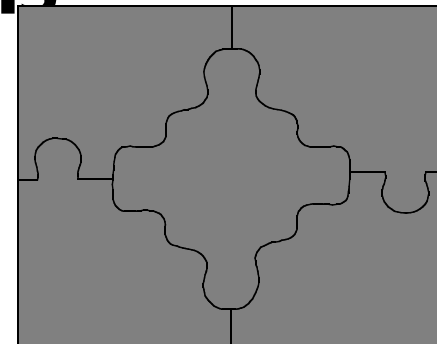


# Sharable, Computer-Interpretable Clinical Guidelines

## An Emerging Core Technology for Future Health Care Systems



***Robert A. Greenes, M.D., Ph.D.***

***Decision Systems Group***

***Brigham & Women's Hospital***

***Boston, MA***

# Quality challenges in health care

---

- reduce errors
- conduct “best practice” medicine

*while*

- devoting less time!
- spending less money!



# How do we improve quality?



- Alerts & reminders
- Measurements & feedback
- Practice guidelines
  - beyond alerts to multi-step care processes
  - focus may be screening, diagnosis, workup, referral, or management
    - consensus-based vs. evidence-based
    - embody “best practices”
    - aim to reduce variation
  - basis for wide range of applications

# **Some applications of guidelines**



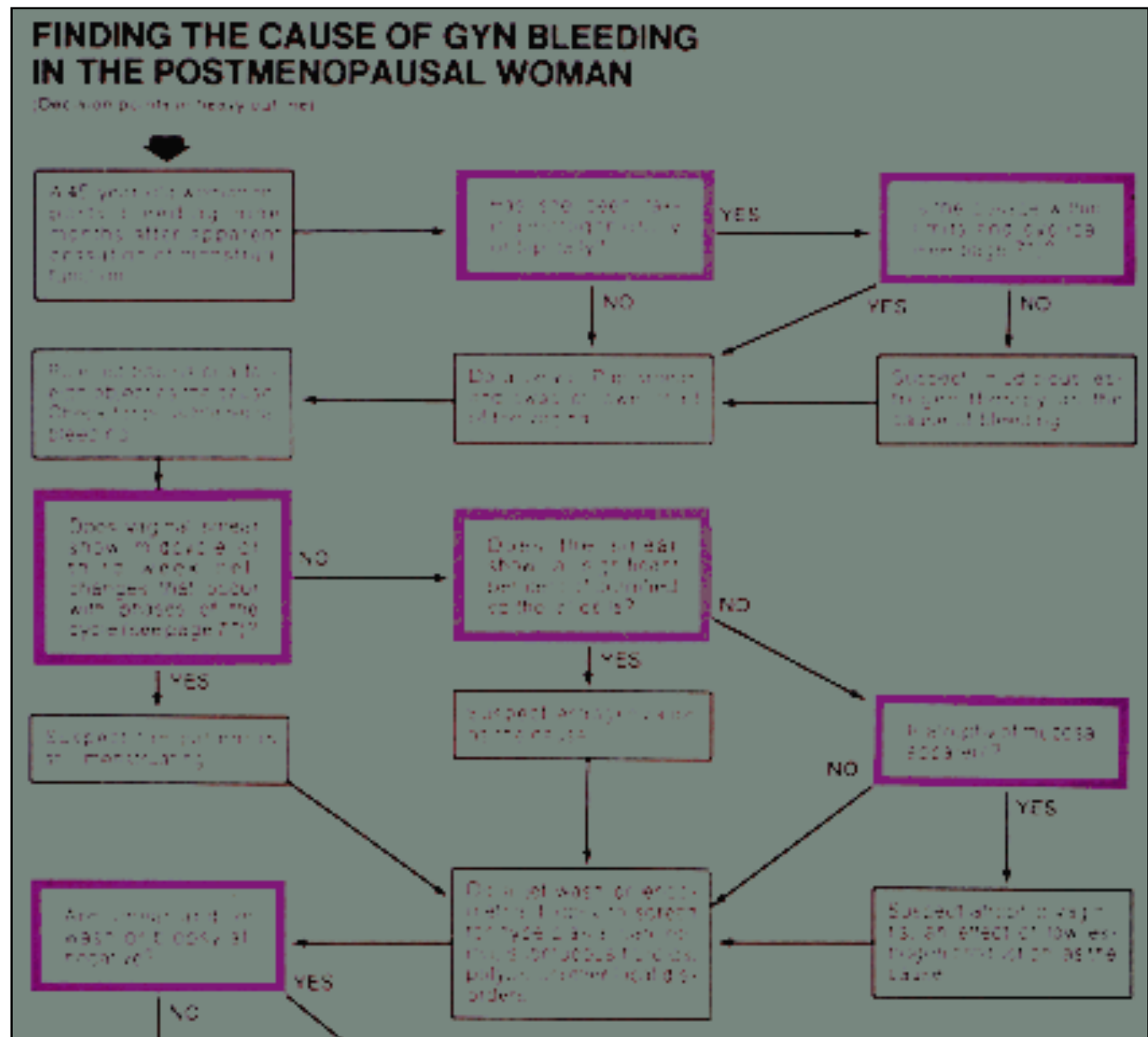
- **Education & reference**
- **Risk assessment**
- **Referral criteria**
- **Appropriateness determination**
- **Consultation**
- **Problem-based encounter forms & info assembly**
- **Workflow management**
- **Clinical trials**
- **Care plans/UR/UM**

# History of the field



- **Long interest dating from early '70s**
  - | dissemination via print → CDROM → Web
- **New surge of activity**
  - | professional societies
  - | government agencies
  - | managed-care organizations & health plans
  - | individual institutions

# A Common Feature in Clinical Journals and Textbooks




# Guideline Dissemination



- **Conventional publication in journals and textbooks**
- **Mailing of monographs or guideline summaries to clinicians**
- **Compilations of guidelines for reference**
- **Online resources**
  - **National and international**
    - see [www.guidelines.gov](http://www.guidelines.gov)
  - **Locally supported**

National Guideline Clearinghouse - Netscape

File Edit View Go Communicator Help

 NATIONAL GUIDELINE CLEARINGHOUSE  
www.guideline.gov

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## About the National Guideline Clearinghouse™ (NGC)

The National Guideline Clearinghouse™ (NGC) is a comprehensive database of evidence-based clinical practice guidelines and related documents produced by the [Agency for Health Care Policy and Research \(AHCPR\)](#), in partnership with the [American Medical Association \(AMA\)](#) and the [American Association of Health Plans \(AAHP\)](#).

