

Material on Website

- <http://www.smi.stanford.edu/projects/sage/tutorial06/SAGEWorkbench.zip> or obtain CD or copy from flash drives
- Unzip SAGEWorkbench to C:\
- Run Workbench from 'startImmunization.bat'
- Apelon DTS plugin user/password: *sageuser/sageuser*
- Documentation folder
 - US Immunization source documents
 - SW Tu Medinfo paper
 - Hrabak/Campbell draft paper on Immunization vocabulary

Modeling Clinical Guidelines using the SAGE Protégé Guideline Workbench

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University, Stanford, CA*

Introductions

- Who are we?
- Who are you?
 - Training and experience:
 - Clinical understanding
 - Computer science background
 - Interest
 - Seeing an example of using Protégé to develop applications
 - Employing Protégé to create decision support technology supporting guidelines

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. Describe the basic procedures of SAGE guideline model formulation
4. Understand the features and function of Protégé environment contributions to SAGE
5. Enumerate the plug-in developments and feature enhancements to Protégé developed for the SAGE guideline workbench
6. Participate in the development and testing of an immunization guideline using Protégé

Overview

- **Overview 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

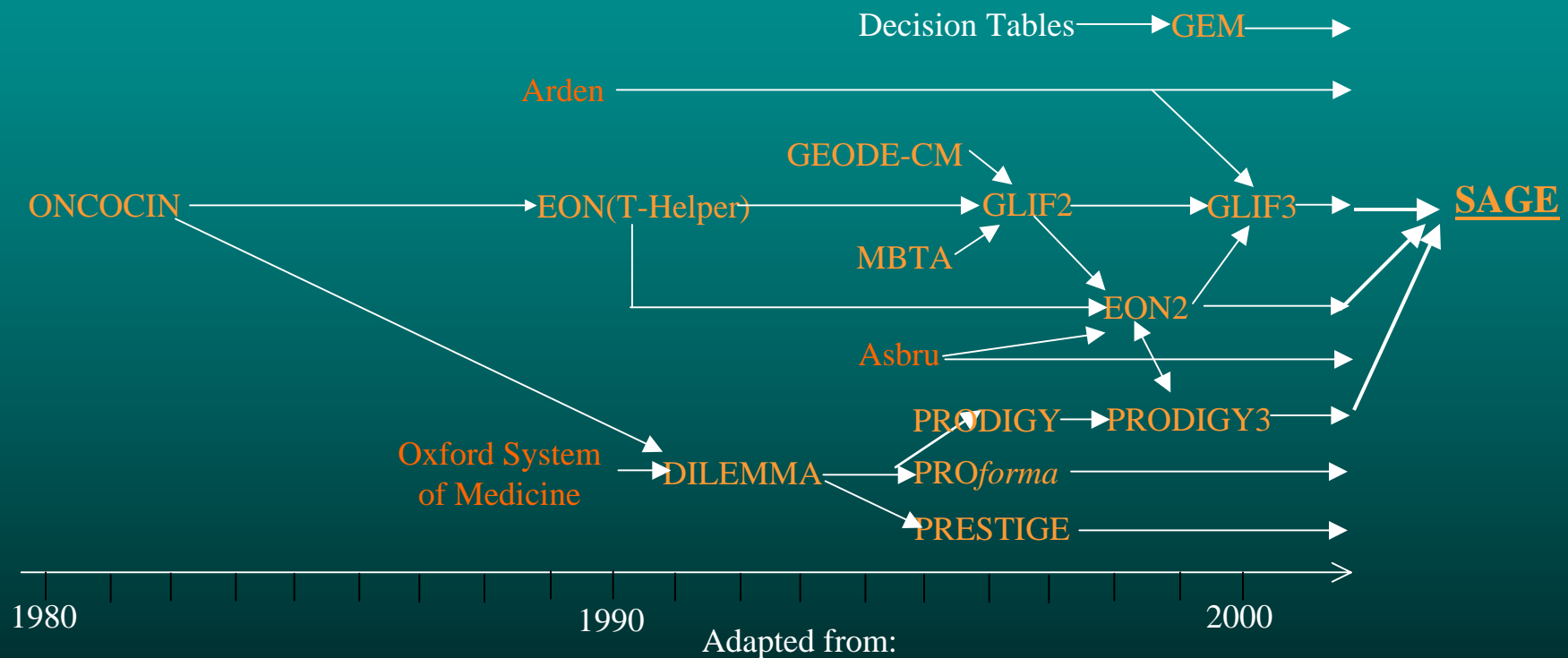
- 1970-80s: Basic studies in expert systems and reminder technology convinced many of CDSS importance
- 1990s:
 - Developing importance of ontologies in scalable systems design
 - Development of SNOMED and Read as reference terminologies for clinical care systems
 - Appearance of practice guidelines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

Clinical Decision Support: Comments on a long History

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

- Expert systems and many of CDSS
CDSS = domain ontology + problem solving method and
- 1990s:
 - Developing importance of ontologies in scalable systems design
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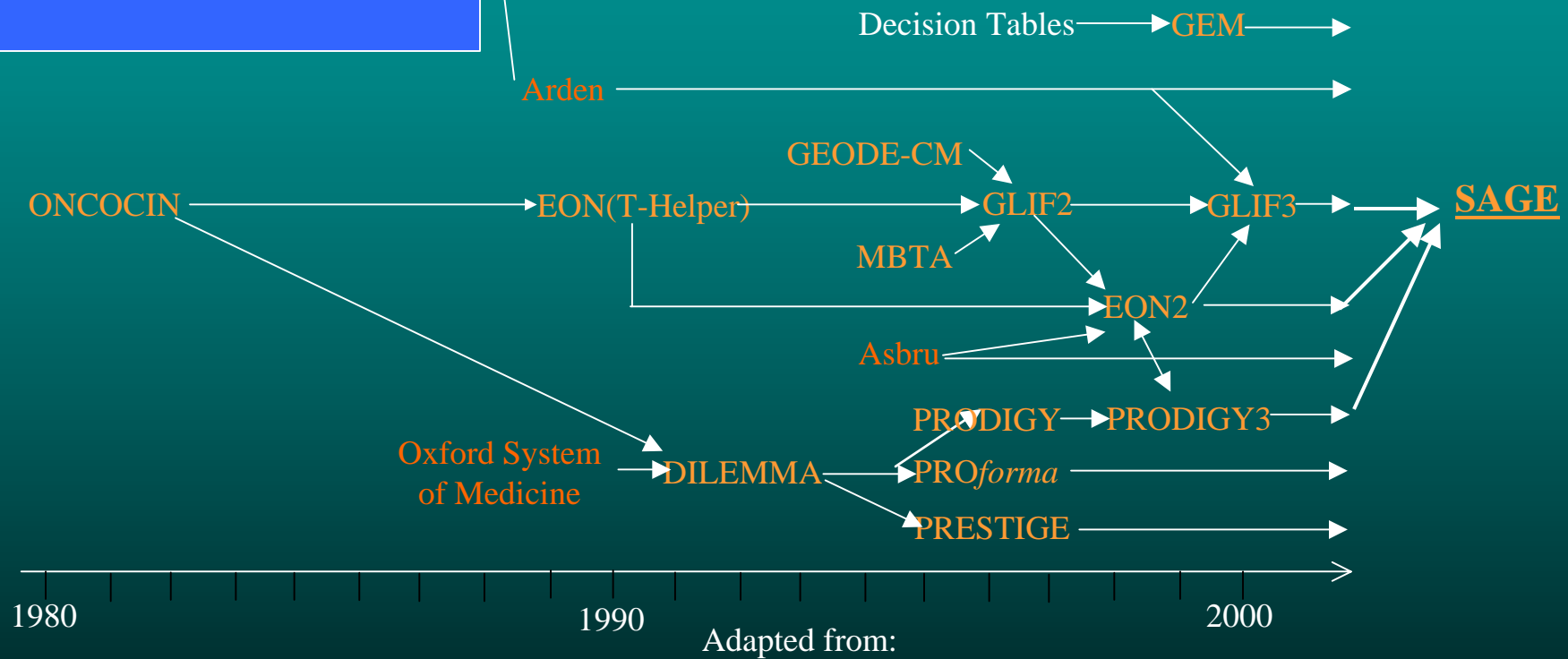
(Partial) Guideline Model Chronology



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

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Oriented to single rules; ANSI standard; curly braces problems

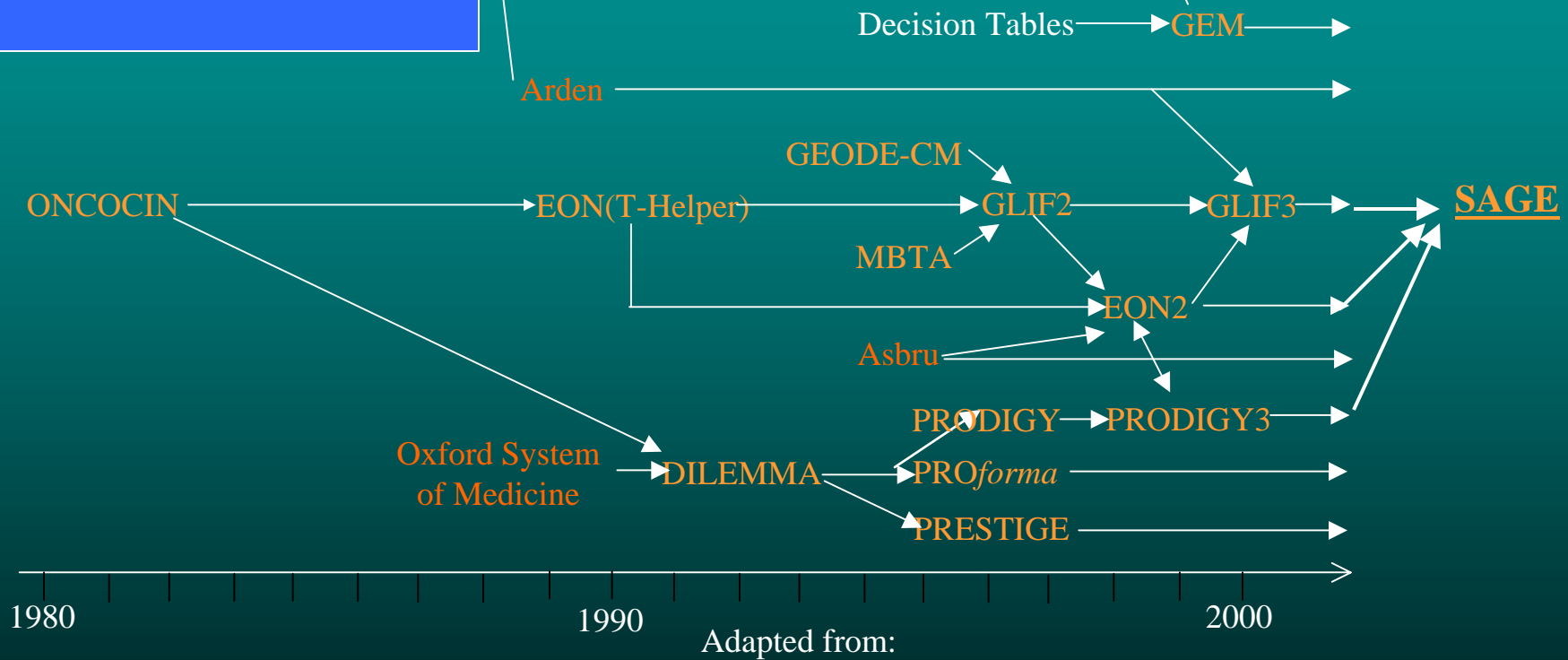


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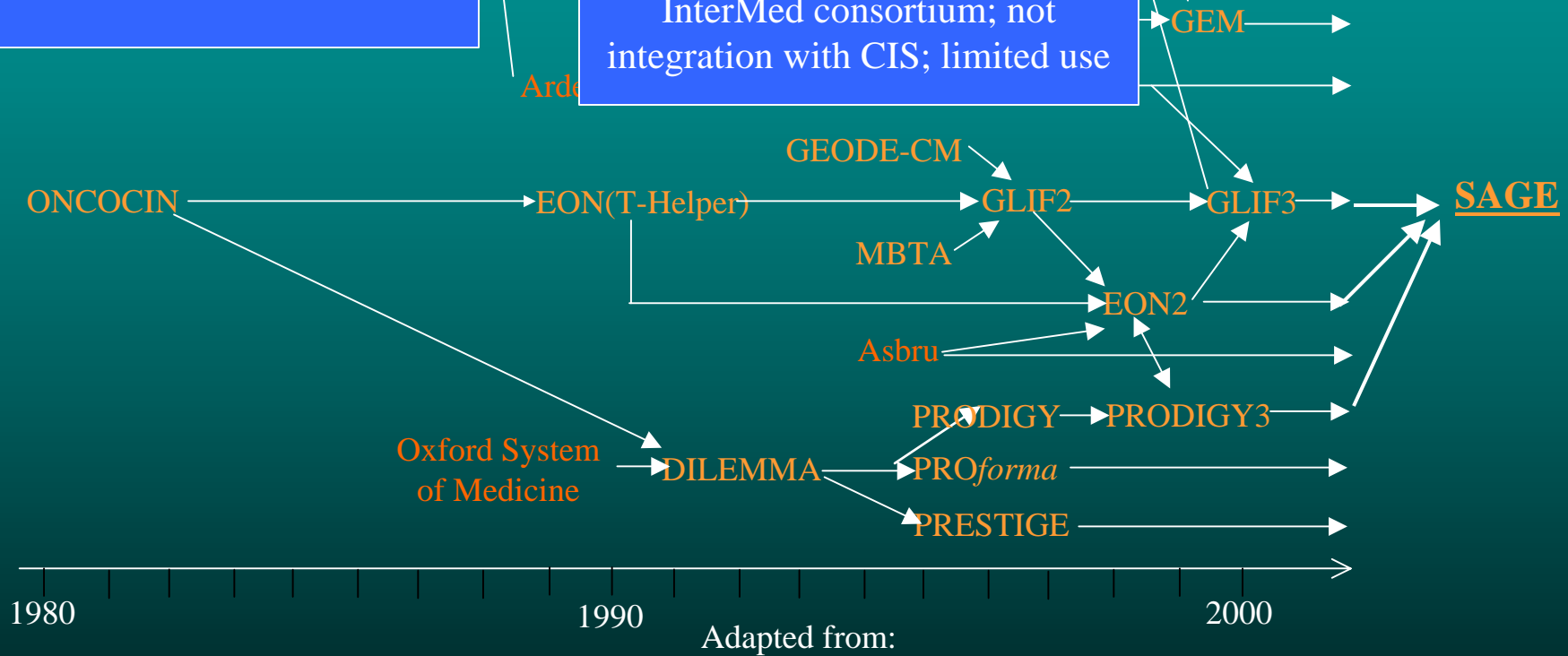
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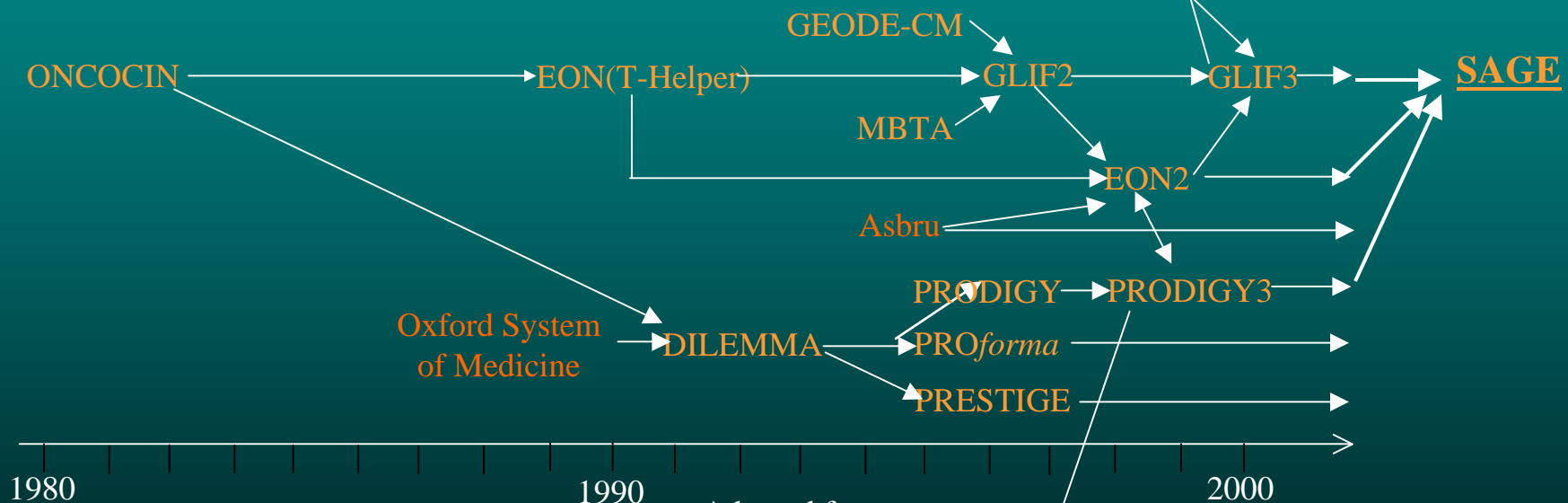
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Arden

GEM

ONCOCIN

EON(T-Helper)

GEODE-CM

GLIF2

MBTA

GLIF3

SAGE

Stanford system being transferred to and used at VA

EON2

Asbru

PRODIGY

PRODIGY3

Oxford System of Medicine

DILEMMA

PROforma

PRESTIGE

1980

1990

2000

P. L. Elkin, M. Peleg, R. Lachin, et al.
Toward Standardization of Clinical Guidelines

Oriented to advising on prescribing practices in chronic disease management

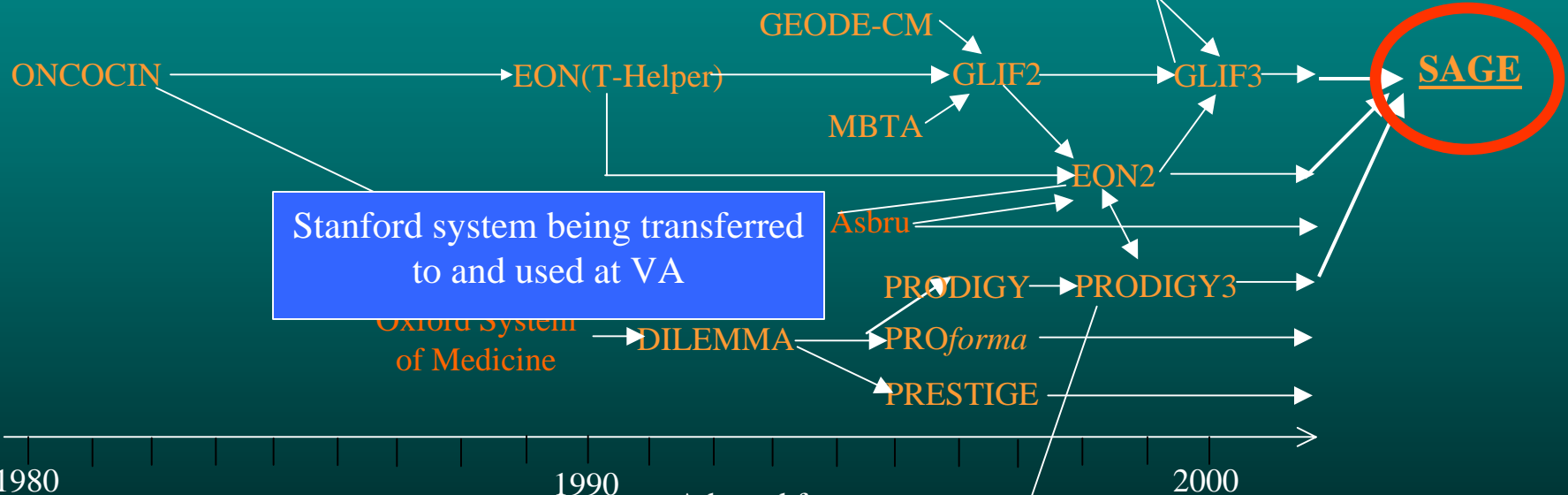
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Requirements of CDSS

- 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

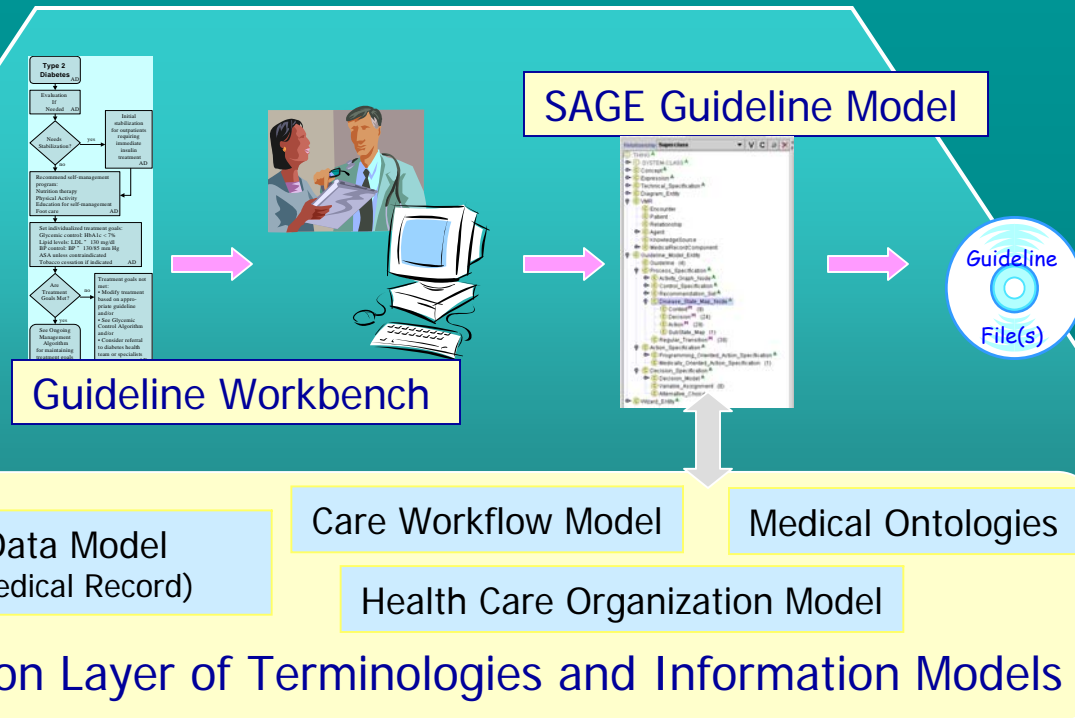
SAGE Project Overview

- 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**

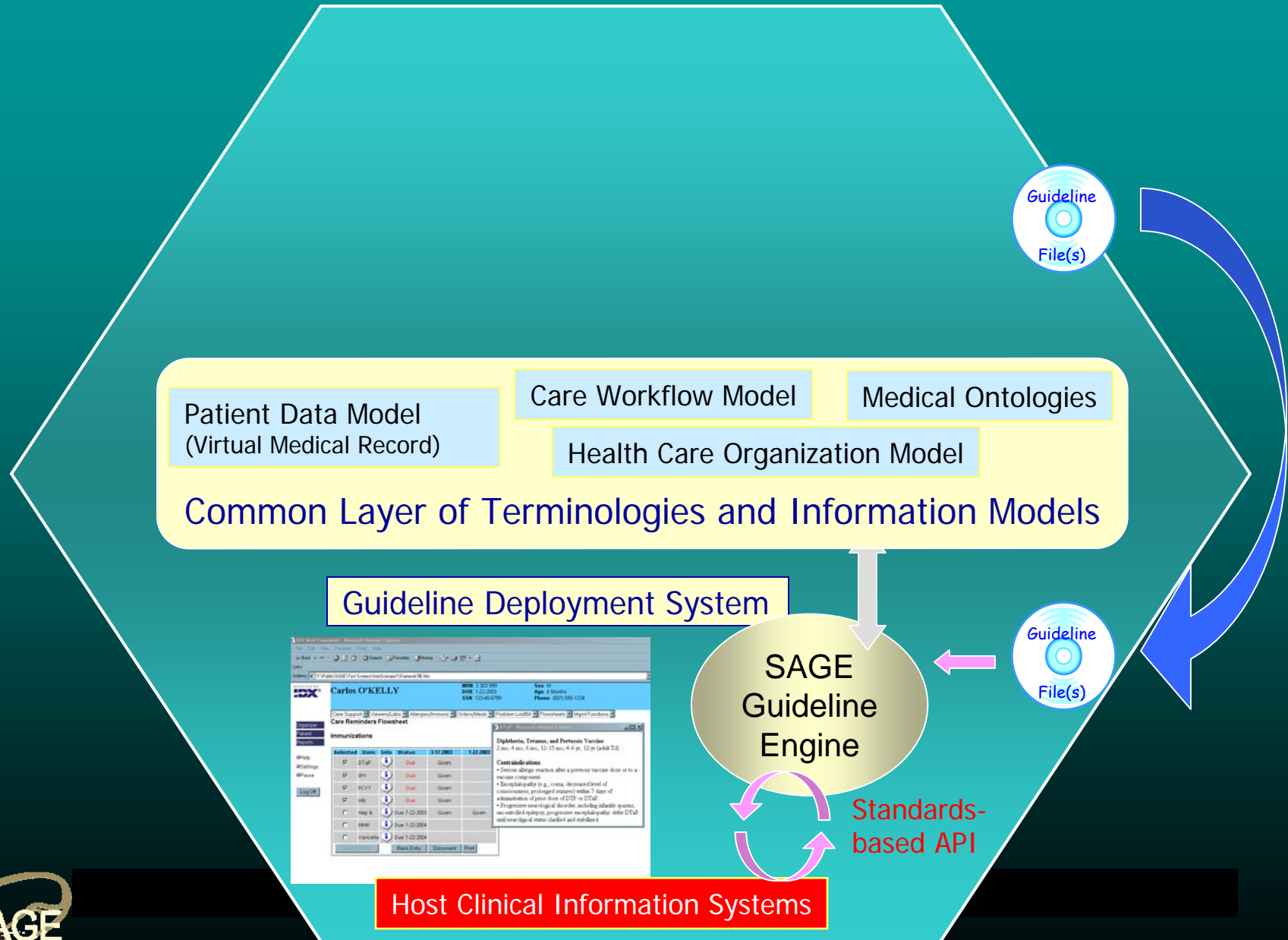
SAGE is partially supported under a grant from the U.S. Department of Commerce, National Institute of Standards and Technology, Advanced Technology Program, Cooperative Agreement Number 70NANB1H3049.



SAGE Infrastructure: Guideline Encoding



SAGE Infrastructure: Guideline Execution



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

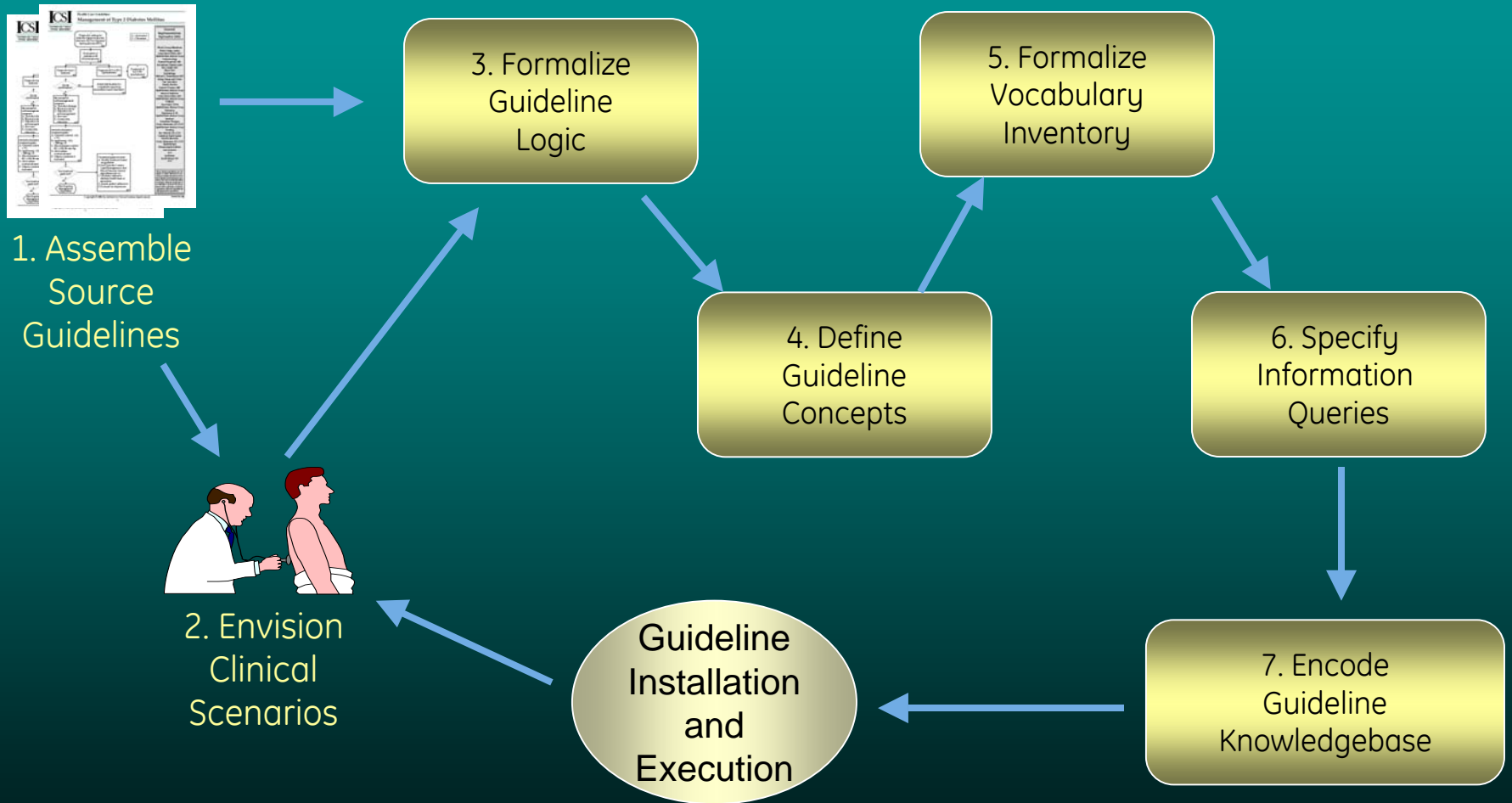
Overview

- Overview of guidelines and challenges to decision support development

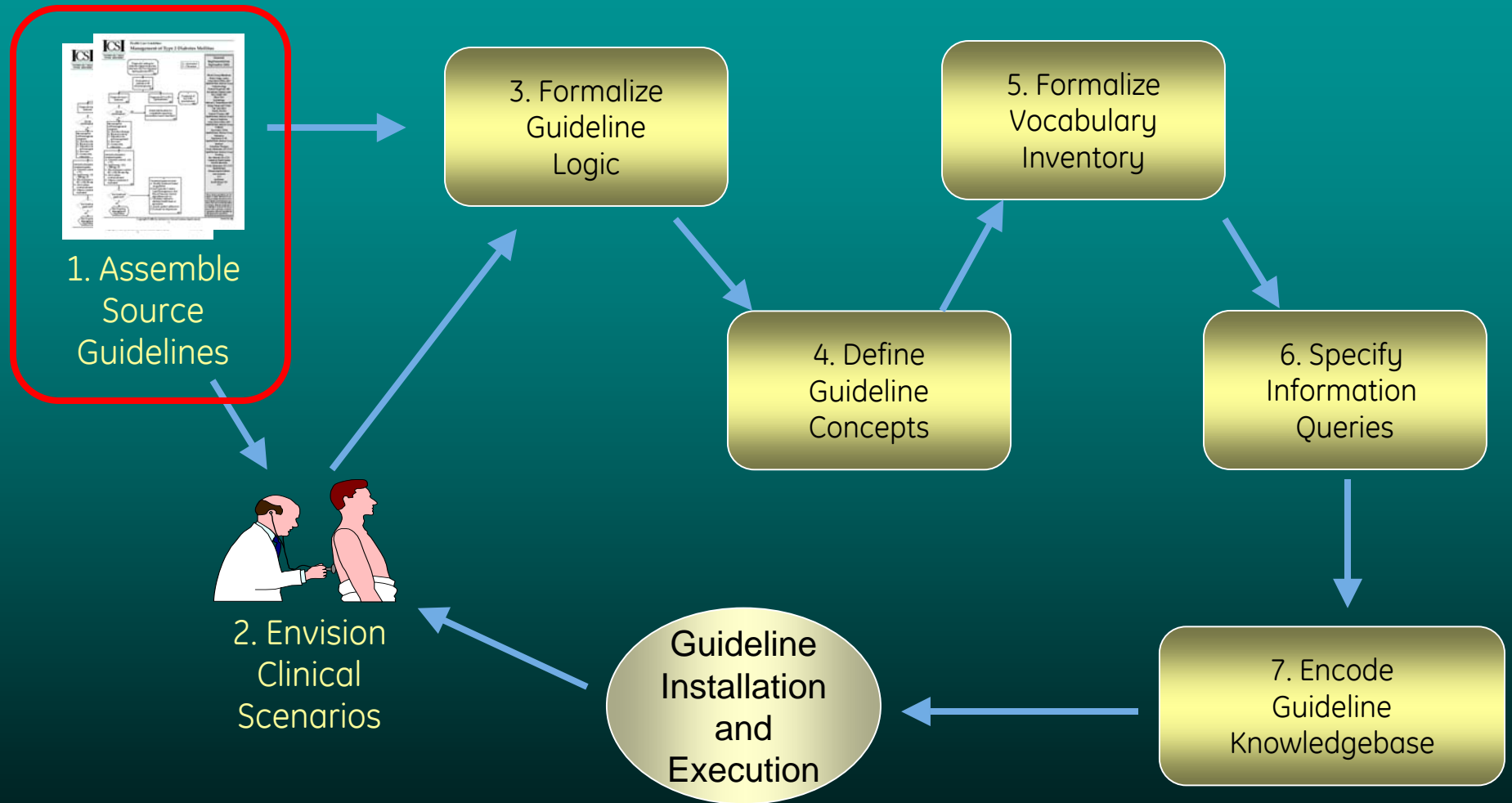
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SAGE Guideline Encoding Process



SAGE Guideline Encoding Process



Source Guideline: CDC Immunizations

The image shows two CDC immunization schedule charts. The top chart is titled 'Recommended Adult Immunization Schedule, by Vaccine and Age Group' and is for the 'UNITED STATES, OCTOBER 2005–SEPTEMBER 2006'. It lists vaccines for three age groups: 18-49 years, 50-64 years, and ≥ 65 years. The bottom chart is titled 'Recommended Childhood and Adolescent Immunization Schedule' and is for the 'UNITED STATES • 2005'. It lists vaccines for children from birth to 18 years, with columns for birth, 1 month, 2 months, 4 months, 6 months, 12 months, 15 months, 18 months, 24 months, 4-6 years, 11-12 years, and 13-18 years. Both charts use color-coding to indicate the timing and frequency of vaccine doses.

