



MET Mobile Emergency Triage

Saving Lives. Saving Dollars.

Poznań University of Technology, Poland
University of Ottawa, Canada
CHEO (Childrens' Hospital of Eastern Ontario), Canada

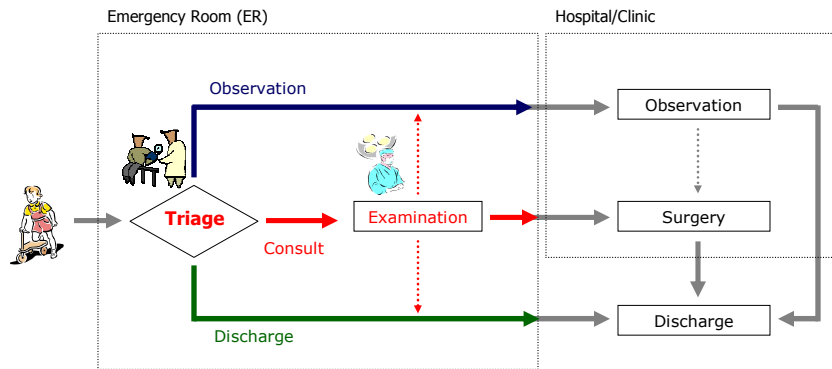


What Triage Means?

- A process for sorting injured people into groups based on their need for or likely benefit from immediate medical treatment. Triage is used in hospital emergency rooms, on battlefields, and at disaster sites when limited medical resources must be allocated
- **Triage ≠ Diagnosis**

Triage Decision

■ Patient management in the ER



Triage Support

■ Why to support triage?

- To increase triage **accuracy**
 - Incorrect decision may be dangerous for patient's health and life
 - Incorrect decision is expensive
- To decrease triage **duration**
 - Delays in diagnosis may cause anxiety to the child and the family
 - Assessments repeated in doubtful cases may be time consuming and painful



Triage Duration

- **Statistics for abdominal pain**
 - „...patients wait an average of 60-90 minutes to be assessed, then remain an additional 150-180 minutes for investigations and observation before a disposition is made. For patients found to have appendicitis, the total time in the ER is greater than 300 minutes, while those admitted with other causes of abdominal pain have an average length of stay greater than 380 minutes...”



Acute Conditions

- **Abdominal pain**
 - At CHEO 3300 visits per year (including trauma), i.e. 8-9 children seen daily
 - Approximately 240 children per year are admitted with acute appendicitis
- **Scrotal pain**
 - A relatively uncommon complaint -- 0.5% of total ER visits, but a common source for surgical consultation in a pediatric ER
 - „... misdiagnosed testicular torsion is one of the most common sources of legal proceedings against urologists and general surgeons...”
- **Hip pain**
 - ???



Abdominal Pain

- Analyzed data

- 723 patients' charts collected between 1996 and 2002, described by 13 clinical features (signs, symptoms, and tests)
- Large number of missing values
- Large number of inconsistent charts (→ *quality of classification* = 62%)



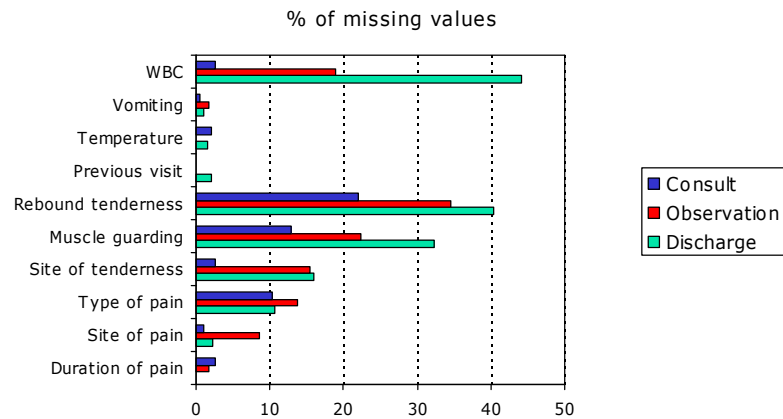
Abdominal Pain (cont.)