The [NGC mission](#) is to provide physicians, nurses, and other health professionals, health care providers, health plans, integrated delivery systems, purchasers and others an accessible mechanism for obtaining objective, detailed information on clinical practice guidelines and to further their dissemination, implementation and use.

Key components of NGC include:

- Structured abstracts (summaries) about the guideline and its development;
- A utility for comparing attributes of two or more guidelines in a side-by-side comparison;
- Syntheses of guidelines covering similar topics, highlighting areas of similarity and difference;
- Links to full-text guidelines, where available, and/or ordering information for print copies;
- An electronic forum for exchanging information on clinical practice guidelines, their development, implementation and use;
- Annotated bibliographies on guideline development methodology, implementation, and use.

[Content Overview](#)

**Disclaimer**

Please read the [NGC disclaimer statement](#).

[Technical Information](#)

Document: Done



# **Yet little impact to date**



- **Dissemination in read-only form**
- **Provenance, evidence base not always clear or trusted**
- **Too general or too specific**
- **Not adaptable or flexible, too “cookbook”**
- **Not integrated with point of care or into workflow**

# **What is needed**



- **High quality guidelines from trusted sources**
- **Standard computer-based representation, sharability**
- **Means for adaptation to local setting**
- **Flexibility of decision/choice model**
- **Integration with clinical applications**

# **The InterMed Collaboratory**



- **Decision Systems Group, Brigham & Women's Hospital, Harvard**
- **Stanford Medical Informatics (SMI)**
- **Department of Medical Informatics, Columbia**
- **Centre for Medical Education, McGill University**
- **American College of Physicians – American Society of Internal Medicine**

# **Toward GL sharing & integration into applications**



- **GuideLine Interchange Format (GLIF)**
  - developed by InterMed project of Columbia, Harvard, Stanford
  - v 2.0 *JAMIA, 1998*
- **Imported/exported by authoring tools**
- **Applications can interpret GLIF-encoded guidelines or convert them to app-specific representations**

# Elements of a GLIF GL



- **Flowchart representing temporal sequence of clinical steps**
  - **Action steps – clinical actions to be performed**
  - **Conditional steps – decision criteria for conditional flowchart traversal**
  - **Branch & synchronization steps – simultaneous pathways**

