Acknowledgments

- Telfer School of Management, University of Ottawa, Ottawa, Canada
- Emergency Department, Children’s Hospital of Eastern Ontario, Ottawa, Canada
- Laboratory of Intelligent Decision Support Systems, Poznan University of Technology, Poznan, Poland
Emergency Triage of Acute Pain Presentations
What Does Triage Mean?

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.
**Process of Emergency Triage**

**Canadian Triage Acuity Scale (CTAS)**
- CTAS1 - Immediate
- CTAS2 - ≤ 15 min.
- CTAS3 - ≤ 30 min.
- CTAS4 - ≤ 1 hour
- CTAS5 - ≤ 2 hours

**Prioritization**
(TMage nurse)

**Priority categories**

- Medical assessment and disposition
  (Physician)

**Discharge**

**Observation/further investigation**

**Consult**
Triage Support

Why to support triage?

- To increase triage accuracy
  - Incorrect decision may be dangerous
  - Incorrect decision is expensive (unnecessary consultations and tests)

- To decrease triage duration
  - Examinations and observation may last several hours (150 – 180 min for typical presentations)
Acute Presentations

- A systematic review of common presentations in the ED failed
  - Limited access to data (even in paper format)

- Interest- and data-driven analysis
  - Despite the interest of physicians difficulties with finding „positive” (sick) patients ⇒ failure of the syncope project

- Many CDSSs used in practice are based on knowledge extracted from medical textbooks – ISABEL (http://www.isabel.org.uk)
Acute Abdominal Pain
Triage of Abdominal Pain

- Primary cause for surgical consult – appendicitis
- Prevalence (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
  - A retrospective chart study produced ~700 charts
- Extensive studies in the past
  - de Dombal, clinical trials with 16,000 patients
  - Structured data collection/entry more useful than actual decision support
Available Decision Support Tools

- Appendicitis scores – MANTRELS
- Requires all attributes to be checked and collected
- Not used at CHEO
Rough set theory with cumulative indiscernibility

- Uses approximations of decision classes (patients who do really need consult and patients who may need consult)
- Handles missing values without any changes to original data (no replacement nor imputation)
- Presents knowledge in form of comprehensive rules (understood by physicians ⇒ Ottawa Ankle Rule)
An Ankle X-Ray series is only required if:
– There is any pain in the malleolar zone (defined (more or less) from the tibia and fibula 6 cm above the articulation with the talus, to the bones of the midfoot) AND any of these findings:
  • Bone tenderness at the posterior edge or tip of the lateral malleolus OR
  • Bone tenderness at the posterior edge or tip of the medial malleolus OR
  • Inability to bear weight both immediately and in the ED

A foot X-Ray series is required only if:
– There is any pain in midfoot AND any of these findings:
  • Bone tenderness at the base of the 5th metatarsal OR
  • Bone tenderness at the navicular OR
  • Inability to bear weight both immediately and in the ED
The diagnosis may be *appendicitis* and the management maybe *consult* when one of the following occurs:
- A male patient experiences right lower quadrant abdominal pain and his white blood cell count is above 20000/mm³;
- A male patient experiences right lower quadrant abdominal pain lasting between 4h and 24h, combined with frequent (more than 3 times) vomiting;
- ...

The diagnosis maybe *resolution* and the management maybe *discharge* when one of the following occurs:
- A patient experiences abdominal pain (neither right lower quadrant nor suprapubic) lasting between 4h and 24h;
- A patient experiences abdominal pain (neither right lower quadrant nor suprapubic) of intermittent character;
- ...
MET1 and MET2 Systems
MET System (1st and 2nd Generation)

- Facilitates triaging recommendations for presentations of acute pain problems
- Supports triage decision with or without complete clinical information
- Provides mobile support through mobile devices and desktop computers
1998 – 2000
- Web-based (PHP + MySQL) application for entering data and triaging patients with abdominal pain
2000 – 2001

- The first Palm-based application (MAT → Mobile Abdominal pain Triage)
**MET History (3)**

