Triaging Pediatric Abdominal Pain in the ED
Could the Answer Be in the Palm of Your Hand?

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Emergency
Outline

• Dilemmas assessing children with abdominal pain
• Clinical Decision Support Systems
  – What are they?
  – How could they help?
• Development of MET-AP
• MET-AP validation trial
• The future . . .

November 14, 2003
Kids and Abdominal Pain

• common presenting complaint
  – 3300 patient visits per year
  – 8-10 patients/day
  – other patients presenting with other complaints
    • significant abdominal pain found during assessment
• large number of outside referrals
  – “R/O Appendicitis”
Assessing Abdominal Pain

- large differential
  - constipation and gas pains most common
  - associated “tummy ache” with most viral illnesses
  - appendicitis most common surgical problem
- history and description of pain often incomplete
- physical exam can be difficult
  - apprehension
  - “ticklish”
Assessing Abdominal Pain

• normal WBC doesn’t rule out pathology
• imaging - Ultrasound
  – not readily available after hours
  – many inconclusive studies
    • “can’t visualize the appendix”
  – time-consuming and costly
    • “Can’t U/S them all!”
Appendicitis Scores

• several versions out there
• some appear to perform well
  – Cut-off 6/10 Sens 1.0, Spec 0.92, PPV 0.96, NPV 0.99
• pretest selection bias
  – referred to surgery as R/O appendicitis
• many not prospectively validated
  – tested on those undergoing laparotomy
Assessing Abdominal Pain

- Time-consuming process
  - average arrival to MD 60-90 minutes
  - average MD to disposition 150-180 minutes
  - 55% have lab, 26% have imaging
Kids admitted with AP

- 240 admitted with appendicitis
- 300 more admitted with other causes
  - 100 discharged as “Adb Pain NYD”
- Average LOS in ER
  - All AP patients 210-270 minutes
  - Appendicitis >300 minutes
  - Other causes >380 minutes
How can we do better?

- Make an accurate disposition decision earlier
  - avoid tests/observation time that delays
    - consulting the surgeon for those with appendicitis
    - discharging those with benign problems
- Clinical Decision Support System
Clinical Decision Support

• Multiple definitions/applications
  – capturing clinical data on which to base
    • program/operational decisions
      – financial data (cost of doing business)
      – increasingly tied to clinical outcomes
    • point-of-care clinical decisions
      – for individual patients
      – may include tools for the patient
Potentials for CDSS

• Increase health care quality
  – change clinician behaviors by promoting EBM
    • literature-based evidence
    • local practice-based evidence
• Increase health care efficiency
  – standardize care/reduce variation
• Reduce medical errors
  – built-in safety net
Examples of CDSS

- Alerts
  - highlighting out-of-range lab values
  - patient ready for R/A
- Reminders
  - patient due for next vaccination
- Critiquing
  - screening in CPOE for drug interactions
- Interpretation
  - ECG
Examples of CDSS

- Predicting
  - risk of mortality from a severity-of-illness score

- Diagnosis
  - listing a differential diagnosis based on the patient’s symptoms and findings

- Assisting
  - calculating adjusted drug dosages for renal function

- Suggestions
  - analyse recent PTT make suggestions heparin dosing to keep PTT in therapeutic range
ISABEL

- web-based differential diagnosis aid for Peds
- information retrieval engine
- matches patterns within unformatted text
- uses standard pediatric textbooks as source
- produces a differential diagnosis based on clinical features entered

www.isabel.uk.org

- remind the clinician of potentially important diagnoses
Leeds, UK Project

- Computer-based diagnosis for abdominal pain
- multiple studies since 1972
- computer database of known patients
- analyzed using Bayesian theory
- structured data collection form, entry into a computer, and feedback mechanism
- baseline rate of initial diagnostic accuracy 45%
  - improves to 57% with structured data collection
  - improves to 65% with whole system
  - post-investigation accuracy also improves
- 1998 estimated cost savings £25m /yr NHS
• Mobile Emergency Triage (MET)
• Developed with the following goals
  – improved data collection
  – assist physician decision-making
  – promote earlier, more accurate triage/disposition decisions
  – NOT a diagnostic test
• Defined three distinct categories of patients
  – appendicitis
  – benign or resolving causes (constipation, viral)
  – other pathology

• Corresponding triage dispositions
  – consult surgery
  – D/C home with F/U prn
  – continue to investigate/observe
MET-AP CDSS

- retrospective data collection
- >700 patients with abdominal pain
- large number of attributes
  - history
  - physical exam
  - investigations
- each patient assigned to one category
• Data mining to find patterns that discriminate between the three categories
  – Rough sets
  – Shapely fuzzy values

• Answer the following questions
  – which attributes are most relevant for the discrimination process?
  – what is the relationship between the attribute and the final decision category?
• **Result**
  – series of *if ... then ...* statements
  – relative weighting of how strongly a given patient matches each of the three decision categories

• **Recommendation can be made despite incomplete data**
  – more data \( \rightarrow \) more accurate recommendation
• 13 attributes identified
  – Demographics
    • age, gender
  – History
    • location of pt’s complaint, duration, constant vs intermittent, vomiting, previous ER visit
  – Physical exam
    • temperature, location of maximal tenderness, rebound, guarding
  – Investigations
    • WBC
MET on Palm

- PDA technology ideally suited
  - takes the “computer” to the bedside
  - quick, easy data entry
  - built-in Sync functionality
    - maintain data centrally
    - communicate with other hospital IT systems
    - transfer patient data between users
    - new generation ready for wireless
MET Architecture

- **MET Server**
  - communication server
  - database server
  - decision algorithm and application server

