

An Introduction to GLIF

Mor Peleg, Ph.D.

Post-doctoral Fellow, SMI, Stanford Medical
School, Stanford University, Stanford, CA

Aziz A. Boxwala, M.B.B.S, Ph.D.

Research Scientist and Instructor
DSG, Harvard Medical School
Brigham & Women's Hospital, Boston, MA



HL7 Winter Working Group Meeting
Orlando • January, 2001

Outline

- Computer-interpretable guidelines
- Sharing computer-interpretable guidelines
- Requirements for a shared guideline model
- GLIF

Computer-interpretable guidelines

- In this talk, we address computer-interpretable guidelines that
 - deliver patient-specific recommendations
 - are integrated with EMRs and Health Information Systems
 - »Automated reminders/alerts
 - »Decision support and task management
 - »Order entry appropriateness, referral criteria...
 - »Background monitoring, care plans, quality review

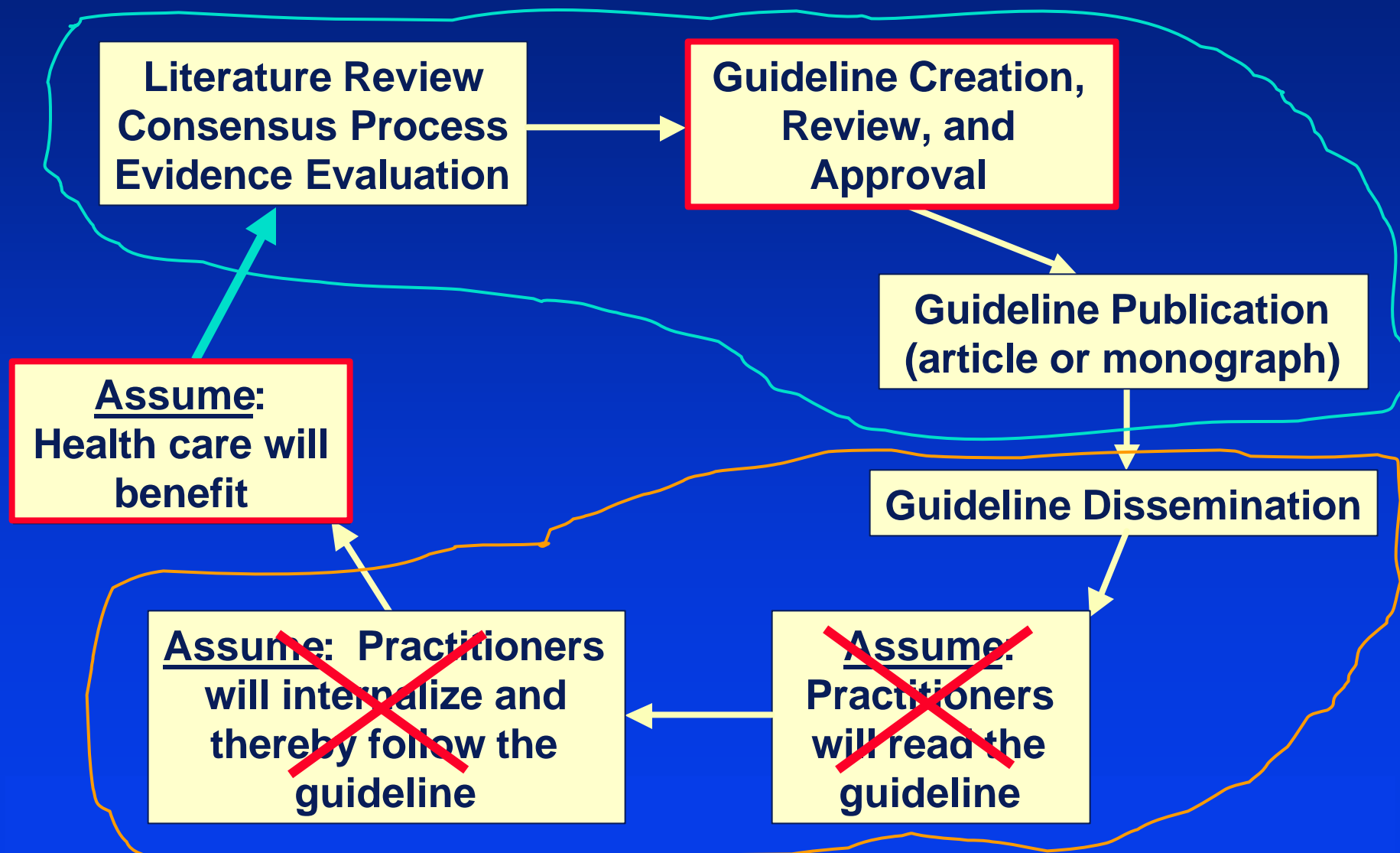
Benefits of computer-interpretable guidelines

- Provide automatic decision support
 - Applied to individual patients
 - Can be during the clinical encounter
- Guidelines can be better designed
 - Software tools and guideline models used to specifying logic precisely
 - Ambiguities reduced
- Can integrate guidelines into workflow
 - Patient-specific guideline knowledge available at point of care, to person or entity needing it

Benefits, cont'd

- Can be used for quality assurance
 - Guideline defines gold-standard of care
 - Perform retrospective analysis to test if patients were treated appropriately
- Simulations for educational purposes
- Can aid in human visualization
 - interactive, dynamic display of guideline pathways
 - allows one to focus on relevant sections of flowchart
 - useful for authoring as well as for use

Benefits: development & dissemination



Outline

- Computer-interpretable guidelines
- Sharing computer-interpretable guidelines
- Requirements for a shared guideline model
- GLIF

Why share computer-interpretable guidelines?

- Leverages cost of guideline development
- Provides consistency in guideline interpretation
- Can minimize misinterpretations and errors through the process of public review
- Facilitates execution rather than just read-only use
- Can provide common basis before local adaptation

Challenges in sharing guidelines by different institutions

- Local adaptation of guidelines
 - Availability of resources and expertise
 - Local workflow issues
 - Practice preferences
- Integration with information systems
 - Match patient data in EMR to GL terms
 - Match recommendations in guideline to actions in order entry system
- Every guideline model needs to address these issues

Obstacles to sharing

- Multiplicity of:
 - conceptual guideline models
 - intended applications
 - authoring tools (separate conceptual from formal, and implementation-specific models?)
 - dissemination formats (XML, RDF...)



