibitor Oral Preparation for Hypertension [SAGE NDF-RT]	false
MedicationOrder:Presence:Aspirin (product) [SNOMED CT]	false

**Messages:**

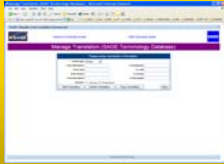
- subject: Notify MD: CVD present so consider lower LDL goal of 70
- message: Patient has known CVD, consider lowering the LDL goal to 70.
- SubjectStr: Sage Mesg.
- AddresseeStr: Primary care physician

**Order:**

00000001 ● Name: Fasting lipid profile (procedure) [SNOMED CT]

- From: SNOMED CT:252150008:1.0
- FromDisplayName: Fasting lipid profile (procedure)
- EndDate: Thu Oct 12 22:10:25 CDT 2006
- StartDate: Thu Oct 12 22:10:25 CDT 2006

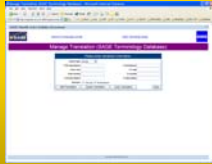
## Map Standard to Local Terminologies



# Localization and Binding to Local CIS

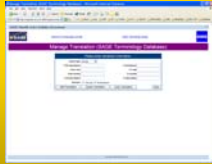
- Interoperable model (such as SAGE) assumes compliance with all information and vocabulary standards
- Implementing this model in a system with parochial terminology requires:
  - Review of scenario assumptions for local applicability
  - Exhaustive mapping to local data tables (code sets must be supported)

Map Standard to  
Local Terminologies



# Mapping Terminologies

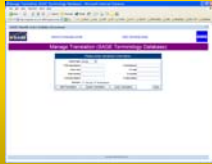
Map Standard to  
Local Terminologies



# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline

Map Standard to  
Local Terminologies

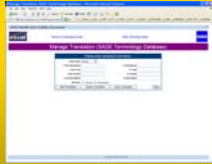


# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline



Map Standard to  
Local Terminologies



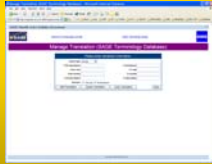
# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline



Must be  
Mapped To

Map Standard to  
Local Terminologies



# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline

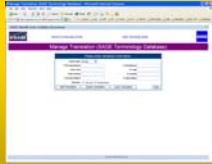


Must be  
Mapped To





Map Standard to  
Local Terminologies

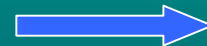


# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline

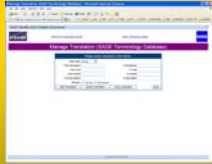


Must be  
Mapped To



Codes and  
terminologies used  
in host CIS

Map Standard to  
Local Terminologies



# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline



Must be  
Mapped To

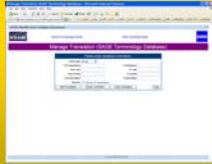


Codes and  
terminologies used  
in host CIS

Diabetes Mellitus:

SNOMED-CT 73211009

Map Standard to  
Local Terminologies



# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline



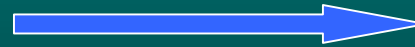
Must be  
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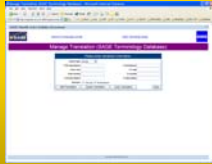
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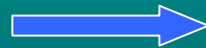


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# Mapping Terminologies

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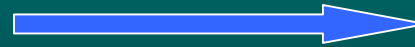


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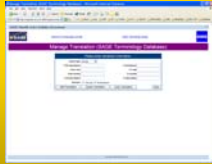
Codes and  
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in host CIS

Diabetes Mellitus:  
SNOMED-CT 73211009



In the local CIS:  
Problem Master Table  
Diabetes Mellitus  
Sequence # 2566

Map Standard to  
Local Terminologies



# Mapping Terminologies

Standards-based  
coded content in  
SAGE Guideline

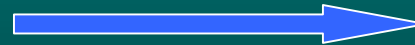


Must be  
Mapped To



Codes and  
terminologies used  
in host CIS

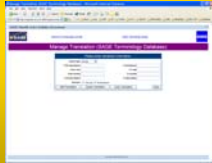
Diabetes Mellitus:  
SNOMED-CT 73211009



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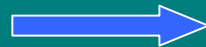
Diabetes Mellitus:  
SNOMED-CT 73211009

Map Standard to  
Local Terminologies

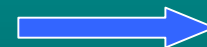


# Mapping Terminologies

Standards-based  
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SAGE Guideline



Must be  
Mapped To



Codes and  
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Diabetes Mellitus:  
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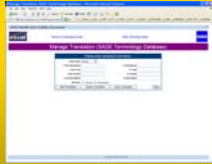


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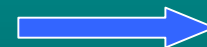


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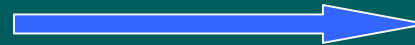


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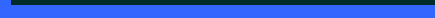
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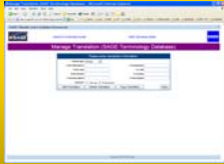
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## Map Standard to Local Terminologies

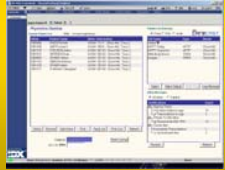


# Mapping Terminologies

VMR Context	From concept	From concept label	Mayo label	Mayo lab code	Mayo Concept
Problem	SNOMED: 73211009	Diabetes mellitus	DM		2202566
Problem	SNOMED: 46635009	Diabetes mellitus type 1	DM type 1		2202569
Problem	SNOMED: 44054006	Diabetes mellitus type 2	DM type 2		2202567
Observation	LOINC: 25514-1	Rubella Virus Ab	Rubella Abs, IgG Only, S	8172- ROCLIS	6109703
Observation	LOINC: 5195-3	Hepatitis B Virus Surface Ag	Hepatitis Bs Ag (HBsAg),S	9013- ROCLIS	6102663
			Hepatitis Bs Ag (HBsAg)	2622- ROCLIS	6101226



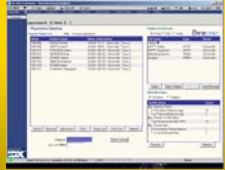
## Activate Guideline



# Validating Run-Time Environment

- Data bases within clinical systems in-use frequently have variable content and may reflect different patterns of usage between sites
- Demonstration cases are valuable for testing but execution against live (parallel) data often exposes:
  - Need for different pragmatics or expanded decision logic
  - Failure of model to handle missing or incomplete data

## Activate Guideline



# Validating Run-Time Environment

- Data bases frequently reflect differences
  - Demonstrated but execution exposes:
    - Need for different pragmatics or expanded decision logic
    - Failure of model to handle missing or incomplete data
- For example:
- 1) Adult patients in US often transfer physicians
  - 2) Immunization history is frequently not recorded in adults
  - 3) Should model make simplifying assumptions regarding primary immunization for Diphtheria / tetanus?

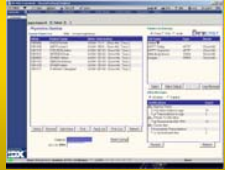
## Activate Guideline



# Quality Assurance Safety Monitoring

- Guideline interventions should generally be tracked and recorded on a patient-by-patient basis
- Consider that one or more implementation scenarios should always address monitoring of success and safety events
- Modeling team should review for safety sentinel events, these should be considered as part of implementation plan

## Activate Guideline



# Examples of Compliance and Safety Monitoring Scenarios

- Report of non-compliance events issued with summary statistics by site and provider
- Babies leaving hospital without record of Hepatitis B vaccination
- Hospitalization of elderly for pneumonia with no history of pneumococcal or influenza vaccinations and clinic visit within past year
- Elderly discharged from hospital in flu season without vaccination

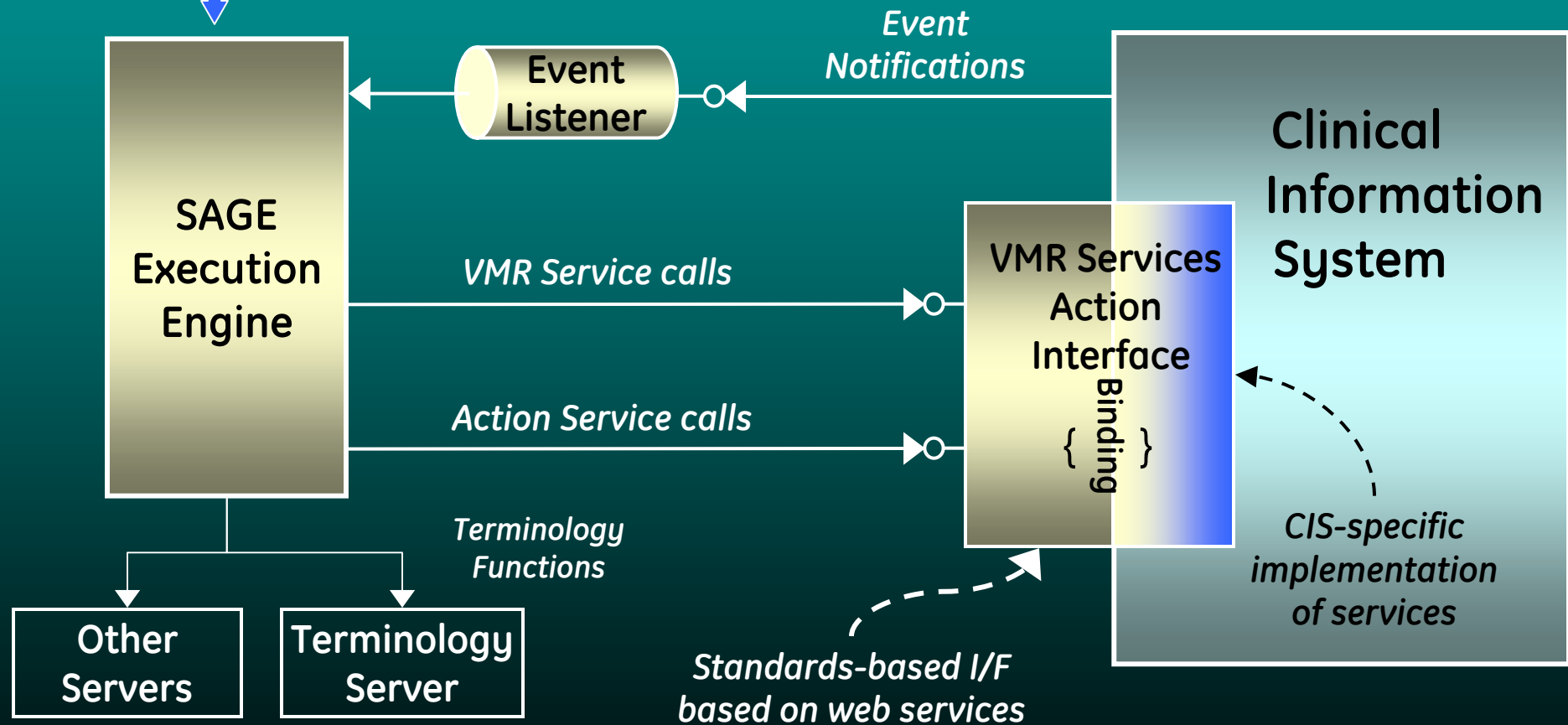
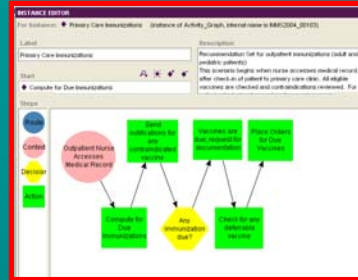
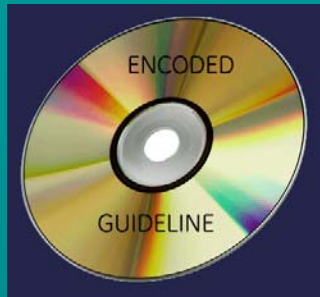
# Overview

- Overview of guidelines and challenges to decision support development

SAGE guideline modeling process:

- Identifying the source clinical guideline
- Creating the implementation scenarios and assembling decision logic
- Developing concept inventory: employing standard vocabulary
- Specifying information queries
- SAGE guideline model and workbench
- Encoding immunization guideline
- Validating the development
- **Demonstration: SAGE at work**

