

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)

Projected Shortage by 2020

Graduate Medical Education

Residency/Fellowship: graduate medical training required for certification to practice independently

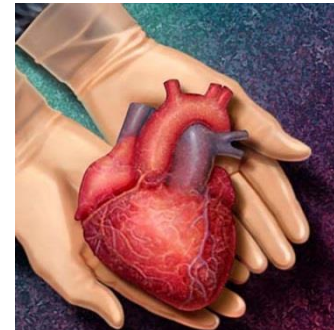


Call Schedule: schedule of residents/fellows responsible for covering emergency operations

Sun	Mon	Tue	July 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			

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



Ask the Audience

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)

$$IAT(\text{transplants}) \sim \text{Exponential}(\lambda=0.10)$$



$$\text{Transplants/year} \sim \text{Poisson}(\lambda=40)$$

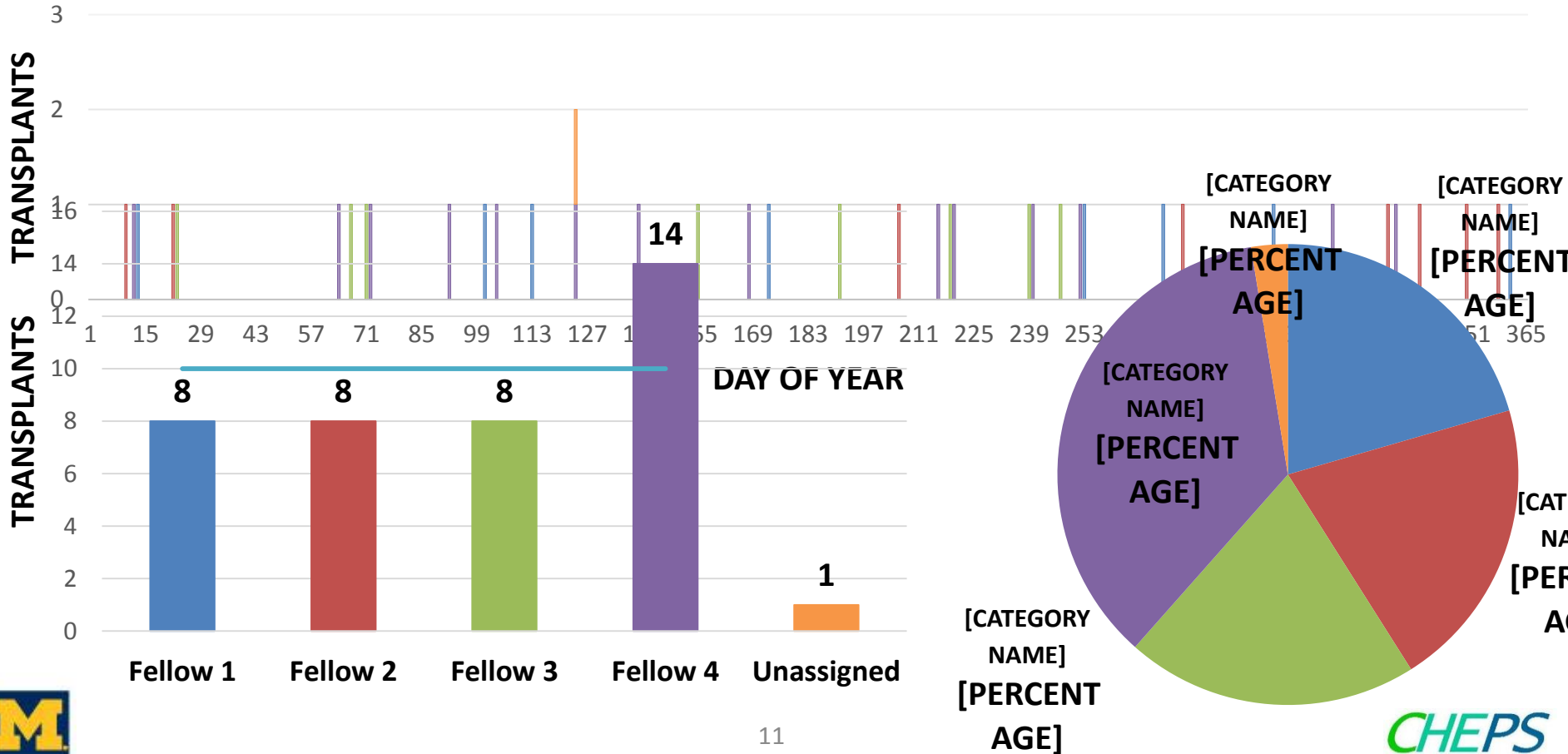
- Simulate transplants occurrences
- Match occurrences to call schedule
- Assess performance and generate graphical reports for medical personnel to inform decision-making