Common shared model

- Ability to share guideline encodings across:
 - different platforms and systems (e.g., EMRs)
 - different guideline models
- Joint development of:
 - shared model that incorporates features of different models
 - tools to support entire guideline life cycle
 - » authoring, validation, local adaptation & mappings, execution, revision and update

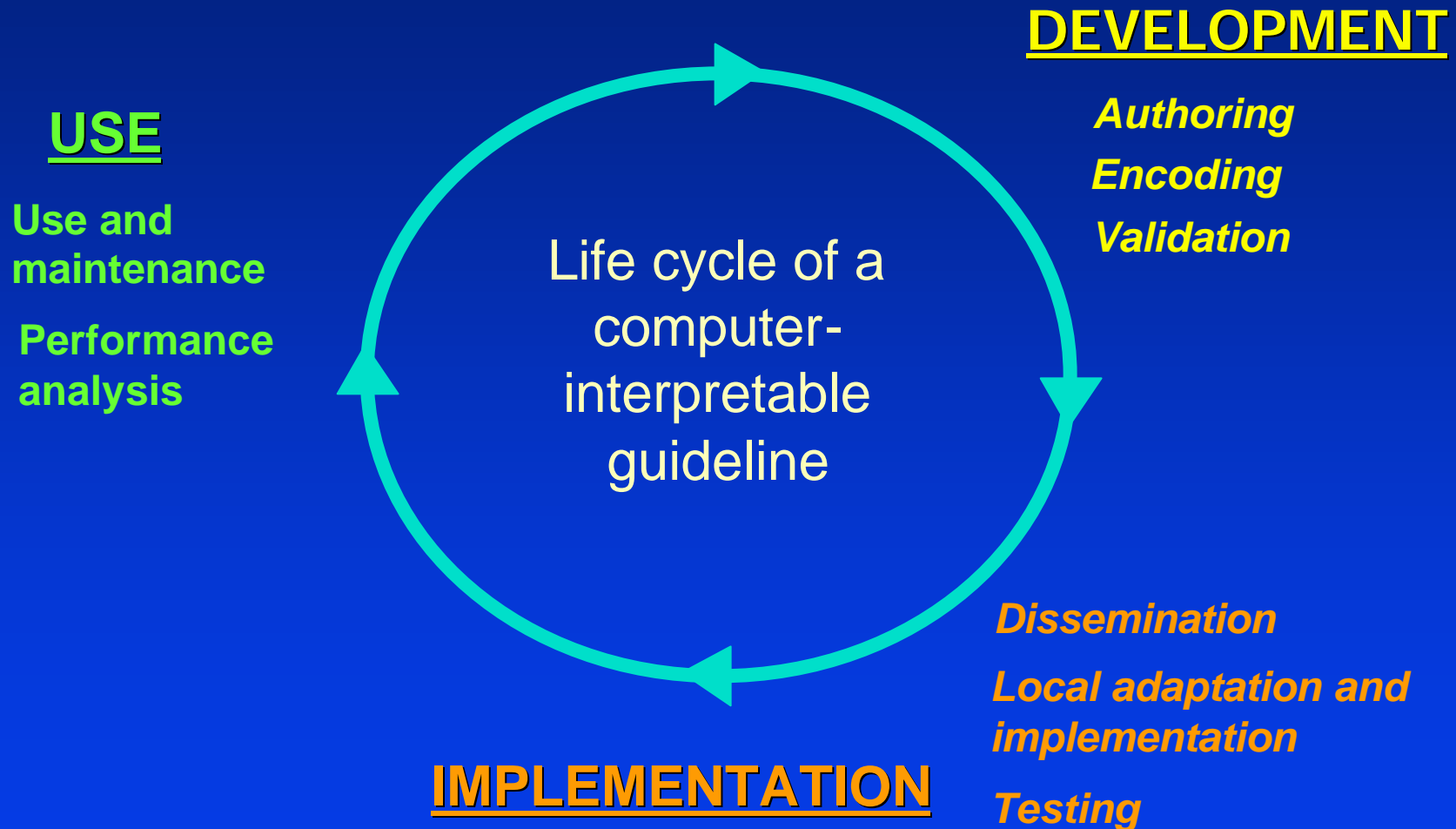
Outline

- Computer-interpretable guidelines
- Sharing computer-interpretable guidelines
- Requirements for a shared guideline model
- GLIF

Functional requirements

- The shared model must be based on a set of functional requirements for sharable guidelines
- The functional requirements are organized according to the life-cycle of a computer-based guideline
- These requirements guide the design of GLIF, although we have not satisfied all of them yet

Life cycle of a computer-interpretable guideline



Development requirements

- Expressiveness
- Comprehensibility

Expressiveness

- Ability to express knowledge content of different types of guidelines
 - Structural parts
 - » Definitions, recommendations, algorithms
 - Decision-support guideline tasks
 - » Expressive decision model
 - » Goal setting
 - » Specifying work to be performed
 - » Data interpretation
 - » Generating alerts and reminders

Comprehensibility

- Guideline visualization and readability
- Complexity management
- Coherence facilitation (e.g., support material)

Implementation Requirements

- Ease of guideline integration into clinical environments
- Ease of sharing actual specifications

Guideline integration into clinical environments

- Local adaptation of guideline content
- Integration with EMR
 - Mapping references to patient data to entries in the medical record
 - Mapping recommendations to implementable actions
 - » e.g. linking to order entry system
 - printing a prescription
- Workflow integration

Ease of sharing actual specifications

- Easy to transport specifications among collaborators
 - Text format
 - XML/RDF
- Standard representations should not contain proprietary, application-dependent details
 - e.g., devoid of visualization details

Use requirements

- Support different usage modes
 - Interactive use
 - Batch processing
- Version control

Outline

- Computer-interpretable guidelines
- Sharing computer-interpretable guidelines
- Requirements for a shared guideline model
- GLIF

