Clinical Decision Support Systems for ED Presentations Impacting the Patient, the Provider, the Emergency Health System?

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Overview

• Who am I?
  • MET Project overview

• Clinical Decision Support Systems
  • Patient-specific systems
  • Helping clinicians, helping learners
  • Helping the system & improving operational efficiency

• Challenges/Opportunities
  • Data
  • Methods of development
  • Clinical validation and evaluation
Who am I?
Who am I?

• I am NOT a world-renowned expert in
  • clinical decision support systems
  • data mining methods
  • artificial intelligence
  • computer programming
  • clinical trials or complex research methods
  • ED operations
Who am I?

I AM

- a pediatric and adult emergentologist
- in touch with the operational challenges in the ED
- committed to improving patient care and ways we deliver care
- a self-taught computer GEEK and lover of TOYS
- a (relatively) new researcher who has found a niche (finally!)
- the Clinical Director of the MET Project
Mobile Emergency Triage
MET Project Team

• TRUE Collaborative Multi-Disciplinary Research
MET Project Overview

*Develop ubiquitous decision support systems to support triage decisions in clinical care*

- **Knowledge Discovery**
  - *capturing the knowledge of the “experienced”*

- **Clinical Decision Support**
  - *translating that knowledge into something usable for the “inexperienced”*

- **m-Health**
  - *bringing the end product to the bedside*
Clinical Decision Support Systems
Clinical Decision Support Systems

• “any program designed to help health-care professionals make clinical decisions”
  • very broad definition
  • misses how important and influential CDSS can be
  • CDSS may help non-clinicians with clinical decisions
    • patients
    • administrators/government
Clinical Decision Support Systems

- Emergency Medicine Information Technology Consensus Conference (SAEM – Orlando 2004)
- identified several recommendations related to the need for ED decision support systems to improve patient care
- “the most exciting promise of computers is the potential for computers to add value by providing decision support to clinicians.”

Clinical Decision Support Systems

- good evidence of features that correlate with positive impact to clinical care, successful implementation
  - automatic decision support as part of existing clinical workflow
  - delivery of decision support at time/location of decision making
  - making support actionable recommendations, not just assessments
  - computer-based generation of decision support

Patient-Specific Systems
CDSS – Patient-specific systems

- 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 of these components and others, integrated with EHR and CPOE
Triage

- triage assessment and categorization extremely important
- systematically applying the correct CTAS score ensures
  - prompt recognition of seriously ill patients
    - key complaints
    - abnormal vital signs
  - true representation of acuity/workload
    - staffing, resource utilization
    - future funding – physician remuneration, ED funding
Computer-assisted Triage

- “Emergency Triage: Comparing a novel computer triage program with standard triage”
  Dong et al. Acad Emerg Med 2005
- compared memory-based nurse triage and computer-assisted nurse triage to a expert panel consensus standard
- computer-assisted had higher agreement with standard
- memory-based nurse triage yielded significant down-triaging of patients
MD Evaluation – The MET Approach

- A definitive diagnosis is not always possible.
- The goal of ED care is to efficiently “triage” patients to the most appropriate disposition path:
  - Discharge home.
  - Observe/investigate for possible pathology.
  - Refer to another specialist for definitive assessment/management of probable pathology.
- “Triage” extends beyond the initial assessment and categorization performed by the triage nurse.
MET CDSS Goals

- Developed with the following goals:
  - improved data collection
    - ensure that the MD is considering all important patient attributes in an organized fashion
      - especially important for the learner
    - data entry and decision support at the point of care
  - assist physician decision-making
  - promote earlier, more accurate triage/disposition decisions
    - get the patient on the right path from the start
  - NOT a diagnostic test
    - focus on “What’s the next step?”, not “What’s the problem?”
Helper NOT Enforcer

• provide a weighted recommendation for all possible outcomes
• allow the physician to combine recommendations with their own clinical judgments
MET-AP Module

- retrospective database of 600 cases
- all documented attributes initially captured
- cases categorized into 1 of 3 outcomes
  - benign
  - appendicitis
  - other significant pathology – intra-abd or extra-abd
- analysis and data mining using rough sets theory
- 13 attributes selected
  - most discriminating
  - most commonly documented on chart
- pilot tested
  - overall accuracy 82%, appendicitis sens 92%/spec 89%
MET-AP Validation Trial