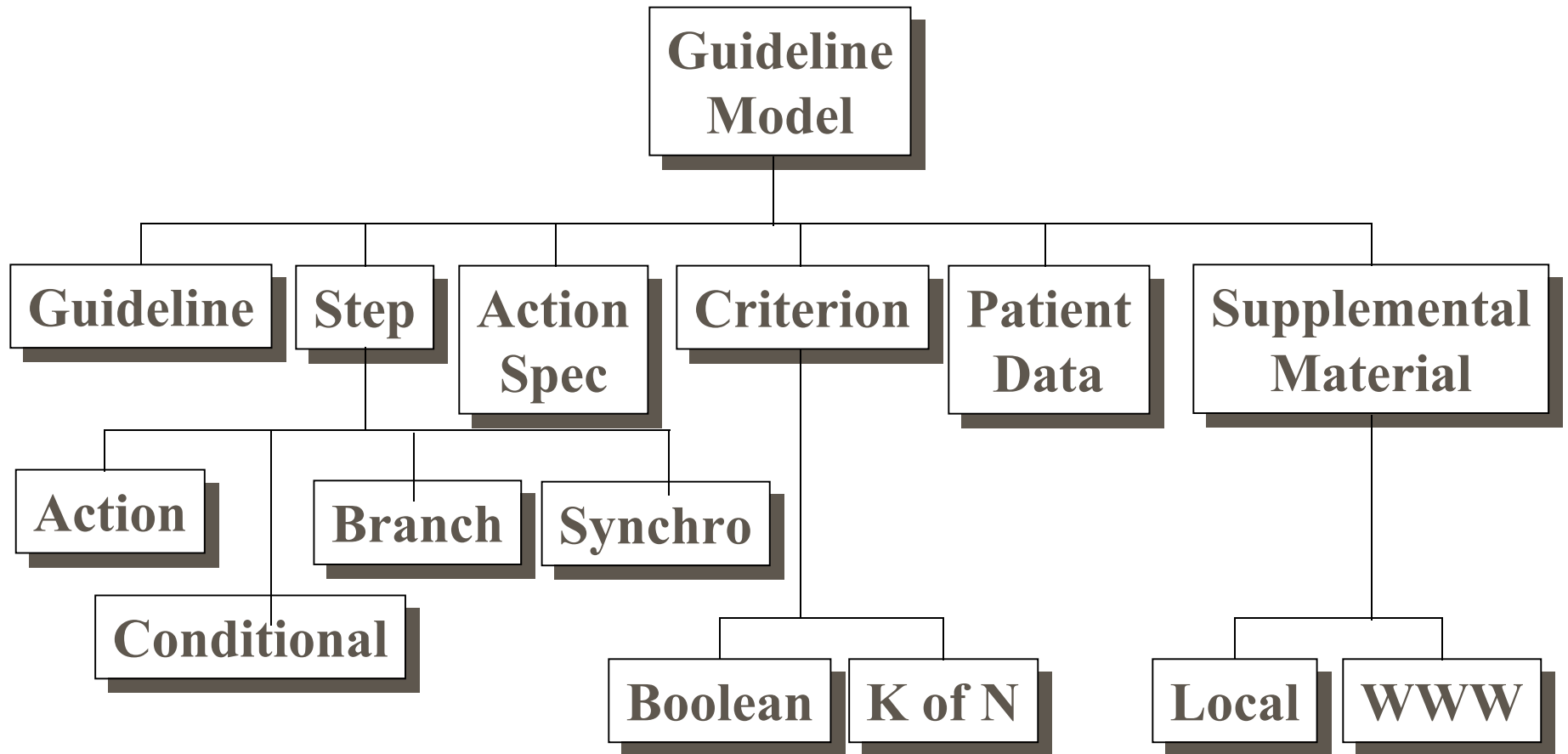
# **Elements of a GLIF GL, cont'd**



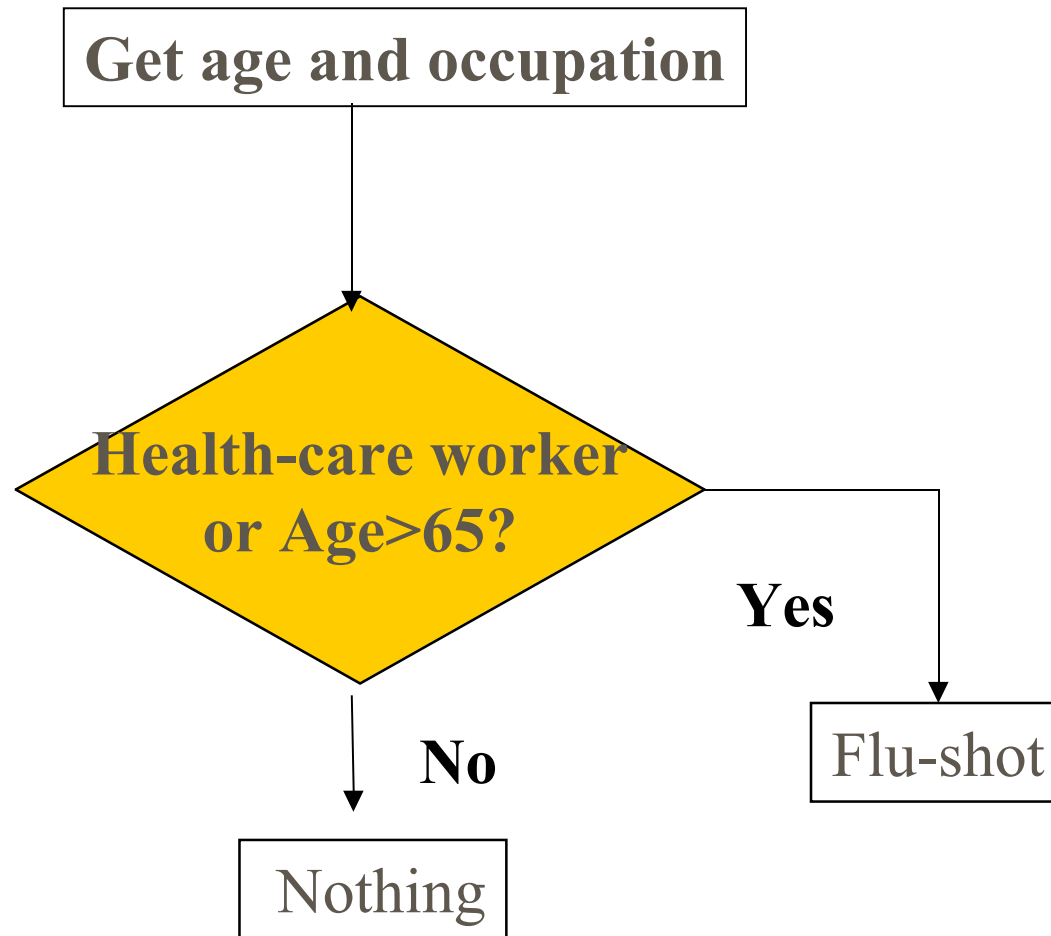
## **■ Other elements**

- Eligibility criteria (for GL or step)**
- Patient data items needed**
- Supporting or documentary resources (text, citations, URLs, DBs)**