- **2002 – 2003**
  - More presentations of pain (MAT → MET1)
  - Support for Palm (Palm OS) and Pocket PC (Windows CE/Mobile)
2004 – 2007

– Support for desktop and tablet computers
– Flexible ontology-driven design, Java-based implementation
Extended client-server architecture for weak-connectivity conditions and integration

MET Architecture (1)
Separation of knowledge and solvers for flexibility and reusability
MET Operations

Interface Engine

- Patient registered
- Patient data available
- "Hospital-wide" patient data updated

MET Server

- Receive, decode and store patient data
- Synchronize patient data
- Synchronize presentation modules
- Encode and send patient data

Admission message

Observation report

Synchronization requested

Patient data

Presentation modules

MET Client

- Synchronize patient data
- Synchronize presentation modules

Observation report

Observation report

"Hospital-wide" patient data updated

Receive, decode and store patient data

Synchronize patient data

Synchronize presentation modules

Encode and send patient data

Synchronization requested

Patient data

Presentation modules

Synchronize patient data

Synchronize presentation modules
Client Technologies (1)

- MAT (pre MET1)
  - Implemented in Satellite Forms Enterprise
  - Development platform and middleware connectivity layer
  - VB-like IDE and language
    - Language limited to simple constructs (no arrays)
    - Limited access to system features (extensions in C++)
- **MET1**
  - Implemented in AppForge
  - Development platform integrated into Visual Basic 6 or Visual Studio 2003
  - Multi-platform run-time environment
    - Virtual machines (Booster) for various platforms and systems (Palm OS, Windows CE, Symbian, RIM)
    - Limited access to native UI controls
  - No longer supported – „intellectual property” owned by Oracle
Client Technologies (3)

- MET2
  - Implemented in Java SE (desktop) and ME (CDC, Pocket PC)
  - User interface implemented in Thinlet GUI Toolkit
    - Cross-platform Java-based UI library
    - UI declared in XML and created at run-time
  - Thinlet is still being developed (http://www.thinlet.com) and expanded (support for Android)
SQL Anywhere (iAnywhere Studio)

– Adaptive Server Anywhere
  • SQL-based server for various platforms
  • Supports „Java in the Database” – Java objects as data types

– MobiLink
  • Flexible synchronization agent for direct client-server connections
  • Advanced SQL-based scripting for non-standard synchronization techniques (aggregation/scattering of fields and records)

– SQL Remote
  • Synchronization agent supporting various ways of communication between a server and clients (e-mail, ftp, ...)

Database/Server Technologies
Clinical Trial of MET1-AP
Clinical Trial of MET1-AP

- **Primary goal**
  - To determine and compare the accuracy of MET1-AP and of the ED personnel (residents, staff physicians)

- **Secondary goals**
  - To determine the inter-observer agreement (primary and secondary observers) of the assessment of clinical attributes
  - To descriptively estimate the potential savings (time and resources) of following the MET1-AP triage
Clinical Trial of MET1-AP (2)

- Duration of the trial – 8 months (July 2003 – February 2004)

- Required number of patients
  - Total of 640 patients (based on the physician accuracy reported in the literature)
  - 60% cross-over of patients seen by both observers (384 patients seen by residents and 384 seen by physicians)
CHEO – Children’s Hospital of Eastern Ontario

- Total pediatric population >400,000
- 55,000 patient visits in the ED per year
- 3 pediatric general surgeons
  (supported by emergency medicine physicians and residents)
Trial Location (2)
Ethical Concerns

- **Voluntary participation**
  - Written consent that might be rescinded at any time

- **No benefit to the patient or ED personnel involved in individual enrollment**
  - Prizes for registration clerks and triage nurses who have recruited many patients

- **Participation involves no risks to the patient’s health or compromise their care in any way**
  - MET1-AP recommendations were kept blinded until the final diagnosis was established
Eligibility of Participants (1)

- Not all patients with consent could be enrolled
  - Eligibility checked after receiving consent to participate
  - Patient had to satisfy all inclusion and none of exclusion criteria