GLIF

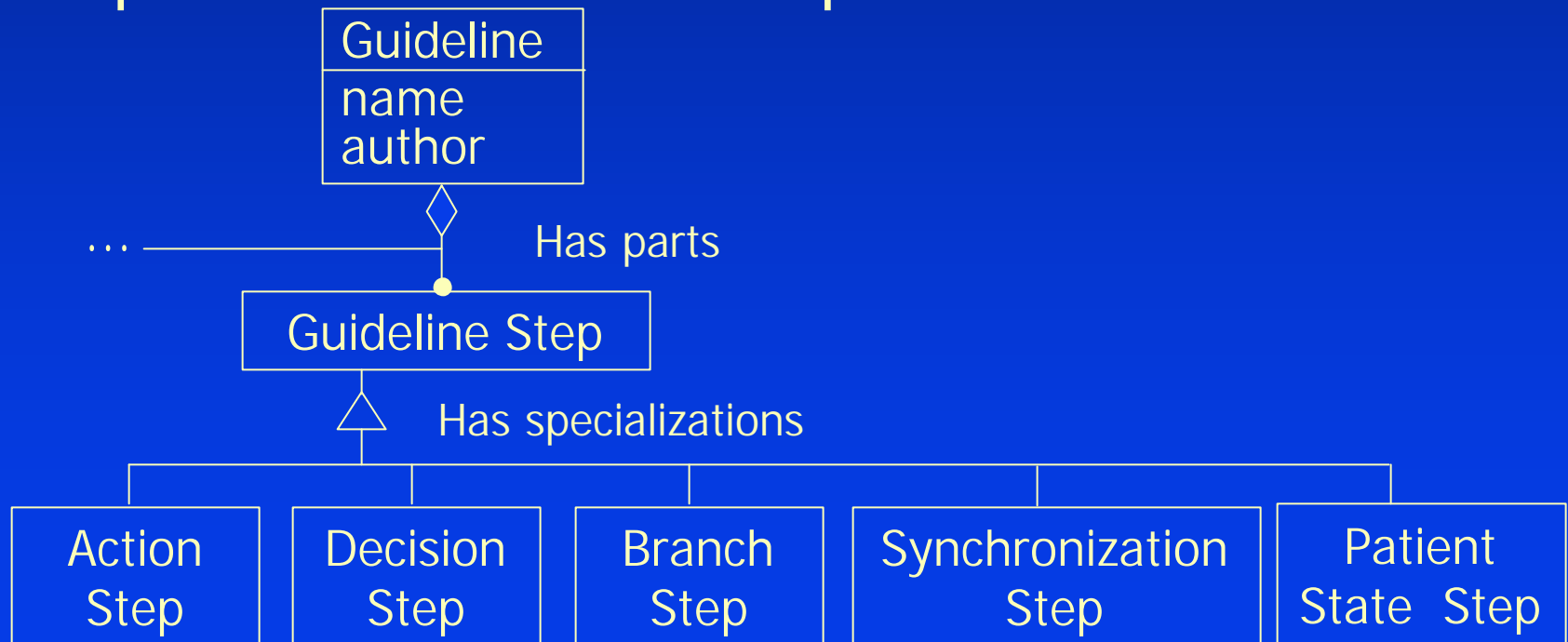
- GuideLine Interchange Format
- A format for sharing clinical guidelines independent of platforms and systems
- Based on an object-oriented logical model of concepts
- Has an XML-based syntax (RDF Schema)

An Approach to Enhance Sharing

- A multi-level representation
- Designed to support multiple vocabularies and medical knowledge bases
- InterMed: multi-institutional development process
- GLIF is evolving as an open standard
 - Cooperation with other guideline modeling groups (Arden, USAM, GEM)

GLIF model

- Object-oriented representation model for guidelines
- Flowchart representation of a temporal sequence of clinical steps



GLIF classes

- Action steps: recommendations for clinical actions to be performed
 - e.g., Prescribe aspirin
- Decision steps: decision criteria for conditional flowchart traversal
 - e.g., if patient has pain then ...
- Branch and synchronization steps allow concurrency
- Patient-state step: characterizes patient's clinical state

GLIF3 Modeling Process

3 Representation Levels

A. Author/viewer level

- Conceptual flowchart of clinical actions and decisions
- Aids in human understanding

B. Abstract machine representation

- Can be executed by an interpreter
- Correctness can be analyzed

C. Integration into application environments

- Application-specific mappings and modifications
- Not yet supported

Abstract Machine Representation

- Unambiguous syntax for logical expressions
 - based on Arden Syntax
- All logical expressions & actions refer to defined concepts (medical ontology)
- Allowed values, ranges, & time constraints
- Can be interpreted and analyzed for correctness
 - syntax, type, and range checking

GLIF example: Guideline

CoughNested4_00021 (instance of Guideline)

Name Cough guideline (top-level)	Maintenance Info (1 values) V C + - X	
Intention Manage chronic cough	Title Managing cough as a defense mechanism and as a symptom	
Eligibility Criteria V C + - chronic cough in immunocompetent adults	Author V C - Richard S. Irwin, MD, FCCP Worcester, MA	Encoder V C - Mor Peleg, PhD
Algorithm V C + - Top-level Cough algorithm	Authoring Date August 1998	Encoded Last Modification Date 10/25/2000
Didactics V C + - http://www.chestnet.org/health.science.policy/#c	Developing Institution V C - American College of Chest Physicians American Thoracic Society Canadian Thoracic Society	Adapting Institution
	Guideline Version	Encoded Guideline Version 2.0
	Guideline Status published	GLIF Version GLIF3
		Representation Status production

Eligibility Criteria

The screenshot shows a software window titled "CoughStudy_00046 (instance of Three_Valued_Criterion)". The window is divided into several sections:

- Name:** A text field containing "Chronic cough in immunocompetent adults".
- Specification:** A text area containing the logical expression:
((now - cough_start_time) > 3 weeks) and
((now - date_of_birth) > 18 years) and
not immunocompromised
- Encoding Language:** A dropdown menu currently set to "GLIF_Arden".
- Didactics:** An empty text area.
- Get Data Items:** A list of three items, each with a small icon to its left:
 - Get cough_start_time
 - Get date_of_birth
 - Get immunocompromised