Simulator: User Inputs

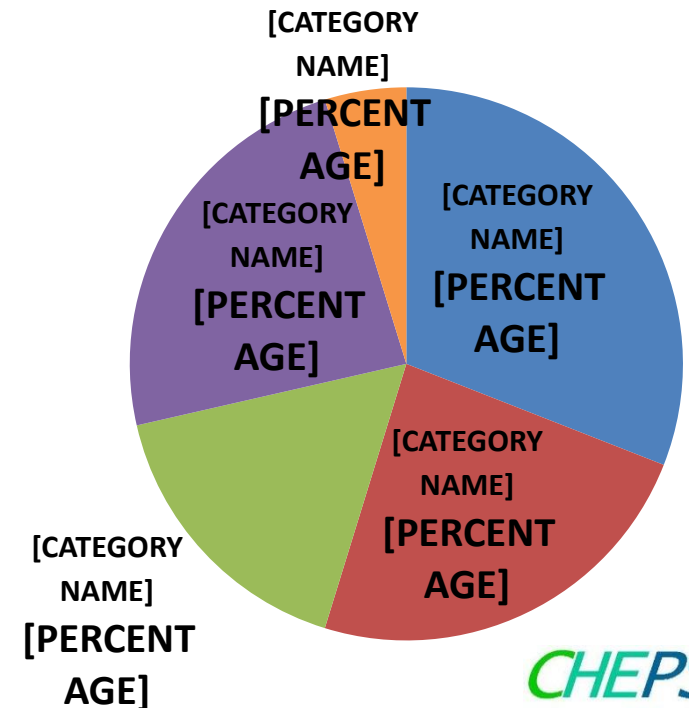
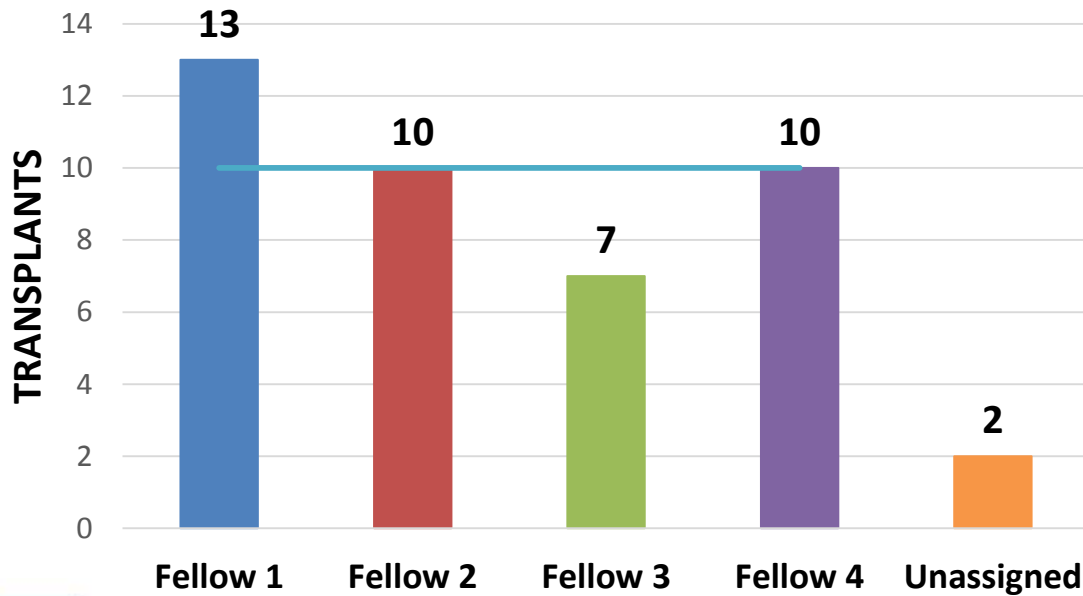
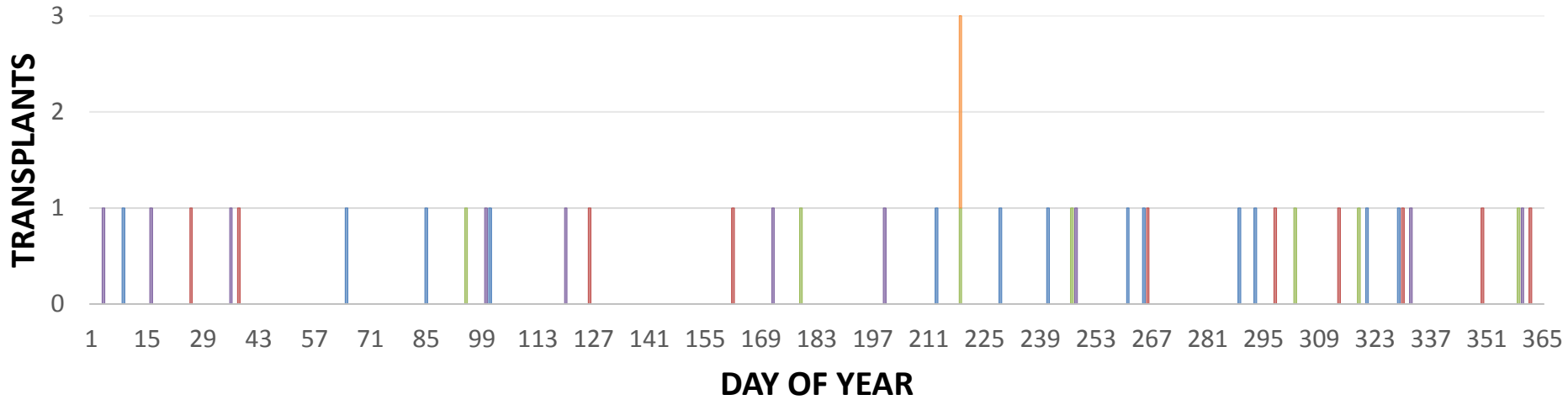
- Number of fellows (4)
- Expected number of transplants per year (40)
- UNOS certification requirement (10)
- Duration of fellowship in days (365)
- Rotation method (*Q4 call schedule*)
- Number of repetitions (1 – 100,000)
- Advanced settings

(default, canonical settings)

