Scheduling Fellows to Achieve Adequate Training on Procedures with Random Occurrences
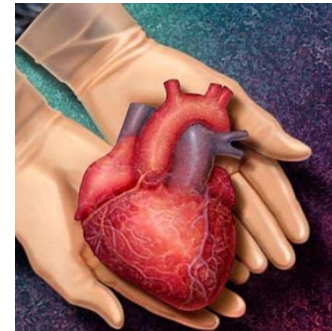
Ryan Chen, B.S.E.

University of Michigan

June 2, 2014

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%.

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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)

Graduate Medical Education

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

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

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

July

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			

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Our Approach

- Analyze historical data (Jan. 2009 – May 2011)

  IAT(transplants) ~ Exponential(λ=0.10)

  $\updownarrow$

  Transplants/year ~ Poisson(λ=40)

- Simulate occurrences of transplants

- Match occurrences to call schedule

- Assess performance and generate graphical reports for medical personnel to inform decision-making

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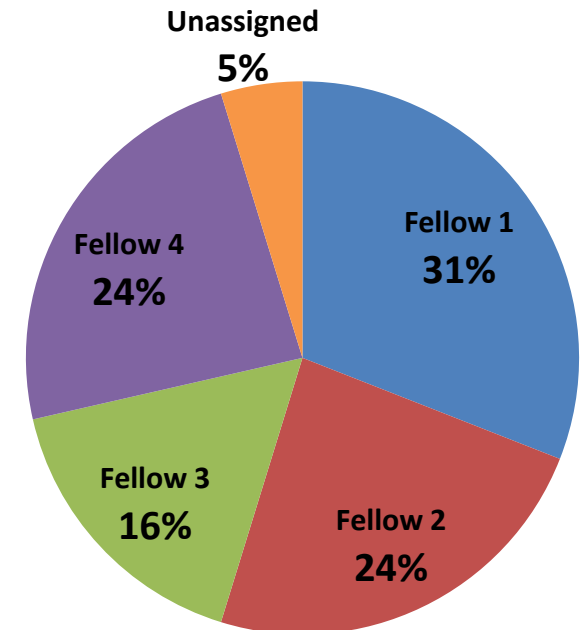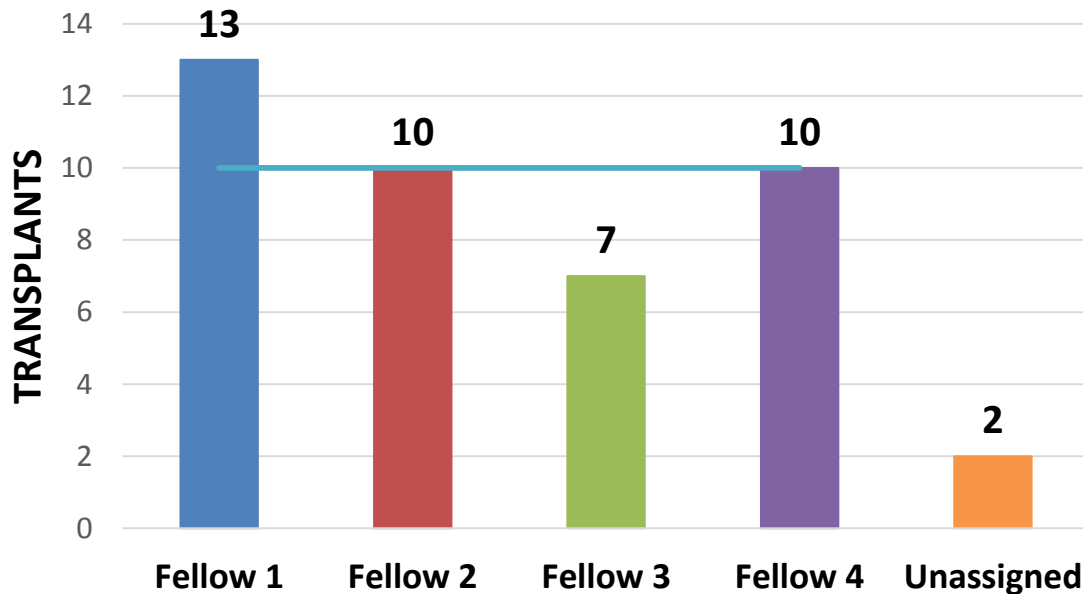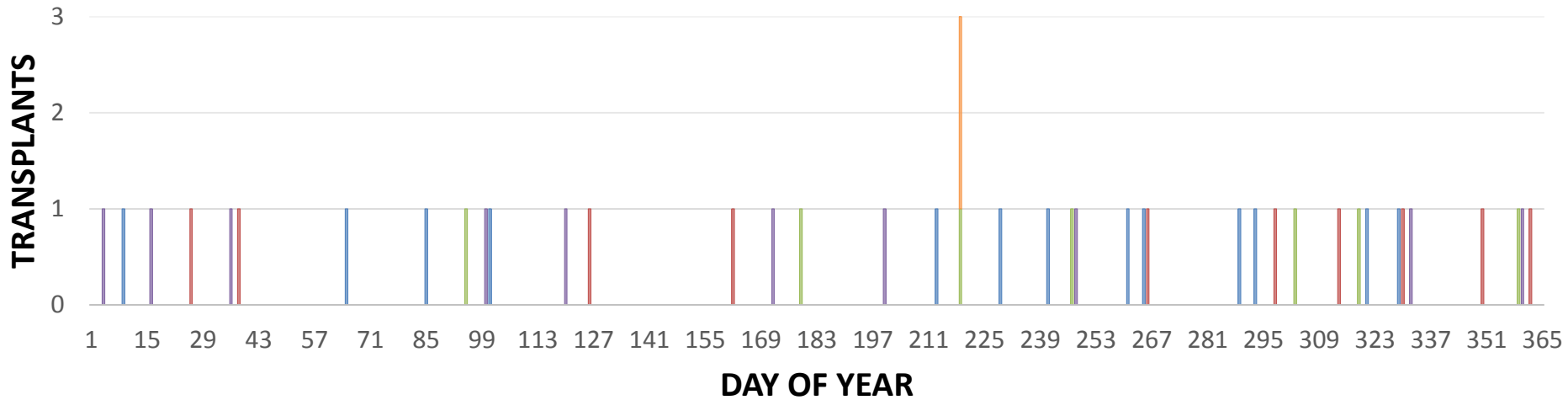UNIVERSITY OF MICHIGAN