# Object Hierarchy



# Flu vaccine guideline





# **Conditional step, in GLIF**



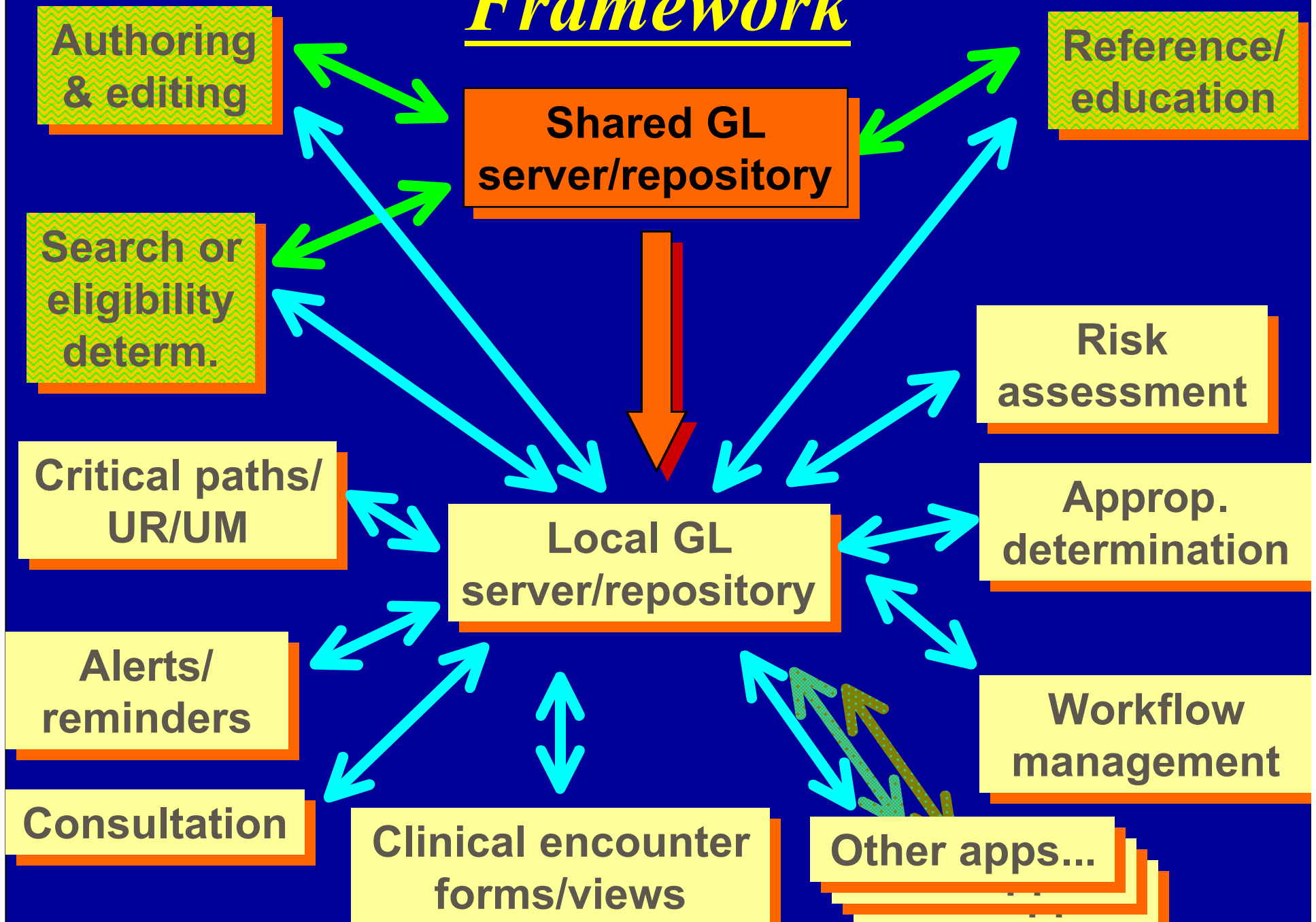
```
{ name = “High risk determination”;  
  condition = Boolean_criterion 1  
    { type = Boolean;  
      spec = “HCW OR age>65”};  
  destination = (Action_Step 3);  
  otherwise = (Conditional_Step 2);}
```