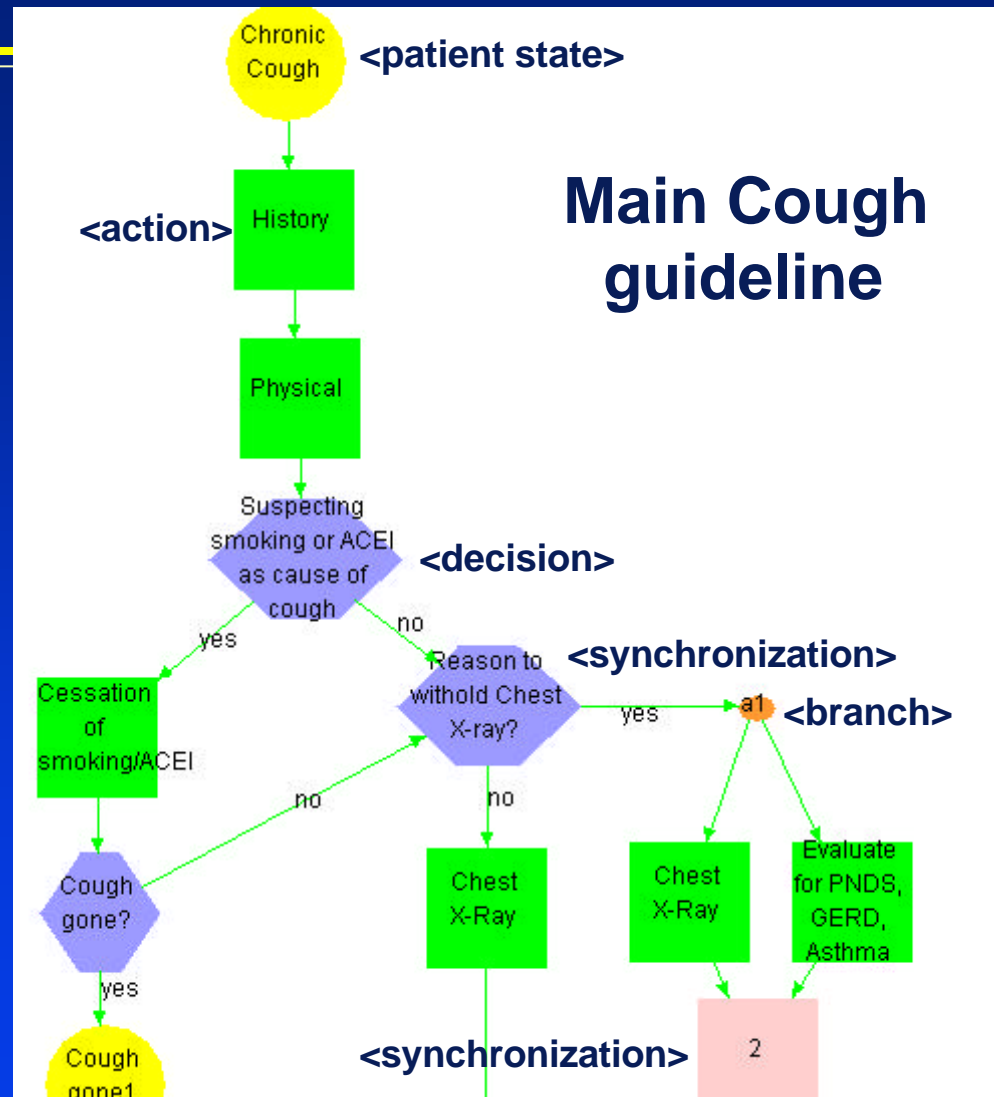
On the right side of the window, there is a large empty text area labeled "Let Expressions". Above this area are four buttons: "V", "C", "+", and "-". Similarly, above the "Didactics" and "Get Data Items" sections are also sets of "V", "C", "+", and "-" buttons.

GLIF example: Guideline

CoughNested4_00021 (instance of Guideline)

Name Cough guideline (top-level)	Maintenance Info (1 values) V C + - X	
Intention Manage chronic cough	Title Managing cough as a defense mechanism and as a symptom	
Eligibility Criteria V C + - chronic cough in immunocompetent adults	Author V C - Richard S. Irwin, MD, FCCP Worcester, MA	Encoder V C - Mor Peleg, PhD
Algorithm V C + - Top-level Cough algorithm	Authoring Date August 1998	Encoded Last Modification Date 10/25/2000
Didactics V C + - http://www.chestnet.org/health.science.policy/#c	Developing Institution V C - American College of Chest Physicians American Thoracic Society Canadian Thoracic Society	Adapting Institution
	Guideline Version	Encoded Guideline Version 2.0
	Guideline Status published	GLIF Version GLIF3
		Representation Status production

Algorithm



Patient state step

CoughStudy_00005 (instance of Patient_State_Step)

Display Name
Chronic Cough

Name
chronic cough in immunocompetent adults

Patient State Description (+ values)

Name
Chronic cough in immunocompetent adults

Specification
((now - cough_start_time) > 3 weeks) and
((now - date_of_birth) > 18 years) and
not immunocompromised

Strength Of Evidence V C + -

Didactics V C + -

Next Step V C + -
parallel

☒ New Encounter

Branch Step

Or “any
order”

CoughStudy_00086 (instance of Branch_Step)

Name: p

Order Constraint: parallel

Branches:

- Evaluate for PNDS, GERD, Asthma
- Chest X-Ray

Strength Of Evidence:

Didactics

Synchronization step

Examples2_00297 (instance of Synchronization_Step)

Name	Strength Of Evidence
2	

Continuation	Didactics
<input type="checkbox"/> ≥ 2	

Next Step
<input type="checkbox"/> Cough gone?

Instead, can write a Boolean expression of (input) guideline steps

Action step

CoughStudy_00091 (instance of Action_Step)

Name	Triggering Events
Order X-Ray	
Tasks	
Chest X-Ray	
Next Step	Exceptions
Iteration Info	
Didactics	Strength Of Evidence
	Strength Of Recommendation
Duration Constraint	

Action tasks

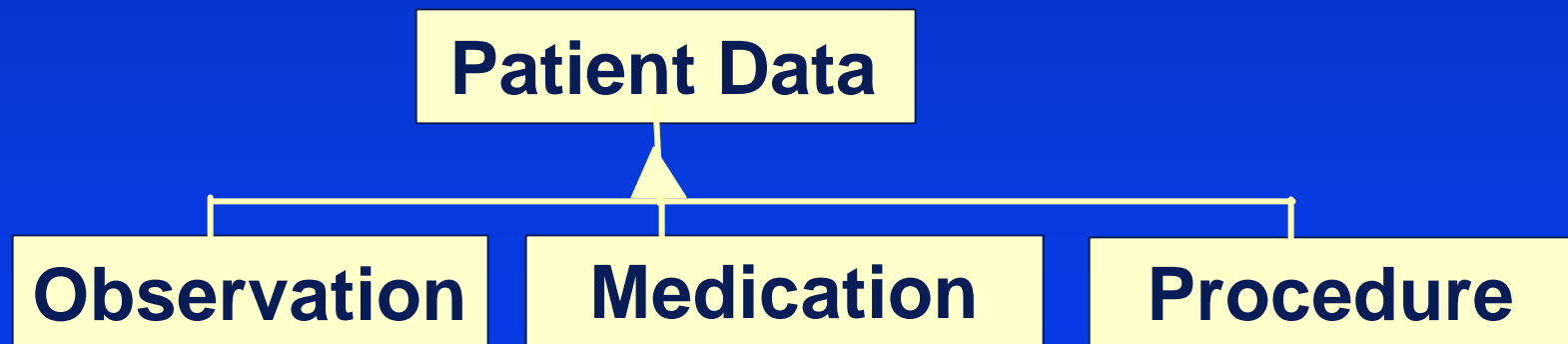
Action tasks specify work to be performed

