

Rough Set Methodology in Clinical Practice

Controlled Hospital Trial of the MET System



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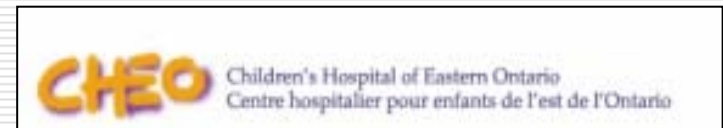
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Outline

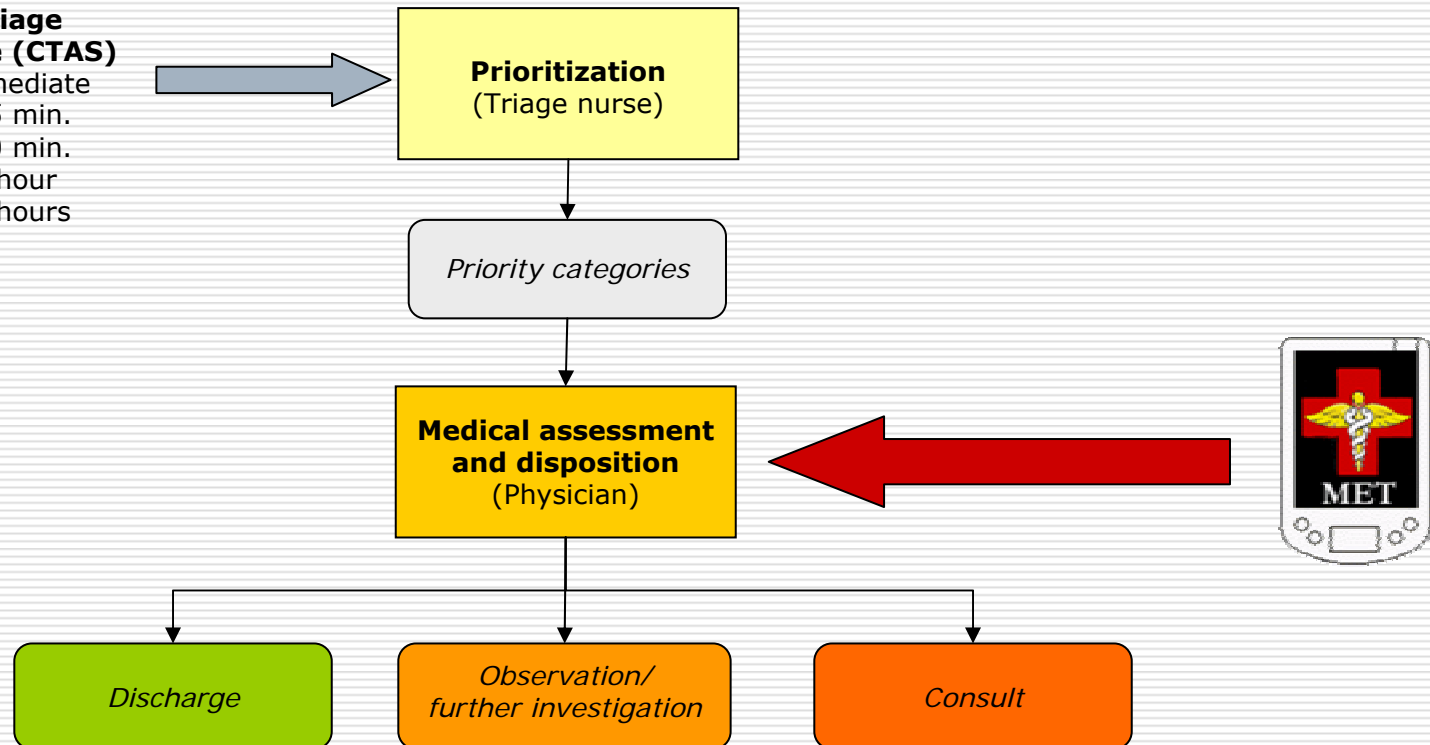
- Emergency triage
 - MET system
 - Architecture
 - Decision models
 - Clinical trial
 - Organization
 - Results
 - Conclusions
-

Emergency Triage

□ Triage ≠ diagnosis

Canadian Triage Acuity Scale (CTAS)