# **A GLIF-based GL tool suite**



- **Tools aimed at providing ability to create, maintain, share, access, and execute clinical GLs**
- **Distributed framework, with tools designed to work with each other**
- **GLIF provides the common sharable representation**

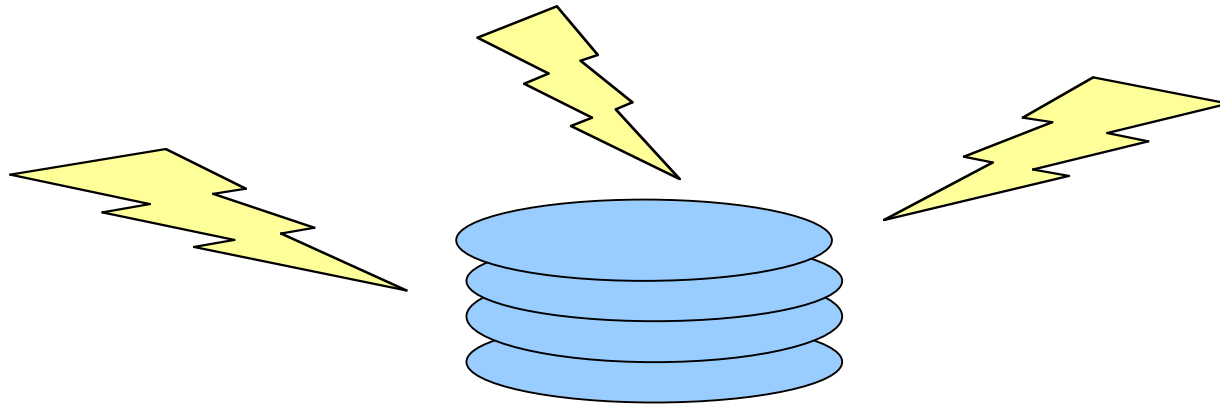
# Framework



# Server/repository

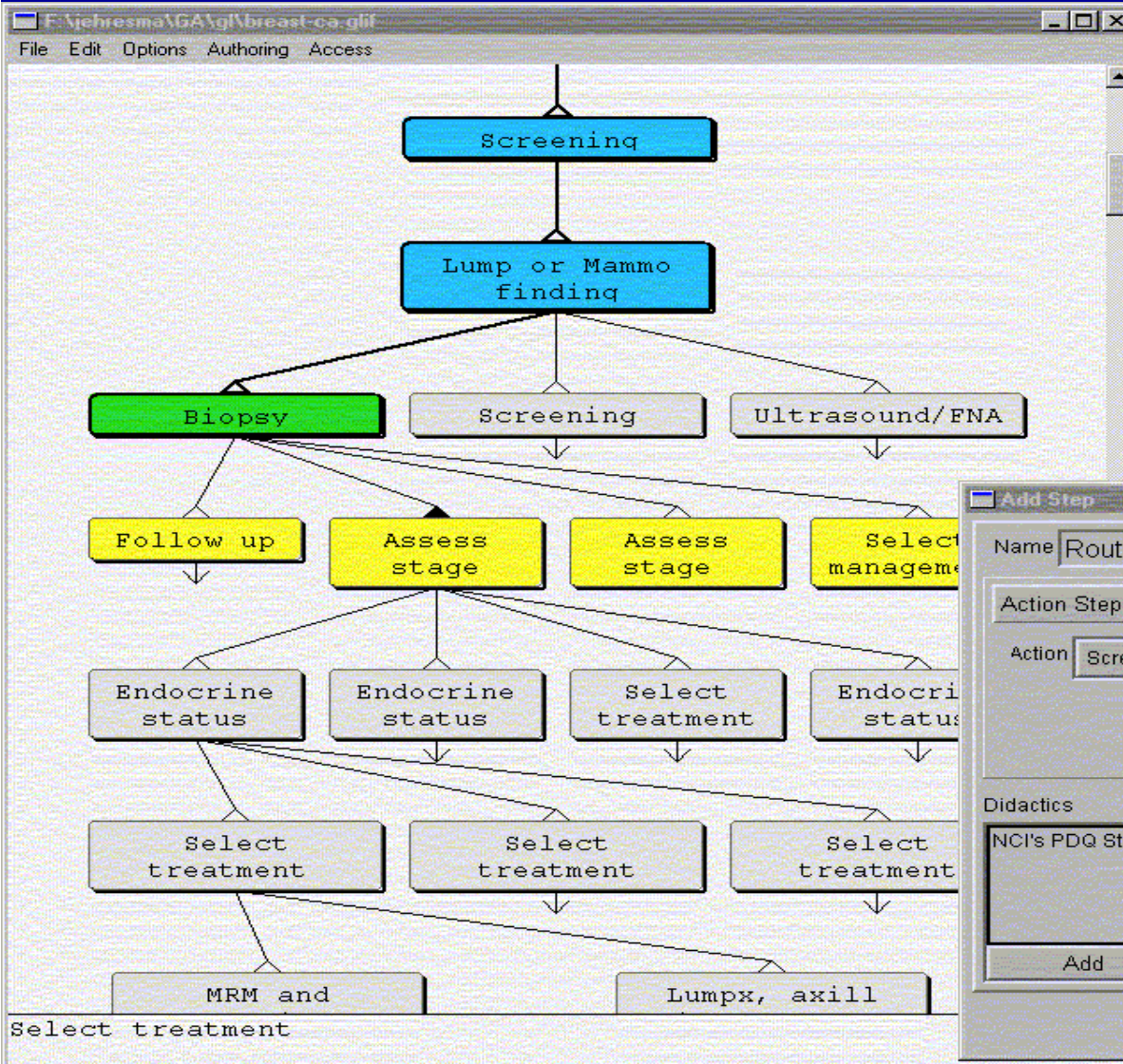
---

- Internet-accessible (CORBA-based)
- Classifies and indexes GLs or protocols
- Controls access over a network



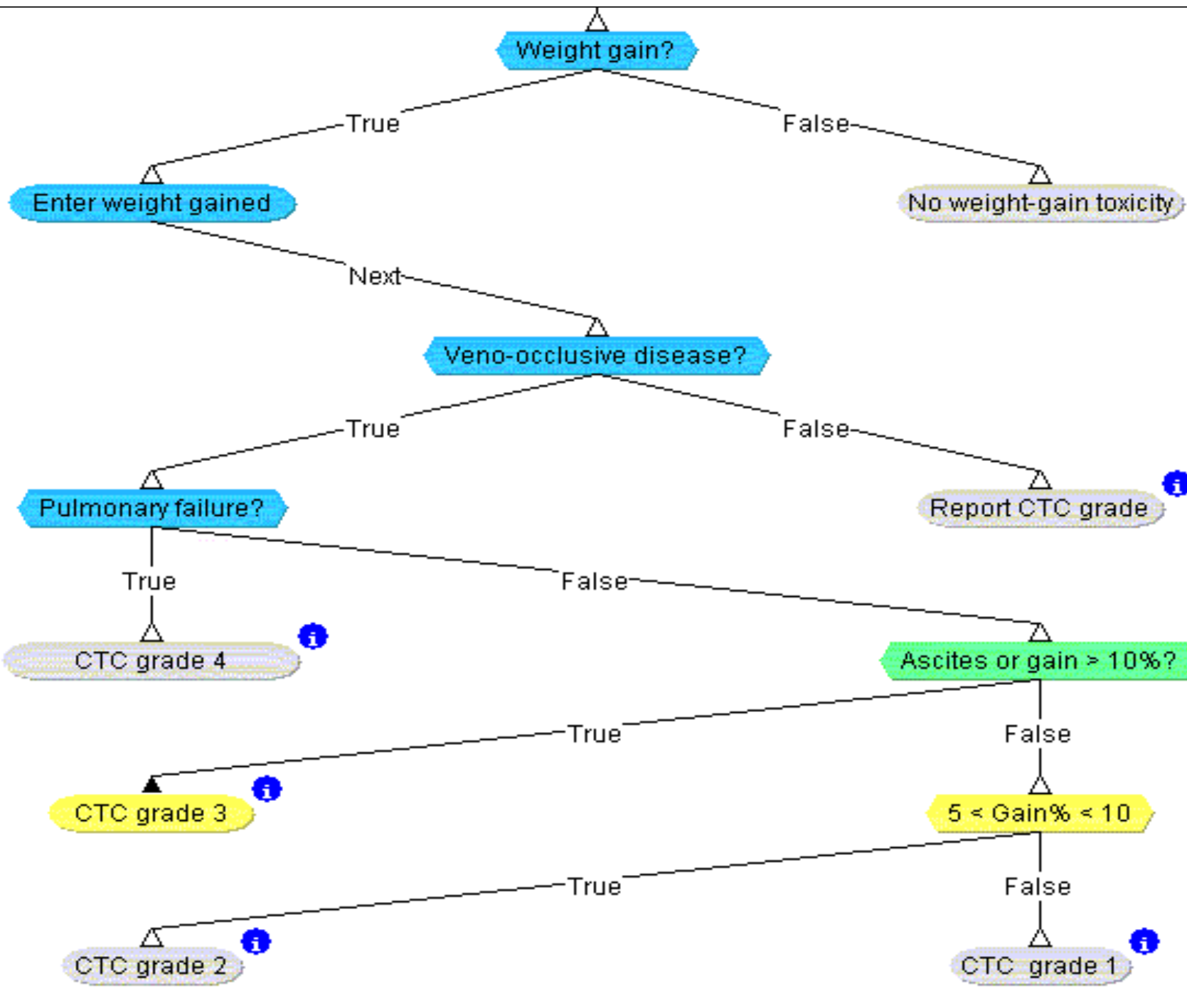


# GL authoring/browsing



The "Add Step" dialog box is open, showing the following fields and options:

- Name: Routine screening
- Action Step: (dropdown menu)
- Action: ScreeningD (dropdown menu)
- Didactics: NCI's PDQ Statement on Screening
- Buttons: Add, Edit, Remove
- Buttons: Ok, Cancel





# Toxicities

Category: CONSTITUTIONAL SYMPTOMS

Toxicity: Weight gain - veno-occlusive disease (VOD)

- Grade 1:  $\geq 2$  -  $< 5\%$
- Grade 2:  $\geq 5$  -  $< 10\%$
- Grade 3:  $\geq 10\%$  or as ascities
- Grade 4:  $\geq 10\%$  or fluid retention resulting in pulmonary failure
- Grade 5: Death related to toxicity

Note: The above criteria are to be used ONLY for weight gain associated with Veno-occlusive Disease.

## Attribution Code

- Unrelated
- Unlikely
- Possible
- Probable
- Definite

Patient Id:  Protocol Id:  Course No.:

Date of Event: (MM/DD/YYYY)

Enter Reset

Weight g

True

Enter weight gained

Next

Veno-occlusive

True

Pulmonary failure?