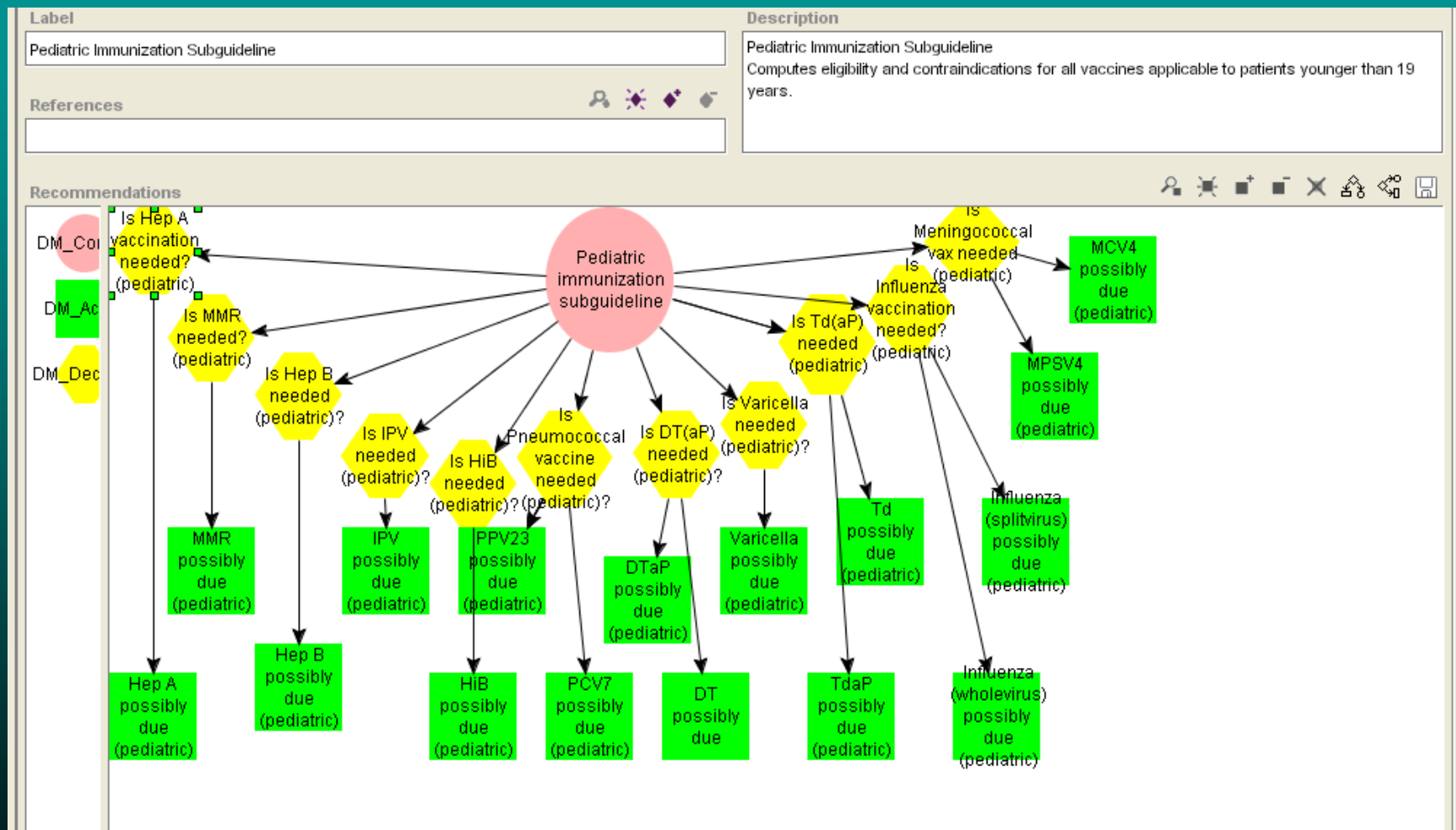
- US Center for Disease Control(CDC):
Advisory Committee on Immunization
Practices issues vaccination schedules
(handout)
- Birth-death guideline for all vaccinations
advised for US healthcare
- 75 complex decision rules
- 172 source clinical concepts
- 1200 criteria in run-time logic

Pediatric Immunization Sub-guideline Schedule

Recommended Childhood and Adolescent Immunization Schedule UNITED STATES • 2005

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	13–18 years
Hepatitis B¹		HepB #1				HepB #3			HepB Series				
			HepB #2										
Diphtheria, Tetanus, Pertussis²				DTaP	DTaP	DTaP		DTaP			DTaP	Td	Td
Haemophilus influenzae type b³				Hib	Hib	Hib	Hib						
Inactivated Poliovirus				IPV	IPV	IPV					IPV		
Measles, Mumps, Rubella⁴							MMR #1				MMR #2	MMR #2	
Varicella⁴							Varicella				Varicella		
Pneumococcal⁵				PCV	PCV	PCV	PCV				PCV	PPV	
Influenza⁷						Influenza (Yearly)					Influenza (Yearly)		
Vaccines below red line are for selected populations													
Hepatitis A⁸											Hepatitis A Series		

SAGE Pediatric Sub-guideline

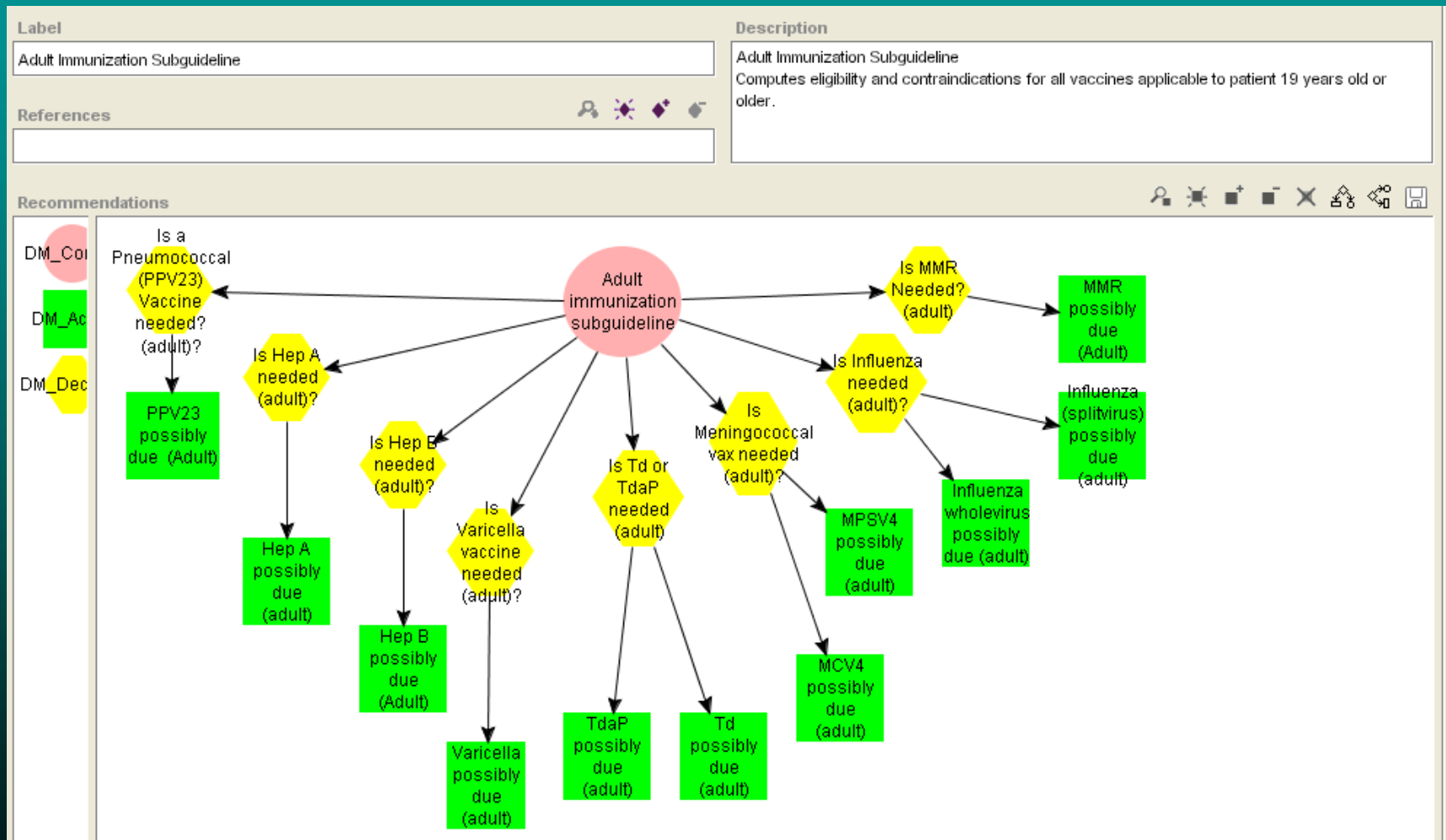


Adult Immunization Sub-guideline Schedule

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) ^{1*}		1-dose booster every 10 yrs		
Measles, mumps, rubella (MMR) ^{2*}		1 or 2 doses	1 dose	
Varicella ^{3*}		2 doses (0, 4–8 wks)	2 doses (0, 4–8 wks)	
--- Vaccines below broken line are for selected populations				
Influenza ^{4*}		1 dose annually	1 dose annually	
Pneumococcal (polysaccharide) ^{5,6}		1–2 doses		1 dose
Hepatitis A ^{7*}		2 doses (0, 6–12 mos, or 0, 6–18 mos)		
Hepatitis B ^{8*}		3 doses (0, 1–2, 4–6 mos)		
Meningococcal ⁹		1 or more doses		

SAGE Adult Sub-guideline



Guideline Focus

- For this discussion we will employ US adult pneumococcal guideline as focus of authoritative source

Use Case: US Adult Pneumococcal Guideline

TABLE 2. Recommendations for the use of pneumococcal vaccine

Groups for which vaccination is recommended	Strength of recommendation*	Revaccination†
Immunocompetent persons[§]		
Persons aged ≥65 years	A	Second dose of vaccine if patient received vaccine ≥5 years previously and were aged <65 years at the time of vaccination.
Persons aged 2–64 years with chronic cardiovascular disease, [¶] chronic pulmonary disease, ^{**} or diabetes mellitus	A	Not recommended.
Persons aged 2–64 years with alcoholism, chronic liver disease, ^{††} or cerebrospinal fluid leaks	B	Not recommended.
Persons aged 2–64 years with functional or anatomic asplenia ^{§§}	A	If patient is aged >10 years: single revaccination ≥5 years after previous dose. If patient is aged ≤10 years: consider revaccination 3 years after previous dose.
Persons aged 2–64 years living in special environments or social settings ^{¶¶}	C	Not recommended.
Immunocompromised persons[§]		
Immunocompromised persons aged ≥2 years, including those with HIV infection, leukemia, lymphoma, Hodgkins disease, multiple myeloma, generalized malignancy, chronic renal failure, or nephrotic syndrome; those receiving immunosuppressive chemotherapy (including corticosteroids); and those who have received an organ or bone marrow transplant.	C	Single revaccination if ≥5 years have elapsed since receipt of first dose. If patient is aged ≤10 years: consider revaccination 3 years after previous dose.

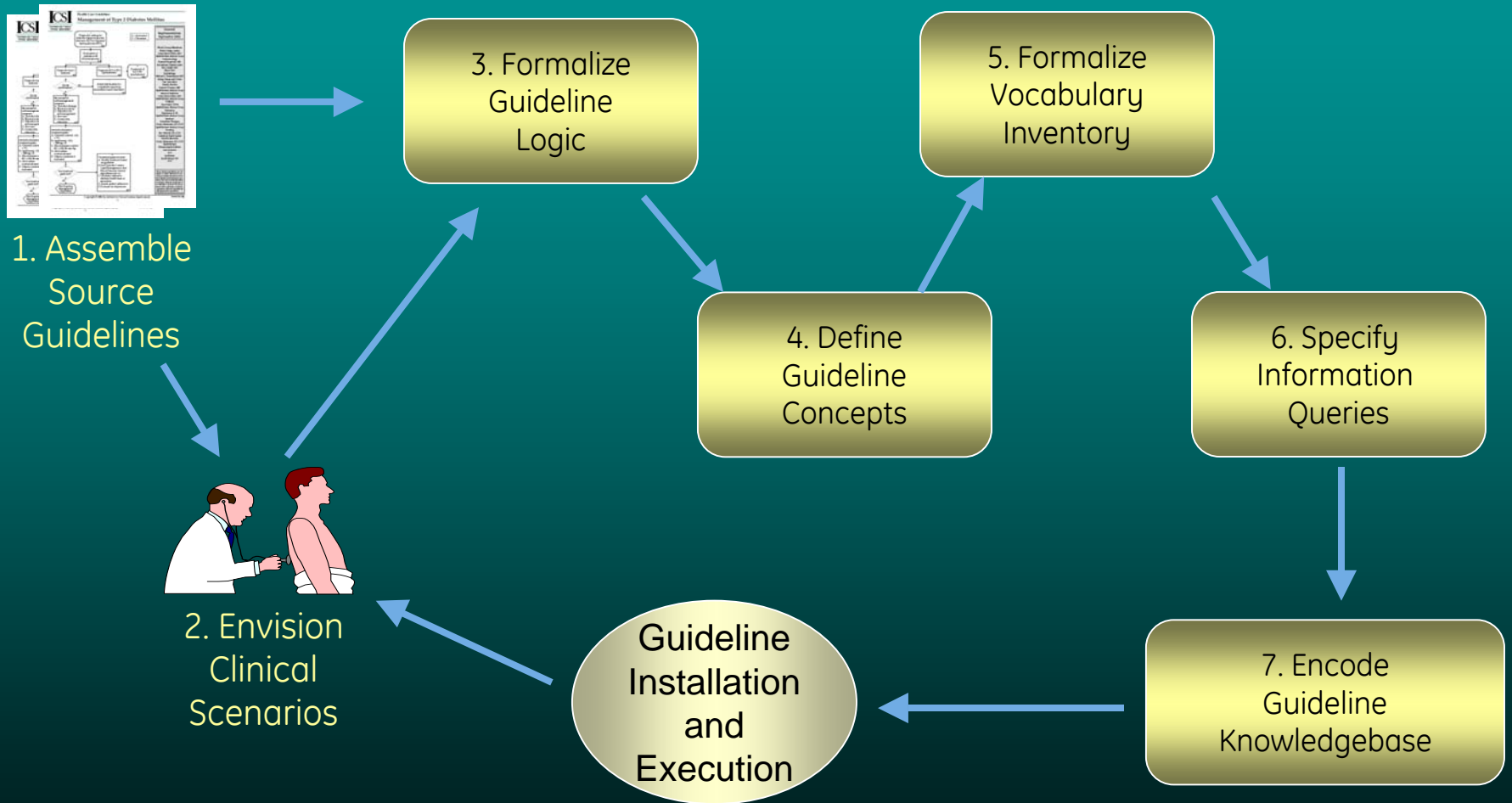
Overview

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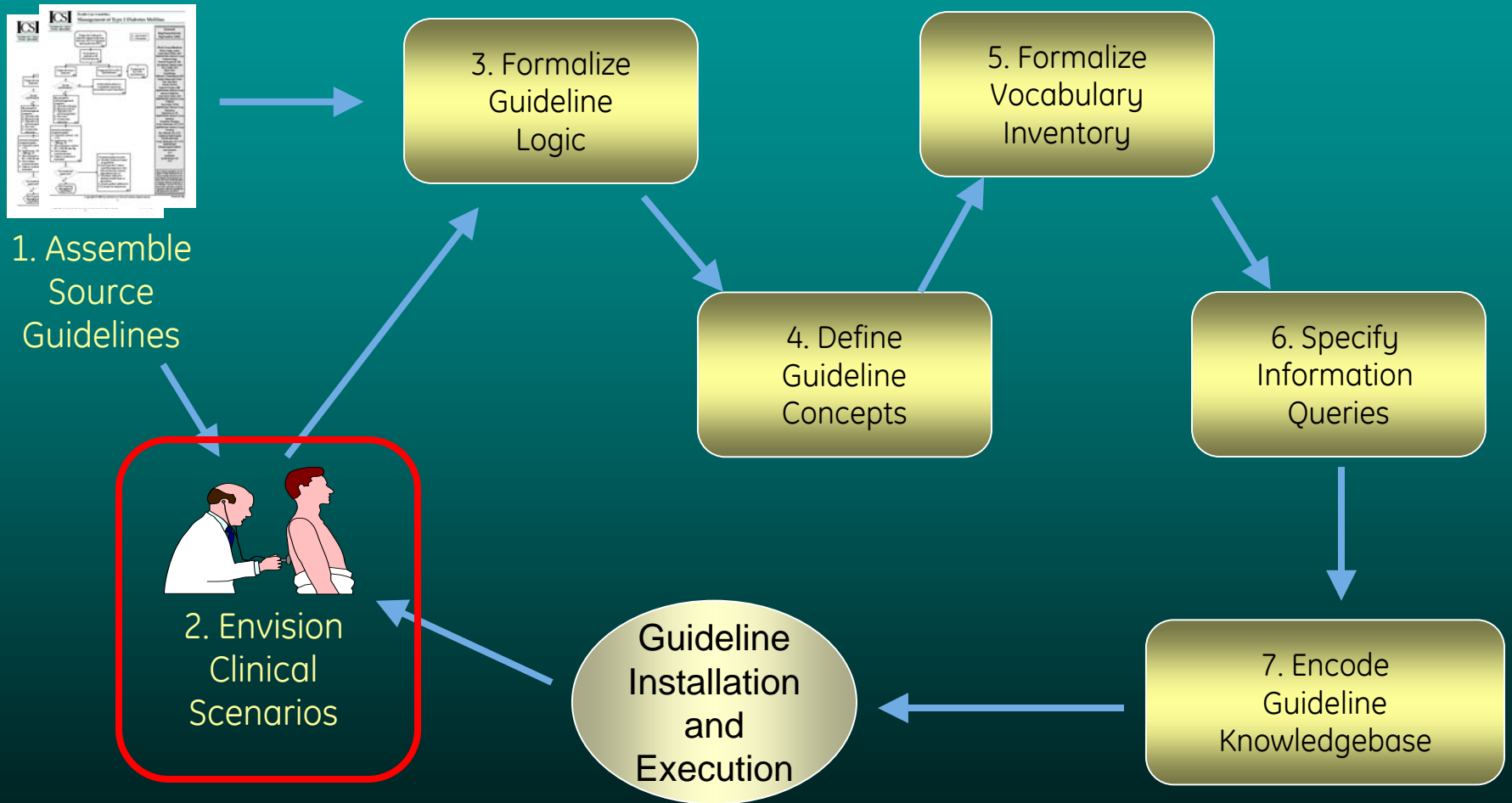
SAGE guideline modeling process: Introduction

- Introduction: Modeling the immunization guideline
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SAGE Guideline Encoding Process



SAGE Guideline Encoding Process



Creating the Guideline Scenarios

- Guidelines must be reflected against patterns of care and clinical work plans to identify opportunities for productive intervention
- Should be integrated within an efficient work model, not controlling or distorting work activities
- Should provide guidance to the individual who is best suited to intervene when intervention is appropriate and timely

Creating Guideline Scenarios

- Generally multi-faceted interventions which reinforce each other across the enterprise are more effective
- Physicians are not always the best targets for effective intervention
- The recipient community should be educated in the nature and rationale for the guideline; acceptance should be obtained; CDSS should only support the process identified as ideal
- Implementation scenarios will be specific to the organization, the clinical workflow and the capabilities of the information system

Primary Care Visit Scenario

- Check-in process
- Nurse interaction
- Physician visit
- Variable check-out process

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
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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
- 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

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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

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Implementation Scenarios

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

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.

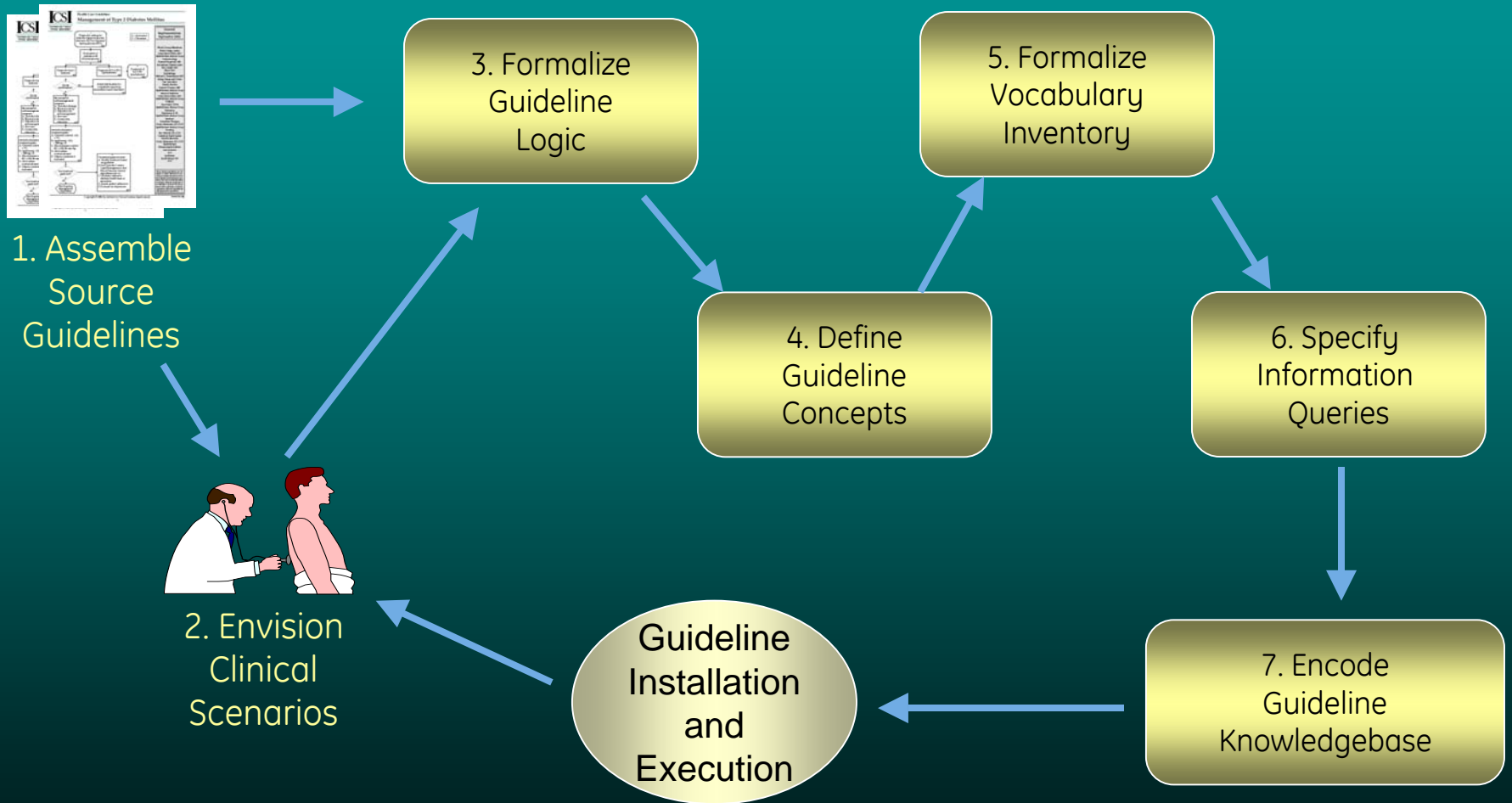
Neonatal Birth Scenario (Admission to Nursery)

- 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.

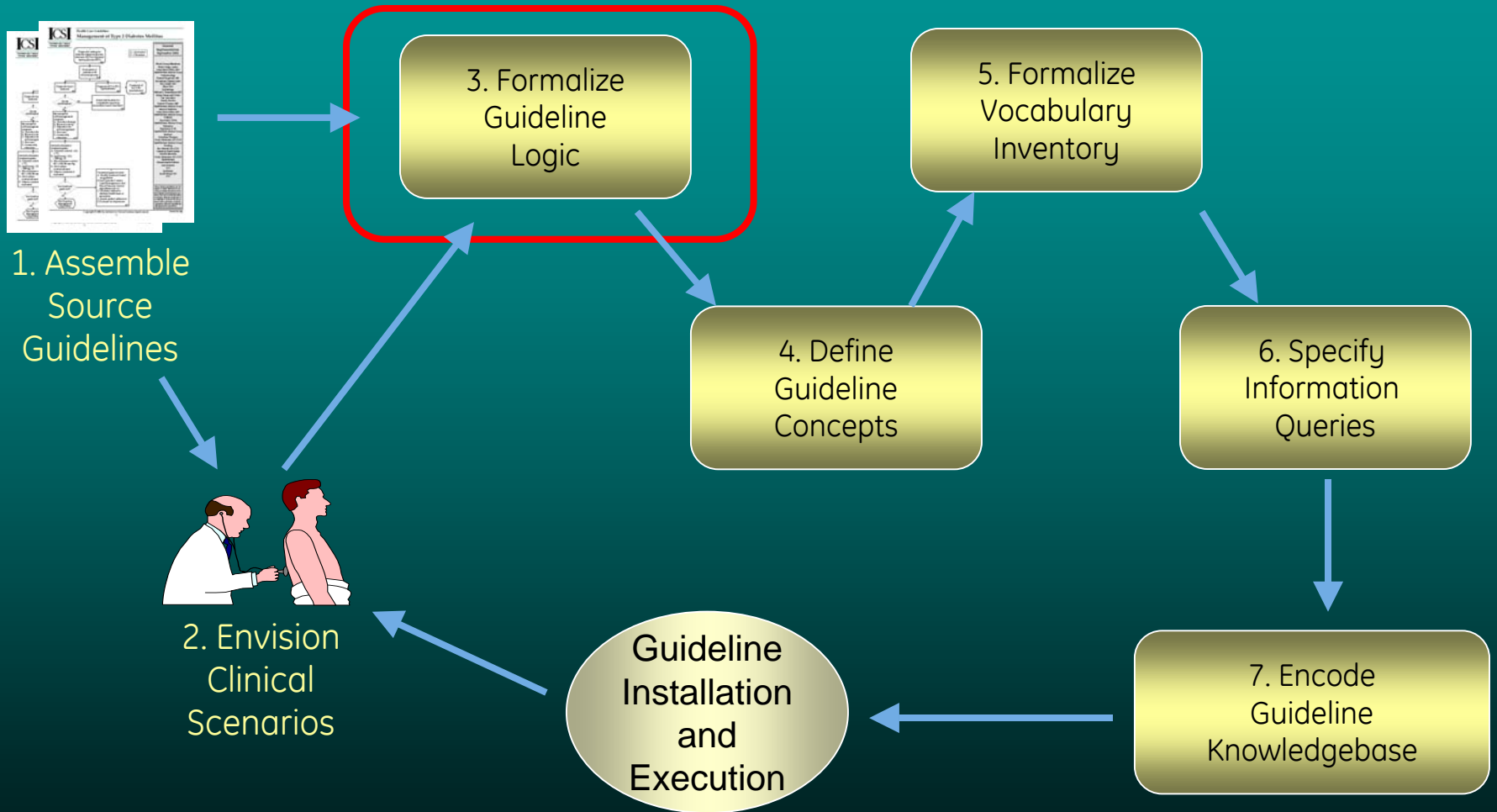
Alternative Scenarios?

- 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 her scheduled list of patients who are due for vaccination
- The long term care facility is issued automated orders verifying eligibility for overdue vaccinations

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Use Case: US Adult Pneumococcal Guideline

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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

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

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A recommendation set is organized around one subset of guideline recommendations that can be implemented in a single work plan

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Requires review and integration of all decision elements: contraindications, deferrals, appropriate timing

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 \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

Decision Logic Inventory: Which Vaccine to Administer?

