Using Computational Modeling For Assessing and Improving Operational Management at Michigan Medicine Emergency Department

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What is the optimal throughput model of patients in the Michigan Medicine ED?
# Solutions for Crowding

## Physician in Triage
Skilled personnel at Triage shown to increase efficiency:
- Nurse
- Physician’s Assistant
- Attending

## Fast Track
Streamlined treatment of non-urgent patients:
- Recently, widely adopted
- Typically staffed by senior staff
- Selectively implemented during peak traffic

## Vertical Treatment
Waiting rooms for mid-acuity (ESI 3) patients:
- Less bed utilization
- Allows for ESI escalation
Patient ED journey pathway without vertical flow

WITHOUT VERTICAL FLOW

- Intake
- Triage
- Eval/Treatment
- Discharge/Admission
Patient ED journey pathway with vertical flow

WITH VERTICAL FLOW

Intake → Triage → Eval/Treatment → Discharge/Admission

ESI 1, 2, 4, 5

ESI 3

Vertical Flow Area → Discharge/Admission

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Implementation Pathway:

Data Gather

Patient Level Data
- ESI levels
- Timestamps
  - LOS
  - TTP

ED Flow Data
- Vertical treatment zone scheme

Modeling

Build
- Ensure proper inputs and outputs
- Incorporate data gathered

Validate
- Compare model outcomes with known outcomes

Presentation

Provide Final Results
- Optimal size
- Impact on time and money saved

Deeper Dive
- Potential U of M collaborations
- Student Involvement
- Professional modeling and consulting
## Patient Flow Modeling Options (Wiler et. al. 2011)

<table>
<thead>
<tr>
<th>Modeling Type</th>
<th>Description</th>
<th>Ability to Forecast ED Crowding</th>
<th>Ability to Predict Process Improvement Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Formula-Based</strong></td>
<td>Past experiences of ED flow used to posit formulas</td>
<td>Poor</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Regression-Based</strong></td>
<td>Statistically predicts dependent variables based on independent variables</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td><strong>Time-Series Analysis</strong></td>
<td>Statistically uses recent past performance to predict current and immediate future performance</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td><strong>Queuing Theory</strong></td>
<td>Mathematical formulas derived from system principles, utilizes many underlying assumptions</td>
<td>Poor</td>
<td>Good</td>
</tr>
<tr>
<td><strong>Discrete-Event Simulation</strong></td>
<td>Computer-generated model used to sample inputs and generate outputs, *most frequently used in literature</td>
<td>Fair</td>
<td>Good</td>
</tr>
</tbody>
</table>
Preliminary Results:

(Simulated) Current Bed Occupancy

(Simulated) Vertical Treatment Zone Impact

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Our Team

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