Using Data and Clinical Decision Support to Improve Quality and Reduce Errors

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Overview

• Background
  – Clinical Decision Support (CDS) value, benefits

• CDS modalities
  – Examples from Partners HealthCare

• Knowledge Management (KM)
  – KM program, challenges, opportunities
  – Assets and tools used at Partners HealthCare

• Conclusions
  – Successful program, CDS strategy, sharing
Healthcare Industry

• Very complex processes with high degree of fragmentation
• Mandatory evolution toward integrated and streamlined processes (value or outcomes-based)
• Growing adoption of information technology (interoperability)
• Clinical decisions supported by evidence – influenced by available local resources and preferences
• Reliance on decision practices guided by a constantly evolving body of knowledge
CDS can improve clinical practice

• Systematic review of 70 studies (RCTs), up to 2003
  – Evaluating the ability of CDS to improve clinical practice
  – Focus on 15 CDS features (derived from literature)

• CDS improved practice in 68% of trials
  – Key features (independent predictors)
    ▪ CDS as part of clinician workflow
    ▪ Recommendations rather than just assessments
    ▪ CDS at the time and location of decision making
    ▪ CDS triggered by computerized data analysis

Improvements require complex CDS

• Report assessed the evidence regarding benefits and costs of health information technology (HIT) systems
  – 256 studies: 156 decision support
• “HIT has the potential to enable a dramatic transformation in the delivery of health care, making it safer, more effective, and more efficient.”
  – “More research is needed ... Much of the existing decision support relies on simple rules, and it should be possible to provide substantially better assistance with the use of more-complex rules and models”

Decisions now require more knowledge

Background: summary

✓ CDS known to improve care
  – Better with more complex CDS
  – But has to follow the patient

✓ US EHR incentives require CDS use
  – Dependency on available structured clinical data
  – And aligned with quality measures

! Knowledge is constantly growing
  – Existing knowledge assets quickly obsolete
  – Must evolve toward individualized decisions
  – Must combine evidence + personal preferences
CLINICAL DECISION SUPPORT (CDS)
Modalities of CDS

- Reference knowledge **selection** and **retrieval**
  - e.g., infobuttons, crawlers (indexing)
- Information **aggregation** and **presentation**
  - e.g., summaries, reports, dashboards
- Data **entry assistance**
  - e.g., forcing functions, calculations, evidence-based templates for ordering and documentation
- **Event monitors**
  - e.g., alerts, reminders, alarms
- Care **workflow assistance**
  - e.g., protocols, care pathways, practice guidelines
- **Descriptive** or **predictive** analytics
  - e.g., diagnosis, prognosis, treatment planning, treatment outcomes
CDS: infobuttons

Information about “Depression”
CDS: alerts for medication ordering
CDS: interruptive alert with action

Clinician **must** cancel current order or discontinue pre-existing order
CDS: geriatric medication dosing

Geriatric Dosing - appropriate doses and frequencies for geriatric population: doses - 0.5 TAB, 1 TAB; frequencies - Q6H, 1 Tablet + 5mg Hydrocodone & 500mg Acetaminophen; Do not exceed 6 tablets/day (70mg of Acetaminophen). For constipation, often worsened by an opioid, add a stool softener and a stimulant.

Clinical Informatics
CDS: preventive care reminders
CDS: summary

- Multiple CDS options available
  - Different modalities from simple to complex
  - But knowledge is constantly changing
  - And local adaptations are frequently needed

- Workflow assistance is very attractive
  - Very difficult to implement pathways & protocols as CDS
  - Knowledge maintenance is very expensive
  - Commercial EHR systems do not support required features

- Needed standards are still evolving
  - Progress: terminologies, data models, and knowledge
  - Inability to implement at scale (no cost-sharing)
CLINICAL KNOWLEDGE MANAGEMENT (CKM)
Clinical Knowledge Management

- **Quantity** of knowledge (explosion)
  - Evolution towards stratified/personalized clinical practice
  - Complex decision making process demanding computerized support
- Knowledge content **maintainability** (long-term)
  - Content diversity and quantity makes traditional curation unrealistic
  - Rate of creation and revision is constantly increasing
- **Distributed** care delivery processes (fragmented)
  - Extensive knowledge is needed beyond organizational boundaries
  - Learning opportunities leading to optimal care and stewardship
- **Patient-centered** care and **shared decision making**
  - Consumers (patient) constantly seeking knowledge (empowerment)
  - Shared responsibility only possible with proper understanding
Implementation challenges

