

Developing a Decision Model for Asthma Exacerbations

Combining Rough Sets and Expert-driven Selection of Clinical Attributes

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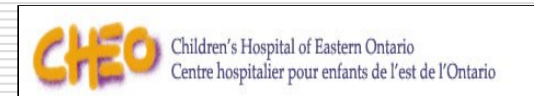
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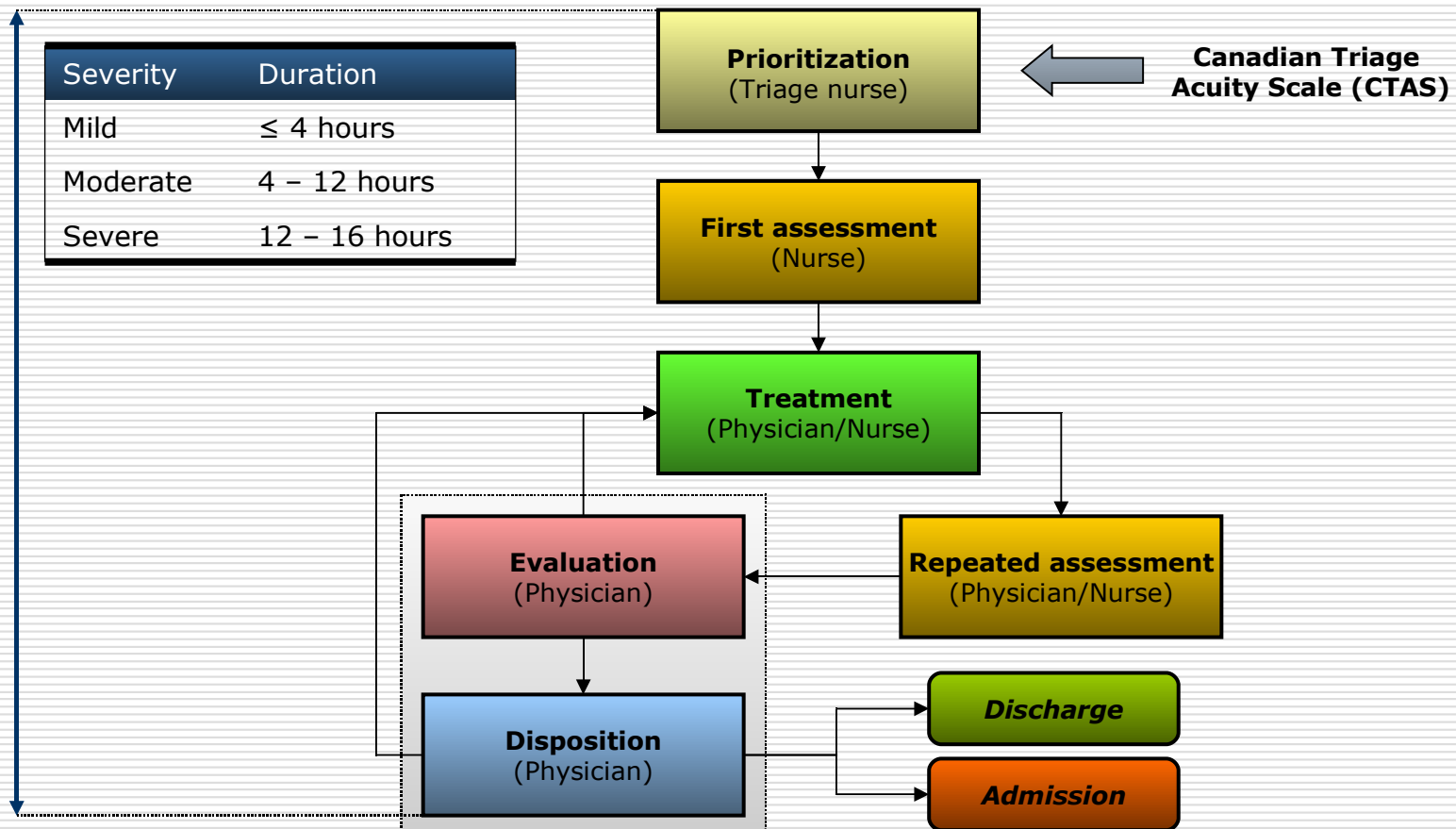
Outline

- Asthma in children and its management
- Existing clinical decision models
- Need for a new decision model
- Retrospective chart study
- Development of a decision model
- Evaluation of a decision model
- Conclusions and future research

