CENTER FOR HEALTHCARE ENGINEERING & PATIENT SAFETY
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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

Prep-quality	Duration
Adequate	Low variability
Inadequate	High variability

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)

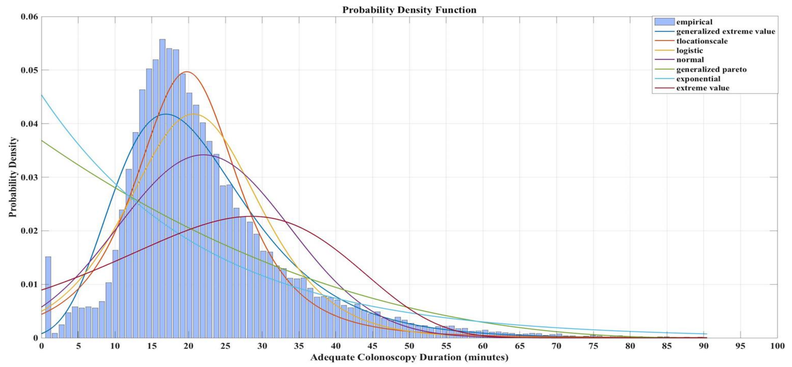

Figure 1. Variability of colonoscopy duration with adequate prep quality (2013-2017)

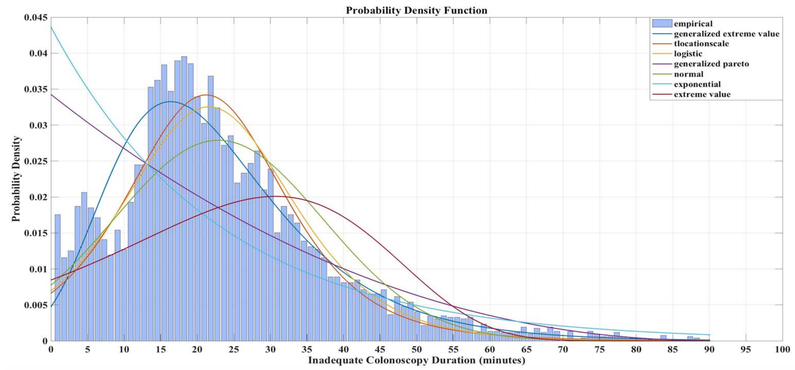

Figure 2. Variability of colonoscopy duration with inadequate prep quality (2013-2017)

(2) Significant Variability in Patient Non-punctuality

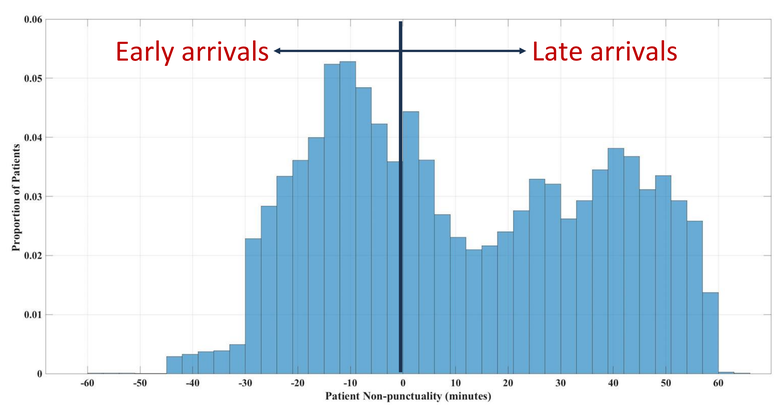

Figure 3. Variability of patient non-punctuality (2013-2017)

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

	Procedure Number and Scheduled Time										
Schedule	1	2	3	4	5	6	7	8	9	10	
Current Schedule	8:30	9:00	9:30	10:00	10:30	11:00	11:30	12:00	12:30	1:00	← Fixed Blocks
Optimal Schedule	8:25	8:55	9:25	9:55	10:25	10:50	11:15	11:40	12:05	12:35	← Variable Blocks

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

*Precentage Reduction $= \frac{\text{optimized schedule} - \text{current schedule}}{\text{current schedule}}\%$

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

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