- **Data availability**
  - Data not coded, coded inconsistently, not enough detail (codes)

- Large number of **dependencies** (frequency of changes)
  - Data definitions, classifications, EHR configuration, new evidence

- **Rudimentary tools** (editing)
  - Incorrect logic, missing values, related rules, automated validation

- **Labor intensive testing**
  - Positive and negative tests, regression testing, automated testing

- **EHR system** or integrated CDS engine
  - Limited integration options, complex configuration, peculiar features

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CKM Program

- **Systematic** and **sustainable** acquisition, adaptation (localization), and management of knowledge assets for different “modalities” of CDS
- Includes the **adaptation** of “reference” knowledge to reflect local and institutional requirements, resources, and priorities
- Follows a well-defined **lifecycle**, including specific stages for documentation, testing, and monitoring – supported by integrated set of tools and resources

CKM Program Components

Personnel

- Domain Experts
- Knowledge Engineers
- Knowledge Modelers
- Terminology Engineers

Framework

- Lifecycle Processes
- Governance Processes
- Software Platform

Assets

- Knowledge
- Information Models
- Concepts & Ontologies
Implementation of CDS modalities

<table>
<thead>
<tr>
<th>CDS modality</th>
<th>Types of Knowledge Assets</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Information selection and retrieval</td>
<td>Reference</td>
</tr>
<tr>
<td>2. Information aggregation and presentation</td>
<td>Actionable</td>
</tr>
<tr>
<td>3. Data entry assistance</td>
<td>Executable</td>
</tr>
<tr>
<td>4. Event monitors</td>
<td></td>
</tr>
<tr>
<td>5. Care workflow assistance</td>
<td></td>
</tr>
<tr>
<td>6. Descriptive or predictive modeling</td>
<td></td>
</tr>
</tbody>
</table>

- Complexity
- Cost
- Availability
- Maintainability

Clinical Informatics
Scope (assets) @ Partners

**Dictionaries**
- Terminologies
- Coding Systems
- Ontologies
- Classifications

**Templates**
- Documentation
- Orders
- Reports
- (Models)

**Rules**
- Alerts
- Reminders
- Workflows
- Protocols

**Reference**
- Manuals
- Books
- Guides
- (Evidence)

**Infrastructure**
*Process*: Collaboration, Lifecycle, Metadata, Namespaces
*Technology*: Editors, Browsers, Portals, Repositories, Software

Clinical Informatics
Inventory of Knowledge Assets
Managed Centrally at Partners (1/2)

<table>
<thead>
<tr>
<th>Knowledge Asset Collection</th>
<th>Collection Size¹</th>
<th>Asset Type</th>
<th>Asset Source²</th>
<th>Asset Editor³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemotherapy Prescribing Dictionary: includes investigational agents</td>
<td>2,800 concepts</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Drug Classification Subsets</td>
<td>2,500 classes</td>
<td>Dictionary</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Immunization Dictionary: includes reference mappings</td>
<td>620 concepts</td>
<td>Dictionary</td>
<td>Local</td>
<td>Vendor</td>
</tr>
<tr>
<td>Master Drug Dictionary (MDD): includes non-commercially available medications</td>
<td>11,000 concepts</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Medication Concept Mappings</td>
<td>15,700 mappings</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Oral Investigational Chemotherapy Dictionary</td>
<td>600 concepts</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Outpatient neonatal dosing dictionary</td>
<td>60 concepts</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Problem List Classification Subsets</td>
<td>530 classes</td>
<td>Dictionary</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Problem List Dictionary</td>
<td>5,000 concepts</td>
<td>Dictionary</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Partners KnowledgeLink (infobutton manager)</td>
<td>650 resource profiles</td>
<td>Reference</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Partners Handbook: portal of electronic clinical reference resources</td>
<td>600 external and 900 internal links</td>
<td>Reference</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Critical Laboratory Alerts</td>
<td>175 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Vendor</td>
</tr>
<tr>
<td>Disease Management and Preventive Care Reminders</td>
<td>340 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Drug Dosing in Elderly</td>
<td>320 dosing rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Drug Dosing in Renal Insufficiency</td>
<td>400 dosing rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
</tbody>
</table>