- **MET Handheld**
  - triage support
  - data collection

- **MET PC Client**
  - MET patient data management

- **Patient Data Repository**
MET on Palm

• Programmed on Palm OS
  – patient database
  – data collection tool for entry of attributes
  – >200 algorithmic steps to produce a triage recommendation
MET-AP Screens

Patient: Peterson, James

**Hx History**
- Site of Pain: RLQ
- Duration of Pain: 5h 30min
- Type of Pain: Intermittent
- Shifting of Pain: Yes
- Previous Visit: No
- Vomiting: Yes

**Physical Exam**
- Site of Tenderness: RLQ
- Rebound: No
- Loc. Guarding: Yes
- Temperature: 38.7°C

**Tests**
- WBCC: 6.0 x 1000

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MET-AP Screens

Patient: Peterson, James

Site of Pain:
- RLQ (checked)
- Lower Abd. (unchecked)
- Other (unchecked)

Duration of Pain: 5h 30min
Type of Pain: Intermit.

Shifting of Pain: Yes (checked)
No (unchecked)

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Prospective Validation Trial

- Retrospective pilot shows promise
- Could it be used in real practice?
- What is the accuracy of MET in real practice?
- What is physician accuracy and is MET better or worse?
- Could we quantify the potential benefits/costs?
## Retrospective Pilot Data

<table>
<thead>
<tr>
<th>MET Recommendation</th>
<th>Final Diagnosis</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benign</td>
<td>Appendicitis</td>
<td>Other</td>
<td>Totals</td>
<td></td>
</tr>
<tr>
<td>Discharge/ Follow-up FD</td>
<td>45</td>
<td>1</td>
<td>2</td>
<td>48 (41%)</td>
<td></td>
</tr>
<tr>
<td>Surgery Consult</td>
<td>8</td>
<td>34</td>
<td>1</td>
<td>43 (37%)</td>
<td></td>
</tr>
<tr>
<td>Further Investigation</td>
<td>7</td>
<td>2</td>
<td>17</td>
<td>26 (22%)</td>
<td></td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>60 (51%)</td>
<td>37 (32%)</td>
<td>20 (17%)</td>
<td>117 (100%)</td>
<td></td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>45/60 (75%)</td>
<td>34/37 (92%)</td>
<td>17/20 (85%)</td>
<td>96/117 (82%)</td>
<td></td>
</tr>
</tbody>
</table>

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How reliably can MET-AP triage pediatric ED patients with acute abdominal pain to one of three disposition categories corresponding to three final diagnosis categories?
Objectives

• To determine the proportion of patients in which
  – MET-AP (trainee, staff) recommendation
  – ED personnel (trainee, staff) prediction
  agrees with the final diagnosis category.
• To compare these proportions to see if there is a difference
  between MET-AP and ED personnel performance
• To determine inter-observer agreements between staff and
  trainees for patient attributes
• To descriptively estimate potential cost savings of following
  MET-AP recommendation
• To compile a prospective data set on which to improve the
  algorithm’s accuracy
Trial Design

- prospective cohort study
- recruit patients with acute abdominal pain presenting to our ED
- 24/7 recruitment by triage/registration/resident/staff
- informed consent to collect patient data and make follow-up telephone call
- where possible – 2 independent observations by staff/resident or resident/staff
Trial Design

• all personnel blinded to MET-AP recommendation
  – only revealed after patient assigned a final category
• patients followed until final category established
  – review of patient chart
  – telephone follow-up about ongoing symptoms, outpatient investigations/management
Sample Size

- Literature estimates physician accuracy at 50%
  - assume trainees are, at best, similar
- MET-AP likely better (pilot data)
- To estimate staff accuracy to within 5%, 19 times out of 20, requires 384 patient assessments
  - trainees and MET-AP require smaller numbers
- Since we want 384 patients with assessments by both staff and trainees and assuming 60% inter-observer rate -> 640 patients
Trial Version of MET-AP

• Trial computer receives all patient demographics from hospital ADT system
• Separate trial management system overlying MET
  – manage lists of current patients
  – inclusion/exclusion criteria on palm
  – capture physician prediction of patient’s triage category
  – keep MET-AP recommendation blinded
  – record all follow-up information
Kick-off

• PSI funding awarded Mar 2003
• Patient enrollment started July 2\textsuperscript{nd}
• Orientation to the palm
  – 17 FT staff
  – 5 fellows
  – >20 PT staff
  – >50 residents
Numbers to Date

- 340 patients enrolled
  - 123 staff physician only
  - 78 resident only
  - 141 both (41% inter-observer)
- Analysis of 230 patients with completed F/U
  - accuracy of MET-AP (staff) 66%
  - 2x2 appendicitis vs not appendicitis
    - Sens 65%, Spec 85%, Accuracy 82%
The Future . . .

- Multiple potential paths for this work
  - MET-AP
    - refining the CDSS based on prospective data
    - implementation and testing in different settings
      - community physicians/ED’s
    - physician acceptance and how they use the recommendation
    - effects on patient outcomes and economic analysis
  - Other clinical problems
    - Scrotal pain (MET-AS) and Hip pain (MET-HP)
    - Asthma/Bronchiolitis decision to D/C vs LS vs admit
    - Adult problems
The Future...

- Multiple paths
  - Other platforms – seamlessly integrated
    - wireless environment
    - Pocket PC, tablets
    - digital phones
    - Web-based
  - Integration with EHR
    - running in the background
    - eliminates duplicate data collection
    - self-adapting as the system is now also linked to outcome
Thank you

• Please visit us at:

www.mobiledss.uottawa.ca