Using Simulation to Evaluate Scheduling Policies for Specialty Care to Consider Patient Preferences

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CHEPS

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POSITIVE IMPACT THROUGH...

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How do we evaluate how scheduling policies impact access to care for rural patients with gastroesophageal reflux disease while also considering patient preference for appointment modality?
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 seeing a healthcare provider:
- 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

Primary Care Provider
First Available Appointment
1st Appointment: check alarm symptoms, homestyle treatment or acid blocker (H2B)
2 - 8 weeks
2nd Appointment: appointment call or follow-up visit, increase H2B dosage
2 - 8 weeks
3rd Appointment: prescribe PPI
2 - 8 weeks
4th Appointment: If no improvement, refer to GI

Home Treatment
Self Refer
Gastrointestinal Doctor
1st Appointment: check reflux, adherence
2 - 8 weeks
Medical Therapy
2 - 8 weeks
Endoscopy
Benign
Cancer
Exit
Exit
Face 2 Face Appointment or nurse follow-up call

exit point
Inputs: Providers and Diagnoses

• Providers
  – PCPs (2)
    • Capacity: 4 Telehealth, 3 Face-to-Face
  – GI (2)
    • Capacity: 4 Telehealth, 3 Face-to-Face

• Disease diagnoses
  – GERD
    • For those who get endoscopy, probability of benign/healthy diagnosis: 0.90
Inputs: Appointments

- Appointment Types
  - Face-to-Face
    - PCP cost: $100
    - GI cost: $200
  - Telehealth
    - PCP cost: $75
    - GI cost: $150
- Exit probability at each appointment: 0.16
- Endoscopy probability: 0.05
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
  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

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 exits (patients “completing” care/leaving system for other reasons)
- Provider utilization
  - Overall, and stratified by face-to-face/telehealth and provider type
- Lead time
- Percentage of appointment preferences met
- Total cost
- Total benign/healthy endoscopy patient and total malignant patients
## Sample Results

<table>
<thead>
<tr>
<th>Metric</th>
<th>Mean Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients completing care</td>
<td>365.8</td>
</tr>
<tr>
<td>Benign/healthy endoscopies</td>
<td>156.1</td>
</tr>
<tr>
<td>Malignant endoscopies</td>
<td>17.3</td>
</tr>
<tr>
<td>Overall provider utilization</td>
<td>0.91</td>
</tr>
<tr>
<td>Face-to-face utilization</td>
<td>0.95</td>
</tr>
<tr>
<td>Telehealth utilization</td>
<td>0.88</td>
</tr>
<tr>
<td>Lead time</td>
<td>5.0 weeks</td>
</tr>
<tr>
<td>Modality preferences met</td>
<td>50.5%</td>
</tr>
<tr>
<td>Total cost</td>
<td>$172,866</td>
</tr>
</tbody>
</table>

Baseline inputs, Policy A1
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)
% Modality Preference Met

A1

Near Prob
PCP Rate
Benign Prob
appUB
exitProb
Self Rate
appUB
endoProb

0.25 0.35 0.45 0.55 0.65 0.75

High Low

A2

Near Prob
exitProb
PCP Rate
appUB
Self Rate
appUB
Benign Prob
appUB

0.25 0.35 0.45 0.55 0.65 0.75

High Low

B1

appUB
PCP Rate
exitProb
endoProb
Near Prob
appUB
Benign Prob
Self Rate

0.8 0.85 0.9 0.95 1

High Low

B2

endoProb
exitProb
appUB
appUB
Benign Prob
Near Prob
PCP Rate
Self Rate

0.9 0.95 1 1.05 1.1

High Low

C1

PCP Rate
exitProb
Near Prob
endoProb
Benign Prob
appUB
Self Rate
appUB

0.9 0.92 0.94 0.96 0.98 1

High Low

C2

appUB
PCP Rate
exitProb
Near Prob
endoProb
Benign Prob
appUB
Self Rate
appUB

0.9 0.92 0.94 0.96 0.98 1

High Low
Considerations: % Preference Met

- Only Near Probability significantly influenced In-Range Policy A
- Appointment time range upper-bound influenced policies B1 and C2, but not any other scheduling policies
- B2 and B1 had the highest preference on average (~0.98-1), while A1 had the lowest preference (~0.5)
Telehealth Utilization

A1
- appUB
- Self Rate
- PCP Rate
- appUB
- exitProb
- Near Prob
- Benign Prob
- endoProb

B1
- endoProb
- Near Prob
- exitProb
- PCP Rate
- appUB
- appUB
- Benign Prob
- Self Rate

C1
- endoProb
- exitProb
- Near Probability
- PCP Rate
- Benign Probability
- appUB
- Self Rate
- appUB

A2
- endoProb
- PCP Rate
- exitProb
- appUB
- Self Rate
- appUB
- Benign Prob
- Near Prob

B2
- Near Prob
- endoProb
- exitProb
- PCP Rate
- appUB
- appUB
- Benign Prob

C2
- endoProb
- exitProb
- Near Probability
- PCP Rate
- Benign Probability
- appUB
- Self Rate
Considerations: Telehealth Utilization

• Appointment upper bound strongly influenced Policy A1
• PCP Rate had significant influence over In Range Policy A
• Telehealth utilization was extremely variable
  – A1 had an average telehealth utilization of 0.9
  – A2 had an average telehealth utilization of 0.35
  – B1, B2, C1, and C2 had an average telehealth utilization of 0.2
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

• Next steps:
  – Updating patient flow to allow more flexibility between appointments
  – Allowing for patient no-shows and cancellations
  – Expanding patient attributes
Planned Future Patient Flow

1. Home treatment
   - PCP
   - Self-referral

   PCP Appt 1: check alarm systems, lifestyle recommendations/acid blocker
     - P(no-show)
     - 2-8 weeks

   PCP Appt 2: follow-up visit, may increase H2B dose
     - P(no-show)
     - 2-8 weeks

   PCP Appt 3: prescribe PPI
     - P(no-show)
     - 2-8 weeks

   PCP Appt 4: if no improvement, refer to GI
     - P(no-show)

   GI Appt 1: check reflux/prescription adherence
     - P(no-show)
     - 2-8 weeks

   GI Appt 2: medical therapy
     - P(no-show)
     - 2-8 weeks

   GI Appt 3: follow-up visit
     - P(no-show)

   GI Appt 4: Endoscopy
     - Benign
     - Malignant

   Exit

   Pr (Exit) >= 0
   Pr (Endoscopy) >= 0
## 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>$P_{\text{PCP1-GI1}}$</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP1-GI4}}$</td>
<td>$P_{\text{exit}}$</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>$P_{\text{PCP2-GI1}}$</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP2-GI4}}$</td>
<td>$P_{\text{exit}}$</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>$P_{\text{PCP3-GI1}}$</td>
<td>0</td>
<td>0</td>
<td>$P_{\text{PCP3-GI4}}$</td>
<td>$P_{\text{exit}}$</td>
</tr>
<tr>
<td>PCP4</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>
<td>$P_{\text{exit}}$</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>$P_{\text{GI1-GI2}}$</td>
<td>0</td>
<td>$P_{\text{GI1-GI4}}$</td>
<td>$P_{\text{exit}}$</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>$P_{\text{GI2-GI3}}$</td>
<td>$P_{\text{GI2-G4}}$</td>
<td>$P_{\text{exit}}$</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>$P_{\text{GI3-GI4}}$</td>
<td>$P_{\text{exit}}$</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>
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