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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

Specifies all clinical details required for
complete deployment

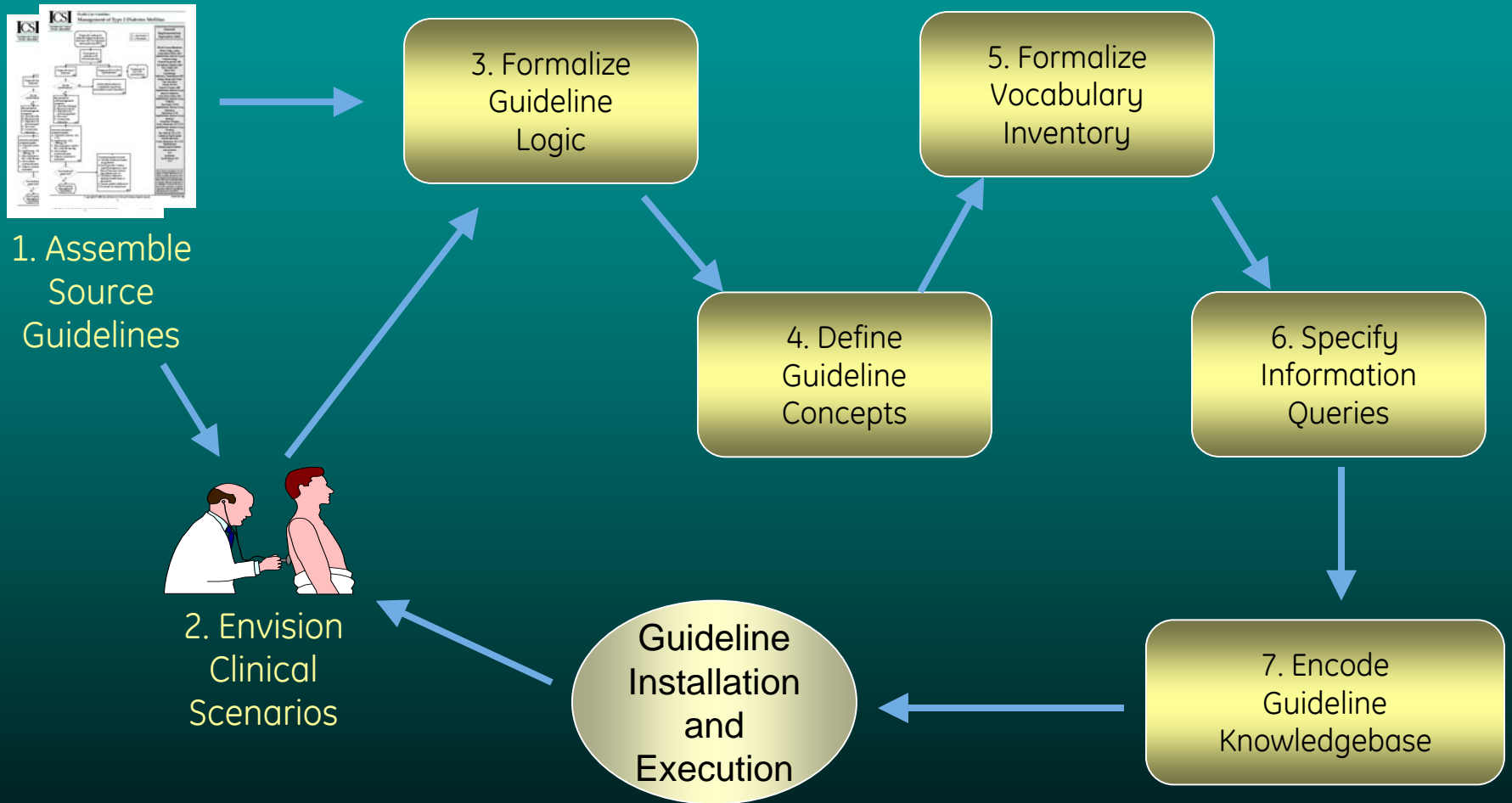
Overview

- Overview of guidelines and challenges to decision support development

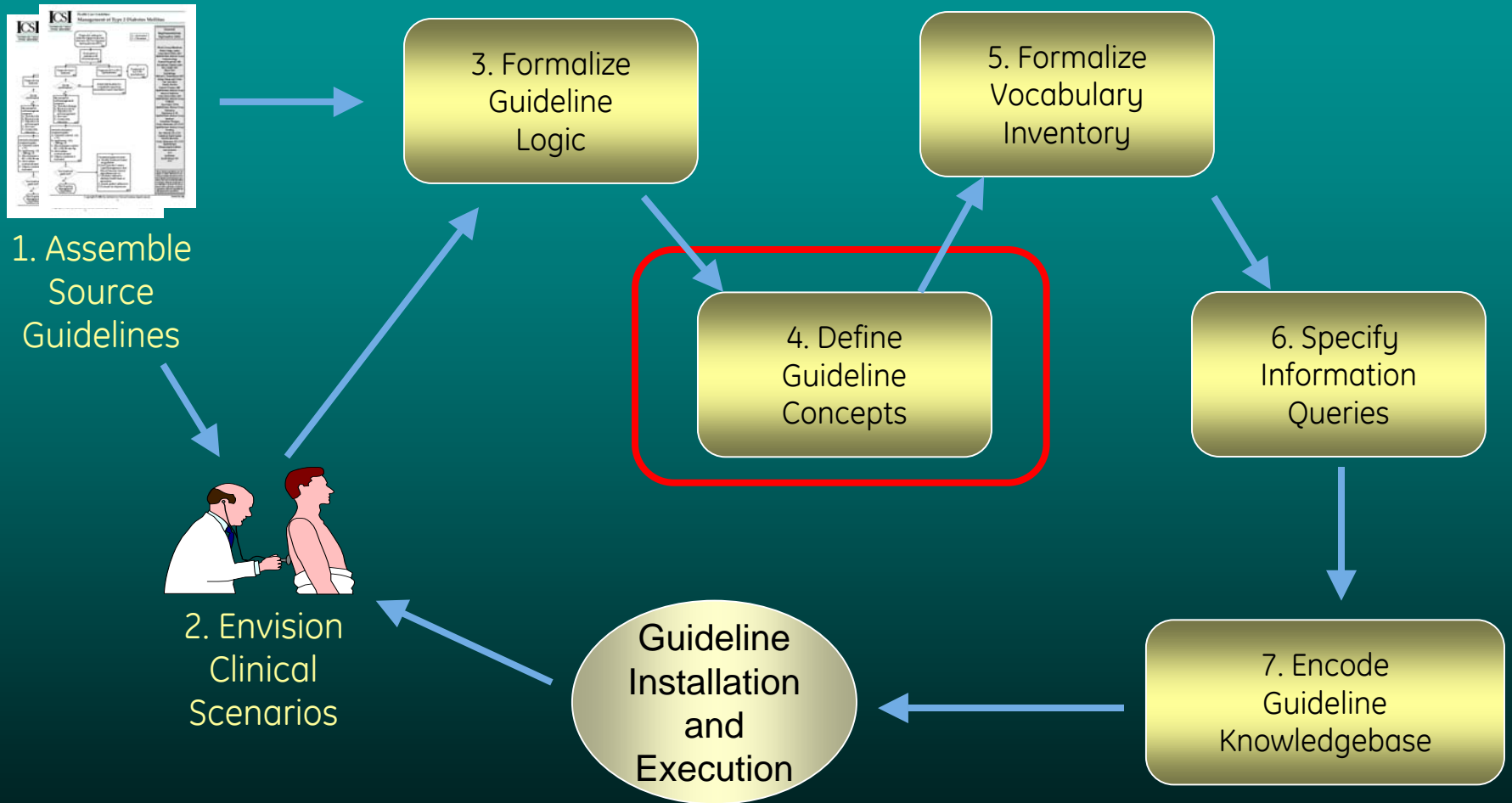
SAGE guideline modeling process:

- Introduction: Modeling the immunization guideline
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- Validating the development
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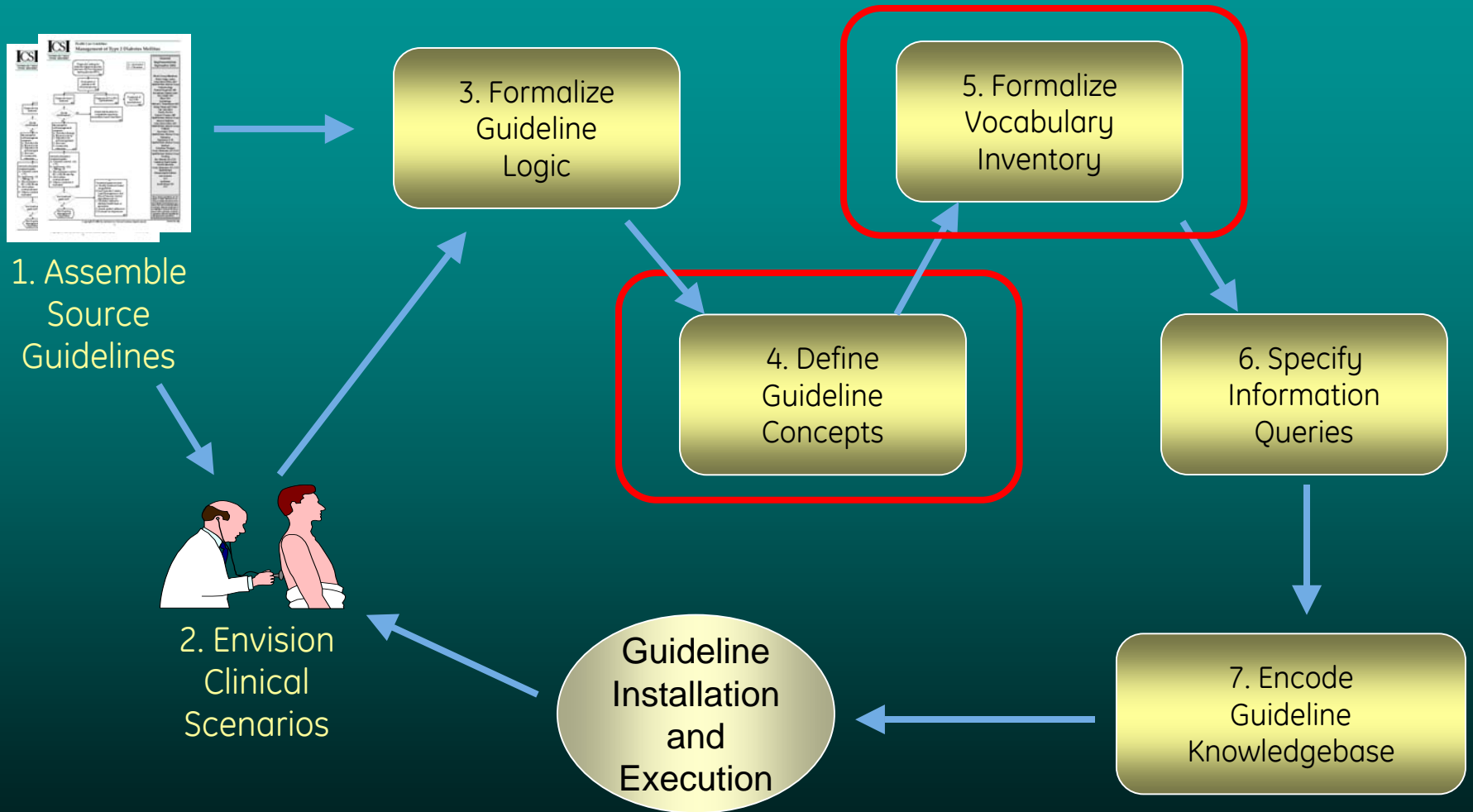
SAGE Guideline Encoding Process



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 cardiovascular disease?
- Functional or anatomic asplenia?
- Who is an immunocompromised person?

Persons aged 2–64 years with chronic cardiovascular disease,[†] chronic pulmonary disease,** or diabetes mellitus

A

Not recommended.

Persons aged 2–64 years with alcoholism, chronic liver disease,^{††} or cerebrospinal fluid leaks

B

Not recommended.

Persons aged 2–64 years with functional or anatomic asplenia^{§§}

A

If patient is aged >10 years: single revaccination ≥5 years after previous dose. If patient is aged ≤10 years: consider revaccination years after previous dose.

Persons aged 2–64 years living in special environments or social settings^{¶¶}

C

Not recommended.

Immunocompromised persons[§]

Immunocompromised persons aged ≥2 years, including those with HIV infection, leukemia, lymphoma, Hodgkins disease, multiple myeloma, generalized malignancy, chronic renal failure, or nephrotic

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Single revaccination if ≥5 years have elapsed since receipt of first dose. If patient is aged ≤10 years: consider revaccination 3 years after previous dose.

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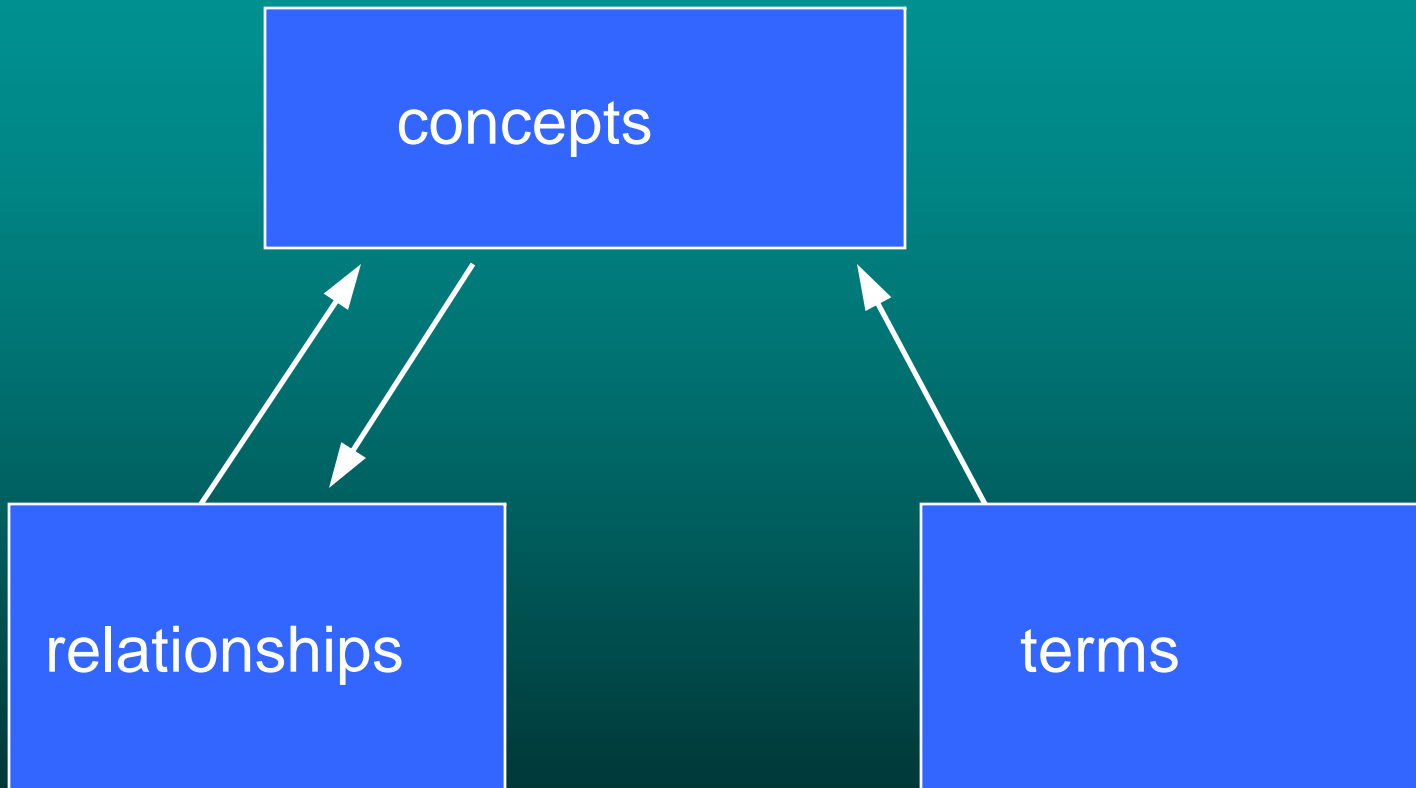
SNOMED CT[®]

- 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

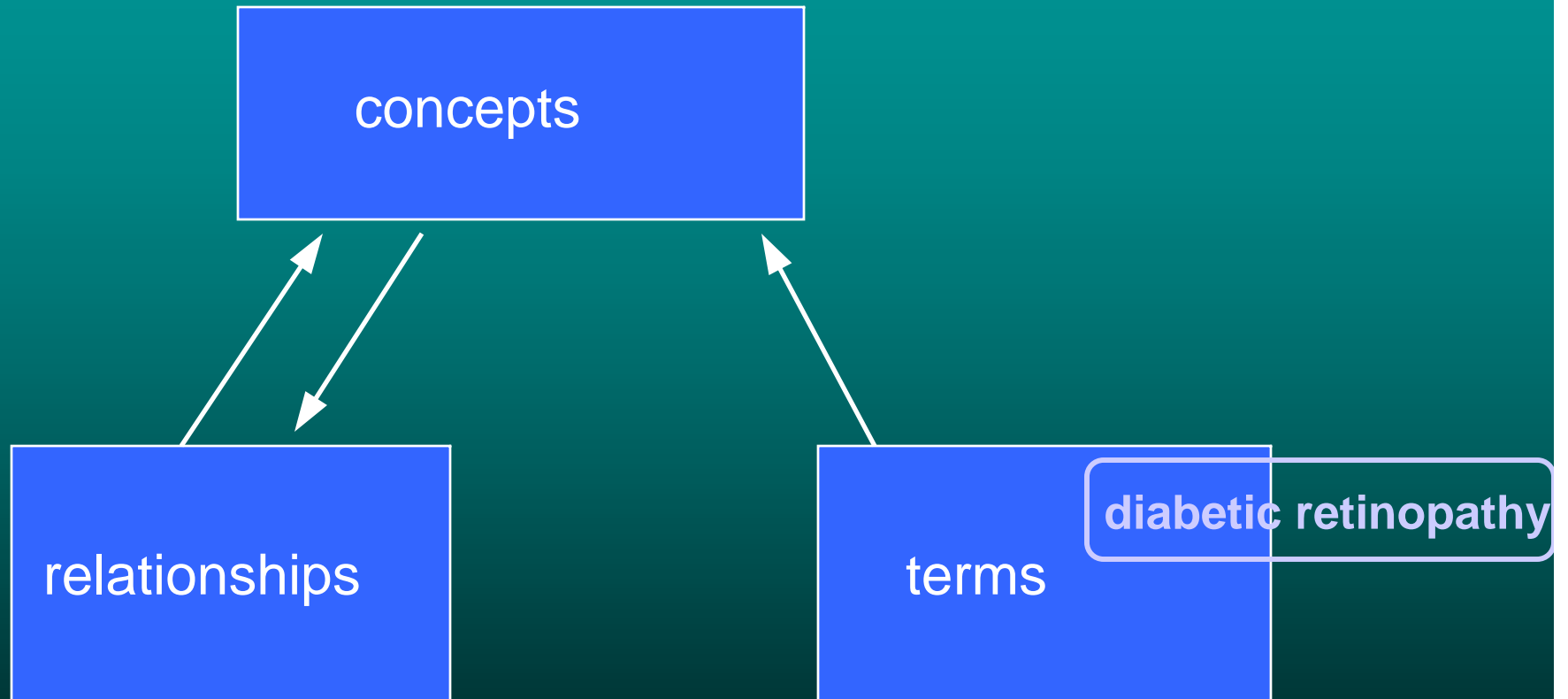
Why do we need SNOMED CT?

- 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.