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)

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Graphical Outputs: One Repetition

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Another Try
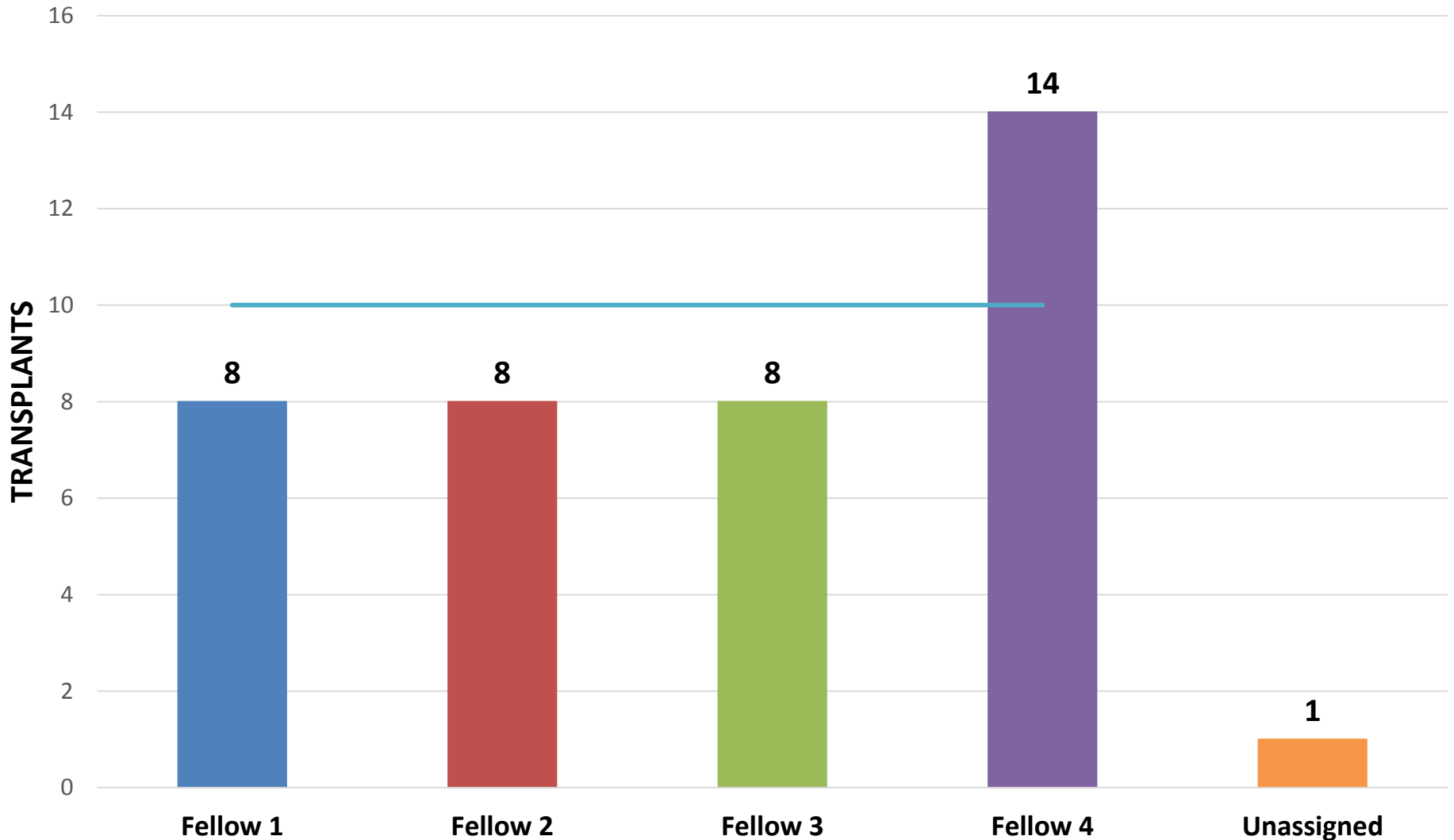
Graphical Outputs: 100,000 Repetitions