• Prospective validation trial (July 2003 – Feb 2004)
  • patients 1-16y
  • acute abdominal pain <10 days duration
  • assessed in the usual fashion
  • staff and/or residents recorded data on a PDA and entered their prediction
    • discharge
    • consult surgery for appendicitis
    • observe/investigate for other pathology
  • chart & telephone follow-up to determine the patient’s final outcome
## Results

<table>
<thead>
<tr>
<th></th>
<th>Staff Physician Assessments (n=457)</th>
<th>Resident Assessments (n=339)</th>
<th>Difference Between Physician Type for Method (n=222)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MET-AP Triage Accuracy</strong></td>
<td>72.2% (67.9, 76.1)</td>
<td>69.3% (64.2, 74.0)</td>
<td>2.9% p=0.755</td>
</tr>
<tr>
<td><strong>MD Prediction Accuracy</strong></td>
<td>70.2% (65.9, 74.2)</td>
<td>62.8% (57.6, 67.8)</td>
<td>7.4% p=1.000</td>
</tr>
<tr>
<td><strong>Difference Between Methods for Physician Type</strong></td>
<td>2.0% p=0.518</td>
<td>6.5% p=0.836</td>
<td></td>
</tr>
</tbody>
</table>
### Breakdown of Performance

<table>
<thead>
<tr>
<th>Final Outcome Category</th>
<th>MET Recommendation</th>
<th>Physician Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D/C</td>
<td>Obs/Inv</td>
</tr>
<tr>
<td>Benign</td>
<td>279</td>
<td>39</td>
</tr>
<tr>
<td>Other</td>
<td>38</td>
<td>18</td>
</tr>
<tr>
<td>Appendicitis</td>
<td>12</td>
<td>3</td>
</tr>
</tbody>
</table>

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ED Operations Research
The Future for MET-AP. . .

- How to improve performance accuracy?
  - weight current attributes differently (mimic conservatism)
  - larger prospective database with better representation of “Other” group
  - new techniques to limit imbalance bias of “Benign” group
  - new attributes
    - existing attributes (explicit knowledge)
      - literature review
    - new attributes (tacit knowledge)
      - qualitative methods to discover tacit knowledge of experts
Other MET Modules

- Hip pain/limp
- Scrotal pain
- Asthma
Investigation & Treatment

- EM in Canada is the leader in developing high quality, highly accurate clinical decision rules
  - Ankle/foot x-ray
  - Knee x-ray
  - C-spine
  - CT head for head injury
  - CT head for pediatric head injury
  - CT/LP for suspected SAH
  - Chest pain evaluation
  - Severe outcomes in bronchiolitis
- all can be easily computerized as stand-alone systems
- need to be incorporated into a larger suite of DSS tools operating in the background of the EHR, CPOE
Decision Support within CPOE

- many opportunities to help clinicians make better treatment/investigation decisions
  - safety (drug interactions, allergy)
  - cost-effectiveness (cheaper antibiotics)
  - adherence to practice guidelines (asthma order sets which prompt for systemic steroids early)
  - other efficiencies (CXR in addition to hip x-ray for elderly fall)
Disposition - MET-Asthma

- prediction based on data from initial RN & MD assessments
  - prior asthma history
  - history of current exacerbation
  - triage vital signs, physical exam
  - response to first round of bronchodilators

- aim to predict length of stay
  - categories
    - short-stay (2-4 hours)
    - long-stay (4-16 hours, or relapse visit)
    - admit (>16 hours, or relapse visit leading to admission)
MET-Asthma

• prediction of LOS is a proxy for severity
  • link prediction to evidence-based guidelines for management
    • ensure patients get steroids early
    • consider more advanced therapies
    • avoid early discharge/relapse visits
  • prompt assessment for other risk factors in severe or recurrent presentations
    • psychosocial stressors
    • medication compliance
Helping Clinicians, Helping Learners
CDSS – Helping the clinicians & learners

