Enterprise Decision Support

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Disclosure

✶ I have no actual or potential conflict of interests to disclose
✶ I will not present any unlabeled / investigational uses of a commercial product
Traditional Models of Decision Support

Traditional Decision Support

- Knowledge Base
- Patient Data
- Mode of Communication

Decision Support
The Five Rights of CDS

- Right Information (evidence-based, appropriate for that condition / situation)
- Right Person (patient, provider, scheduler)
- Right Format (alert, reminder, sound)
- Right Channel (EHR, PHR, pager)
- Right Time (during action, before next visit)

Patient Data Today

- Symptoms → Reported
  - Patient demographic
  - Chief Complaint
- Signs → Elicited
  - Vital signs & physiologic monitoring
  - Physical Findings
- Diagnostic
  - Lab tests
  - Radiographic tests
Patient Data Today

* Symptoms → Reported
  * "12 yr boy"
  * "cough"

* Signs → Elicited
  * "tachypnea"
  * "low O₂ saturation"

* Diagnostic
  * Elevated WBC
  * Infiltrate on CXR

Knowledge Base Today

* Electronic Representation of a clinical rule
  * IF → THEN... ELSE

* Decision Table
  * CASE
    * WHEN A AND B → THEN
    * WHEN B OR C → THEN
    * ELSE D

* Expert System
  * Elaboration of above
Knowledge Base Today

- **Electronic Representation**
  - IF “cc: cough”
  - THEN recommend “asthma” and “pneumonia” ordersets

- **Decision Table**
  - IF “fever” AND (“cough” OR “tachypnea”) NOT (“influenza positive”) THEN “pneumonia orderset”

- **Expert System**
  - Complex decision rules for treatment of CAP in children

Communication Today

- **On Demand**
  - Relevant data
  - External reference links
  - Executable CDS Tool

- **Automatic**
  - Reminders
  - Alerts
  - Hard-Stops
Communication Today

- **On Demand**
  - Show last creatinine for Gent
  - Link to external formulary
  - Button that computes med interactions before submitting order

- **Automatic**
  - Ordersets with defaults
  - Health-maintenance reminder
  - Popup "modal" alert for dosing error
  - Required override for drug-drug interaction

*(Notably almost all are in EHR)*

Same, but Different

Enterprise CDS
Emerging Model: Enterprise CDS

Population Data

Data Warehouse + Analytical Tool

Enterprise Decision Support

Expanded Modes of Communication

Patient (Population) Data

- **Symptoms → Reported**
  - Outbreak detection by census tract & chief complaint

- **Signs → Elicited**
  - Condition specific decision support, unique to your population of patients

- **Diagnostic**
  - Population management using enterprise data (ex: HbA1c)
Knowledge Base Tomorrow

- **Electronic Representation**
  - Just-in-time rule derivation
- **Decision Table**
  - Enterprise-wide rule-engine
  - Fuzzy logic, temporal association
  - Adaptive / robust trigger tools
  - Federated decision support
- **Big Data**
  - Query & visualization of large and complex datasets

Communication Tomorrow

- **On Demand**
  - Dashboards
  - Mobile Apps
  - Ubiquitous computing
- **Automatic**
  - Mobile Devices
  - Google Glass
Location + Query ("symptom") Data

Detecting influenza epidemics using search engine query data
Jeremy Ginsberg1, Matthew H. McNeil2, Rajan S. Patel1, Lynnette Brammer1, Mark S. Smolinski1 & Larry Brilliant1
1Google Inc. 2Center for Disease Control and Prevention

<table>
<thead>
<tr>
<th>Search Query Topic</th>
<th>Top 45 Queries</th>
<th>Next 55 Queries</th>
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<tbody>
<tr>
<td>Influenza Complication</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Cold/Flu remedy</td>
<td>8</td>
<td>0.03</td>
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<td>General Influenza Symptoms</td>
<td>5</td>
<td>0.07</td>
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<td>Tamiflu for Influenza</td>
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<td>Specific Influenza Symptom</td>
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<tr>
<td>Symptoms of an Influenza Complication</td>
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<td>0.92</td>
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<tr>
<td>Antiviral Medication</td>
<td>3</td>
<td>3.17</td>
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<tr>
<td>General Influenza Remedies</td>
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<tr>
<td>Symptoms of a Related Disease</td>
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<tr>
<td>Related Disease</td>
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<td>0.65</td>
</tr>
<tr>
<td>Unrelated to Influenza</td>
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<td>0.00</td>
</tr>
</tbody>
</table>

13 yr-old female with SLE, APLAS, pancreatitis, proteinuria. Because of risk of thrombosis, team considered thrombolysis but was worried about risk of bleeding. No literature to support a choice, no consensus among local experts.