True

False

CTC grade 4



True

CTC grade 3



Set Current Step

Open Weight-gain VOD CTC Report Form

True

CTC grade 2



# Eligibility determination & patient recruiting



## FACTs Breast Cancer Clinical Trials Search Form

Reset

Search Trials

### Patient Characteristics

Age:  years

Sex:  F  M

Premenopausal  Postmenopausal

### Functional Status

ECOG

Life Expectancy: >  months

### Disease Characteristics

T  N  M  OR Stage

Histologically Confirmed  Yes  No

Cytologically Confirmed  Yes  No

Measurable Disease  Yes  No

Evaluable Disease  Yes  No

Disease Free  Yes  No



Internet zone



FACTS Results Page - Microsoft Internet Explorer

File Edit View Go Favorites Help

Address <http://telmato.bwh.harvard.edu:8000/DEV/FormOut.asp> infoseek Links

## Results - Abbreviated Listing

This is a listing of the 15 clinical trials that your patient may qualify for. Please note that we cannot determine with certainty whether your patient matches *all* of the eligibility criteria for any trial. The number of criteria matched and number of criteria still unknown are shown next to the name of each trial. The trials are listed in order of probability of match, with the highest probability trials listed first.

Click here for a [FACTS Detailed Listing](#) or click on a Protocol below to view the complete PDQ abstract.

**Key:** M - Number of criteria matched, U - Number of criteria still unknown

Clinical Trial Name	M	U
1. <a href="#">Protocol 12665: Phase III Study of Prolonged Adjuvant Tamoxifen for Breast Cancer</a>	1	5
2. <a href="#">Protocol 10198: Phase II Pilot Study of PBSC Mobilization with High-Dose Cyclophosphamide/Etoposide or with Cyclophosphamide/Etoposide/Cisplatin Followed by G-CSF or GM-CSF in Cancer Patients Undergoing Transplantation (Summary Last Modified 10/97)</a>	2	7
3. <a href="#">Protocol 13151: Phase II Study of Interleukin-2 in Patients with Hematologic Malignancies or Solid Tumors Who Have Received Autologous Bone Marrow or Peripheral Blood Progenitor Cell Transplantation (Summary Last Modified 06/98)</a>	2	10
4. <a href="#">Protocol 12039: Phase II Study of Neoadjuvant Continuous Weekly Doxorubicin/Cyclophosphamide (AC) for Locally Advanced and Inflammatory Breast Cancer (Summary Last Modified 01/98)</a>	6	11
5. <a href="#">Protocol 11793: Phase II Pilot Study of Stem Cell Mobilization with Paclitaxel/Cyclophosphamide Followed by High-Dose Melphalan/Etoposide with Autologous T-Cell-Depleted CD34+ Peripheral Blood Stem Cell Rescue for Metastatic and High-Risk Breast Cancer (Summary Last Modified 08/98)</a>	5	14
6. <a href="#">Protocol 13184: Phase II Study of High Dose Combination Chemotherapy and Autologous or Syngeneic Peripheral Blood Stem Cell Rescue Followed by Immunotherapy With Interleukin-2 and Sargramostim (GM-CSF) in Patients With Inflammatory Stage IIIB and Responsive Metastatic Stage IV Breast Cancer</a>	5	14

Internet zone

# Execution “engine”



- **Tracks & interprets GLIF-based guideline, as data are obtained**
- **Used as a core in multiple applications**
  - | **risk assessment**
  - | **consultation**
  - | **clinical trial protocol**
  - | **disease management**
  - | **workflow support**
  - | **educational simulations**

# Risk assessment

## Summary of your responses

*Use the back button of your browser to change any of this information*

Age	53
Do you have diabetes?	No
Do you smoke?	Yes
Gender	Female

## Please fill in the information below

HDL Cholesterol	<input type="text" value="34"/>	mg/dl
LDL Cholesterol	<input type="text" value="170"/>	mg/dl
Total Cholesterol	<input type="text" value="280"/>	mg/dl
Blood pressure	<input type="text" value="140"/>	BP Systolic (mmHg)

## Recommendations

*Please keep in mind that if you left an answer blank, we used the average risk for that question to generate these recommendations.*

- Based on your answers, your risk for developing heart disease within the next 10 years is 13%. The average risk for a 53 year old woman is 8%. If any member of your family (1st degree relative) developed heart disease before the age of 45 in men, 55 in women, your risk is further increased.
- Your risk is higher than average. We suggest you see your doctor.
- We suggest reviewing all of the following risk factors with your doctor
  - Smoking
  - Total cholesterol
  - LDL cholesterol
  - HDL cholesterol
  - Blood pressure
- Your risk could be further improved by
  - Lowering your total cholesterol
  - Lowering your LDL cholesterol
  - Lowering your blood pressure
  - Not Smoking

**Heart disease  
risk**

# Consultation

Recommended reading	Recommended actions
<a href="#">Medline: Influenza vaccine efficacy</a>	Obtain patient data regarding contra-indications
<a href="#">Guideline in XML</a>	

Enter patient data	
Hypersensitive to eggs	<input type="radio"/> True <input checked="" type="radio"/> False
History of anaphylactic hypersensitivity to vaccination	<input type="radio"/> True <input checked="" type="radio"/> False
Guillain-Barre syndrome within 6 weeks of a previous vaccine	<input type="radio"/> True <input checked="" type="radio"/> False
Current severe acute illness	<input checked="" type="radio"/> True <input type="radio"/> False

Next ->

Flu vaccine guideline

Recommended reading	Recommended actions
<a href="#">Medline: Influenza vaccine efficacy</a>	Wait for acute illness to resolve then reapply guideline
<a href="#">Guideline in XML</a>	

Next ->



# Protocol-based care

Visit - Neoadjuvant hormonal therapy	
<b>Reference material</b> <a href="#">Common toxicity criteria</a>	<b>Tasks for this visit</b> <ul style="list-style-type: none"><li><a href="#">Order now</a> - Leuprolide acetate (Lupron) 7.5 mg IM today. Repeat at 28 days interval.</li><li><a href="#">Order now</a> - Flutamide (Eulexin) 250 mg PO, TID. Continue until next visit (after 28 days).</li></ul>
<b>Solid tumor flowsheet</b>	
Serum prostate-specific antigen	
Temperature	

