Mobile Emergency Triage System in the Emergency Department: Development and Clinical Experience

www.mobiledss.uottawa.ca

Ken Farion
Children’s Hospital of Eastern Ontario

Wojtek Michalowski
University of Ottawa

Steven Rubin
Children’s Hospital of Eastern Ontario
MET Project Overview

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
Outline

• Triage in the Emergency Department (ED)

• System development

• System architecture

• System interactions

• Abdominal Pain Clinical trial
Triage of a child in the ED

The issue: To facilitate ED triage of acute childhood conditions at the point of care
**Mobile Emergency Triage system**

*MET* is a Clinical Decision Support System designed to assist physicians as they make **triage** decisions as to whether a child presenting to the ED with a specific acute complaint should be **discharged** to the family physician, needs **further investigation or observation**, or requires **urgent specialist consultation**
System development: data collection

Retrospective chart reviews were conducted from 1997-2003 at CHEO for abdominal pain, scrotal pain, hip pain:

- Patients with the presenting complaint or subsequently diagnosed with one of the conditions of interest
- Establish the domains of clinical signs and symptoms
- Develop an understanding of the triage process
- Provide data to develop the respective clinical algorithms.
System development: data mining

Some issues:
- Imprecise information
- Missing data vs irrelevant data
- Imbalanced data
- Some information is more important than the others
- Clinicians need to understand and accept methodology.

A hybrid approach involving data mining and Shapley fuzzy measures was used to evaluate clinical ED data and to create decision rules comprising the clinical decision model.
Data mining 101

- To find patterns that discriminated between the respective triage categories of patients

- To answer two questions:
  - which attributes are most relevant for the discrimination?
  - what are the relationships between the attributes and the triage categories?
Clinical algorithm

- Complex relationships are captured as \textit{if ... then ...} statements
- Combinations of attributes (and values) can be assessed for patterns
- Should operate without a complete set of values
  - not all values must be recorded (WBC)
- Should provide a strength of matching each of the final triage categories
  - often a patient does not “fit” only one triage in an “all or nothing” manner
Providing clinical support

Anytime and Anywhere

• Clinical support is needed at the point of care
  This calls for the use of computing devices that are more portable than desktop computers and that can work offline

• Clinical support is required for complex patient management problems
  This calls for a system’s design that allows for versatility and easy adjustment to the problem at hand
**MET solution**

- **New architecture: extended client-server**
  Suitable for weak connectivity situation where the client performs some tasks of the server while there is no connectivity

- **Model-based interface design**

![Diagram of interface design]

- Interface model
- Interface agent
- Physical interface
- Platform model
**MET Server**

**Problem subsystem**
- Abdominal pain
- Scrotal pain
- Hip pain

**Solver subsystem**
- Heuristic classifier

**Patients’ database**
Synchronized with a client database

**Builder**

**Platform subsystem**
- Cell phone
- Handheld
- Desktop

**Interface subsystem**
- Pictogram editor
- List editor
- Numeric editor

**Integrator**
MET client: Mobile device

Clinical decision model
  Heuristic classifier
  Pictogram editor...

Problem subsystem Jr.
Solver subsystem Jr.
Interface subsystem Jr.
Database subsystem Jr.

Executor
**MET interactions: design principles**

**Objective:** To develop a system that does not deter physicians from routine patient management.
MET interactions
MET interactions
MET interactions
Clinical trial at CHEO: Abdominal Pain (AP) in children

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”

Time-consuming process
- average arrival to MD 60-90 minutes
- average MD to disposition 150-180 minutes
- 55% have lab, 26% have imaging
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 and “ticklish”
- Normal WBC doesn’t rule out pathology
- Imaging - Ultrasound
  - Not readily available after hours
  - Many inconclusive studies
  - Time-consuming and costly
Trial 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 CHEO ED
- 24/7 recruitment by triage/registration/resident/staff
  - no on-site study personnel
- Informed consent to collect patient data and make follow-up telephone call
- Where possible – 2 independent observations by staff/resident or resident/staff
- All clinicians blinded to MET-AP recommendation
- Patients followed until final outcome is established
Trial version of MET-AP

- **MET** server receives all patient demographics from hospital ADT system
- Separate trial management system overlying MET application for:
  - Managing lists of current patients
  - Providing inclusion/exclusion criteria on Palm
  - Capture physician prediction of patient’s triage category
  - Recording all follow-up information
Integrating with hospital’s IS

Hospital System 1

Hospital System 2

Audit and follow-up web-based applications

DataGate HL7 broker

EPIC Hospital IS

HL7 messages

Text messages

Management subsystem

Integration subsystem

Sync subsystem

Database

Mobile client

Mobile client

Mobile client

Mobile client
Preliminary trial results

• Analysis of 259/600 patients with complete F/U
  2x2 Consult vs Non-consult
  Physicians: Sens 67%, Spec 94%, Accuracy 91%
  MET: Sens 70%, Spec 91%, Accuracy 88%

Other successes
• real-time integration with hospital IS
• real-time data collection by day-to-day users
The Future . . .

**MET-AP**
- Refining the system based on prospective data
- Physician acceptance and how they use the recommendation
- RCT to assess effects on patient outcomes/economic analysis
- Multi-center study (community vs other academic centres)

**MET clinical modules**
- Acute Scrotum (MET-AS), Hip Pain (MET-HP), Asthma Exacerbation (MET-AE), Viral Bronchiolitis (MET-VB)

**MET shell**
- Platform independent and self-adapting
- Integration with HER
- Wireless
Acknowledgements

Rhonda Correll, Emergency Research Co-ordinator, CHEO
Greg Forestell, Information Services, CHEO
Joanne Ross, Information Services, CHEO
John Pike, Division of Urology, CHEO
Bernard Plouffe, UQO
Szymon Wilk, Poznan University of Technology

Mathieu Chiasson, MET Research Team
Nataliya Milman, MET Research Team
Roksana Mottahedi, MET Research Team
Leticia Troppman, MET Research Team
Thank you

Please visit us at:

www.mobiledss.uottawa.ca