Performed an "electronic cohort" study from EHR-derived data warehouse. Found 98 patients with SLE. 10% developed thrombus, but risk in patients with proteinuria was 14-fold higher. Risk in pancreatitis was 12-fold higher (95% CI 3-96). Decision made to anticoagulate.
Condition-Specific CDS
Real-Time Antibiogram

Trigger Tools
Infection Surveillance
## Trigger Tools

<table>
<thead>
<tr>
<th>CA</th>
<th>CB</th>
<th>CD</th>
<th>CE</th>
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<tbody>
<tr>
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<td><code>{result} contains('item.nestKey') AND </code>{result} includes('resultInclude')`</td>
<td><code>{result} contains('item.nestKey') AND </code>{result} includes('resultInclude')`</td>
<td><code>{result} contains('item.nestKey')</code></td>
</tr>
<tr>
<td>Domain/String/Column</td>
<td>String/Includes</td>
<td>String/Includes</td>
<td>String/AlertDesc</td>
</tr>
</tbody>
</table>

- **AND** If item mnemonic is one of: `(separate items with commas)`
- **AND** If TEXT result includes phrase(s): `(separate items with commas)`
- **AND** If result TEXT does NOT include any of: `(separate items with commas)`

### Rules
- RSV, PCR, RSV/PCR: **RSV, POSITIVE FOR RSV**
- **RSV +** Positive RSV
- **RSV -** Likely negative Culture
- Adenovirus
- Adeno+
- Influenza
- Flu+
- Rotavirus

## Data Visualization

### Alert Fatigue

![Alert Fatigue Analysis App]

- **Alert Type**
  - **Incident:** 87.82%
  - **Infection:** 22.79%
- **Alert Sources**
  - **Alert Source One:** 80.71%
  - **Alert Source Two:** 19.29%
New Delivery Methods

Image from Airstrip Technologies – http://airstriptech.com

Clinical/Business Intelligence Levels at CHOP 2012

* Adapted from TDWI, Power of Predictive Analytics,ureen, 2011
Financial Decision Support

- Goal to implement a cost-based accounting system
- Understand what drives the cost of care
  - Labor
  - Facilities & Overhead
  - Supplies
- Use as the basis for understanding and improving value
Shareable / Federated Decision Support

EHR
Sends encrypted patient data

Web Service
 Parses data and executes rules.
Returns CDS Payload

EHR
Displays clinical practice recommendations

Comparison

EHR and Site-Specific CDS
- All CDS content created & maintained locally
- Maintenance is overwhelming
- Those who can't build content do without
- Vendor in awkward position of maintaining CDS
- Can integrate EHR actions

Federated CDS
- CDS content created by national experts
- Reduced maintenance burden
- CDS available to all, potential business case
- Vendor can focus on building the EHR software, leave content to the experts
How Feasible is This?

- SEBASTIEN (Kawamoto & Lobach, Duke U.)
- SANDS (Wright & Sittig, Partners)
- OpenCDS.org (Kawamoto, U. Utah)
- CareAssistant (Grundmeier et al, CHOP)

**Common elements:**
- Knowledge authoring tool
- Standards-based transport protocol
- Predictable & computable payload

Care Assistant

- Developed in-house by CBMI
- Custom library with hooks to Caché DB
  - Can read data from Epic EHR
  - Can write data to Epic EHR
  - Can populate documentation, med orders, procedure orders
- Presents a web frame within Epic, can show HTML+CSS+Javascript content
- Externalized Clinical Logic in JBoss Rules (aka Drools)
  - GUI or low-level code authoring
  - Supports temporal reasoning
Conclusion

- Enterprise CDS: using all available data thoughtfully to achieve optimal care
- Draw associations / conclusions previously too challenging to make
- "Outsource" complex rules
- Shrink the temporal gap between data collection and knowledge generation
- Increase probability of achieving all 5 "Rights"
Grand Challenges

- Improve effectiveness of CDS
- Improved models of human-computer interface
- Better summarizations of patient data
- Better prioritization / filtering of recommendations
- Combine recommendations for multiple conditions
- Use freetext information to drive CDS
Grand Challenges

- Create new CDS
  - Prioritize CDS content development
  - Mine large clinical databases for new CDS content
- Disseminate existing CDS knowledge and interventions
  - Disseminate best practices in design and implementation
  - Create architecture for sharing CDS
  - Create internet-accessible CDS repositories

The Future is Bright!

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