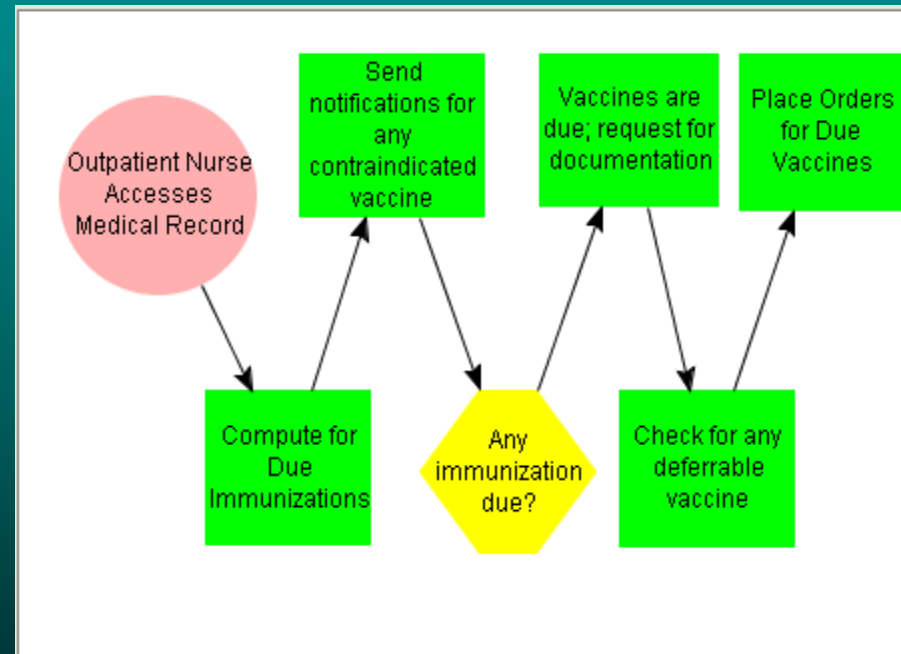
# SAGE Guideline Deployment System Execution Architecture



# Immunizations Guideline

## Primary Care Visit Scenario

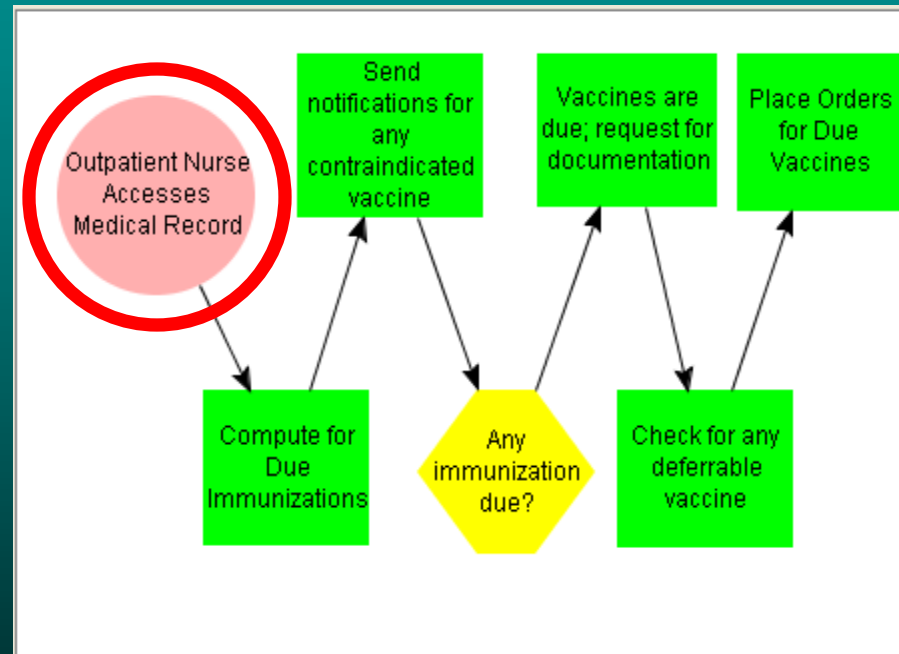
- Patient checks into clinic
- Nurse accesses the patient record, triggering CDSS (SAGE)
  - Event sent from web page
- CIS queries problem list, order profile, procedure history and vaccination history to evaluate vaccinations due or due but contraindicated
- In Carecast, Inbox messages sent:
  - 'Vaccines due or due but contraindicated'
  - Inquire about illness and obtain immunization consent
  - Generate vaccine information sheets (VIS)
- In Carecast, clinician documents consent and verifies absence of severe illness (SAGE queries in CIS)
- SAGE checks for any vaccine deferral reasons
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- Nurse administers vaccines and documents care



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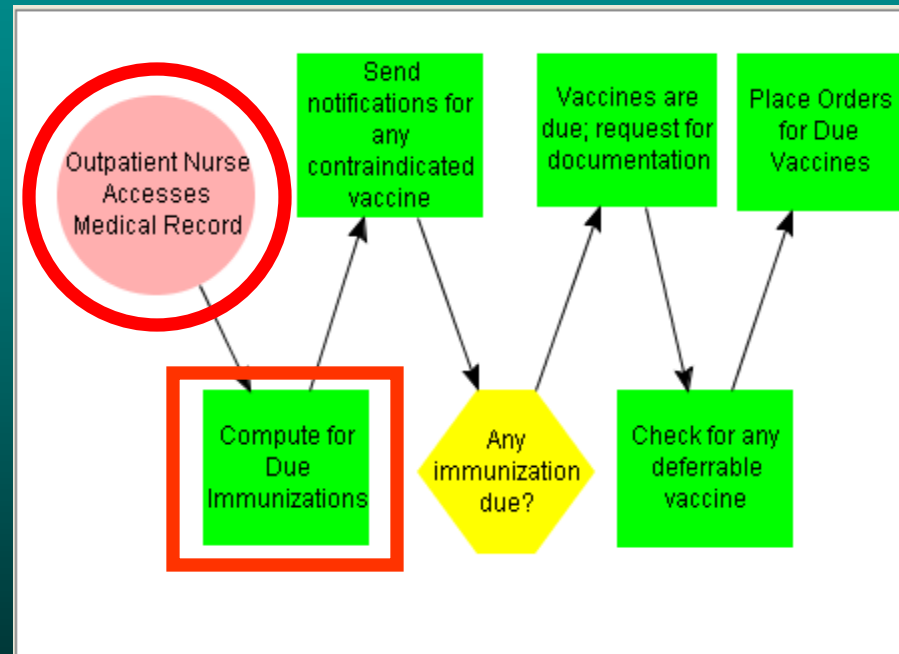




# Immunizations Guideline

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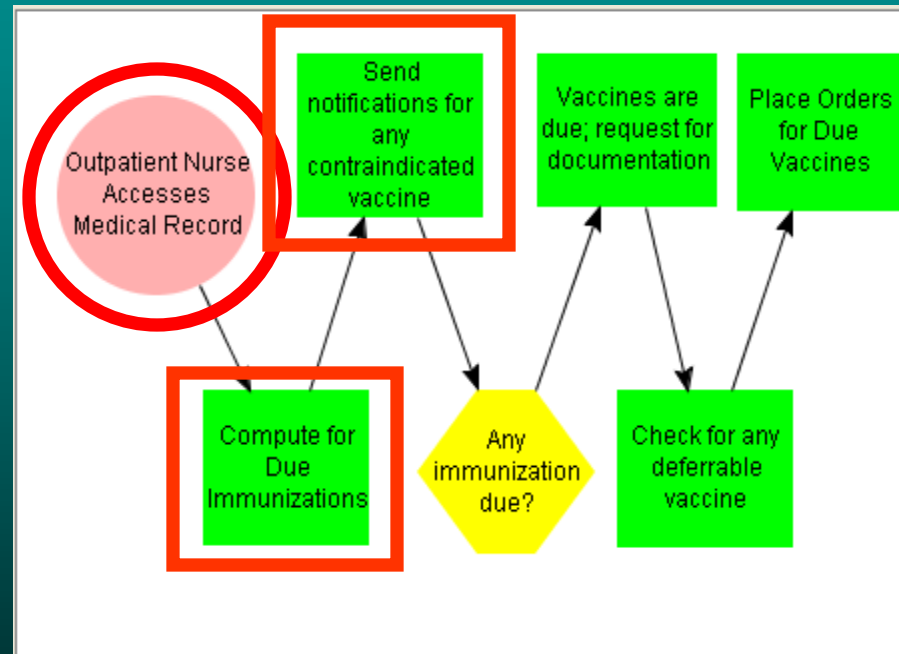
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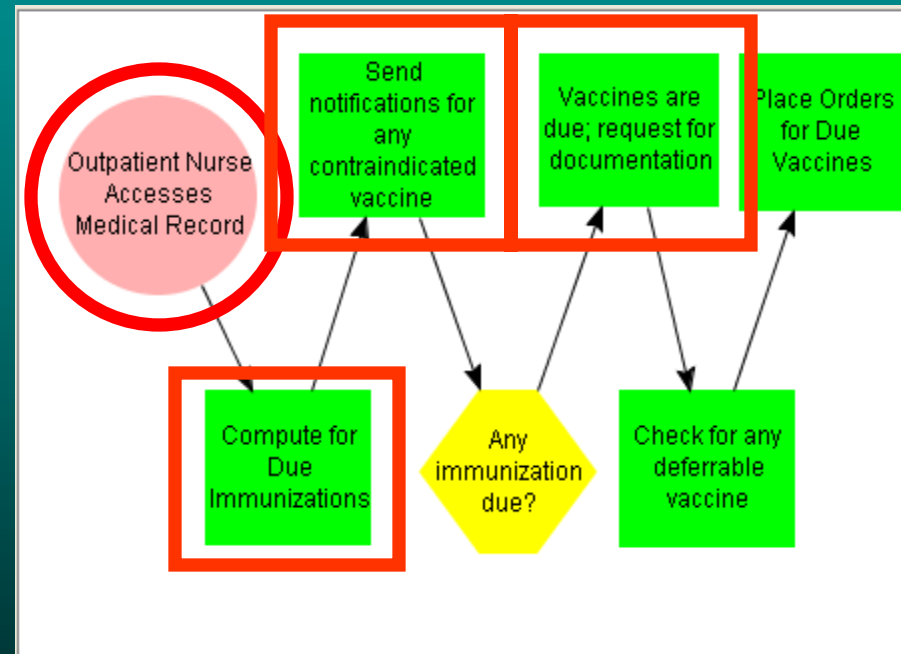
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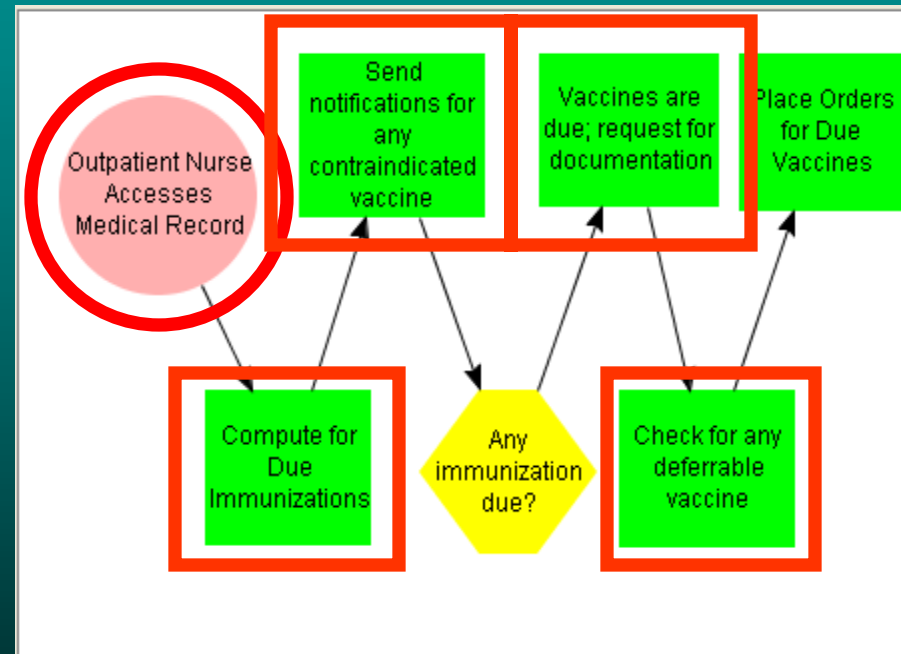
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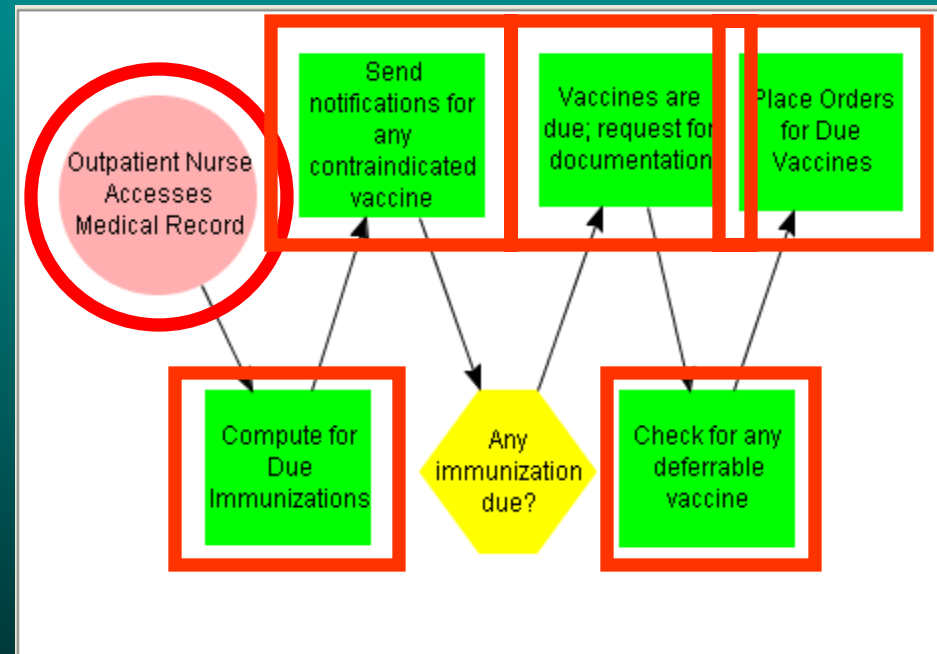
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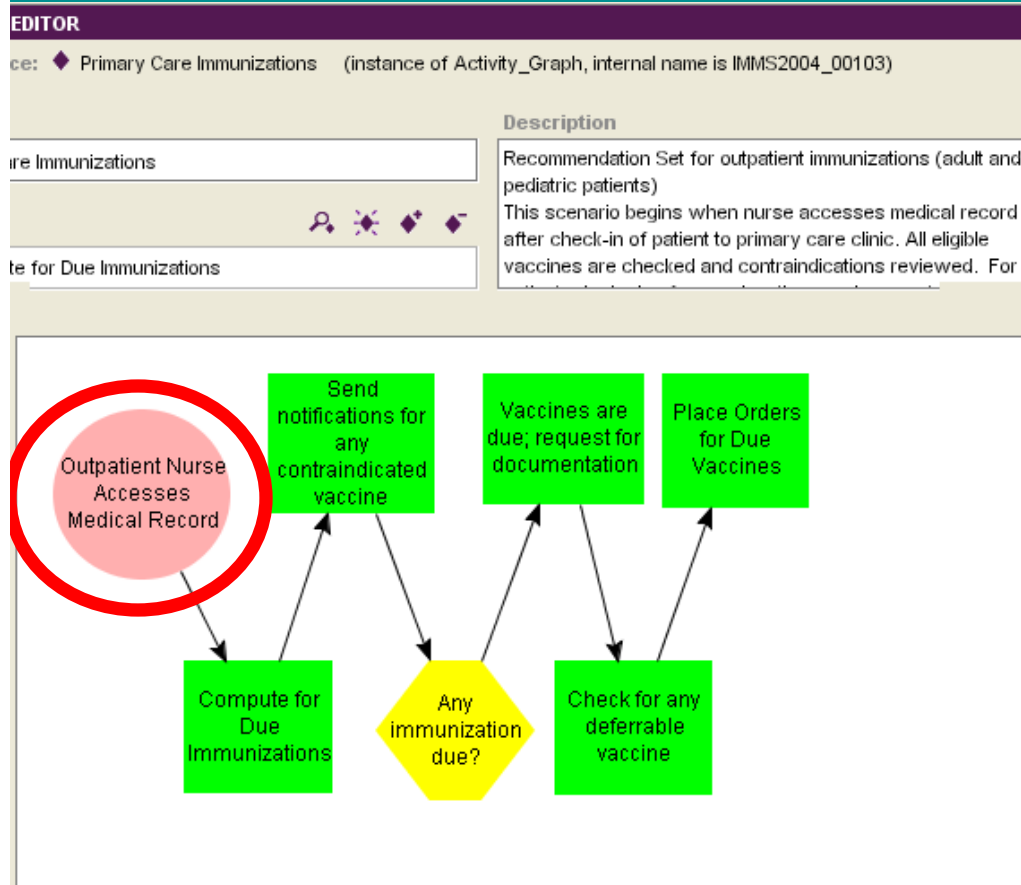
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# Patient: Yura Sage

