WORKING SMARTER NOT HARDER: USING SIMULATION TO EVALUATE EVIDENCE-BASED STRATEGIES TO OFFLOAD ENDOSCOPY BACKLOGS RELATED TO COVID-19

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Slides adapted from Vandeusen’s presentation on Digestive Disease Week
CHEPS

INNOVATING HEALTHCARE DELIVERY

FOSTERING LEARNING

BUILDING COMMUNITY

POSITIVE IMPACT THROUGH...
Research
Education
Implementation
Outreach
Dissemination
AGENDA

- Background
- Methods and Simulation Overview
- Strategies
- Outcomes and Results
DISCLOSURES

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We report no conflicts of interest.
BACKGROUND

- COVID-19 pandemic caused cancellation or deferral of many elective endoscopies starting in March 2020
  - Health system policies
  - Staff and facility re-deployment
  - Distancing and room turnover policies
  - Deferral by patients

Endoscopy volume in VA Health System from Jan 2019 to May 2020

POTENTIAL CLINICAL IMPACT OF DELAYED ENDOSCOPY

- Increased time between abnormal FIT/FOBT and colonoscopy is associated with higher colorectal cancer (CRC) incidence, later stage disease, and death

- In UK, COVID-19 has been associated with a sustained reduction in patients diagnosed with, referred for and treated for CRC.

EVIDENCE-BASED STRATEGIES TO POTENTIALLY REDUCE BACKLOGS

- Preferentially screen for CRC using **high-sensitivity stool-based testing (FIT)** instead of colonoscopy.

- **Extend the follow-up interval to 7 years** for patients with 1-2 low-risk adenomas completely removed on prior high-quality endoscopy who had been recommended to return in 5 years.

- Both are guideline-recommended strategies for CRC prevention.

This study quantifies the impact of evidence-based strategies to improve endoscopy access during the COVID-19 pandemic.
METHODS

- Created a model of a single endoscopy unit within an integrated healthcare system, similar to the Veterans Affairs Health System
  - Assumed no external referrals
- Used discrete-event simulation in C++
- Model started at beginning of COVID-19 pandemic (March 2020)
- Model duration 150 weeks
- Each simulation run is replicated 100 times
METHODS - SIMULATION OVERVIEW

Patient Arrives
Attempt to schedule

Patient Not Scheduled
Joins queue for future weeks

Queue Processing
Patients seen from queue based on priority level + time in queue
## MODEL INPUTS: DISTRIBUTION OF PATIENTS BY CATEGORY

<table>
<thead>
<tr>
<th>Patient Category</th>
<th>Proportion of Weekly Cases</th>
<th>Prioritization Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening Colonoscopy</td>
<td>23%</td>
<td>4</td>
</tr>
<tr>
<td>Low-Risk Surveillance Colonoscopy</td>
<td>15%</td>
<td>3</td>
</tr>
<tr>
<td>High-Risk Surveillance Colonoscopy</td>
<td>15%</td>
<td>2</td>
</tr>
<tr>
<td>Diagnostic – Colonoscopy (incl. FIT+)</td>
<td>25%</td>
<td>1</td>
</tr>
<tr>
<td>Diagnostic – Upper Endoscopy</td>
<td>22%</td>
<td>1</td>
</tr>
</tbody>
</table>

## MODEL INPUTS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weekly New Patient Arrivals (number of patients)</td>
<td>113</td>
</tr>
<tr>
<td>Weekly Endoscopy Capacity (number of appointments)</td>
<td>110</td>
</tr>
<tr>
<td>Baseline Wait Time (weeks)</td>
<td>7.1</td>
</tr>
<tr>
<td>Likelihood that Screening Patients follow-through with FIT</td>
<td>85%</td>
</tr>
<tr>
<td>Likelihood of Positive FIT</td>
<td>15%</td>
</tr>
<tr>
<td>Patients in system at simulation start (number of patients)</td>
<td>802</td>
</tr>
<tr>
<td>COVID-Related Capacity Limits</td>
<td></td>
</tr>
<tr>
<td>Weeks 1-10</td>
<td>5%</td>
</tr>
<tr>
<td>Weeks 11-20</td>
<td>50%</td>
</tr>
<tr>
<td>Weeks 21-30</td>
<td>75%</td>
</tr>
<tr>
<td>Weeks 31-150</td>
<td>100%</td>
</tr>
</tbody>
</table>
STRATEGIES

**Exchange**
Patients referred for colonoscopy are changed to FIT-based screening

**Extend**
For patients with 1-2 adenomas on prior exam, extend the interval from 5 to 7 years

**Overtime**
Add capacity to reflect one day of weekend endoscopy hours
OUTCOMES

- Average patient waiting time
- Weeks to system recovery
- Number of patients who wait more than 4 weeks
- Number of patients seen for endoscopy
RESULTS: AVERAGE PATIENT WAIT TIME

Wait Time (Weeks)

- Base Case
- Exchange
- Extend
- Overtime

0
10
20
30
40
50
60
70
80

Screening
Low-Risk Surveillance
High-Risk Surveillance
Diagnostic
Overall
RESULTS: AVERAGE PATIENT WAIT TIME