- Medically-Oriented
 - Prescription
 - Lab test order
- Programming-Oriented
 - Call sub-guideline
 - Send message
 - Get patient data (from EMR or User)

Medically-oriented tasks

- Refer to a medical domain ontology that supports:
 - Standard vocabularies
 - Standard data models for representing patient data

e.g., HL-7's Unified Service Action Model (USAM)



A medically-oriented task

CoughStudy_00243 (instance of Medically_Oriented_Action_Specification)

Name: Chest X-Ray

Description:

Intention:

Medical Task (Literal Data Item):

Name: Chest X-Ray

Concept: Chest X-Ray

Data Model Class Id: Procedure

Data Model Source Id: USAM

Data Value (Procedure):

Service Cd: Chest X-Ray

Mood Cd: order

Method Cd:

Critical Time:

Activity Time:

Confidentiality Cd:

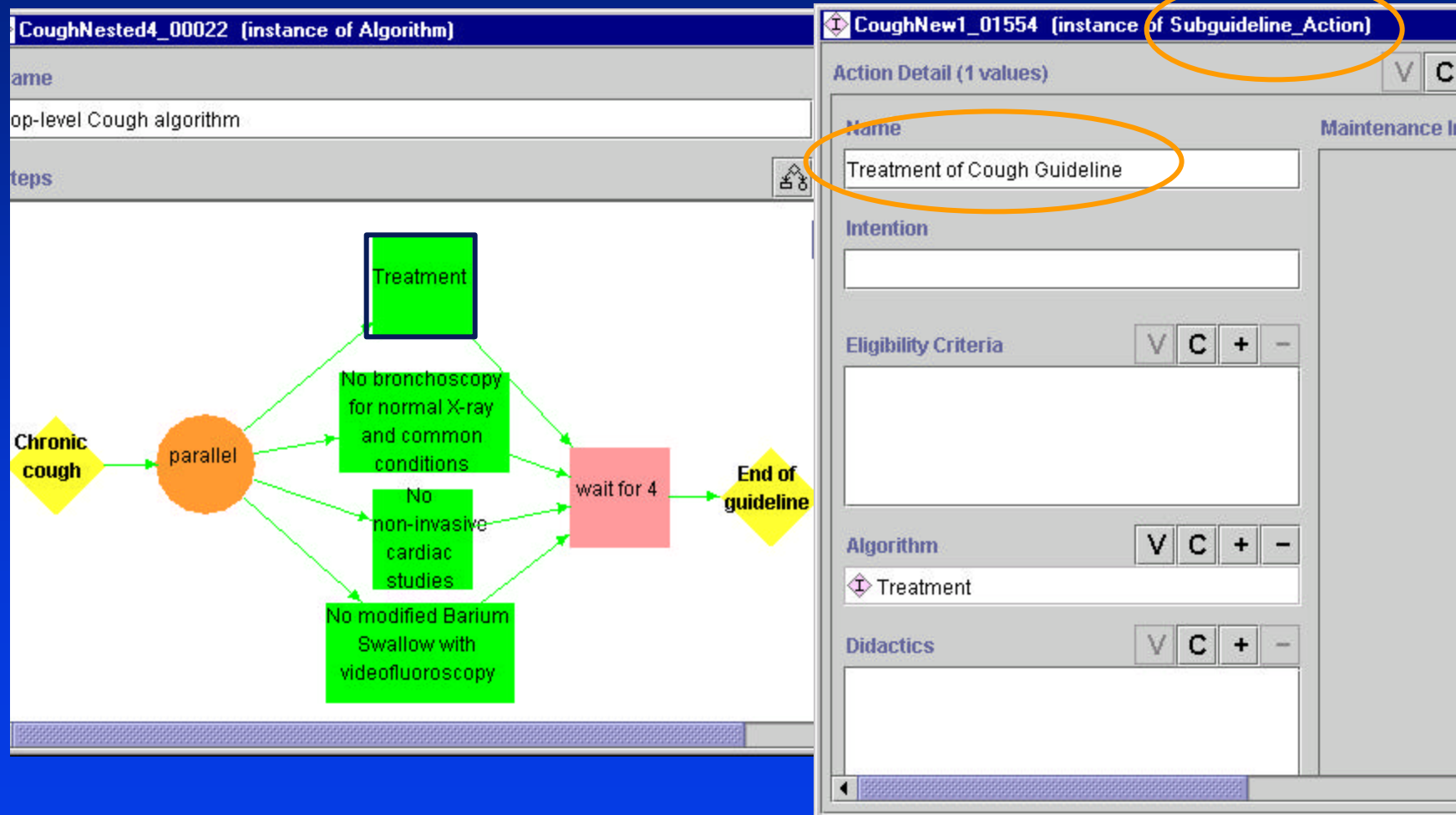
CoughStudy_00245 (instanc...)

