Pulmonary Clinic Flow Simulation Model Review

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Purpose & Background

• In order to improve patient flow through clinic, we need to understand the impact of the scheduling template as well as the interrelationships of all of the process steps, variability of patient needs, and the availability of appropriate staff at each step in the process.

• "Simulation is the process of designing and creating a computerized mathematical model of a real or proposed system for the purpose of conducting numerical experiments to give us a better understanding of the behavior of that system for a given set of conditions."

• Because of the difficulty to test different options on the system itself, a simulation model is a perfect tool for providing insight into what changes need to be made, and we can test changes to see the impact to clinic flow in a computer “laboratory” setting.

(Source Radiology/MRI Flow: Amy Anneken)
Simulation Model Design

This model simulates the clinic flow of the Pulmonary Department (located at the base) from patient arrival to service completion that may include pulmonary testing procedures and the services of multiple providers in order to find improvements in flow that results favorable service level measures for the patients while maintaining or improving clinical efficiency.

AIM
• To examine and test the effect of operational changes on clinical measures.

Potential What-If Scenarios/Recommendations
• How should exam rooms be allocated to doctors in a clinic setting?
• Are the resource allocations sufficient?
• Can scheduling or flow modifications be made to improve clinic measures?
• Can variance reduction improve performance?

Outcome Performance Measures
• Patient Touch Time/ Wait Time Measures
• Resource Utilization
• Clinic Duration
Patients arrive based on scheduling templates of physicians with appointment type determined by template.

Flow scenarios (by appt type) assigned based on historical data.
Operations Results

PDSA Clinic Results

- Equal Rooms
- Split Rooms
- No Room Assignments
- PFT Add
- 4 Nurses
- 3 Nurses
- 3 Nurses - No Room Assignments

Avg Clinic Dur (Min)

Touch Time Ratio

Clinic Duration

Touch Time Ratio

change the outcome
Patient Results

PDSA Patient Results

Minutes

Equal Rooms | Split Rooms | No Room Assignments | PFT Add | 4 Nurses | 3 Nurses | 3 Nurses - No Room Asgn

Exam Room Wait | Waiting Room Wait | Patient Touch Time

change the outcome
Understanding Patient Flow

Some principles of patient flow:

- Time is a finite and costly resource
- Variability is only bad when it’s unanticipated
- System-level performance depends on each individual’s actions; everything’s connected
- Waiting is minimized when schedule matches actual work
Variability in Consultation Durations

60-minute appointments

Consultation duration (minutes)
Variability in Consultation Durations

Consultation duration (minutes)

40-min. appts
60-min.
80-min.
special cause?

<10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-100 100-110 111-120

change the outcome®
PDSA: Reduce Activity Duration Uncertainty

Hold physician consultation times to scheduled durations
  - If scheduled for 30 minutes, then the physician’s meeting with patient ends at 30 minutes (if not before)
  - Depends on physician and patient/appointment type

Hold non-physician activity times to 150% of historical averages
Methods

• Data collection
  – Manual timestamp entry into EPIC
  – 1 clinic met data integrity threshold
  – Extracted empirical time distributions

• Simulation
  – Built simulation model of that specific clinic
  – 150 replications of a clinic session per scenario
  – Used same patient set each time (var. reduction)
Improvement in Clinic Duration

Target: <5 hrs

All Providers

Only Physicians

Only Non-Physicians

Mean | % @ Target | Mean | % @ Target | Mean | % @ Target
--- | --- | --- | --- | --- | ---
-2.66% | 29.03% | -12.32% | 109.68% | -15.90% | 190.32%
Improvement in Patient Visit Duration

Target: <1 hr

All Providers

Only Non-Physicians

- Mean: -4.92%
- % @ Target: 22.20%

Only Physicians

- Mean: -11.51%
- % @ Target: 10.59%

Mean: -17.04%
% @ Target: 33.60%
Improvement in Touch Time Ratio

Target: >.70

All Providers

- Mean: 14.10%
- % @ Target: 14.10%

Only Physicians

- Mean: 9.78%
- % @ Target: 9.78%

Only Non-Physicians

- Mean: 4.28%
- % @ Target: 4.28%

Bars represent the mean and percentage of providers reaching the target.
### Raw Numerical Results