Mean Number of Fellows Certified = 1.91

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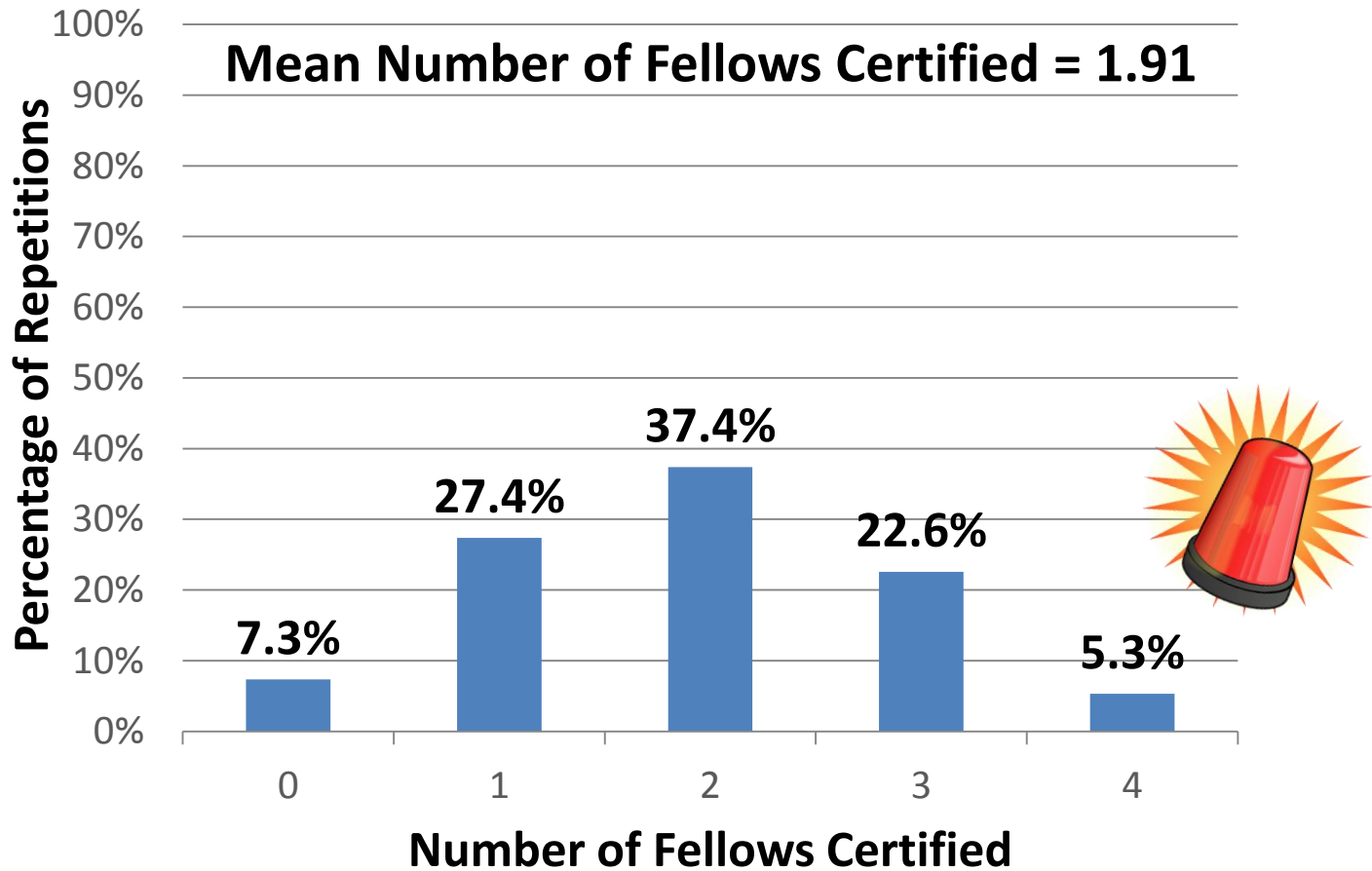
Implications: Potential System Changes