- Inclusion criteria
  - Age between 1 and 17 years
  - Presenting complaint of abdominal pain
  - Duration of pain 10 days or less
Eligibility of Participants

- Exclusion criteria
  - Pain as the result of trauma
  - Pain potentially caused by an acute disease for which the patient is currently undergoing treatment
  - Pain similar to previous episodes explained by a chronic or underlying illness
  - Previous abdominal surgery
  - Prior enrolment for this episode of abdominal pain
  - Direct referral to General Surgery or other consultant service for assessment
  - A language barrier (neither English, nor French) or other barrier to complete telephone follow-up
Trial Flowchart (1)

Prioritization

Registration

Patient is registered in the ADT system

Patient is registered in the MET system

Abdominal pain?

No

Yes

Examination and evaluation

Using mobile MET client

Audit #1

Based on electronic and paper charts of all patients
Trial Flowchart (2)

1. **Include patient?**
   - **Yes**: Telephone follow-up
     - **Audit #2**: Based on electronic and paper charts. Verified disposition is established
     - **Store patient for analysis**
   - **No**: Remove patient

2. **Trial mgmnt system**
Prioritization and Registration (1)

- Demographic information and presenting complaint is entered into the ADT system (EPIC)
  - Complaint entered as a free text – problems with parsing (abbreviations, spelling errors etc.)
  - One of the unused fields in EPIC was activated and used as a trigger (MET Abd Pain)
### Prioritization and Registration

<table>
<thead>
<tr>
<th>A.P.</th>
<th>Abdominal Pain Right Lower Quadrant</th>
<th>Fever/Diarrhea/Abdominal Pain</th>
</tr>
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<tbody>
<tr>
<td>Abdominal Pain</td>
<td>Abdominal Pain X3 Days</td>
<td>Left Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain and Fever</td>
<td>Abdominal Pain, Dizziness</td>
<td>Left Side Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain &amp; Fever</td>
<td>Abdominal Pain, Vomiting, Fever</td>
<td>Left Sided Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain &amp; Vomiting</td>
<td>Abdominal Pain, Vomiting</td>
<td>Lethargy / Vomiting</td>
</tr>
<tr>
<td>Abdominal Pain - Diabetic</td>
<td>Abdominal Pain, Diarrhea</td>
<td>Mid Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain - Fever</td>
<td>Abdominal Pain, Vomiting/Diarrhea</td>
<td>Nausea / Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain - Fever - Vomiting</td>
<td>Abdominal Pain</td>
<td>R.L.Q. Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain - Rule Out Appendicitis</td>
<td>Back Pain / Abdominal Pain</td>
<td>Right Lower Quadrant Abdominal Pain</td>
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<tr>
<td>Abdominal Pain - Vomiting</td>
<td>Constipation</td>
<td>Right Lower Quadrant Pain</td>
</tr>
<tr>
<td>Abdominal Pain / Back Pain</td>
<td>Diarrhea / Abdominal Pain</td>
<td>Right Lower Quadrant Pain / Anxiety</td>
</tr>
<tr>
<td>Abdominal Pain / Fever</td>
<td>Diarrhea and Vomiting</td>
<td>Right Upper Quad Pain</td>
</tr>
<tr>
<td>Abdominal Pain / Flank Pain</td>
<td>EpiGastric Pain</td>
<td>RLG Pain</td>
</tr>
<tr>
<td>Abdominal Pain / Headache</td>
<td>Fever</td>
<td>Rule Out Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain / Post Ultra Sound</td>
<td>Fever - Vomiting</td>
<td>Rule Out Diabetes</td>
</tr>
<tr>
<td>Abdominal Pain / Rule Out Bloody Stool</td>
<td>Fever - Vomiting - Abdominal Pain</td>
<td>Stomach Aches</td>
</tr>
<tr>
<td>Abdominal Pain / Vomiting</td>
<td>Fever / Abdominal Pain</td>
<td>Stomach Cramps &amp; Fever</td>
</tr>
<tr>
<td>Abdominal Pain Fever Vomiting</td>
<td>Fever, Abdominal Pain</td>
<td>Syncope / Sore Throat / Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain Intermittent</td>
<td>Fever / Abdominal Pain</td>
<td>Vomiting &amp; Diarrhea / Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain Left Side</td>
<td>Fever / Abdominal Pain</td>
<td>Vomiting - Abdominal Pain</td>
</tr>
<tr>
<td>Abdominal Pain Right</td>
<td>Fever / Abdominal Pain</td>
<td>Vomiting / Abdominal Pain</td>
</tr>
</tbody>
</table>
Examination and Evaluation (1)

