Clinical Decision Support Systems for ED Presentations

Impacting the Patient, the Provider, the Emergency Health System?

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Acknowledgements

- NSERC
- Physicians' Services Incorporated Foundation
- CHEO Research Institute

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?

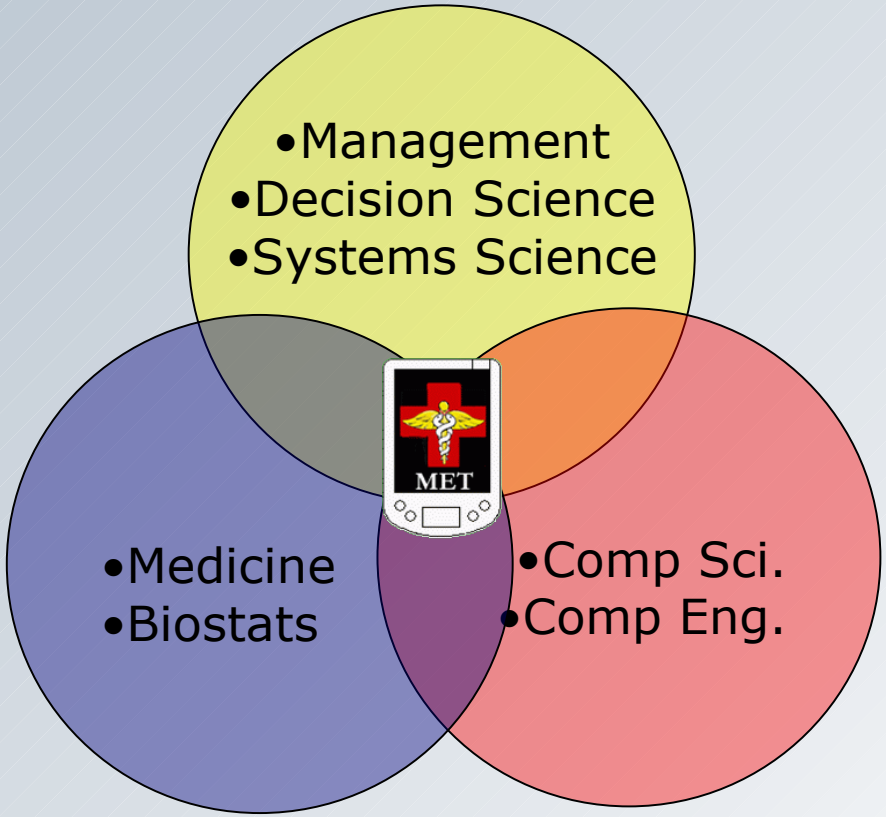
- I AM
  - a pediatric and adult emergentologist
  - in touch with the operational challenges in the ED
  - committed to improving patient care and ways we deliver care
  - a self-taught computer GEEK and lover of TOYS
  - a (relatively) new researcher who has found a niche (finally!)
  - the Clinical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

MET

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."

Keynote address: medical informatics and emergency medicine. Feied et al. *Acad Emerg Med*. 2004.

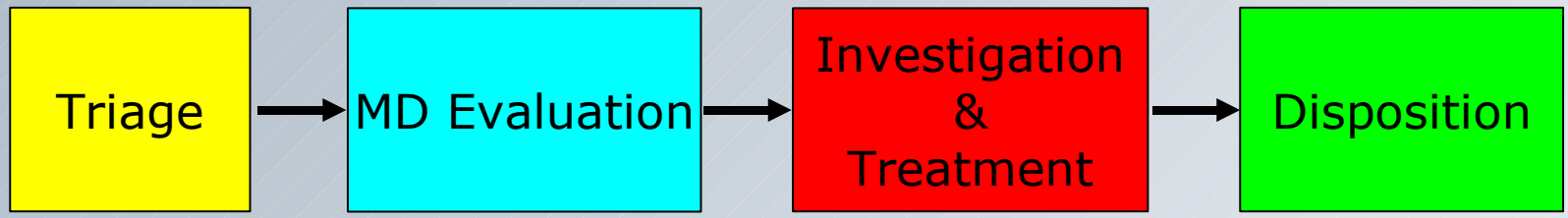
Clinical Decision Support Systems

- 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

Improving clinical practice using clinical decision support systems: A systematic review of trials to identify features critical to success. Kawamoto et al. *Br Med J*. 2005.