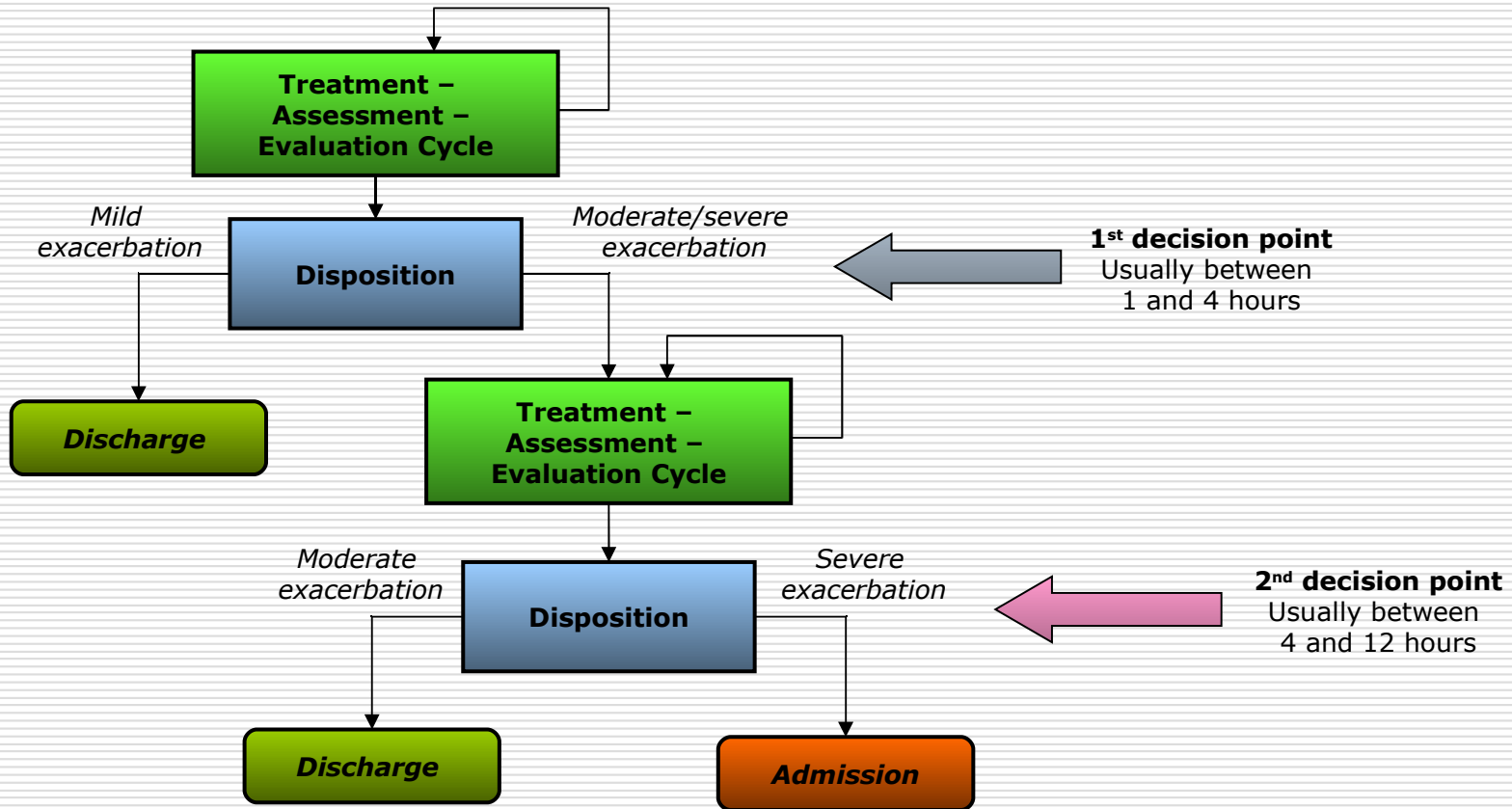
Asthma in Children

- Respiratory disease in which the airways constrict in response to some triggers (e.g., virus, animal dander, dust)
- Most common chronic disease in children (10% of Canadian population)
- Most common reason for visits to the emergency department (ED)
- Expensive – children with asthma use 3 times more prescriptions, and require 2 times as many ambulatory care and ED visits as other pediatric patients

ED Management Workflow (1)



ED Management Workflow (2)



