INDUSTRIAL & SYSTEMS ENGINEERING
TEXAS A&M UNIVERSITY

AnyLogic®

A Discrete Event Simulation Model for Outpatient Appointment Scheduling

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Agenda

- Problem Introduction and Background
- Why AnyLogic?
- Model
- Results
- Benefits Achieved
  - Demo
- Recent Work

Clinic Overview

- Indiana University Health Arnett (IUHA) is an integrated healthcare system serving Tippecanoe County and the surrounding area.
- Partnership with Indiana University School of Medicine.

- **Total admissions:** 136,371
- **Total outpatient visits:** 2,638,074
- **Total Physicians:** 2,111
- **Total team members:** 29,395

Business Challenge Solved

- **Problem:** Tasked with creating a model to generate a predictive schedule to account for a high number of patients that do not show up to their appointments (**no-shows**).
- **Limitations:** Physician schedule and patient policy
- **Goals**: Increase physician utilization, decrease physician overtime, and decrease patient waiting time

Why AnyLogic?

- Offers a systematic approach to the problem
- Makes implementing discrete events possible
- Gives the option to monitor discrete event measurable such as utilization, time in system, wait time, etc.
- Easy for others to use/learn
- Engaging interface options
- Versatility allows for multi-method simulation model extensions

Model Components

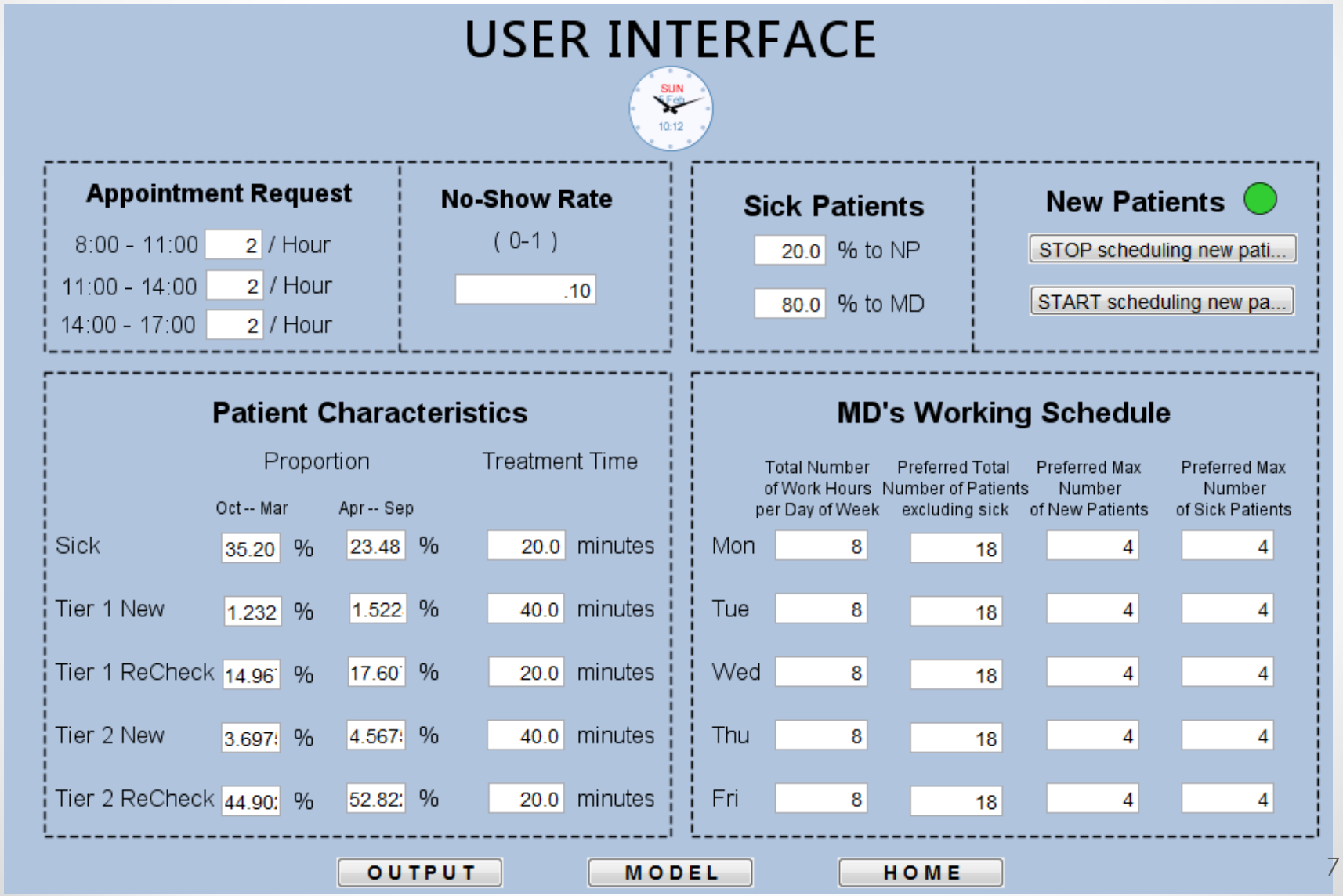
1. Home Screen (initialized)