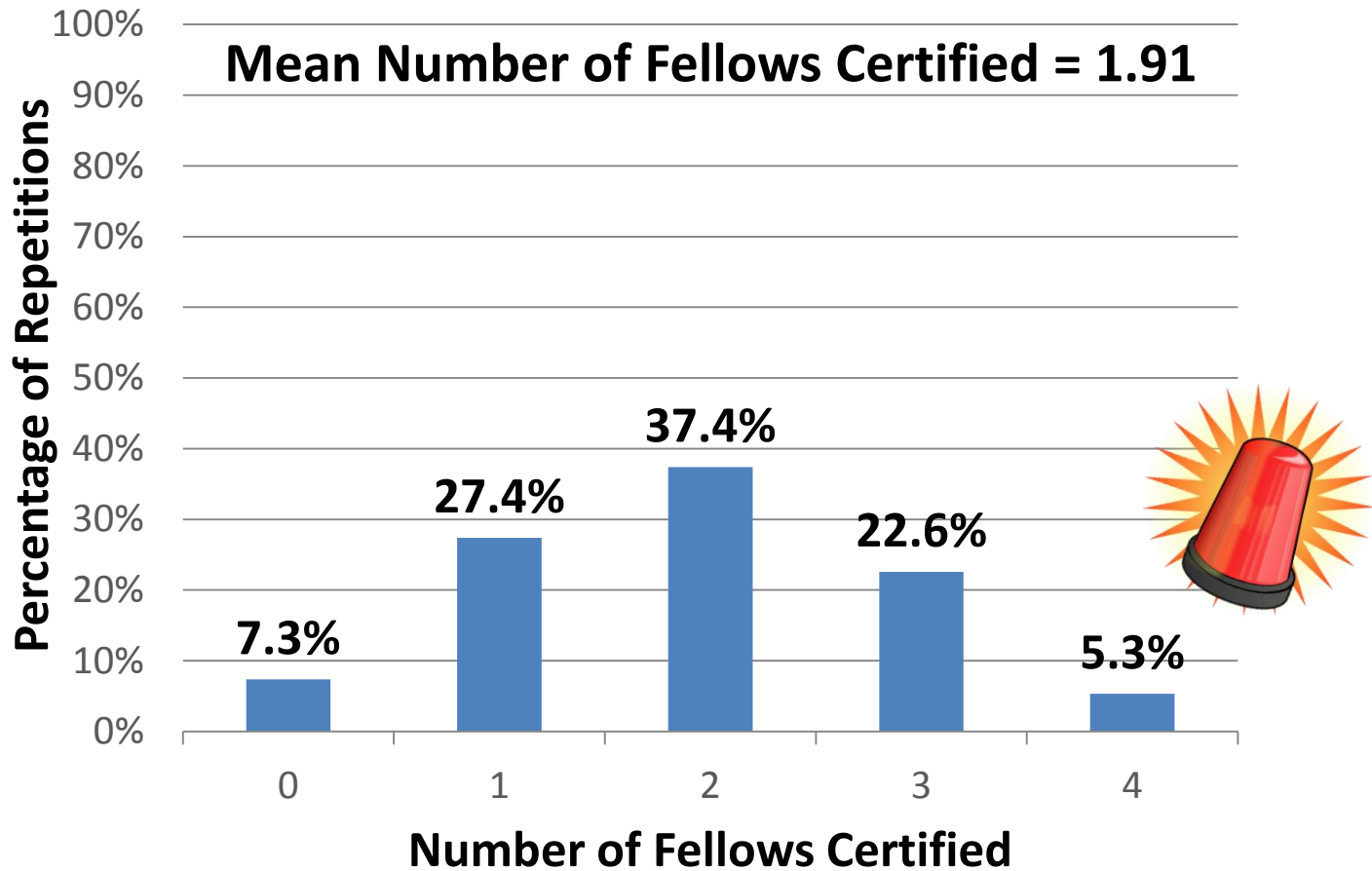
Graphical Outputs: A Single Repetition







Graphical Outputs: Another Repetition