- Clinical features

Age	numeric (discretized)
Sex	male, female
Site of pain	RLQ, lower abdomen, other
Type of pain	constant, intermittent
Duration of pain	numeric (discretized)
Vomiting	yes, no
Previous visit to ER	yes, no
Temperature	numeric (discretized)
Site of tenderness	RLQ, lower abdomen, other
Rebound tenderness	yes, no
Muscle guarding	yes, no
Shifting of pain	yes, no
WBC	numeric (discretized)

Abdominal Pain (cont.)

■ Missing values



Scrotal Pain

■ Analyzed data

- 231 patients' charts collected between 1998 and 2002, described by 13 clinical features
- Large number of missing values
- **Extremely** large number of inconsistent charts (→ *quality of classification* = 46%)
- Multi-valued clinical features

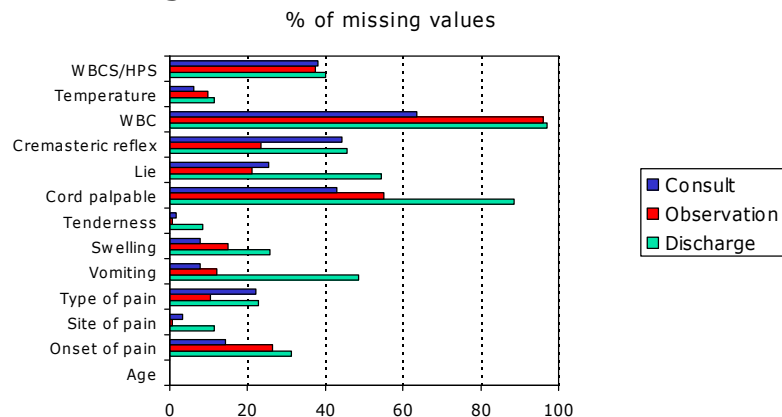
Scrotal Pain (cont.)

Clinical features

Age	numeric (discretized)
Onset of pain	acute, gradual
Site of pain	left, right, both
Type of pain	constant, intermittent
Vomiting	yes, no
Swelling	left, right, both, none
Tenderness	upper pole, posteriori, entire testis, not specific, none
Cord palpable	normal, abnormal
Cremasteric reflex	normal, abnormal
Lie	normal, elevated, transverse, transverse & elevated
WBC	numeric (discretized)
Temperature	numeric (discretized)
WBCS/HPS	numeric (discretized)

Scrotal Pain (cont.)

Missing values





Scrotal Pain (cont.)

- Inconsistent charts

Age	8 years (< 11 years)	3 years (< 11 years)
Onset of pain	?	acute
Location of pain	right testis	right testis
Type of pain	intermittent	intermittent
Vomiting	no	no
Swelling	none	none
Tenderness	none	none
Cord palpable	normal	?
Lie	normal	normal
Cremasteric reflex	normal	normal
WBC	?	?
Temperature	36.8 °C (< 37 °C)	36.3 °C (< 37 °C)
WBCS/HPS	3 (negative)	negative
Discharge diagnosis	torsion of appendix testis (→ observation)	Resolved torsion of testis (→ consult)



Hip Pain

- Analyzed data
 - 217 patients' charts collected between 1994 and 2002, described by 25 clinical features
 - Multi-valued clinical features
- Physicians were statistically narrow-minded ☹



Hip Pain (cont.)

■ Clinical features

Age	numeric (discretized)
Sex	male, female
Duration of pain	numeric (discretized)
Location of pain	medial hip, lateral hip, both, thigh
Type of pain	constant, with movement only, with WB only
Positional pain	yes, no
Patient wakes up at night	yes, no
Limp present	yes, no
Limp limits activity	yes, no
Patient refuses to WB	yes, no
Radiation of pain	localized to hip, to knee, to thigh, to back
Alleviating factors	none, rest, NSIDS, pain medication, positional
Hx of trauma	yes, no



Hip Pain (cont.)