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

	Staff Physician Assessments (n=457)	Resident Assessments (n=339)	Difference Between Physician Type for Method (n=222)
MET-AP Triage Accuracy	**72.2%** (67.9, 76.1)	**69.3%** (64.2, 74.0)	2.9% p=0.755
MD Prediction Accuracy	**70.2%** (65.9, 74.2)	**62.8%** (57.6, 67.8)	7.4% p=1.000
Difference Between Methods for Physician Type	2.0% p=0.518	6.5% p=0.836	

Breakdown of Performance

Final Outcome Category	MET Recommendation			Physician Prediction		
	D/C	Obs/Inv	Cons	D/C	Obs/Inv	Cons
Benign	**279**	**39**	**30**	**248**	**85**	**15**
Other	**38**	**18**	**5**	**16**	**39**	**6**
Appendicitis	**12**	**3**	**33**	**1**	**13**	**34**

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

Effects of computerized clinical decision support systems on practitioner performance and patient outcomes: A systematic review.
Garg et al. *JAMA*. 2005.

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 protype developed from 75 learning cases
- allows prediction of LOS if an activity or event (variance) doesn’t occur according to the typical sequence/timing

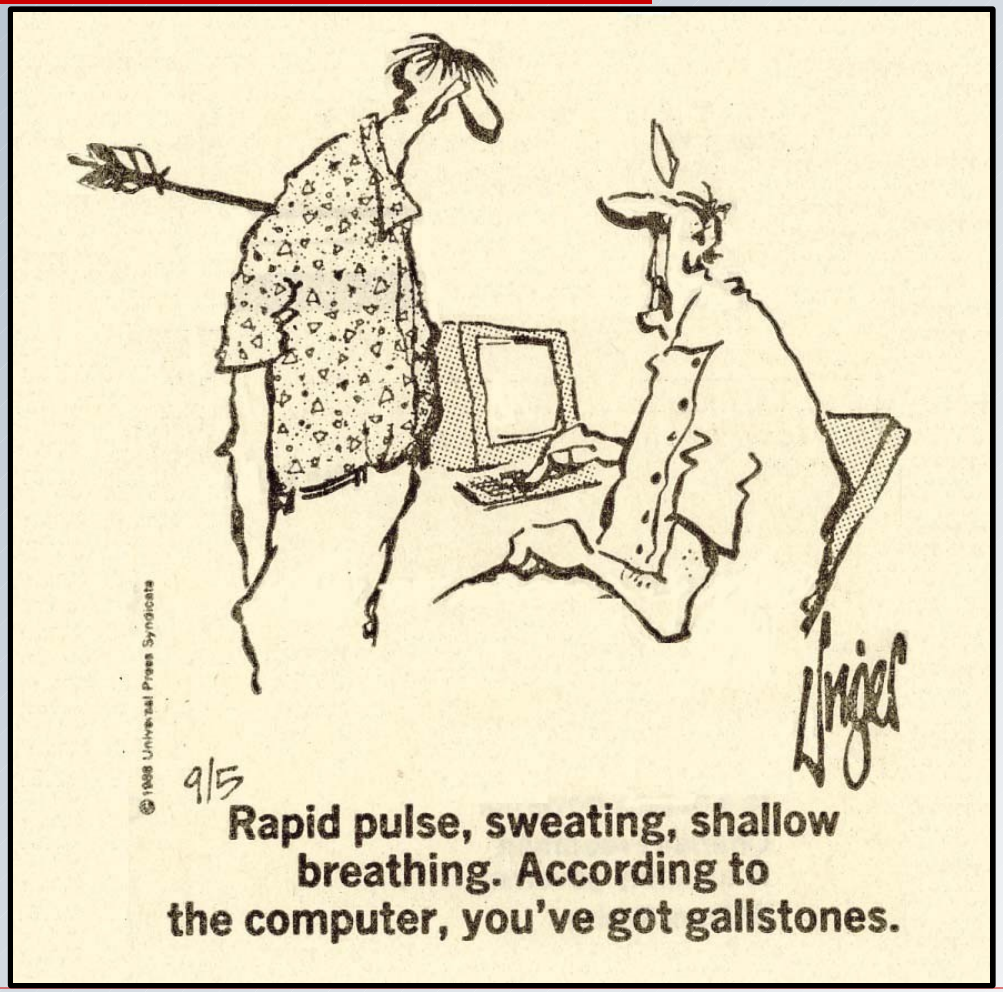
Applying this an ED presentation

- 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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