CTAS1 - Immediate
CTAS2 - ≤ 15 min.
CTAS3 - ≤ 30 min.
CTAS4 - ≤ 1 hour
CTAS5 - ≤ 2 hours



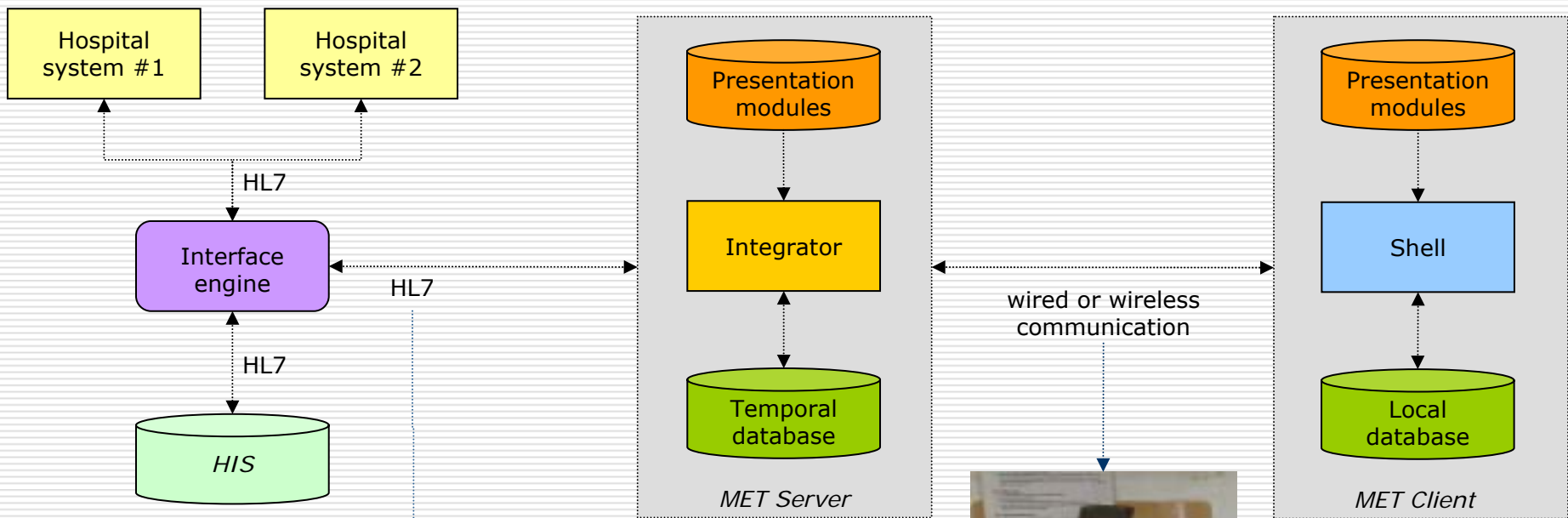
MET: Mobile Emergency Triage

- ❑ Flexible triage support system
- ❑ Available directly at the point of care
 - Runs on mobile devices
 - Runs in weak connectivity
- ❑ Fully integrated with hospital information system (HIS)