■ Clinical features

Hx of fever	yes, no
Other joints involved	yes, no
Hip swelling	yes, no
Hip position	normal, ER, flexed, abducted
ROM	normal, limited (1 dir.), limited (≥ 2 dir.)
Pain with passive movement	no pain, ER, IR, flexion, compression, ...
Tenderness	medial hip, lateral hip, no tenderness
Gait/ambulation	normal, painful, unable to WB, reduced WB
Temperature	numeric (discretized)
WBC	numeric (discretized)
ESR	numeric (discretized)
X-Ray	normal, slip, fracture, other

Developing Clinical Algorithm

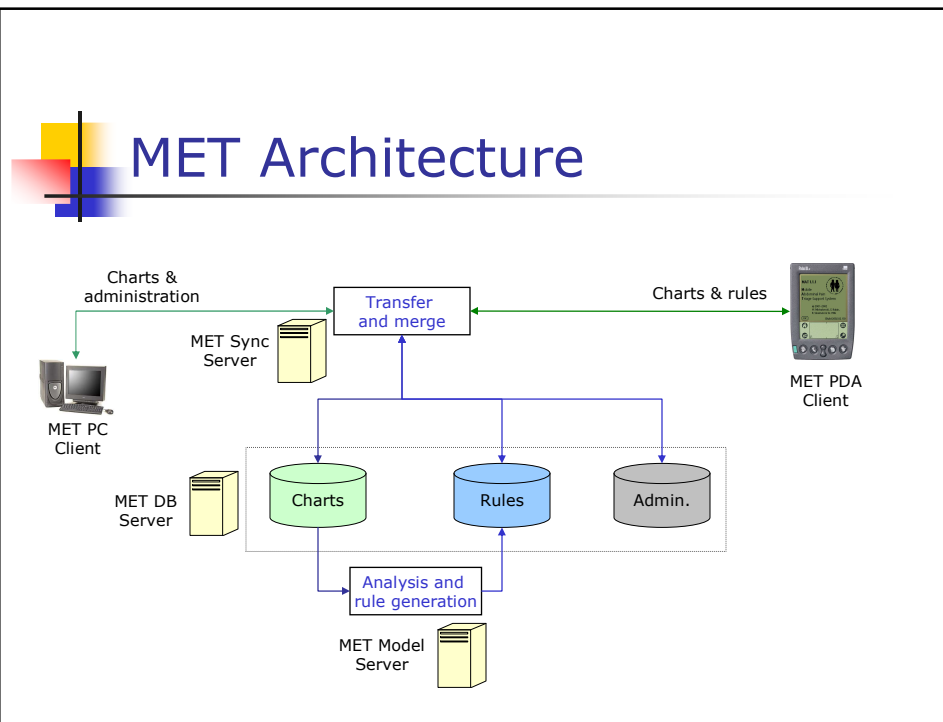
- Describing triage using clinical algorithm
 - Clinical algorithm = rules + classification strategy
- Applied methodology – **rough sets**
 - Classical approach (based on indiscernibility relation)
 - Variable precision model (VPM)
 - Extension for handling missing values (→ support for *evidence based medicine*)
 - Fuzzy measures for assessing relevance of clinical features
 - LEM2 for inducing decision rules

Developing MET

■ MET: Mobile Emergency Triage

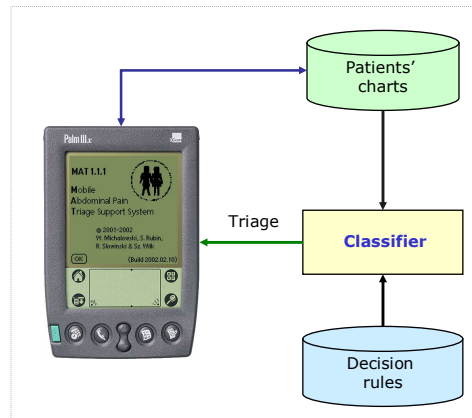


- Facilitates triaging recommendations for acute conditions
- Supports triage decision with or without complete clinical information
- Provides mobile support through handheld devices



