Improving Patient-Centered Workflow with Clinical Decision Support Systems

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Overview: CDSS

• Rationale: Why do we need decision support, and what is it?
• Process: Developing decision support interventions
• Information system infrastructure: data, terminology, data model
• Putting it all together: Decision engine, knowledge representation & standards

Take-Home Messages

• Clinical Decision Support System ≠ Computer system
  – People matter!

• Clinical Decision Support System ≠ Decision support engine
  – Data infrastructure is key!

• Clinical Decision Support System ≠ One-time CDSS purchase
  – Knowledge maintenance is important!

I. CDSS Need: Medical Errors

Estimated annual mortality

- Air travel deaths: 300
- AIDS: 16,500
- Breast cancer: 43,000
- Highway fatalities: 43,500
- Preventable medical errors: 44,000 - (1 jet crash/day) 98,000

Costs of Preventable Medical Errors

Annually:

- USA: Only 54.9% of adults receive recommended care for typical conditions
  – community-acquired pneumonia: 39%
  – asthma: 53.5%
  – hypertension: 64.9%

- Delay in adoption: 10+ years for adoption of thrombolytic therapy

...180,000 people die each year partly as a result of iatrogenic injury...
**What is Clinical Decision Support?**

**Different Levels**

- **Organization of Data:** the CIS / EHR
- **Stand-Alone Expert Systems**
  - often require redundant data entry
- **Data Repository:** Mining
- **CDSS Integrated into Workflow**
  - push information to the clinician at the point of care
  - examples: alerting in EHR, CPOE

**Examples (continued)**

- **Reminders of Redundant Test Ordering**
  - intervention: reminder of recent lab result
  - result: reduction in hospital charges (13%)  
- **CPOE Implementation**
  - Population: hospitalized patients over 4 years
  - Non-missed-dose medication error rate fell 81%
  - Potentially injurious errors fell 86%
- **Systematic review**
  - 68 studies
  - 66% of 65 studies showed benefit on physician performance
  - 9/15 drug dosing
  - 1/5 diagnostic aids
  - 14/19 preventive care
  - 19/26 other
  - 6/14 studies showed benefit on patient outcome

**Case Studies:**

**Examples of CDSS Effectiveness**

- **Perioperative Antibiotic Administration**
  - intervention: reminder re timing and type of abx
  - period: 1988 - 1994
  - result: perioperative wound infections dec 1.8% - > 0.9%
  - avg # doses: 19 -> 5.3
  - overall antibiotic cost (constant $) per treated patient: $123 -> $52

**CDSS Role in Optimizing Throughput**

- **Clinical/Patient Safety**
  - Avoiding preventable ADEs
  - Enhancing compliance with guidelines
- **Administrative Alerting**
  - Resource assignment vs insurance coverage (formularies, bed classification, etc)
  - Billing correctness (E/M coding)
  - Resource utilization (vaccine supplies, bed availability)
Developing Decision Support Interventions: CDS Implementers’ Workbook

• Goal: Provide practical advice to organizations implementing decision support
  – Iterative implementation process
  – Practical tools: worksheets, etc
• Part of the HIMSS Patient Safety Task Force

http://www.himss.org/cdsworkbook/

The Steps

I. Document/prioritize drivers
II. Catalog infrastructure
III. Select interventions
IV. Establish logistics
V. Launch interventions
VI. Evaluate impact => enhance

Step #1: Identify Goals

• Support disease management initiatives
• Improve clinical performance: safety & quality
• Foster evidence/guideline-based practice
• Improve reimbursement; reduce cost
• Improve communication
• Improve regulatory/reporting/accreditation compliance
• Address clinician/patient questions

Step #1: Stakeholders and Other Sources of Goals

• Institutional analyses: cost, safety, quality…
  – Committees: P&T, UR, QI, Patient Safety…
  – Data driven: analytical tools
• Local Stakeholders
  – Interviews, surveys, observation
• Community priorities and programs
• Promising targets
  – Strong evidence/quality measures
  – Systematic analyses – external

Step #1: Decomposing Goals Into Measurable Objectives

High-level goal / program: Patient safety

Focused Goal: Decrease medication errors / ADE’s

Objective: Decrease severe drug interactions
Objective: Prevent therapeutic duplication
Objective: Prevent allergic reactions to drugs

Step #2: Identify What (Systems) You Have

• Catalog all information systems and their data
• Identify what kind of decision support those IS can provide (or you can build)
• How can multiple systems be synthesized to support goals?
Step #3: Selecting Interventions => CDS Types

- Forms and templates (encounter documentation)
- Relevant data presentation (flowsheets, CPM)
- Order sets
- Integrated guidelines (active guidelines)
- Reference information (links/infobuttons)
- Reactive/unsolicited alerts (drug interactions)

Step #3: Workflow Opportunities

Step #4: Validate/Build/Develop Logistics

- What, when, who, where, how
- Establish feedback mechanisms
- Identify evaluation parameters
- Finalize content of interventions