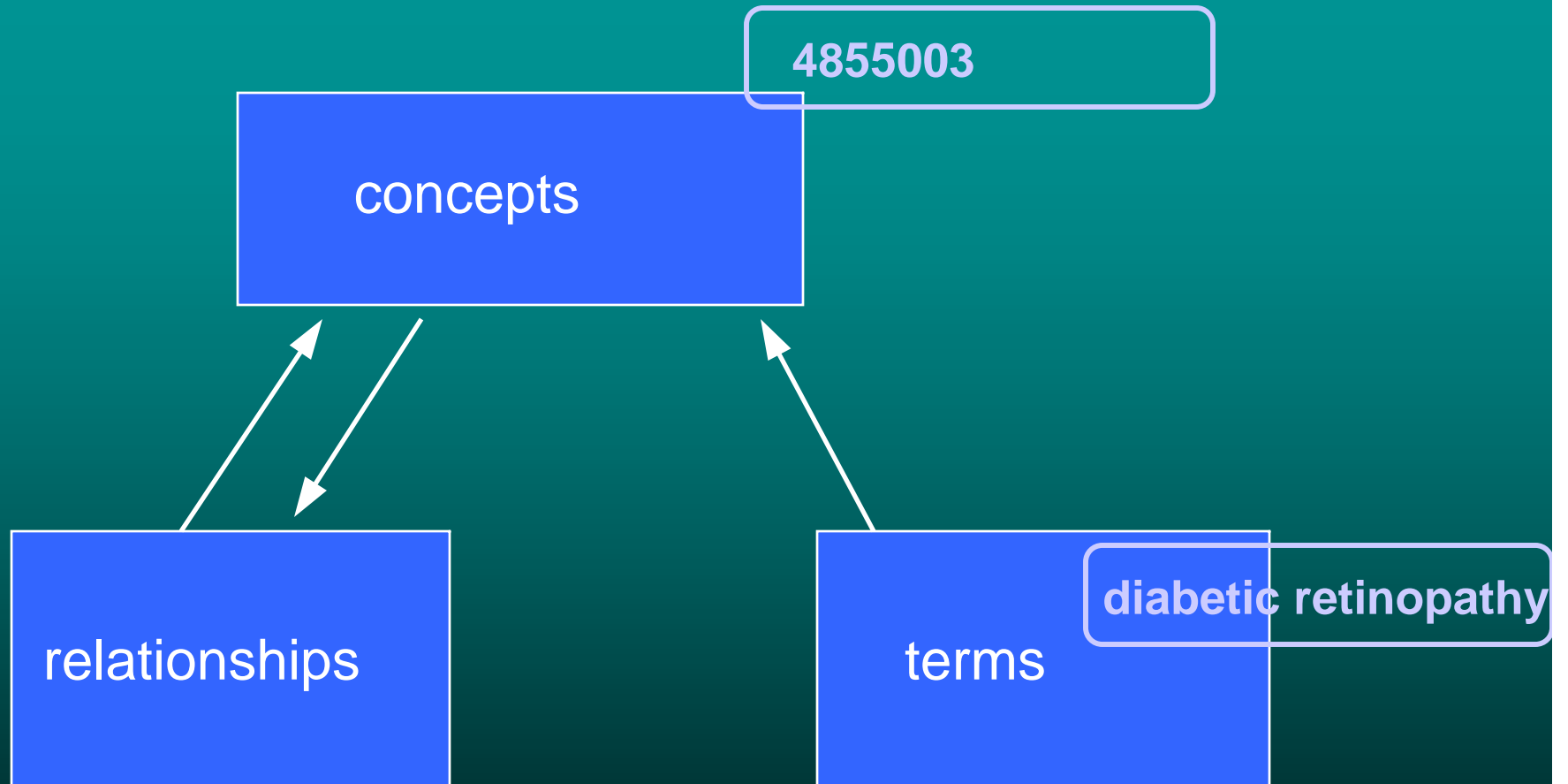
SNOMED CT Structure



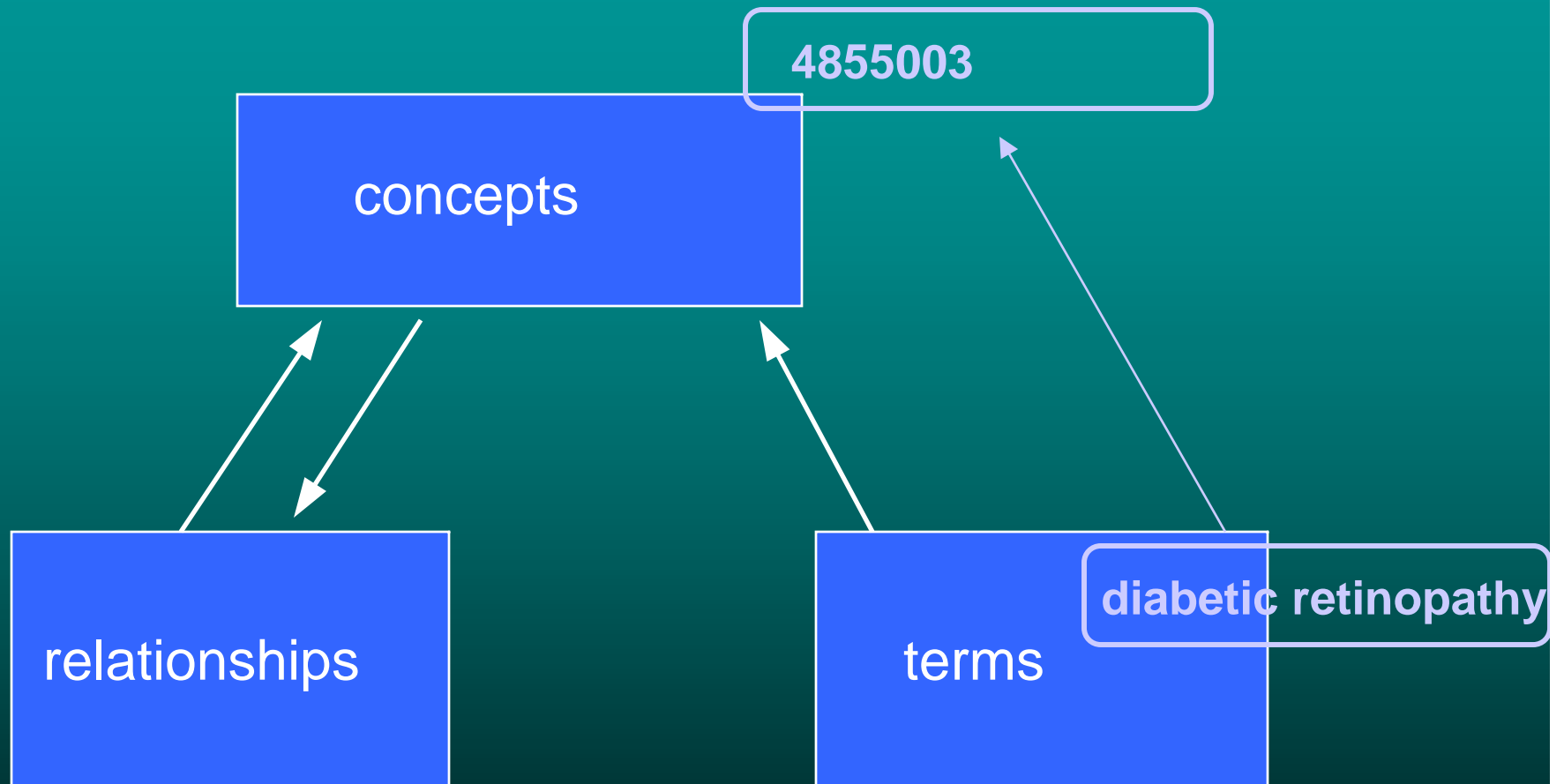
SNOMED CT Structure



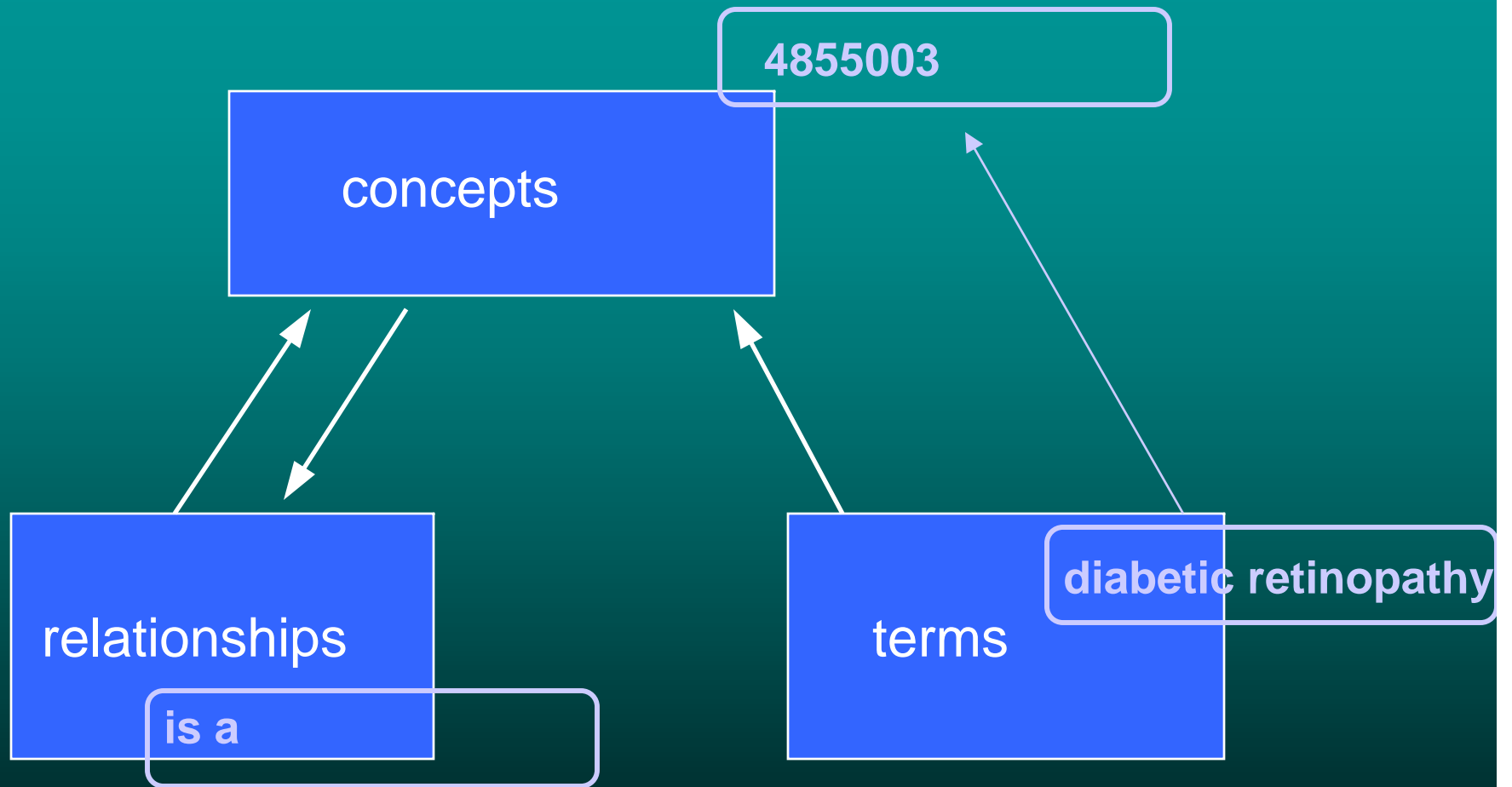
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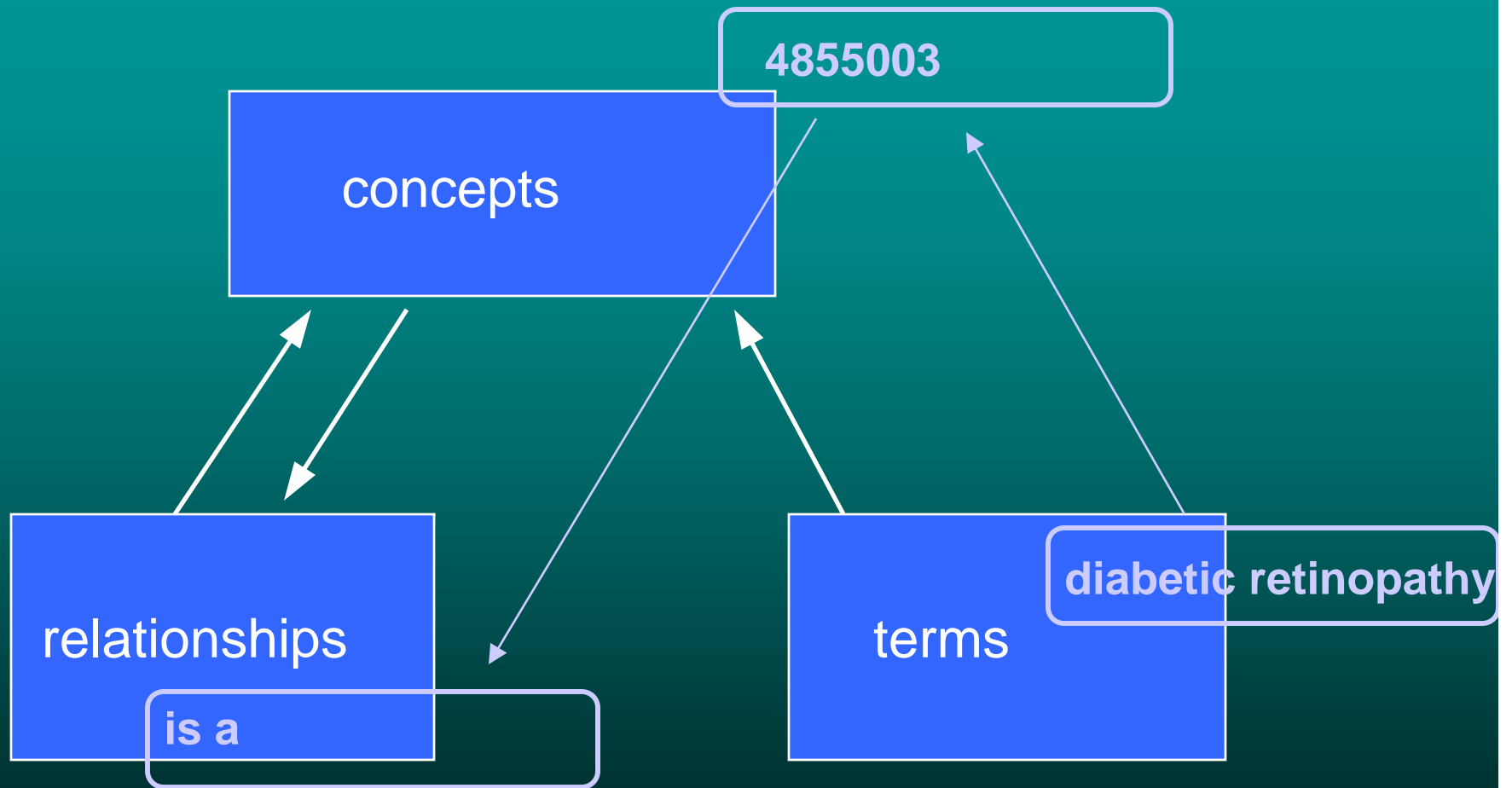
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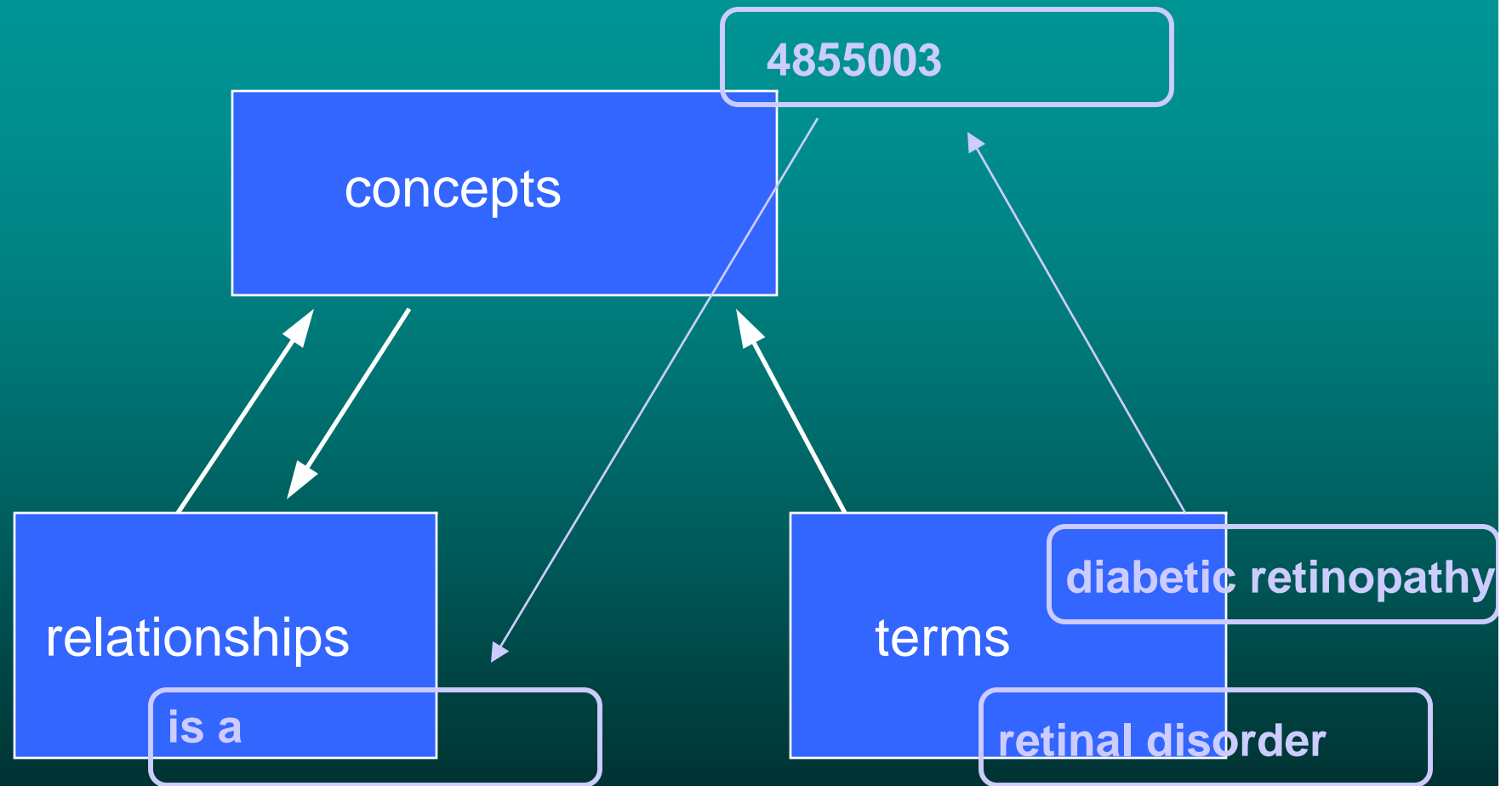
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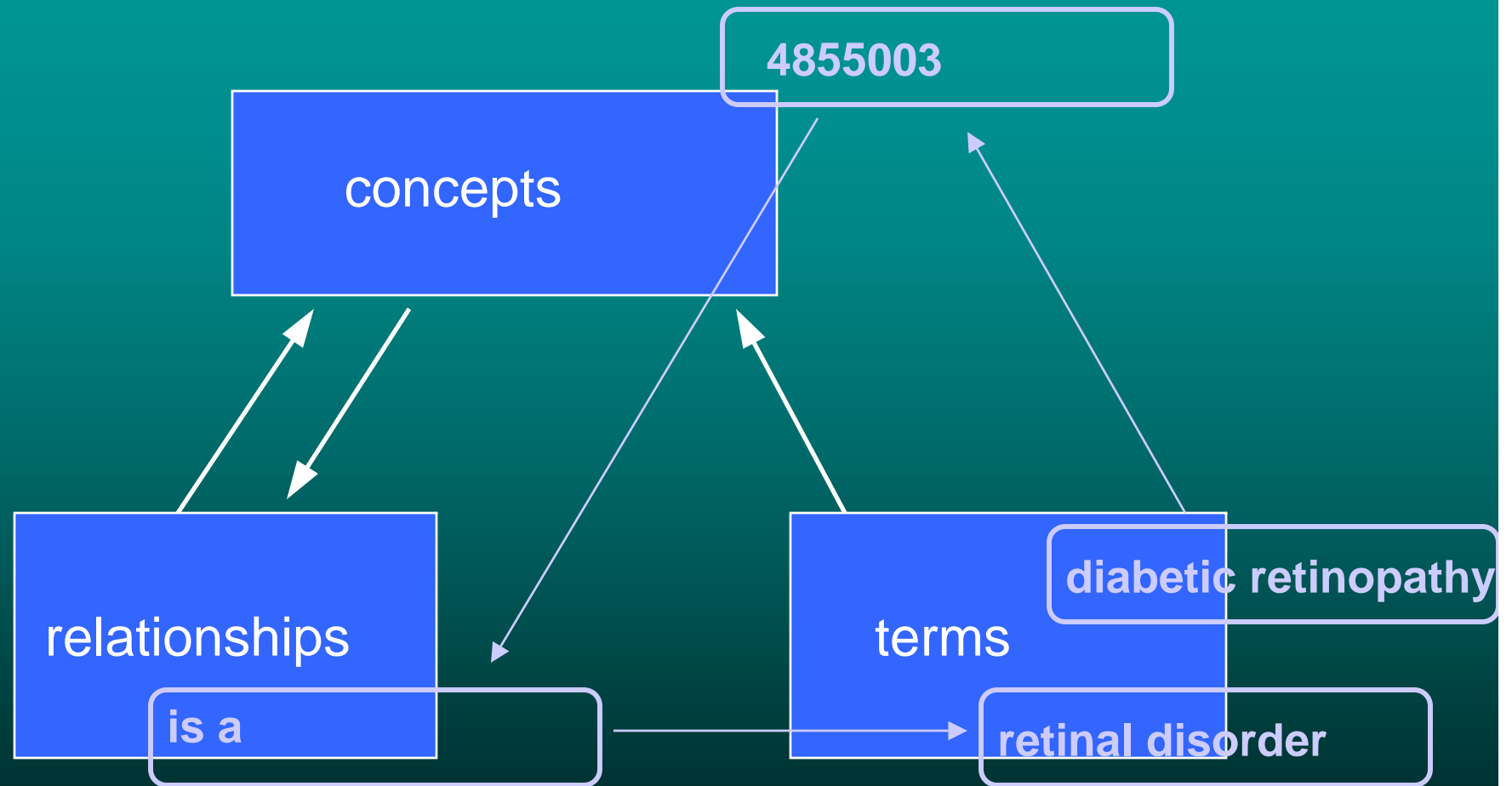
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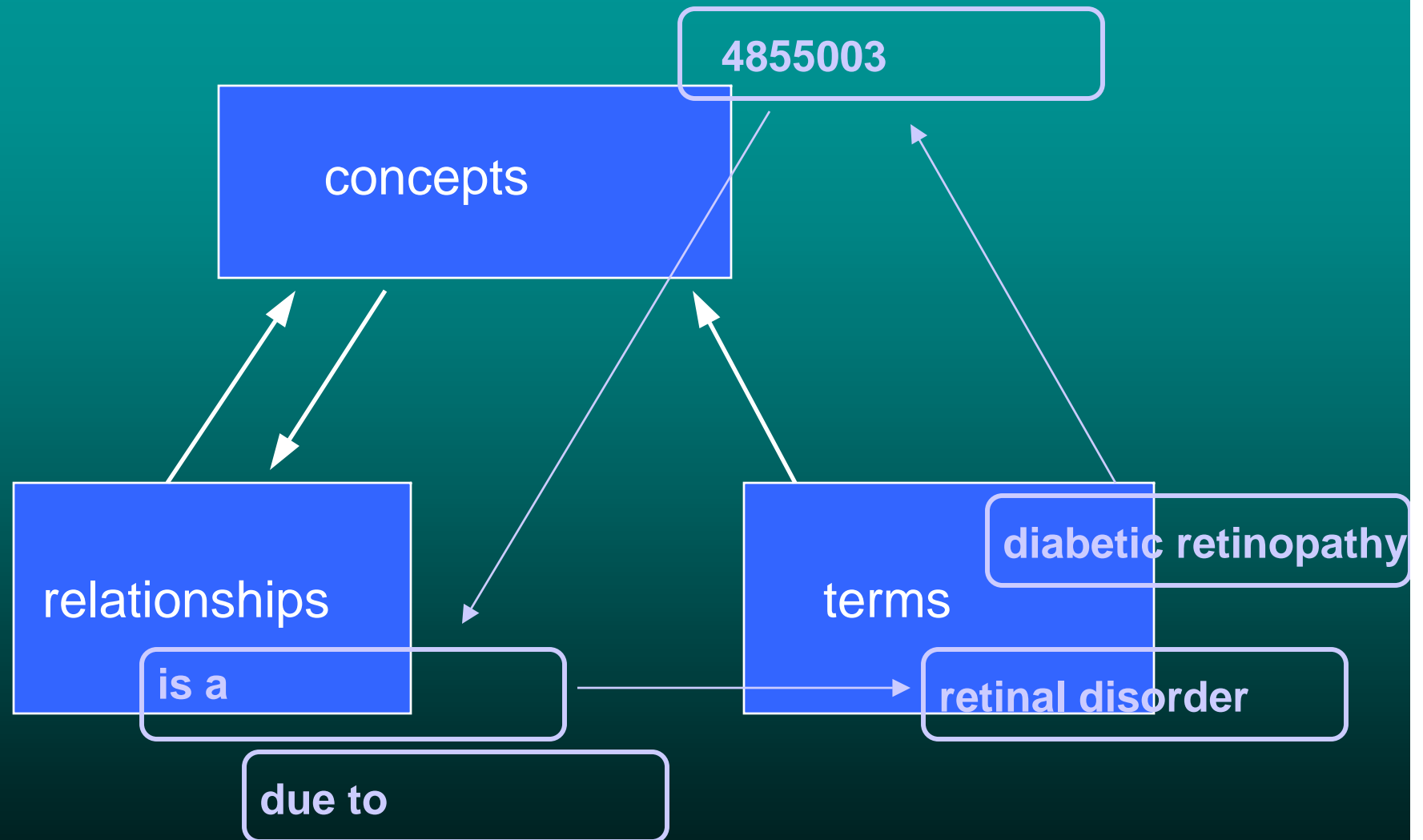
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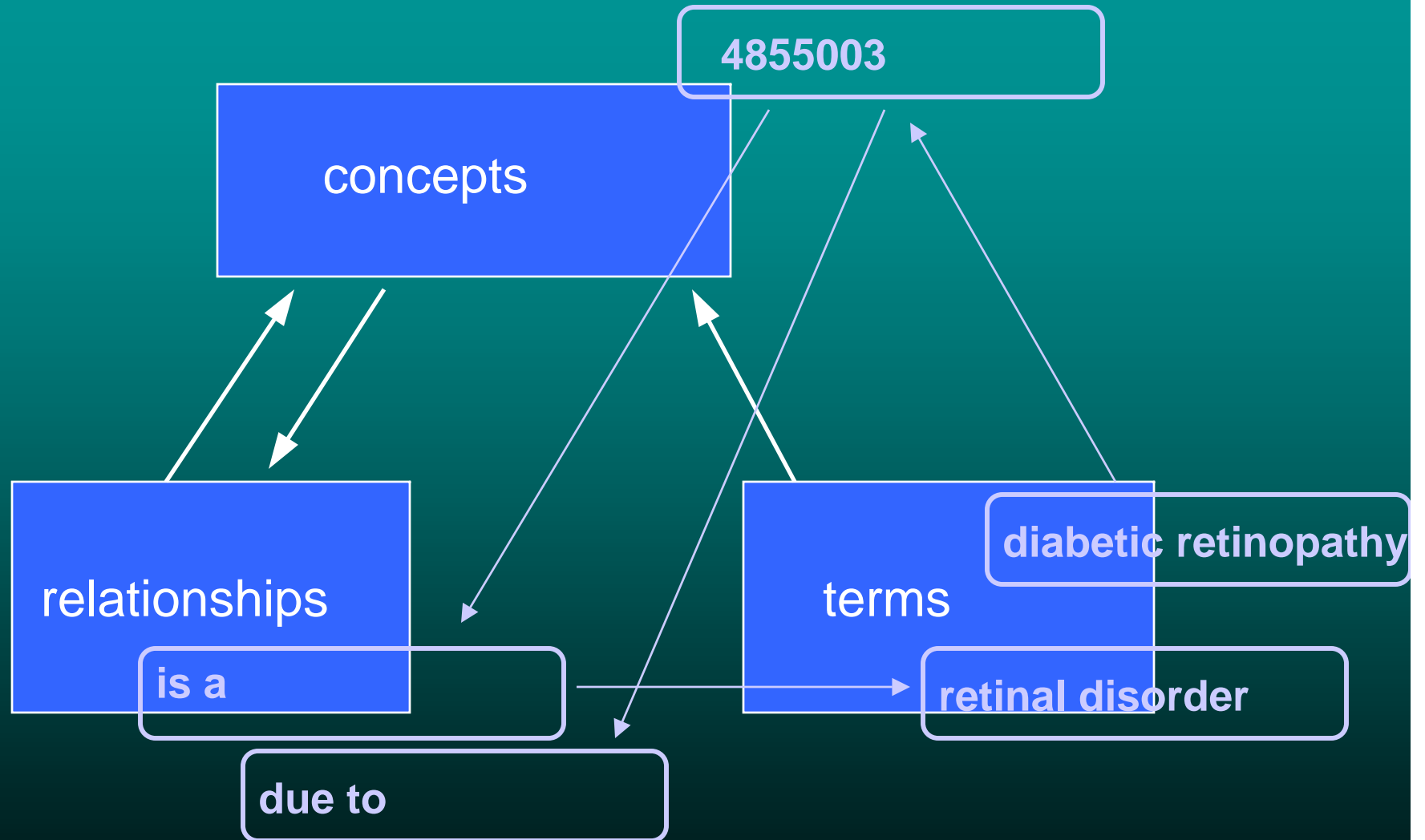
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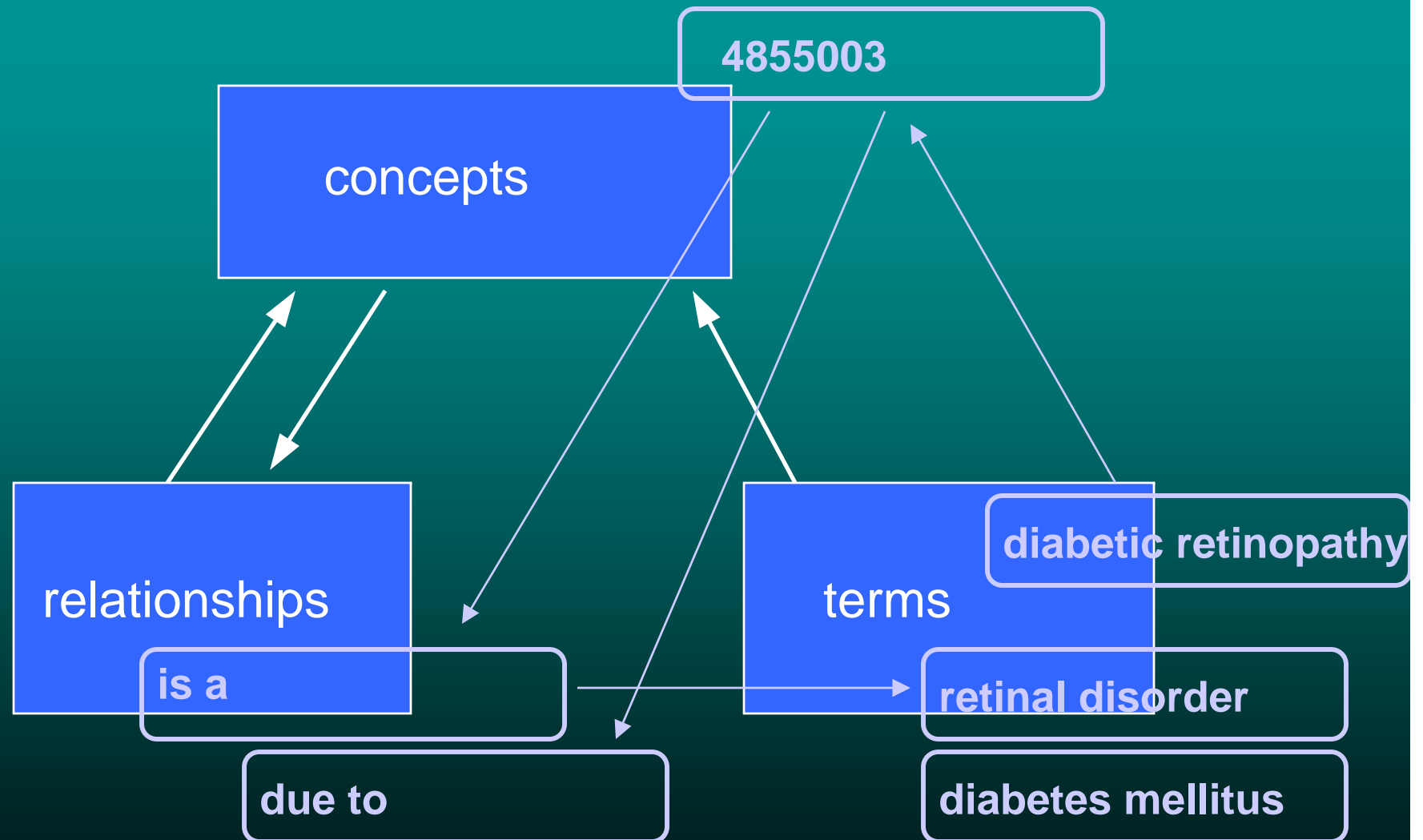
SNOMED CT Structure



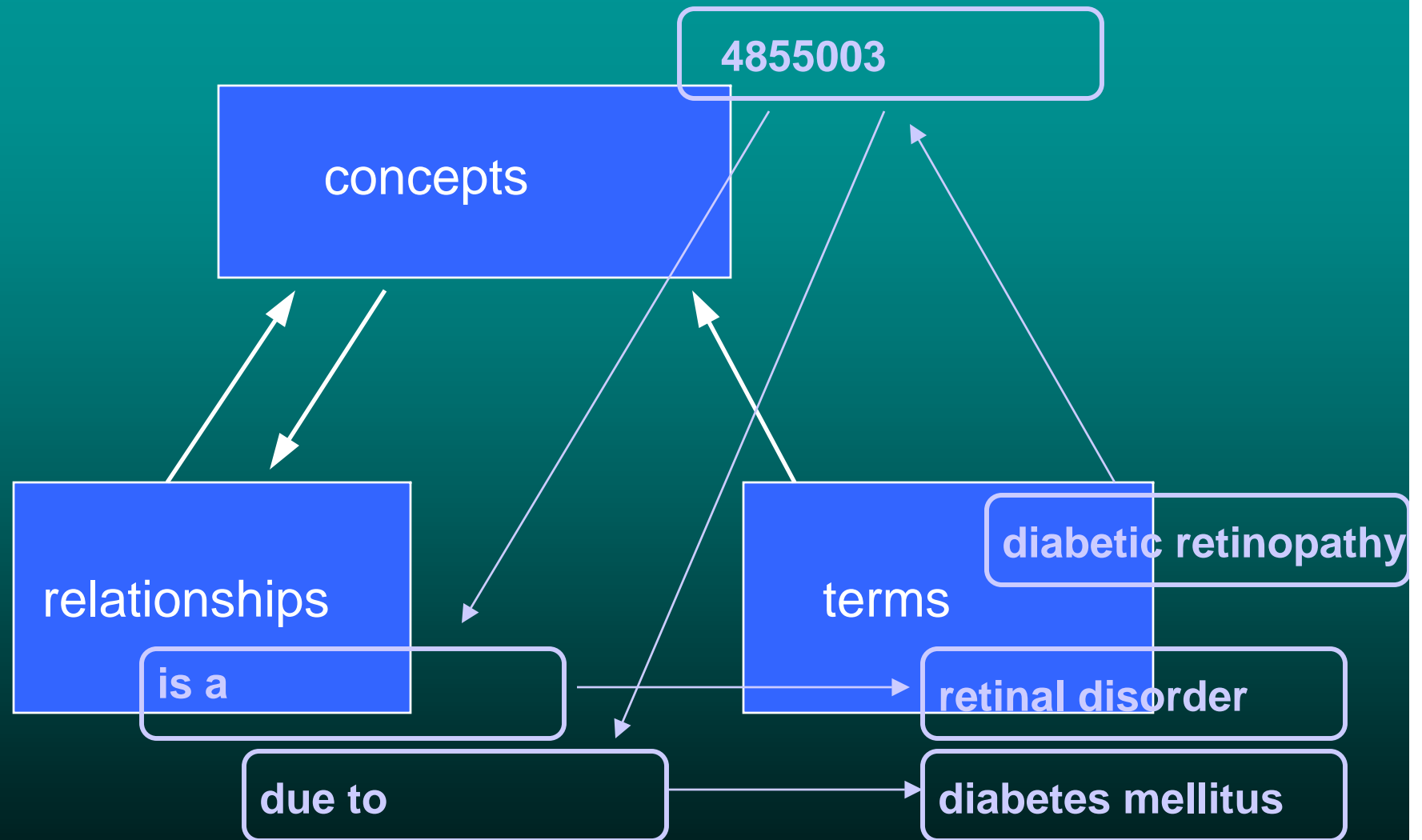
SNOMED CT Structure



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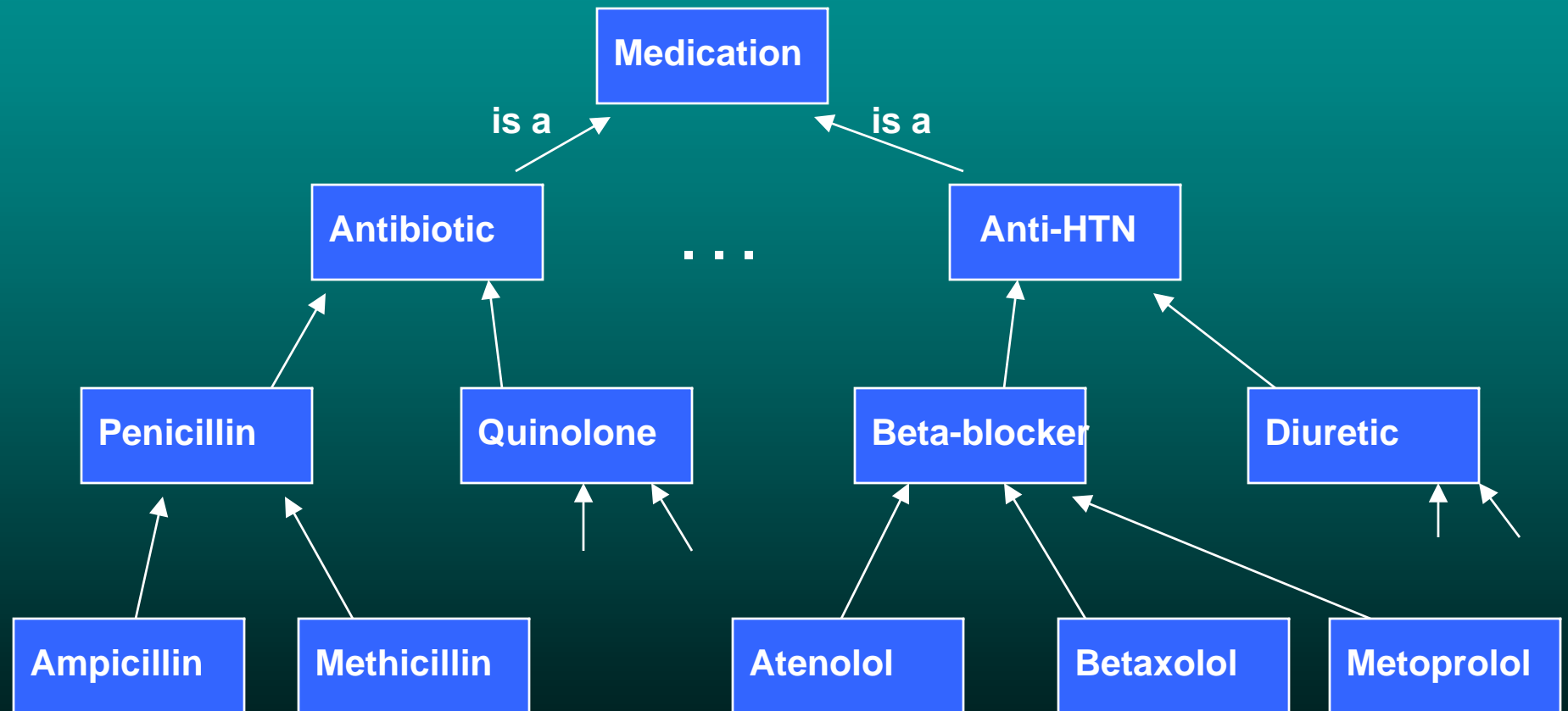


