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

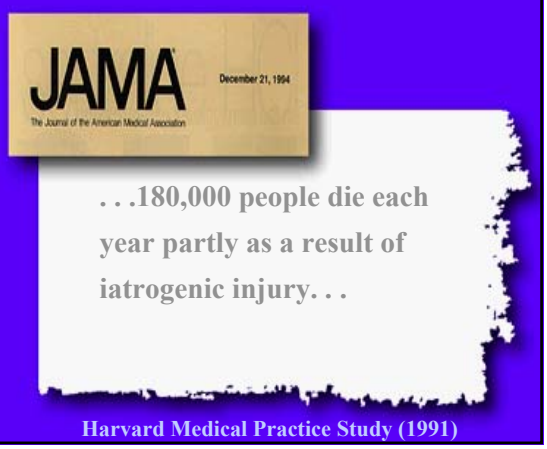
- Clinical Decision Support *System* ≠ Computer *system*
  - People matter!
- Clinical *Decision Support* System ≠ Decision support engine
  - Data infrastructure is key!
- Clinical Decision Support System ≠ One-time CDSS purchase
  - Knowledge maintenance is important!

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 (*1 jet crash/day*)	44,000 - 98,000

Costs of Preventable Medical Errors
$29 billion/year overall

Institute of Medicine. To Err is Human: Building a Safer Health System. Kohn LT, Corrigan JM, Donaldson MS eds. Washington: National Academies Press, 1999.



Harvard Medical Practice Study (1991)

CDSS Need

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

McGlynn EA, Asch SM, Adams J et al. The quality of health care delivered to adults in the United States. N Engl J Med 2003;348:2635-2645.

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

Antman EM, Lau J, Kupelnick B et al. A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts. Treatments for myocardial infarction. JAMA 1992;268(2):240-8.

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

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

Pestotnik SL, Classen DC, Evans RS, Burke JP. Implementing antibiotic practice guidelines through computer-assisted decision support: clinical and financial outcomes. Ann Intern Med 1996;124(10):884-90.

Examples (continued)

- Reminders of Redundant Test Ordering
  - *intervention*: reminder of recent lab result
  - *result*: reduction in hospital charges (13%)

Tierney WM, Miller ME, Overhage JM et al. Physician inpatient order writing on microcomputer workstations. Effects on resource utilization. JAMA 1993;269(3):379-83.

- CPOE Implementation
  - Population: hospitalized patients over 4 years
  - Non-missed-dose medication error rate fell 81%
  - Potentially injurious errors fell 86%

Bates DW, Teich JM, Lee J. The impact of computerized physician order entry on medication error prevention. J Am Med Inform Assoc 1999;6(4):313-21.

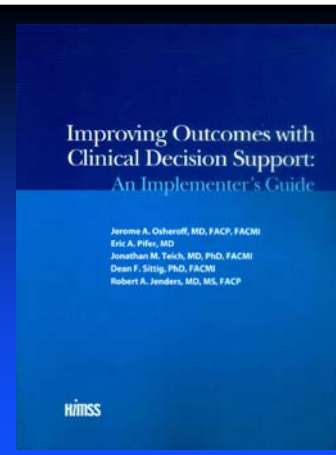
Examples (continued)

- 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

Hunt DL, Haynes RB, Hanna SE et al. Effects of computer-based clinical decision support systems on physician performance and patient outcomes: a systematic review. JAMA 1998;280(15):1339-46.

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)



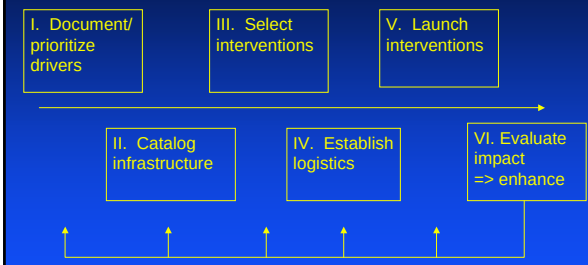
Developing Decision Support Interventions: CDS Implementers' Workbook

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

Osheroff JA, Pifer EA, Teich JM, Sittig DF, Jenders RA. Improving Outcomes With Clinical Decision Support. Chicago: Health Information Management Systems Society, 2005.