- 36 year old Caucasian female
- Allergies: Penicillin
- Problems: Hypertension, rheumatoid arthritis, nasal allergies, chronic bronchitis, history of splenectomy
- Medications: Cytoxan 50mg (alkylating agent), Celebrex 200mg
- Vaccination History:
  - 1 dose Pneumococcal (PPV23)vaccine (last dose 2000)
  - 2 doses Diphtheria containing vaccine
  - 1 dose Hepatitis B vaccine

# SAGE Triggering Event: 'Outpatient nurse accesses the patient record'



# SAGE Triggering Event: 'Outpatient nurse accesses the patient record'





# SAGE Triggering Event: 'Outpatient nurse accesses the patient record'

**EDITOR**

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Description

ire Immunizations

te for Due Immunizations

Outpatient Nurse  
Accesses  
Medical Record

Compute for  
Due  
Immunizations

**LastWord Client**

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

▼ Pt. Info & Misc. ▼ Orders ▼ Notes ▼ Procedures ▼ Lab ▼ Ancillary ▼ Nursing ▼ Meds ▼ Summary

**Desktop**

Current Patient List GRP: SAGEimmunizatio Sage

MRN	Patient Name	Other Information
01000217	SAGE, Geriatric male	
01000224	SAGE, Jaundice baby	S 01IN-C Campbell, James R
01000214	SAGE, Yura	
01000199	SAGE, Neonate	S 02IN-A Campbell, James R
01000222	SAGE, One year old	
01000216	SAGE, Pedi8yearold A	

Select Remove Add Active Find.. Temp List Print List Refresh

Command Central

Command: Active MRN: Global Name Lookup

**Patient List Directory**

☑ Freq ☐ Folders ☐ Avail

List Name	Type
Hotlist ♥	
SAGECAP	GRP
SAGEdiabetes	GRP
SAGEimmunization	GRP
SAGEtest	GRP
TemporaryList	PERS

Select Make Default Make Fre

**InBox Messages**

☑ All Mine ☐ Patient

**Notifications**

Create Resolve Refresh

**SAGE**

# SAGE Server Log: Carecast Event Notification

```
execute local call
setting config...
  params...
  SAGE_KEY=1:null
  PATIENT_ID=1
  INTERNAL_ID=null
  CLEAR_STATES=true
  ORIGINAL_EVENT=admin
  EVENT=admin
  GUIDELINE_ID=null
  AUDIT=
done config
arg: -pid=01000214
arg: -hostname=1asage01
arg: -event=Outpatient nurse accesses patient record
arg: -local
arg: -iid=
params...
      Outpatient nurse accesses patient record
context 00000ms: Nurse Updates Medical Record
context 00000ms: Compute vaccine eligibility
  evaluate: 1148116403097 >= 19.0YEAR
  criterion 02469ms: AGE >= 19 YEAR result=true pid=01000214 gid=4
  evaluate: 1148116403113 < 19.0YEAR
  criterion 00016ms: age < 19 years result=false pid=01000214 gid=4
  evaluate: 1148116403128 >= 19.0YEAR
  criterion 00015ms: AGE >= 19 YEAR result=true pid=01000214 gid=4
decision 02500ms: Determine eligibility by age
  evaluate: 1148116403144 >= 19.0YEAR
  criterion 00016ms: AGE >= 19 YEAR result=true pid=01000214 gid=4
context 00016ms: Adult immunization subguideline
```



# SAGE Server Log: Carecast Event Notification

```
execute local call
setting config...
  params...
  SAGE_KEY=1:null
  PATIENT_ID=1
  INTERNAL_ID=null
  CLEAR_STATES=true
  ORIGINAL_EVENT=admin
  EVENT=admin
  GUIDELINE_ID=null
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  EVENT=admin
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# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description	Gde
A	Health care maintenance	
A	Hypertension	
A	Rheumatoid arthritis	
A	Chronic rhinitis	
A	Chronic bronchitis	
A	Splenectomy	

Update Guidelines

Patient Order List

ALL ACTIVE Save Session Context Prefs Expand

Current Order	ST	Sub ST	Start Date	Problem
Tetanus-Diphtheria Toxoids-Td Inj (5-2Lf unit) IM I...	A		25May2006	
Diph,Pertus(Acel),Tetanus Pedi Susp (15-10-5Lf...	A		16May2006	
Cyclophosphamide Tab (50mg) po PO BID #60 T...	A		1-Apr2006	
Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	

Modify D/C Issue

Dept Buttons Common Search Click on button to view suggested orders Order Log

Specify Search Information

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Searching for

- ☒ All
- ☐ Non-Meds
- ☐ Meds
- ☐ Ord Sets

Find Matches Show Favi...

Fac: 5 Loc:

Prescription Historical

Syn Order Selections

Select Order

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Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	

Modify D/C Issue

Dept Buttons Common Search Click on button to view suggested orders Order Log

Specify Search Information

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Searching for

- ☒ All
- ☐ Non-Meds
- ☐ Meds
- ☐ Ord Sets

Find Matches Show Favi...

Fac: 5 Loc:

Prescription Historical

Select Order

# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations

Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description	Gde
A	Health care maintenance	
A	Hypertension	
A	Rheumatoid arthritis	
A	Chronic rhinitis	
A	Chronic bronchitis	
A	Splenectomy	

Update Guidelines

Patient Order List

ALL ACTIVE

Current Order	ST	Sub ST	Start Date	Problem
Tetanus-Diphtheria Toxoids-Td Inj (5-2Lf unit) IM I...	A		25May2006	
Diph,Pertus(Acel),Tetanus Pedi Susp (15-10-5Lf...	A		16May2006	
Cyclophosphamide Tab (50mg) po PO BID #60 T...	A		1-Apr2006	
Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	

Modify D/C Issue

Dept Buttons Common Search Click on button to view suggested orders Order Log

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Searching for

- ☒ All
- ☐ Non-Meds
- ☐ Meds
- ☐ Ord Sets

Find Matches Show Favi...

Prescription Historical

Fac: 5 Loc:

Select Order

# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description	Gde
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A	Chronic rhinitis	
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Diph,Pertus(Acel),Tetanus Pedi Susp (15-10-5Lf...	A		16May2006	
Cyclophosphamide Tab (50mg) po PO BID #60 T...	A		1-Apr2006	
Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	

Update Guidelines Modify D/C Issue

Dept Buttons Common Search Click on button to view suggested orders Order Log

Specify Search Information

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Searching for

- ☒ All
- ☐ Non-Meds
- ☐ Meds
- ☐ Ord Sets

Find Matches Show Favi...

Prescription Historical

Fac: 5 Loc:

Select Order



# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations

Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description	Gde
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A	Rheumatoid arthritis	
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A	Chronic bronchitis	
A	Splenectomy	

Patient Order List

Current Order	ST	Sub ST	Start Date	Problem
Tetanus-Diphtheria Toxoids-Td Inj (5-2Lf unit) IM I...	A		25May2006	
Diph,Pertus(Acel),Tetanus Pedi Susp (15-10-5Lf...	A		16May2006	
Cyclophosphamide Tab (50mg) po PO BID #60 T...	A		1-Apr2006	
Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	

Update Guidelines Modify D/C Issue

Dept Buttons Common Search Click on button to view suggested orders Order Log

Specify Search Information

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Searching for

- ☒ All
- ☐ Non-Meds
- ☐ Meds
- ☐ Ord Sets

Find Matches Show Favi...

Fac: 5 Loc:

Prescription Historical

Order Selections

Select Order

# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations

Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description
A	Health care mainte
A	Hypertension
A	Rheumatoid arthritis
A	Chronic rhinitis
A	Chronic bronchitis
A	Splenectomy

Dept Buttons Common

Specify Search Information

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Fac: 5

