Improving patient flow in an outpatient chemotherapy infusion center

Pamela Martinez Villarreal[1], Matthew Rouhana[1], Prof. Amy Cohn[1], Carolina Typaldos[2]
[1]Department of Industrial and Operations Engineering, Ann Arbor, MI.
[2]University of Michigan Comprehensive Cancer Center, Ann Arbor, MI.

Introduction

The flow through an outpatient chemotherapy infusion center contains elements of randomness throughout the process. This can cause disruptions that lead to patient delays and overtime for the staff. We study the full process experienced by infusion patients in the University of Michigan Comprehensive Cancer Center, identify key bottlenecks within this process, and develop engineering-based techniques aimed at reducing patient delays and improving staff workload balance.

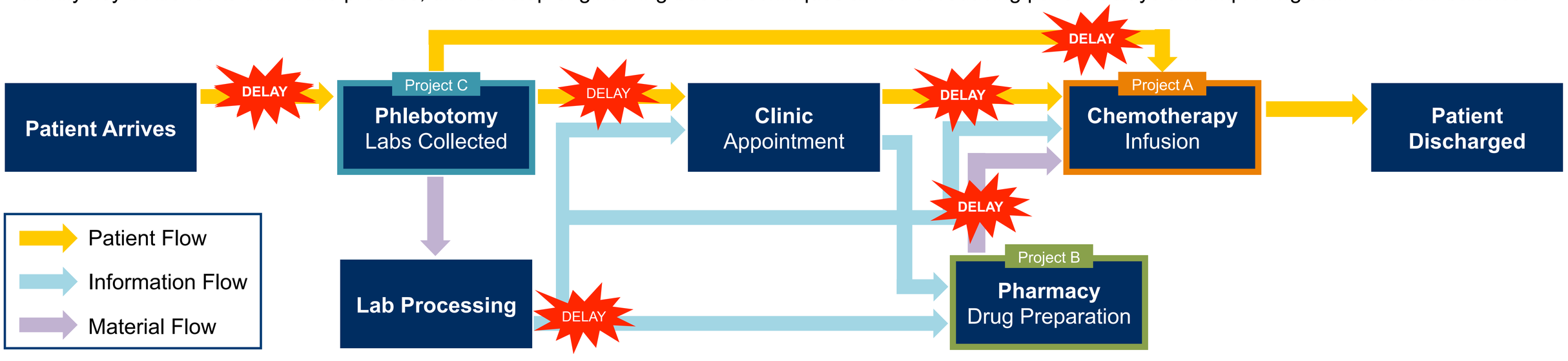

Figure 1: Process flow overview.

Project A: Infusion Scheduling

Background: Patients wait ~45 minutes after arrival at infusion before being seated in a chair, due to high treatment time variability. Improved scheduling of infusion patients could result in reduced total length of operations and patient wait time.

Methods: Considering patient acuity, age, and other characteristics can be used to tailor appointment lengths to each patient. Using appointment templating, more consistent and reliable schedules can be created for patients.

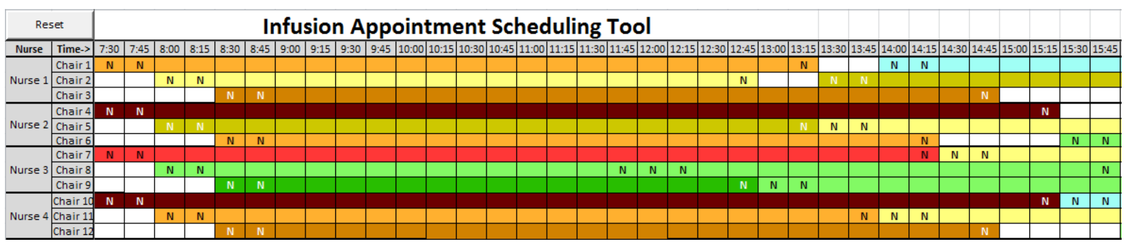

Figure 3: Prototype of infusion appointment scheduling tool.

Current Work*:* Incorporate patient acuity into model, develop and implement scheduling guidelines.

Project B: Pharmacy Pre-Mix Tool

Background: Infusion drugs are expensive and their use uncertain (e.g. patient cancellation). Thus, pharmacy does not prepare most drugs in advance. “Pre-mixing” may help improve patient waiting times/workload balance.

Methods: Collected and analyzed data on prices, treatment times, deferral rate, etc.

Table 2: Factor influence on objective function.

Factor	Effect on Priority
Drug cost	Low cost → Higher priority
Probability of deferral or dosage change	Low probability → Higher priority
Number of patients receiving drug	Higher number of patients → Higher priority

Current Work: Developing optimization model to determine which drugs should be prepared in advance.

Maximize:
Trade-off between projected savings (wait time and workload) vs. risk of drug waste
Subject to:
Capacity: You can only make X number of drugs at a time
Production: Each dose can only be made once
Time: Drugs have to be made within the pre-mix period

Figure 2: Description of model formulation.

Project C: Lab Process Analysis

Background: Lab results are needed by the provider before a clinic appointment to assess the patient and by the pharmacy to initiate drug preparation/infusion process. We are concerned about: patient waiting time, balanced phlebotomist workload, and lab results being available within 1 hour.

Methods: Workflow analysis and time study of blood draw area, discrete event simulation of patient flow through area, and Table Top Simulation for education and brainstorming.

Findings: Total processing time (blood draw and lab analysis) exceeds 1 hour (blood draw alone accounts for 34.12 min, on average).

Table 1: Time study results.

Step	Mean Time (Std Dev) in Minutes
Patient waits for check-in	2.67 (3.92)
Check-in	3.27 (2.15)
Patient waits for call back	4.38 (5.64)
Blood draw	**Vein**: 5.11 (3.75) **Port**: 13.28 (4.64)
Batch	15.16 (4.15)
Prepare and send capsule	1.49 (1.03)

Current Work: Developing a discrete-event simulation of the current state to test and measure the impact of different future/“what if” scenarios on the patient flow, waiting times, and resource utilization percentages. These scenarios will include changes in existing staff roles and their tasks, phlebotomist’s work flow, and the layout of the phlebotomy station.

Acknowledgements

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

Clinical Collaborators: Dr. Marian Grace Boxer, Diane Drago, Corinne Hardecki, Jennifer Mathie, Carol McMahon, Harry Neusius, Kelly Procailo, Renee Stoklosa, Irene Turkewycz, Dr. Alon Weizer

Student Collaborators: Hassan Abbas, Jeremy Castaing, Ajaay Chandrasekaran, Chhavi Chaudhry, Madalina Jiga, Jonathon McCormick, Donald Richardson, Stephanie See, Brooke Szymanski, Jonathan Zhou