2. Input Screen – takes input from the user on the clinic capacity preferences, no-show rates, patient mix, and more

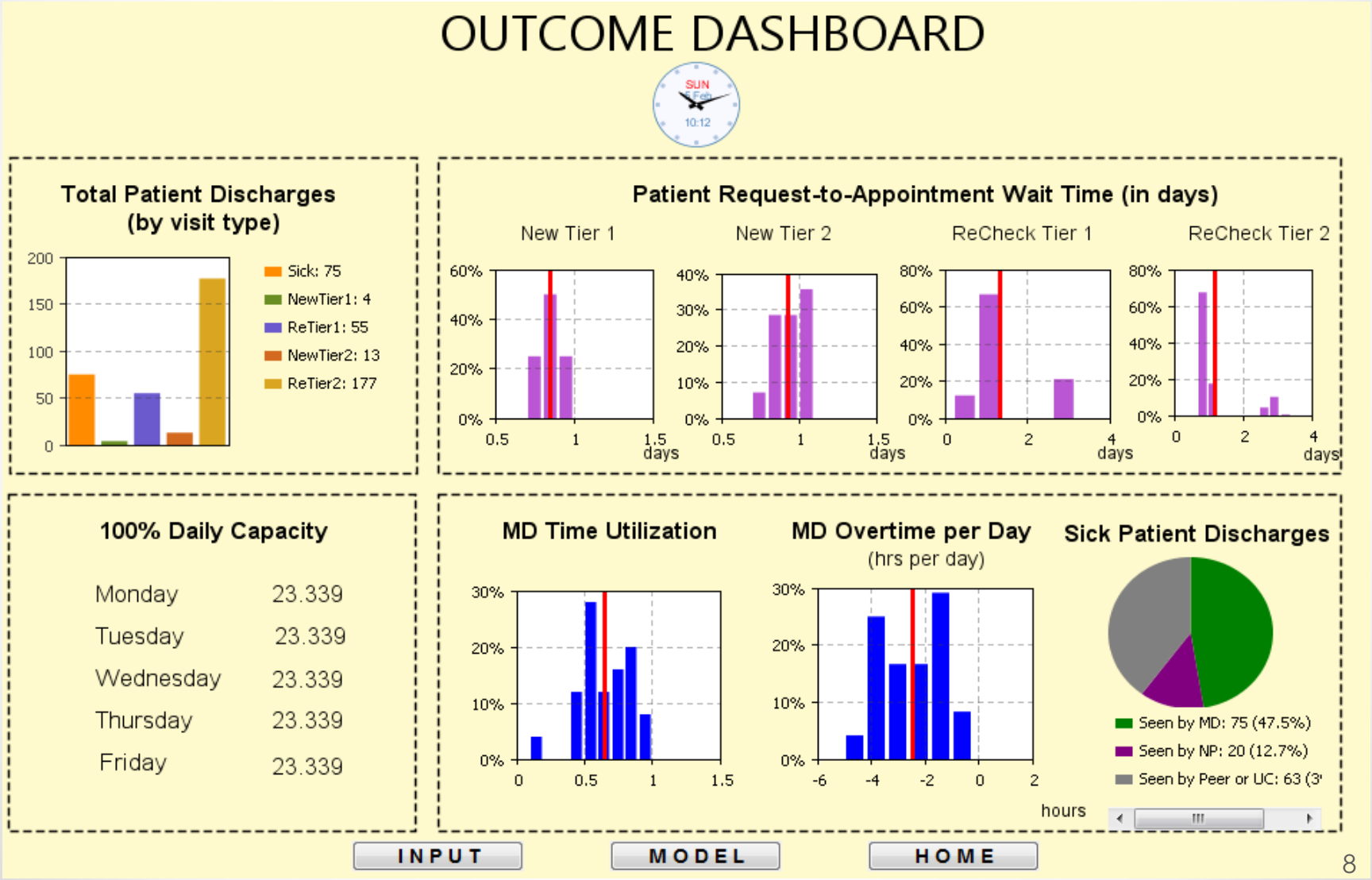
3. Model – shows the model's code, sequence of operations, and more

4. Output Screen – shows the model results and performance measures for a simulation run

Model Input


USER INTERFACE
SUN
10:12
Appointment Request
8:00 - 11:00 2 / Hour
11:00 - 14:00 2 / Hour
14:00 - 17:00 2 / Hour
No-Show Rate
(0-1)
.10
Sick Patients
20.0 % to NP
80.0 % to MD
New Patients
STOP scheduling new pati...
START scheduling new pa...
Patient Characteristics
Proportion
Treatment Time
Oct -- Mar
Apr -- Sep
Sick 35.20 % 23.48 % 20.0 minutes
Tier 1 New 1.232 % 1.522 % 40.0 minutes
Tier 1 ReCheck 14.96 % 17.60 % 20.0 minutes
Tier 2 New 3.697 % 4.567 % 40.0 minutes
Tier 2 ReCheck 44.90 % 52.82 % 20.0 minutes
MD's Working Schedule
Total Number of Work Hours per Day of Week
Preferred Total Number of Patients excluding sick
Preferred Max Number of New Patients
Preferred Max Number of Sick Patients
Mon 8 18 4 4
Tue 8 18 4 4
Wed 8 18 4 4
Thu 8 18 4 4
Fri 8 18 4 4
OUTPUT
MODEL
HOME

