Using Computerized Simulation to Improve the Assigning of Surgical Residents to Training Opportunities

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Transplant Surgery at UMHS

• 2-year Fellowship in Section of Thoracic Surgery
• 2 junior + 2 senior fellows each year
• Q4 call schedule
• UNOS Certification Requirements:
  – 20 heart transplants
  – 15 lung transplants
If a program has 4 fellows on a Q4 call schedule and expects 40 transplants per year, the probability that each fellow participates in at least 10 transplants within a year (to be on track for 20 in 2 years) is...

~5%.
Motivation

• 3 of 10 deaths due to cardiovascular disease or COPD in the United States
• Medicare population expected to double by 2030
• Aging cardiothoracic (CT) surgeons
  – Mean age: 55 years old
  – 65% (lung) and 70% (heart) are 51+ years old
• Decreasing number of CT surgeons nationally
  – 2004-08: 26% decline in CT fellows
  – 2010: fewer applicants than positions (93/116)
**Residency/Fellowship:** graduate medical training required for certification to practice independently

**Call Schedule:** schedule of residents/fellows responsible for covering emergency operations

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<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
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<td>3</td>
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<td>29</td>
<td>Chen</td>
<td>30</td>
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Medical School: 4 years
Residency: 3 – 7 years
Fellowship: 2 – 3 years
Independent Practice
Our Approach

• Analyze historical data (Jan. 2009 – May 2011)
  \[ IAT(\text{transplants}) \sim \text{Exponential}(\lambda=0.10) \]
  \[ \text{Transplants/year} \sim \text{Poisson}(\lambda=40) \]

• Simulate occurrences of transplants
• Match occurrences to call schedule
• Assess performance and generate graphical reports for medical personnel to inform decision-making
Simulator: User Inputs

- Number of fellows (4)
- Expected number of transplants per year (40)
- UNOS certification requirement (10)
- Duration of fellowship in days (365)
- Rotation method (Q4 call schedule)
- Number of repetitions (1 – 100,000)
- Advanced settings

(default, canonical settings)
Graphical Outputs: One Repetition

Day of Year

Transplants

Fellow 1: 13
Fellow 2: 10
Fellow 3: 7
Fellow 4: 10
Unassigned: 2

Unassigned: 5%
Fellow 4: 24%
Fellow 3: 16%
Fellow 2: 31%
Fellow 1: 31%
Another Try

Transplants

<table>
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<tr>
<th>Fellow</th>
<th>Transplants</th>
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<tbody>
<tr>
<td>Fellow 1</td>
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<td>Unassigned</td>
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</table>
Graphical Outputs: 100,000 Repetitions

Mean Number of Fellows Certified = 1.91

Number of Fellows Certified

Percentage of Repetitions

- 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Number of Fellows Certified

- 0
- 1
- 2
- 3
- 4

Percentage

- 7.3%
- 27.4%
- 37.4%
- 22.6%
- 5.3%
Implications: Potential System Changes

• Change certification policies
  – Surgical simulator certification
  – Proficiency-based certification

• Try alternative scheduling paradigms
  – On call until procedure
  – On call until certified
Mean Number of Fellows Certified = 1.94
100,000 Repetitions: On Call Until Certified

Mean Number of Fellows Certified = 3.32

Number of Fellows Certified

Percentage of Repetitions

0.0% 0.0% 7.1% 53.9% 38.9%
Conclusions

• We can use simulation to assess program performance
• Alternative scheduling paradigms may increase the rate of certification for cardiothoracic transplants at UMHS, but feasibility is a concern
• UMHS should not expect to adequately train all fellows for cardiothoracic transplants in most years
Current Efforts and Future Work

• Redesign the simulator to incorporate:
  – Other procedure types (scheduled and unscheduled)
  – Other distributions to describe procedure arrivals
  – ACGME work-hour restrictions
  – Fellow characteristics (junior vs. senior, etc.)
  – More fellow-to-procedure matching paradigms

• Assess other residency/fellowship programs at UMHS and partner institutions

• Build optimization models
Collaborators

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Questions / Comments

The simulator can be found at: transplantsimulator.herobo.com.

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