## Drug order entry

Drug name	<input type="text" value="Leuprolide"/>
Dose	<input type="text" value="7.5 mg"/>
Route	<input type="text" value="IM"/>
Frequency	<input type="text" value="stat"/>
Period	<input type="text"/>
<input type="button" value="Submit Order"/> <input type="button" value="Cancel Order"/>	

## Prostate cancer protocol

## Adverse Events

**Category: CONSTITUTIONAL SYMPTOMS**

**Adverse Event** Weight gain - Veno-Occlusive Disease (VOD) for BMT studies if specified in the protocol

- Grade 1:**  $\geq 2$  -  $< 5\%$
- Grade 2:**  $\geq 5$  -  $< 10\%$
- Grade 3:**  $\geq 10\%$  or as ascites
- Grade 4:**  $\geq 10\%$  or fluid retention resulting in pulmonary failure
- Grade 5:** death related to toxicity

**Note:** Also consider Ascites, Edema, Pleural effusion (non-malignant)

**Attribution Code**

- Unrelated
- Unlikely
- Possible
- Probable
- Definite

**Patient Id:**  **Protocol Id:**  **Course No.:**

**Date of Event:**(MM/DD/YYYY)

# **Guideline-driven clinical encounter**



- **A possible model for integration into practice**
  - **tailored information assembly**
  - **disease management as a primary focus**
  - **suggestions triggered by data entry**
  - **workflow facilitated by anticipating user needs**

Patient Info: 1234-12-1111 Jane Smith 56 yo F 10 Main Street, Boston MA 02115 (617)555-5555

Navigation: Home Patient Problem Diabetes HELP

EXIT

Subheading: Review Subjective / Objective Assessment Plan Information

- Subjective
- Fingerstick Glucose
- ROS
- Other
- Objective
- Vital Signs
- Physical Exam
- Lab
- Other

ROS



	+	-	?		+	-	?	
	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<a href="#">LH</a>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Leg Ulcers</a>
	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">CP</a>	<input checked="" type="radio"/>	<input type="radio"/>	<input type="radio"/>	<a href="#">Polydipsia</a>
	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">SOB</a>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Polyuria</a>
	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<a href="#">N</a>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Hypoglycemic symptoms</a>
	<input type="radio"/>	<input checked="" type="radio"/>	<input type="radio"/>	<a href="#">V</a>	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Hyperglycemic symptoms</a>
	<input type="radio"/>	<input type="radio"/>	<input checked="" type="radio"/>	<a href="#">Palp</a>				<a href="#">Other</a>

Visit Note

1234-12-1111 Jane Smith 56 yo F 10 Main Street, Boston MA 02115 (617)555-5555

View Full Size

Subjective:

- Patient with Diabetes Mellitus Headaches, and h/o Depression.
- Home glucose monitoring: pre-breakfast 180-220 and pre-dinner 220-250.
- ROS: No LH, N, V, but complains of polydipsia.

Update Text

Patient Info: 1234-12-1111 Jane Smith 56 yo F 10 Main Street, Boston MA 02115 (617)555-5555

Navigation: Home Patient Problem Diabetes HELP EXIT

Subheading: Review Subjective / Objective Assessment Plan Information

Assessment

- Patient with DM with  excellent  good  fair  poor glucose control ⓘ
- Home monitoring suggests need to change medication regimen ⓘ
- Patient is overdue for the following:
  - HbA1c ⓘ
  - Urine Protein Studies ⓘ
  - Dilated Eye Exam ⓘ
  - Diabetic-Nurse teaching visit ⓘ

[Accept All](#)

[Other](#)

Visit Note

View Full Size

Update Text

Assessment:

- Patient with DM poor glucose control.
- Home monitoring suggests need to change medication regimen.
- Overdue for: HbA 1C, urine protein study or urine microalbumin, dilated eye exam, diabetic-nurse teaching visit



Patient Info: 1234-12-1111 Jane Smith 56 yo F 10 Main Street, Boston MA 02115 (617)555-5555

Navigation: Home Patient P

Subheading: Review Subjective / Obj

Assessment

- Patient with DM with  excellent  g
- Home monitoring suggests need to cha
- Patient is overdue for the following:
  - HbA1c *i*
  - Urine Protein Studies *i*
  - Dilated Eye Exam *i*
  - Diabetic-Nurse teaching visit *i*

[Accept All](#)

[Other](#)