Model Output

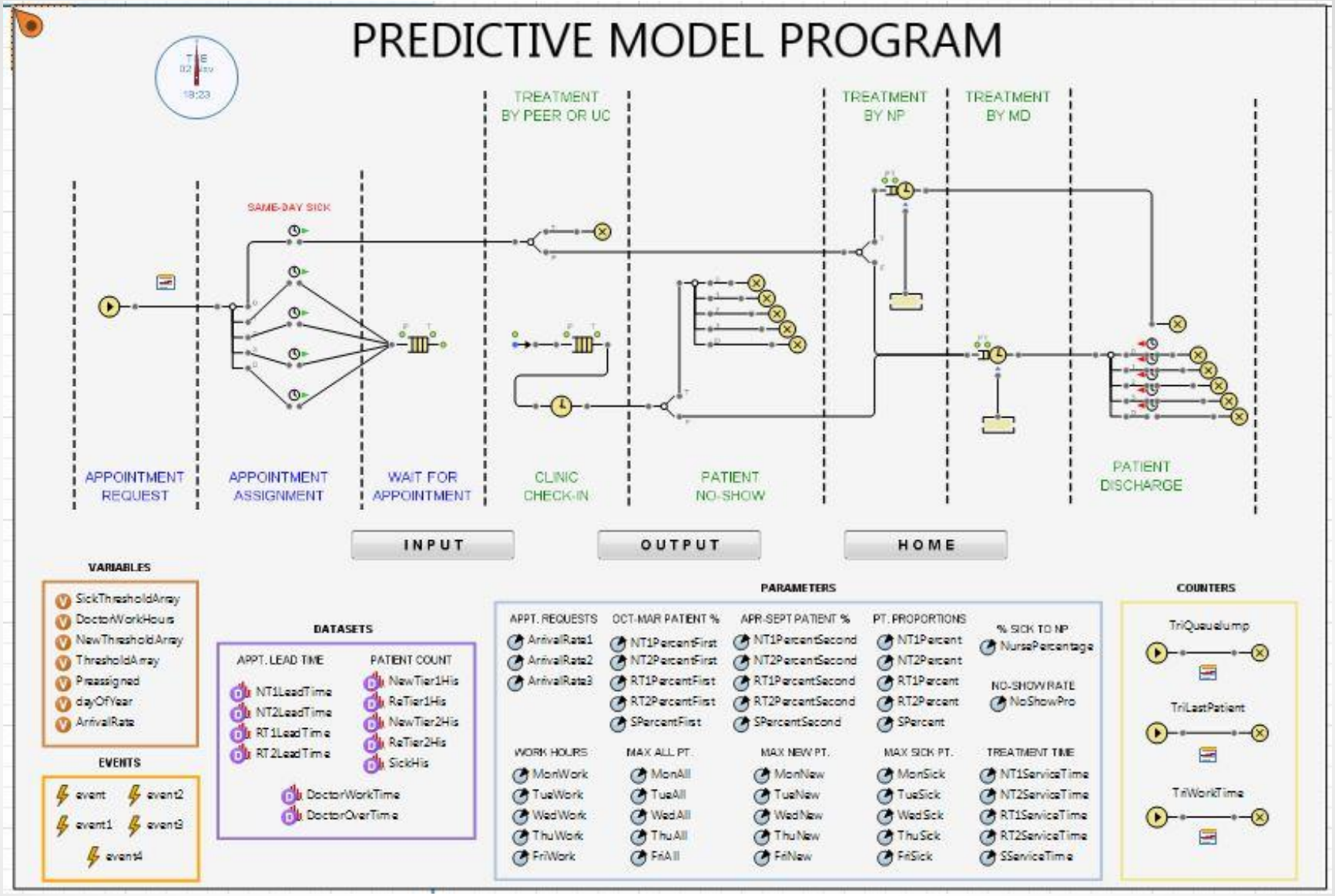


Model Demonstration

Model available at:

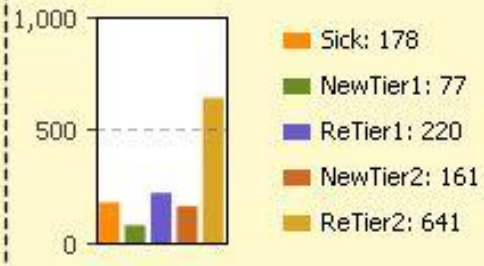
- http://www.runthemodel.com/models/924/

PREDICTIVE MODEL PROGRAM

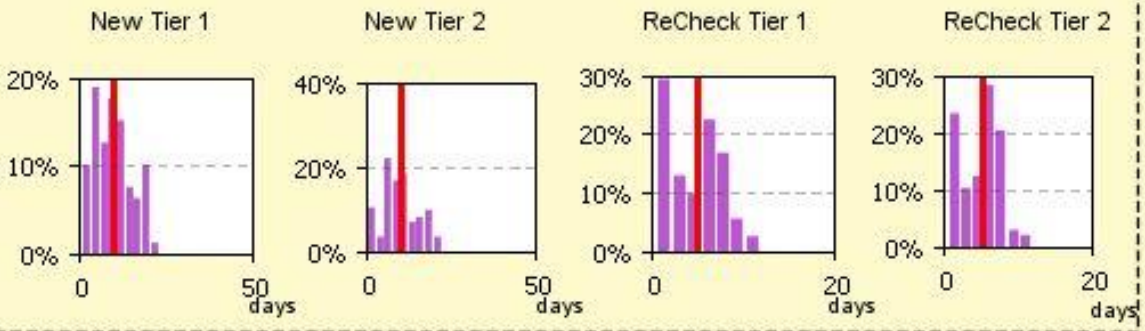


OUTCOME DASHBOARD

Total Patient Discharges (by visit type)



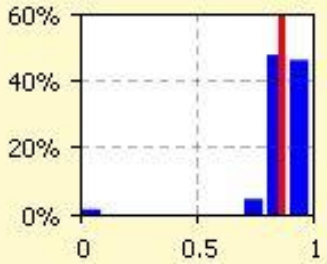
Patient Request-to-Appointment Wait Time (in days)



100% Daily Capacity

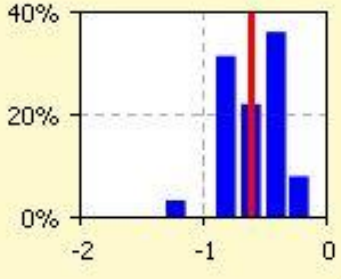
Monday	26
Tuesday	26
Wednesday	26
Thursday	26
Friday	26

