Using Simulation to Inform Policy Decisions to Improve Access to Healthcare

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CHEPS

INNOVATING HEALTHCARE DELIVERY

FOSTERING LEARNING

BUILDING COMMUNITY

POSITIVE IMPACT THROUGH...

Research
Education
Implementation
Outreach
Dissemination
Central Question

How do we use simulation to inform policy to improve access to care?

Case Study: Gastroesophageal reflux disease (GERD) patients who may prefer telehealth versus in-person appointments
Background

• Primary vs. specialty healthcare
  – Primary care providers: routine care, maintain health over time
  – Specialists: trained in a particular branch of medicine
• Timely access to care impacts outcomes
• Telehealth has the potential to improve access to care, especially for patients living in rural areas
  – Rural residents tend to be older, poorer, and sicker than urban residents
  – Distance to care is a significant barrier to care

29% of Americans report an unmet health need/delay in seeking healthcare

- Negative health outcomes
- Increased cost
- Operational burden
Problem Focus

• Patients using VA Medical Center in Ann Arbor, MI
• Currently considering GERD patients
  – Gastroesophageal reflux disease
• Face-to-face versus telehealth
• Simulate patients flowing through our system
  – How do scheduling policies impact patients’ ability to get the care they prefer?
  – What policies or system factors impact access?
GERD Patient Flow

Home Treatment

PCP Appt 1
2-8 weeks

PCP Appt 2
2-8 weeks

PCP Appt 3
2-8 weeks

PCP Appt 4

GI Appt 1
2-8 weeks

GI Appt 2
2-8 weeks

GI Appt 3

GI Appt 4
(Endoscopy)

Notes:
- PCP Appt 1, GI Appt 1, and GI Appt 4 MUST be conducted face-to-face (F2F).
- At all appointments, patients may no-show (dashed line back to same appointment).
- At the end of all appointments except GI Appt 4, patients may exit the system or be referred for endoscopy as their next appointment.
Transition Probability Matrix

<table>
<thead>
<tr>
<th>Starting at</th>
<th>PCP1</th>
<th>PCP2</th>
<th>PCP3</th>
<th>PCP4</th>
<th>GI1</th>
<th>GI2</th>
<th>GI3</th>
<th>GI4</th>
<th>Exit</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCP1</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{PCP1-PCP2}}$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP1-GI4}}$</td>
</tr>
<tr>
<td>PCP2</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{PCP2-PCP3}}$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP2-GI4}}$</td>
</tr>
<tr>
<td>PCP3</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{PCP3-PCP4}}$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP3-GI4}}$</td>
</tr>
<tr>
<td>PCP4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{PCP3-GI1}}$</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP4-GI4}}$</td>
</tr>
<tr>
<td>GI1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{G11-GI2}}$</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{GI1-GI4}}$</td>
</tr>
<tr>
<td>GI2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{G12-GI3}}$</td>
<td>0</td>
<td>$P_{\text{GI2-G4}}$</td>
</tr>
<tr>
<td>GI3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>$P_{\text{G13-GI4}}$</td>
<td>0</td>
</tr>
<tr>
<td>GI4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{no-show}}$</td>
<td>0</td>
</tr>
</tbody>
</table>
Inputs: Appointment Types and Providers

- Appointment Types
  - Face-to-Face
  - Telehealth
- Exit probability at each appointment: 0.16
- Endoscopy probability at each appointment: 0.05
- Providers
  - PCPs (2)
    - Capacity: 4 Telehealth, 3 Face-to-Face
  - GI (2)
    - Capacity: 4 Telehealth, 3 Face-to-Face
Inputs: Patients

- Patient Arrivals
  - PCP: 5/week
  - Self-Refer to GI: 7/week

- Patient location
  - Probability of “far” patient: 0.014
    - “Far” = more than 40 miles from clinic

- Patient preference
  - Prefer telehealth for “near” patients: 0.5
  - Prefer telehealth for “far” patients: 1.0
Scheduling Policies

• “In-Range” Policies
  A. First available – any type
  B. First available – preferred only
  C. First preferred available. If no preferred, first available of any type