```

criterion 00015ms: Record of PPV23 administration is not present (0) result=false pid=01000214
  evaluate: true AND false
criterion 00062ms: PPV23 first dose indicated (adult) result=false pid=01000214 gid=4
  evaluate: 1 equals 1
criterion 00000ms: # of PPV23 = 1 result=true pid=01000214 gid=4
criterion 00000ms: Chronic renal failure result=false pid=01000214 gid=4
criterion 00000ms: Nephrotic syndrome result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 00000ms: Cochlear implant problem history result=false pid=01000214 gid=4
criterion 00016ms: Functional asplenia result=false pid=01000214 gid=4
criterion 00000ms: Congenital asplenia result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 00000ms: Sickle cell disease result=false pid=01000214 gid=4
criterion 00000ms: Asplenia syndrome result=false pid=01000214 gid=4
criterion 00000ms: Hyposplenism result=false pid=01000214 gid=4
criterion 00000ms: Splenectomy problem history result=true pid=01000214 gid=4
criterion 00016ms: Functional or anatomic asplenia result=true pid=01000214 gid=4
criterion 00016ms: Pneumococcal (PPV23) revaccination High risk Loss of immunity indications (
  evaluate: 1148116411003 >= 65.0YEAR
criterion 00015ms: AGE >= 65 YEAR result=false pid=01000214 gid=4
  evaluate: Wed Jun 07 00:00:00 CDT 2000 before Mon Apr 30 00:00:00 CDT 2035
criterion 00016ms: last PPV23 vaccine given before age 65 result=true pid=01000214 gid=4
  evaluate: false AND true
criterion 00031ms: Age >= 65 years AND last PPV23 given < age 65 years result=false pid=01000214
  evaluate: true OR false
    
```



# SAGE Queries Record: Problem List and Active Orders

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Label: Primary Care Immunizations

Description: Recommendation Set for outpatient immunizations (adult and

Start: ♦ Compute for Due Immunizations

Steps:

- Route
- Context
- Decision
- Action

Outpatient Nurse Accesses Medical Record

Send notifications any contraindica vaccine

Compute for Due Immunizations

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Status	Problem Description
A	Health care mainte
A	Hypertension
A	Rheumatoid arthritis
A	Chronic rhinitis
A	Chronic bronchitis
A	Splenectomy

Dept Buttons Common

Order Search Text:

Search Method

- ☒ Begins With
- ☐ Contains
- ☐ Leading Word

Fac: 5

```

criterion 00015ms: Record of PPV23 administration is not present (0) result=false pid=01000214
  evaluate: true AND false
criterion 00062ms: PPV23 first dose indicated (adult) result=false pid=01000214 gid=4
  evaluate: 1 equals 1
criterion 00000ms: # of PPV23 = 1 result=true pid=01000214 gid=4
criterion 00000ms: Chronic renal failure result=false pid=01000214 gid=4
criterion 00000ms: Nephrotic syndrome result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 00000ms: Cochlear implant problem history result=false pid=01000214 gid=4
criterion 00016ms: Functional asplenia result=false pid=01000214 gid=4
criterion 00000ms: Congenital asplenia result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 00000ms: Sickle cell disease result=false pid=01000214 gid=4
criterion 00000ms: Asplenia syndrome result=false pid=01000214 gid=4
criterion 00000ms: Unexplained result=false pid=01000214 gid=4
criterion 00000ms: Splenectomy problem history result=true pid=01000214 gid=4
criterion 00016ms: Functional or anatomic asplenia result=true pid=01000214 gid=4
criterion 00016ms: Pneumococcal (PPV23) revaccination High Risk Loss or immunity indications (
  evaluate: 1148116411003 >= 65.0YEAR
criterion 00015ms: AGE >= 65 YEAR result=false pid=01000214 gid=4
  evaluate: Wed Jun 07 00:00:00 CDT 2000 before Mon Apr 30 00:00:00 CDT 2035
criterion 00016ms: last PPV23 vaccine given before age 65 result=true pid=01000214 gid=4
  evaluate: false AND true
criterion 00031ms: Age >= 65 years AND last PPV23 given < age 65 years result=false pid=010002
  evaluate: true OR false
  
```



# SAGE Queries Record: Contraindications

## INSTANCE EDITOR

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

### Label

Primary Care Immunizations

### Description

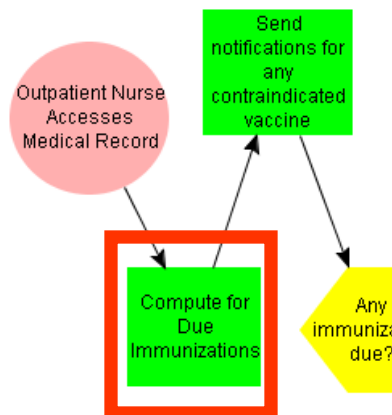
Recommendation Set for outpatient immunizations (adult and pediatric patients)  
This scenario begins when nurse accesses medical record

### Start

♦ Compute for Due Immunizations

### Steps

Route  
Context  
Decision  
Action



```

criterion 00000ms: CSF leak result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to Gelatin result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to rubella vaccine result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to measles vaccine result=false pid=01000214 gid=4
criterion 01140ms: Untreated active tuberculosis result=false pid=01000214 gid=4
criterion 01719ms: Congenital immunodeficiency result=false pid=01000214 gid=4
criterion 00000ms: HIV+ result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 01734ms: Leukemia result=false pid=01000214 gid=4
criterion 02875ms: Lymphoma (includes Hodgkin's) result=false pid=01000214 gid=4
criterion 01250ms: Multiple myeloma result=false pid=01000214 gid=4
criterion 01219ms: Generalized Malignancy result=false pid=01000214 gid=4
criterion 01313ms: Bone marrow transplant recipient result=false pid=01000214 gid=4
criterion 01172ms: Immunodeficiency due to chemotherapy result=false pid=01000214 gid=4
criterion 00953ms: Antimetabolite therapy result=false pid=01000214 gid=4
  evaluate: 0 > 12
criterion 00781ms: Long term steroid therapy (12 glucocorticoid doses last six months) result=false p
criterion 01469ms: Solid organ transplant problem history result=false pid=01000214 gid=4
criterion 00656ms: Treatment with alkylating agent within last three months result=true pid=01000214
criterion 15156ms: Immunosuppressive conditions result=true pid=01000214 gid=4
criterion 18953ms: MMR CONTRAINDICATIONS result=true pid=01000214 gid=4
  evaluate: NOT true
criterion 18969ms: MMR NOT contraindicated result=false pid=01000214 gid=4
  
```



# SAGE Queries Record: Contraindications

## INSTANCE EDITOR

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

### Label

Primary Care Immunizations

### Description

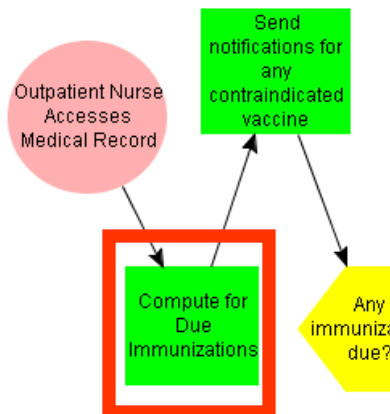
Recommendation Set for outpatient immunizations (adult and pediatric patients)  
This scenario begins when nurse accesses medical record

### Start

♦ Compute for Due Immunizations

### Steps

- Route
- Context
- Decision
- Action



```

criterion 00000ms: CSF leak result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to Gelatin result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to rubella vaccine result=false pid=01000214 gid=4
  evaluate: true = false
criterion 00000ms: Anaphylaxis reaction to measles vaccine result=false pid=01000214 gid=4
criterion 01140ms: Untreated active tuberculosis result=false pid=01000214 gid=4
criterion 01719ms: Congenital immunodeficiency result=false pid=01000214 gid=4
criterion 00000ms: HIV+ result=false pid=01000214 gid=4
  evaluate: false OR false
criterion 01734ms: Leukemia result=false pid=01000214 gid=4
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criterion 01250ms: Multiple myeloma result=false pid=01000214 gid=4
criterion 01219ms: Generalized Malignancy result=false pid=01000214 gid=4
criterion 01313ms: Bone marrow transplant recipient result=false pid=01000214 gid=4
criterion 01172ms: Immunodeficiency due to chemotherapy result=false pid=01000214 gid=4
criterion 00953ms: Antimetabolite therapy result=false pid=01000214 gid=4
  evaluate: 0 > 12
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criterion 01469ms: Solid organ transplant problem history result=false pid=01000214 gid=4
criterion 00656ms: Treatment with alkylating agent within last three months result=true pid=01000214
criterion 15156ms: Immunosuppressive conditions result=true pid=01000214 gid=4
criterion 18953ms: MMR CONTRAINDICATIONS result=true pid=01000214 gid=4
  evaluate: NOT true
criterion 18969ms: MMR NOT contraindicated result=false pid=01000214 gid=4
  
```



# SAGE Queries Record: Contraindications

## INSTANCE EDITOR

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

### Label

Primary Care Immunizations

### Description

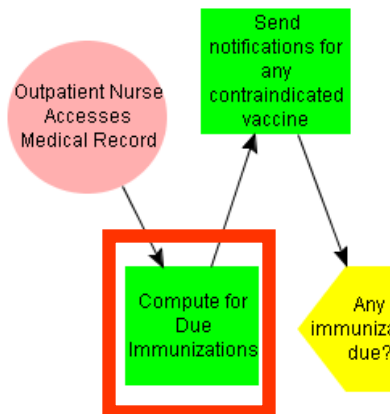
Recommendation Set for outpatient immunizations (adult and pediatric patients)  
This scenario begins when nurse accesses medical record

### Start

♦ Compute for Due Immunizations

### Steps

- Route
- Context
- Decision
- Action



```

criterion 00000ms: CSF leak result=false pid=01000214 gid=4
  evaluate: true = false
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criterion 00000ms: Anaphylaxis reaction to rubella vaccine result=false pid=01000214 gid=4
  evaluate: true = false
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criterion 01719ms: Congenital immunodeficiency result=false pid=01000214 gid=4
criterion 00000ms: HIV+ result=false pid=01000214 gid=4
  evaluate: false OR false
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criterion 01172ms: Immunodeficiency due to chemotherapy result=false pid=01000214 gid=4
criterion 00953ms: Antimetabolite therapy result=false pid=01000214 gid=4
  evaluate: 0 > 12
criterion 00781ms: Long term steroid therapy (12 glucocorticoid doses last six months) result=false p
criterion 01111ms: Solid organ transplant recipient result=false pid=01000214 gid=4
criterion 00656ms: Treatment with alkylating agent within last three months result=true pid=01000214
criterion 19100ms: Immunosuppressive conditions result=true pid=01000214 gid=4
criterion 18953ms: MMR CONTRAINDICATIONS result=true pid=01000214 gid=4
  evaluate: NOT true
criterion 18969ms: MMR NOT contraindicated result=false pid=01000214 gid=4
  
```



# SAGE Recommendations

- Vaccines due but contraindicated
  - MMR
  - Varicella
- Vaccines due:
  - Hepatitis B
  - PPV23
  - MCV4
  - Influenza split virus

# Inbox Notification

## 'Due' and 'Contraindicated' Vaccines

**EDITOR**

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccine

ire Immunizations

te for Due Immunizations

```

graph TD
    A((Outpatient Nurse Accesses Medical Record)) --> B[Compute for Due Immunizations]
    B --> C[Send notifications for any contraindicated vaccine]
    C --> D{Any immunization due?}
    D --> E[Vaccine due; require documentation]
    
```

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

▼ Pt. Info & Misc. ▼ Orders ▼ Notes ▼ Procedures ▼ Lab ▼ Ancillary ▼ Nursing ▼ Meds ▼

**Notification:** Patient message

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

subject: Send notification that MMR is contraindicated  
message:MMR vaccine is due but contraindicated

subject: Send notification that varicella vaccine is contraindicated  
message:Varicella vaccine is due but contraindicated

subject: Hep B due notification to report  
message:Hep B vaccination is due

Forwarded/Reassigned By:USER, SAGE

Reason for Forward/Reassign



# Inbox Notification

## 'Due' and 'Contraindicated' Vaccines

**EDITOR**

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccine

ire Immunizations

te for Due Immunizations