<table>
<thead>
<tr>
<th></th>
<th>Clinic Duration</th>
<th>Patient Cycle Time</th>
<th>Patient Touch Time</th>
<th>Patient Wait Time</th>
<th>Exam Room Wait</th>
<th>Waiting Room Wait</th>
<th>Touch Time Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target</strong></td>
<td>&lt; 5 hours</td>
<td>&lt; 1 hour</td>
<td>&lt; 1 hour</td>
<td>&lt; 30 minutes</td>
<td>&lt; 30 minutes</td>
<td>&lt; 30 minutes</td>
<td>&gt; .70</td>
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<tr>
<td><strong>Mean</strong></td>
<td>350.61</td>
<td>112.03</td>
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<td>34.89</td>
<td>20.91</td>
<td>13.52</td>
<td>0.68</td>
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<td>14.48%</td>
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<td>78.53%</td>
<td>83.22%</td>
<td>51.87%</td>
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<tr>
<td><strong>Mean</strong></td>
<td>341.29</td>
<td>106.53</td>
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<td>32.94</td>
<td>20.51</td>
<td>11.99</td>
<td>0.68</td>
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<td>25.81%</td>
<td>17.69%</td>
<td>47.57%</td>
<td>62.84%</td>
<td>79.65%</td>
<td>84.75%</td>
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<tr>
<td><strong>Mean</strong></td>
<td>307.41</td>
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<td>90.09%</td>
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<tr>
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<td>-2.66%</td>
<td>-4.92%</td>
<td>-4.93%</td>
<td>-5.57%</td>
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<td>29.03%</td>
<td>22.20%</td>
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<td><strong>Mean</strong></td>
<td>-12.32%</td>
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<td>-6.80%</td>
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<td>109.68%</td>
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<td>6.14%</td>
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<td><strong>% Meeting Target</strong></td>
<td>190.32%</td>
<td>33.60%</td>
<td>14.51%</td>
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**% Change**

**Clinic Duration**

- 2.66%
- 29.03%
- 12.32%
- 109.68%
- 15.90%
- 190.32%

**Patient Cycle Time**

- 4.92%
- 22.20%
- 11.51%
- 10.59%
- 17.04%
- 33.60%

**Patient Touch Time**

- 4.93%
- 8.84%
- 6.80%
- 6.14%
- 11.78%
- 14.51%

**Patient Wait Time**

- 5.57%
- 3.60%
- 22.91%
- 11.38%
- 30.30%
- 17.45%

**Exam Room Wait**

- 1.91%
- 1.43%
- 18.38%
- 8.11%
- 22.63%
- 10.36%

**Waiting Room Wait**

- 11.37%
- 1.84%
- 30.60%
- 5.60%
- 43.13%
- 8.26%

**Touch Time Ratio**

- 0.48%
- 2.50%
- 3.34%
- 9.78%
- 4.28%
- 14.10%
Full-Factorial Experiment

Three levels for physicians:
- Baseline (empirical data)
- 150% of scheduled duration
- 100% of scheduled duration

Three levels for non-physicians:
- Baseline (empirical data)
- 150% of mean
- 100% of mean
Clinic Duration

- Nonphys (% of mean)
  - Base
  - 150%
  - 100%
- Physician (% of scheduled appt)
  - Base
  - 150%
  - 100%
Patient Visit Duration

Nonphys (% of mean)

Physician (% of scheduled appt)

Base

100%

150%

115

110

105

100

95

90

85

80

min
Patient Touch Time Ratio

Bar chart showing the comparison of nonphysician and physician touch time ratios at different percentages of mean and scheduled appointment times.
## Raw Numerical Results

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Cap Nonphys. at 150% of Mean</th>
<th>Cap Physician at 150% of Sched. Duration</th>
<th>Both II (150% Phys, 100% Nonphys)</th>
<th>Both III (100% Phys, 150% Nonphys)</th>
<th>Both I (100% Phys, 100% NonPhys)</th>
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<tr>
<td>% Change</td>
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<td>1.18%</td>
<td>28.95%</td>
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<td>89.13%</td>
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<tr>
<td><strong>Touch Time Ratio</strong></td>
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<td>&gt; .70</td>
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<td>1.50%</td>
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</tbody>
</table>
Conclusions

Methodological
• Simulation allows for rapid prototyping of potentially disruptive changes and improvement activity
• Validity of results depends on input data

Operational
• Accurate scheduling + conscientious behavior can lead to large improvement on key metrics
• Managerial decisions influence flow with the potential for synergy
• Improvements rely on actions of all providers