

Simulation of patient scheduling for colonoscopy

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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.

Patient Flow Overview

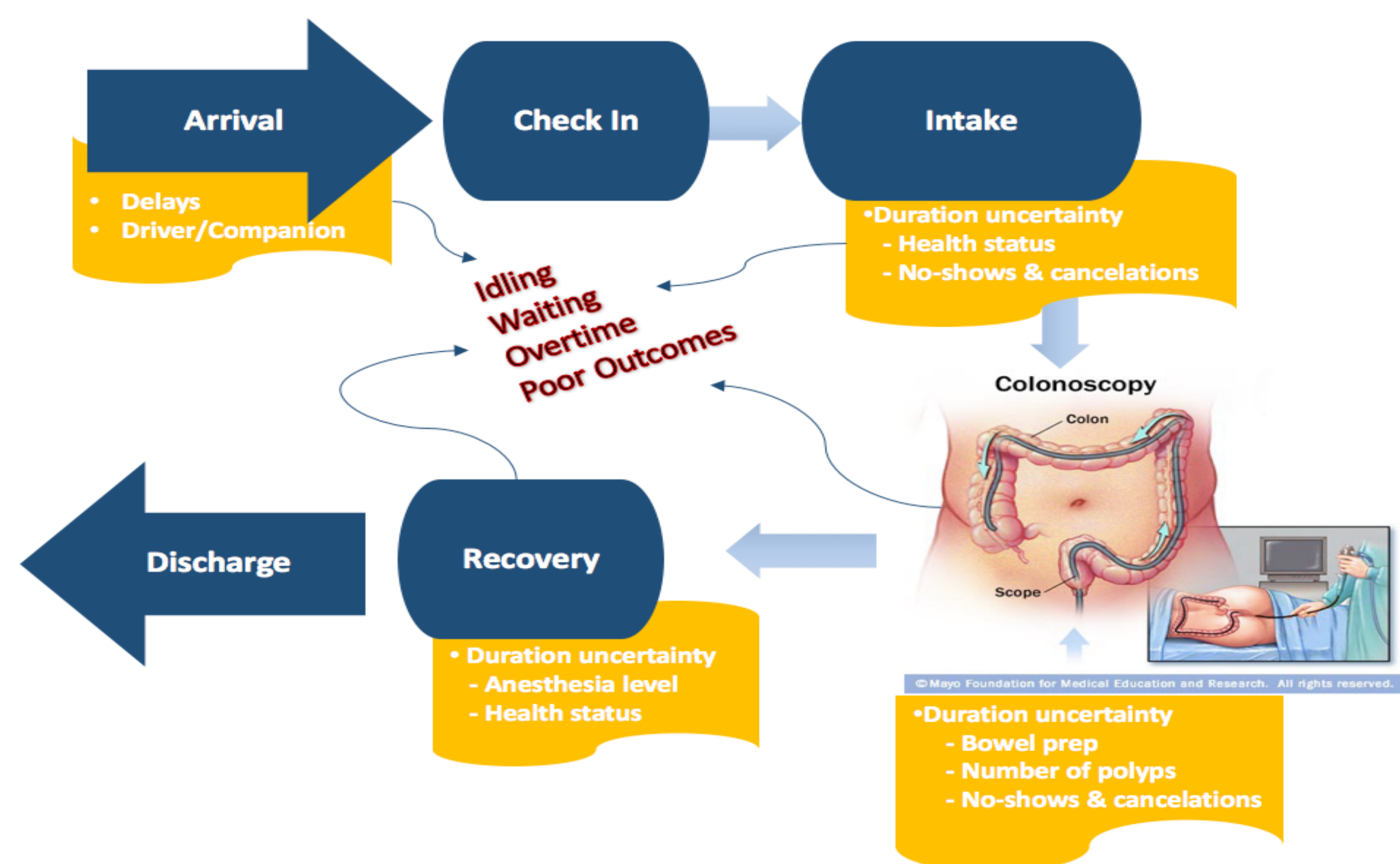


Figure 1: Typical flow of a single patient on the day of colonoscopy and major sources of variability highlighted

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.
- Evaluated results under 4 (potentially conflicting) metrics:
 1. Overtime.
 2. Idle time.
 3. Waiting time.
 4. Patient total time in the unit.

Table 1: Tested Heuristics

Heuristics	Ordering method
SPF:	Schedule procedures in ascending order of duration mean.
LPF:	Schedule procedures in descending order of duration mean.
SVF:	Schedule procedures in ascending order of duration variance.
LVF:	Schedule procedures in descending order of duration variance.
INP:	Schedule procedures in an ascending order of probability of no-show.
DNP:	Schedule procedures in an descending order of probability of no-show.
INPV:	Schedule procedures in an descending order of probability of no-show x duration variance.
DNPV:	Schedule procedures in an ascending order of probability of no-show x duration variance.