```

graph TD
    A((Outpatient Nurse Accesses Medical Record)) --> B[Send notifications for any contraindicated vaccine]
    A --> C[Compute for Due Immunizations]
    B --> D{Any immunization due?}
    C --> D
    D --> E[Vaccine due; require documentation]
    
```

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds

**Notification:** Patient message

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

subject: Send notification that MMR is contraindicated  
message:MMR vaccine is due but contraindicated

subject: Send notification that varicella vaccine is contraindicated  
message:Varicella vaccine is due but contraindicated

subject: Hep B due notification to report  
message:Hep B vaccination is due

Forwarded/Reassigned By:USER, SAGE

Reason for Forward/Reassign

# Inbox Notification

## 'Due' and 'Contraindicated' Vaccines

**EDITOR**

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccine

ire Immunizations

te for Due Immunizations

```

graph TD
    A((Outpatient Nurse Accesses Medical Record)) --> B[Send notifications for any contraindicated vaccine]
    A --> C[Compute for Due Immunizations]
    B --> D{Any immunization due?}
    C --> D
    D --> E[Vaccine due; require documentation]
    
```

The flowchart illustrates the process for sending notifications for contraindicated vaccines. It starts with an outpatient nurse accessing a medical record, which leads to two parallel actions: sending notifications for any contraindicated vaccine and computing for due immunizations. Both actions lead to a decision point: 'Any immunization due?'. If the answer is yes, the process continues to 'Vaccine due; require documentation'.

**01000214 SAGE, Yura - M**

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds

**Notification:** Patient message

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

subject: Send notification that MMR is contraindicated  
message:MMR vaccine is due but contraindicated

subject: Send notification that varicella vaccine is contraindicated  
message:Varicella vaccine is due but contraindicated

subject: Hep B due notification to report  
message:Hep B vaccination is due

Forwarded/Reassigned By:USER, SAGE

Reason for Forward/Reassign



# Inbox Notification

## 'Due' and 'Contraindicated' Vaccines

**EDITOR**

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccine

ire Immunizations

te for Due Immunizations

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds

**Notification:** Patient message

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

subject: Send notification that MMR is contraindicated  
message:MMR vaccine is due but contraindicated

subject: Send notification that varicella vaccine is contraindicated  
message:Varicella vaccine is due but contraindicated

subject: Hep B due notification to report  
message:Hep B vaccination is due

Forwarded/Reassigned By:USER, SAGE

Reason for Forward/Reassign

```

graph TD
    A((Outpatient Nurse Accesses Medical Record)) --> B[Compute for Due Immunizations]
    B --> C[Send notifications for any contraindicated vaccine]
    B --> D{Any immunization due?}
    C --> E[Vaccine due; require documentation]
  
```

**SAGE**

# SAGE Queries Record: 'Vaccines are due, request for documentation'

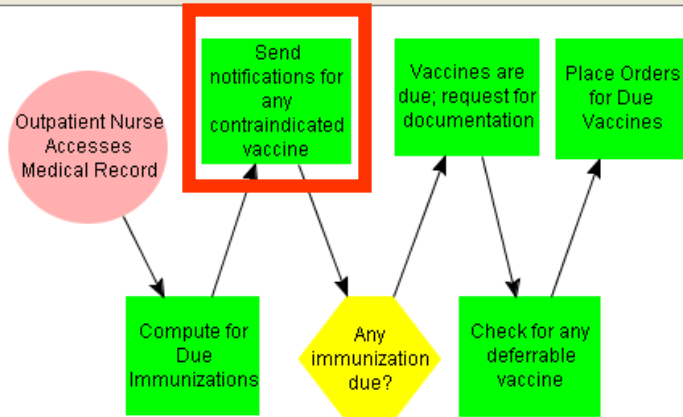
**EDITOR**

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

action sp: Generate Pneumococcal (PPV23) education material pid=01000214 gid=4
action sp: Pneumococcal (PPV23) vaccination actions pid=01000214 gid=4
criterion 00172ms: Influenza splitvirus vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Influenza (splitvirus) education material pid=01000214 gid=4
action sp: influenza splitvirus vaccination actions pid=01000214 gid=4
criterion 00171ms: Td vaccine is DUE result=false pid=01000214 gid=4
action sp: Td vaccination actions pid=01000214 gid=4
criterion 00188ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action sp: DTaP vaccination actions pid=01000214 gid=4
criterion 00281ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action sp: Pneumococcal (PCV7) vaccine actions pid=01000214 gid=4
criterion 00172ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action sp: Varicella vaccination actions pid=01000214 gid=4
criterion 00172ms: MCV4 vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Meningococcal (MCV4) education material pid=01000214 gid=4
action sp: Meningococcal (MCV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action sp: DT vaccination actions pid=01000214 gid=4
criterion 00157ms: MPSV4 vaccine is DUE result=false pid=01000214 gid=4
action sp: Meningococcal (MPSV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: TdaP vaccine is DUE result=false pid=01000214 gid=4
action sp: TdaP vaccination actions pid=01000214 gid=4
criterion 00188ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gi
action sp: Influenza wholevirus vaccination actions pid=01000214 gid=4
action 03453ms: Vaccines are due; request for documentation
  
```



key

# SAGE Queries Record: 'Vaccines are due, request for documentation'

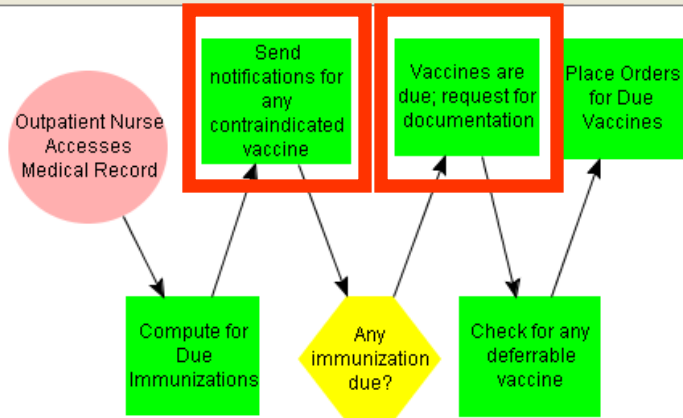
**EDITOR**

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

action sp: Generate Pneumococcal (PPV23) education material pid=01000214 gid=4
action sp: Pneumococcal (PPV23) vaccination actions pid=01000214 gid=4
criterion 00172ms: Influenza splitvirus vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Influenza (splitvirus) education material pid=01000214 gid=4
action sp: influenza splitvirus vaccination actions pid=01000214 gid=4
criterion 00171ms: Td vaccine is DUE result=false pid=01000214 gid=4
action sp: Td vaccination actions pid=01000214 gid=4
criterion 00188ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action sp: DTaP vaccination actions pid=01000214 gid=4
criterion 00281ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action sp: Pneumococcal (PCV7) vaccine actions pid=01000214 gid=4
criterion 00172ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action sp: Varicella vaccination actions pid=01000214 gid=4
criterion 00172ms: MCV4 vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Meningococcal (MCV4) education material pid=01000214 gid=4
action sp: Meningococcal (MCV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action sp: DT vaccination actions pid=01000214 gid=4
criterion 00157ms: MPSV4 vaccine is DUE result=false pid=01000214 gid=4
action sp: Meningococcal (MPSV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: TdaP vaccine is DUE result=false pid=01000214 gid=4
action sp: TdaP vaccination actions pid=01000214 gid=4
criterion 00188ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gi
action sp: Influenza wholevirus vaccination actions pid=01000214 gid=4
action 03453ms: Vaccines are due; request for documentation
  
```



key

# SAGE Queries Record: 'Vaccines are due, request for documentation'

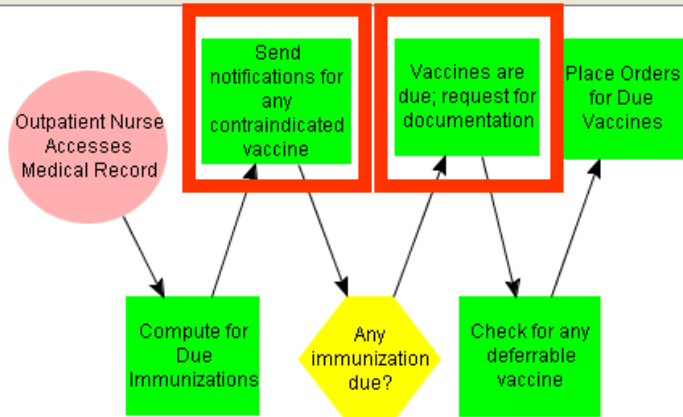
**EDITOR**

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Description**

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

action sp: Generate Pneumococcal (PPV23) education material pid=01000214 gid=4
action sp: Pneumococcal (PPV23) vaccination actions pid=01000214 gid=4
criterion 00172ms: Influenza splitvirus vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Influenza (splitvirus) education material pid=01000214 gid=4
action sp: influenza splitvirus vaccination actions pid=01000214 gid=4
criterion 00171ms: Td vaccine is DUE result=false pid=01000214 gid=4
action sp: Td vaccination actions pid=01000214 gid=4
criterion 00188ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action sp: DTaP vaccination actions pid=01000214 gid=4
criterion 00281ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action sp: Pneumococcal (PCV7) vaccine actions pid=01000214 gid=4
criterion 00172ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action sp: Varicella vaccination actions pid=01000214 gid=4
criterion 00172ms: MCV4 vaccine is DUE result=true pid=01000214 gid=4
action sp: Generate Meningococcal (MCV4) education material pid=01000214 gid=4
action sp: Meningococcal (MCV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action sp: DT vaccination actions pid=01000214 gid=4
criterion 00157ms: MPSV4 vaccine is DUE result=false pid=01000214 gid=4
action sp: Meningococcal (MPSV4) vaccination actions pid=01000214 gid=4
criterion 00172ms: TdaP vaccine is DUE result=false pid=01000214 gid=4
action sp: TdaP vaccination actions pid=01000214 gid=4
criterion 00188ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gi
action sp: Influenza wholevirus vaccination actions pid=01000214 gid=4
action 03453ms: Vaccines are due; request for documentation
  
```



key

# Inbox Notification

## 'Generate Vaccine Educational Material'

**INSTANCE EDITOR**  
For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)  
Label: Primary Care Immunizations  
Description: Recommendation Set for outpatient immunizations (adult and pediatric patients)  
Start: ♦ Compute for Due Immunizations  
Steps:

- Route
- Context
- Decision
- Action

```
graph TD; Start([Outpatient Nurse Accesses Medical Record]) --> Compute[Compute for Due Immunizations]; Compute --> Send[Send notifications for any contraindicated vaccine]; Send --> Due{Any immunization due?}; Due --> Check[Check for deferrable vaccine]; Due --> Documentation[Vaccines are due; request for documentation]; Check --> Documentation; Documentation --> End([End]);
```

The flowchart illustrates the process for generating vaccine educational material. It begins with a pink circle labeled 'Outpatient Nurse Accesses Medical Record'. This leads to a green rectangle 'Compute for Due Immunizations', which then leads to another green rectangle 'Send notifications for any contraindicated vaccine'. From there, the flow goes to a yellow diamond decision point 'Any immunization due?'. If the answer is yes, it leads to a green rectangle 'Check for deferrable vaccine', which then leads to a green rectangle 'Vaccines are due; request for documentation'. This final step is highlighted with a red border. The flowchart also includes a legend on the left with icons for Route (blue circle), Context (pink circle), Decision (yellow diamond), and Action (green rectangle).

**01000214 SAGE, Yura - M**  
File Patient Session Navigate Tools Help  
PICK INFO PAGE HOME ? EXIT OK  
▼ Pt. Info & Misc. ▼ Orders ▼ Notes ▼ Procedures ▼ Lab ▼ Ancillary ▼ Nursing ▼ Meds ▼ Summary  
**Notification:** Patient message  

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

subject: Generate Hep B education material  
message: <http://www.cdc.gov/nip/publications/VIS/vis-hep-b.pdf>

subject: Generate Pneumococcal (PPV23) education material  
message: <http://www.cdc.gov/nip/publications/VIS/vis-ppv.pdf>

subject: Generate Influenza (splitvirus) education material

Forwarded/Reassigned By:USER, SAGE

Reason for Forward/Reassign: \_\_\_\_\_

Full Subject Text:Sage Mesg.

The SAGE logo is located in the bottom left corner of the slide. It features a stylized 'S' and 'A' in a circular arrangement, followed by the word 'SAGE' in a bold, sans-serif font.