MET Architecture #1

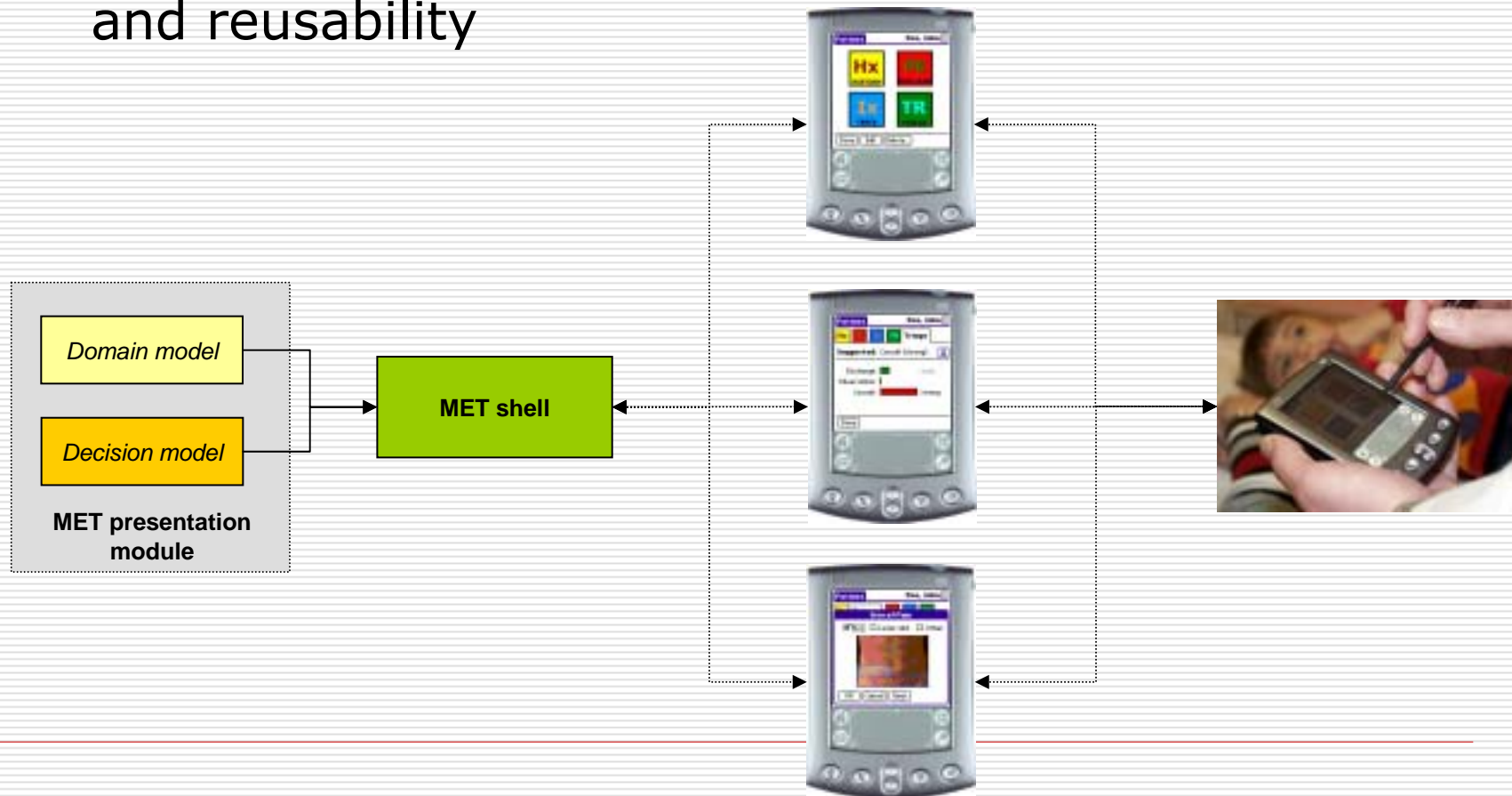
- Extended client-server architecture for integration with HIS and weak connectivity



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MSH|^~\| 4||. ||199908180016||ADT^A04|ADT  
PID|1||000395122||THOMAS^KYLE^C^||196  
NK1|1|SMITH^MARY^C|M|12914 164TH AVE NE  
PV1|1|E|EMG-W^^|1|||||||ER|||ER||N|  
GT1|1||SMITH^JAMES^M||12914 164TH AVE N  
IN1|1|PRE2||LIFE PRUDENT BUYER|PO BOX 2
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MET Architecture #2

- Separation of knowledge and solvers for flexibility and reusability



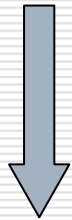
Development of a Decision Model

- Rough set theory with **cumulative indiscernibility**
 - Handles missing values without any changes to original data
 - Easily „integrates“ with already developed algorithms and methods

 - Decision models for **abdominal pain**, scrotal pain, hip pain and asthma (in progress)
-

Decision Model for Abdominal Pain – First Attempt #1

- **Goal:** to develop the „Ottawa Abdominal Pain Rule“



- Comprehensive clinical guideline for „manual“ use
- Inspired by „Ottawa Ankle Rule“

- Analysis of retrospective data



- 175 patient charts
- 14 clinical attributes (history, examination, tests)
- 2 decision classes (discharge, consult)

- Set of 10 rules translated by physicians into a paper clinical guideline
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Decision Model for Abdominal Pain – First Attempt #2

□ „Ottawa Abdominal Pain Rule“

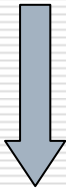
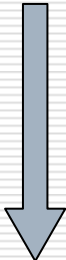
The diagnosis may be *appendicitis* and the management maybe *consult* when one of the following occurs:

- 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;
- A male patient who already visited the ER in last 24 hours experiences right lower quadrant abdominal pain, 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;
- A patient experiences abdominal pain (neither right lower quadrant nor suprapubic) not accompanied by vomiting;
- ...