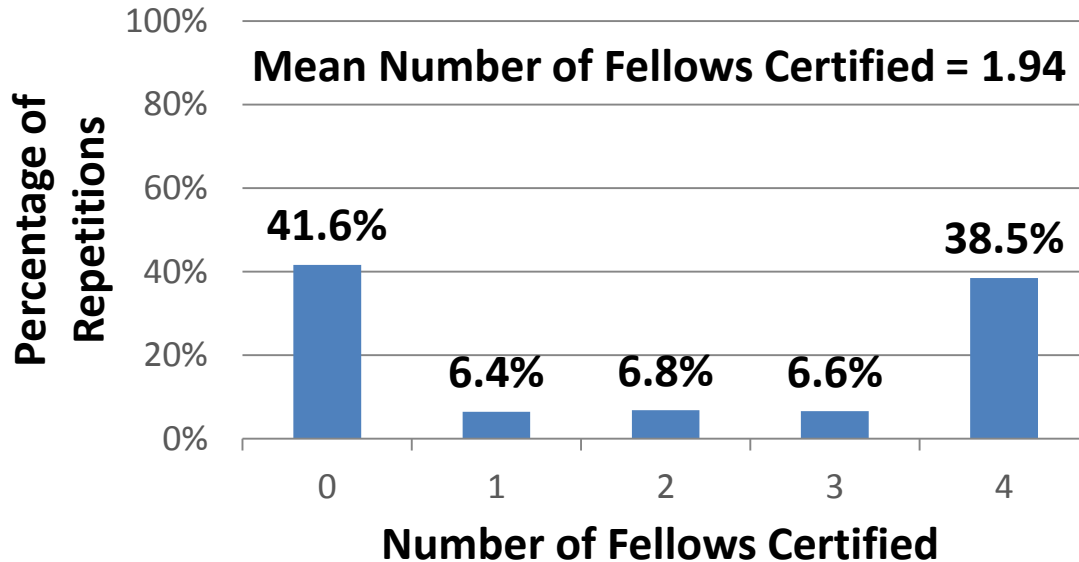
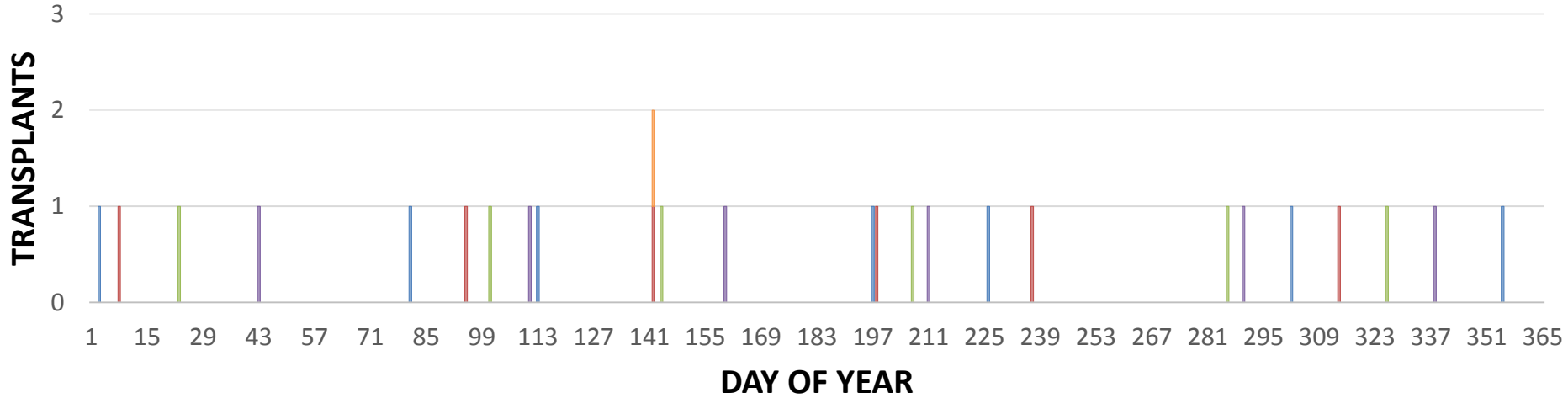
Graphical Outputs: 100,000 Repetitions