SNOMED CT Structure



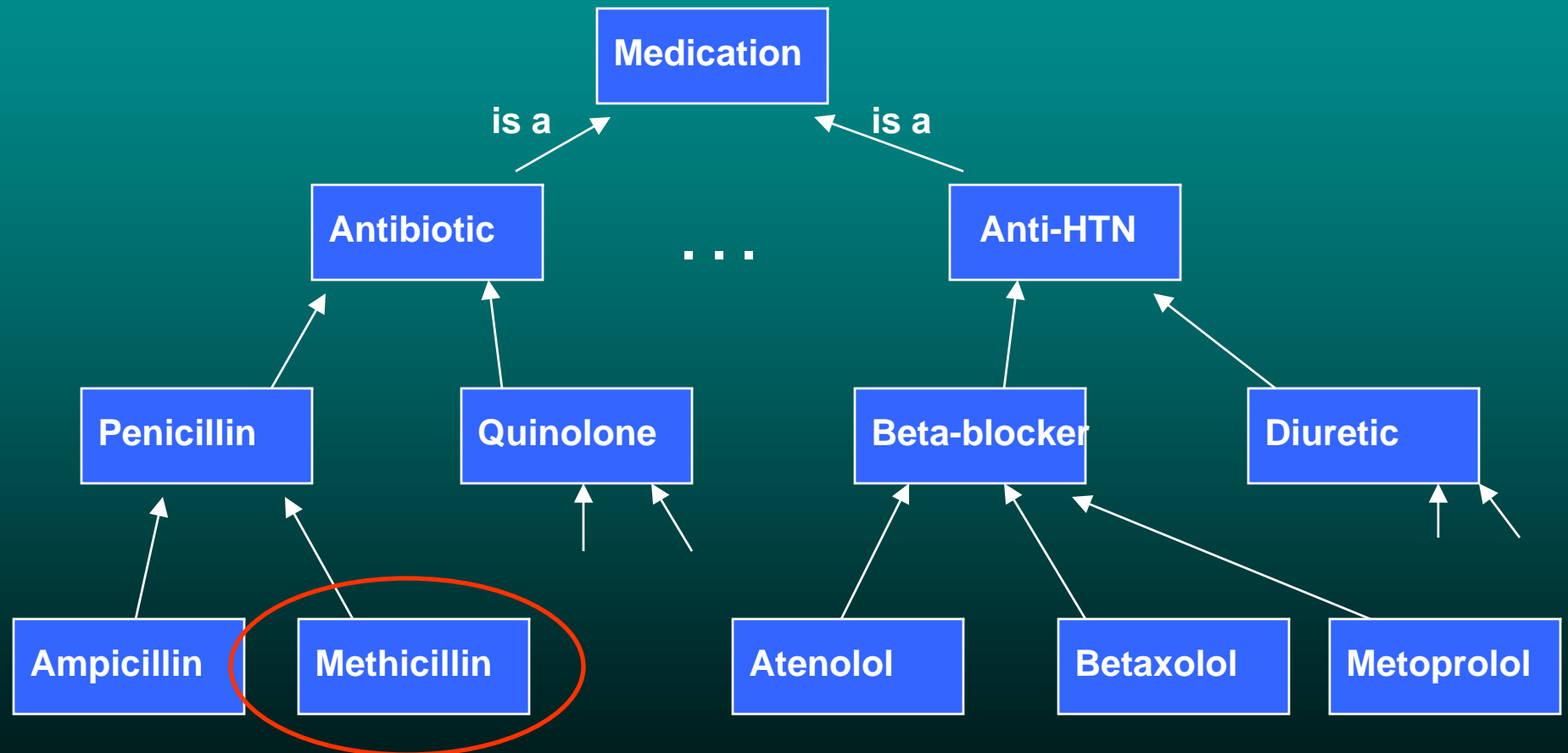
The Inheritance Hierarchy

Concepts are arranged in a tree hierarchy



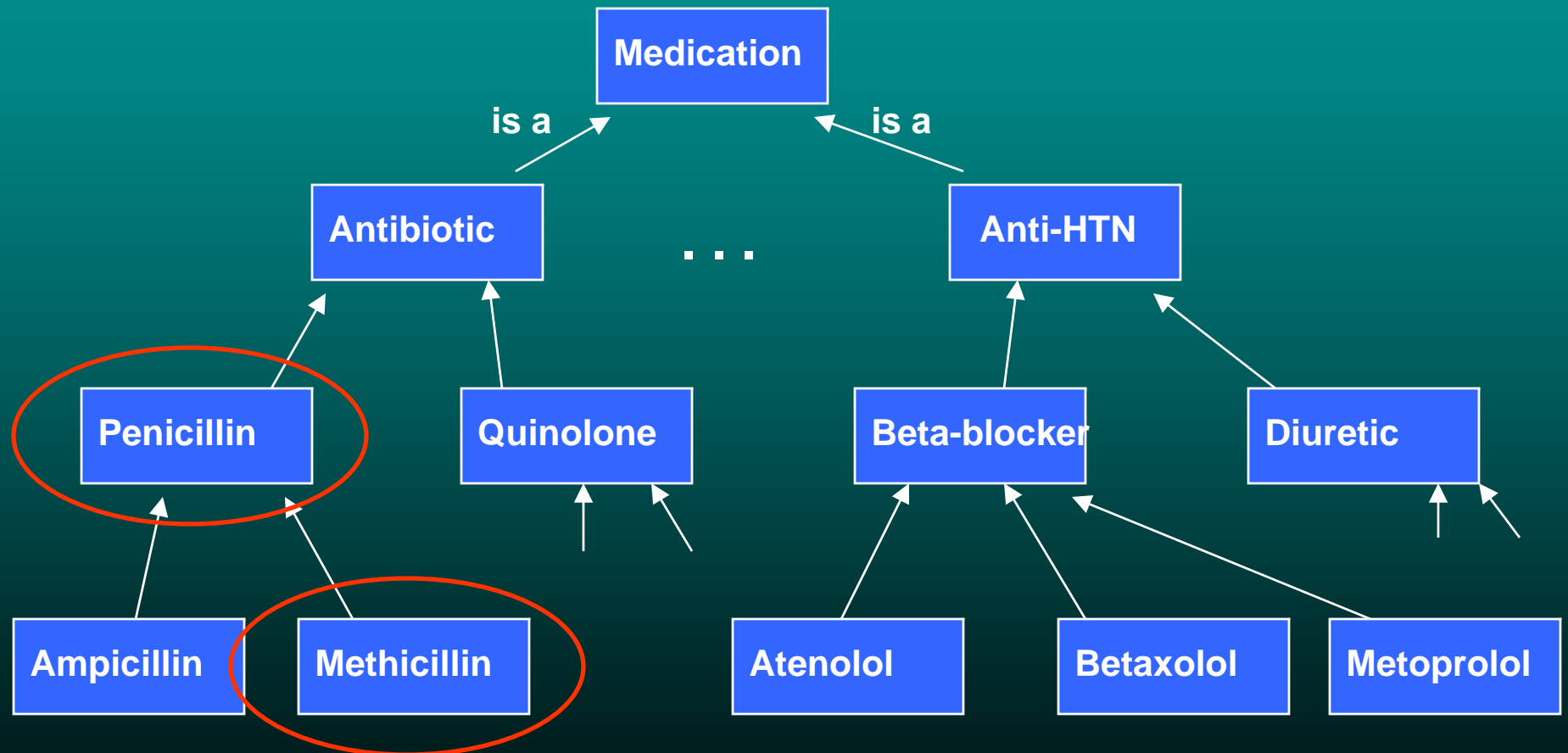
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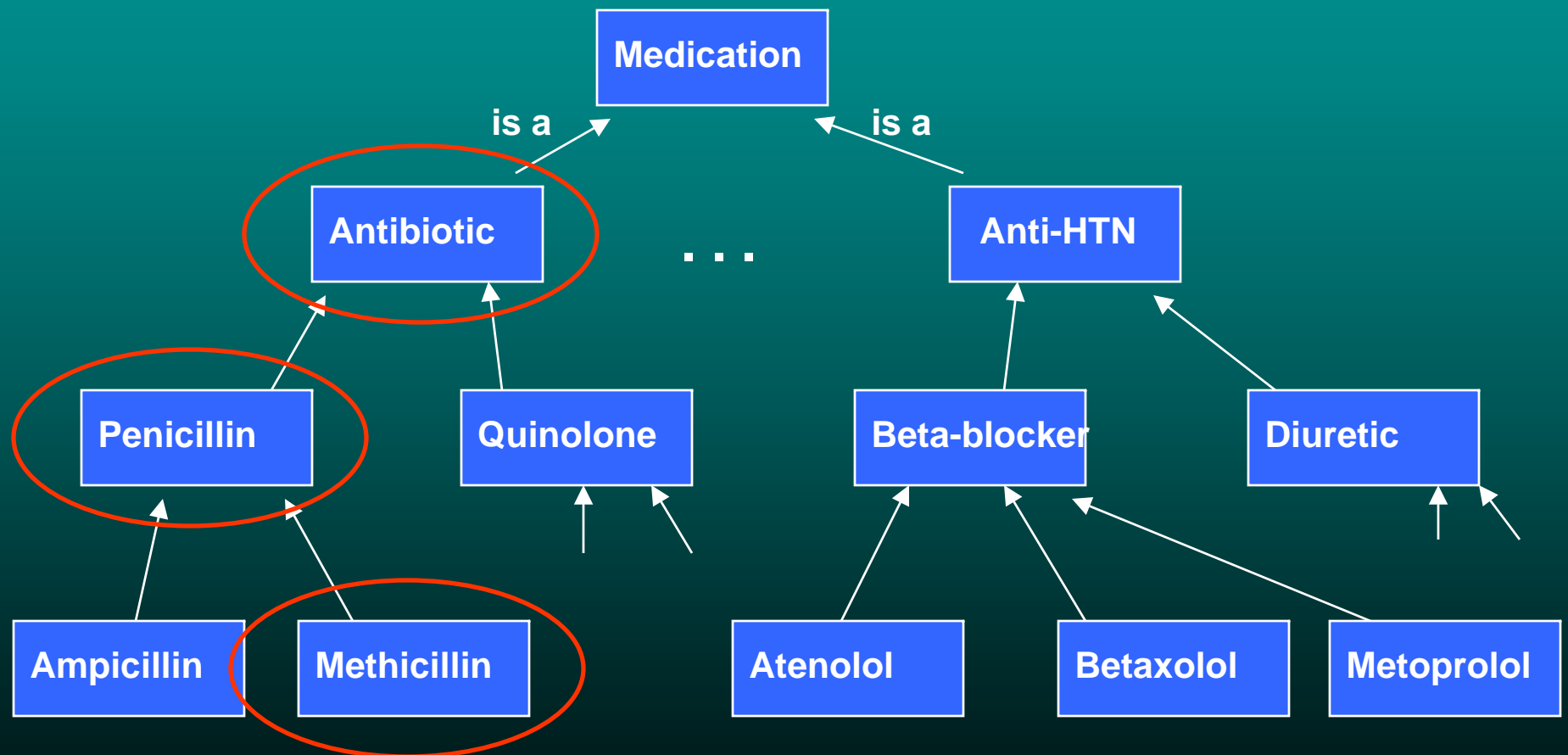
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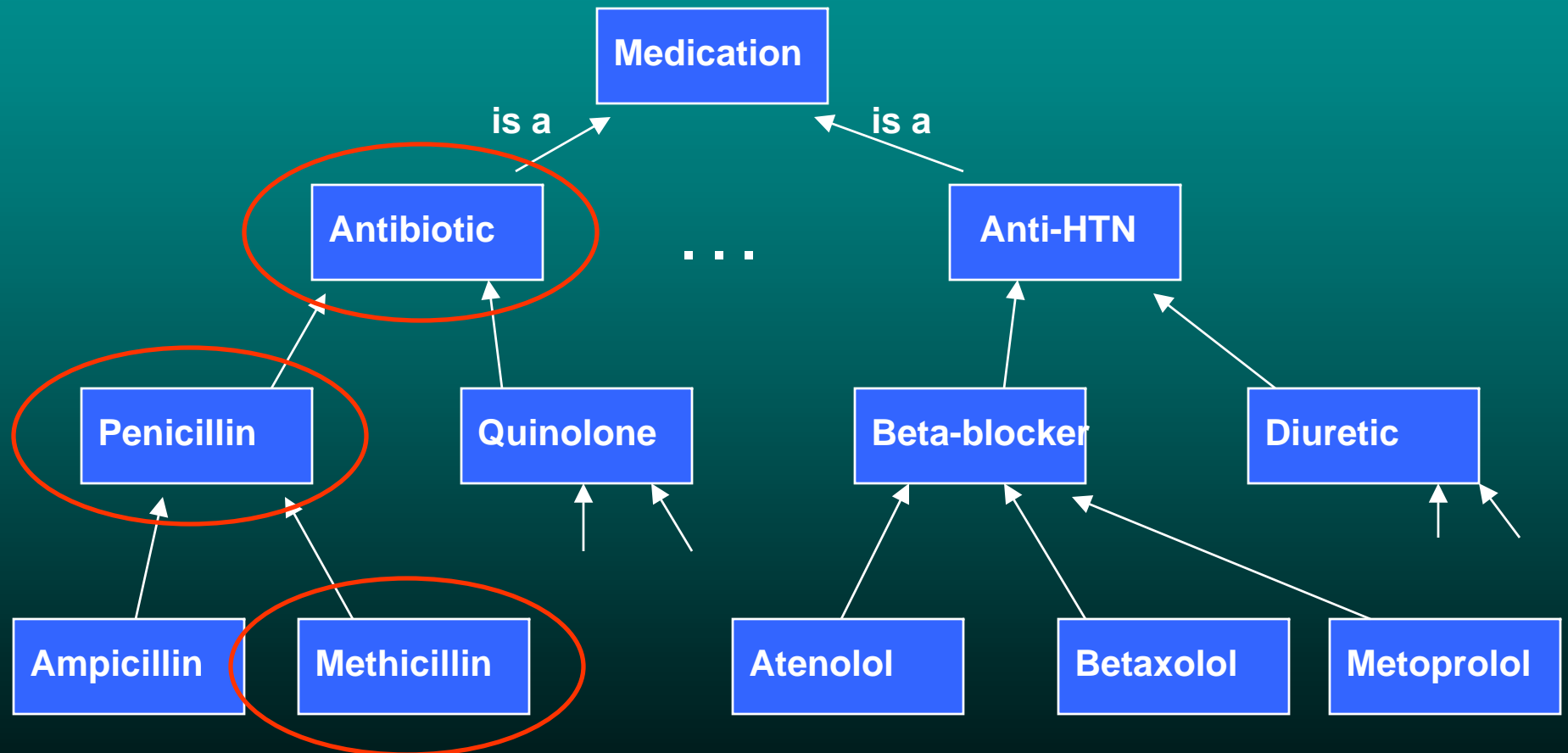
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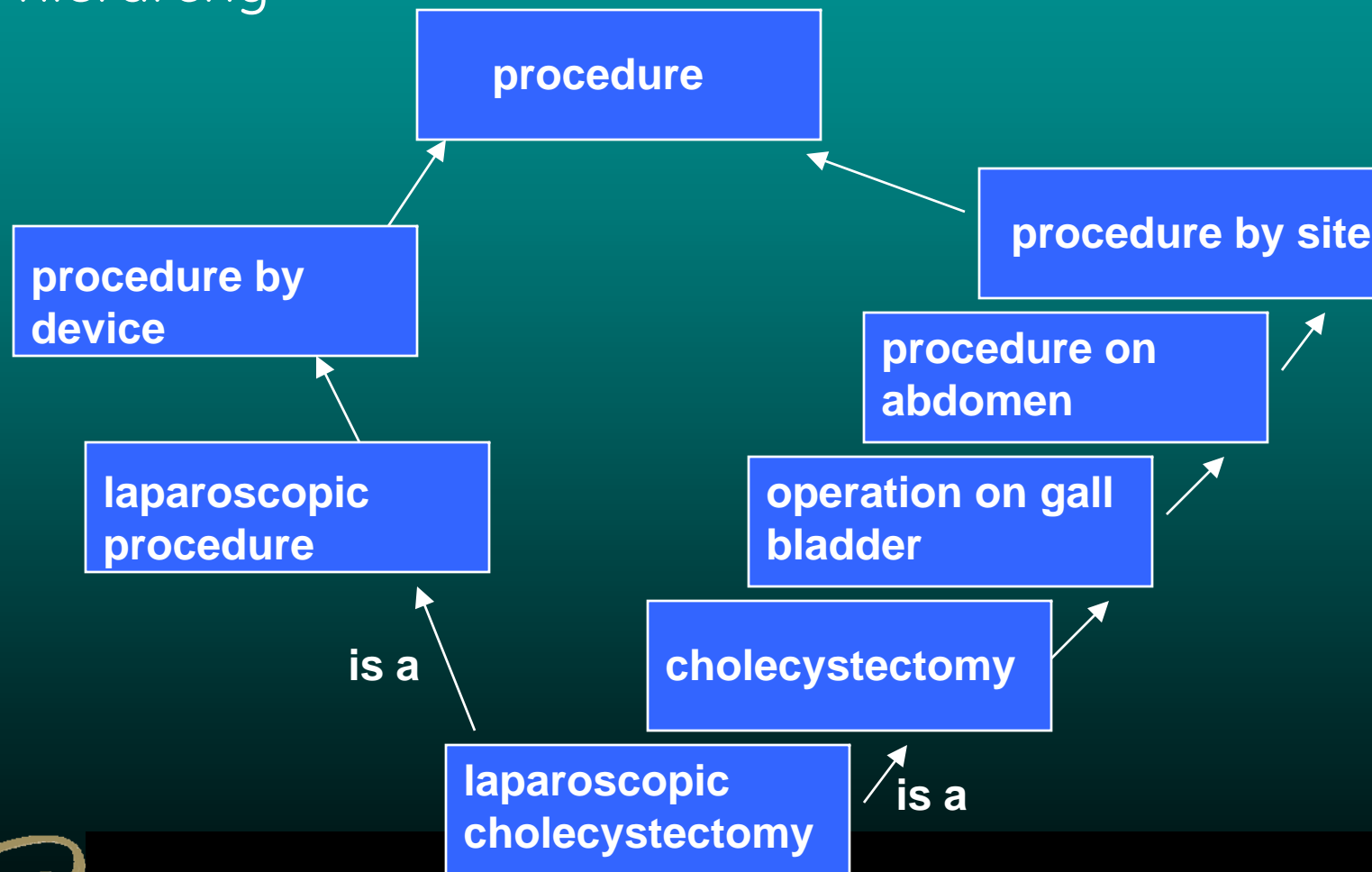
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Antibiotic subsumes Penicillin and Methicillin

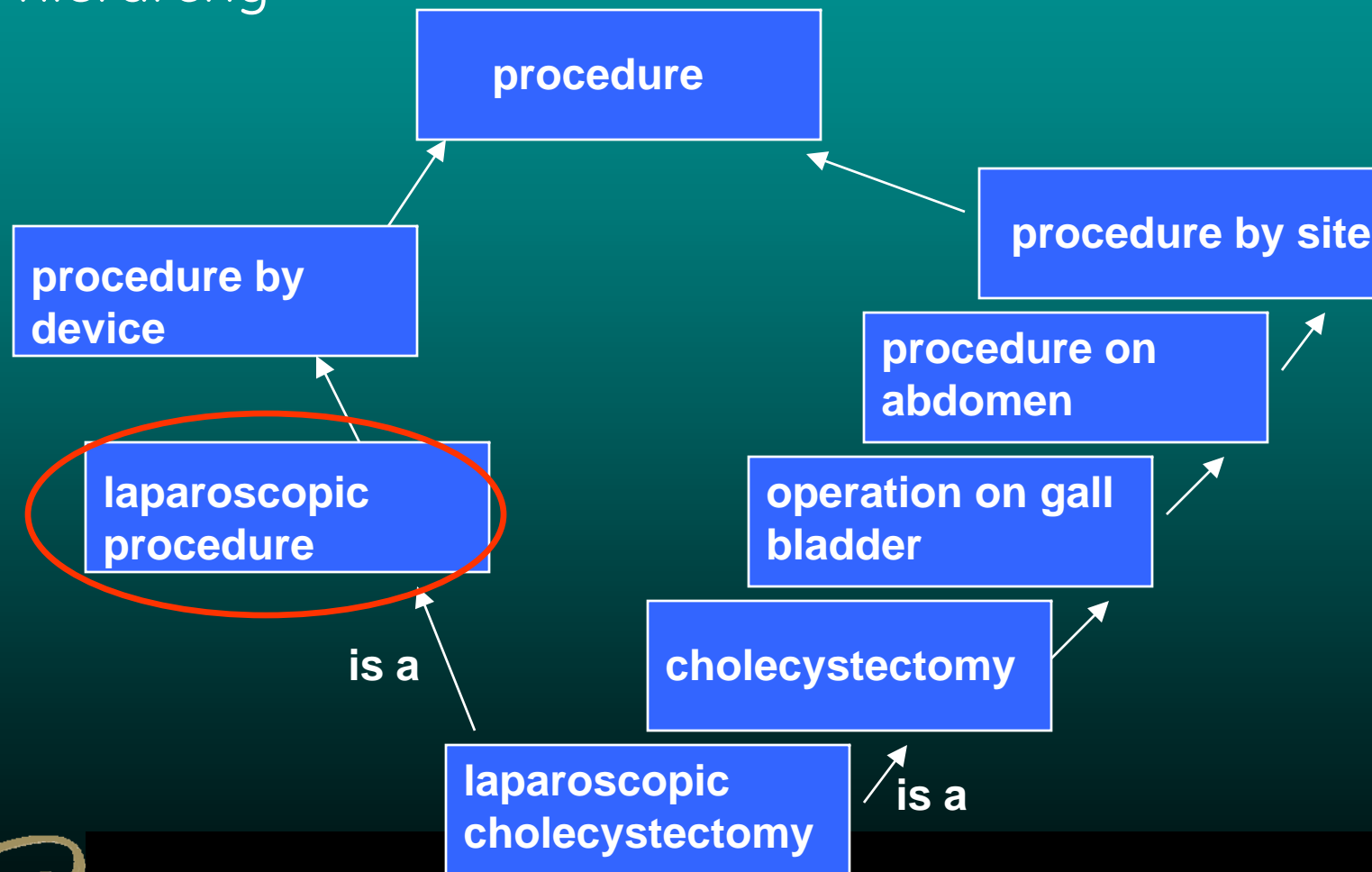
Polyhierarchical structure

A concept may have more than one parent in the hierarchy



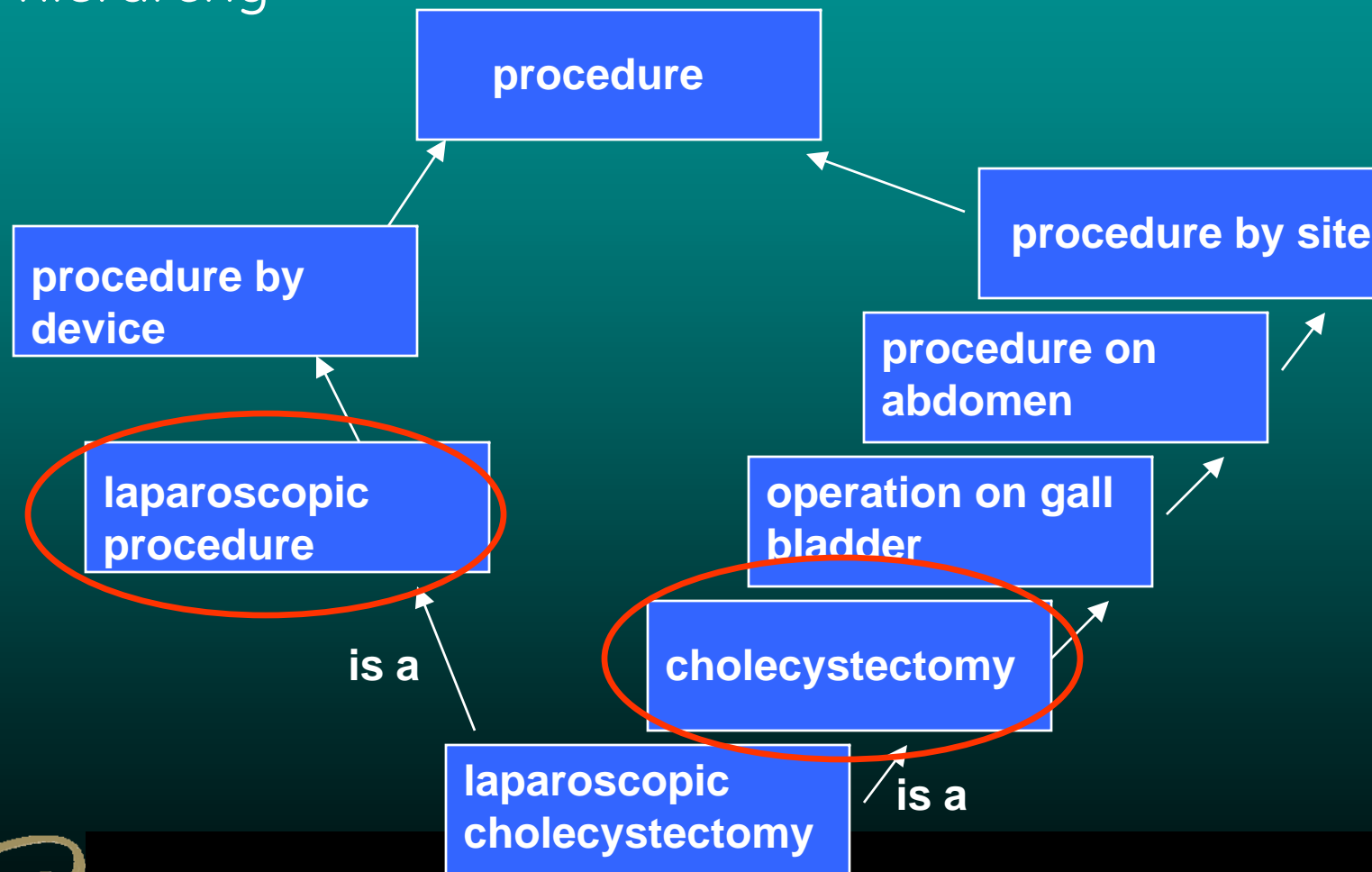
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Pre- and Post-Coordination

Suprarenal Artery Embolus
297143008

or

Occlusion of Artery	2929001
Associated Morphology	116676008
Embolus	55584005
Finding Site	363698007
Suprarenal Artery	89500000

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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...

Persons aged 2–64 years with chronic cardiovascular disease,[†] chronic pulmonary disease,^{**} or diabetes mellitus

A

Not recommended.

Persons aged 2–64 years with alcoholism, chronic liver disease,^{††} or cerebrospinal fluid leaks

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Immunocompromised persons[§]

Immunocompromised persons aged ≥2 years, including those with HIV infection, leukemia, lymphoma, Hodgkins disease, multiple myeloma, generalized malignancy, chronic renal failure, or nephrotic syndrome; those receiving immunosuppressive chemotherapy (including corticosteroids); and those who have received an organ or bone marrow transplant.

C

Single revaccination if ≥5 years have elapsed since receipt of first dose. If patient is aged ≤10 years: consider revaccination 3 years after previous dose.

“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)

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- 127040003 (Hemoglobin S disease)

CDSS Vocabulary Services

Effective use of SNOMED vocabulary by the CDSS requires that these functions (at a minimum) be supported by the query/vocabulary management software:

- 1) Query for an instance of concept
- 2) Query for ... a concept or any of its children
- 3) Query for ... a set of concepts defined as a Boolean construction of SNOMED concepts
- 4) Query for ... an concept defined as an extension to SNOMED-CT

Vocabulary Services: Vendor Requirements for Immunizations

Vocabulary Service	Frequency
I: Concept identification	17%
II: Aggregation and concept subsumption	81.1%
III a&b: Boolean definition without negation	4.6%
IIIb: Boolean definition including negation	1.5%
IV: Post-coordination and extensions	6.1%

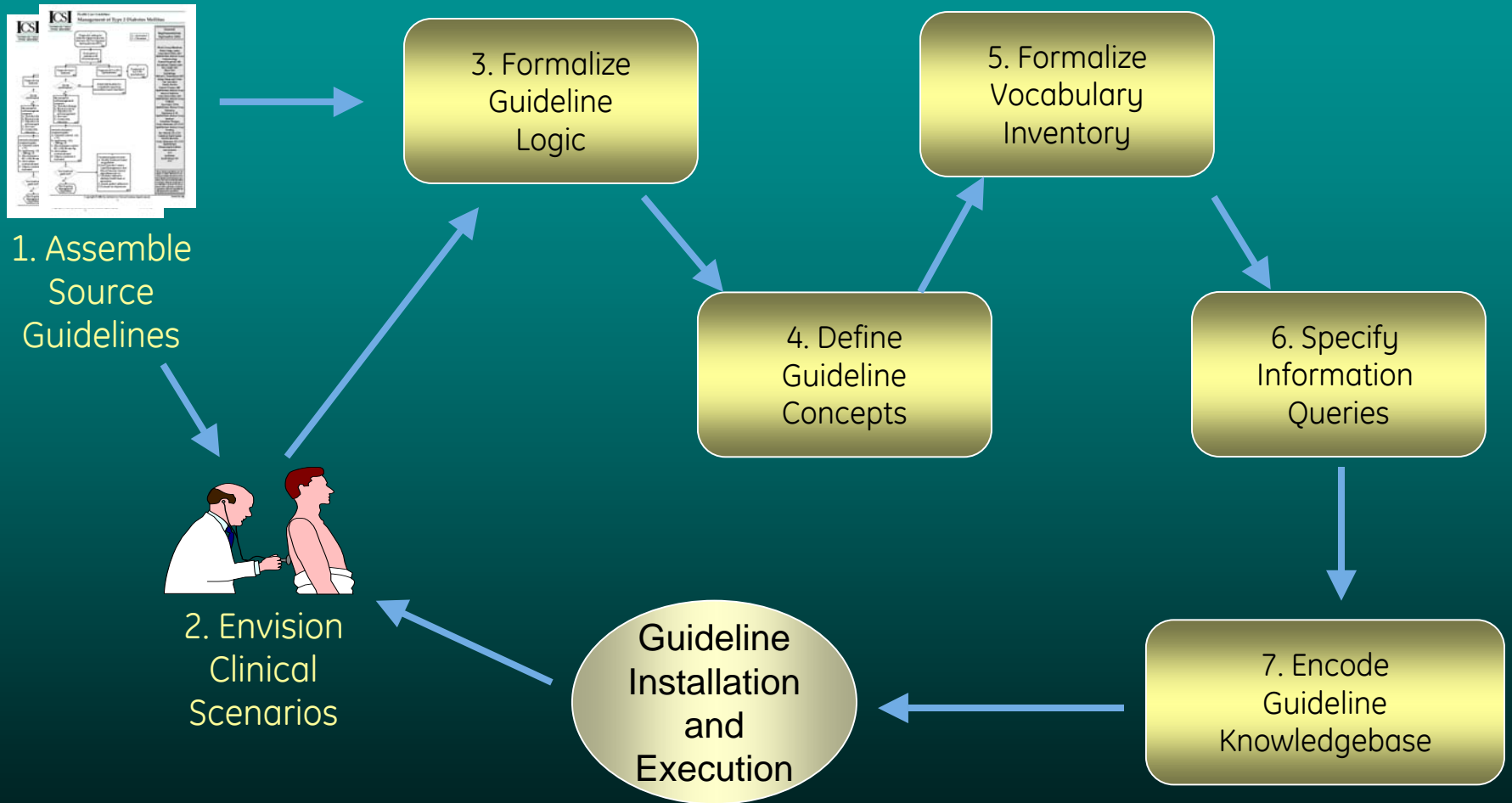
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- Overview of guidelines and challenges to decision support development

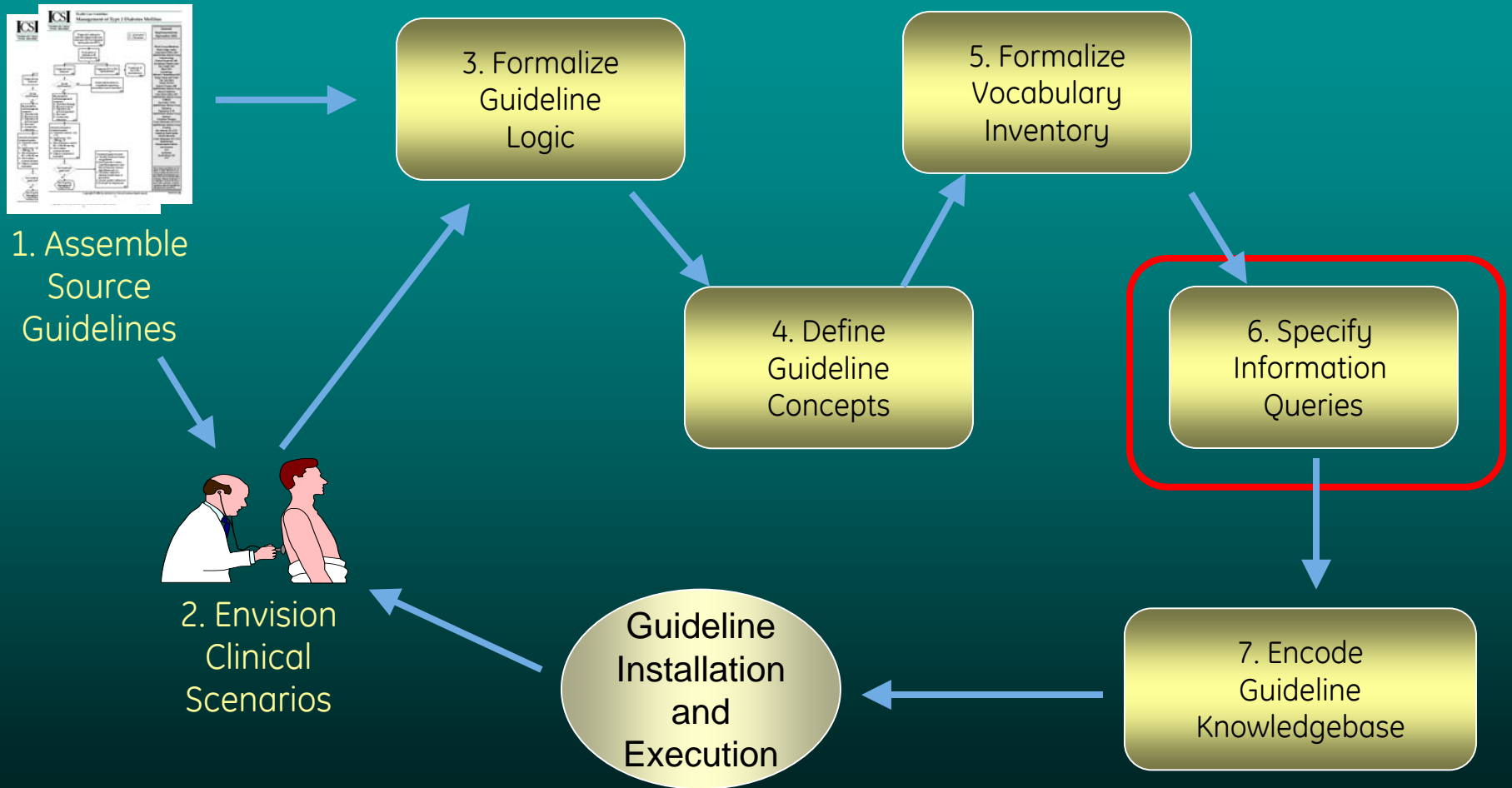
SAGE guideline modeling process:

- 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

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
 - Object-oriented vs Relational
 - Variation in patient data components