Existing Decision Models

- Scales and severity indices (e.g., Asthma Severity Scale, Acute Asthma Index) used in clinical practice
 - Aimed at hospital management and better use of hospital resources (e.g., beds)
 - Identify the need for hospitalization – decide between severe and mild/moderate exacerbations
 - Developed for use between 1 and 4 hours (the latter, the better accuracy, as more information is available)

- Scales and indices used in more complex statistical decision models of limited clinical adoption

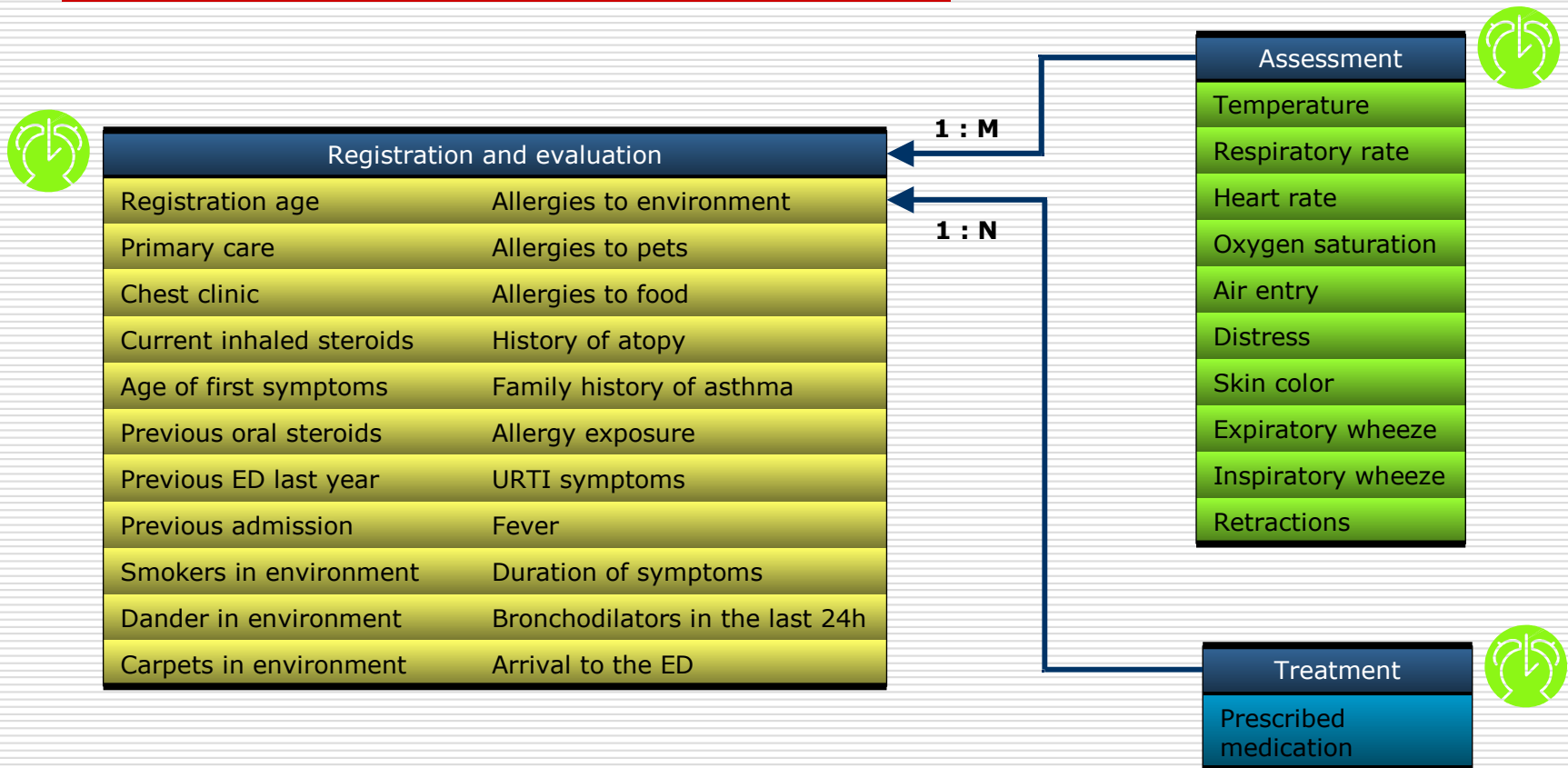
New Decision Model

- No existing model for the ED management – need for a new decision model
- Requirements for a new decision model
 - To provide support at the 1st decision point (at 2 hours)
 - To work with limited patient's information (typically available during first 2 hours after arrival to ED)
 - To be intuitive, easy to interpret and comprehend by physicians
 - To be accurate
- New decision model based on knowledge discovered from historical and verified data