- Primary and secondary patient records
  - Entered independently by primary and secondary observers
  - Each observer asked for consent and checked patient’s eligibility
Examination and Evaluation (2)

- Authentication limited to two classes of users (physicians and residents)
  - Too many users (around 150) to support their management and easy “personal” logging in
- It was very difficult to establish proper wording for the triage screen
  - Once the wording was established, it was too long to fit it the small screen
Problems with Synchronization

- Because of hardware and organizational limitations we were not able to use wireless networking
- Failures of cradles
- Incorrect placing handhelds on cradles (⇒ human factor)
Audit #1

- Filtering patients for further analysis
- Identification of missed eligible patients

Logged as: Szymon Wilk
User Type: Administration

Where do you want to redirect this audit?
- Include to Followup
- Exclude from Analysis
- Cancel
- Not Approached but Eligible

Disposition: pediatrics

Extra Note:

ER Diagnosis:
appendicitis is suspected

Visit Info

<table>
<thead>
<tr>
<th>File Number</th>
<th>First</th>
<th>Middle</th>
<th>Last</th>
<th>Is Eligible</th>
<th>Is Approached</th>
<th>Has given consent</th>
<th>Visit Date</th>
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<tbody>
<tr>
<td>2022</td>
<td>Claudia</td>
<td>B</td>
<td>Laurin</td>
<td>False</td>
<td></td>
<td></td>
<td>10/23/2003 8:34:00 AM</td>
</tr>
</tbody>
</table>
Telephone Follow-up (1)

- Collecting additional information about patient’s history following the ED visit
- Recording additional assessments and resources required by a patient after the ED visit

Name of the Patient: Claudia B Laurin

Did your child’s pain resolve before leaving the hospital (either ER or after inpatient admission)?
  Has the pain recurred at any point in the last 10 days?
  Yes ☑ No ☐
  Yes ☑ No ☐
  Recurred twice

Has your child had any of the following symptoms since leaving hospital, either with abdominal pain or without?

- Vomiting: ☑
- Diarrhea: ☐
- Constipation or painful defecation: ☐
- Fever: ☑
Name of the Patient: Claudia B Laurin

Have you sought further medical assessment or had any further tests since your ER visit? ☑ Yes ☐ No

<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Location</th>
<th>Result</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>GP or Pediatrician</td>
<td>Ottawa, Bank Street</td>
<td>Flu</td>
<td>03/11/2003</td>
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<td></td>
<td></td>
<td></td>
<td>03/11/2003</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>03/11/2003</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Resource Pre-Decision ER</th>
<th>Post-Decision ER</th>
<th>Post-Decision In Patient</th>
<th>Post-Decision Out Patient</th>
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<tbody>
<tr>
<td>Lab-Bld</td>
<td>1</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Lab-Urine</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IVIS_L</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Oral Med</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>IV Med</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Audit #2

- Establishing verified triage disposition (used as the gold standard for calculating triage accuracy)
- Filtering patients for final study
Enrolled Patients

The process for enrolling patients is outlined below:

- **34,527 visits** were observed from July 2003 to February 2004.
- Of these, **1157 visits** were excluded due to abdominal pain.
- **467 not approached**.
- **1098 eligible visits** were approached, of which 631 were approached.
- **38 refused consent**.
- **593 enrolled**.
- **457 seen by physicians**.
- **574 analyzed**.
- **339 seen by residents**.
- **12 excluded post, 7 lost to follow-up**.
Inter-observer reliability (Cohen’s kappa) of assessment for clinical attributes

