Improving Patient Flow at C.S. Mott Children's Hospital

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Agenda

• Patient flow: ED and Inpatient Settings
• Asthma Patients
• Neural Networks

• Ongoing and Future Work
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Patient Flow at Mott

Emergency Department

Observation Protocol

Inpatient Unit

<24

<24

24+

Home

Home
Patient Flow at Mott

• In the ED patients can stay up to 24 hours
• So at the 23rd hour latest, the doctor has to make a disposition decision
  • Admit: send to the inpatient unit
  • Discharge: send them home
• As deadline approaches, it’s harder to make the decision for certain patients
Patient Flow at Mott + Our work

• Main issue: Wrong disposition decision can lead to patient readmissions and inappropriate admissions

• Our work:
  • Help doctors make disposition decisions
  • Use available data to predict disposition decisions
  • Case Study: Asthma Patients
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Asthma

Chronic Lung Disorder - airway inflammation and constriction

• Causes: allergens, genetics, viruses
• Characteristics: airway edema, accumulation of mucus in the lungs, and bronchoconstriction
• In Children:
  • more prone to respiratory failure than adults
  • Respiratory arrest often precedes cardiac arrest
Why Asthma Patients?

Second leading cause of all pediatric ED visits
Why Asthma?

• Patients are “easier” to identify
• Patients have straightforward list of treatments
• Patients take longer than standard ED visits, possible observation unit candidates
• Clinical collaborator support of Dr. Michelle Macy and Dr. Allison Cator at UMHS
  • Clinical Insights
  • Access to data
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Neural Networks Intro

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

Input Layer
Neural Networks

Input Layer

Hidden layer

W
Neural Networks

Input Layer

Hidden layer

Output Layer

$W$

$W'$
Neural Networks

• NN toolbox in **Matlab**
  • Training 70% - used for training
  • Validation 15% - stops training once networks learns
  • Test 15% - not used in training, independent set

• Use network to predict outputs of new data set (~300 samples) and compare with actual outputs
Neural Networks: Data

Input Variables

- Age
- Sex
- Gender
- Race
- Payer
- Acuity Level
- Time of admission
- Medications given
- Rate of Change of Vital Signs: Pulse Oximetry, Temperature, Respiratory Rate, SpO2

June 2012- March 2013
~2,000 samples of respiratory patients
MiChart Mott ED
Neural Networks: Data

“Correct” Disposition Decision
- NN predicted values are continuous
- Threshold of 0.5
- Mapped to binary values
  - 0 - discharge
  - 1 - admit
## Results: Neural Network

<table>
<thead>
<tr>
<th>Data “correct”</th>
<th>Discharge</th>
<th>Admit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharge</td>
<td>93.1%</td>
<td>6.9%</td>
</tr>
<tr>
<td>Admit</td>
<td>55.4%</td>
<td>44.6%</td>
</tr>
</tbody>
</table>
## Results: Data Analysis

| Data “correct” | Doctors |  |  |
|----------------|---------|------------------|
|                | Discharge | Admit             |
| Discharge      | 92.6%     | 7.4%              |
| Admit          | 14.4%     | 85.6%             |
# Results Aggregated

<table>
<thead>
<tr>
<th>Data &quot;correct&quot;</th>
<th>Neural Network</th>
<th>Doctors</th>
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Results

• Doctors are better than our model
• BUT, If model can strongly predict the disposition of the patient, it can aid the admit discharge decision that doctor makes, in real time
• Thus, more appropriate care for the patient
  • Reduce readmissions
  • Reduce inappropriate admissions
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Next Steps: Neural Networks

• Better input variables to fine tune model
• More data
• Validate with different methods:
  • Regression, find significant variables
• Predict Length of Stay (LOS) as output:
  • Better aid to disposition decision ~ observation unit candidates
Next Steps: Simulation Model

Emergency Department $\xrightarrow{<24}$ Observation Unit $\xrightarrow{<24}$ Inpatient Unit $\xrightarrow{24+}$ Home
Remarks

• Not just for asthma patients, but can look at other populations in the future
Thank you!
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