MD Time Utilization

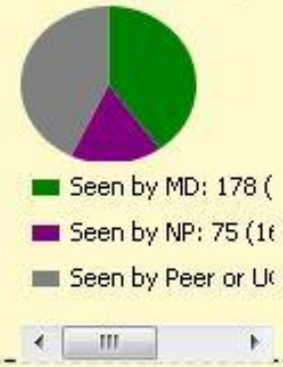


MD Overtime per Day

(hrs per day)



Sick Patient Discharges



INPUT MODEL HOME

Why is this Significant

- Presents a method to test theories before implementing them in the clinic
- Offers low risk low cost way to get theoretical results
- Gives different forecasts to help the clinic prepare for the future such as when the clinic will reach maximum capacity
- Outputs include several different ideas to back up any recommendations

Benefit Achieved

- Can determine patient-type capacity settings for physician schedule
- Results include how long, on average, each patient waits between scheduling their appointment and being seen by the physician
- Shows the number of sick patients seen by the nurse as opposed to the doctor
- Increases the utilization of the physician and decreases the patient waiting time

Update

- Unfortunately, the model was never utilized by IUHA
- Currently extending the model to a new setting for the Diabetes Health and Wellness Institute (DHWI)
  - 2 graduate students
  - 1 senior design team (4 undergraduates)
  - Exploring new scheduling policies
  - Results of the new analysis at DHWI will be implemented in their clinic setting January 2016

References

- [1] Li, Yan et al. "Clinic Scheduling – Boustany – Purdue Healthcare Advisors." http://www.runthemodel.com/models/924/
- [2] http://iuhealth.org/about-iu-health/

Questions?

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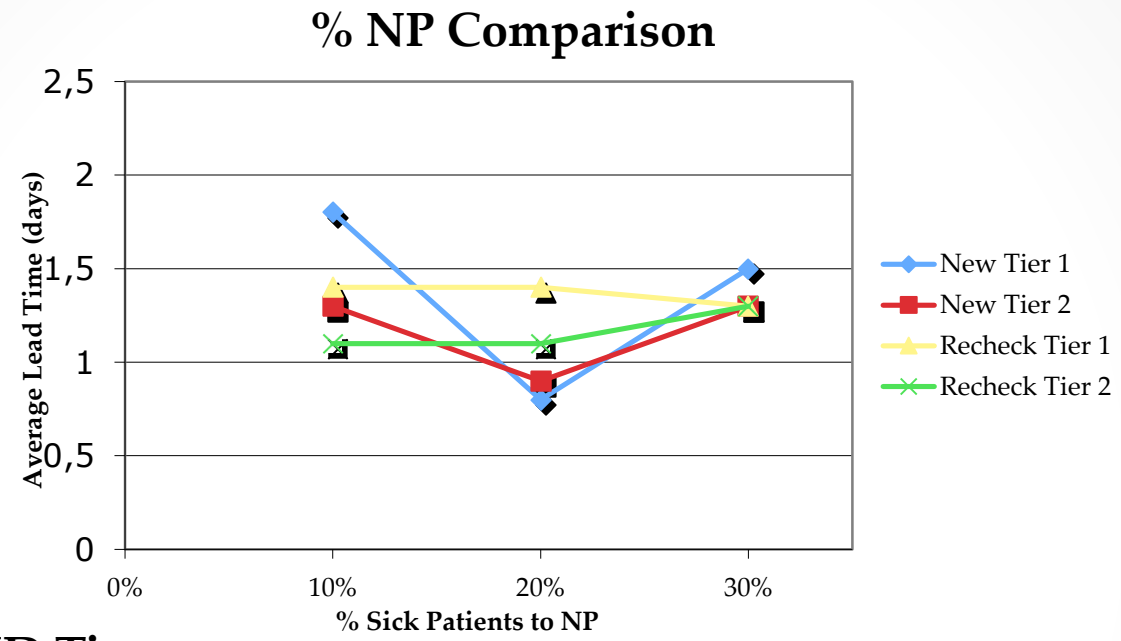
Q&A

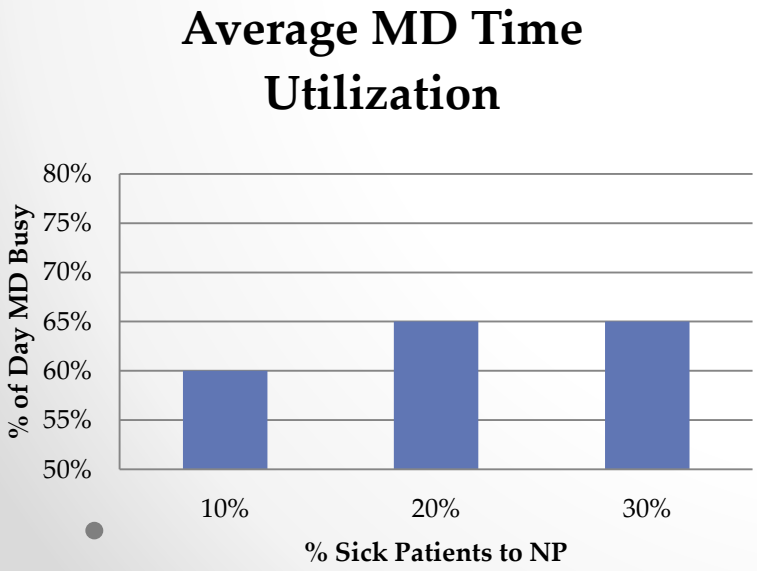
- Was the model utilize by IUHA and what benefit was achieved?
- Why was this model a discrete-event model as opposed to a agent-based model?
- Have you thought about allowing the user modify the NP's working schedule?

