Improving Patient Flow in an Outpatient Cancer Center

Elizabeth Olin[1], AJ Chandrasekaran[2], Prof. Amy Cohn[1], Carolina Typaldos[3]
[1]Department of Industrial and Operations Engineering, Ann Arbor, MI.
[2]Department of Electrical Engineering and Computer Science, Ann Arbor, MI.
[3]University of Michigan Comprehensive Cancer Center, Ann Arbor, MI.

Introduction

Patient visit to an outpatient Cancer Center

- Often long, multi-step process
- Can take anywhere from 30 min to 8 hrs
- Requires coordination of multiple departments
- Many opportunities for disruptions and delays
    - Delay domino effect

Concerns

- Very long visit lengths
- Added stress and risk to patients
- Increase in provider overtime

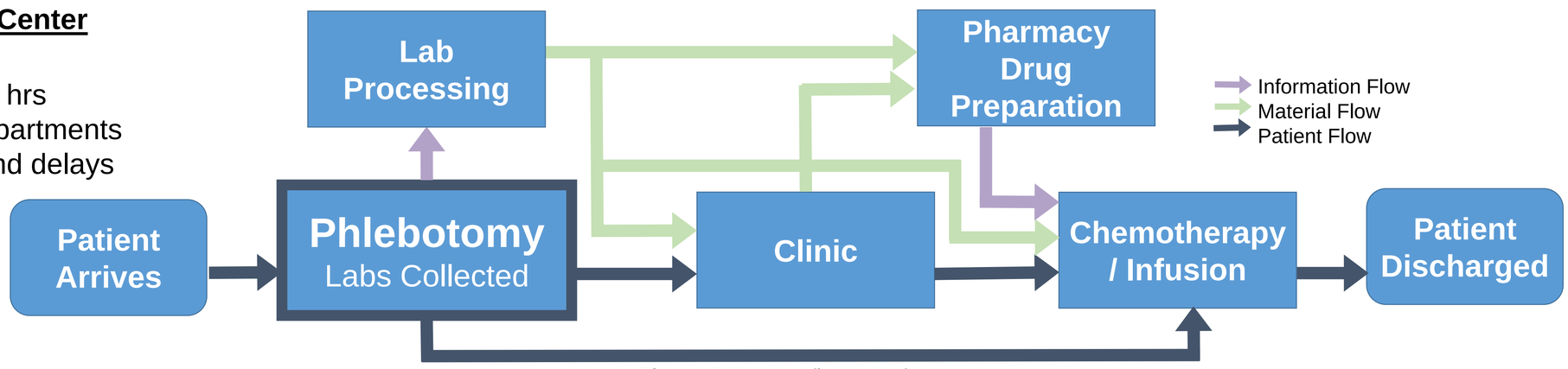


Figure 1: Process flow overview.

Phlebotomy

Current State

- Nearly all infusion patients enter the system through phlebotomy
- Blood drawn for labs needed:
    - By **provider** before clinic appointment to assess patient
    - By **pharmacy** to initiate drug preparation
- Multi-step/ multi-wait process, increasing patient wait times

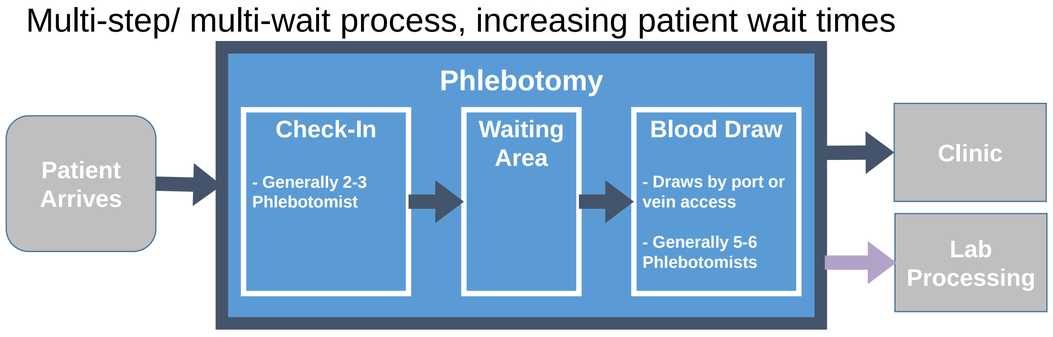


Figure 2: Phlebotomy flow overview.

- Non-uniform volume throughout the day
    - In order to fit in all following appointments, much higher patient volume in the morning

Problem Statement

- Determine changes in patient flow, phlebotomist work flow and/or staffing decisions to improve efficiencies and decrease wait times
- Unable to actually implement various changes in the working environment in order to test and assess effectiveness

Discrete Event Simulation

Approach

- Developed using C++
- Can manipulate input parameters to observe effect on various metrics
- Manipulability of simulation models allows users to explore the impact of changes without the risk of implementation
- Can assess impact of policy changes before actual implementation
- Maintain a growing queue of events that occur throughout the day, sorted by time of occurrence
- Model both patient and phlebotomist actions