Concept Name: Chest X-Ray

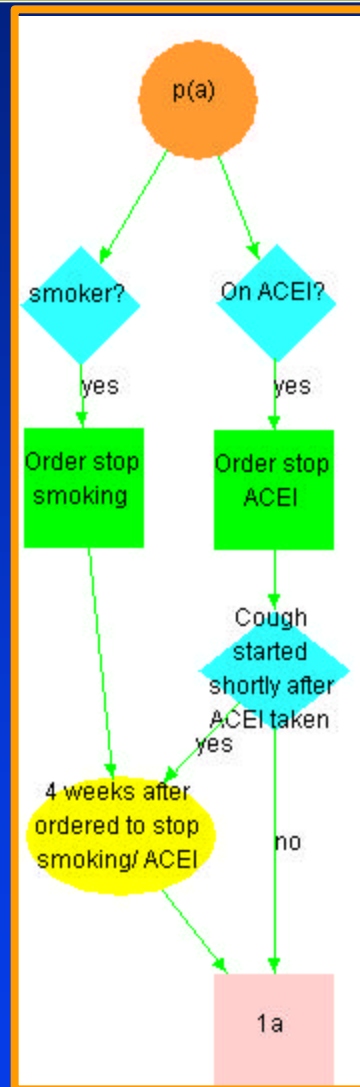
Concept Id: C0202783

Concept Source: UMLS

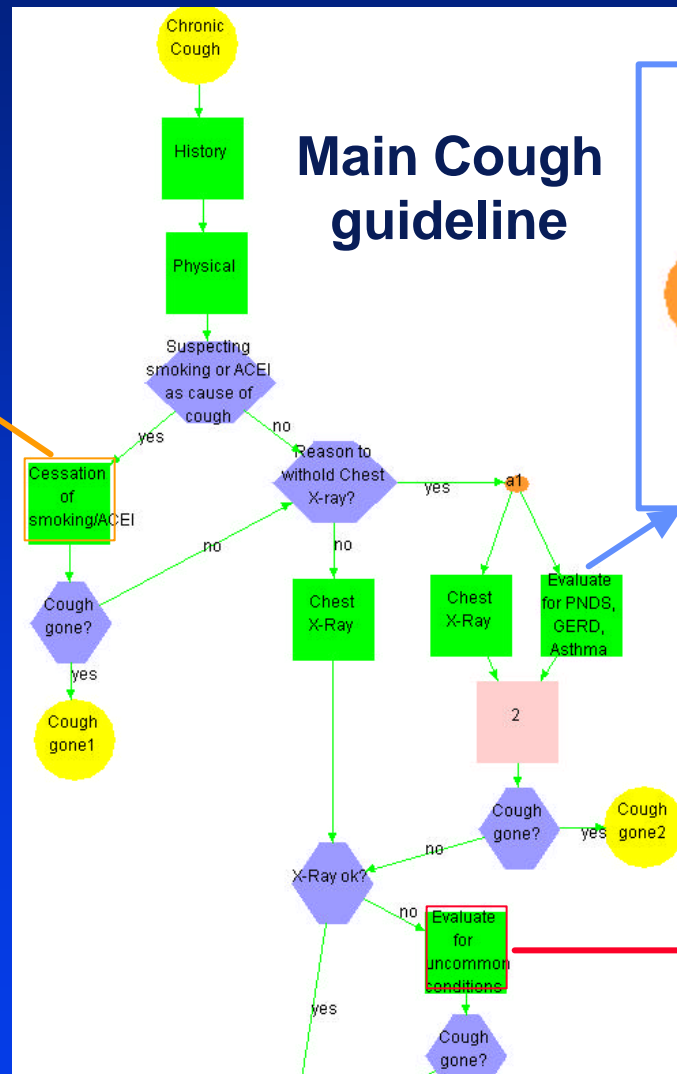
Calling Sub-guidelines: Nesting



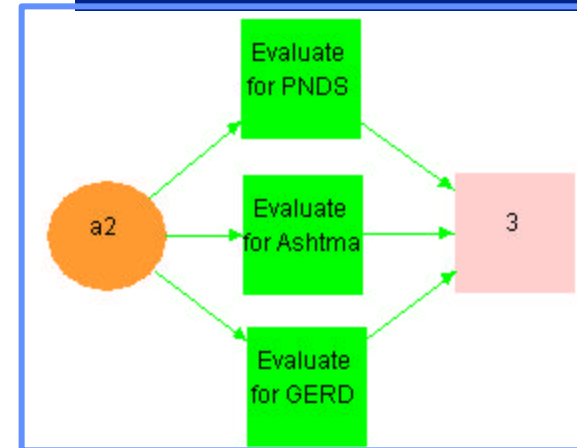
Nesting (comprehensibility)



January 2001



Main Cough guideline



Mor Peleg and Aziz Boxwala

Get data task

CoughStudy_00031 (instance of Get_Data_Action)

Name
Get Date Of Birth

Description

Intention

Data Source Type
EMR

Attribute To Be Assigned
data_value.value.pq_value

Data Item
Date Of Birth

Temporal Constraint
EARLIEST_recording_time

Variable Name
date_of_birth

Where Constraint

Get knowledge task

hypertension_00412 (instance of Get_Knowledge_Action)

Name
Get Contraindicated drugs for the patient

Description

Intention

Attribute To Be Assigned
concept_from

Variable Name
contraindicated_drugs

Temporal Constraint

Input Relationships V C + -
ACEI has_contraindication pregnancy
beta-blocker has_contraindication Chronic-Obstruct
beta-blocker has_contraindication Second degree a
beta-blocker has_contraindication Third degree atric