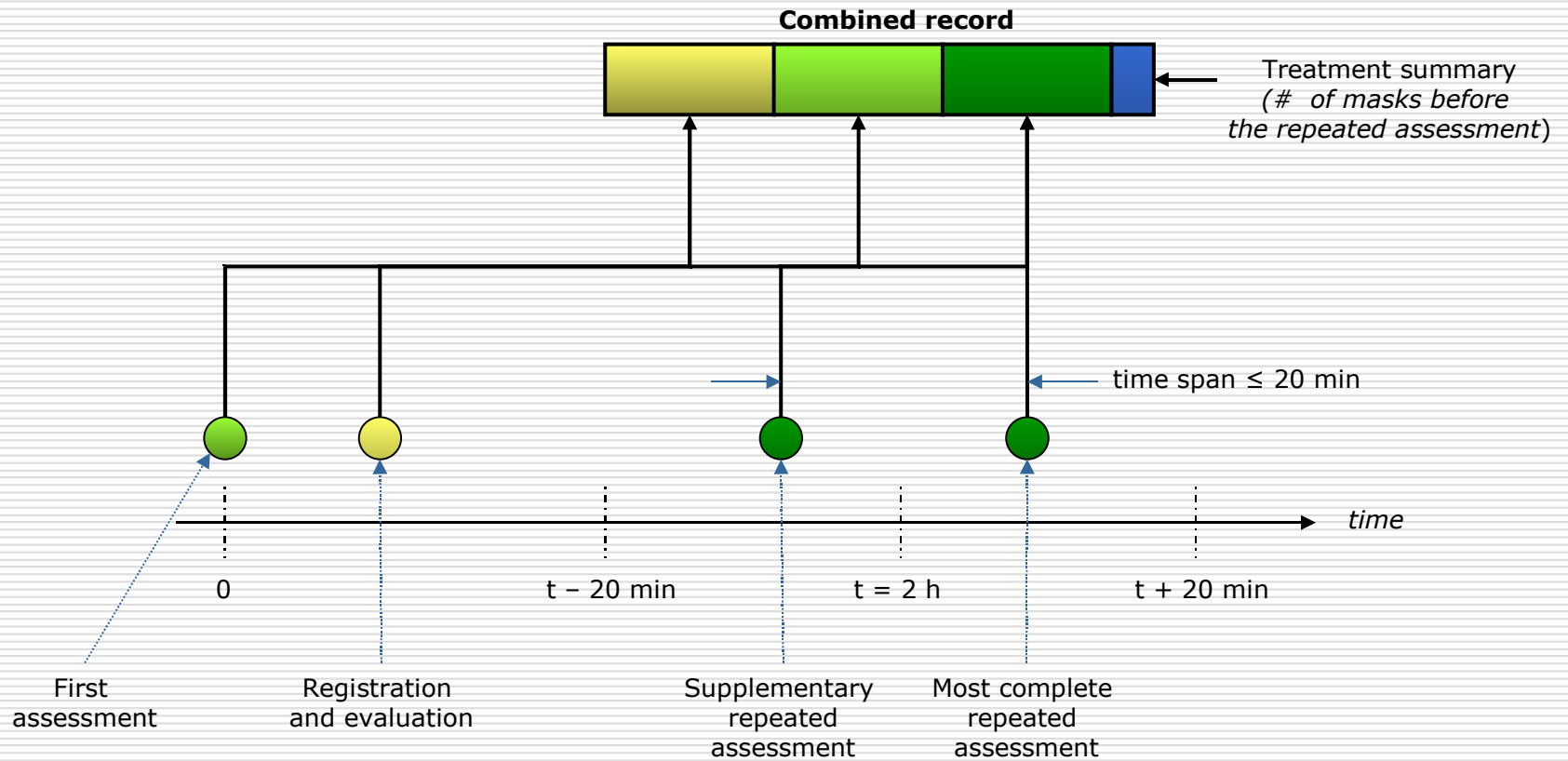
Retrospective Chart Study (1)

- Conducted in the ED at CHEO in the summer 2004
- Included patients seen in the ED in 2003 for asthma exacerbations
- Charts of included patients reviewed for all additional visits from 1/2000
- 773 visits identified between 11/2000 and 7/2004, corresponding ED charts extracted and transcribed
- A gold clinical standard (correct decision) established for all identified visits