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

The Steps



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

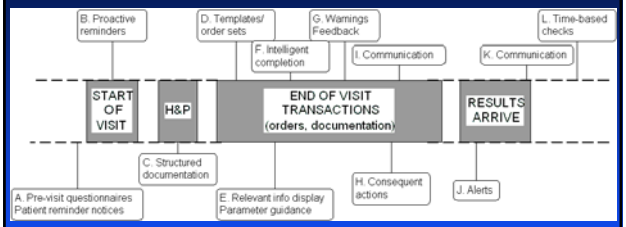
Step #2: Identify What (Systems) You Have

- 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

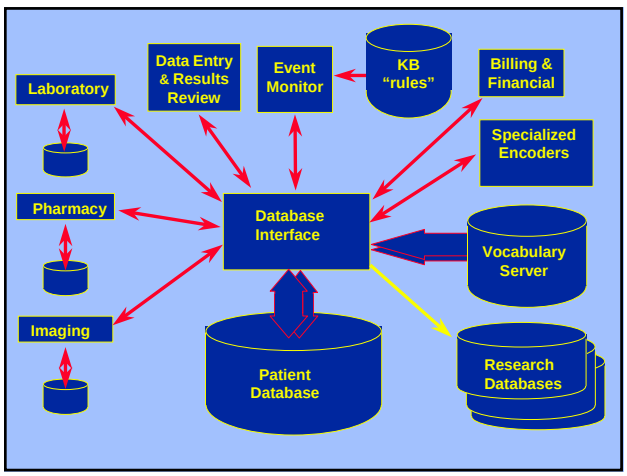
- Necessary underpinning to decision support initiatives
- Key Elements
  - Data
  - Terminology
  - Central data repository (Data model)

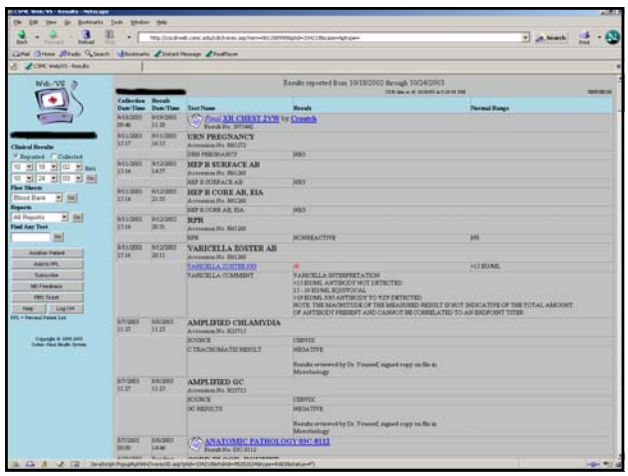
Acquisition of Clinical Data: Requirements

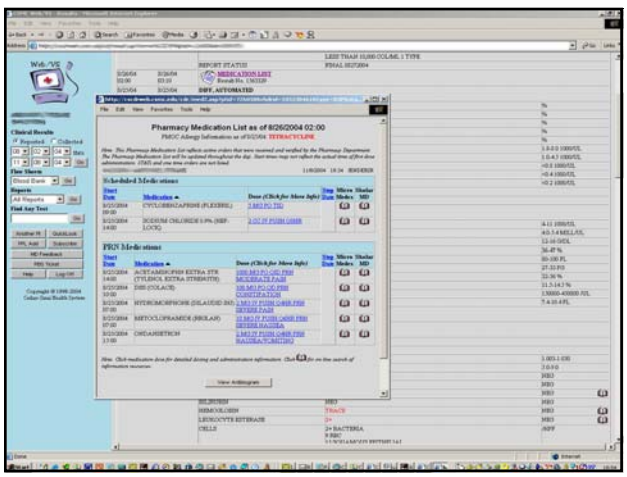
- Electronic format (allows automated processing)
- Communication network
  - Use of standards (HL7) to facilitate interchange between different vendors
- Data model / repository: Share data among applications

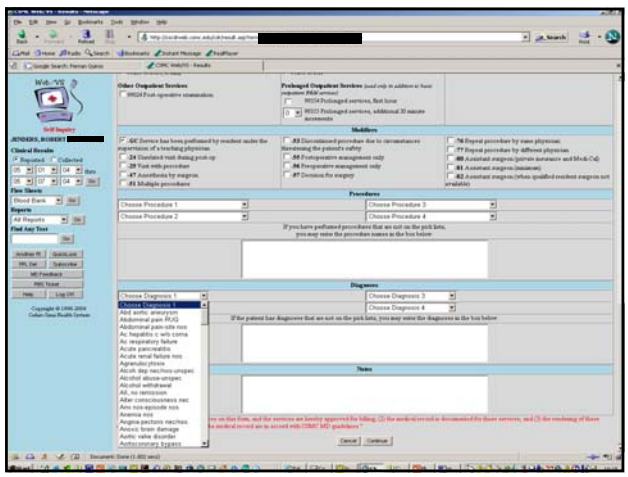
Structured Data: How do we get it?

