Simulated Co-Location of Patients Admitted to an Inpatient Internal Medicine Teaching Unit
Potential Impacts on Efficiency and Physician-Nurse Collaboration

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Overview

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2 Definition of Problem

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4 New Metrics of Interest

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7 Summary
Hospital Unit

London Health Sciences Center
University Hospital Campus
Internal Medicine Inpatient Teaching Unit
### Staffing Levels

<table>
<thead>
<tr>
<th>Shift</th>
<th>Three Physician Teams</th>
<th>Nursing Staff</th>
</tr>
</thead>
</table>
| **Day Shift**| 1 Attending Physician  
               1-2 Senior Residents  
               2-4 Junior Residents  | 4 Patients per Nurse   |
| **Night Shift**| 1 Attending Physician  
                            1 Senior Resident     | 6 Patients per Nurse   |
Definition of Problem

Goal 1

Reduce the number of physician team members that a nurse must interact with when reporting on their patients.
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Goal 2
Reduce variance in the number of patients between the three teams at daily census times.
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Goal 1
Reduce the number of physician team members that a nurse must interact with when reporting on their patients.

Goal 2
Reduce variance in the number of patients between the three teams at daily census times.

Constraint
Avoid a significant impact on patients in the emergency department while maintaining current staffing levels.
Modelling Patient Flow

- Inter-Admission Time
- Decision to admit to medicine
  - Admission Location
  - LOS
  - Precautions / Acuity
  - Team Assignment
- Move patient to decant bed
- Clean Bed
- Move patient to medicine bed
- Discharge Patient
- Move patient to off-service bed
- Nursing Rounds
  - Day vs Night
  - RN vs RPN
## Performance Metrics

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>Observed Value</th>
<th>Simulation 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting Time</td>
<td>6.4</td>
<td>(6.7, 7.4)</td>
</tr>
<tr>
<td>Admitted Patients Waiting</td>
<td>3.4</td>
<td>(3.0, 3.3)</td>
</tr>
<tr>
<td>Floor Utilization</td>
<td>94.8%</td>
<td>(94.3%, 95.2%)</td>
</tr>
<tr>
<td>Medicine Utilization</td>
<td>83.5%</td>
<td>(82.1%, 83.2%)</td>
</tr>
</tbody>
</table>
New Metrics

Definition (Patients Per Nurse)

$$PPN = \frac{\# \text{ Patients assigned to a team}}{\# \text{ Nurses assigned to those patients}}$$

- A measure of the number of nurses each physician team interacts with, normalized for the number of patients the team has.

- Optimally want to maximize this value for each team.
Patients Per Nurse (PPN)

<table>
<thead>
<tr>
<th>Time of Observation</th>
<th>Simulation 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start Day</td>
<td>(1.49, 1.51)</td>
</tr>
<tr>
<td>End Day</td>
<td>(1.46, 1.48)</td>
</tr>
<tr>
<td>Start Night</td>
<td>(1.80, 1.82)</td>
</tr>
<tr>
<td>End Night</td>
<td>(1.84, 1.87)</td>
</tr>
</tbody>
</table>
New Metrics

Definition (Team Census Variance)

$$TCV = \frac{\sum_{\text{Physician teams}} (\text{Team Census} - \text{Avg Census})^2}{3}$$

- A measure of how equally the patients are distributed among the teams.
- Optimally want to minimize this value.
### Team Census Variance (TCV)

<table>
<thead>
<tr>
<th></th>
<th>Observed Value</th>
<th>Simulation 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCV</td>
<td>7.36</td>
<td>(6.02, 6.71)</td>
</tr>
</tbody>
</table>
Proposed Changes

Bed Assignment

- Each bed is assigned a team, and may only hold patients from that team.
- Once a patient is assigned a bed, they must remain there for the duration of their stay.
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Bed Assignment

- Each bed is assigned a team, and may only hold patients from that team.
- Once a patient is assigned a bed, they must remain there for the duration of their stay.

Team Assignment

- Primarily, patients receive the first available bed.
- Secondarily, patients are assigned to the team with the least number of patients.
Bed Assignment

FOURTH FLOOR

Team C

Team B

Team A
Team Assignment

Weekly Average Census by Team for Reference Version

- Team A
- Team B
- Team C

Weekly Average Census by Team for Lowest Census Version

- Team A
- Team B
- Team C

Average Morning Census

Week
## Performance Metrics

<table>
<thead>
<tr>
<th>Performance Metric</th>
<th>Reference Simulation</th>
<th>Co-location 95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waiting Time</td>
<td>7.1</td>
<td>(6.8, 7.4)</td>
<td>&gt; 0.05</td>
</tr>
<tr>
<td>Admitted Patients Waiting</td>
<td>3.1</td>
<td>(3.0, 3.3)</td>
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<td>Floor Utilization</td>
<td>94.7%</td>
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<td>Medicine Utilization</td>
<td>82.7%</td>
<td>(82.2%, 83.1%)</td>
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## Results

### Patients Per Nurse (PPN)

<table>
<thead>
<tr>
<th></th>
<th>Start Day</th>
<th>End Day</th>
<th>Start Night</th>
<th>End Night</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Simulation</td>
<td>1.5</td>
<td>1.5</td>
<td>1.8</td>
<td>1.9</td>
</tr>
<tr>
<td>Team A</td>
<td>3.2</td>
<td>3.1</td>
<td>4.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Team B</td>
<td>3.2</td>
<td>3.1</td>
<td>4.4</td>
<td>4.7</td>
</tr>
<tr>
<td>Team C</td>
<td>3.3</td>
<td>3.1</td>
<td>3.9</td>
<td>4.1</td>
</tr>
<tr>
<td>Optimal PPN</td>
<td>3.4</td>
<td>3.4</td>
<td>5.1</td>
<td>5.1</td>
</tr>
</tbody>
</table>
## Results

### Team Census Variance (TCV)

<table>
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<tr>
<th>Reference</th>
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<tbody>
<tr>
<td>TCV</td>
<td>6.37</td>
<td>(0.40, 0.43)</td>
</tr>
</tbody>
</table>
Goal

- Maximize patients per nurse and minimize team census variance.
Summary

Goal

- Maximize patients per nurse and minimize team census variance.

Solution

- Assign a team to each bed so that team nurses are co-located.
- Assign patients to the team with the lowest census when possible.