Example

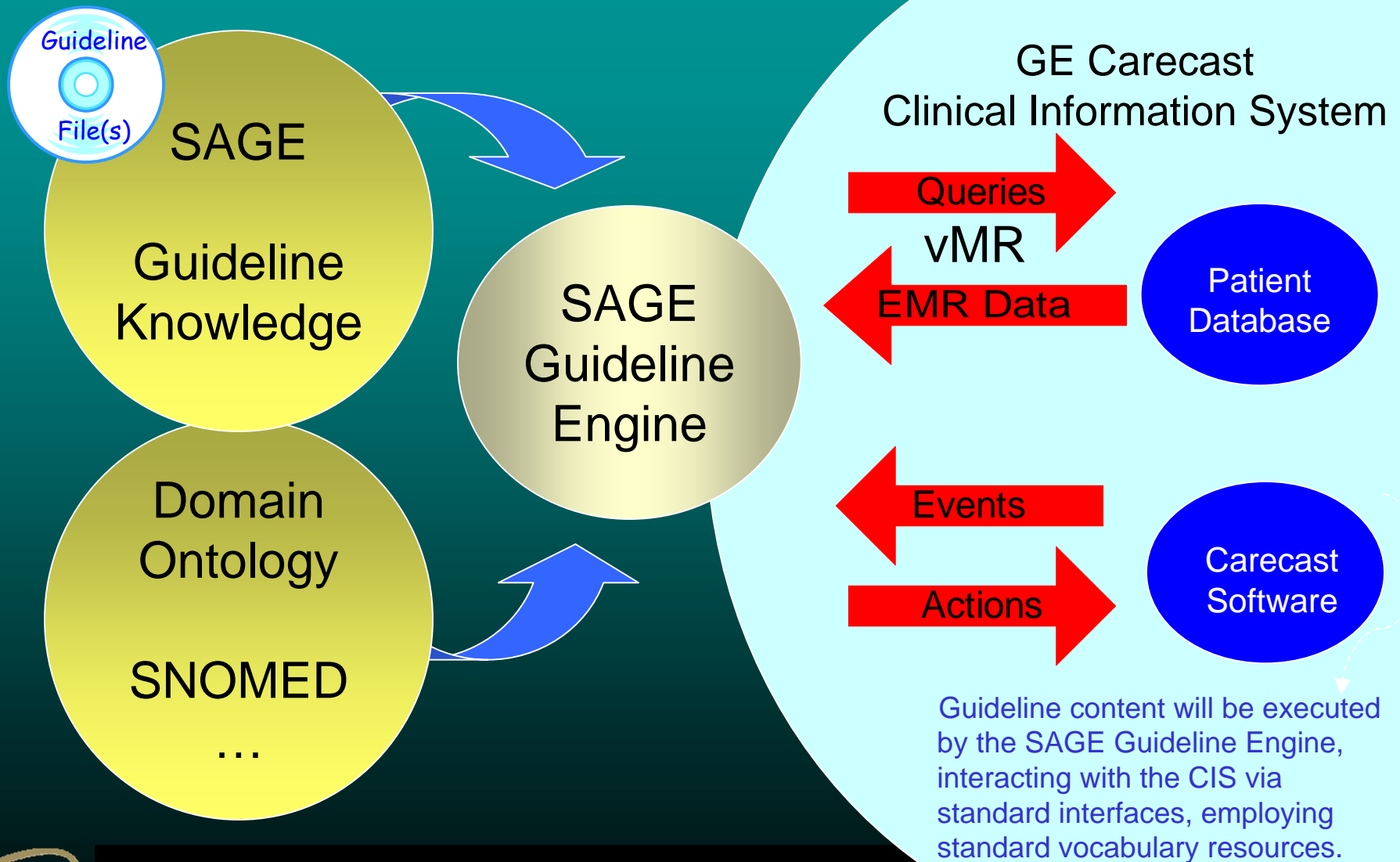
Possible Representations of a patient's Diabetes Mellitus

- 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

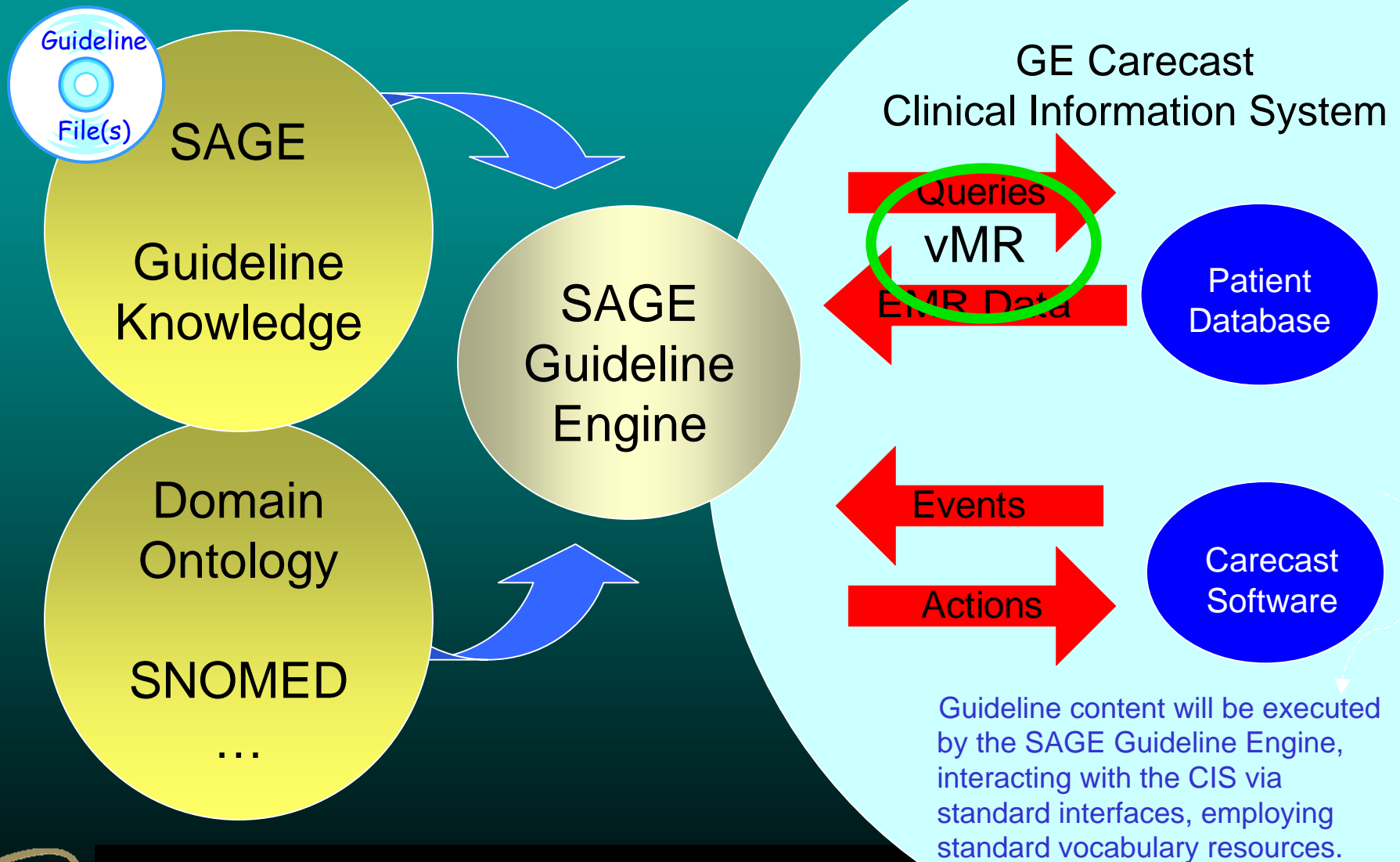
Information Model and Use of Vocabulary

- Interoperable decision support 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

SAGE Knowledge Management Environment



SAGE Knowledge Management Environment



HL7 RIM and Knowledge Modeling

- HL7 – A Standards Development Organization dedicated to definition of interoperability standards for electronic healthcare information
- HL7 RIM (Reference Information Model) v3 specifies the “grammar” of HL7 messages, including data type definitions
- The HL7 RIM v3 is the basis for the SAGE idealized information model
- Developed in dialogue with the Clinical Decision Support Technical Committee of HL7, this model is termed the vMR (virtual medical record)

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

Binding Information Queries to the vMR

- Effective linking of the decision support logic to the clinical record depends upon:
 - Information model
 - Vocabulary (ontology) employed
 - Pragmatics of recording by those who use the CIS

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

Interaction of vMR and Vocabulary

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 - Observation: code = 275937001|“family history of colon cancer”
 - Observation: code = 363406005|“colon cancer”, subject = 303071001|“family member”
- “Elevated blood sugar”
 - O The “context free” assumption within SNOMED states that the concept assertion always implies:
 - 1) Involves the patient
 - 2) Current state
 - 3) Assertion is present

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?

Binding Information Queries to the vMR

- The knowledge engineer must consider each of these three layers when creating decision support functionality
- For interoperability, the most common (or all) use cases must be supported
- At the time of localization of shared knowledge, the knowledge base must be examined for differences of interpretation of information model and patterns of data use in the local system

Overview

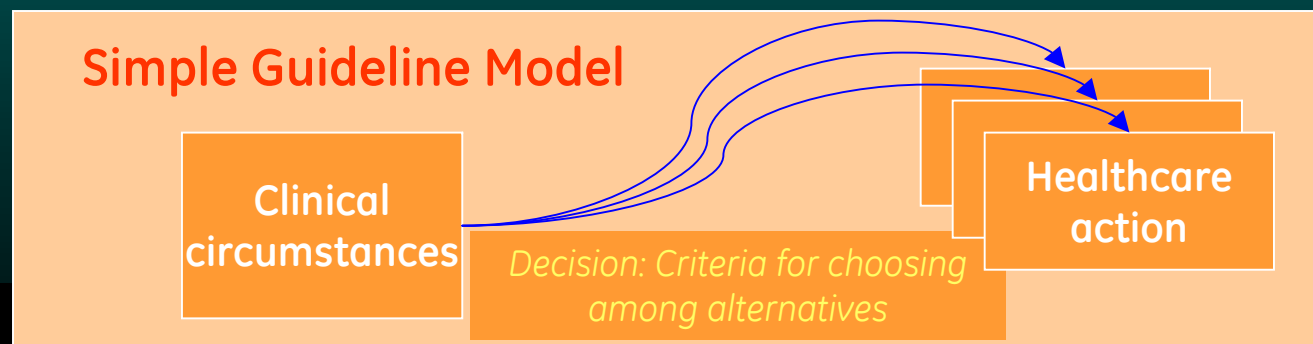
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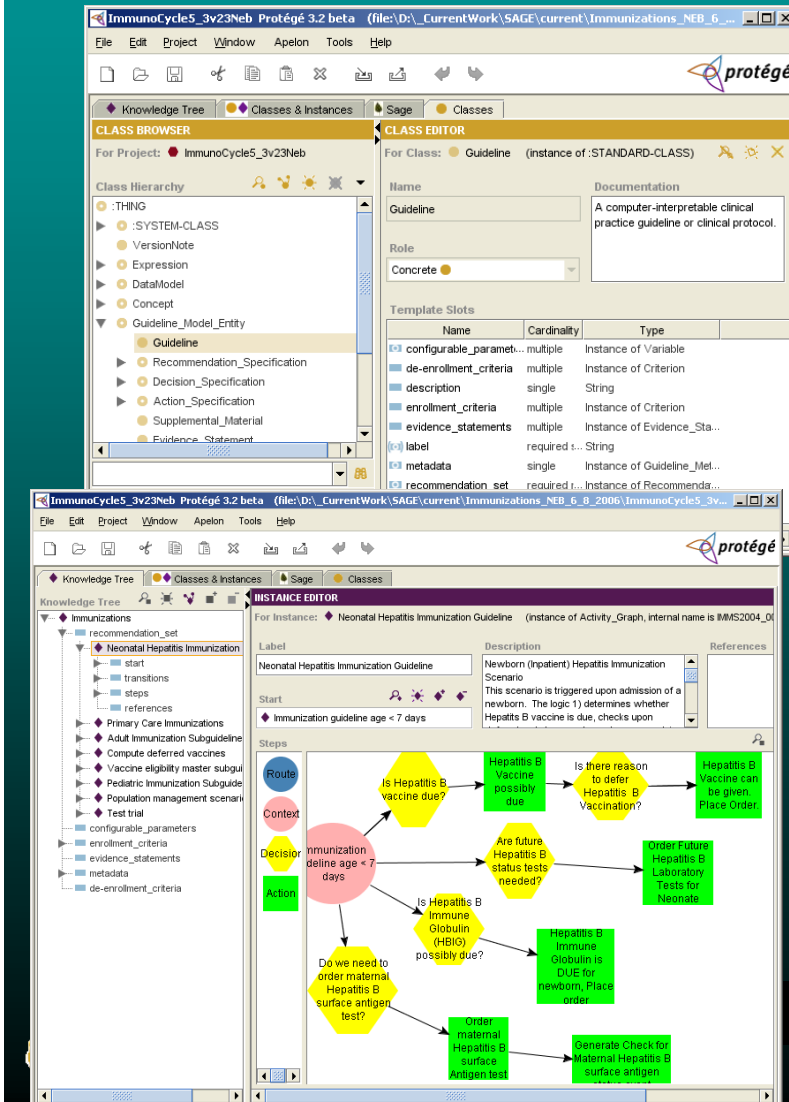
Model-Based Approach to Encoding Guidelines

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

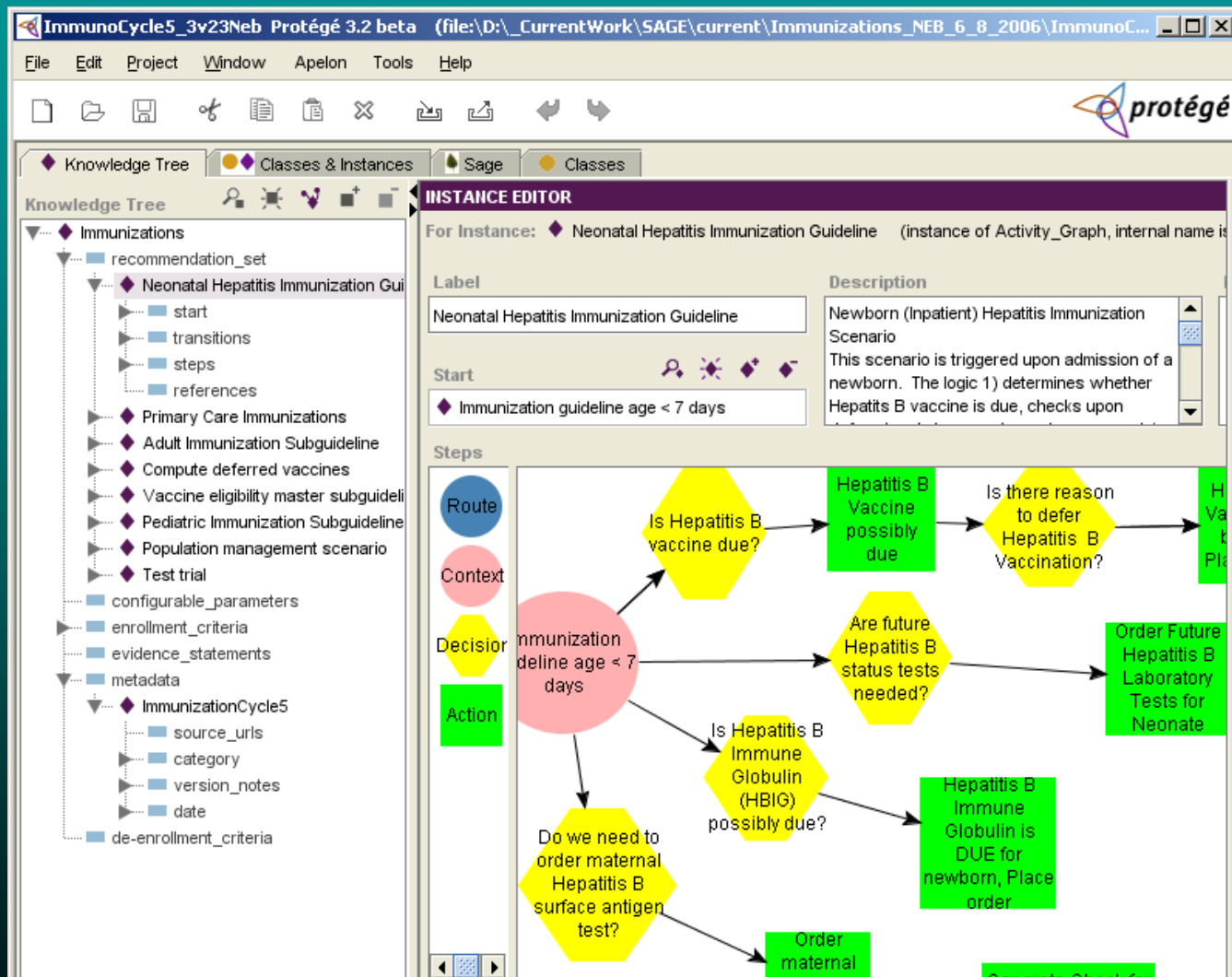


SAGE Guideline Model and Modeling Environment

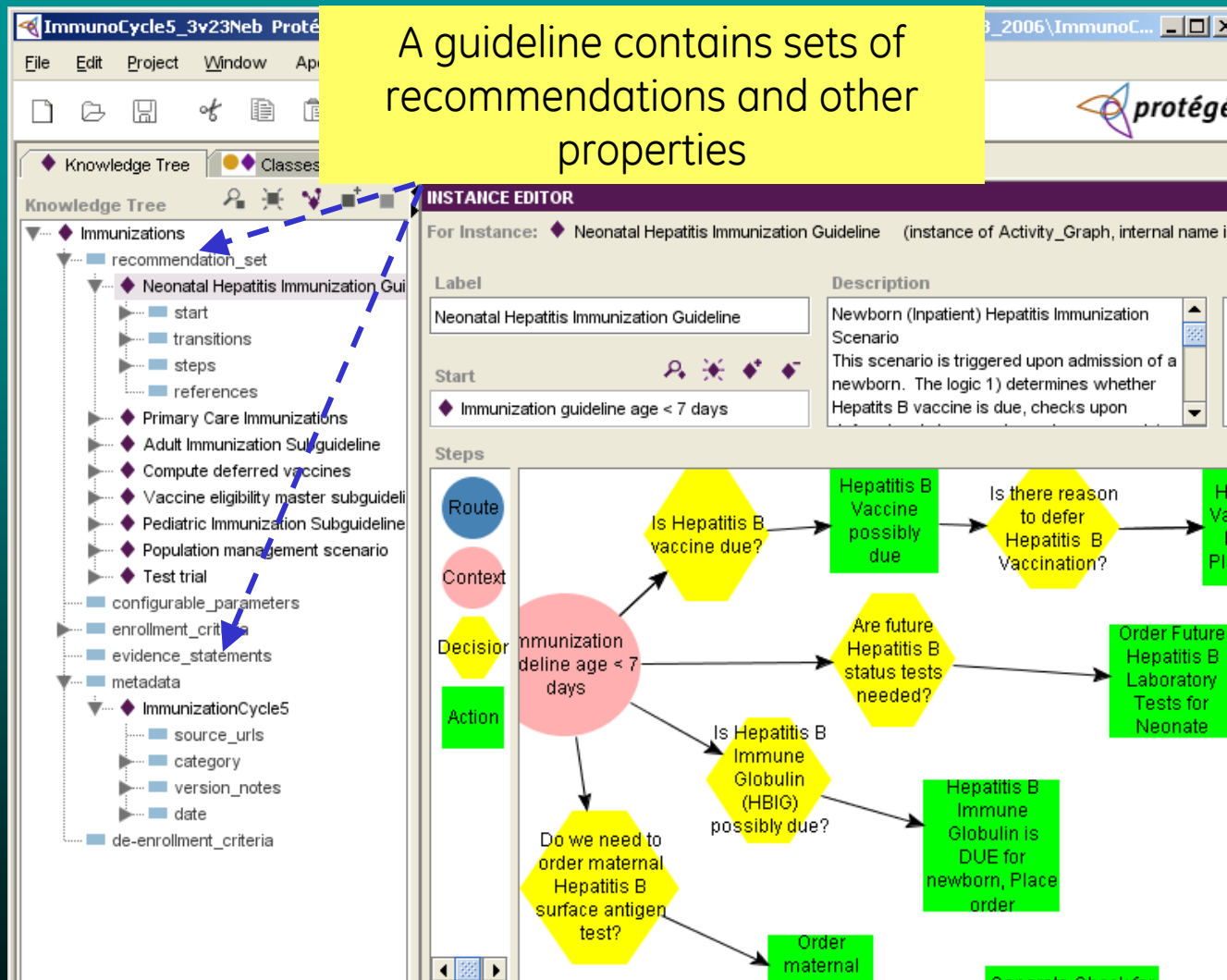
- Guideline model represented as a collection of **classes** and **relationships** among them
- Encoding a guideline (e.g. immunization guideline) means **creating instances** of these classes
- Use of graph widget to specify guideline recommendations as directed graphs



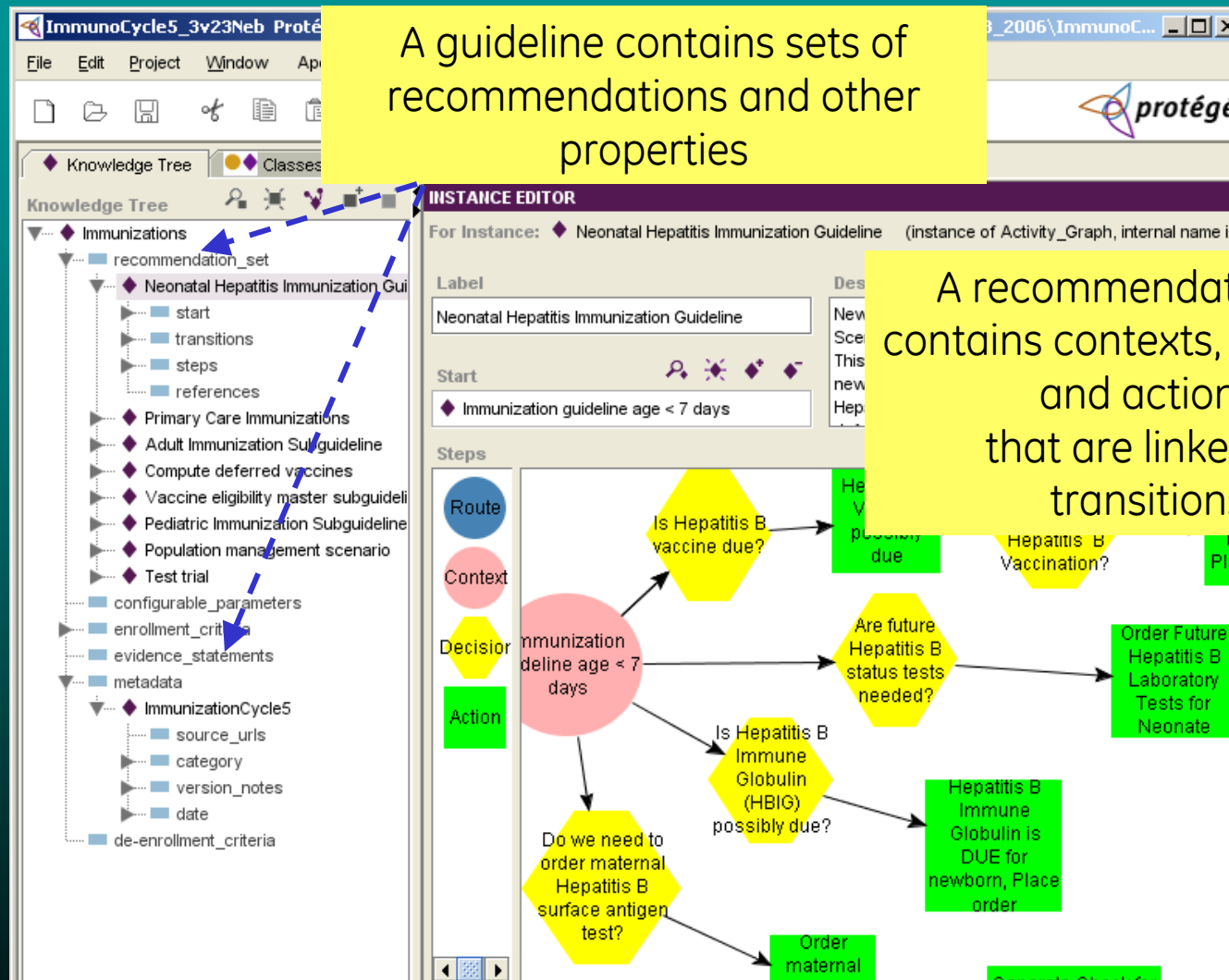
Structure of a SAGE Guideline



Structure of a SAGE Guideline



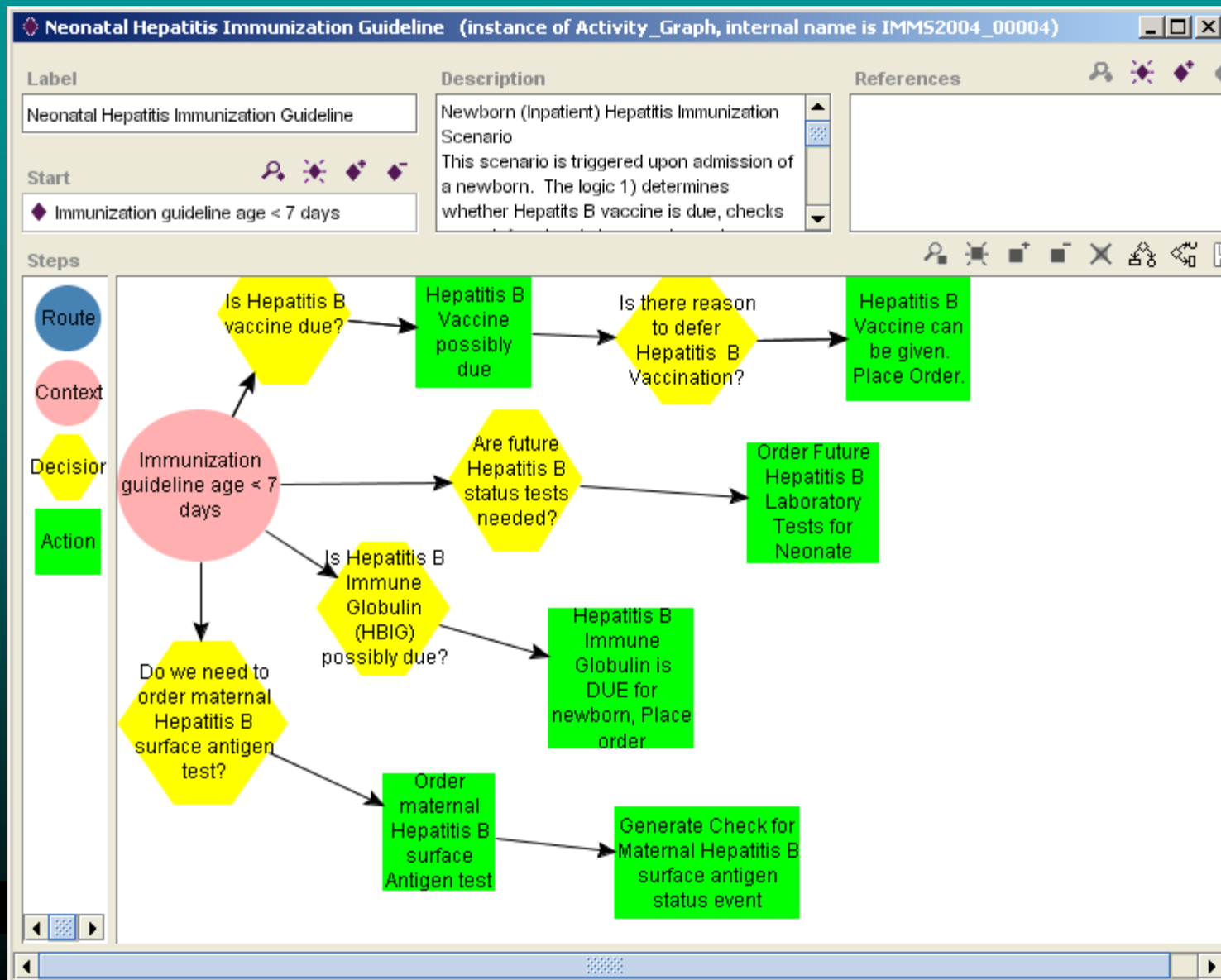
Structure of a SAGE Guideline



A guideline contains sets of recommendations and other properties

A recommendation set contains contexts, decisions, and actions that are linked by transitions

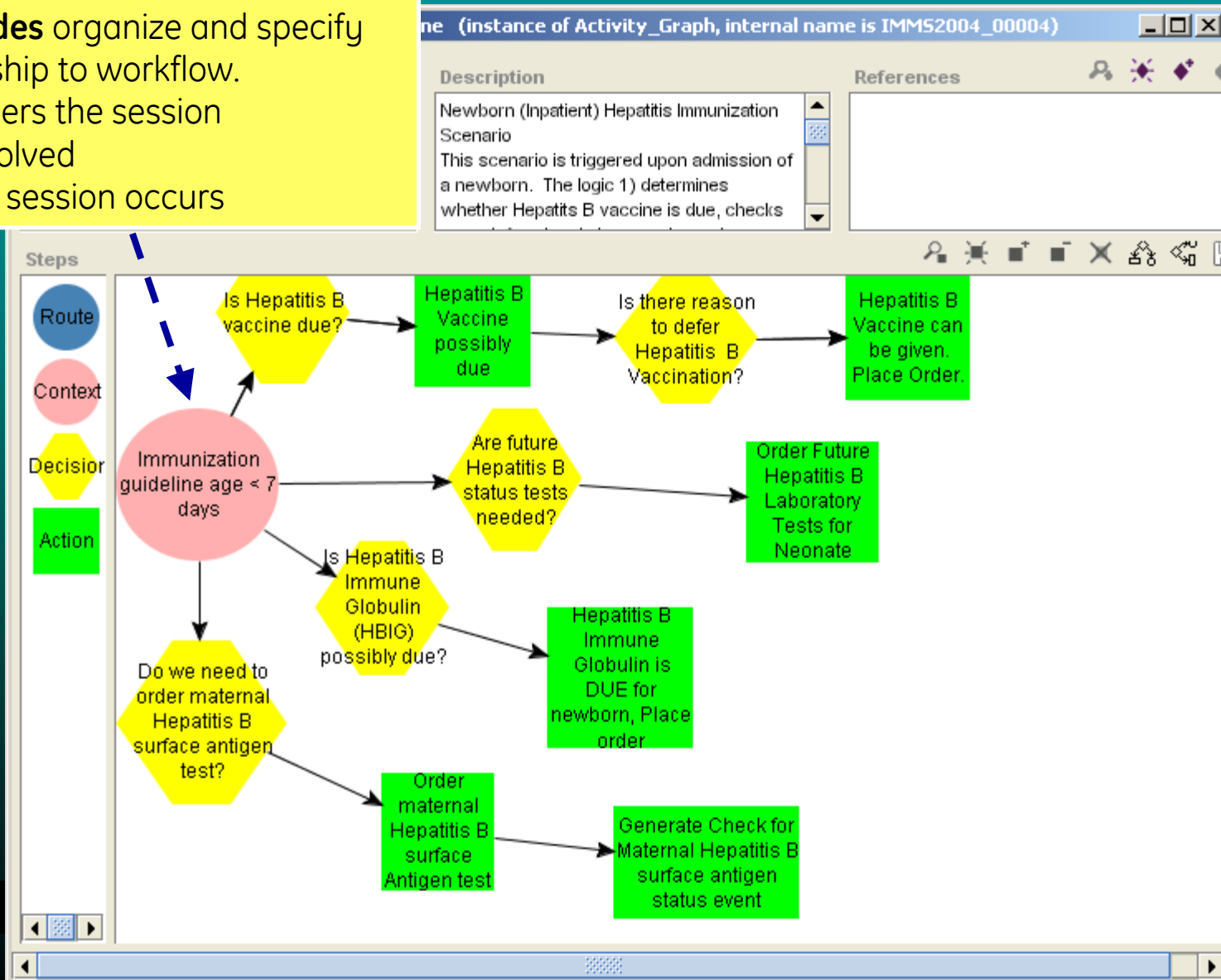
A Guideline Recommendation: Basic Components