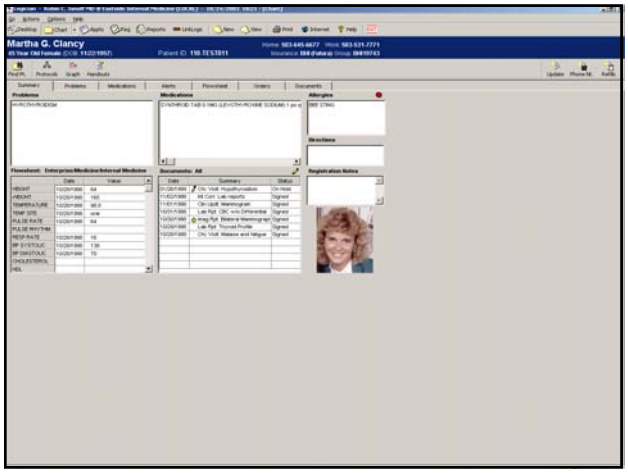
- Direct entry/capture
  - Captured from devices (lab, vitals monitor, etc)
  - Entered by human beings using structured forms
- Transform after the fact
  - Computer-assisted e-coding & NLP











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

Uses for Structured / Coded Data (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

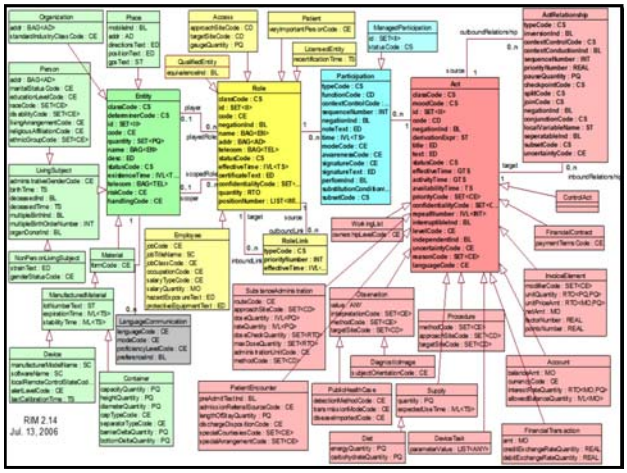
More Standards: Consolidated Health Informatics Initiative

- 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

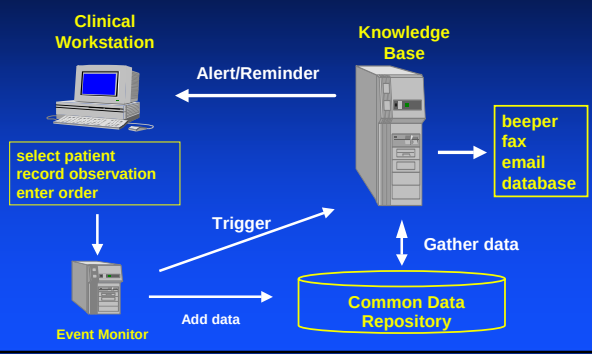
Schadow G, Russler DC, Mead CN, McDonald CJ. Integrating medical information and knowledge in the HL7 RIM. Proc AMIA Symp 2000;:764-768.



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

Hripcsak G, Clayton PD, Jenders RA, Cimino JJ, Johnson SB. Design of a clinical event monitor. Comput Biomed Res 1996;29:194-221.

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

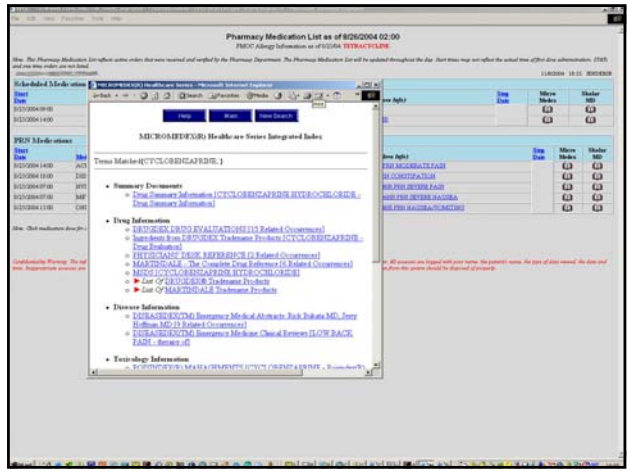
- ASTM v1 1992, HL7 v2 1999, v2.1 (ANSI) 2002, v2.5 2005
  - Adopted by several major vendors
- Formalism for procedural medical knowledge
- Unit of representation = Medical Logic Module (MLM)
  - Enough logic + data to make a single decision
  - Generate alerts/reminders

Jenders RA, Dasgupta B. Challenges in implementing a knowledge editor for the Arden Syntax: knowledge base maintenance and standardization of database linkages. Proc AMIA Symp 2002;:355-359.

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

Cimino JJ, Li J, Bakken S, Patel VL. Theoretical, empirical and practical approaches to resolving the unmet information needs of clinical information system users. Proc AMIA Symp 2002;:170-174.



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

Koppel R, Metlay JP, Cohen A et al. Role of computerized physician order entry systems in facilitating medical errors. JAMA 2005;293:1197-1203.

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)

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!

Thank You!

- IQPC
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