Providing Decision Support to Physicians at the Point of Care
MET3-Asthma Clinical Decision Support System

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Outline

- Clinical decision support
- Task-based ED workflow model
- MET3-Asthma – an overview
- Tasks
  - Challenges
  - Opportunities
  - MET3-Asthma solution
- Clinical decision support – next steps
Clinical Decision Support

- Clinical decision support (CDS): *providing clinicians or patients with computer-generated clinical knowledge and patient-related information, intelligently filtered or presented at appropriate times, to enhance patient care*
  - Very broad definition
  - CDS may help non-clinicians with clinical decisions
    - Patients
    - Other health care providers
Clinical Decision Support System

- Good evidence for existence of specific features that positively correlate with successful clinical implementation:
  - Automatic decision support as part of existing clinical workflow
  - Delivery of decision support at time/location of decision making
  - Provision of actionable recommendations, not just assessments
  - Computer-based generation of decision support

CDS – Patient-specific Systems in ED

- Multiple opportunities throughout the ED visit
- Many stand-alone or niche systems in place
  - Drug and reference manuals
  - Patient/procedure trackers for individual clinicians
  - Computerized versions of existing clinical decision rules
- Need to move towards a comprehensive system integrated with EHR and CPOE
Computer-assisted Triage

- Comparing memory-based nurse triage and computer-assisted nurse triage to a expert panel consensus standard
  - Computer-assisted had higher agreement with standard of care
  - Memory-based nurse triage yielded significant down-triaging of patients

Investigation and Treatment

- Emergency medicine in Canada is the leader in developing high quality clinical decision rules
- All can be easily computerized as stand-alone systems
- Need to develop a capacity to facilitate uptake
- Need to be incorporated into a larger suite of CDSS tools operating in the background of the EHR, CPOE

Dayan et al. “Development of the capacity necessary to perform and promote knowledge translation research in emergency medicine”. Acad Emerg Med 2008

Steil and Bennett “Implementation of clinical decision rules in the emergency department”. Acad Emerg Med 2007
Decision Support with CPOE

- **Benefits**
  - Safety (decreased transcription errors)
  - Standardized drug ordering
  - Adherence to practice guidelines (order sets which prompt for specific medications)
  - Drug references and dosage calculators

- **Imperfections**
  - Dosage problems (min. vs. therapeutic, etc.)
  - Human-machine interface problems (multiple screens, lack of correspondence to work organization)

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Koppel et al. “Role of computerized physician order entry systems in facilitating medication errors”. *JAMA* 2005
CDS – Improved MD Performance

Systematic review of trials assessing the effects of CDS, compared to care without CDS

- 64% of 97 studies showed improved MD performance
  - 40% of diagnostic systems
  - 76% of reminder systems
  - 62% of disease management systems
  - 65% of drug-dosing/prescribing systems

- Limited effect on patient outcome
  - only 13% showed improvement

CDS Means Different Thing to Different People

- **Clinicians** want simple charting templates or default values, exchange of information, reports and notes, problem lists.

- **CDS developers** want documentation forms and templates, pathway support and time-based checks, sophisticated prediction models, terminology reconciliation modules.

- **Hospital administrators** want cost-effective patient management, seamless integration with legacy systems.
Requirements for Effective CDS

- Speed is everything
- Anticipate needs and deliver in real time
- Fit into user’s workflow
- Little things can make a big difference
- Make interactions easy
- Changing direction is easier than stopping
- Summarize patient data
- Create shareable CDS modules available across intra and extra nets

Sittig et al. “Grand challenges in clinical decision support”. *JBI*, 2008
Workflow: Lack of Consensus on Representing
Task-based ED Workflow Model

- Presenting complaint
- Diagnosis formulation task
- Data collection task
- Treatment planning task
- Follow-up
Implications for CDS

- Provide MD with support for all tasks
- Access and integrate all patient data
- Be available at the point of care (POC)
1. Patient is registered. The ADT notifies the EHR and the MET3.
2. The MD uses the MET3 to record and retrieve patient data.
3. The MD asks for diagnostic support. The MET3 provides a diagnostic suggestion.
4. The MD orders a test and the MET3 passes this request to the LIS.
5. ...
6. Upon prescription of a treatment, the MET3 consults an embedded guideline.
7. The MD requests the evidence. The MET3 retrieves evidence from repository.
8. ...
MET3-Asthma (MET3-AE)