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



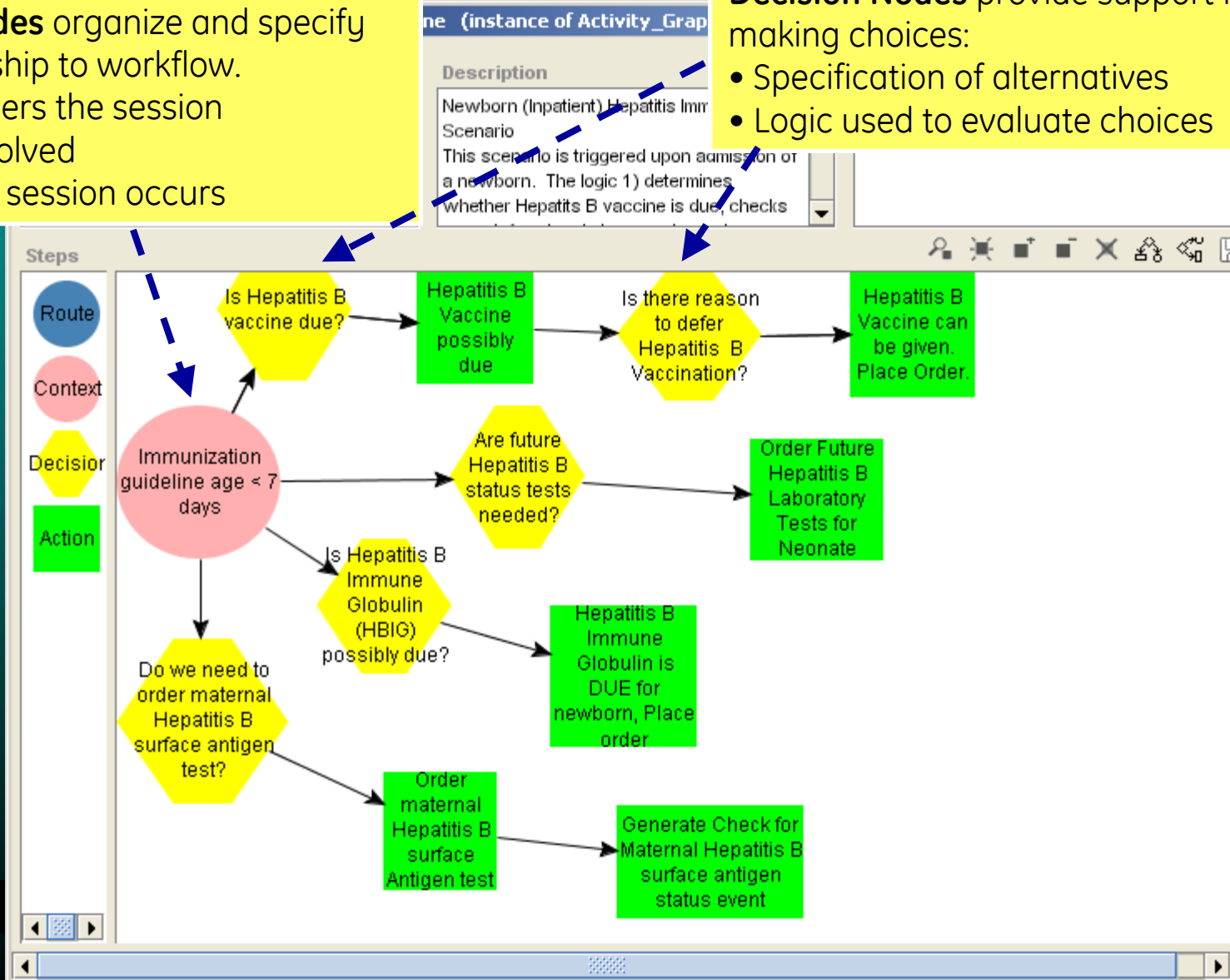
A Guideline Recommendation: Basic Components

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Decision Nodes provide support for making choices:

- Specification of alternatives
- Logic used to evaluate choices



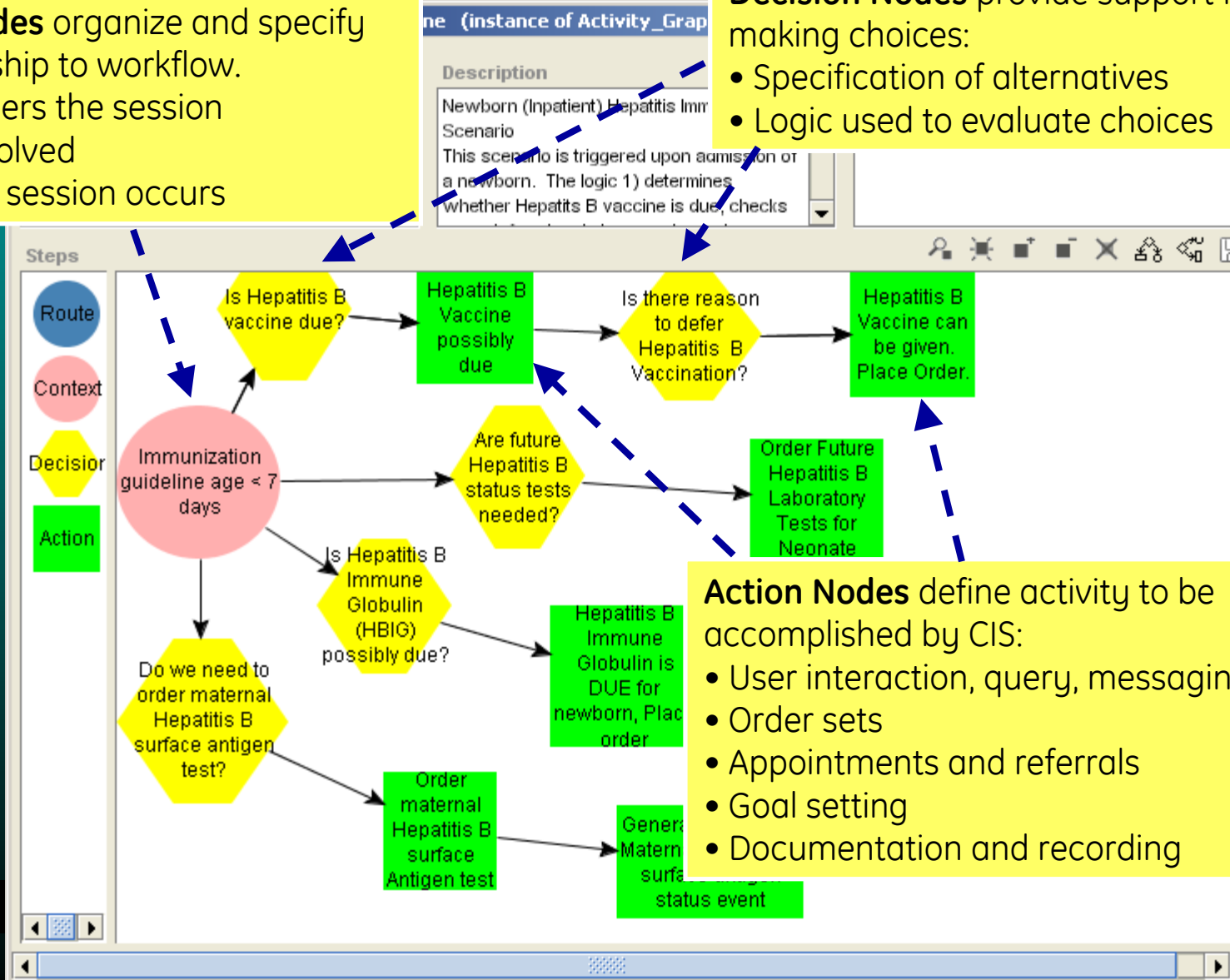
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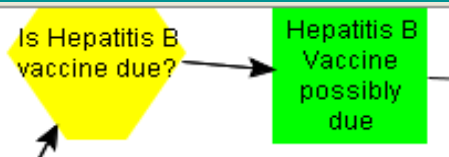
- Specification of alternatives
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Action Nodes define activity to be accomplished by CIS:

- 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?

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

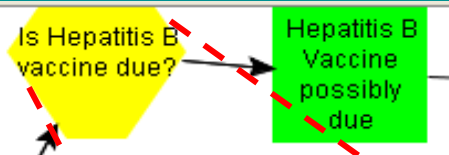
Strict Rule In

- ◆ 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

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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

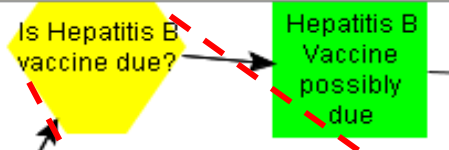
Strict Rule In

- 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

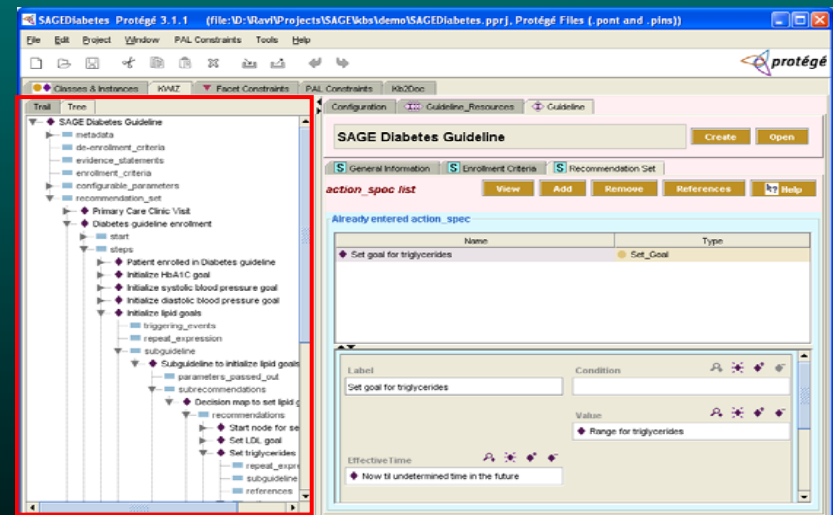
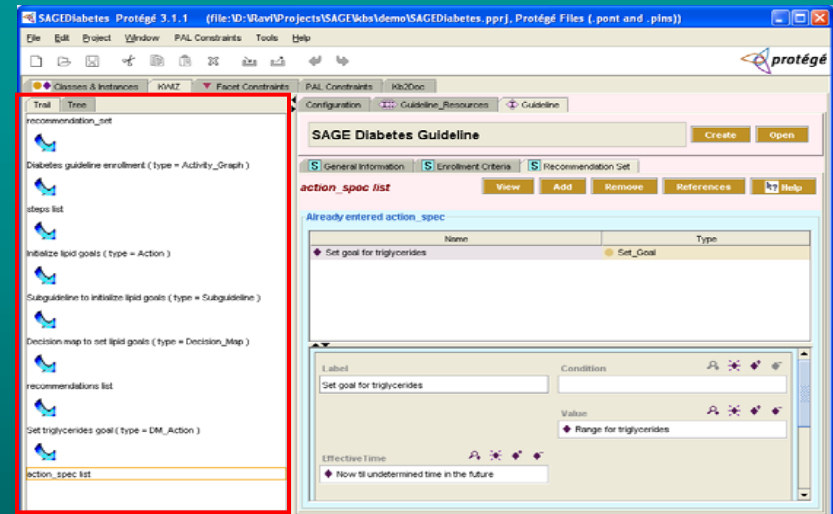
Rule In

Features of SAGE Protégé Workbench

- Alternative instance form: KWIZ tab
- Generation of XML/HTML: kb2doc tab
- Constraint checking: FacetConstraint tab & PALConstraint tab
- Case-based testing: SAGE tab
- Terminology server: Apelon terminology plugin

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](#)

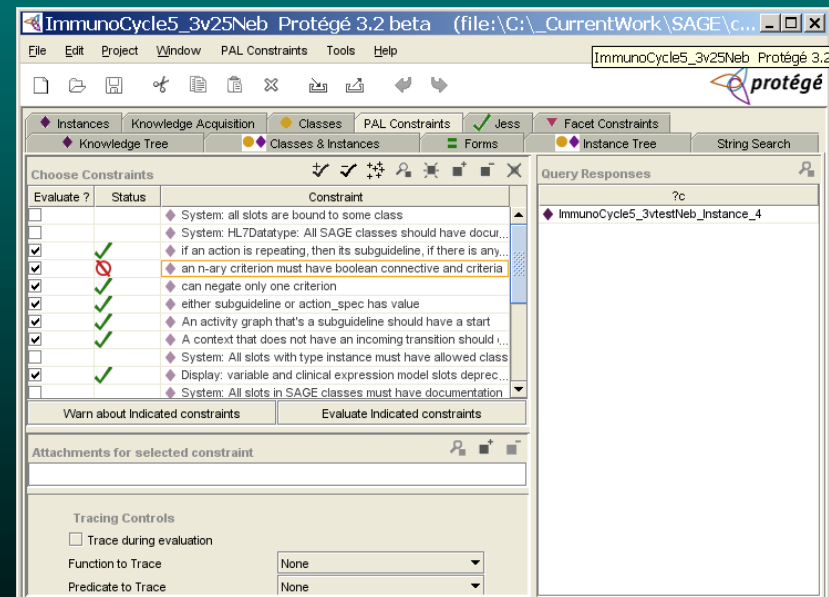
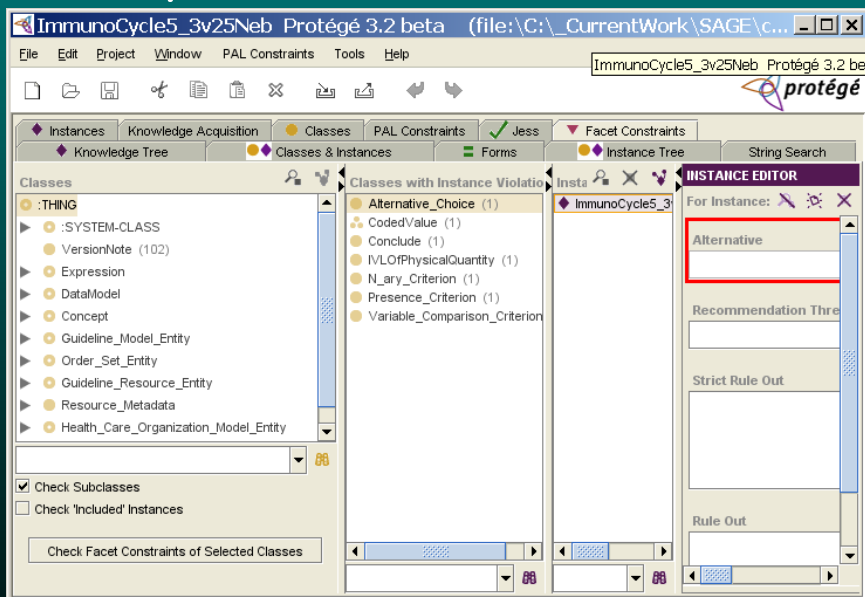
Recommendation Set (Activity Graph): Neonatal Hepatitis Immunization Guideline

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



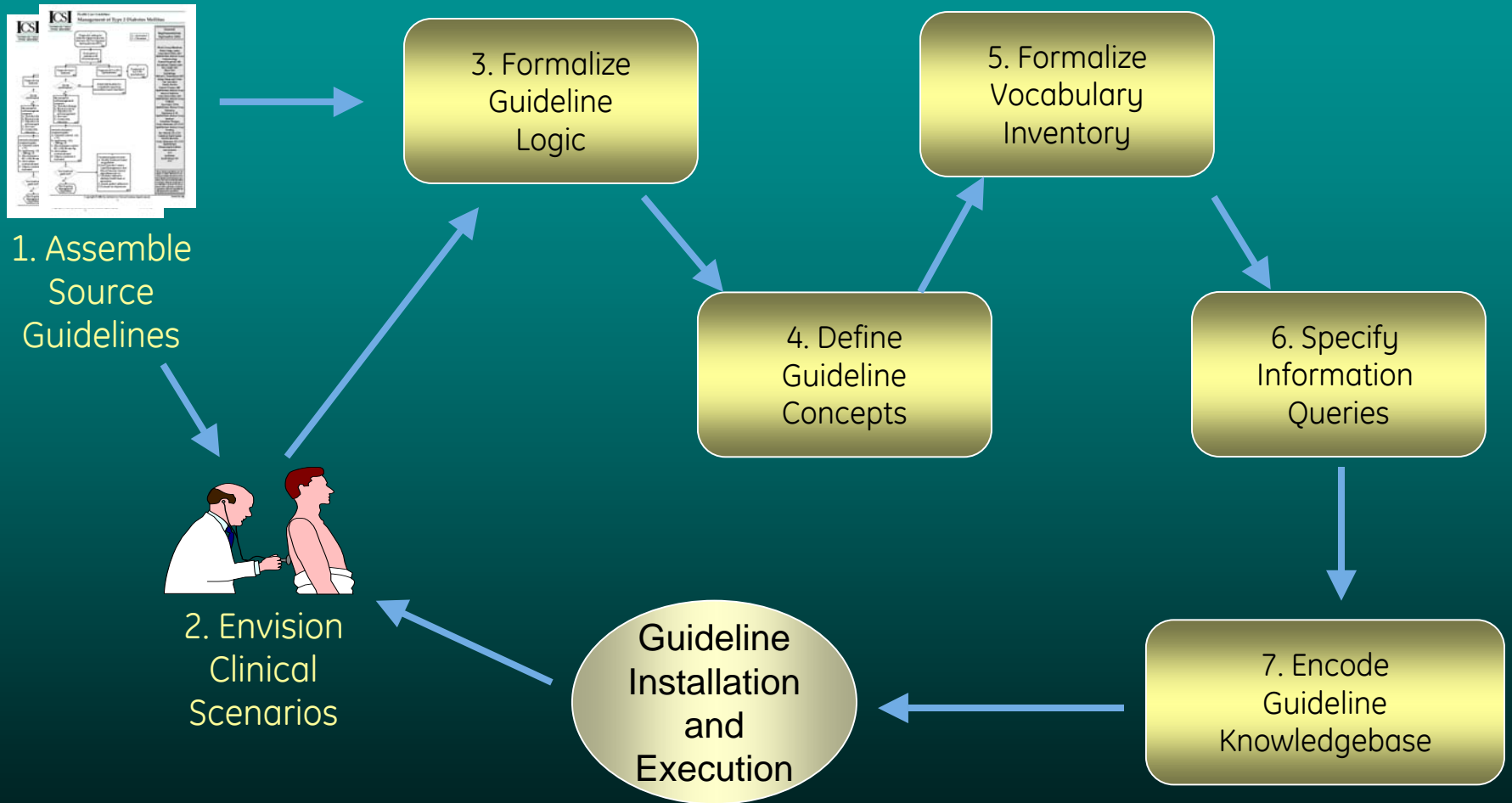
Overview

- Overview of guidelines and challenges to decision support development

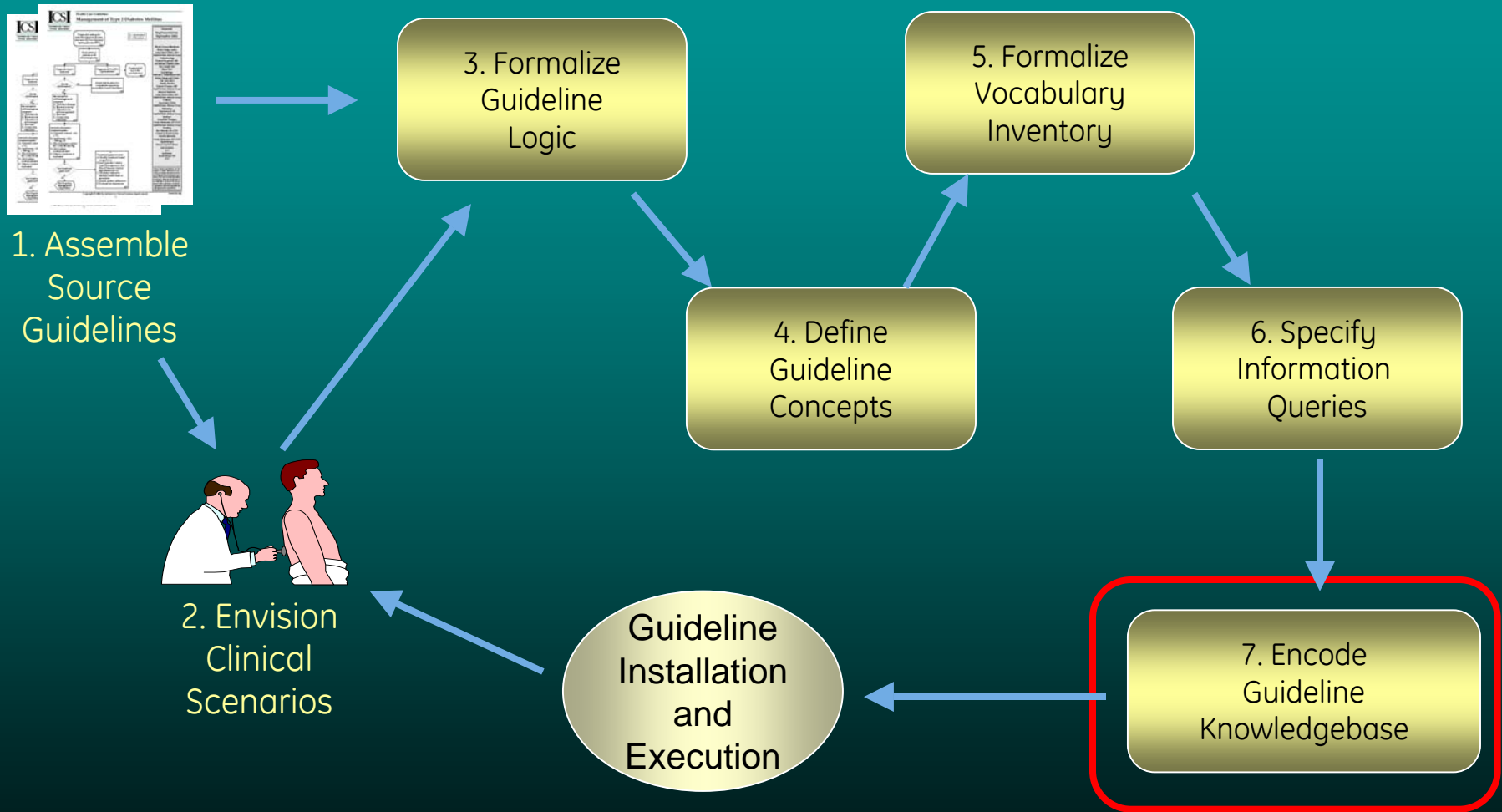
SAGE guideline modeling process:

- 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 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

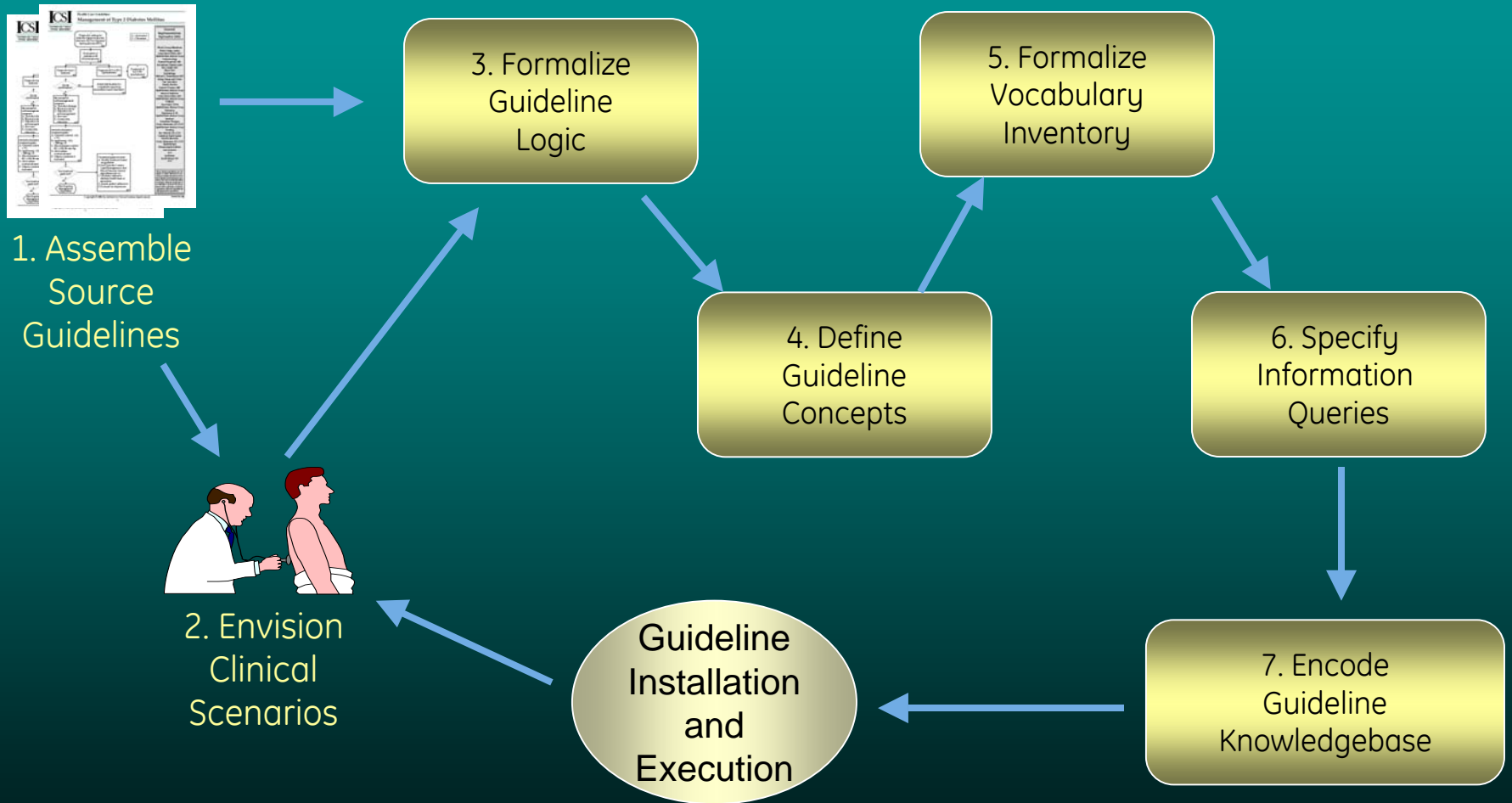
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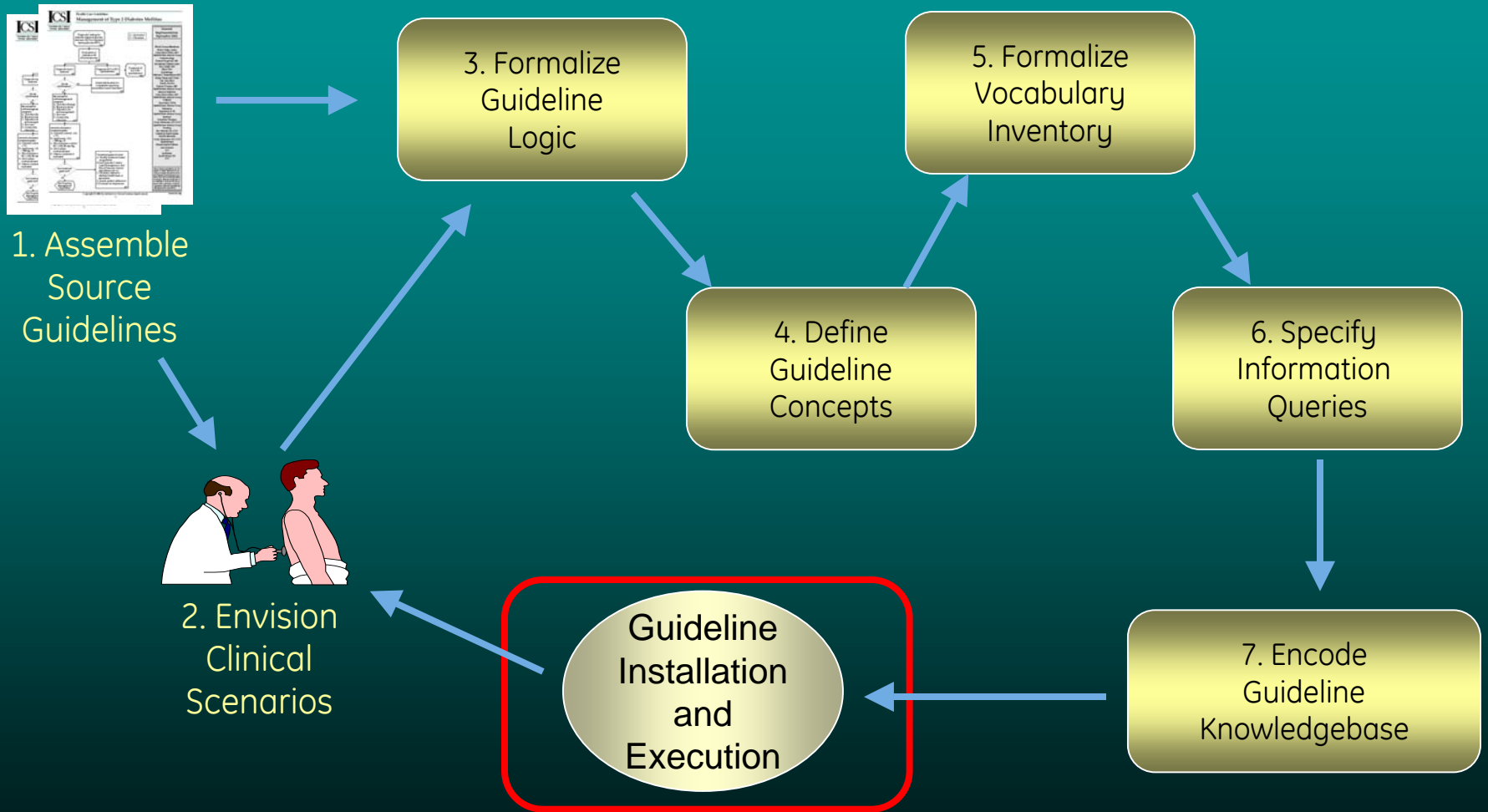
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- Specifying information queries
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- Encoding immunization guideline
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- Demonstration: SAGE at work

SAGE Guideline Encoding Process



SAGE Guideline Encoding Process



Validating the Encoding

- Validation of decision logic
- Internal review by modeler team
- Validation of run-time environment
 - Simulated cases
 - Copies of live data records
- Quality assurance plan
- Evaluation and feedback

Validating the Decision Logic

- Guideline workflow logic is often more complicated than can be embodied in simple rules
- As the complexity of the scenarios increases, probability of errors rises geometrically
- CDSS environment should consider workbench for testing important to overall activity
- Internal consistency checking of bindings and data constraints should be integrated within the CDSS workbench

Dynamic tests:

Demonstration

SAGE TAB

Patient: Yura Sage

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

Validating the 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

Validating the Run-Time Environment

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 Dt?

in-use
and may
between sites
for testing
data often

- Need for different pragmatics or expanded decision logic
- Failure of model to handle missing or incomplete data

Localization and Binding to Vendor 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)

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

Possible Compliance / 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

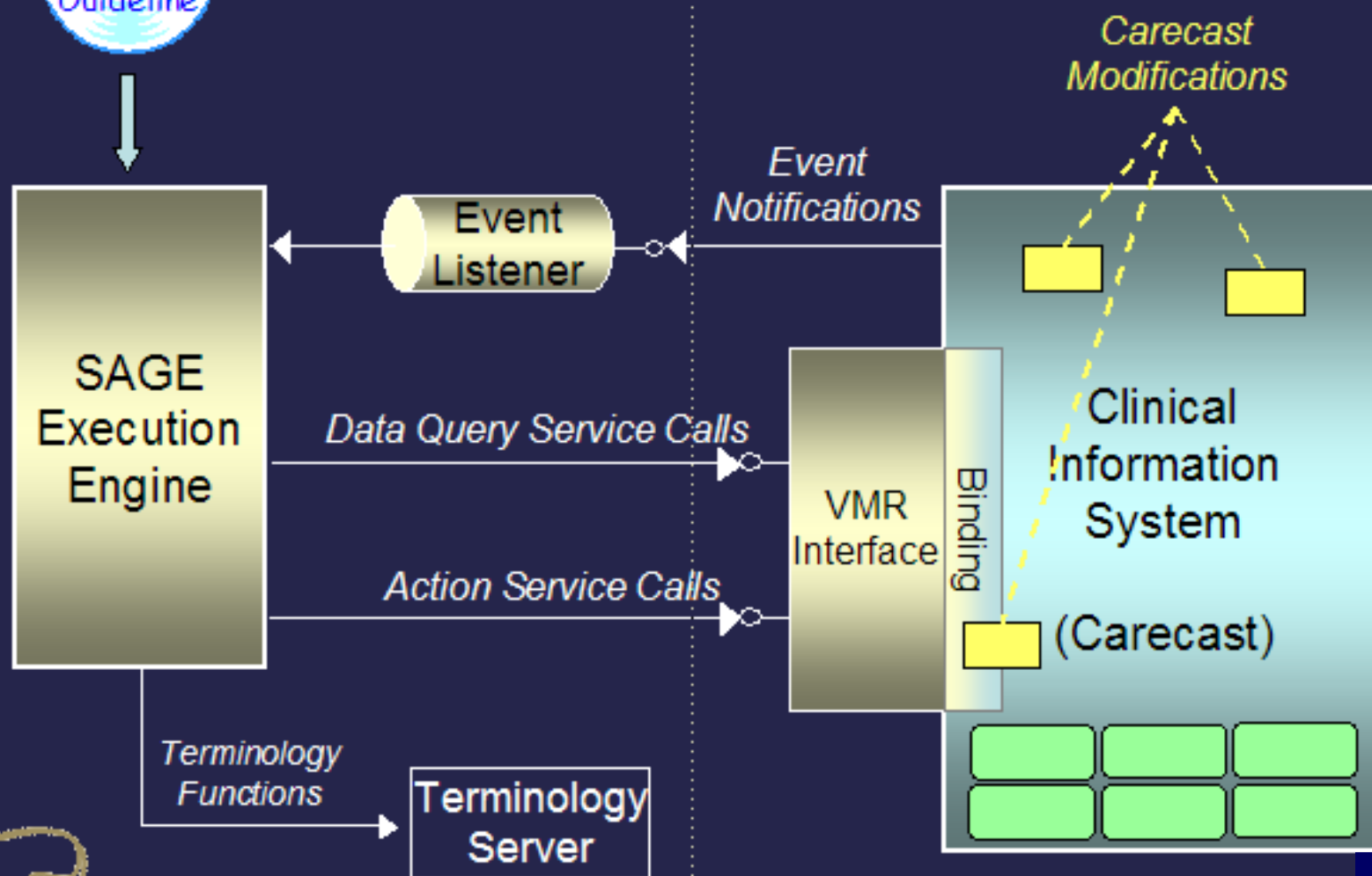
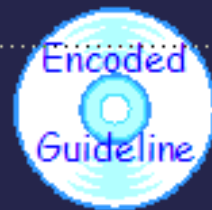
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- Specifying information queries
- SAGE guideline model and workbench
- Encoding immunization guideline
- Validating the development
- **Demonstration: SAGE at work**

SAGE Guideline Deployment System Execution Architecture



SAGE in Action!