Basic Flow Logic

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Input : Set of Heuristic
Output: Metric values
1 for each heuristic do
2   for r=1:1000 do
3     Randomly generate a "type" for each patient (which defines a distribution of treatment times).
4     Generate a treatment time for that patient based on their corresponding distribution.
5     Order the patients according to the policy.
6     Process the patients throughout the day.
7     Calculate the metrics for the day.
8   end
9   Calculate the average of metrics over all simulation days for this heuristic.
10 end
11 return Average of metric values over all days for each heuristic.
12 Compare across policies
  
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Figure 2: Monte Carlo simulation logic for each heuristic

Preliminary Results

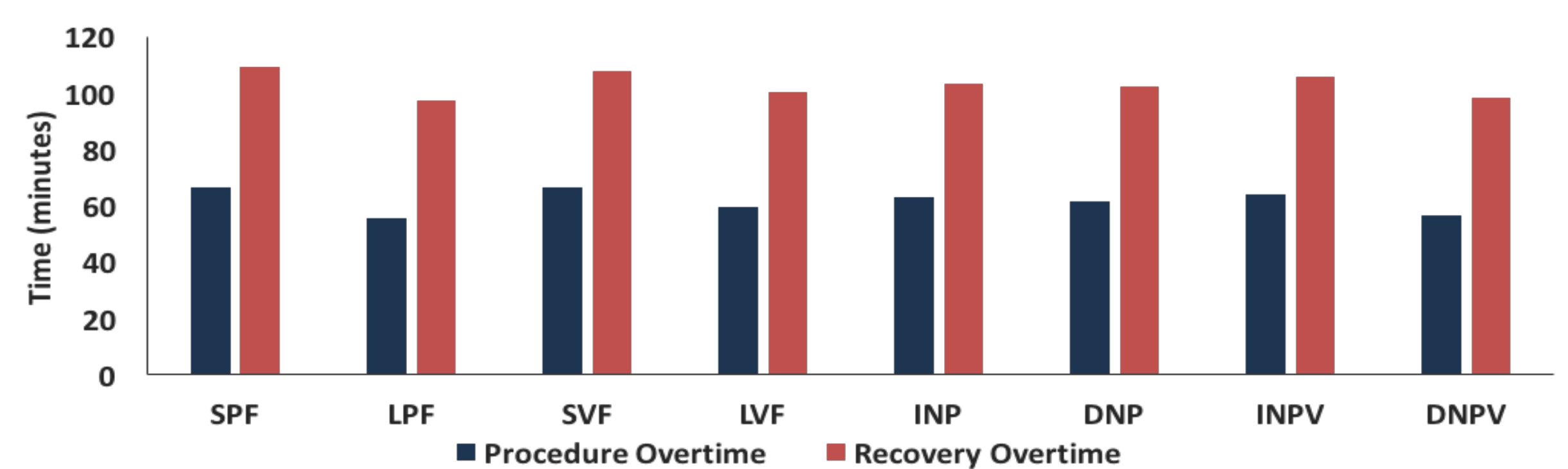


Figure 3: Average procedure and recovery rooms overtimes per day.

