From Big Data to Good Data: Analysis of the Variability in Colonoscopy Appointments
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Background and Problem Statement

Colonoscopy Procedure
• Main screening test for colorectal cancer (CRC). CRC is the second leading cause of cancer-related deaths in the U.S.
• Allows for direct visual examination of the colon & rectum
• Performed by a gastroenterologist in an endoscopy clinic

Challenges to Daily Colonoscopy Schedule
• Patient non-punctuality
• Significant variability in procedure duration in part due to the quality of the patient’s pre-procedure bowel prep

<table>
<thead>
<tr>
<th>Prep-quality</th>
<th>Duration</th>
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<tbody>
<tr>
<td>Adequate</td>
<td>Low variability</td>
</tr>
<tr>
<td>Inadequate</td>
<td>High variability</td>
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Challenges to Analyzing Colonoscopy Schedule
• Historical data are stored in two different systems, which make data hard to gather and analyze
  – MiChart: appointment scheduling, patient demographics, patient and family clinical history, indication for colonoscopy, insurance type, procedure outcomes
  – ProVation: appointment scheduling data, patient timestamps, clinic location, bowel prep adequacy

Our Approach
• Clinical Observations: to learn about the domain and develop a nuanced understanding of the problem
• Build Data Warehouse and Analysis Tools: to learn about the variability and characteristics of the daily schedules
• Optimization and Simulation: to design, propose, and evaluate different colonoscopy scheduling templates from which the clinic managers can select the most preferred one based on the quality of each

Do we Really Have a Problem?

(1) Significant and Different Variability in Colonoscopy Duration Based on Prep Quality (Adequate & Inadequate)

Figure 1. Variability of colonoscopy duration with adequate prep quality (2013-2017)

(2) Significant Variability in Patient Non-punctuality

Early arrivals Late arrivals

Future Action Items
• Continue observations at the University of Michigan endoscopy clinics
• Obtain a better approximation of the empirical probability distributions of colonoscopy duration and patient non-punctuality
• Use the identified distributions of colonoscopy duration and patient non-punctuality to optimize the clinics’ appointment schedules
• Build a data-driven scheduling tool that can be used by clinic managers

Schedule Optimization
• By incorporating the variability in colonoscopy duration and patient non-punctuality when building the colonoscopy schedule, it is possible to reduce patient delays, idling, and clinic overtime
• We built a statistical model that approximates (predicts) the variability in patient non-punctuality colonoscopy duration as a function of bowel prep quality
• We developed a mathematical model that predicts patient non-punctuality and colonoscopy duration (based on historical data) in order to optimize the colonoscopy appointment schedule

Performance Metric Percentage Reduction
Overtime -74%
Total Idle Time -51%
Waiting Time -66%

Future Action Items
• The Seth Bonder Foundation
• The University of Michigan Gastroenterology Learning Community
• The Health System Data Warehouse
• CHEPS students and staff
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