• “Out-of-range” policies
  1. First available – any type
  2. First available - preferred
Scheduling Policies

• “In-Range” Policies
  A. First available – any type
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  C. First preferred available. If no preferred, first available of any type

• “Out-of-range” policies
  1. First available – any type
  2. First available - preferred

Example: Policy C1, patient prefers telehealth appointments

Patient needs next appointment

Look for next “in-range” (next 2-8 weeks) telehealth appointment

If no in-range telehealth appointments, look for in-range face-to-face appointments

If no in-range appointments, schedule first available out-of-range appointment of any type
Simulation Methods

• Simulate in C++
  – Unit of time: weeks
  – Simulation length: 52 weeks
  – Replications: 500
• Sensitivity analyses to determine influential inputs
Metrics

• Total patient arrivals
• Total patients completing care
• Provider utilization
  – Overall, and stratified by face-to-face/telehealth and provider type
• Lead time
• Percentage of appointment preferences met
## Sample Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mean Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients seeking care</td>
<td>355.23</td>
</tr>
<tr>
<td>Patients completing care</td>
<td>299.01</td>
</tr>
<tr>
<td>Overall provider utilization</td>
<td>70.12%</td>
</tr>
<tr>
<td>Face-to-face utilization</td>
<td>99.13%</td>
</tr>
<tr>
<td>Telehealth utilization</td>
<td>48.36%</td>
</tr>
<tr>
<td>Lead time</td>
<td>2.9 weeks</td>
</tr>
<tr>
<td>Modality preferences met</td>
<td>99.98%</td>
</tr>
</tbody>
</table>

Baseline inputs, Policy C1
Impact of scheduling policies

<table>
<thead>
<tr>
<th>Scheduling Policy</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Appt Pref. Met</td>
<td>50.09</td>
<td>50.68</td>
<td>99.97</td>
<td>100.00</td>
<td>99.98</td>
<td>100.00</td>
</tr>
</tbody>
</table>

“In-Range” Policies
A. First available – any type
B. First available – preferred only
C. First preferred available (any type if no preferred)

“Out-of-range” policies
1. First available – any type
2. First available – preferred
Impact of scheduling policies

"In-Range" Policies

A. First available – any type
B. First available – preferred only
C. First preferred available (any type if no preferred)

"Out-of-range" policies

1. First available – any type
2. First available – preferred

<table>
<thead>
<tr>
<th></th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provider Utilization</td>
<td>78.5</td>
<td>78.4</td>
<td>70.0</td>
<td>69.7</td>
<td>70.1</td>
<td>69.7</td>
</tr>
<tr>
<td>F2F</td>
<td>99.5</td>
<td>99.5</td>
<td>99.1</td>
<td>99.1</td>
<td>99.1</td>
<td>98.9</td>
</tr>
<tr>
<td>Telehealth</td>
<td>48.2</td>
<td>62.6</td>
<td>47.7</td>
<td>48.4</td>
<td>47.7</td>
<td>47.7</td>
</tr>
</tbody>
</table>

Diagram:
- Scheduling Policy
- Provider Utilization
- Overall, F2F, Telehealth
Impact of scheduling policies

“In-Range” Policies
A. First available – any type
B. First available – preferred only
C. First preferred available (any type if no preferred)

“Out-of-range” policies
1. First available – any type
2. First available – preferred
Impact of increasing % of rural patients

<table>
<thead>
<tr>
<th>% of patients who live far from care</th>
<th>Provider Utilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>Overall: 69.7</td>
</tr>
<tr>
<td>1.4% (Baseline)</td>
<td>F2F: 47.8, Telehealth: 48.4</td>
</tr>
<tr>
<td>10%</td>
<td>Overall: 71.2</td>
</tr>
<tr>
<td>50%</td>
<td>Overall: 78.0</td>
</tr>
</tbody>
</table>

Overall and Telehealth utilization are compared across different percentages of rural patients.
Impact of increasing % of rural patients