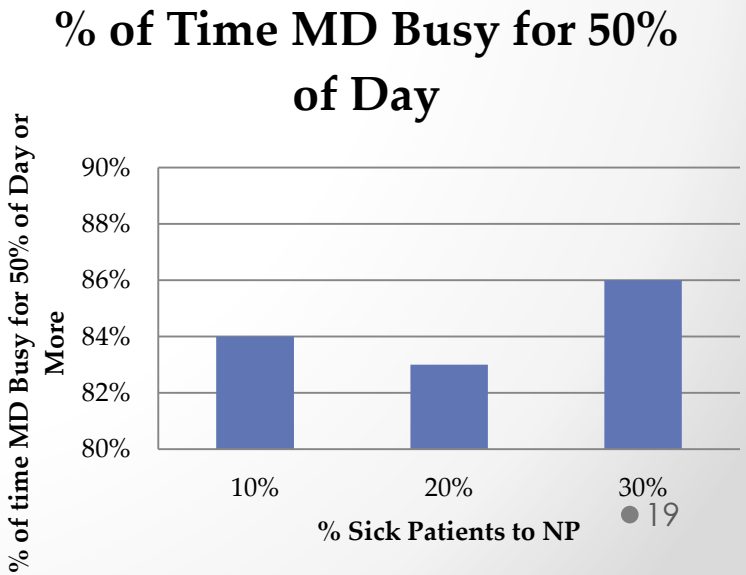
Executive Summary

- The system consists of a full service acute care hospital and a multispecialty clinic with approximately 200 providers at multiple locations.
- IUHA seeks to develop a scheduling methodology that provides same day access for a designated patient population while allowing acceptable access to the remaining patient population.
- Currently provider schedules are being driven by individual preference which leads to increased variation in scheduling rules that fail to meet employer or patient expectations.
- To address the challenge in appointment scheduling at IHUA, we developed a discrete-event simulation model using AnyLogic to predict the operational performance of the clinic under different demand patterns and staffing scenarios.
- Specifically, decision-makers can input population characteristics (e.g., arrival rate, probability of no-show, composition of different patient types) of the specific clinic and the physician work schedules.
- The model will then predict performance measures such as the average patient request-to-appointment time, clinic utilization, and physician working overtime for up to two years.
- The simulation model provides a great tool for IUHA to improve its operational efficiency and patient satisfaction. This model could also be used to help appointment scheduling in other outpatient clinics with similar settings.