- **Base Case**: 70.3 weeks
- **Exchange**: 41.3 weeks
- **Extend**: 33.2 weeks

* = 0 patients in this category
RESULTS: AVERAGE PATIENT WAIT TIME

* = 0 patients in this category
RESULTS: AVERAGE PATIENT WAIT TIME

* = 0 patients in this category
RESULTS: AVERAGE PATIENT WAIT TIME

<table>
<thead>
<tr>
<th></th>
<th>Wait Time (Weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td></td>
</tr>
<tr>
<td></td>
<td>70.3</td>
</tr>
<tr>
<td></td>
<td>23.1</td>
</tr>
<tr>
<td></td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>28.8</td>
</tr>
<tr>
<td></td>
<td>10.9</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>9.8</td>
</tr>
<tr>
<td>Exchange</td>
<td></td>
</tr>
<tr>
<td></td>
<td>41.3</td>
</tr>
<tr>
<td></td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>14.1</td>
</tr>
<tr>
<td>Extend</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33.2</td>
</tr>
<tr>
<td></td>
<td>10.1</td>
</tr>
<tr>
<td></td>
<td>5.7</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Overtime</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>11.3</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

* = 0 patients in this category
## RESULTS: WEEKS TO SYSTEM RECOVERY

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Weeks to Recovery</th>
<th>Number of Patients in Queue after 150 Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Case</td>
<td>&gt;150</td>
<td>2,937</td>
</tr>
<tr>
<td>Exchange</td>
<td>130</td>
<td>0</td>
</tr>
<tr>
<td>Extend</td>
<td>&gt;150</td>
<td>1,291</td>
</tr>
<tr>
<td>Overtime</td>
<td>148</td>
<td>0</td>
</tr>
</tbody>
</table>
RESULTS: NUMBER OF PATIENTS WAITING > 4 WEEKS

<table>
<thead>
<tr>
<th>Number of Patients Waiting</th>
<th>Base Case</th>
<th>Exchange</th>
<th>Extend</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5,445</td>
<td>2,816</td>
<td>3,448</td>
<td>3,732</td>
</tr>
<tr>
<td>Screening</td>
<td>2,960</td>
<td>909</td>
<td>1,854</td>
<td>1,640</td>
</tr>
<tr>
<td>Low-Risk Surveillance</td>
<td>971</td>
<td>742</td>
<td>685</td>
<td>787</td>
</tr>
<tr>
<td>High-Risk Surveillance</td>
<td>869</td>
<td>1,165</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnostic</td>
<td>655</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RESULTS: NUMBER OF PATIENTS SEEN

- **Base Case**: 14,289 patients
- **Exchange**: 13,812 patients
- **Extend**: 14,287 patients
- **Overtime**: 17,198 patients
RESULTS: AVERAGE PATIENT WAIT TIME (COMBINED STRATEGIES)

- Exchange + Extend: 10.9
- Exchange + Overtime: 11.3
- Extend + Overtime: 12.7
- All Strategies: 6.3

* = 0 patients in this category
RESULTS: NUMBER OF PATIENTS WAITING > 4 WEEKS (COMBINED STRATEGIES)

Exchange + Extend
- Screening: 915
- Low-Risk Surveillance: 651
- High-Risk Surveillance: 539
- Diagnostic: 1,566

Exchange + Overtime
- Screening: 771
- Low-Risk Surveillance: 539
- High-Risk Surveillance: 800
- Diagnostic: 2,110

Extend + Overtime
- Screening: 1,203
- Low-Risk Surveillance: 771
- High-Risk Surveillance: 590
- Diagnostic: 824

All Strategies
- Screening: 760
- Low-Risk Surveillance: 514
- High-Risk Surveillance: 1,203
- Diagnostic: 2,617
By triaging patients effectively, we can perform most diagnostic and high-risk surveillance procedures in a timely fashion.

Without offloading strategies, prolonged queues and wait times develop, especially for screening colonoscopies.

An Overtime strategy of one weekend endoscopy day increased colonoscopy volume and had the greatest impact on the number of screening procedures completed.

Exchange strategy reduced overall wait times more than Extend, and similarly to Overtime.

Combining strategies is most effective in improving metrics.
LIMITATIONS

- Rigid patient prioritization structure (always see diagnostic patients first, etc.)
- Strategy implementation is static throughout the simulation period
- Demand is static throughout the simulation period
- Sensitivity analysis results not reported here
APPLICATIONS

- Inputs can be changed, and the simulation applied to specific endoscopy locations

- Took data from different VA site locations around the nation and ran the simulation with their data

- Determine the best strategy on an individual case-by-case basis
CONCLUSIONS

- “Business as usual” is likely to be ineffective at restoring access in clinical settings that have developed substantial backlogs
- Simulation modelling can provide a powerful tool to identify the most clinically appropriate and effective strategies to reduce backlogs after COVID-19
- Endoscopy units may lack incentives or resources to implement offloading strategies, such as Exchange

- To maximize endoscopy volume: Overtime
- To minimize average wait time: Exchange
- Combining strategies can provide greater impact
ACKNOWLEDGMENTS

Researchers

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