Decreasing Variability in Health Care

HST950

Decision Systems Group, Brigham & Women's Hospital
Harvard Medical School

Peter Szolovits, PhD
Isaac Kohane, MD, PhD
Lucila Ohno-Machado, MD, PhD

Variability in Health Care

- Decision support systems
  - Integration of guidelines into practice
    - Decrease variability, homogenize

  - Knowledge discovery in biomedical data
    - Increase variability, customize

  - Support for clinical trials

Guidelines and clinical protocols

- What are they?
- Why computerize?
- Knowledge representation
- Application in breast cancer protocol eligibility with uncertain information

Decreasing practice variation

- Studies demonstrate huge variability in practices

What are clinical guidelines?

- Institute of Medicine definition
  - systematically developed statements to assist practitioner and patient decisions about appropriate healthcare for specific clinical circumstances

- A recommended strategy for management of a medical problem in order to
  - Reduce inappropriate use of resources $$$$$
  - Reduce practice variation
  - Improve outcomes

Conventional publication

- Guidelines can be developed and published by
  - A medical institution, to be used locally
  - National and international organizations, used by many medical institutions

- Conventional publication
  - In journals and textbooks
  - Booklets or guideline summaries
  - Compilations of guidelines for reference

Types of guidelines

☐ Risk assessment
☐ Chronic disease management
  ■ Diabetes, asthma, hypertension
☐ Screening
☐ Diagnosis and workup
☐ Protocol-based care (clinical trials)

Clinical Trial Protocols

□Goal is to intervene in a random part of the eligible patient and leave the other part with current standard of care

□Carefully selected population, with few comorbidities (other diseases)

□Homogeneous care in each arm to investigate statistical significance of differences

Select patients
Randomize into
   - intervention arm
   - control arm
Compare outcomes

Where do the recommendations come from?

□ Panel of experts (most common)
  ■ Hard to get experts to agree on anything
□ Decision analysis models (least common)
  ■ Difficult to obtain probabilities and utilities
□ Observational studies
  ■ Small numbers may lead to wrong recommendations
□ Clinical trials
  ■ Controlled populations, strict eligibility criteria

A major problem is to match the patient in front of you with carefully selected patient population used in the trials

Ways of helping implement guidelines/clinical trials

□Help authors to create guidelines that make sense (verify the "logic")

□Eligibility determination for a variety of competing guidelines/protocols

□Assistance in implementing the prescribed actions

Eligibility determination

☐There are hundreds of guidelines and clinical trials out there

☐Automated eligibility could warn providers of guidelines/protocols that match the patient

☐MAJOR problem: uncertainty in patient status (tests to be done, info not available)

Increase versus decrease variability

☐ Recommendations are based on "average" or "mode" patient

☐ "Mode" patient may not exist

☐ If more info is available, why not use it?

Example

□Consent forms for interventional cardiology procedures:

□Acknowledgement that risk of death in hospital is about 2%

□Who is at 2% risk?

Why people want to computerize guidelines

- Provide automatic decision support
  - Applied to individual patients
  - During the clinical encounter

- Ambiguities in guidelines may be reduced
  - Software tools and guideline models can promote specifying logic precisely

- Can integrate guidelines into workflow
  - Patient-specific guideline knowledge available at point of care

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

Computer-interpretable guidelines

- Interactive guidelines
  - Enter patient parameters to traverse guideline

- Guidelines embedded in EPR Systems
  - Automated reminders/alerts
  - Decision support and task management

… Why people want to computerize guidelines

- Can be used for quality assurance
  - Guideline defines gold-standard of care
  - Perform retrospective analysis to test if patients were treated appropriately

- Allows for interactive visualization of guideline logic
  - e.g., allows one to focus on relevant sections of flowchart

$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

Why share guidelines?