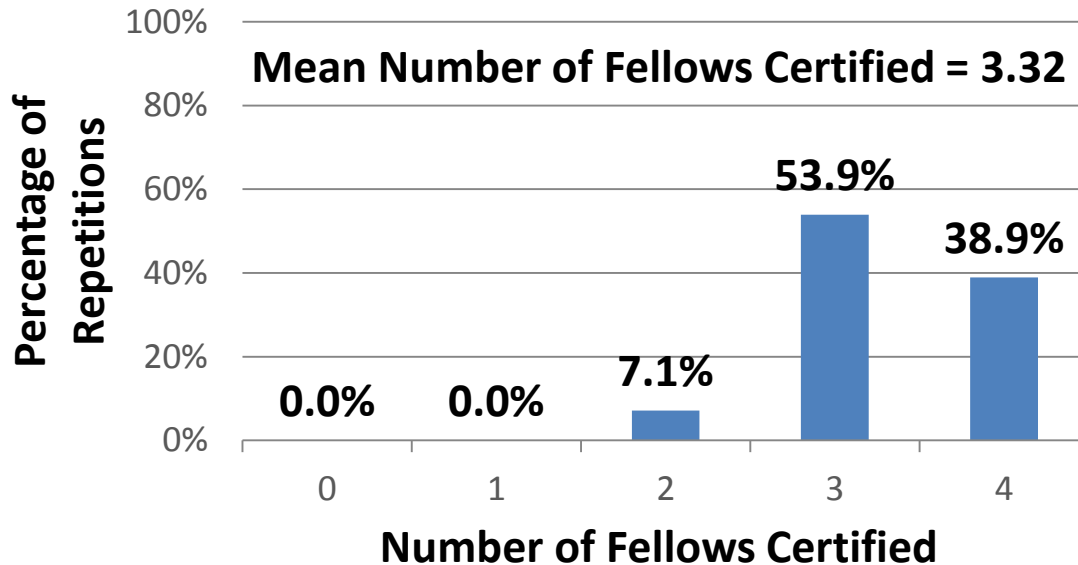
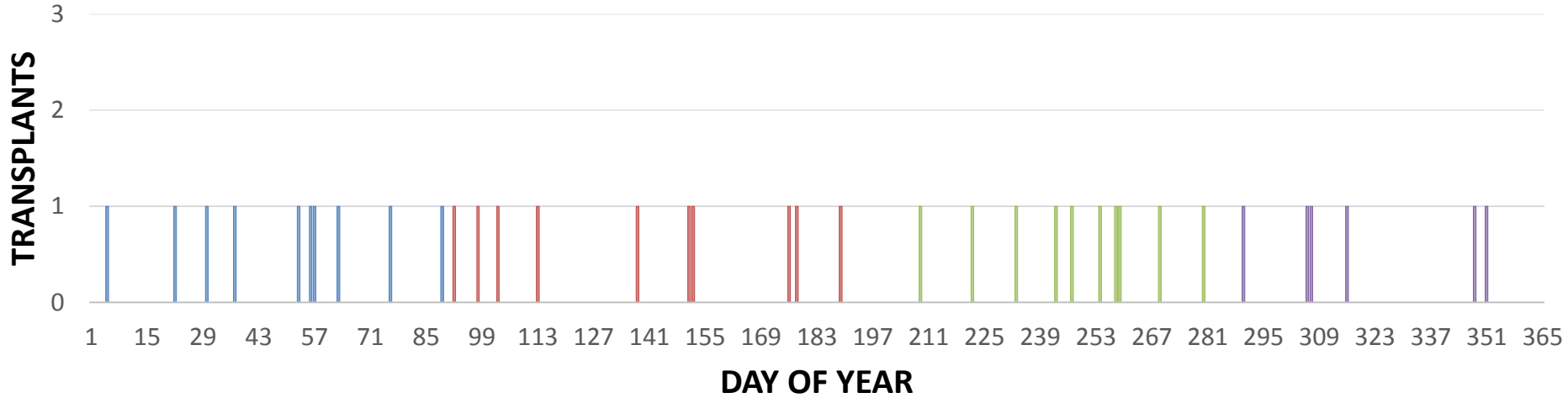
Implications: Potential System Changes

-  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

100,00 Repetitions: On Call Until Procedure



100,00 Repetitions: On Call Until Certified



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

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

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