# Inbox Notification

## 'Generate Vaccine Educational Material'

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Label**  
Primary Care Immunizations

**Description**  
Recommendation Set for outpatient immunizations (adult and pediatric patients)  
This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked.

**Start**  
♦ Compute for Due Immunizations

**Steps**

- Route
- Context
- Decision
- Action

Flowchart steps:

- Outpatient Nurse Accesses Medical Record (Pink circle)
- Compute for Due Immunizations (Green rectangle)
- Send notifications for any contraindicated vaccine (Green rectangle)
- Any immunization due? (Yellow diamond)
- Vaccines are due; request for documentation (Green rectangle, highlighted with a red border)
- Check for deferrable vaccine (Green rectangle)

**Notification:** Patient message

Date	Time	Subject	From	FYI	Note
2-Oct2006	09:12	Sage Mesg.	USER, SAGE		

Notification details:

- subject: Generate Hep B education material  
message: <http://www.cdc.gov/nip/publications/VIS/vis-hep-b.pdf>
- subject: Generate Pneumococcal (PPV23) education material  
message: <http://www.cdc.gov/nip/publications/VIS/vis-ppv.pdf>
- subject: Generate Influenza (splitvirus) education material

Reason for Forward/Reassign: \_\_\_\_\_

Full Subject Text: Sage Mesg.

**SAGE**



# Inbox Notification 'Generate Vaccine Educational Material'

**INSTANCE EDITOR**

For Instance: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

**Label**  
Primary Care Immunizations

**Description**  
Recommendation Set for outpatient immunizations (adult and pediatric patients)  
This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked.

**Start**  
♦ Compute for Due Immunizations

**Steps**

- Route
- Context
- Decision
- Action

Flowchart steps:

- Outpatient Nurse Accesses Medical Record (Context)
- Compute for Due Immunizations (Action)
- Any immunization due? (Decision)
- Send notifications for any contraindicated vaccine (Action)
- Vaccines are due; request for documentation (Action)
- Check for deferred vaccine (Action)

**Notification:** Patient message

Date	Time
2-Oct2006	09:12

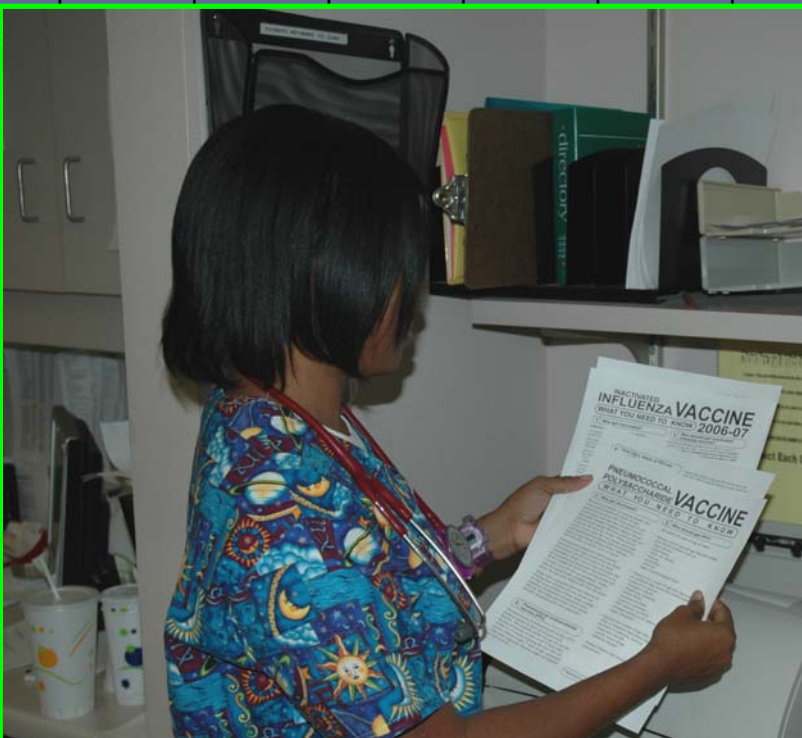
subject: Generate Hep B education  
message: <http://www.cdc.gov/nip/pub>

subject: Generate Pneumococcal (PPV)  
message: <http://www.cdc.gov/nip/pub>

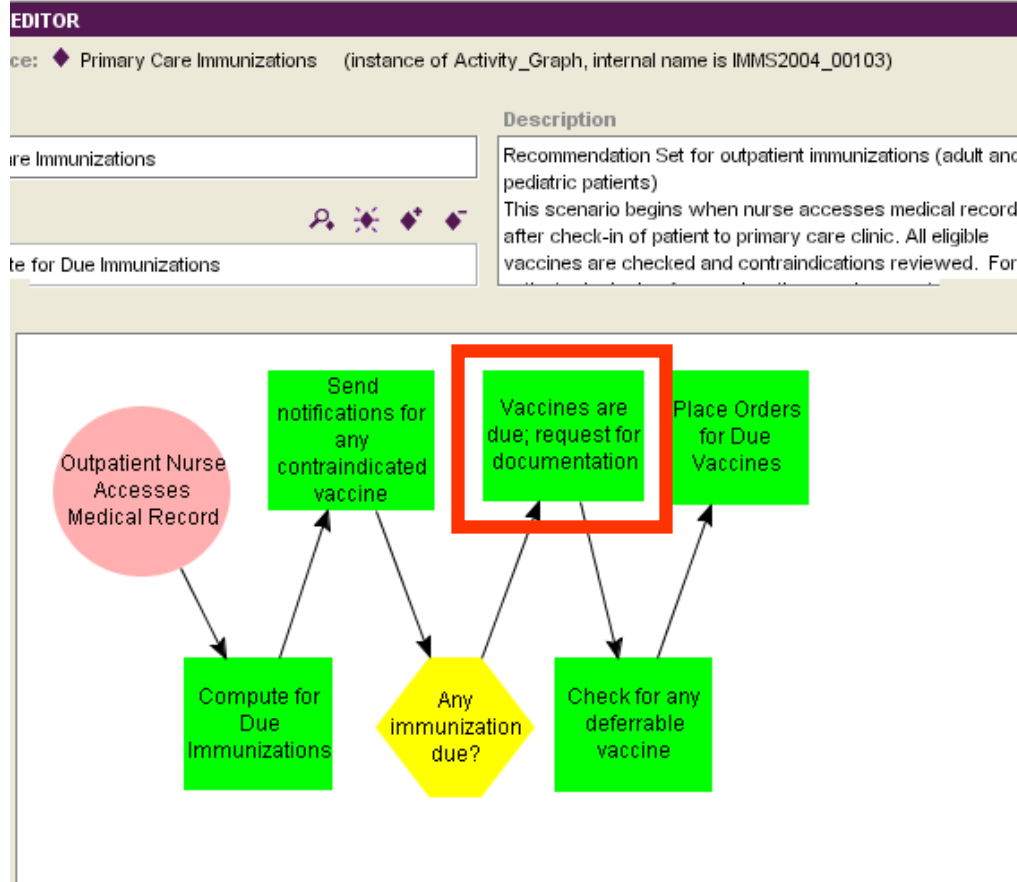
subject: Generate Influenza (split)

Reason for Forward/Reassign: \_\_\_\_\_

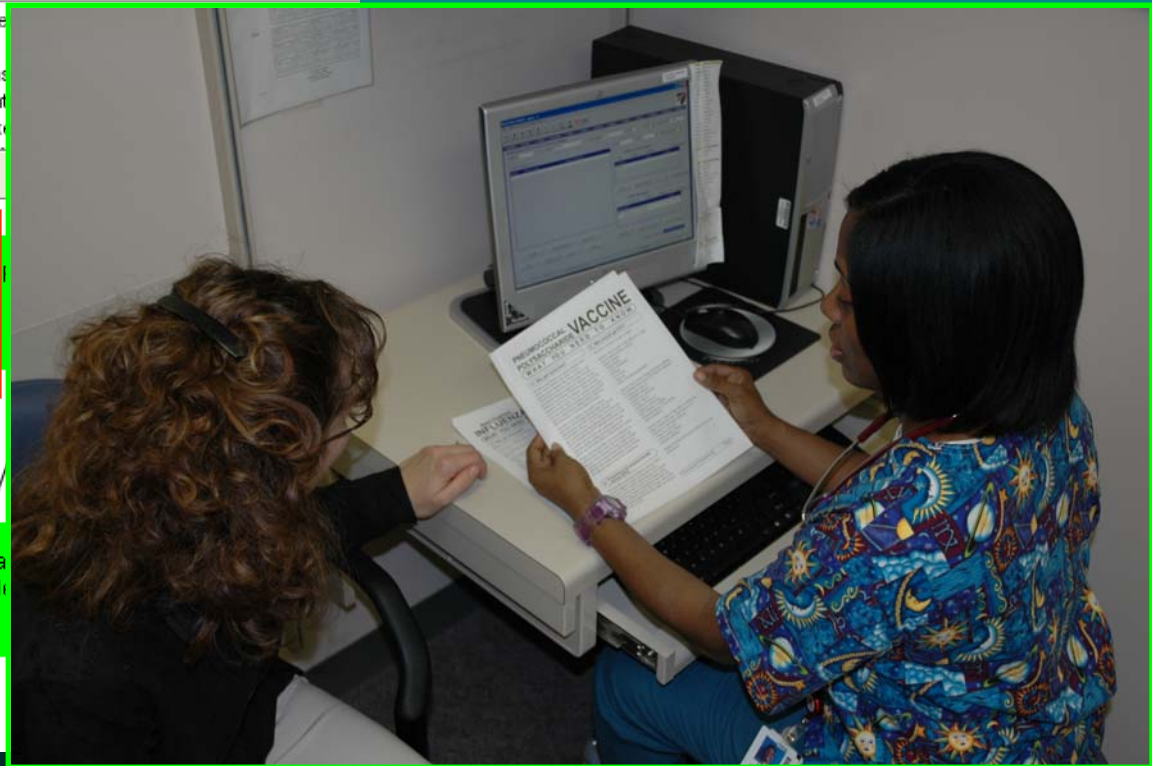
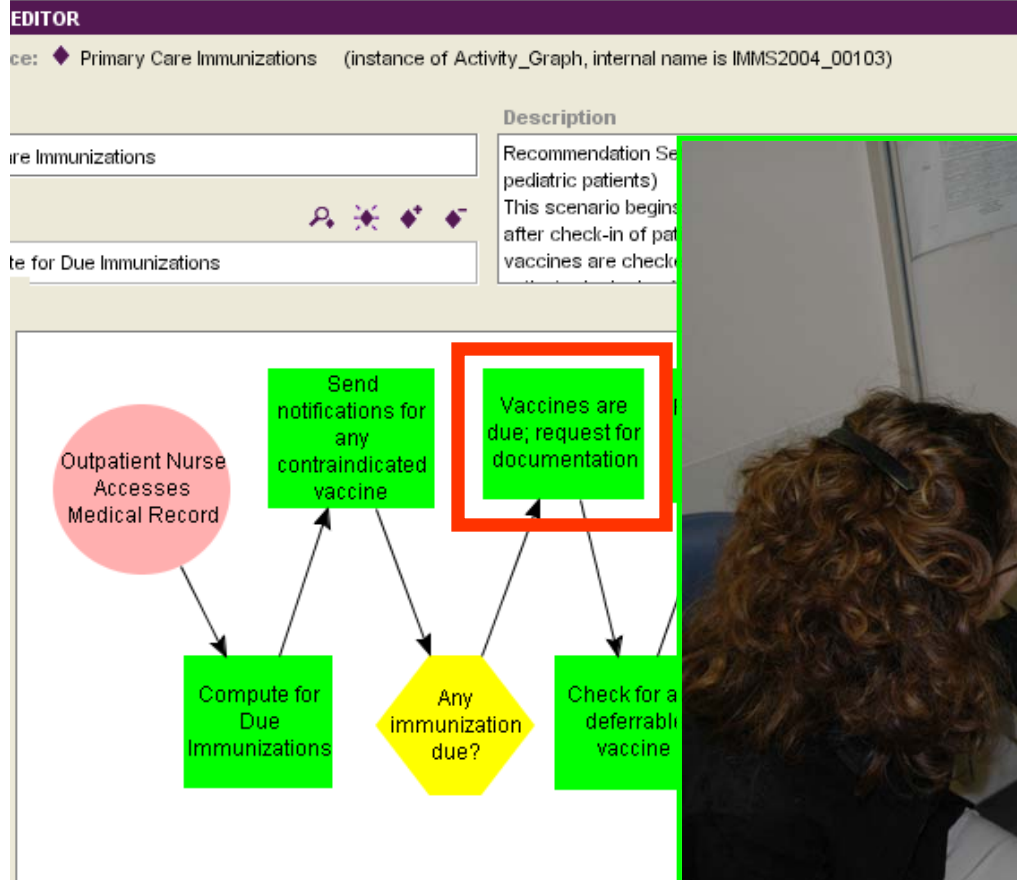
Full Subject Text: Sage Messg.



