



Scheduling Surgical Fellows to Achieve Adequate Training on Procedures with Random Occurrences: An Evaluation

William Pozehl BSE¹, Amy Cohn PhD¹, Rishi Reddy MD², Jake Seagull PhD³, Mark Daskin PhD¹, Ryan Chen¹
 1. Department of Industrial and Operations Engineering, 2. Department of Surgery, 3. Department of Medical Education

Introduction

Heart and lung disease are the 1st and 3rd leading causes of death in America¹. These diseases especially afflict the elderly, a population expected to double by 2030². Heart or lung transplantation may be necessary for end-stage patients. However, a majority of the trained cardiothoracic (CT) surgeons that perform these transplants are nearing retirement. Furthermore, we trained 26% fewer new CT surgeons nationally from 2004 to 2008³. A 2010 report comparing supply of and demand for CT surgeons projected a shortage of these physicians by 2020³. Efficacious training of new CT transplant surgeons is imperative to combat these challenges. We seek to evaluate the performance of such a training program in this regard.

Graduate Medical Education

Becoming a CT surgeon requires many years of training. Medical school graduates that want to become CT surgeons must first complete a General Surgery residency followed by a Thoracic Surgery fellowship. Having completing these programs, certified CT surgeons may practice independently. This career trajectory is shown below.



Figure 1. Career trajectory for a cardiothoracic (CT) surgeon. Our research focuses on evaluating program performance at the fellowship stage.

During fellowship, training physicians must satisfy numerous requirements subject to work-hour restrictions. An important requirement is working a call schedule to cover emergency operations, including transplants. An example call schedule is shown below.

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1 Chen	2 Jones	3 Smith	4 Reddy	5 Chen	6 Jones
7 Smith	8 Reddy	9 Chen	10 Jones	11 Smith	12 Reddy	13 Chen
14 Jones	15 Smith	16 Reddy	17 Chen	18 Jones	19 Smith	20 Reddy
21 Chen	22 Jones	23 Smith	24 Reddy	25 Chen	26 Jones	27 Smith
28 Reddy	29 Chen	30 Jones	31 Smith			

Figure 2. Call schedules are commonly used to assign responsibility of handling emergency cases. In Q4 call schedules like this one, each fellow is on call every 4th day. Q4 call schedules are

Methods

We assessed the performance of the Fellowship in Thoracic Surgery at the University of Michigan Health System (UMHS) with respect to adequately training its fellows for heart and lung transplantation by:

- Analyzing transplant historical data (Jan. '09 – May '11)
- Simulating transplant arrivals
- Matching transplants to the on call fellow
- Generating graphical reports

We developed a simulator tool to perform steps 2 – 4 rapidly under various input parameters.

Results

Sample single- and multiple-repetition simulation outputs are shown in Figures 3 and 4, respectively.

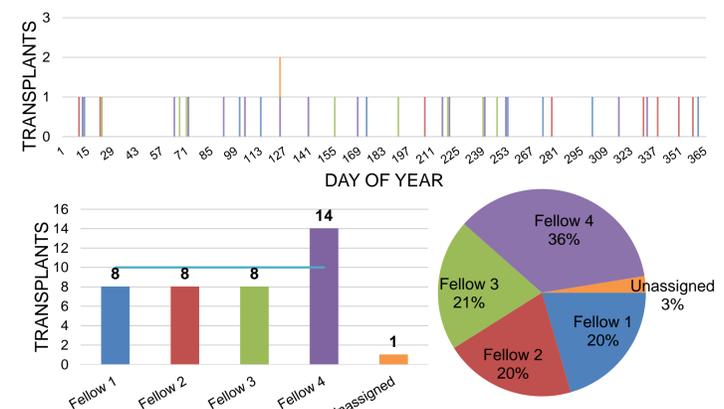


Figure 3. For single repetitions, the simulator generates three representations of the distribution of transplants in time and amongst the fellows, including a timeline for which color indicates fellow assignment, a bar chart with indicated certification requirements, and a pie chart.

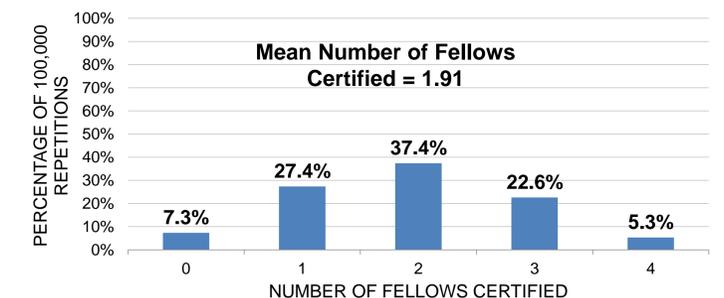


Figure 4. For multiple repetitions, the simulator generates a discrete probability distribution illustrating the probability of adequately training each number of fellows, overlaying the chart with the mean number adequately trained.

Conclusions

The simulator tool may be used to evaluate program performance. In the specific case of training fellows for cardiothoracic transplants, the UMHS should expect to certify all its fellows only about 5% of the time under current conditions. On average, the program is expected to certify fewer than half of the fellows in a given year. These results imply potential system changes, including:

- Program size reduction
- Case volume expansion
- Call schedule alternatives
- Certification policy changes

The simulator may be used to evaluate the effects of the first two potential changes by changing input parameters appropriately. The simulator also has the capability to test some theoretical alternative call schedules, including staying on call until receiving a single transplant opportunity or until receiving the number necessary for certification. Though the simulator is designed for assessing certification with respect to transplants, it may also be applied to other operations with random arrivals but fixed physician schedules.

Acknowledgements

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For more information, contact Professor Amy Cohn, Associate Director of the Center for Healthcare Engineering and Patient Safety (amycohn@med.umich.edu).