Step #5: Test & Roll Out Interventions

- Test & validate content before roll-out
- Develop roll-out plan and schedule
- Establish mechanism for feedback to content and manner of interventions
- Cultivate clinician-champions

Step #6: Evaluate Effect and Feed Back

- Assess utilization of interventions
- Gather user responses to interventions
- Assess process and clinical outcomes in terms of previously identified outcome variables
- Feed back into process (choice of goals, choice of mechanisms, logistics)

III. Infrastructure

- Necessary underpinning to decision support initiatives
- **Key Elements**
  - Data
  - Terminology
  - Central data repository (Data model)
Acquisition of Clinical Data: Requirements

- Electronic format (allows automated processing)
- Communication network
  - Use of standards (HL7) to facilitate interchange between different vendors
- Data model / repository: Share data among applications

Structured Data: How do we get it?

- Direct entry/capture
  - Captured from devices (lab, vital signs monitor, etc)
  - Entered by human beings using structured forms
- Transform after the fact
  - Computer-assisted e-coding & NLP
Uses for Structured / Coded Data

- **Clinical care**: Sharing data from disparate sources
  - Integration in a CDR

- **Decision support**: Automated interpretation of data

- **Public health**: Surveillance across a population

(continued)

- **Research**: Pool data to discover new knowledge

- **Quality assurance**: Detect risks and intervene

- **Administration**: Manage resources

- **Reimbursement**: Justify payment for services

Standard Vocabularies: Examples

- **Endorsed by CMS** (45 CFR 162 = HIPAA requirement, final rule adopted 20 Feb 2003)
  - ICD9-CM
  - NDC (retail pharmacies)
  - CPT-4
  - HCPCS
  - Code on Dental Procedures & Nomenclature

More Standards:

- **Consolidated Health Informatics Initiative**
  - HL7: messages
  - NCPDP: ordering from pharmacies
  - IEEE 1073: Medical Information Bus (devices)
  - DICOM: imaging
  - LOINC: laboratory, vital signs
  - SNOMED CT: lab results contents, non-lab intervention/procedures, anatomy, dx/problems, nursing
  - Federal med terminologies: FDA (ingredients, manufactured forms, packages), NLM RxNorm (clinical drugs), VA NDF-RT (classification)

Standard Data Models: HL7 RIM

- **High-level, abstract model of all exchangeable data**
  - Concepts are objects: Act (e.g., observations), Living Subject, etc
  - Object attributes
  - Relationship among objects

- **Common reference for all HL7 v3 standards**

Schwam G, Recker RC, Mead CS, McDonald CJ. Integrating medical information and knowledge in the HL7 RIM. Free ASMA Symp 2000; 704-748.
IV. Putting It All Together: CDSS & Standards

- Use integrated data (CDR, vocabulary) + knowledge to provide decision support

- Key elements of the CDSS
  - Event monitor
  - KR formalisms
  - Delivery mechanisms (email, fax, pager, EMR)

CDSS: Integrating Data

- Clinical Event Monitor
  - Architecture:
    - Check data (events) being stored
    - Trigger appropriate procedural knowledge
    - Notify clinical user of relevant data and conclusions
  - Typical Output: alerts and reminders
    - routed via email, beeper, fax, EMR
  - Examples:
    - HELP System (LDS Hospital)
    - CUMC
    - Vendor HIS/EMR software

HL7 Standards

- Data standards
  - Messaging (v2.x, v3)
  - Data model (RIM)
  - Documentation (CDA)
  - Application integration (CCOW)
  - EHR Functional Model and Specification

- Decision support
  - Arden Syntax
  - Infobuttons
  - Order sets
  - GELLO & guideline standard

Guideline Models: Arden Syntax

  - Adopted by several major vendors

- Formalism for procedural medical knowledge

- Unit of representation = Medical Logic Module (MLM)
  - Enough logic + data to make a single decision
  - Generate alerts/reminders

Reference:
Infobutton Standard

- **Infobutton**: Application that mediates queries of knowledge sources by clinical applications (EHRs, etc)

- **Process**
  - Clinical information system invokes infobutton manager (IM) with patient/user data
  - IM creates 1+ infobuttons, each = different kind of query
  - User chooses infobutton to execute query against a knowledge source, which displays response


Order Sets

- **Rationale**: Considerable effort expended to develop order sets
  - Goal: Preserve and share

- **Different levels**
  - Document model: Maintain and share as a unit
  - Execution model: Use within a CPOE system

- **Current status**: Draft in progress

CPOE

- **CDSS Method**: Brings together many different kinds of decision support: order sets, drug interaction checking, order validation

- **Challenge**: Expensive, pervasive change (~5% use)

- **Issues**
  - May give rise to errors
  - May uncover pre-existing problems with governance and workflow


Summary

- **Decision support**: Broad definition, great need

- **Developing interventions**: Determine priorities, engage stakeholders, obtain widespread support
  - = organizational change

- **Information infrastructure**
  - Data (acquisition)
  - Terminology
  - Data model

- **CDSS**: Attention to knowledge delivery and format (standards)

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Thank You!

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