Decision Model for Abdominal Pain – MET Approach

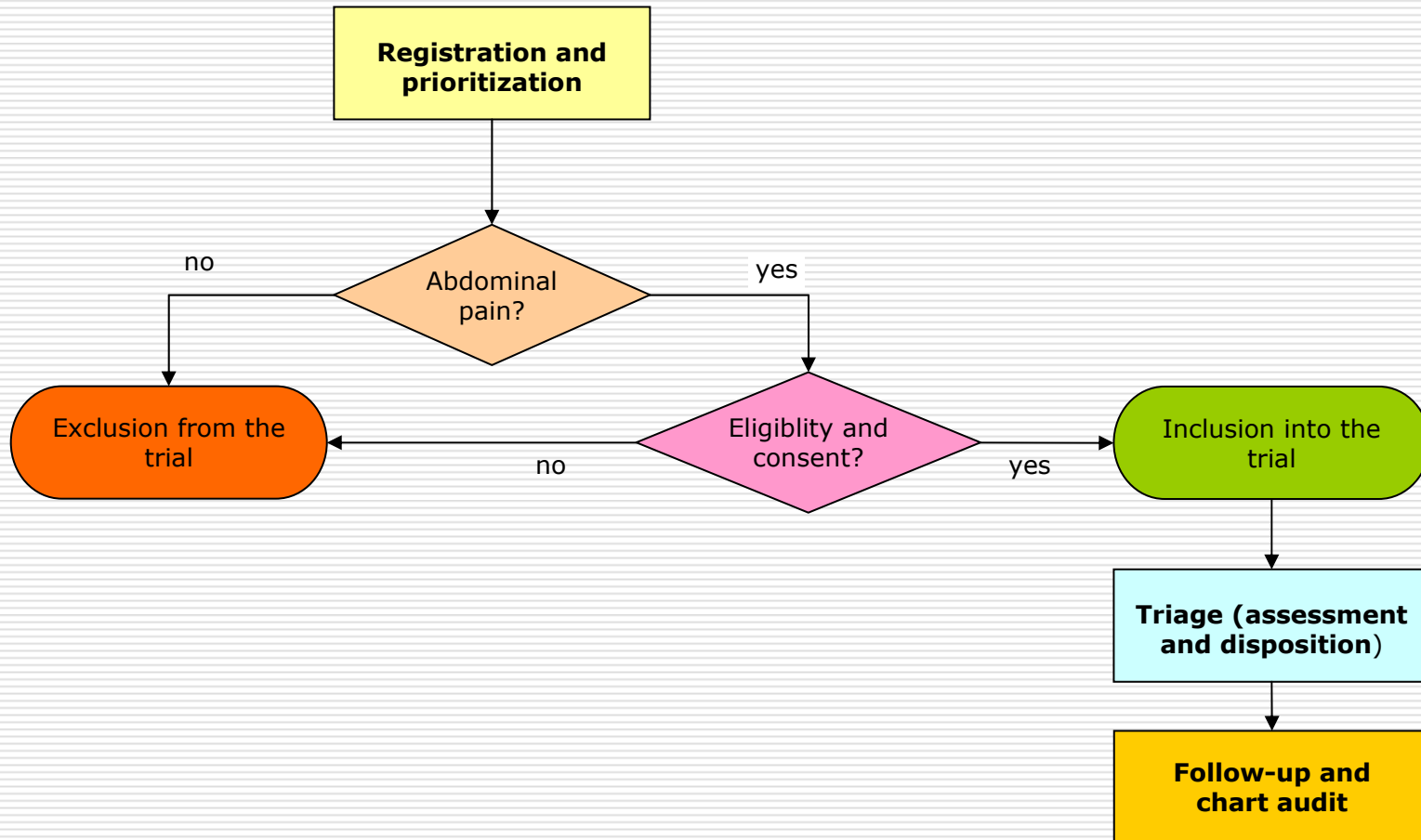
- **Goal:** to develop a decision model for MET
 - Accurate decision model for „computerized“ use
 - Concise and effective – for a lean computing platform
 - Analysis of retrospective data
 - 623 patient charts
 - 13 clinical attributes (history, examination, tests)
 - 3 decision classes (discharge, observation, consult)
 - Set of 172 rules embedded in a decision model for the abdominal pain MET module
-

