Predicting Disposition for Pediatric Asthma Patients

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Collaborators

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- Mark Grum, IOE MS
- Brooke Szymanski, Nursing
- Stephanie See, BSN
Agenda

• Background
• Data
• Preliminary Results
• Continuing Work
• Implications
U of M Mott Children’s Hospital

- Part of the University of Michigan Health System
- Brand new facility
- 350 Beds
- 28 Emergency Department beds
Emergency Department

Observation Protocol

Inpatient Unit

<6

<24

24+

Home

Home

Home
Emergency Department

\[ t_0 \quad t_1 \quad t_2 \quad t_3 \quad \ldots \quad t_n \]
Project Motivation

• Difficult to make disposition decisions
• Ramifications of incorrect decisions
  • ED Readmits
  • Inappropriate admissions
• Mobilization of resources
  • Many levels of coordination in the hospital system
  • Long length of stays
Objective and Approach

- Test & Treat
- Test & Treat
- Test & Treat
- ... Disposition Decision

- Admit
- Discharge

$t_0 \rightarrow t_1 \rightarrow t_2 \rightarrow t_3 \rightarrow \ldots \rightarrow t_n$

$t_{\text{predict}}$
Method of Development

- Observations
  - Pediatric Emergency Department
  - Pediatric Inpatient Unit
  - Adult Medical Observation Unit
  - Nursing

- Collaboration
  - ED Attending Physicians
  - Engineering Professors
  - Multidisciplinary research team

- Research
  - Predictive Modeling
  - Clinical Understanding and Bilingualism
Approach: Neural Networks

- Supervised Machine Learning
- Mathematical way to model how our brain learns
  - Neuron
  - Synapses
- Captures and represents complex nonlinear relationships
Neural Networks

Input Layer
Neural Networks
Neural Networks
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Data Source

• C.S. Mott Children’s Hospital ED
• Electronic Medical Record - MiChart (EPIC)
• June 2012-March 2013
• 18,000 cases
Data Variables

Demographic Variables
- Age
- Sex
- Gender
- Race
- Payer
- Acuity level
- Time of admission

Clinical Variables
- Medications given
- Medication counts
- Blood pressure
- Weight
- Temperature
- Respiratory rate
- SpO2
Population Selection

- Comparatively simple testing and treatments

Second leading cause of all pediatric ED visits

- Injury and poisoning: 7,647,000
- Respiratory disorders: 6,096,000
- Nervous system disorders: 3,383,000
- Infectious and parasitic diseases: 2,383,000
- Digestive disorders: 1,793,000
- Skin and subcutaneous tissue disorders: 1,555,000
- Mental and behavioral health conditions: 1,091,000
- Musculoskeletal disorders: 1,087,000
- Genitourinary disorders: 981,000
- Endocrine disorders: 690,000
Data Variables

Output Variable

Disposition Decision

• 0- discharge
• 1- admit
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Preliminary Results

Single Model
(all time periods)

Multiple Models
(cumulative time periods)
Preliminary Results: Single Model
(All Time Periods)

<table>
<thead>
<tr>
<th>NN Disposition</th>
<th>Actual Disposition</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>discharge</td>
<td>89%</td>
<td>164</td>
</tr>
<tr>
<td>admit</td>
<td>21%</td>
<td>77</td>
</tr>
</tbody>
</table>

Discharge: 152
Admit: 89

Actual Disposition 83% accuracy
Multiple Model Approach

- Test & Treat
- Test & Treat
- Test & Treat
- Disposition Decision

$t_0$, $t_1$, $t_2$, $t_3$, ..., $t_n$, $t_{\text{predict}}$

- Admit
- Discharge
Preliminary Results: Multiple Models
(Cumulative Time Frames)

Accuracy (%)

Time Frame (hours since admit)

2, 0.811
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Continuing Work

- Better designed feature space
- More data
- Validate with different methods:
  - SVM
  - Regularized Logistic Regression, significant variables
- Analysis on “Corrected” Disposition
- Predict Length of Stay (LOS) as output:
  - Better aid to disposition decision ~ observation unit candidates
- Expanding to include other patient populations
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Implications

• Earlier disposition prediction = earlier mobilization of resources
  • Patients that should go home will go some sooner and free up beds for other patients in need
  • Very sick patients will get treatment at the appropriate level of care faster

• Accurate prediction of disposition can result in better patient outcomes
  • Fewer readmissions
  • Fewer inappropriate admissions
Acknowledgment

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CHEPS and the HEPS Master’s Program

• **CHEPS:** The Center for Healthcare Engineering and Patient Safety

• **HEPS:** Industrial and Operations Engineering (IOE) Master’s Concentration in Healthcare Engineering and Patient Safety offered by CHEPS

• CHEPS and HEPS offer unique multidisciplinary teams from engineering, medicine, public health, nursing, and more collaborating with healthcare professionals to better provide and care for patients

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Questions

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