Data Transcription and Organization



Data Preprocessing



Final Data Set

- 362 combined records
- 34 clinical attributes (9 attributes with $\geq 60\%$ of missing values excluded from analysis)
- 2 decision classes – mild and moderate/severe
- Split into learning and testing sets using the date of visit
 - Learning set – before 10/2003
 - Testing set – 10/2003 and later

	Final set	Learning set	Testing set
# of combined records	362	239	123
% of mild	45.0	41.0	52.8
% of moderate/severe	55.0	59.0	47.2

Development of a Decision Model

- Rough set theory with cumulative indiscernibility used to construct rule-based decision models
- Expert-driven approach to selection of clinical attributes used in a decision model
- 4 sets of clinical attributes leading to 4 decision models
 - **Model A** – all collected attributes
 - **Model B** – attributes collected during registration and evaluation
 - **Model C** – attributes collected during assessments combined with treatment summary
 - **Model D** – attributes from Model C and attributes from Model B as per asthma guidelines

Evaluation of a Decision Model

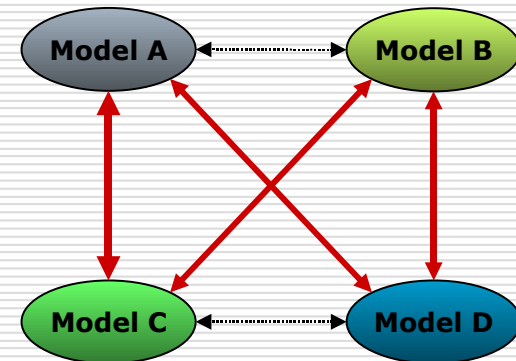
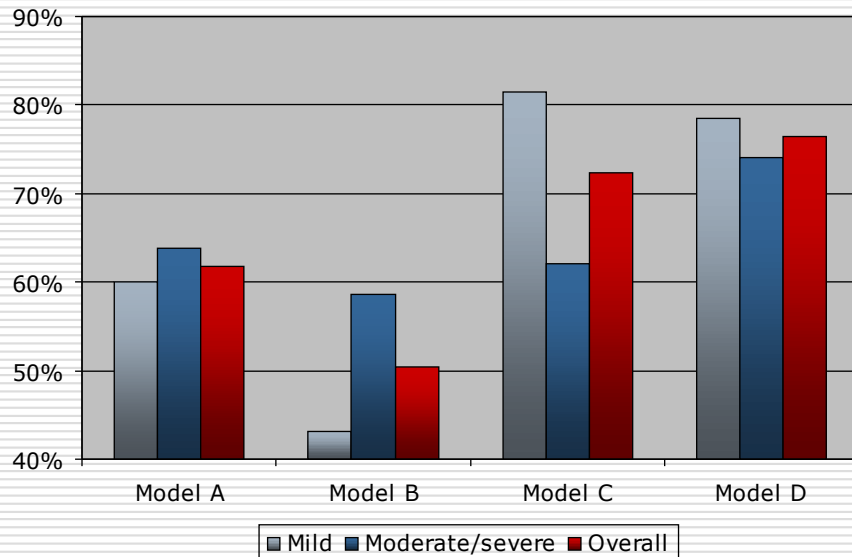
- Classification results on the testing set compared to the clinical gold standard
- Classification accuracies (overall and in both decision classes) used as performance measures
- McNemar's test used to compare paired outcomes of classifications by decision models

Results of Evaluation

Class	Model			
	A	B	C	D
Mild	60.0%	43.1%	81.5%	78.5%
Moderate/severe	63.8%	58.6%	62.1%	74.1%
Overall	61.8%	50.4%	72.4%	76.4%

	Model B	Model C	Model D
Model A	2.817	3.892	6.881
Model B		10.090	16.569
Model C			0.552

significance 0.95, threshold 3.841



Conclusions and Future Research

- ❑ Decision model based on attributes selected by the expert (Model D) offered the best performance
- ❑ Expert-driven selection of attributes should improve chances of model's acceptance in clinical practice
- ❑ Prospective study to collect better quality data
- ❑ Inclusion of tacit knowledge in the decision model
- ❑ Development of a decision model for the 2nd decision point (support for the complete management workflow)
- ❑ Implementation in the MET system and clinical trial in the ED at CHEO

Thank You

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