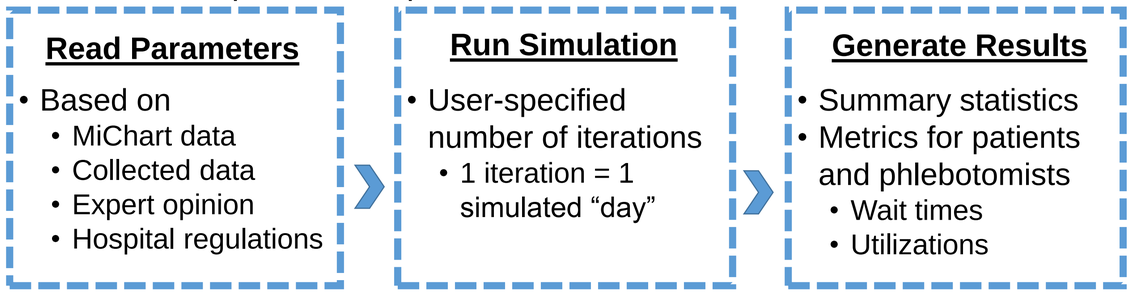
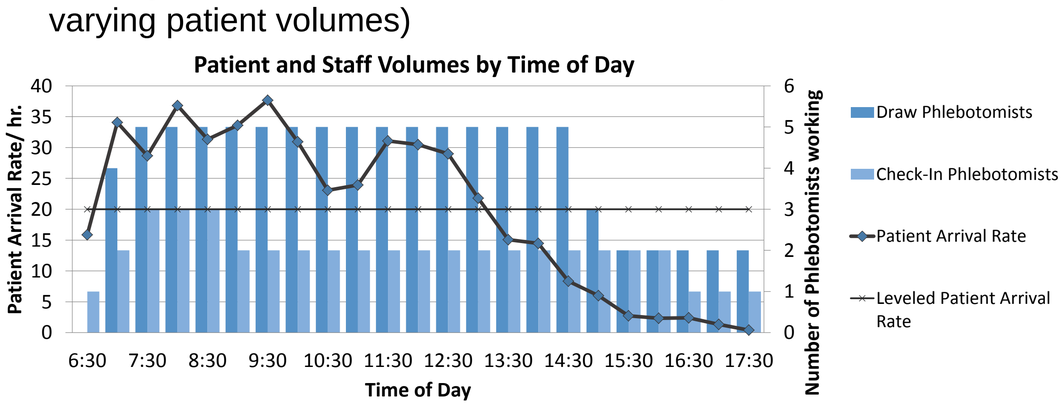


Figure 3: Simulation process overview.

Base Case

- Patient arrival distributions representing current uneven volumes
- Staffing levels based on current schedule (tailored to accommodate varying patient volumes)



"What-If" Analysis

Level system variability

Scenario	Mean Wait Time (min) Check-In	Draw	Total
Base Case	2:52	8:21	11:14
Level Arrivals	2:47	6:18	8:03
Level Arrivals & Adjust Staffing (2 Check-in, 5 Draw all day)	1:18	1:28	2:47

Figure 4: Effect of leveling variable on wait times.

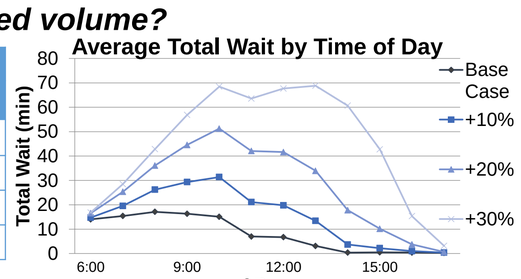
- Leveling patient arrivals/ staffing schedules results in huge wait time reductions but is unrealistic due to lack of control over patient arrivals

Patient volumes increase

1. Can current capacity handle increased volume?

Scenario (from Base Case)	Mean Wait Time (min) Check-In	Draw	Total
Base Case	2:52	8:21	11:14
+10% Patient Volume	4:40	16:45	21:25
+20% Patient Volume	7:24	28:45	36:10
+30% Patient Volume	12:44	40:40	53:29

Figure 5: Effect of increased volume on wait times.



- Increased patient volumes with current staffing levels quickly leads to much larger wait times

2. How could staffing changes help accommodate?

Scenario (from +20% Patient Volume)		Mean Wait Time (min) Check-In	Draw	Total
No additional Phlebotomist	**+20% Patient Volume**	7:24	28:45	36:10
	1Check-in becomes Draw	1:47:15	5:32	1:42:43
1 Additional Phlebotomist	**+1Draw**	7:32	6:29	14:01
	+1Check-in	0:59	32:54	33:53
2 Additional Phlebotomists	**+1Draw & +1Check-in**	0:58	10:35	11:34

Figure 6: Effects of staffing changes on wait times.

- At 20% increased volume:
    - Making a check-in phlebotomists draw helps reduce the long draw waits but causes much longer waits overall
    - Adding 1 additional draw phlebotomist would have more impact in reducing wait times than 1 additional check-in
    - Adding 1 additional Phlebotomist to both check-in and draw results in wait times comparable to the current base case

Future Work

- Continued improvement towards representing reality (current state)
    - More accurate service time distributions
    - More accurate arrival rate data
    - Non-instantaneous service transitions
    - Incorporation of additional roles
    - Incorporation of dynamic roles/staffing
- Exploration of additional "what-if" scenarios
- Implementation of improvements
- Additional applications (outside of Phlebotomy) of model functionalities

Acknowledgements

This research is generously supported by the Center for Healthcare Engineering and Patient Safety, the Seth Bonder Foundation, the U of M College of Engineering SURE Program, and the UMHS Comprehensive Cancer Center.

We also thank all the CHEPS students that helped with this research and all the Cancer Center clinical collaborators, especially those representatives from the Phlebotomy Department.