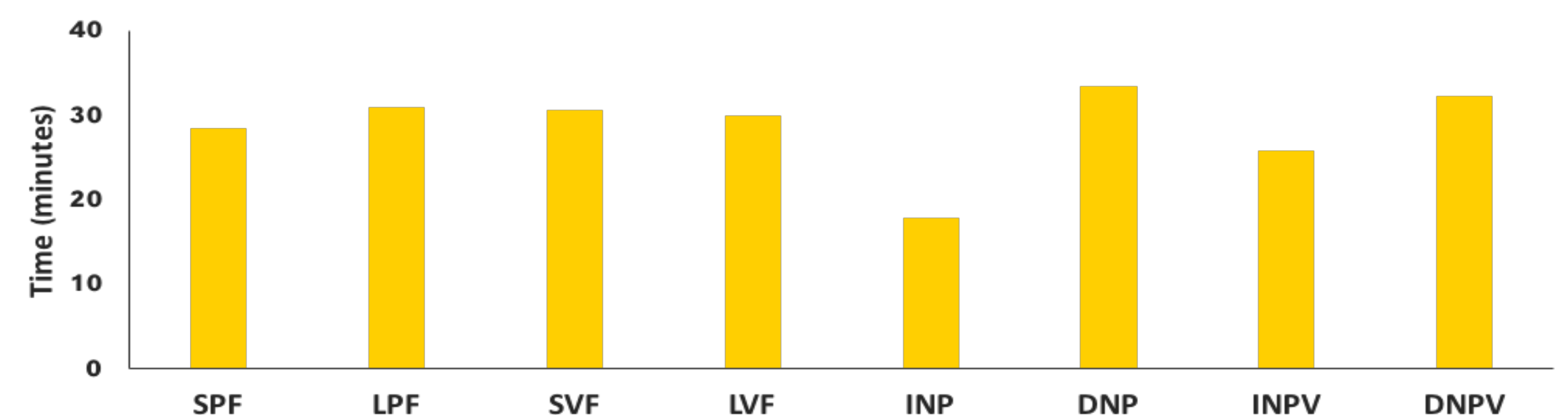


Figure 4: Average idle time per day

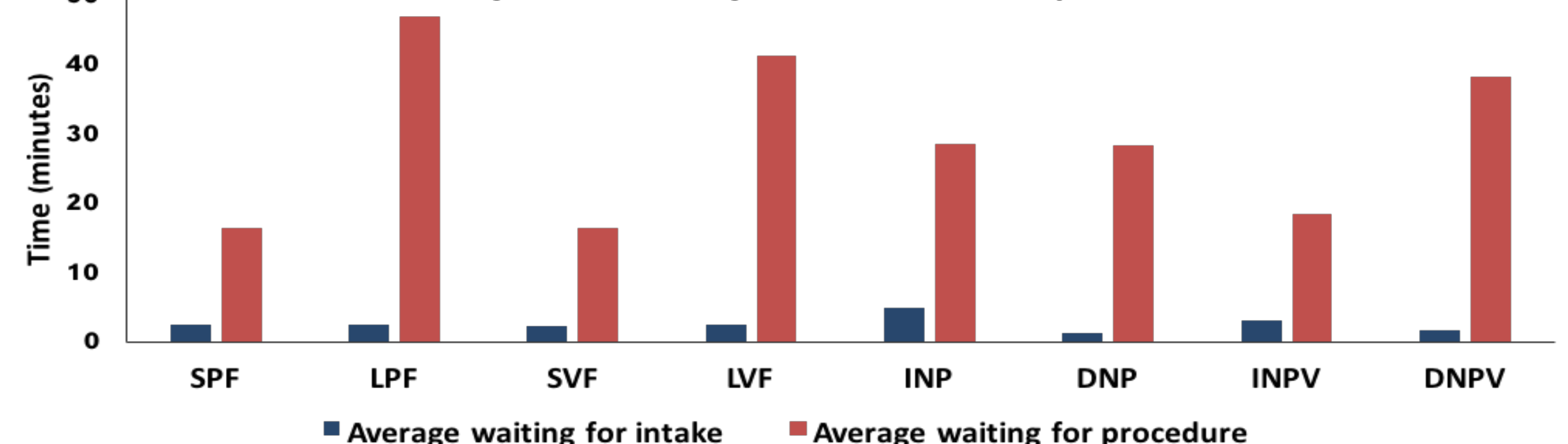


Figure 5: Average waiting time for intake and for procedure per day over all patients

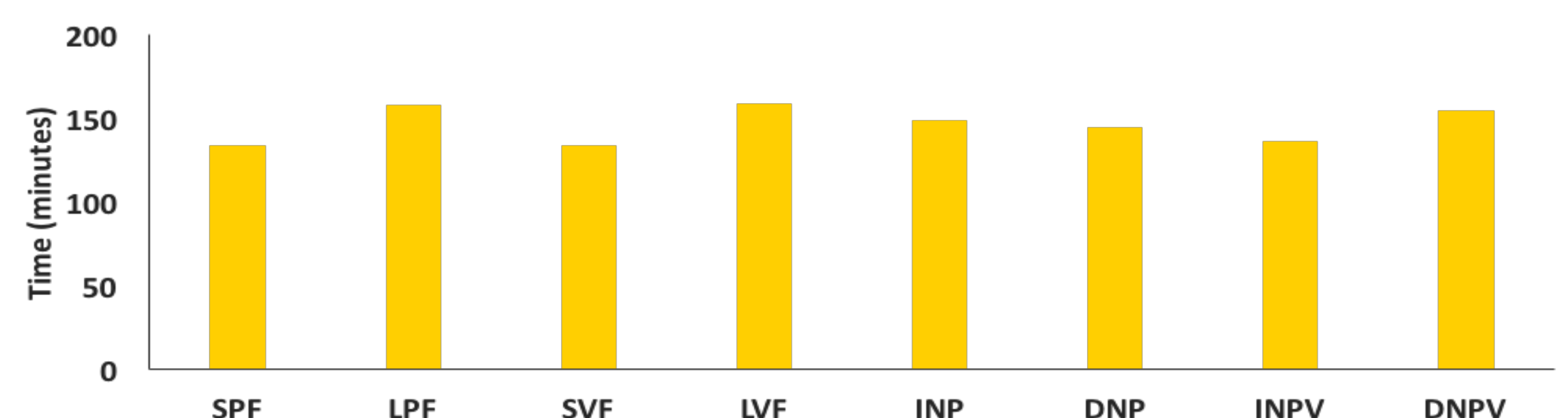


Figure 6: Average total time spent in the unit per day over all patients

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