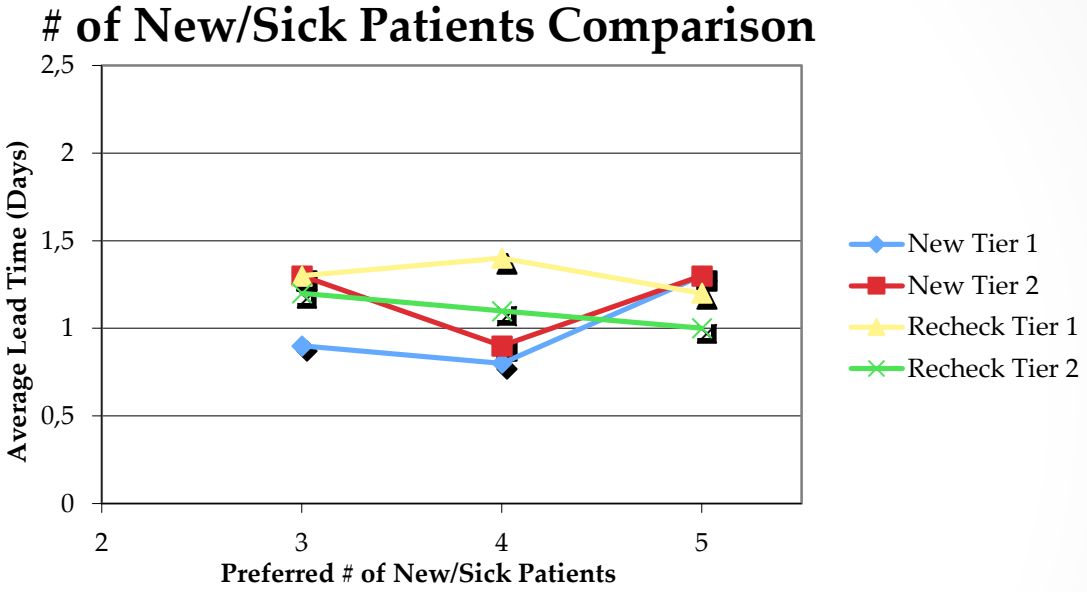
% of Sick Patients to NP

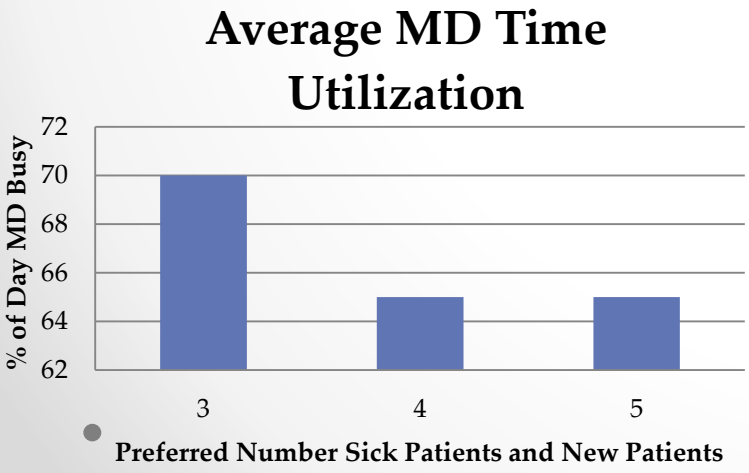


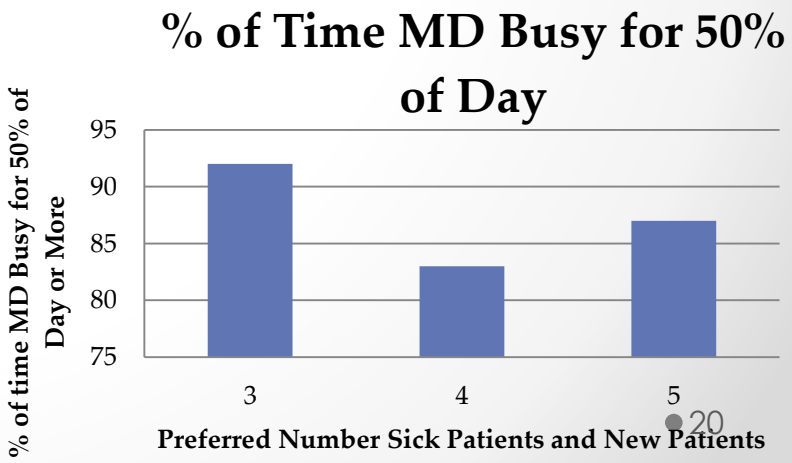




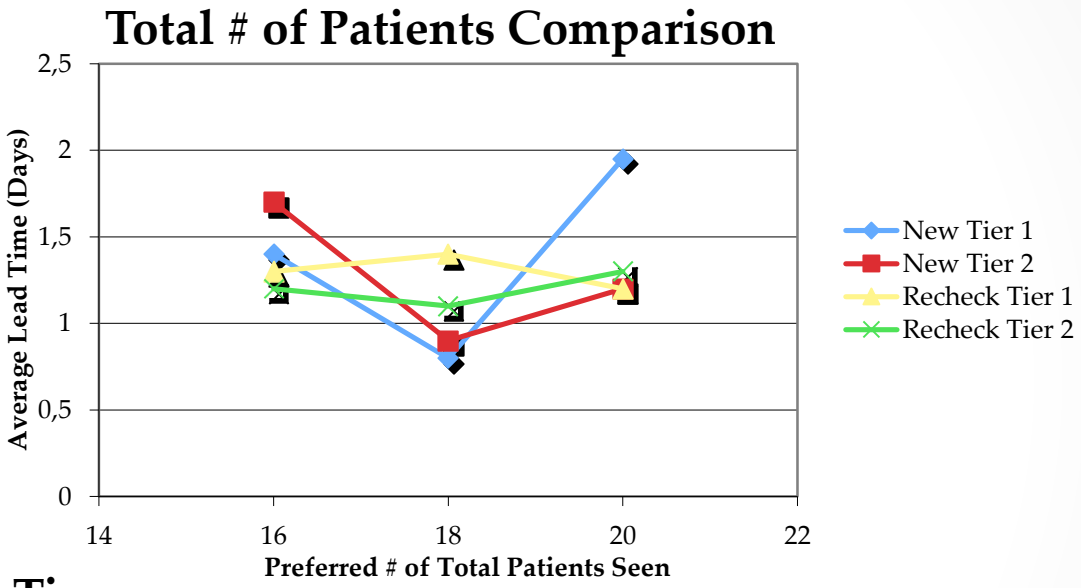
Preferred Number of New and Sick Patients