- 0%: 3.0 weeks
- 1.4% (Baseline): 2.9 weeks
- 10%: 2.9 weeks
- 50%: 2.7 weeks
<table>
<thead>
<tr>
<th>Provider Staffing</th>
<th>Overall</th>
<th>F2F</th>
<th>Telehealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 PCP, 2 GI (Baseline)</td>
<td>70.1</td>
<td>48.4</td>
<td>53.7</td>
</tr>
<tr>
<td>1 PCP, 2 GI</td>
<td>75.0</td>
<td>53.7</td>
<td>58.9</td>
</tr>
<tr>
<td>4 PCP, 2 GI</td>
<td>58.9</td>
<td>37.2</td>
<td>43.8</td>
</tr>
<tr>
<td>2 PCP, 1 GI</td>
<td>67.4</td>
<td>43.8</td>
<td>45.4</td>
</tr>
<tr>
<td>2 PCP, 4 GI</td>
<td>69.3</td>
<td>45.4</td>
<td>45.4</td>
</tr>
</tbody>
</table>

Impact of providers staffed
Impact of providers staffed

Provider Staffing

Lead Time (weeks)

- 2 PCP, 2 GI (Baseline) = 2.9 weeks
- 1 PCP, 2 GI = 8.6 weeks
- 4 PCP, 2 GI = 1.5 weeks
- 2 PCP, 1 GI = 4.6 weeks
- 2 PCP, 4 GI = 1.8 weeks
Lead Time
Conclusions & next steps

• Telehealth helps reduce barriers to accessing healthcare for rural populations
• Appropriate scheduling policies explicitly allow us to accommodate patient preferences for appointment modalities
• When considering access to specialty care, can’t forget about capacity of primary care as well

• Potential next steps:
  – Expanding patient attributes
  – Correlating no-show probability with appointment preference
Beyond this case study...

Policies for triaging colonoscopy patients under reduced capacity due to COVID-19

Understand how a predictive model impacts patient access for chronic liver disease care
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FOR REFERENCE: Sensitivity Analyses

• Inputs changed (one at a time, ± 50%):
  – PCP_Rate (# of patients/week that arrive to PCP)
    • Example: baseline is 5 patients/week, check 3 and 8 patients/week
  – Self_Rate (# of patients/week that arrive via self-referral)
  – ApptLB/UB(lower bound/upper bound of appointment range)
  – ExitProb (probability a patient will complete care at each appointment)
  – NearProb (probability that a patient will live within 40 miles)
  – BenignProb (probability that patient will receive a benign result from endoscopy)
For Reference - Lead Time
For Reference - Telehealth Utilization

A1
- NumPCPs
- PCPArrivals
- PCPCapacity
- MaxNoShows
- AppTimeLB
- NumGlis
- GICapacity
- GIArrivals
- TeleNearProb
- BenignProb
- AppTimeUB
- FarProb

A2
- NumPCPs
- PCPArrivals
- PCPCapacity
- MaxNoShows
- AppTimeLB
- NumGlis
- GICapacity
- GIArrivals
- TeleNearProb
- BenignProb
- AppTimeUB
- FarProb

B1
- TeleNearProb
- MaxNoShows
- NumPCPs
- PCPArrivals
- PCPCapacity
- GICapacity
- GIArrivals
- NumGlis
- FarProb
- AppTimeLB
- BenignProb
- AppTimeUB

B2
- TeleNearProb
- MaxNoShows
- NumPCPs
- PCPArrivals
- PCPCapacity
- GICapacity
- GIArrivals
- NumGlis
- FarProb
- BenignProb
- NumGlis
- AppTimeUB

C1
- TeleNearProb
- MaxNoShows
- NumPCPs
- PCPArrivals
- PCPCapacity
- GICapacity
- GIArrivals
- NumGlis
- FarProb
- AppTimeLB
- BenignProb

C2
- TeleNearProb
- MaxNoShows
- NumPCPs
- PCPArrivals
- PCPCapacity
- GICapacity
- GIArrivals
- NumGlis
- FarProb
- BenignProb
- NumGlis
- AppTimeUB

A1
- TeleNearProb
- MaxNoShows
- NumPCPs
- PCPArrivals
- PCPCapacity
- GICapacity
- GIArrivals
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- FarProb
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C2