Primary Care Visit Scenario

Patient: Yura Sage

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

Primary Care Visit Scenario

- Patient checks into clinic
- Clinician accesses the patient record, triggering CDSS (SAGE)
 - Event sent from web page
- CIS queries problem list, procedure history and vaccination history to evaluate vaccinations due or due but contraindicated
- In Carecast, Inbox messages sent:
 - ‘Vaccines due/ 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
- Carecast Inbox message sent:
 - Order session: orders present for due vaccines

Questions?

Discussion...

Carecast / SAGE interactions

CIS (CareCast) Logon

LastWord Client

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

User Number ==> SAGEUSER

Password: *****

**** \$PMMSG - 5.1.7 The Nebraska Medical Center SAGE Pathway ****

CareCast Version 5.10.28
Copyright (C) 1981-1999
IDX Systems, Inc.

Patient: Yura Sage

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 Flowcharts

Desktop

Current Patient List: GRP: SAGEimmunization Sage

MRN	Patient Name	Other Information
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01000214	SAGE, Yura	
01000199	SAGE, Neonate	S 02IN-A Campbell, James R
01000222	SAGE, One year old	
01000216	SAGE, Pediatric year old 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	Owner
Hotlist		
SAGECAP	GRP	Sage
SAGEdiabetes	GRP	Sage
SAGEimmunization	GRP	Sage
SAGETest	GRP	Sage
TemporaryList	PERS	User, Sage

Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
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Create Resolve Refresh Sage

.SAGMD S

Problem List and Current Orders

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
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: Searching for:

Search Method: ☒ Begins With ☐ Contains ☐ Leading Word

☒ All ☐ Non-Meds ☐ Meds ☐ Ord Sets

Find Matches Show Favori...

Fac: 5 Loc:

☐ Prescription ☐ Historical

Order Selections

Syn

Select Order

Problem List and Current Orders

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

Icons: ? (Help), ? (Info), ? (Page), ? (Page), ? (Home), ? (Exit), ? (OK)

Navigation: Pt. Info & Misc., Order, Notes, Procedures, Lab, Ancillary, Nursing, Meds, Summary, Flowcharts

Patient Problem List

Add: [] Expand

Status	Problem Description	Gde
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- ☐ Leading Word

Searching for:

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

Find Matches Show Favori...

Fac: 5 Loc: []

☐ Prescription ☐ Historical

Order Selections

Syn []

Select Order

Problem List and Current Orders

01000214 SAGE, Yura - M

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☐ Ord Sets

Find Matches Show Favori...

Fac: 5 Loc: []

☐ Prescription
☐ Historical

Syn Order Selections

--	--

Select Order

SAGE Triggering Event

Send Event To SAGE Engine - Microsoft Internet Explorer provided by The Nebraska Medical Center



File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Reload Print View Source

Address <http://10.16.8.16:9080/sage/protected/SendEvent.faces> Go Links

Google Search 17 blocked Check AutoLink AutoFill Options

SAGE: Sharable Active Guideline Environment v1.0

Send Event To SAGE Engine

Please enter event information.

Event: Outpatient nurse accesses patient record

Patient ID: 01000214

Internal ID:

Copyright 2006 SAGE Project

SAGE Triggering Event

Send Event To SAGE Engine - Microsoft Internet Explorer provided by The Nebraska Medical Center



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Copyright 2006 SAGE Project

Inbox Messages

01000214 SAGE, Yura - M

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PICK INFO PAGE PAGE HOME ? EXIT OK

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01000222	SAGE, One year old	
01000216	SAGE, Pediatric year old A	

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

Command Central

Command: DCENTRY

Active MRN: 01000214 Global Name Lookup

Patient List Directory

☒ Freq ☐ Folders ☐ Avail

List Name	Type	Owner
Hotlist		
SAGECAP	GRP	Sage
SAGEdiabetes	GRP	Sage
SAGEimmunization	GRP	Sage
SAGETest	GRP	Sage
TemporaryList	PERS	User, Sage

Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
Unsolicited	
Patient message	2

Create Resolve Refresh Sage

Inbox Messages

01000214 SAGE, Yura - M

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Global Name Lookup

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☒ All Mine ☐ Patient

Notifications	Count
Unsolicited	
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Create Resolve Refresh Sage

Query for Consent and Illness

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

Notification: Patient message

Date	Time	Subject	From	FYI	Note
16Jul2006	21:00	Sage Mesg.	USER, SAGE		
16Jul2006	21:00	Sage Mesg.	USER, SAGE		

subject: Obtain immunization consent
message:

subject: Inquire about illness
message:

Forwarded/Reassigned By: USER, SAGE

Reason for Forward/Reassign

Full Subject Text: Sage Mesg.

Annotate

Audit

Forward

Hold

Reassign

Reject

Reply

Resolve

Cancel

Query for Consent and Illness

01000214 SAGE, Yura - M

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PICK INFO PAGE PAGE HOME ? EXIT OK

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Full Subject Text:Sage Mesg.

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Hold

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Reject

Reply

Resolve

Cancel

Generate Vaccine Information

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

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Date	Time	Subject	From	FYI	Note
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16Jul2006	21:00	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 Meningococcal (MCV4) education material
Forwarded/Reassigned By: USER, SAGE

Reason for Forward/Reassign

Full Subject Text: Sage Mesg.

Annotate

Audit

Forward

Hold

Reassign

Reject

Reply

Resolve

Cancel

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01000214 SAGE, Yura - M

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Forwarded/Reassigned By: USER, SAGE

Reason for Forward/Reassign

Full Subject Text: Sage Mesg.

Annotate
Audit
Forward
Hold
Reassign
Reject
Reply
Resolve
Cancel

SAGE Button Active

01000214 SAGE, Yura - M

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Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
---------------	-------

Create Resolve Refresh Sage

SAGE Button Active

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

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TemporaryList	PERS	User, Sage

Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
---------------	-------

Create Resolve Refresh Sage

Sage Reports Log: Due and Due but Contraindicated Vaccines

Admin - Microsoft Internet Explorer provided by The Nebraska Medical Center

File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Reload Print Mail New Window New Tab

Address <http://10.16.8.16:9080/sage/protected/sageadmin?systemcommand=sagereslog> Go Links

Google Search 17 blocked Check AutoLink AutoFill Options

Observation	01000214	<ul style="list-style-type: none">From: SNOMED CT:31874001Name: MCV4 vaccine is due [SAGE]From: SAGE:C127FromDisplayName: MCV4 vaccine is dueStateName: ImmunoCycle5_2Neb_Instance_140031ActionType: Conclude
Observation	01000214	<ul style="list-style-type: none">Name: Contraindicated (qualifier value) [SNOMED CT]From: SNOMED CT:410536001FromDisplayName: Contraindicated (qualifier value)Name: Varicella vaccine is due [SAGE]From: SAGE:C120FromDisplayName: Varicella vaccine is dueStateName: ImmunoCycle5_3v4Neb_Instance_30000ActionType: Conclude
Display	01000214	<ul style="list-style-type: none">subject: Generate Hep B education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-hep-b.pdf*subject: Generate Pneumococcal (PPV23) education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-ppv.pdf*subject: Generate Meningococcal (MCV4) education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-mening.pdf*SubjectStr: Sage MesgAddresseeStr: Session_Owner
Display	01000214	<ul style="list-style-type: none">subject: Send notification that MMR is contraindicated message:MMR vaccine is due but contraindicatedsubject: Send notification that varicella vaccine is contraindicated message:Varicella vaccine is due but contraindicatedsubject: Hep B due notification to report message:Hep B vaccination is duesubject: Meningococcal (MCV4) due notification to report message:Meningococcal MCV4 vaccination is duesubject: Pneumococcal (PPV23) due notification to report message:Pneumococcal PPV23 vaccination is duesubject: Obtain immunization consent message: \parsubject: Inquire about illness message: \parSubjectStr: Sage MesgAddresseeStr: Primary care physician

Provider Queries 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

Sage:

Pending

Is a serious illness present in this patient that renders immunization inadvisab

Has Immunization consent been given?

resolve

refresh

Is Serious Illness Present?

The screenshot displays the SAGE SGPRS (Sage Global Patient Record System) interface. The main window title is "01000214 SAGE, Yura - M". The menu bar includes "File", "Patient", "Session", "Navigate", "Tools", and "Help". The toolbar contains icons for "PICK", "INFO", "PAGE", "HOME", and buttons for "?", "EXIT", and "OK".

A dialog box titled "SGPRS" is open, displaying the question: "Is a serious illness present in this patient that renders immunization inadvisab". Below the question is a list box with two options: "Absent (qualifier value)" and "Present (qualifier value)". At the bottom of the dialog box are two buttons: "submit" and "back out".

The background interface shows a sidebar with "Pt. Info & Misc" and "Sage:" sections. The "Sage:" section has a dropdown menu with "Pe", "Is", and "Ha" visible. The "Flowcharts" section is also visible on the right.

Has Consent Been Given?

The screenshot displays a medical software window titled "01000214 SAGE, Yura - M". The menu bar includes "File", "Patient", "Session", "Navigate", "Tools", and "Help". The toolbar contains icons for "PICK", "INFO", "PAGE", "HOME", and buttons for "?", "EXIT", and "OK". A sidebar on the left shows "Pt. Info & Misc" and "Sage:". The main area features a dialog box titled "SGPRS" with the question "Has Immunization consent been given?". Below the question is a list box containing two items: "True (qualifier value)" and "False (qualifier value)". At the bottom of the dialog are "submit" and "back out" buttons.

01000214 SAGE, Yura - M

File Patient Session Navigate Tools Help

PICK INFO PAGE PAGE HOME ? EXIT OK

Pt. Info & Misc

Sage:

SGPRS

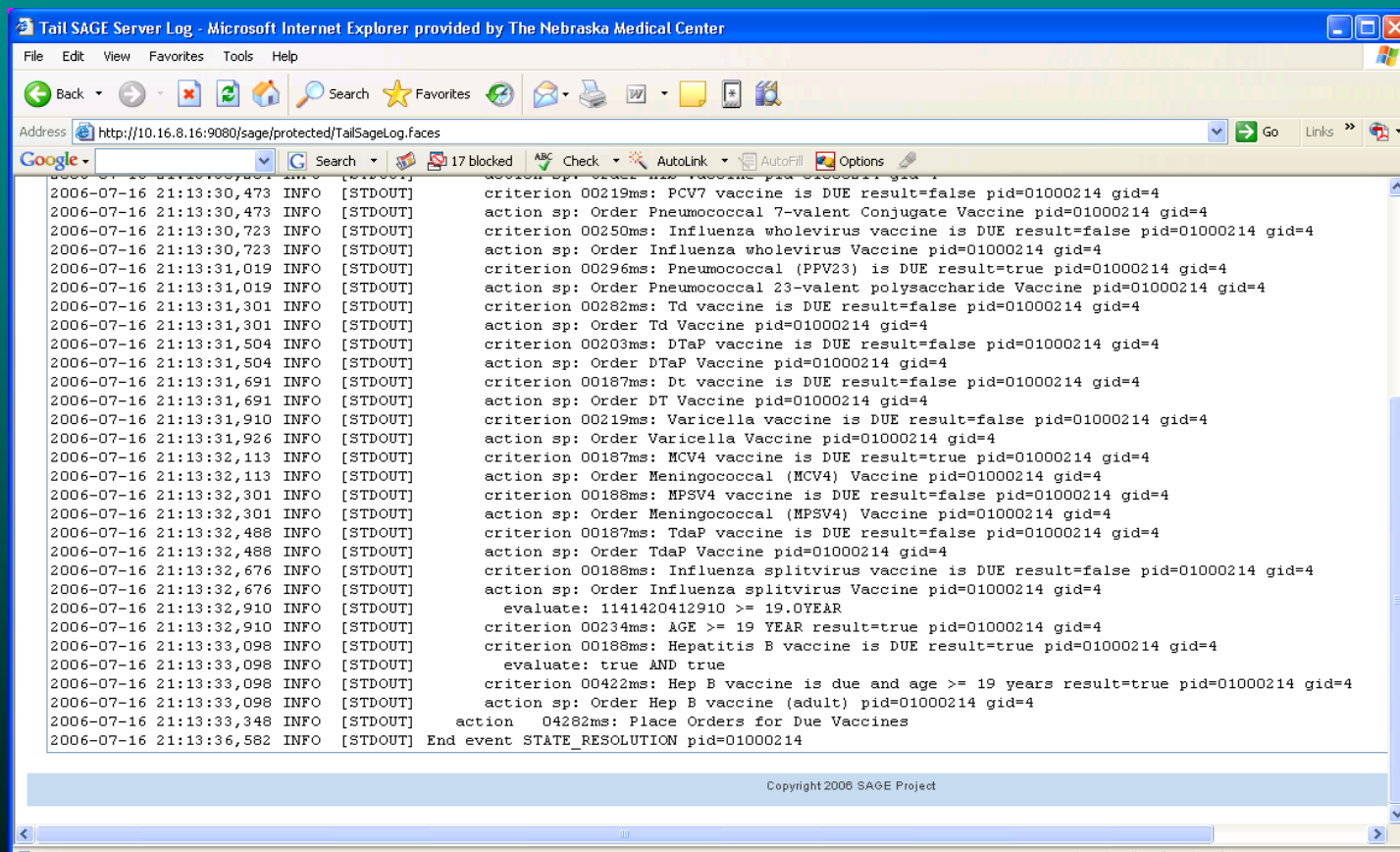
Has Immunization consent been given?

True (qualifier value)

False (qualifier value)

submit back out

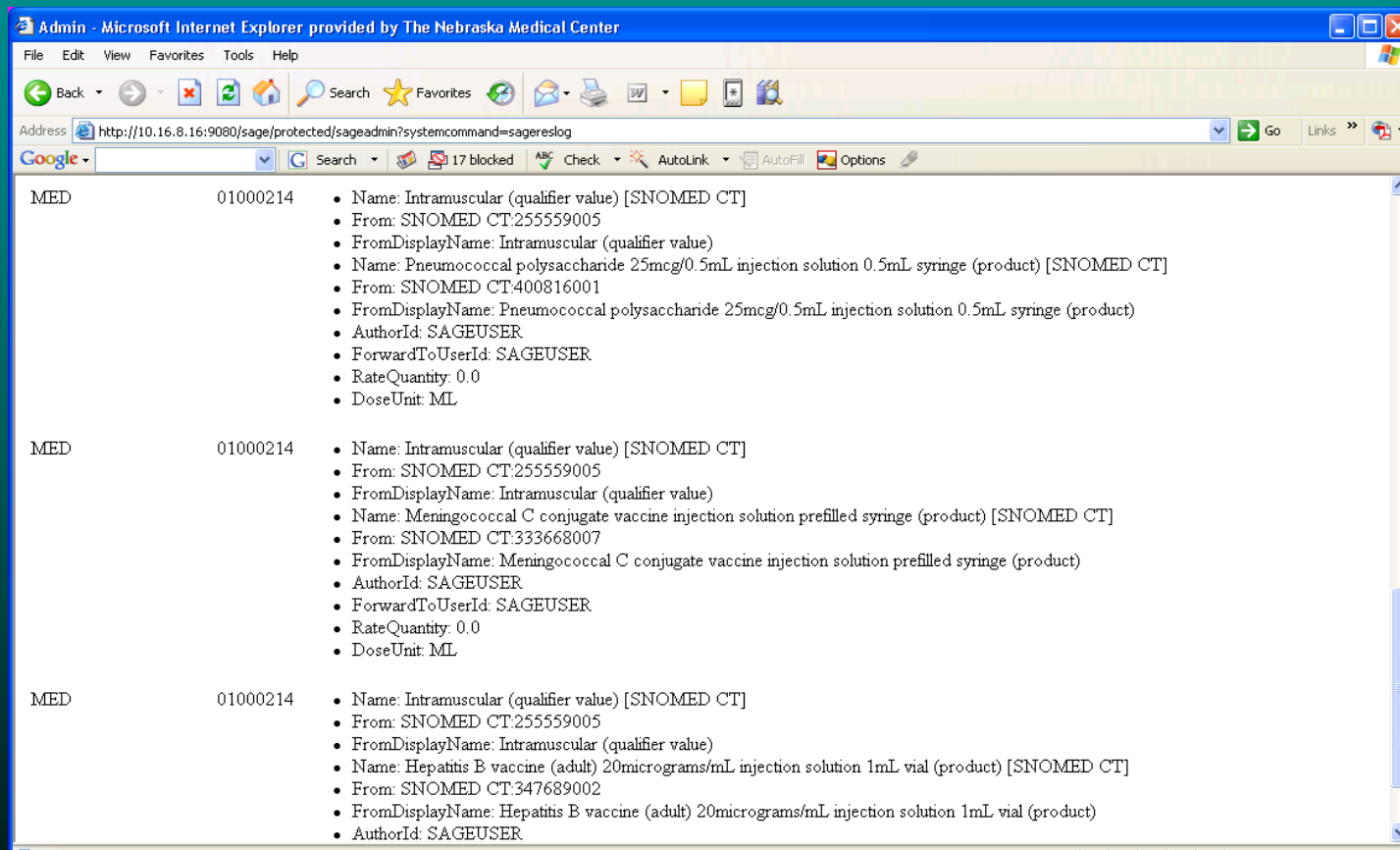
SAGE Log: 'Place Orders for Due Vaccines'



```
2006-07-16 21:13:30,473 INFO [STDOUT] action sp: Order PCV7 vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:30,473 INFO [STDOUT] action sp: Order Pneumococcal 7-valent Conjugate Vaccine pid=01000214 gid=4
2006-07-16 21:13:30,723 INFO [STDOUT] criterion 00250ms: Influenza wholevirus vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:30,723 INFO [STDOUT] action sp: Order Influenza wholevirus Vaccine pid=01000214 gid=4
2006-07-16 21:13:31,019 INFO [STDOUT] criterion 00296ms: Pneumococcal (PPV23) is DUE result=true pid=01000214 gid=4
2006-07-16 21:13:31,019 INFO [STDOUT] action sp: Order Pneumococcal 23-valent polysaccharide Vaccine pid=01000214 gid=4
2006-07-16 21:13:31,301 INFO [STDOUT] criterion 00282ms: Td vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:31,301 INFO [STDOUT] action sp: Order Td Vaccine pid=01000214 gid=4
2006-07-16 21:13:31,504 INFO [STDOUT] criterion 00203ms: DTaP vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:31,504 INFO [STDOUT] action sp: Order DTaP Vaccine pid=01000214 gid=4
2006-07-16 21:13:31,691 INFO [STDOUT] criterion 00187ms: Dt vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:31,691 INFO [STDOUT] action sp: Order DT Vaccine pid=01000214 gid=4
2006-07-16 21:13:31,910 INFO [STDOUT] criterion 00219ms: Varicella vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:31,926 INFO [STDOUT] action sp: Order Varicella Vaccine pid=01000214 gid=4
2006-07-16 21:13:32,113 INFO [STDOUT] criterion 00187ms: MCV4 vaccine is DUE result=true pid=01000214 gid=4
2006-07-16 21:13:32,113 INFO [STDOUT] action sp: Order Meningococcal (MCV4) Vaccine pid=01000214 gid=4
2006-07-16 21:13:32,301 INFO [STDOUT] criterion 00188ms: MPSV4 vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:32,301 INFO [STDOUT] action sp: Order Meningococcal (MPSV4) Vaccine pid=01000214 gid=4
2006-07-16 21:13:32,488 INFO [STDOUT] criterion 00187ms: Tdap vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:32,488 INFO [STDOUT] action sp: Order Tdap Vaccine pid=01000214 gid=4
2006-07-16 21:13:32,676 INFO [STDOUT] criterion 00188ms: Influenza splitvirus vaccine is DUE result=false pid=01000214 gid=4
2006-07-16 21:13:32,676 INFO [STDOUT] action sp: Order Influenza splitvirus Vaccine pid=01000214 gid=4
2006-07-16 21:13:32,910 INFO [STDOUT] evaluate: 1141420412910 >= 19.0YEAR
2006-07-16 21:13:32,910 INFO [STDOUT] criterion 00234ms: AGE >= 19 YEAR result=true pid=01000214 gid=4
2006-07-16 21:13:33,098 INFO [STDOUT] criterion 00188ms: Hepatitis B vaccine is DUE result=true pid=01000214 gid=4
2006-07-16 21:13:33,098 INFO [STDOUT] evaluate: true AND true
2006-07-16 21:13:33,098 INFO [STDOUT] criterion 00422ms: Hep B vaccine is due and age >= 19 years result=true pid=01000214 gid=4
2006-07-16 21:13:33,098 INFO [STDOUT] action sp: Order Hep B vaccine (adult) pid=01000214 gid=4
2006-07-16 21:13:33,348 INFO [STDOUT] action 04282ms: Place Orders for Due Vaccines
2006-07-16 21:13:36,582 INFO [STDOUT] End event STATE_RESOLUTION pid=01000214
```

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SAGE Reports Log: Med Orders



MED	01000214	<ul style="list-style-type: none">• Name: Intramuscular (qualifier value) [SNOMED CT]• From: SNOMED CT:255559005• FromDisplayName: Intramuscular (qualifier value)• Name: Pneumococcal polysaccharide 25mcg/0.5mL injection solution 0.5mL syringe (product) [SNOMED CT]• From: SNOMED CT:400816001• FromDisplayName: Pneumococcal polysaccharide 25mcg/0.5mL injection solution 0.5mL syringe (product)• AuthorId: SAGEUSER• ForwardToUserId: SAGEUSER• RateQuantity: 0.0• DoseUnit: ML
MED	01000214	<ul style="list-style-type: none">• Name: Intramuscular (qualifier value) [SNOMED CT]• From: SNOMED CT:255559005• FromDisplayName: Intramuscular (qualifier value)• Name: Meningococcal C conjugate vaccine injection solution prefilled syringe (product) [SNOMED CT]• From: SNOMED CT:333668007• FromDisplayName: Meningococcal C conjugate vaccine injection solution prefilled syringe (product)• AuthorId: SAGEUSER• ForwardToUserId: SAGEUSER• RateQuantity: 0.0• DoseUnit: ML
MED	01000214	<ul style="list-style-type: none">• Name: Intramuscular (qualifier value) [SNOMED CT]• From: SNOMED CT:255559005• FromDisplayName: Intramuscular (qualifier value)• Name: Hepatitis B vaccine (adult) 20micrograms/mL injection solution 1mL vial (product) [SNOMED CT]• From: SNOMED CT:347689002• FromDisplayName: Hepatitis B vaccine (adult) 20micrograms/mL injection solution 1mL vial (product)• AuthorId: SAGEUSER

Inbox Message: 1 Order Session

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

Desktop

Current Patient List: GRP: SAGEimmunization 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, Pediatric year old A	

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

Command Central

Command: DCENTRY

Active MRN: 01000214 Global Name Lookup

Patient List Directory

☒ Freq ☐ Folders ☐ Avail

List Name	Type	Owner
Hotlist		
SAGECAP	GRP	Sage
SAGEdiabetes	GRP	Sage
SAGEimmunization	GRP	Sage
SAGETest	GRP	Sage
TemporaryList	PERS	User, Sage

Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
SAGE	
You have saved order sessions	1

Create Resolve Refresh Sage

Inbox Message: 1 Order Session

The screenshot displays the SAGE Desktop application window. The title bar reads "01000214 SAGE, Yura - M". The menu bar includes "File", "Patient", "Session", "Navigate", "Tools", and "Help". A toolbar contains icons for "PICK", "INFO", "PAGE", "HOME", "?", "EXIT", and "OK". Below the toolbar is a tabbed interface with tabs for "Pt. Info & Misc.", "Orders", "Notes", "Procedures", "Lab", "Ancillary", "Nursing", "Meds", "Summary", and "Flowcharts". The "Desktop" section shows the "Current Patient List" for "GRP: SAGEimmunization Sage". The list includes patients with MRNs 01000217, 01000224, 01000214 (highlighted), 01000199, 01000222, and 01000216. To the right, the "Patient List Directory" shows a list of lists including "Hotlist", "SAGECAP", "SAGEdiabetes", "SAGEimmunization", "SAGETest", and "TemporaryList". Below the directory are buttons for "Select", "Make Default", "Make Freq", and "Move/Remove". The "InBox Messages" section, highlighted with a red box, shows a notification for "SAGE" with the message "You have saved order sessions" and a count of 1. At the bottom, the "Command Central" section shows "Command: DCENTRY" and "Active MRN: 01000214".

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

Desktop

Current Patient List: GRP: SAGEimmunization Sage

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

Patient List Directory

☒ Freq ☐ Folders ☐ Avail

List Name	Type	Owner
Hotlist		
SAGECAP	GRP	Sage
SAGEdiabetes	GRP	Sage
SAGEimmunization	GRP	Sage
SAGETest	GRP	Sage
TemporaryList	PERS	User, Sage

Select Make Default Make Freq Move/Remove

InBox Messages

☒ All Mine ☐ Patient

Notifications	Count
SAGE	
You have saved order sessions	1

Create Resolve Refresh Sage

Command Central

Command: DCENTRY

Active MRN: 01000214 Global Name Lookup

3 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) inj IM prn	U		16Jul2006	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj IM prn	U		16Jul2006	
Meningococcal C conjugate vaccine IM prn	U		16Jul2006	
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 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

3 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	Code
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) inj IM prn	U		16Jul2006	
Pneumovax 23 Syringe (25mcg/0.5 mL) inj IM prn	U		16Jul2006	
Meningococcal C conjugate vaccine IM prn	U		16Jul2006	
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 #60 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 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 Reports Log: 'Due' and 'Due but Contraindicated' Vaccines

Admin - Microsoft Internet Explorer provided by The Nebraska Medical Center

Address: <http://10.16.8.16:9080/sage/protected/sageadmin?systemcommand=sagereslog>

TYPE	PATIENT	
Observation	01000214	<ul style="list-style-type: none">From: SNOMED CT:31874001Name: Hepatitis B vaccine is due [SAGE]From: SAGE:C116FromDisplayName: Hepatitis B vaccine is dueStateName: IMMS2004_00271ActionType: Conclude
Observation	01000214	<ul style="list-style-type: none">Name: Contraindicated (qualifier value) [SNOMED CT]From: SNOMED CT:410536001FromDisplayName: Contraindicated (qualifier value)Name: MMR vaccine is due [SAGE]From: SAGE:C115FromDisplayName: MMR vaccine is dueStateName: ImmunoCycle5_3v4Neb_Instance_40023ActionType: Conclude
Observation	01000214	<ul style="list-style-type: none">From: SNOMED CT:31874001Name: PPV23 vaccine is due [SAGE]From: SAGE:C122FromDisplayName: PPV23 vaccine is dueStateName: IMMS2004_00192ActionType: Conclude
Observation	01000214	<ul style="list-style-type: none">From: SNOMED CT:31874001Name: MCV4 vaccine is due [SAGE]From: SAGE:C127FromDisplayName: MCV4 vaccine is due

Sage Reports Log: Due and Due but Contraindicated Vaccines

The screenshot shows a web browser window titled "Admin - Microsoft Internet Explorer provided by The Nebraska Medical Center". The address bar shows the URL: http://10.16.8.16:9080/sage/protected/sageadmin?systemcommand=sagereslog. Below the address bar is a search bar and various navigation icons.

ID	Type	Details
01000214	Observation	<ul style="list-style-type: none"> From: SNOMED CT:31874001 Name: MCV4 vaccine is due [SAGE] From: SAGE:C127 FromDisplayName: MCV4 vaccine is due StateName: ImmunoCycle5_2Neb_Instance_140031 ActionType: Conclude
01000214	Observation	<ul style="list-style-type: none"> Name: Contraindicated (qualifier value) [SNOMED CT] From: SNOMED CT:410536001 FromDisplayName: Contraindicated (qualifier value) Name: Varicella vaccine is due [SAGE] From: SAGE:C120 FromDisplayName: Varicella vaccine is due StateName: ImmunoCycle5_3v4Neb_Instance_30000 ActionType: Conclude
01000214	Display	<ul style="list-style-type: none"> subject: Generate Hep B education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-hep-b.pdf* subject: Generate Pneumococcal (PPV23) education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-ppv.pdf* subject: Generate Meningococcal (MCV4) education material message: \par http://www.cdc.gov/nip/publications/VIS/vis-mening.pdf* SubjectStr: Sage Mesg. AddresseeStr: Session_Owner
01000214	Display	<ul style="list-style-type: none"> 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 subject: Meningococcal (MCV4) due notification to report message:Meningococcal MCV4 vaccination is due subject: Pneumococcal (PPV23) due notification to report message:Pneumococcal PPV23 vaccination is due subject: Obtain immunization consent message: \par subject: Inquire about illness message: \par SubjectStr: Sage Mesg. AddresseeStr: Primary care physician