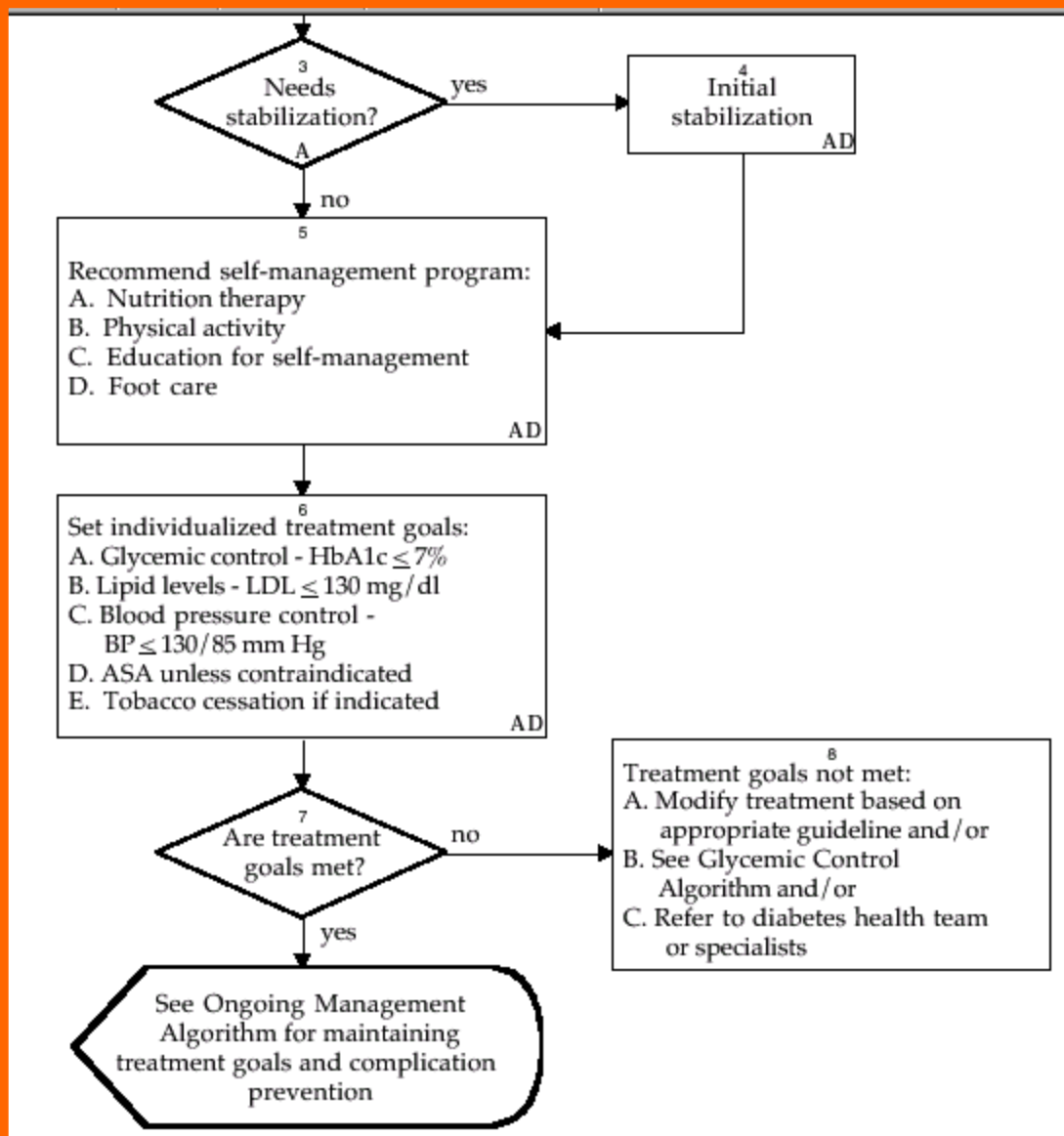
Visit Note

Assessment:

- Patient with DM poor glucose con
- Home monitoring suggests need t
- Overdue for: HbA 1C, urine prote
- diabetic-nurse teaching visit

View Full Size

Update Text



Patient Info: 1234-12-1111 Jane Smith 56 yo F 10 Main Street, Boston MA 02115 (617)555-5555

Navigation: Home Patient Problem Diabetes HELP

Subheading: Review Subjective / Objective Assessment Plan Information

Plan

- Adjust Diabetes Medication
  - > Increase Metformin to  500 mg TID  875 mg BID ⓘ
  - > Begin Insulin  ⓘ
- Begin Home Monitoring ⓘ
- Obtain:
  - Serum HbA1C ⓘ  Urine Microalbumin ⓘ
  - Urine Protein ⓘ  Other
- Refer to:
  - Ophthalmology ⓘ
  - Diabetes-Nurse Educator ⓘ

[Other](#)

[ [Enter All Orders](#) ]

Visit Note

[View Full Size](#)

[Update Text](#)

Plan:

1. **Diabetes:** Increase Metformin to 875bid. Metformin instruction sheet given. Continue home glucose monitoring. Obtain lab tests: HbA1C, urine microalbumin. Refer to Ophthalmology for dilated eye exam and to nurse practitioner for diabetic-teaching visit.
2. **General:** Return to clinic in 3 months time.

# **Hypotheses (yet untested)**



- **Approach will provide positive effect on:**
  - **structured record keeping**
  - **adoption of best practices**
  - **physician attitudes**
  - **workflow**

# GLIF 3



- **GLIF 2, as published in 1998:**
  - **underspecified, yet has spawned a number of implementations & extensions**
- **GLIF 3 created as a draft model for a proposed standard approach**
  - **focus of an international workshop in Boston, March, 2000**

# Framework



- **In GLIF 3 we approach the issue of sharing at three different levels:**
  - **A. Author/viewer**
    - | human able to navigate, edit, use
  - **B. Abstract machine representation**
    - | correctness, completeness of representation able to be proved
  - **C. Integration into application environments**
    - | linkage to clinical information systems &

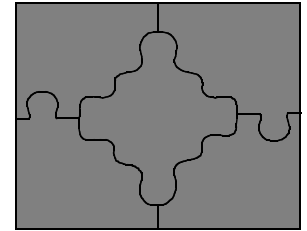
# Rationale for tri-level framework



- Enables standardization requirements for each level to be considered separately
- Fosters ability to reconcile various formalisms that address different levels
  - e.g., prior GLIF work was focused on level A, Arden syntax aimed primarily at Levels B, C
- Combined focus facilitates use at all

# **GL Workshop**

**Boston, MA, March 3-4, 2000**



- **Brought together multiple stakeholders concerned with the development, dissemination, & use of clinical practice guidelines (GLs)**
  - **To identify the collective needs & purposes of GLs & for sharing of them -- the functional requirements**
  - **To develop a robust representation model**
  - **To establish a process to foster sharing**

# Sponsors



- US Army
- NLM
- CDC
- AHRQ



# **Stakeholders represented**



- **Government**
- **Professional specialty organizations**
- **Insurers**
- **Health care provider organizations**
- **Academic medical informatics**
- **Industry -- content, systems, tools providers, consultants/integrators**

# International Scope



## ■ Representation from

- UK
- Netherlands
- Italy
- Taiwan
- Canada
- Brazil
- India
- France
- Japan
- USA

# **Breakout groups**



- **A. Functional requirements**
- **B. Representation models**
- **C. Special needs of clinical trials**
- **D. Infrastructure & tools**
- **E. Organization & process**

# Some meeting outcomes

---

- Establishment of 5 on-going task forces
- Production of white papers
- Presentations
  - AMIA, HIMSS, professional special organizations, other forums
- A Web site for exchange
  - <http://www.glif.org>
- Decision to form consortium to



# Summary & current status



- **GLs have many potential roles**
- **Goal of GL representation for sharability**
- **Have demonstrated use of GLIF as basis for a suite of tools to support above**
- **Development beginning to converge on:**
  - | **standards**
  - | **infrastructure & tools**

# **Where do we go from here:**

## **An agenda**



- 1. Promote adoption of a GL representation standard**
- 2. Develop internet resource for access to:**
  - specifications, tools, well-coded GLs, discussion & information exchange**
- 3. Support projects to:**
  - demonstrate feasibility of sharing & reuse**
  - explore ways to integrate GLs into**