Where Constraint V C + -
patient has the indication

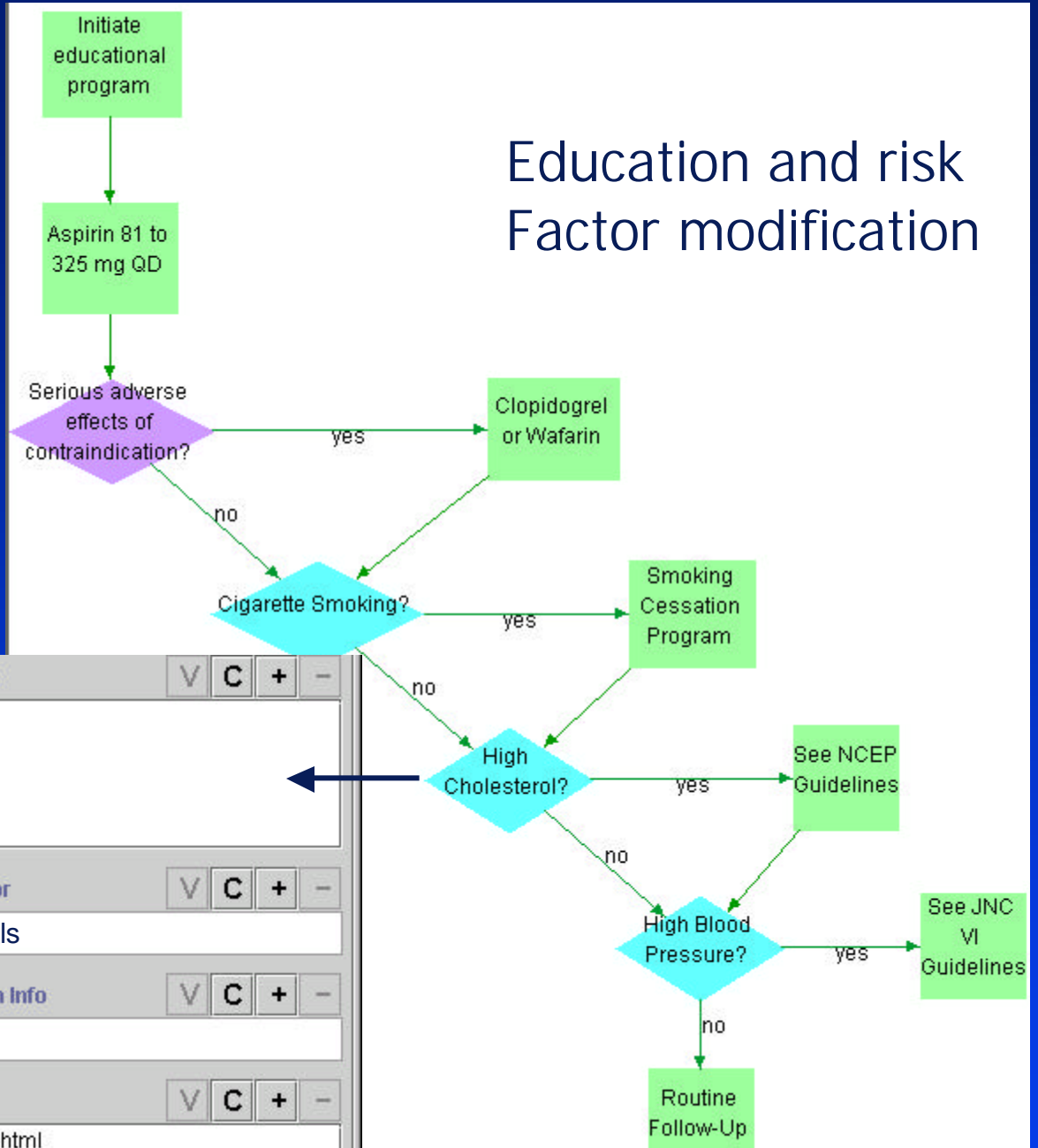
Decision model

- Case Step
 - represent decisions that can be automated by directly evaluating logical criteria based on data items from the EMR
- Choice Step
 - represent choices that should be made by the user since they are either safety-critical or require knowledge that is not specified by the guideline

Case step

Level B

Education and risk
Factor modification



Name	
High Cholesterol?	
Condition [V] [C] [+] [-]	
LDL_Cholesterol > 160 mg/dL	
Decision Detail [V] [C] [+] [-]	
Default Next Step [V] [C] [+] [-]	
Didactics [V] [C] [+] [-]	
http://www.acc.org/clinical/guidelines/june99/index.html	
Options [V] [C] [+] [-]	
yes no	
Operator [V] [C] [+] [-]	
equals	
Iteration Info [V] [C] [+] [-]	

Specifying patient data

KB_5337_00018 (instance of Literal_Data_Item)

Name: LDL Cholesterol

Data Value: Observation

Summary Information: This slot currently has 1 value.

Referring Concept: C0023824

Ontology: UMLS

RIM: USAM

(Created by the Protégé authoring tool)

Service Cd: LDL_Cholesterol

Mood Cd: event

Critical Time: (07-18-00, 07-18-00)

Activity Time:

Recording Time: (07-18-00:21:00)

Value: 80 mg/dL

Normal Range: < 130 mg/dL

Id: 360-78-7920

Method Cd: serum, 12h fast

Severity:

Certainty: high

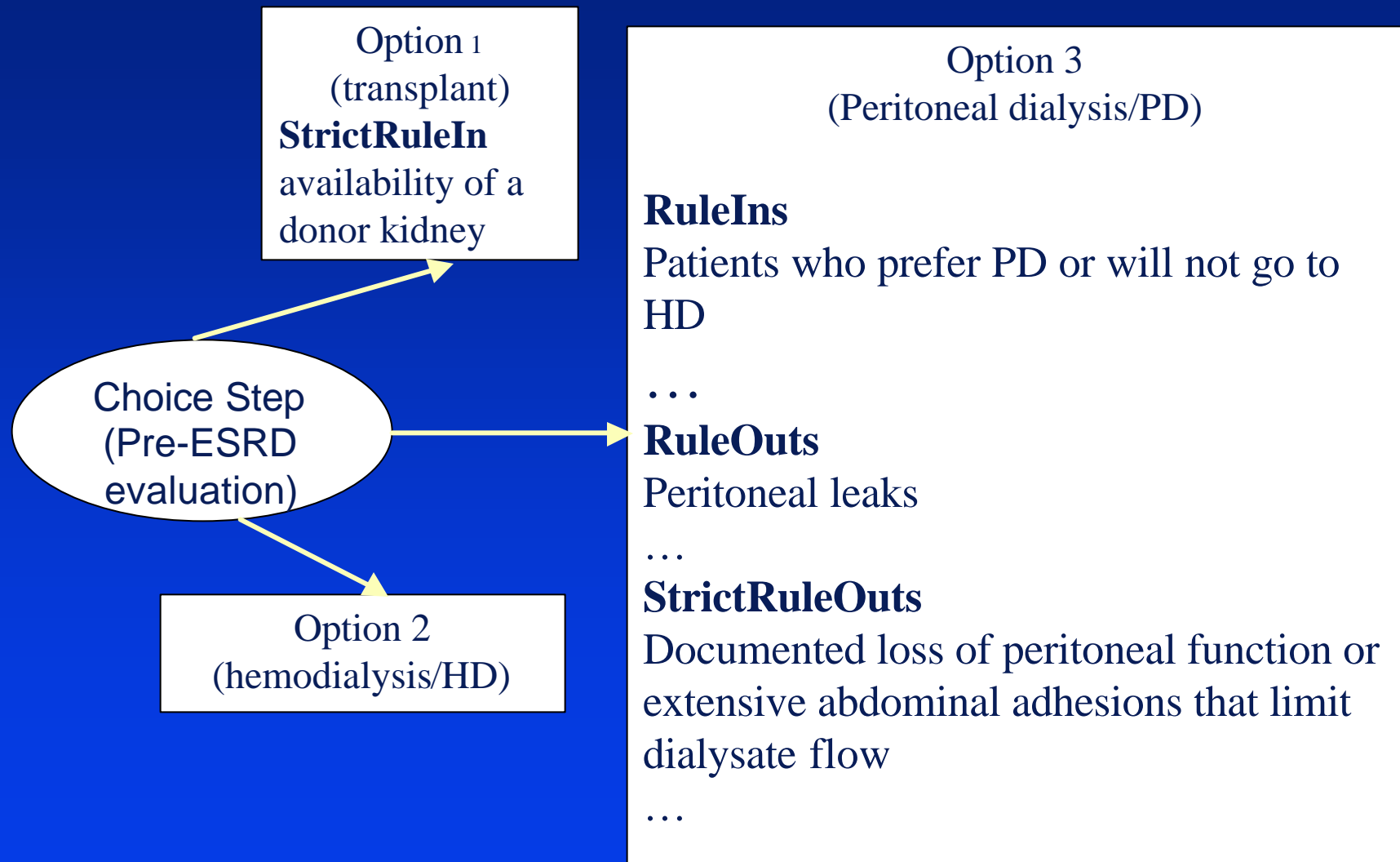
Status Cs: completed

Confidentiality Cd:

Body Site Cd:

Interpretation Cd: normal

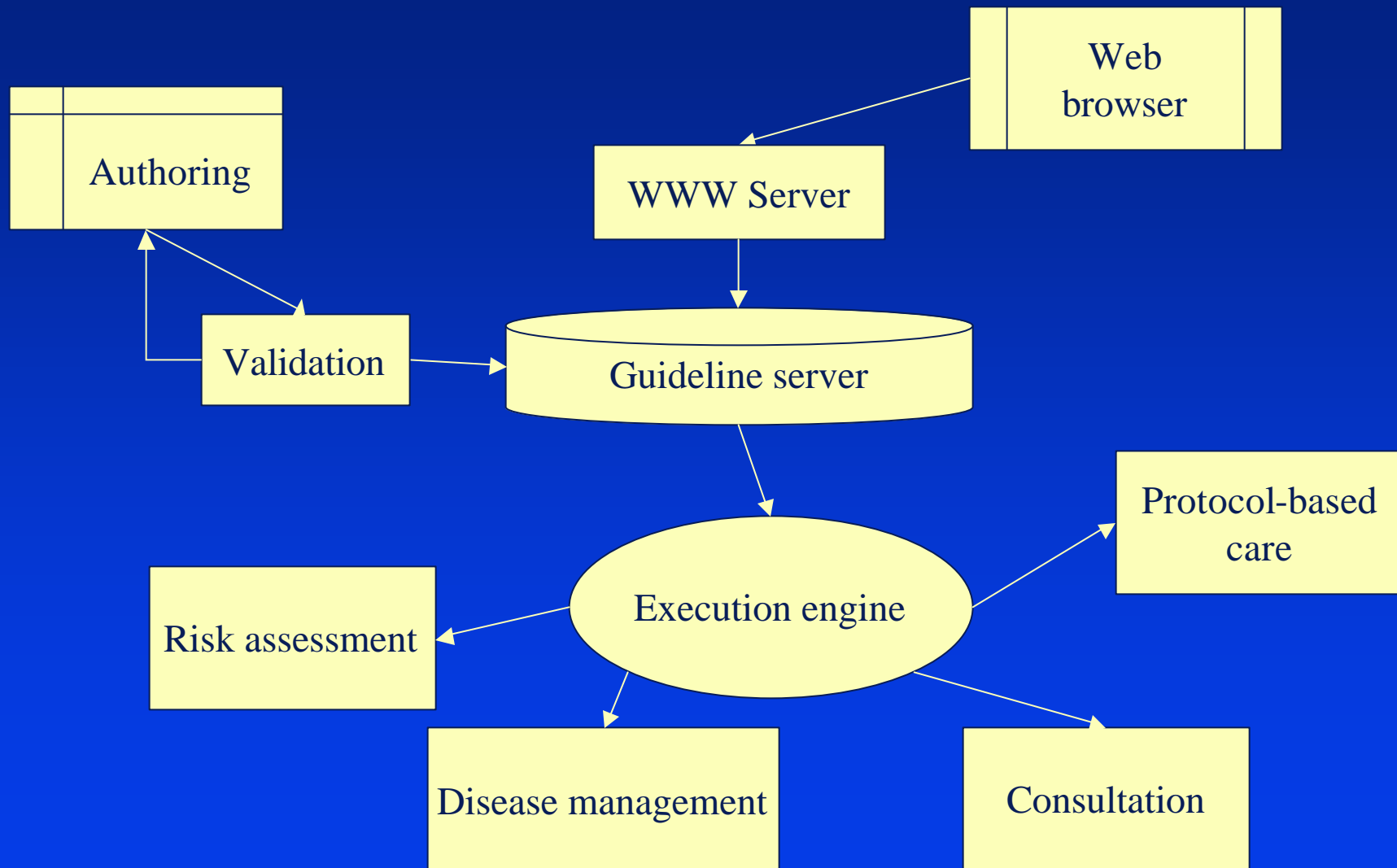
Choice Step



GLIF3: Summary

- GLIF3 is a language designed to allow sharing of clinical guidelines across different platforms and systems
- GLIF3 enables encoding of the logic of guidelines in a way that is computable
 - Highly structured specification
 - Formal expression syntax (based on Arden Syntax)
 - Medical domain ontology (vocabularies, USAM)
- For more information see www.GLIF.org

Architecture for software tools

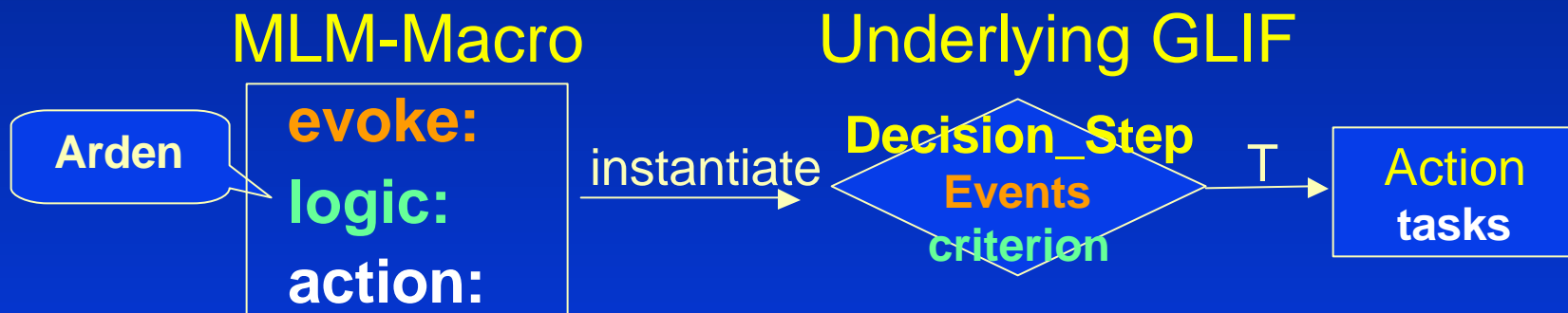


GLIF: a proposed basis for a shared representation

- GLIF addresses authoring & dissemination
- InterMed's major focus now is on:
 - mapping to clinical information systems
 - tools to facilitate validation and execution
- Under the HL7 GLIF SIG:
 - collaborative refinement and extension to support the needs of the guideline life cycle
 - reconciliation of functional requirements of different models and identification of those most important for supporting implementation

Macro Step

- Subclasses of action and decision steps
- Declaratively specify a procedural pattern



- Benefits for authoring, visual understanding, and execution of guidelines