## Inventory of Knowledge Assets Managed Centrally at Partners (2/2)

<table>
<thead>
<tr>
<th>Knowledge Asset Collection</th>
<th>Collection Size¹</th>
<th>Asset Type</th>
<th>Asset Source²</th>
<th>Asset Editor³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug-Disease Alerts</td>
<td>510 rules</td>
<td>Rule</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Drug-Drug Interaction Alerts</td>
<td>10,000 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Drug-Laboratory Alerts</td>
<td>440 rules</td>
<td>Rule</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Drug-Pregnancy Alerts</td>
<td>690 rules</td>
<td>Rule</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Drug-Utilization Alerts</td>
<td>15 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Duplicate Therapy Alerts</td>
<td>25 category rules</td>
<td>Rule</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Family History Reminders</td>
<td>25 algorithms</td>
<td>Rule</td>
<td>Local</td>
<td>N/A</td>
</tr>
<tr>
<td>Food-Drug Interaction Alerts</td>
<td>130 rules</td>
<td>Rule</td>
<td>Custom</td>
<td>Local</td>
</tr>
<tr>
<td>Health Monitoring</td>
<td>70 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Immunization Schedule Reminders</td>
<td>370 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Vendor</td>
</tr>
<tr>
<td>Problem-list Reminders</td>
<td>80 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Relevant Laboratory Results for Order Entry</td>
<td>600 rules</td>
<td>Rule</td>
<td>Local</td>
<td>Local</td>
</tr>
<tr>
<td>Documentation Calculated Functions (inpatient)</td>
<td>500 functions</td>
<td>Template</td>
<td>Local</td>
<td>Vendor</td>
</tr>
<tr>
<td>Documentation Forms (inpatient)</td>
<td>500 templates and 11,800 data elements</td>
<td>Template</td>
<td>Local</td>
<td>Vendor</td>
</tr>
<tr>
<td>Documentation Flowsheets (outpatient)</td>
<td>5 templates</td>
<td>Template</td>
<td>Local</td>
<td>Local</td>
</tr>
</tbody>
</table>

¹Collection Size: not exact numbers given constantly changing nature of most collections, with assets periodically added and retired.
²Asset Source: “Local” represents assets not available in 3rd-party knowledge sources (i.e., proprietary Partners assets); “Custom” represents assets obtained from 3rd-party knowledge sources, but subsequently curated and modified by Partners for internal use.
³Asset Editor: “Local” represents an editor (authoring tool) developed internally by Partners; “Vendor” represents editors obtained from 3rd-party vendors, including generic XML-editing tools; “N/A” represents assets implemented as source code (no editor).
Basic CKM scenario: Portal

- Web-base portal (intranet/Internet)
- **Open access** to a complete inventory of knowledge assets created and/or used (multiple types)
- Asset *metadata*, including identification, provenance, lifecycle, designations (labels and names), and classifications
- Essential *documentation* (detailed specifications)
- Enables process *transparency* and effective *collaboration* (including reuse)
CKM Portal Overview
CONCLUSIONS
CDS has to follow the patient

- Clinical systems might have very similar CDS features, but are frequently not configured the same way
  - CDS triggered in one setting may not be confirmed or re-enacted in subsequent settings
  - Care transitions associated with safety incidents
- Without continuity and consistency across settings and institutions, interventions have decreased effectiveness for disseminating evidence and reducing unwarranted variability
Knowledge Exchange is vital

- Home
  - CDS?
    - Rehabilitation Phase
      - CDS?
        - Hospital Procedure
          - CDS?
            - Shared Repository?
              - Integrated KM Programs?
    - CDS?
      - Ambulatory Visit
        - CDS?
Successful CKM Program

• Enables health care institutions to effectively utilize knowledge-driven computer systems
  – Improve care safety and quality
  – Keep pace with frequent scientific advances
  – Embrace new care delivery models
  – Promote continuous learning

• Overcome knowledge engineering and implementation challenges
Strategic Goals @ Partners

• Enable all knowledge content to be **accessible**, **updatable**, and **maintained** with an audit trail

• Reduce the **cost** and increase **efficiency** of both design and implementation maintenance

• Enable **stakeholder** involvement in the design process to support effective adoption and use

• Ensure alignment with **quality**, **safety**, and **operating** business drivers (Risk Contracts, CQI, ACO, etc.)

• Avoid potential **liability** of making incorrect or incomplete recommendations due to lack of **coverage** or **update**
Long-term strategy relies on CDS

By 2020, ninety percent of clinical decisions will be supported by accurate, timely, and up-to-date clinical information, and will reflect the best available evidence and informed personal preference.

ONC & IOM: Emphasis now on the “Electronic infrastructure for continuous learning and quality-driven health and health care programs.”
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