# Queries for Provider 'Illness present?', 'Consent given?'



# Queries for Provider 'Illness present?', 'Consent given?'



# Queries for Provider 'Illness present?', 'Consent given?'

## EDITOR

ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

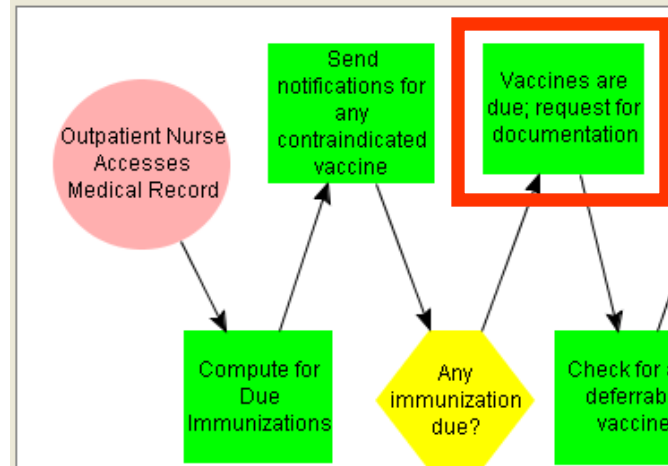
ire Immunizations



te for Due Immunizations

### Description

Recommendation Set  
pediatric patients)  
This scenario begins  
after check-in of pat  
vaccines are check



▼ Pt. Info & Misc. ▼ Orders ▼ Notes ▼ Procedures ▼ Lab ▼ Ancillary ▼ Nursing

Sage:

Pending

Is a serious illness present in this patient that renders immunization inadvisab  
Has Immunization consent been given?



# Queries for Provider 'Illness present?', 'Consent given?'

EDITOR  
ce: ♦ Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

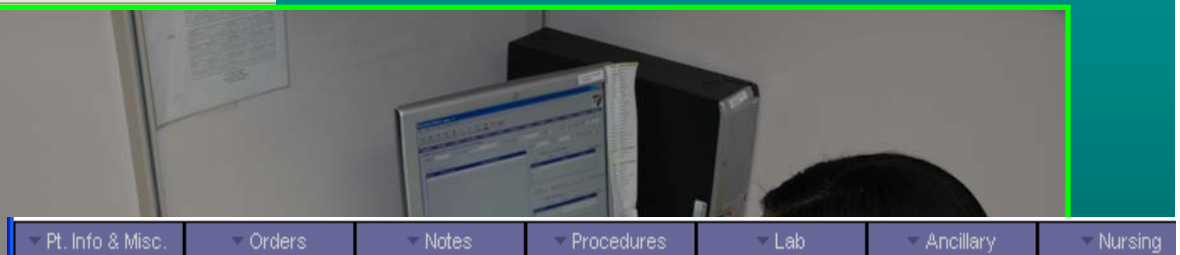
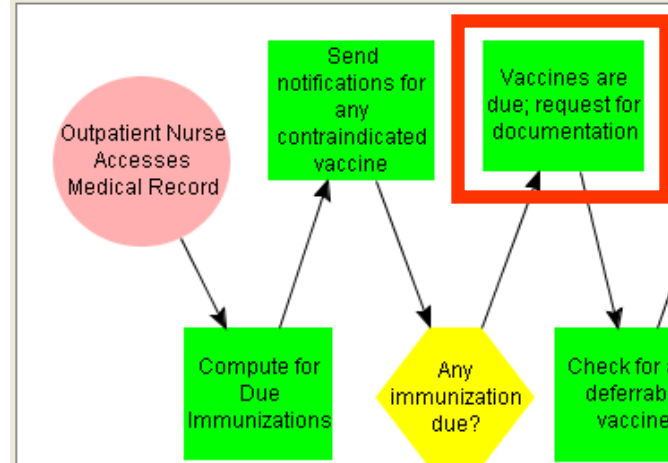
ire Immunizations



te for Due Immunizations

## Description

Recommendation Se  
pediatric patients)  
This scenario begins  
after check-in of pat  
vaccines are checke



Sage:

Pending

▼ Pt. Info & Misc. ▼ Orders ▼ Notes ▼ Procedures ▼ Lab ▼ Ancillary

Sage:

SGPRS

Has Immunization consent been given?

True (qualifier value)

False (qualifier value)

submit

back out

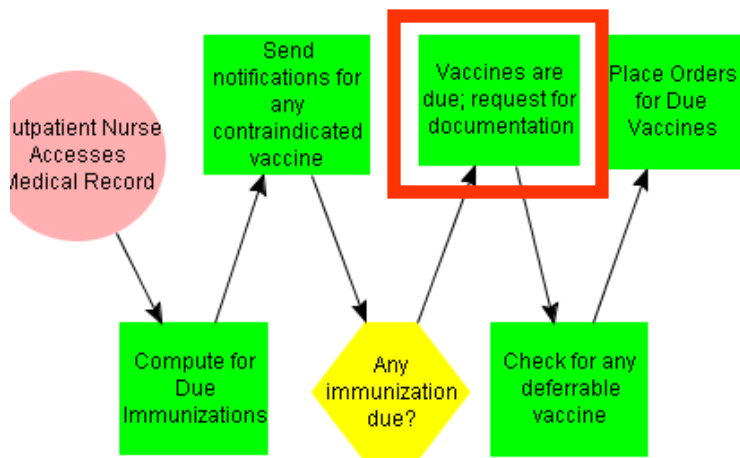
# SAGE Server Log

## 'Finally Due' Logic Evaluation

### Check for Deferral Reasons

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

	Description
Immunizations	Recommendation Set for outpatient immunizations (adult and pediatric patients)
Due Immunizations	This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



# SAGE Server Log

## 'Finally Due' Logic Evaluation

### Check for Deferral Reasons

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

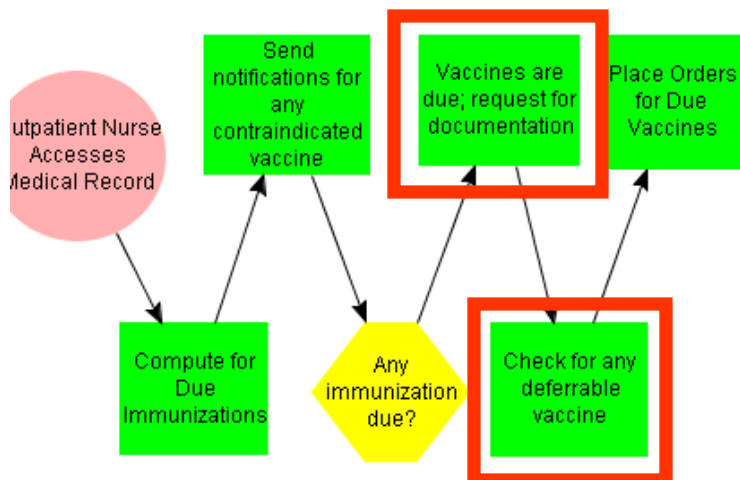
inizations

ue Immunizations

Description

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



# SAGE Server Log

## 'Finally Due' Logic Evaluation

### Check for Deferral Reasons

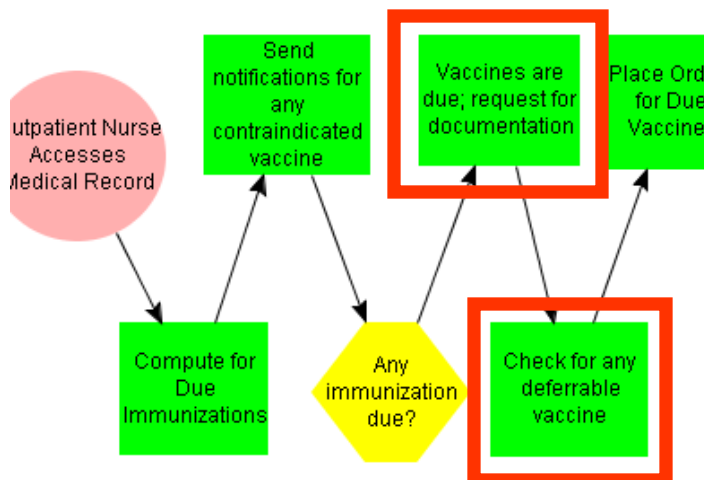
Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

inizations

ue Immunizations

Description

Recommendation Set for outpatient pediatric patients)  
This scenario begins when nurse after check-in of patient to primary vaccines are checked and con



decision 00609ms: Is IPV (polio) finally due?

criterion 00187ms: ILLNESS PRESENT determined by care provider result=false

criterion 00188ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: OR false

criterion 00203ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: false OR false

evaluate: true = false

criterion 00000ms: Anaphylaxis reaction to Latex result=false pid=01000214

criterion 00390ms: Pneumococcal Vaccine should be DEFERRED result=false pid

criterion 00188ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid

criterion 00219ms: ILLNESS PRESENT determined by care provider result=false

criterion 00187ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: OR false

criterion 00187ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: false OR false

evaluate: true = false

criterion 00000ms: Anaphylaxis reaction to Latex result=false pid=01000214

criterion 00406ms: Pneumococcal Vaccine should be DEFERRED result=false pid

criterion 00203ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4

decision 01187ms: Pneumococcal Vaccine finally due?





# SAGE Server Log

## 'Finally Due' Logic Evaluation

### Check for Deferral Reasons

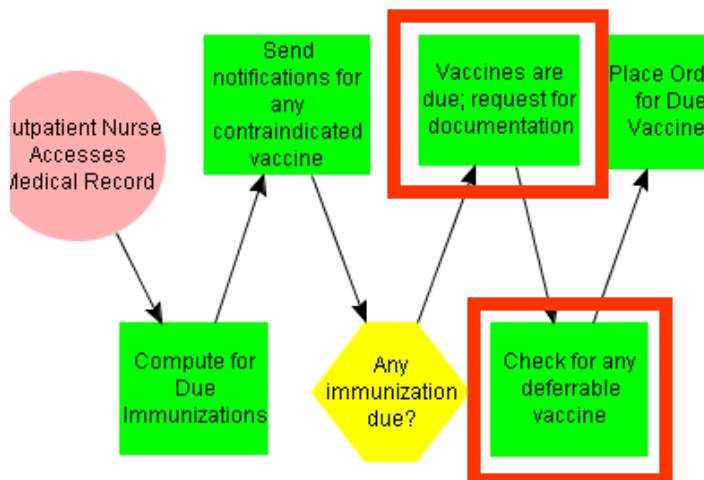
Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

Description

Recommendation Set for outpatient pediatric patients)  
This scenario begins when nurse after check-in of patient to primary care vaccines are checked and contraindications are checked.

Primary Care Immunizations

Primary Care Immunizations



decision 00609ms: Is IPV (polio) finally due?

criterion 00187ms: ILLNESS PRESENT determined by care provider result=false

criterion 00188ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: OR false

criterion 00203ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: false OR false

evaluate: true = false

criterion 00000ms: Anaphylaxis reaction to Latex result=false pid=01000214

criterion 00390ms: Pneumococcal Vaccine should be DEFERRED result=false pid=01000214

criterion 00188ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid=4

criterion 00219ms: ILLNESS PRESENT determined by care provider result=false

criterion 00187ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: OR false

criterion 00187ms: Consent NOT GIVEN result=false pid=01000214 gid=4

evaluate: false OR false

evaluate: true = false

criterion 00000ms: Anaphylaxis reaction to Latex result=false pid=01000214

criterion 00406ms: Pneumococcal Vaccine should be DEFERRED result=false pid=01000214

criterion 00203ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4

decision 01187ms: Pneumococcal Vaccine finally due?