Clinical Trial

- **Goal:** to verify prospectively and compare triage accuracy of physicians, residents and MET
- Conducted at CHEO (Children's Hospital of Eastern Ontario) between July 2003 – February 2004
- Physicians and residents blinded to MET recommendation because of ethical concerns

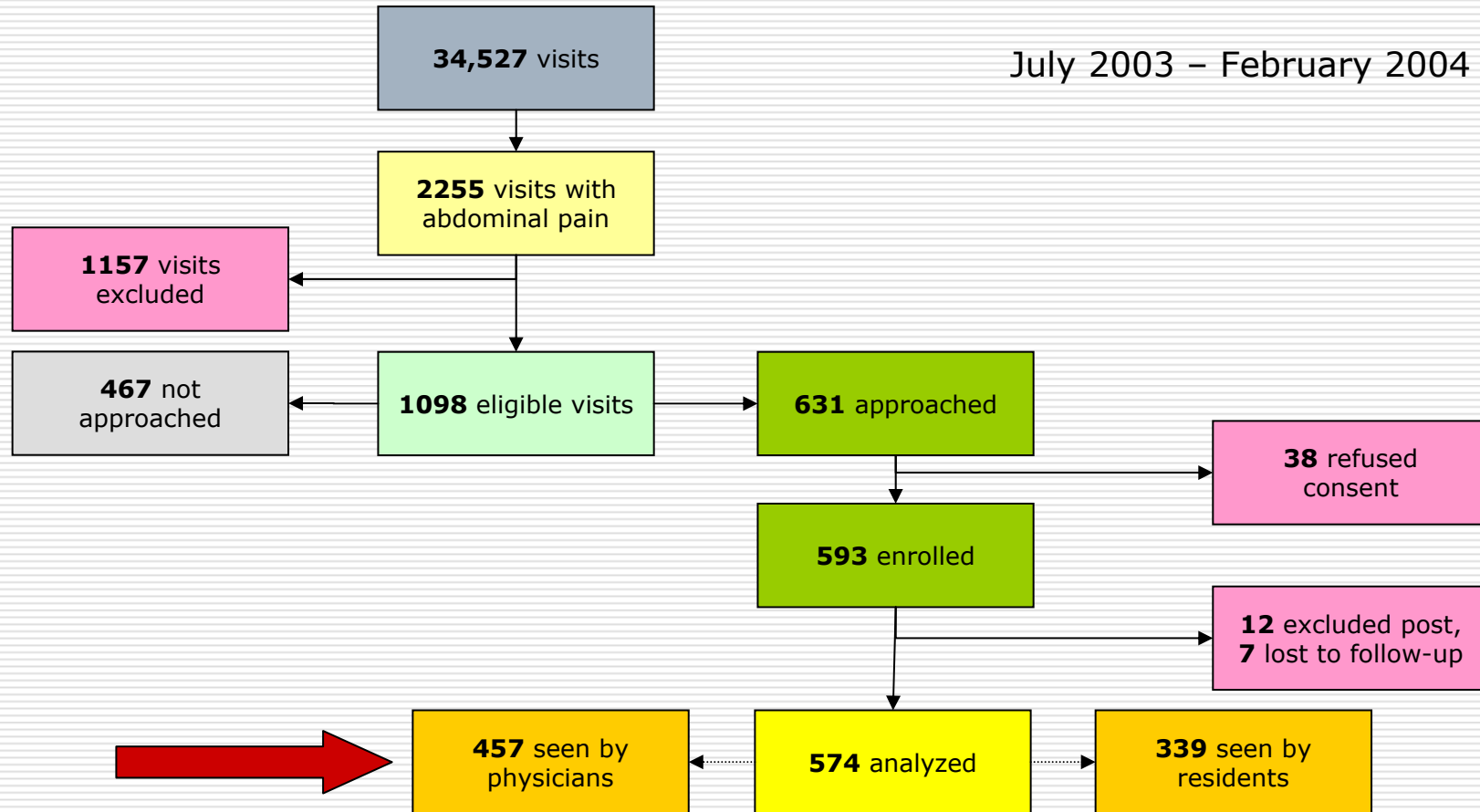


Organization of the Trial

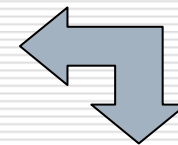
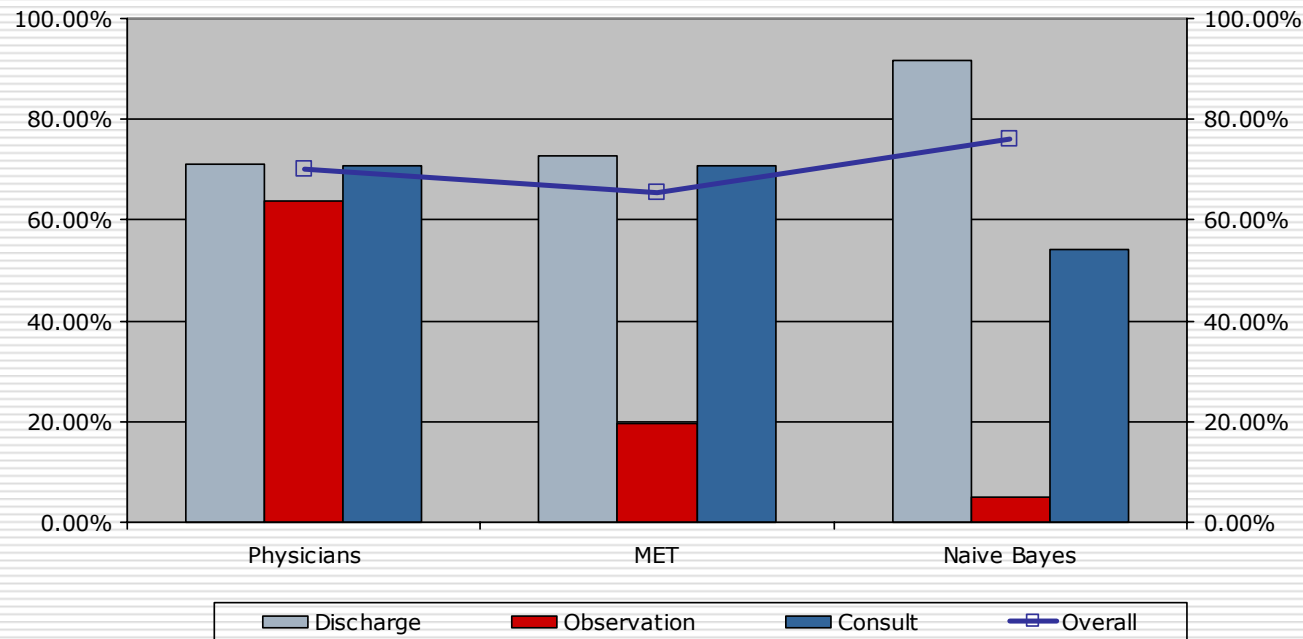


Results of the Trial: Enrolled Patients

July 2003 – February 2004



Results of the Trial: Triage Accuracy



	Physicians	MET	Naive Bayes
Overall	70.24%	65.43%	76.15%
Discharge	71.26%	72.70%	91.67%
Observation	63.93%	19.67%	4.92%
Consult	70.83%	70.83%	54.17%

Results of the Trial: Misclassifications

Physicians

	Discharge	Observation	Consult
Discharge	248	85	15
Observation	16	39	6
Consult	1	13	34

MET

	Discharge	Observation	Consult
Discharge	253	75	20
Observation	38	12	11
Consult	10	4	34

Naive Bayes

	Discharge	Observation	Consult
Discharge	319	12	17
Observation	56	3	2
Consult	17	5	26

Conclusions

- ❑ Rough sets turned out to be a very useful tool for analyzing medical data
 - ❑ MET offered accuracy similar to physicians using a very limited amount of data
 - ❑ MET integrated with the workflow and allowed for electronic structured data collection
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Future Research

- ❑ Identification of latent clinical attributes that would improve accuracy of MET
 - ❑ Cost-sensitive approach for inducing rules and using them for classification
 - ❑ Multi-center clinical trial with MET suggestions available to users
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Acknowledgment

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□ MET Research Team

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-

Thank You

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