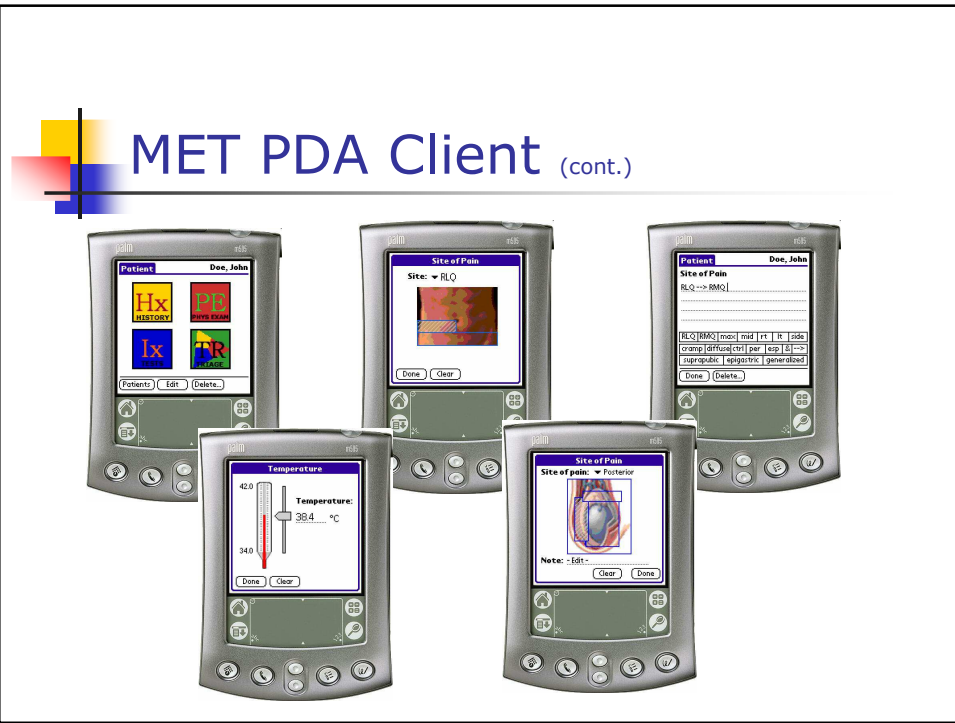
- ## MET PDA Client
- **Tasks**
 - Collecting data → structured data entry improves triage
 - Supporting and suggesting triage (no numerical results, qualitative information instead)
 - **Technology**
 - AppForge MobileVB – (almost) the same code for *PalmOS* and *PocketPC* platforms

MET PDA Client (cont.)



MET PDA Client (cont.)

- User interface solutions
 - Dividing clinical features into three categories (signs, symptoms, and tests)
 - Graphical data entry (→ direct manipulation): pictograms and sliders
 - Predefined keywords for entering comments



MET PC Client

- Tasks
 - Collecting and modifying data (→ patients' registration and further editing)
 - Managing users and devices
 - Generating reports
- Technology
 - ? (Visual Basic)

MET Sync Server

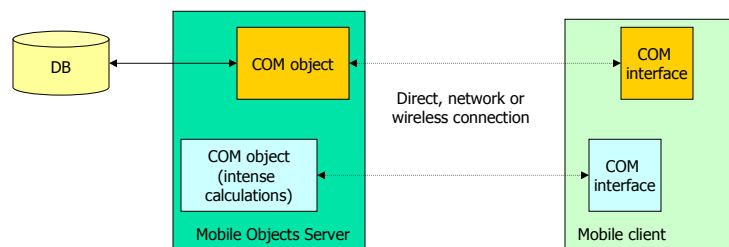
■ Tasks

- Synchronizing data between clients (PDA and PC) and DB server
- User and device tracking and authorization
- Supporting mobility and CSCW (point of presence, notification server) – in future