# SAGE Server Log

## 'Place Orders for Due Vaccines'

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

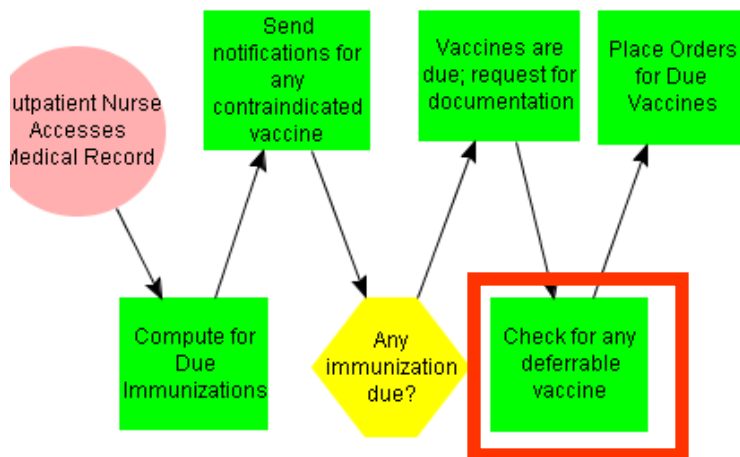
inizations

ue Immunizations

Description

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

criterion 00203ms: age < 19 years result=false pid=01000214 gid=4
criterion 00281ms: Hepatitis B vaccine is DUE result=true pid=01000214 gid=4
evaluate: false AND true
criterion 00484ms: Hep B vaccine is due and age < 19 years result=false pid=01000214 gid=4
action sp: Order Hep B Vaccine (children) pid=01000214 gid=4
criterion 00250ms: IPV vaccine is DUE result=false pid=01000214 gid=4
action sp: Order IPV (Polio) Vaccine pid=01000214 gid=4
criterion 00203ms: Hep A vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Hep A Vaccine pid=01000214 gid=4
criterion 00219ms: HiB vaccine is due result=false pid=01000214 gid=4
action sp: Order Hib Vaccine pid=01000214 gid=4
criterion 00265ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Pneumococcal 7-valent Conjugate Vaccine pid=01000214 gid=4
criterion 00203ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Influenza wholevirus Vaccine pid=01000214 gid=4
criterion 00219ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid=4
action sp: Order Pneumococcal 23-valent polysaccharide Vaccine pid=01000214 gid=4
criterion 00203ms: Td vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Td Vaccine pid=01000214 gid=4
criterion 00203ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action sp: Order DTaP Vaccine pid=01000214 gid=4
criterion 00235ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action sp: Order DT Vaccine pid=01000214 gid=4
criterion 00203ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Varicella Vaccine pid=01000214 gid=4
    
```



# SAGE Server Log

## 'Place Orders for Due Vaccines'

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

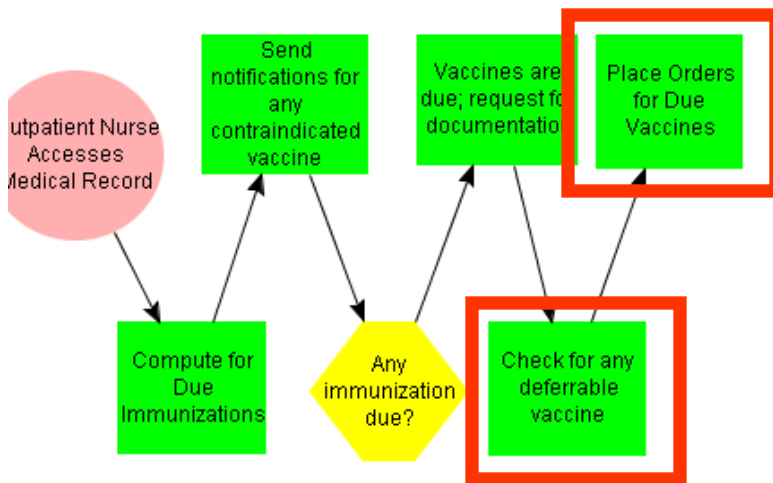
inizations

ue Immunizations

Description

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

criterion 00203ms: age < 19 years result=false pid=01000214 gid=4
criterion 00281ms: Hepatitis B vaccine is DUE result=true pid=01000214 gid=4
evaluate: false AND true
criterion 00484ms: Hep B vaccine is due and age < 19 years result=false pid=01000214 gid=4
action sp: Order Hep B Vaccine (children) pid=01000214 gid=4
criterion 00250ms: IPV vaccine is DUE result=false pid=01000214 gid=4
action sp: Order IPV (Polio) Vaccine pid=01000214 gid=4
criterion 00203ms: Hep A vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Hep A Vaccine pid=01000214 gid=4
criterion 00219ms: HiB vaccine is due result=false pid=01000214 gid=4
action sp: Order Hib Vaccine pid=01000214 gid=4
criterion 00265ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Pneumococcal 7-valent Conjugate Vaccine pid=01000214 gid=4
criterion 00203ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Influenza wholevirus Vaccine pid=01000214 gid=4
criterion 00219ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid=4
action sp: Order Pneumococcal 23-valent polysaccharide Vaccine pid=01000214 gid=4
criterion 00203ms: Td vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Td Vaccine pid=01000214 gid=4
criterion 00203ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action sp: Order DTaP Vaccine pid=01000214 gid=4
criterion 00235ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action sp: Order DT Vaccine pid=01000214 gid=4
criterion 00203ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action sp: Order Varicella Vaccine pid=01000214 gid=4
  
```



# SAGE Server Log

## 'Place Orders for Due Vaccines'

Primary Care Immunizations (instance of Activity\_Graph, internal name is IMMS2004\_00103)

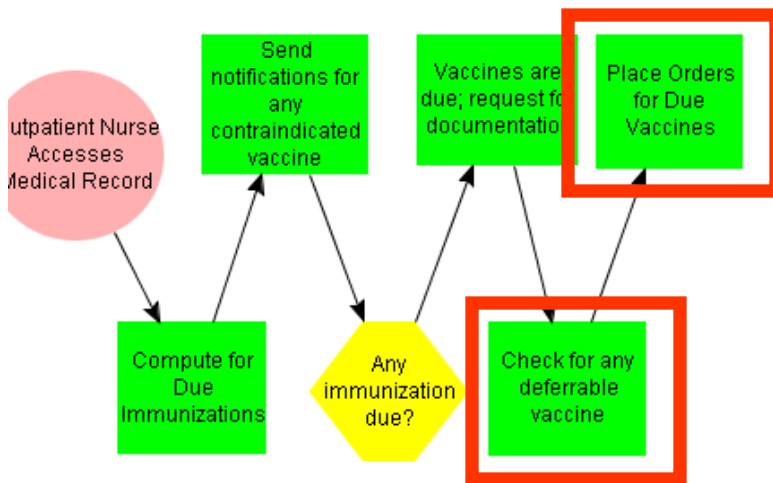
inizations

ue Immunizations

Description

Recommendation Set for outpatient immunizations (adult and pediatric patients)

This scenario begins when nurse accesses medical record after check-in of patient to primary care clinic. All eligible vaccines are checked and contraindications reviewed. For



```

criterion 00203ms: age < 19 years result=false pid=01000214 gid=4
criterion 00281ms: Hepatitis B vaccine is DUE result=true pid=01000214 gid=4
evaluate: false AND true
criterion 00404ms: Hep B vaccine is due and age < 19 years result=false pid=01000214 gid=4
action ep: Order Hep B Vaccine (children) pid=01000214 gid=4
criterion 00250ms: IPV vaccine is DUE result=false pid=01000214 gid=4
action ep: Order IPV (Polio) Vaccine pid=01000214 gid=4
criterion 00203ms: Hep A vaccine is DUE result=false pid=01000214 gid=4
action ep: Order Hep A Vaccine pid=01000214 gid=4
criterion 00219ms: Hib vaccine is due result=false pid=01000214 gid=4
action ep: Order Hib Vaccine pid=01000214 gid=4
criterion 00265ms: PCV7 vaccine is DUE result=false pid=01000214 gid=4
action ep: Order Pneumococcal 7-valent Conjugate Vaccine pid=01000214 gid=4
criterion 00203ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gid=4
action ep: Order Influenza wholevirus Vaccine pid=01000214 gid=4
criterion 00219ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid=4
action ep: Order Pneumococcal 23-valent polysaccharide Vaccine pid=01000214 gid=4
criterion 00203ms: Td vaccine is DUE result=false pid=01000214 gid=4
action ep: Order Td Vaccine pid=01000214 gid=4
criterion 00203ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
action ep: Order DTaP Vaccine pid=01000214 gid=4
criterion 00235ms: Dt vaccine is DUE result=false pid=01000214 gid=4
action ep: Order DT Vaccine pid=01000214 gid=4
criterion 00203ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
action ep: Order Varicella Vaccine pid=01000214 gid=4
    
```



# 4 Un-issued Orders to Resolve

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Add: Expand

Status	Problem Description	Gde
A	Health care maintenance	
A	Hypertension	
A	Rheumatoid arthritis	
A	Chronic rhinitis	
A	Chronic bronchitis	
A	Splenectomy	

Update Guidelines

Patient Order List

ALL ACTIVE Save Session Context Prefs Expand

Current Order	ST	Sub ST	Start Date	Problem
Hepatitis B Vac Recombinant Syringe (10mcg/0.5 mL) IM	U		2-Oct2006	
Influenza Virus Vac. Tri-Split Syringe IM IM prn	U		2-Oct2006	
Meningococcal C conjugate vaccine IM prn	U		2-Oct2006	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj IM prn	U		2-Oct2006	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj INJ x1	A	HX	7-Jun2000	
Celebrex Cap (200mg) po PO Q AM #30 CAP ref...	A		1-Jan2006	Health care maintena
Cyclophosphamide Tab (50mg) po PO BID #60 T...	A		1-Apr2006	
Hepatitis B Vac Recombinant Susp (20mcg/mL) ...	A		1-Jan2004	
Diph,Pertus(Acel),Tetanus Pedi Susp (15-10-5Lf...	A		16May2006	
Tetanus-Diphtheria Toxoids-Td Inj (5-2Lf unit) IM I...	A		25May2006	

Modify D/C Issue

Dept Buttons Common Search Meds Personal Prescriptions Order Log

Specify Search Information

Order Search Text:

Search Method

☒ Begins With  
☐ Contains  
☐ Leading Word

Searching for

☒ All  
☐ Non-Meds  
☐ Meds  
☐ Ord Sets

Find Matches Show FAVORITES

Fac: 5 Loc:

☐ Prescription  
☐ Historical

Syn Order Selections

Select Order

# 4 Un-issued Orders to Resolve

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc. Orders Notes Procedures Lab Ancillary Nursing Meds Summary Flowcharts

Patient Problem List

Add: Expand

Status	Problem Description	Gde
A	Health care maintenance	
A	Hypertension	
A	Rheumatoid arthritis	
A	Chronic rhinitis	
A	Chronic bronchitis	
A	Splenectomy	

Update Guidelines

Patient Order List

ALL ACTIVE Save Session Context Prefs Expand

ST	Start Date	Problem
U	2-Oct2006	
U	2-Oct2006	
U	2-Oct2006	
U	2-Oct2006	
A	7-Jun2000	
A	1-Jan2006	Health care maintena
A	1-Apr2006	
A	1-Jan2004	
A	16May2006	
A	25May2006	

Modify D/C Issue

Dept Buttons Common Search Meds Personal Prescriptions Order Log

Specify Search Information

Order Search Text:

Search Method

☒ Begins With  
☐ Contains  
☐ Leading Word

Searching for

☒ All  
☐ Non-Meds  
☐ Meds  
☐ Ord Sets

Find Matches Show FAVORI...

Fac: 5 Loc:

☐ Prescription  
☐ Historical

Syn Order Selections

Select Order

# SAGE in Action!

## Primary Care Visit Scenario

### Patient: Yura Sage

- 36 year old Caucasian female
- Allergies: Penicillins
- Problems: Hypertension, rheumatoid arthritis, nasal allergies, chronic bronchitis, **history of splenectomy**
- Medications: **Cytosan 50mg (alkylating agent)**, Celebrex 200mg
- Vaccination History :
  - **1 dose Pneumococcal (PPV23)vaccine**
  - **2 doses Diphtheria containing vaccine**
  - **1 dose Hepatitis B vaccine**

# SAGE in Action!

## Primary Care Visit Scenario

### Patient: Yura Sage

- Final vaccination orders recommended:
  - Pneumococcal (PPV23)
  - Hepatitis B
  - Meningococcal (MCV4)
  - Influenza split virus



# Scenario Concludes



Questions?

Discussion...