Simulation of Patient Scheduling for Colonoscopy

Karmel Shehadeh1,2, Jacob Kurlander3, Sameer Saini4, Amy Cohn1,2, Luis Garcia-Guzman1,2, Henry Ballout1,2, Jackson Bennett4, Ajaay Chandrasekaran5, Abhilash Rao1,2, Meng Sang1,2, Pranjal Singh1,2, William Yang1,2, Bill Zhang2

1Department of Industrial and Operations Engineering, University of Michigan, 2Center for Healthcare Engineering and Patient Safety, 3University of Michigan Medical School, 4University of Michigan Health System

Problem Statement

Background
- Colorectal cancer (CRC) is the second leading cause of cancer-related deaths in the U.S.
- Colonoscopy can both identify existing cancers, so treatment can be started, and prevent future cancers, through the detection and removal of polyps.
- Largely due to the pre-procedure bowel prep, there can be significant variability in procedure time.
- This negatively impacts providers and capacity utilization. More importantly, long delays for patients can have negative health effects.

Objectives
- Develop a simulation-based framework for evaluating patient schedules under multiple criteria
- Analyze and compare several heuristic scheduling and sequencing rules

Methods
- Monte Carlo simulation to evaluate 8 different scheduling heuristics.
- Intake, procedure and recovery durations were generated uniformly using their minimum and maximum possible values based on expert knowledge and field observations.
- Evaluated results under 4 (potentially conflicting) metrics:
  1. Overtime.
  2. Idle time.
  3. Waiting time.
  4. Patient total time in the unit.

<table>
<thead>
<tr>
<th>Heuristics</th>
<th>Ordering method</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF</td>
<td>Schedule procedures in ascending order of duration mean.</td>
</tr>
<tr>
<td>LPF</td>
<td>Schedule procedures in descending order of duration mean.</td>
</tr>
<tr>
<td>SVF</td>
<td>Schedule procedures in ascending order of duration variance.</td>
</tr>
<tr>
<td>LVF</td>
<td>Schedule procedures in descending order of duration variance.</td>
</tr>
<tr>
<td>INP</td>
<td>Schedule procedures in an ascending order of probability of no-show.</td>
</tr>
<tr>
<td>DNP</td>
<td>Schedule procedures in an descending order of probability of no-show.</td>
</tr>
<tr>
<td>INPV</td>
<td>Schedule procedures in an descending order of probability of no-show x duration variance.</td>
</tr>
<tr>
<td>DNPV</td>
<td>Schedule procedures in an ascending order of probability of no-show x duration variance.</td>
</tr>
</tbody>
</table>

Preliminary Results

- Figure 1: Typical flow of a single patient on the day of colonoscopy and major sources of variability highlighted

Basic Flow Logic

- Figure 2: Monte Carlo simulation logic for each heuristic

Acknowledgements

- The Seth Bonder Foundation
- Summer Undergraduate Research in Engineering–SURE (for UM undergraduate students)
- We also express our gratitude to Dr. Jacob Kurlander, Dr. Sameer Saini and all CHEPS students who have contributed to this project