□Provide consistency in guideline interpretation

□Reduce cost of guideline development

□Minimize misinterpretations and errors through the process of public review

Challenges in sharing guidelines

- Local adaptation of guidelines
  - Must allow care sites flexibility in modifying guidelines for
    - Availability of resources and expertise
    - Local workflow issues
    - Practice preferences
    - Differences in patient population

Patient and Provider Preferences

- Who cares?

- Who elicits preferences for a particular patient?

- How does this get taken into account?

Patient and Clinician Vocabulary: How Different Are They?

…Challenges in sharing guidelines

- Integration with information systems
  - Match patient data in EPR to terms in guideline
  - Match recommendations in guideline to actions in order entry system

Guideline models

- Guideline models make explicit
  - Knowledge concepts contained in a guideline
  - Structure of the concepts and relationships among them
  - Scope of the model
    - Types of guidelines, e.g. alerts vs. multi-encounter guidelines
    - Level of detail, e.g. structured or text specification

Models for guidelines and rules

☐ Individual decision rules (single step)
- Arden Syntax

☐ Multi-step guidelines, modeled as sets of guideline tasks that are
- connected in a graph
- nested

Arden Medical Logic Modules

□Format for representation and sharing of single medical decision

□Each medical decision (rule) is called a medical logic module (MLM)

□Suitable for alerts and reminders

□A guideline may be represented by a chained set of MLMs

…Arden MLM

- Simplified example
  - data:
    - potassium_storage := event {'1730'};
    - potassium:= read last { '32471'};
  - evoke: potassium_storage (to EPR)
  - logic: potassium > 5 mmol/L
  - action: write "Potassium is significantly elevated";

…Arden Syntax

- Standard published by ANSI

- Part of HL7 activity

- Supported by many commercially- available hospital information systems

…Models for multi-step guidelines

☐ Multi-step guidelines, modeled as hierarchical sets of nested guideline tasks

- EON
- PRODIGY
- PRO*forma*
- Asbru
- GLIF

This is an incomplete list!

EON

- Developed by Tu and Musen (Stanford)
- Extensible collection of models where guideline developers select modeling solutions from a   toolkit
- Concept model, patient information model, guideline model
  - e.g., multiple abstraction methods
- Temporal query based on formal temporal model
- Temporal abstraction use specifications of abstractions in knowledge base

PRODIGY

- Developed by Ian Purves, Peter Johnson, and colleagues, at the U of Newcastle, UK

- Simple and understandable model
  - Few modeling primitives
  - Complexity management techniques
  - Eases the encoding process

- Sufficiently expressive to represent chronic disease management GLs

Proforma

- Developed by John Fox et al., (ICRF, UK)

- Emphasis on soundness, safety, and verifiability
  - PROforma is a formal specification language, based on a logic language

- Guidelines are constraint satisfaction graphs
  - Nodes represent guideline tasks

Asbru

- Developed by Shahar, Miksch and colleagues

- Emphasis on guideline intentions, not only action prescriptions
  - e.g., maintain a certain blood pressure

- Expressive language for representing time-oriented actions, conditions, and intentions in a uniform fashion

- Guidelines are modeled as plans that can be hierarchically decomposed into (sub)plans or actions

GuideLine Interchange Format: Version 3

□Emphasis on sharing guidelines across different institutions and software applications

- ■A consensus-based multi-institutional process (InterMed: a collaboration of Stanford, Harvard, Columbia)
- ■An open process – the product is not proprietary
- ■Supports the use of vocabularies and medical knowledge bases

… GLIF3

Object-oriented representation model for guidelines

Guideline

name

author

Guideline Step

Has parts

Has specializations

Action Step

Decision Step

Branch Step

Synchronization Step

Patient State Step

…

… GLIF3

- 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 …

- Action and decision steps can be nested

- Branch and synchronization steps allow concurrency

… GLIF3

- Patient-state step
  - characterize patient's clinical state
  - serve as entry points into the guideline

- Steps refer to patient data items (age, cough)

