Scheduling Residents to Achieve Adequate Training on Procedures with Random Occurrences

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Overview

- Motivation
- Graduate Medical Education
- Transplant Surgery at UMHS
- Ask the Audience
- Simulator Walkthrough
- Conclusions
- Current Efforts and Next Steps
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

Medical School: 4 years
Residency: 3 – 7 years
Fellowship: 2 – 3 years
Independent Practice

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

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Transplant Surgery at UMHS

- 2-year Fellowship in Section of Thoracic Surgery
- High-volume training program
- 2 junior + 2 senior fellows each year
- Q4 call schedule
- Beyond scope of core program requirements
- 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, what is the probability that each fellow participates in at least 10 transplants within a year?

A) 5%
B) 25%
C) 45%
D) 65%
E) 85%
Answering the Question

• 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 transplants occurrences
• 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: A Single Repetition

Day of Year

Transplants

Fellow 1 8
Fellow 2 8
Fellow 3 8
Fellow 4 14
Unassigned 1

Categorical Analysis

CATEGORY NAME [PERCENTAGE]
Graphical Outputs: 100,000 Repetitions

Mean Number of Fellows Certified = 1.91
Implications: Potential System Changes

- Reduce program size **✗**
- Increase program case volume **✗**
- Change certification policies **✓**
  - Surgical simulator certification
  - Proficiency-based certification
- Try alternative scheduling paradigms **✓**
  - On Call Until Procedure
  - On Call Until Certified
100,000 Repetitions: On Call Until Procedure

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:
- 0: 0.0%
- 1: 0.0%
- 2: 7.1%
- 3: 53.9%
- 4: 38.9%
Conclusions

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

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

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