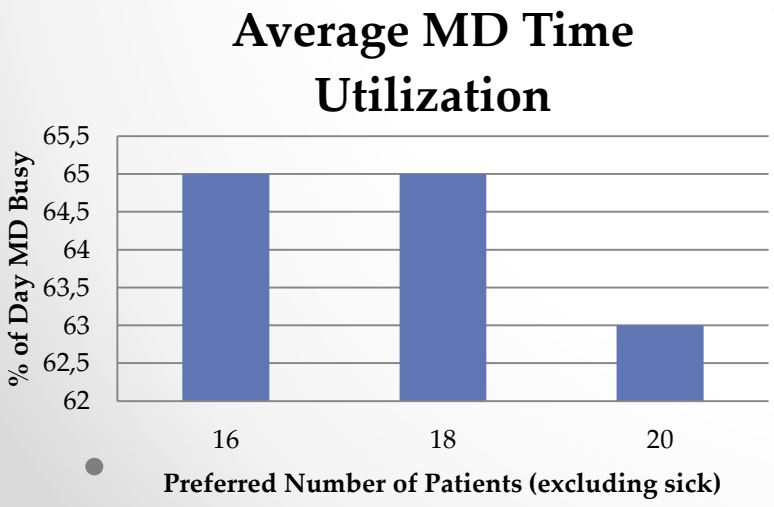


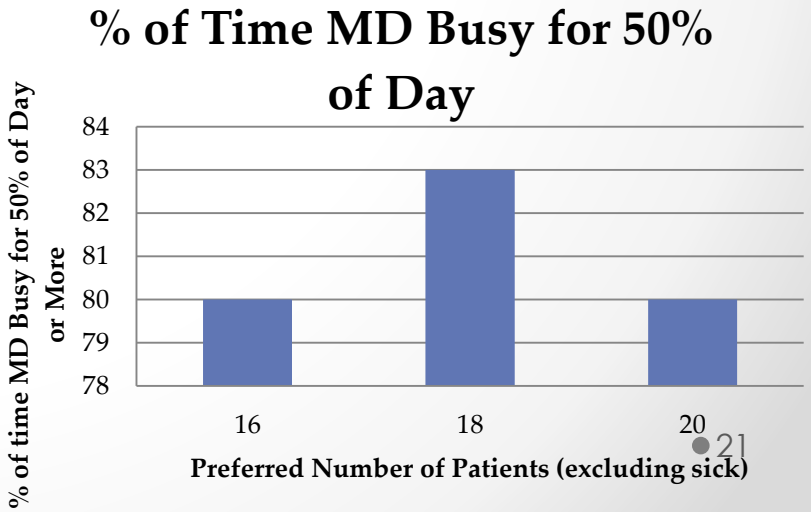




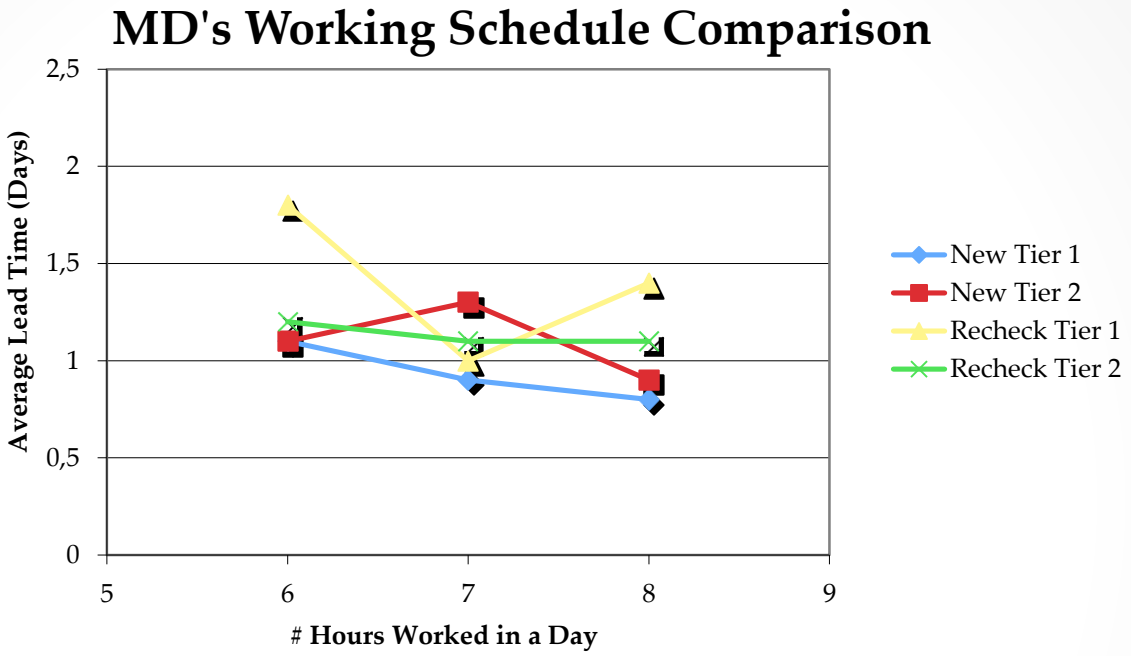
Preferred Number of Patients (Excluding Sick)