- Calculated for 222 patients seen by both observers
- Kappa > 0.70 considered as satisfactory

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of pain</td>
<td>0.825</td>
</tr>
<tr>
<td>Localized guarding</td>
<td>0.309</td>
</tr>
<tr>
<td>Previous visit</td>
<td>0.481</td>
</tr>
<tr>
<td>Rebound tenderness</td>
<td>0.449</td>
</tr>
<tr>
<td>Shifting of pain</td>
<td>0.521</td>
</tr>
<tr>
<td>Site of pain</td>
<td>0.513</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Kappa</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site of tenderness</td>
<td>0.573</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.945</td>
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<tr>
<td>Type of pain</td>
<td>0.475</td>
</tr>
<tr>
<td>Vomiting</td>
<td>0.890</td>
</tr>
<tr>
<td>WBC</td>
<td>0.952</td>
</tr>
</tbody>
</table>
Possible explanation of inconsistencies

- Patient’s state changes in the ED
- Patient or parents give different answers to different observers
- Residents are not experienced enough to collect valid values of some attributes
- Constrained data entry on MET and free entry on a chart may lead to ambiguous “mappings”
- Users make mistakes when entering data (e.g., duration of pain – fixed later)
MET works as an assistant
  – Provides strengths for all possible triage dispositions
  – Marks the strongest disposition as a suggested one (physician does not have to follow it)

The suggested disposition was considered an ultimate one and compare to a gold standard (from Follow-up #2)
### Triage Misclassifications

#### Physicians

<table>
<thead>
<tr>
<th></th>
<th>Discharge</th>
<th>Observation</th>
<th>Consult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>248</td>
<td>85</td>
<td>15</td>
</tr>
<tr>
<td>Observation</td>
<td>16</td>
<td>39</td>
<td>6</td>
</tr>
<tr>
<td>Consult</td>
<td>1</td>
<td>13</td>
<td>34</td>
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</table>

#### MET1-AP/Physicians

<table>
<thead>
<tr>
<th></th>
<th>Discharge</th>
<th>Observation</th>
<th>Consult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>279</td>
<td>39</td>
<td>30</td>
</tr>
<tr>
<td>Observation</td>
<td>38</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Consult</td>
<td>12</td>
<td>3</td>
<td>33</td>
</tr>
</tbody>
</table>

#### Residents

<table>
<thead>
<tr>
<th></th>
<th>Discharge</th>
<th>Observation</th>
<th>Consult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>166</td>
<td>80</td>
<td>17</td>
</tr>
<tr>
<td>Observation</td>
<td>11</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td>Consult</td>
<td>2</td>
<td>13</td>
<td>23</td>
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</table>

#### MET1-AP/Residents

<table>
<thead>
<tr>
<th></th>
<th>Discharge</th>
<th>Observation</th>
<th>Consult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>209</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Observation</td>
<td>23</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Consult</td>
<td>14</td>
<td>5</td>
<td>19</td>
</tr>
</tbody>
</table>
Broad Triage Categories

- Broad observation category
- Multiple possible diagnostic outcomes bound to a single triage outcome

<table>
<thead>
<tr>
<th>Hernia</th>
<th>Leukemia</th>
<th>Urinary Tract Infection</th>
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</thead>
<tbody>
<tr>
<td>Intussusception</td>
<td>Inflammatory Bowel Disease</td>
<td>Nephrolithiasis</td>
</tr>
<tr>
<td>Volvulus</td>
<td>Infectious Colitis</td>
<td>Ovarian Torsion</td>
</tr>
<tr>
<td>Bowel Obstruction</td>
<td>Intra-abdominal Abscess</td>
<td>Ovarian Cyst</td>
</tr>
<tr>
<td>Mesenteric Adenitis</td>
<td>Malabsorptive Syndromes</td>
<td>Testicular Torsion</td>
</tr>
<tr>
<td>Gastritis, Ulcer Disease</td>
<td>Porphyria</td>
<td>Epididymitis</td>
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<tr>
<td>Hepatitis</td>
<td>Toxin Ingestion</td>
<td>Diabetes</td>
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<tr>
<td>Biliary Colic, Cholecystitis</td>
<td>Pneumonia, Asthma</td>
<td>Other Metabolic Derangements</td>
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<tr>
<td>Pancreatitis</td>
<td>Group A Strep Pharyngitis</td>
<td>Sickle Cell Crisis</td>
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<tr>
<td>Ingested Foreign Body</td>
<td>Abdominal Wall Contusion</td>
<td>Henoch-Schonlein Purpura</td>
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<tr>
<td>Intra-abdominal Neoplasm</td>
<td>Hemolytic Uremic Syndrome</td>
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</table>
Physicians were asked to triage patients using only information supplied to MET1-AP