- benefits to the clinician
  - prompted and organized history/physical, knowledge-based charting
    - more thorough assessments
    - better documentation medico legally
    - trainees learn to organize information -> improved decision-making
  - CPOE decision support emphasizes practice guidelines
- CDSS can also help expose the clinician to the evidence
  - linked access to relative information in PubMed, Up-to-Date, other reference materials
CDSS – Improved physician performance

- systematic review of trials assessing the effects of CDSS, compared to care without CDSS
- 64% of 97 studies showed improved MD performance
  - 4/10 diagnostic systems
  - 16/21 reminder systems
  - 23/37 disease management systems
  - 19/29 drug-dosing/prescribing systems
- limited effect on patient outcome
  - only 7/52 showed improvement

Helping the System & Improving Operational Efficiencies
The “Old” Decision Support

- Decision support for the system typically viewed as
  - retrospective – not real-time
  - basis for strategic decision-making for events far in the future

- need to change the model
  - prospective – seeing it as it is happening
  - predictive of what’s likely happening in the next few hours or days
  - basis for real-time adjustments within a solution-framework already in place
Clinical Pathways & Care Maps

- operationalize best practices
- represents sequencing and timing of interventions
- minimize delays
- improve resource utilizations
- enhance quality of care
- monitor and patient’s progress measured according to standard process and clinical outcomes expected, e.g., length of stay (LOS).
Bayesian Belief Network of a pathway

• models the pathway composed of events with associated conditional probabilities and relationships between these events
• generates an answer to conditional-type queries
  • “Considering the patient’s health status at time “x”, what impact would “y” have on meeting expected outcome “z”?”
Radical Prostatectomy Pathway

- The Ottawa Hospital
- 4-day sequence of events & outcomes for typical OR through discharge
- MET-RPP prototype developed from 75 learning cases
- allows prediction of LOS if an activity or event (variance) doesn’t occur according to the typical sequence/timing
Applying this an ED presentation

- MET-Asthma
- data collection, treatment recommendations, disposition decisions linked to existing asthma clinical pathway
- predictions now based on the patient presentation as well as variances to standard care
Department or Hospital-wide system

- consolidate prediction data from a number of common ED and inpatient presentations
- now have real-time modeling of global ED and hospital resource utilization, LOS for the next 24 hours
- can begin to see the “little things” that culminate in an over-capacity state
- strategically allocate resources to fix the “little things”
- proactively manage the impending over-capacity state
Challenges/Opportunities
Data

• deficiency in data
  • paucity of centres with EHR
  • few comprehensive clinical data repositories

• standards/protocols for data sharing/pooling
  • systems very institution-based
  • hard to integrate

• privacy and security
  • who sanctions combining identifiable patient data from multiple sources?
  • who has access?
  • to how much of the total picture?
One possible solution - Ontologies

- data structure
  - defines the knowledge contained within the data structure
  - also defines how the knowledge attributes relate to one another and to other similar data structures
  - helps create a standardized vocabulary out of multiple unique vocabularies

- ontologies can also be extended to
  - re-usable components of systems operating on thin devices
  - manage inter-operability between platforms
  - data access and security privileges across systems
Methods of Development

- expert-based versus knowledge-based
  - how to capture the tacit knowledge of experts?
    - clinicians, administrators, operations/systems experts
  - what source of existing knowledge?
    - does retrospective data work?
    - can we overcome data issues between sources?
- clinical decision rules versus artificial intelligence
  - recursive partitioning versus data mining and modeling?
  - what’s best when the subject isn’t the patient, but a department or health system?
Clinical Validation and Evaluation

- what outcomes need to be shown?
  - patient care
  - physician performance
  - health system performance

- what level of accuracy is clinically acceptable? medico legally defensible?

- by what methods do we evaluate?
  - what statistical analysis is appropriate?
  - do we need RCT evidence? at what level of randomization?
    - patient
    - practitioner
    - system

- don’t forget system usability, reliability
What I hope I’ve accomplished

• shared my “clinician’s view” of clinical decision support systems
  • examples of what exists
  • ideas of where we might go
  • issues that must be faced
• role CDSS might play in improving ED operations
Thank you

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