- Expression language: derived from Arden Syntax logic grammar

- Medical domain ontology

…GLIF3

- Medical ontology
  - Concept model
    - concepts defined by id from controlled vocabulary
    - concept relationships (e.g., contradindication, is-a)
  - Patient information model
    - Default model is based on HL7 RIM
    - User-defined concepts and data model classes

Workshop: Towards a Sharable Guideline Representation

- Hosted by InterMed in March 2000 in Boston
- 80 attendees from 8 countries
- Representation from
  - Government
  - Professional specialty organizations
  - Insurers
  - Health care provider organizations
  - Academic medical informatics
  - Industry

Purpose of the meeting

□ To recognize the need for a standard

□ To identify the the functional requirements for sharing guidelines

□ To establish a process for the development of a robust representation model

□ To establish a process to foster sharing

Life cycle of a computer-interpretable guideline

USE
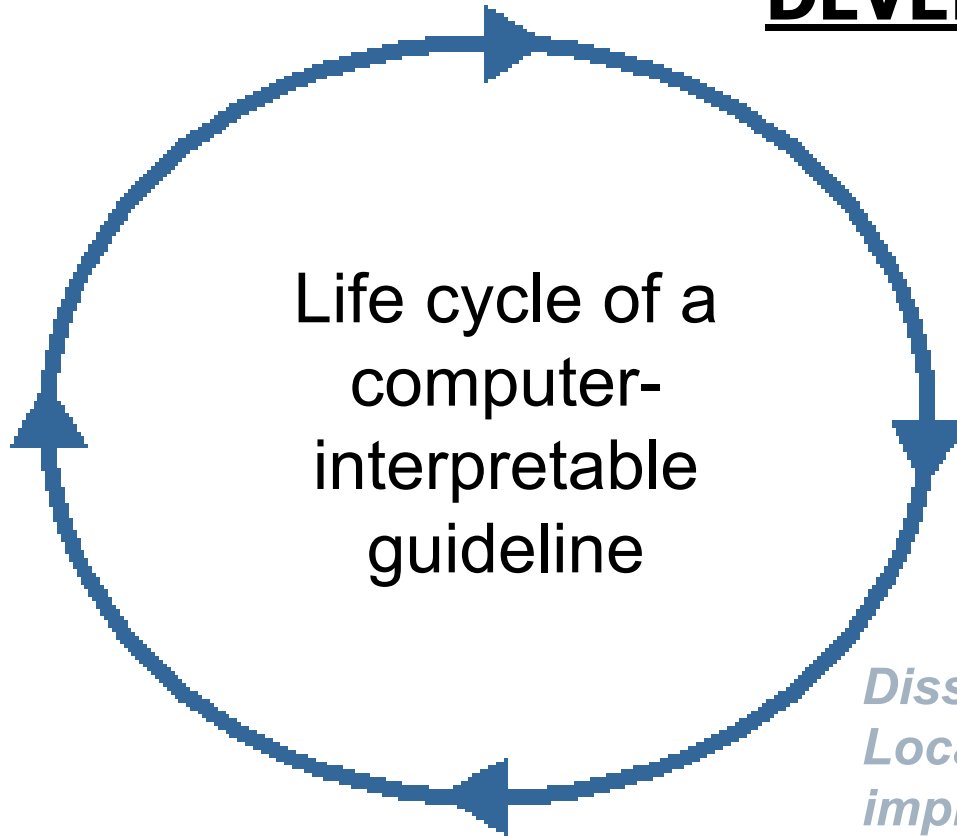**Use and maintenance**
Performance analysis

DEVELOPMENT

Authoring
Encoding
Validation

Life cycle of a computer-interpretable guideline

Dissemination
Local adaptation and implementation
Testing

IMPLEMENTATION

Take home message

□It is not all about the technical difficulty…

□It is about whether people believe in guidelines

□It is about whether how a guideline fits a particular case

□It is about whether it makes a difference for this particular case