- Change certification policies
  - Surgical simulator certification
  - Proficiency-based certification
- Try alternative scheduling paradigms
  - On call until procedure
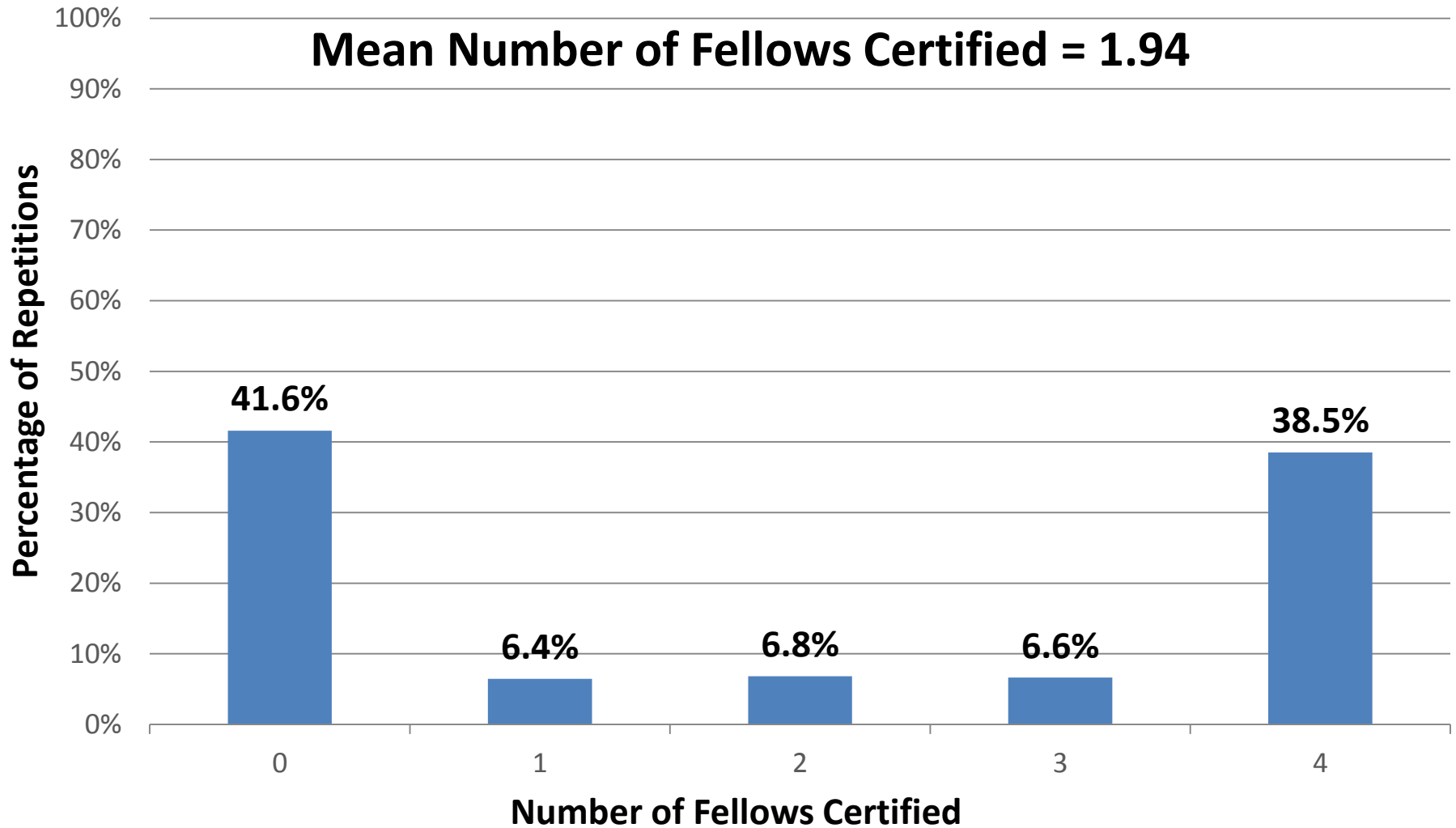 - On call until certified

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100,000 Repetitions: On Call Until Procedure

Mean Number of Fellows Certified = 1.94

Chart showing Percentage of Repetitions vs Number of Fellows Certified:
- 0: 41.6%
- 1: 6.4%
- 2: 6.8%
- 3: 6.6%
- 4: 38.5%

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100,000 Repetitions: On Call Until Certified

Mean Number of Fellows Certified = 3.32

Percentage of Repetitions (y-axis, 0% to 100%) vs Number of Fellows Certified (x-axis):
- 0: 0.0%
- 1: 0.0%
- 2: 7.1%
- 3: 53.9%
- 4: 38.9%

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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

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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

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Questions / Comments ? !

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

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