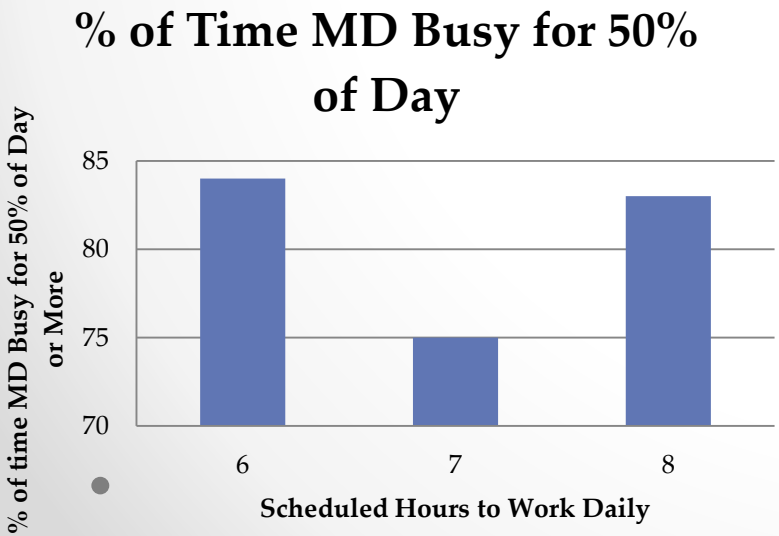


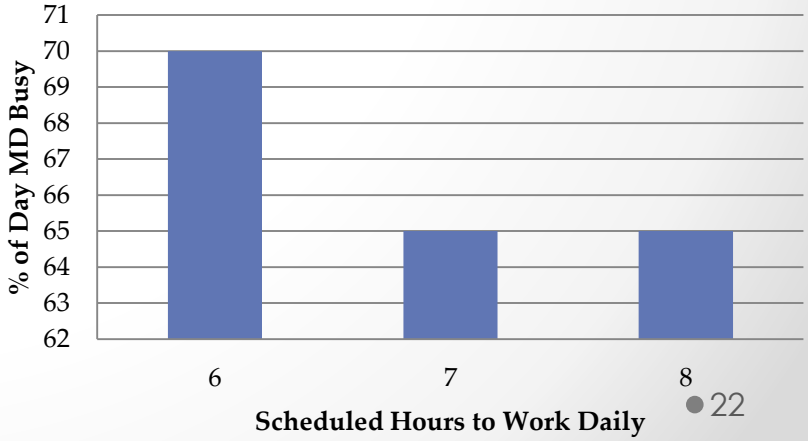




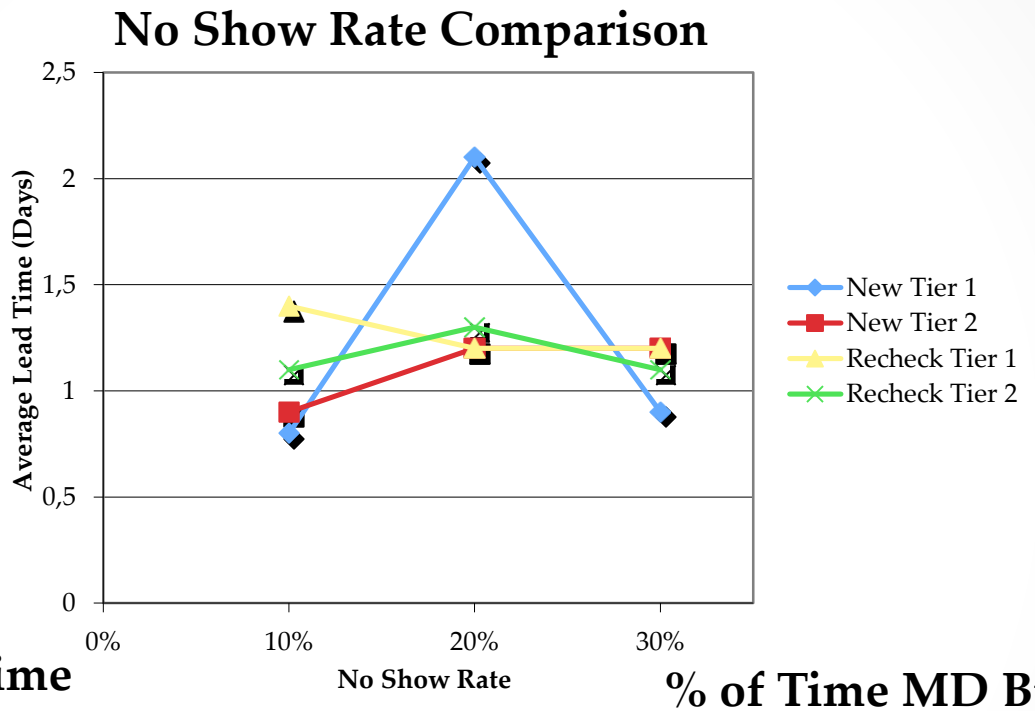
Hours Worked Per Day

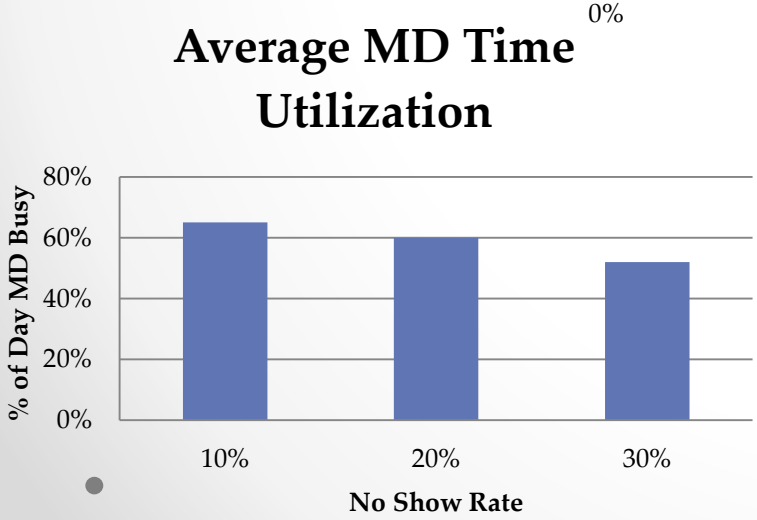


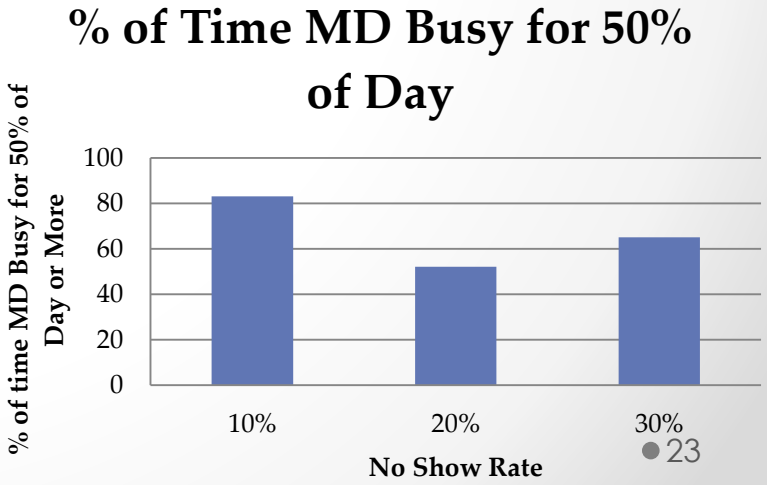




No Show Rate


No Show Rate Comparison
Average Lead Time (Days)
2,5
2
1,5
1
0,5
0
0%
10%
20%
30%
No Show Rate
New Tier 1
New Tier 2
Recheck Tier 1
Recheck Tier 2


Average MD Time Utilization
% of Day MD Busy
80%
60%
40%
20%
0%
10%
20%
30%
No Show Rate


% of Time MD Busy for 50% of Day
% of time MD Busy for 50% of Day or More
100
80
60
40
20
0
10%
20%
30%
No Show Rate