■ Technology

- XTND Mobile Objects → distributed COM objects

Mobile Objects





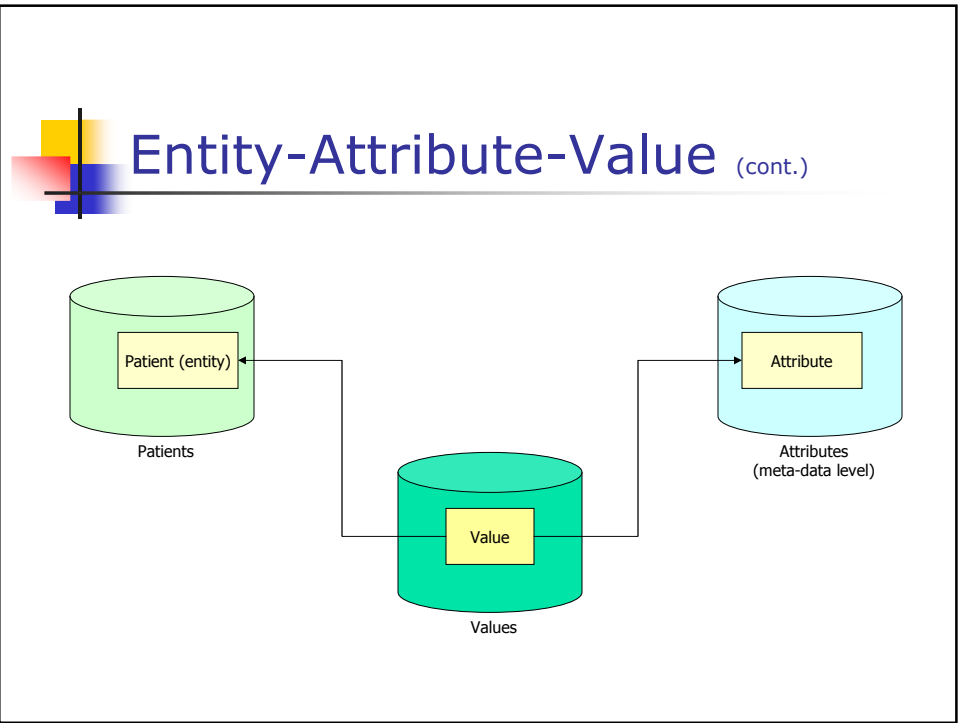
MET DB Server

- Tasks
 - Storing patients' charts, decision rules, and „administrative“ data
 - Entity-attribute-value (EAV) approach for enhancing flexibility (meta-data level for describing clinical features)
- Technology
 - MS SQL Server 2000 – platform used at CHEO for all hospital management systems



Entity-Attribute-Value

- EAV approach
 - Typical for medical applications
 - Data structure can be easily modified
 - Efficient storage – only known values are kept in a database
 - More difficult to use than a classical (table-oriented) approach → suggested for volatile or complex (more than one condition) problems



- ## MET Model Server
- **Tasks**
 - Updating an „intelligent“ engine after collecting a number of new charts
 - Incremental approach to data analysis – in future?
 - **Technology**
 - ? (Visual Basic)



MET in Action

- Comparison of MET and U/S classification accuracies
 - U/S → golden standard for abdominal pain

	U/S	MET
Sensitivity	80.0%	86.7%
Specificity	95.7%	82.9%
PPV	88.9%	68.4%
NPV	91.8%	93.5%
Classification Accuracy	91.0%	84.0%



Clinical Trial

- Primary objective
 - To determine the accuracy of the MET-AP clinical support system (trainee, staff physician) and the accuracy of the ED personnel (trainee, staff physician)
- Secondary objectives
 - To compare the accuracy of MET-AP with the accuracy ED personnel decisions (trainee, staff physician)
 - To determine the inter-observer agreement of the ED personnel's assessment of subjective patient attributes
 - To descriptively estimate the potential savings (time and resources) of following the MET-AP triage
 - To combine the complete prospective data sets with previous retrospective data



MET in Poland

- Ottawa

- „... CHEO is a tertiary-care pediatric teaching hospital affiliated with the University of Ottawa. It serves patients up to 18 years of age from the municipality of Ottawa, as well as surrounding communities in Eastern Ontario and Western Quebec (total pediatric population **>400,000**). The ED has 55,000 patient visits per year and is staffed 24-hours per day by specialty-trained Pediatric Emergency Medicine physicians. **Three Pediatric General Surgeons**, supported by residents from various programs, provide surgical coverage ...”

- Poznań

- Approximately 60 Pediatric General Surgeons
- „... there are too many surgeons to introduce such system...”



The End

Mobility + Processing power – Health \$ = MET opportunity