- ED management of pediatric asthma patients
  - Supports early management (around 1 hour after triage)
  - Designed for MDs and nurses @ POC
  - Integrates with HIS (ADT, EHR) to share patient data and with the Cochrane Library to retrieve evidence
  - Uses decision model for predicting severity of exacerbation and integrates with the guideline for treatment options
  - Provides patient-specific evidence

- User-driven support CDS
MET3-AE: Linking Workflow Tasks with the CDS Functions

- **Model Manager Agent**: Provides abstract models
- **Treatment Suggester Agent**: Suggests treatment plan
- **Diagnosis Suggester Agent**: Suggests exacerbation severity
- **Evidence Provider Agent**: Provides clinical evidence
- **Data Manager Agent**: Manages patient data
- **HIS Synchronizer Agent**: Synchronizes patient data

**System Components**:
- **Model Repository**
- **Evidence Repository**
- **Data Repository**
- **HL7 Integration Engine**
- **HIS (EHR, ADT...)**

**Client Device**:
- **Encounter Assistant Agent**: Assists with data collection, assists with diagnosis, assists with treatment
Data Collection Task

- Challenge
  - Terminological hotchpotch
  - Paper-based charting and documentation
  - Novice vs. expert
  - Clinician-friendly interface
  - Integration with hospital’s information infrastructure
Data Collection Task

- Opportunity
  - Structured data collection helps in patient management
  - Support for EBM
  - Elimination of duplication and reduction of documentation effort
  - Improved quality of data for research and analysis
Data Collection Task

- MET3-AE
  - Available at the POC on different computing devices
  - Integrates with other hospital systems
  - MD-driven interface design
Data Collection Task: MET3-AE Interface
Diagnosis Formulation Task

- **Challenge**
  - Patients have complex, multisystem diseases
  - MDs have different abilities and practice styles
  - Nobody likes “cook book medicine”
  - Lack of quality data to develop good diagnostic models
  - Practice variations between different sites
Diagnosis Formulation Task

- **Opportunity**
  - Significant advancements in data mining to find patterns in messy clinical data
  - Ability to bring EBM to POC
  - Ability to help novice MD in decision-making
  - Ability to improve patient outcomes through evidence-based management
  - Ability to manage practice variations within a site
Diagnosis Formulation Task

- MET3-AE
  - Advanced data mining to build prediction model
    - Retrospective chart study with relevant patients identified using ICD-10 code (manually verified by MD) and data items transcribed by a trained abstractor
    - Filtering of data using external data sources to remove questionable records
    - Normalizing values of age-dependent attributes
    - Using robust prediction models with regards to missing values
    - Involving MD in model’s evaluation
## Diagnosis Formulation Task

- **MET3-AE**
  - Comprehensive experimental design and evaluation

### Step 1: Attribute filtering

### Step 2: Date-based split

### Step 3: Data preprocessing

### Step 4: Construction of possible models

### Step 5: Evaluation of possible models

### Step 6: Selection of the best model

### Step 7: Validation of the selected model

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<thead>
<tr>
<th>Model</th>
<th>Sensitivity</th>
<th>Specificity</th>
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</thead>
<tbody>
<tr>
<td>Tree-based with record filtering</td>
<td>76%</td>
<td>65%</td>
</tr>
<tr>
<td>Tree-based with record filtering and contextual normalization</td>
<td>84%</td>
<td>71%</td>
</tr>
<tr>
<td>Logistic regression</td>
<td>69%</td>
<td>68%</td>
</tr>
</tbody>
</table>
Diagnosis Formulation Task

- MET3-AE
  - Computer implementation for non-obstructive use
Treatment Planning Task

Challenge
- Patients with co-morbidity
- Guidelines are population-based instead of patient-specific
- Drug-drug and drug-disease interactions
Treatment Planning Task\(^2\)

- **Opportunity**
  - Support for prescribing and linking with CPOE
  - Customization of the guidelines for a patient and a site
  - Bringing patient-specific evidence at POC
  - Implementation of pathways/caremaps
Treatment Planning Task

- **MET3-AE**
  - Linking with CAEP guideline
Treatment Planning Task

- MET3-AE
  - Providing patient-specific evidence from Cochrane
CDS: Next Steps

- Develop methods and platform to facilitate full customization of the guidelines:
  - Support management of a patients with co-morbidity
  - Support site-specific practice
  - Integrate with EHR, CPOE, ADT, LIS
Customized Guideline Model

CPG #1 → Customization → Patient with comorbidities → Reconciliation → Intelligent CPG

CPG #2 → Customization → Adverse interactions

Local site → Single point of entry
Selected Publications