<table>
<thead>
<tr>
<th>Gold standard</th>
<th>ED</th>
<th>Post-ED</th>
<th>MET</th>
<th>Comment</th>
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<tbody>
<tr>
<td>discharge</td>
<td>discharge</td>
<td>observation</td>
<td>discharge</td>
<td>would want to see urine, preg test if &gt;12, menstrual hx, bowel movement history; Constant nature with rebound is worrisome</td>
</tr>
<tr>
<td>discharge</td>
<td>observation</td>
<td>discharge</td>
<td>observation</td>
<td>likely viral</td>
</tr>
<tr>
<td>consult</td>
<td>observation</td>
<td>discharge</td>
<td>observation</td>
<td>likely viral</td>
</tr>
<tr>
<td>discharge</td>
<td>consult</td>
<td>consult</td>
<td>observation</td>
<td>Would want to also rule out ovarian torsion</td>
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</tr>
<tr>
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<td>observation</td>
<td>observation</td>
<td>observation</td>
<td>would want to assess for resp symptoms</td>
</tr>
<tr>
<td>Gold standard</td>
<td>ED</td>
<td>Post-ED</td>
<td>MET</td>
<td>Comment</td>
</tr>
<tr>
<td>---------------</td>
<td>--------</td>
<td>---------</td>
<td>--------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>observation</td>
<td>discharge</td>
<td>observation</td>
<td>consult</td>
<td>would want to see urine, preg test if &gt;12, menstrual hx, bowel movement history; Constant nature in Lower abd &gt;24 hours</td>
</tr>
<tr>
<td>observation</td>
<td>observation</td>
<td>observation</td>
<td>observation</td>
<td>would get an U/S</td>
</tr>
<tr>
<td>consult</td>
<td>consult</td>
<td>consult</td>
<td>consult</td>
<td></td>
</tr>
<tr>
<td>observation</td>
<td>observation</td>
<td>observation</td>
<td>consult</td>
<td>? early appendix - would get U/S</td>
</tr>
<tr>
<td>consult</td>
<td>consult</td>
<td>consult</td>
<td>consult</td>
<td></td>
</tr>
<tr>
<td>observation</td>
<td>consult</td>
<td>observation</td>
<td>observation</td>
<td>CXR, though likely still benign (D/C)</td>
</tr>
<tr>
<td>observation</td>
<td>consult</td>
<td>observation</td>
<td>observation</td>
<td>Same as above - without more info, I can't classify them differently.</td>
</tr>
<tr>
<td>observation</td>
<td>observation</td>
<td>discharge</td>
<td>discharge</td>
<td></td>
</tr>
<tr>
<td>consult</td>
<td>consult</td>
<td>observation</td>
<td>discharge</td>
<td>would get an U/S</td>
</tr>
<tr>
<td>observation</td>
<td>observation</td>
<td>discharge</td>
<td>observation</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions from the Trial

- Decision rules provided a comprehensible and readable representation of discovered clinical knowledge.
- A successful decision support tool has to be available at the point of care and needs to be integrated with electronic patient record.
- Accuracy of the system was comparable to accuracy of physicians, however, the system was less conservative due to imbalanced data, latent attributes, broad categories.
- Clinical experience and acumen is still necessary!