Agenda

- The Team

- Background

- Blood Draw Station

    – Organization and Layout

    – Operation and Process Flow

- Discrete Event Simulation

    – Data Collection

    – Design and Logic

- Table-Top Simulation

- Current/Future Work

The Team

Hassan Abbas	Nursing Student
Jeremy Castaing, Ph.D Candidate	Industrial and Operations Engineering
Ajaay Chandrasekaran	Computer Science Student
Chhavi Chaudhry	Industrial and Operations Engineering Student
Amy Cohn, Ph.D.	Associate Director, CHEPS
Diane Drago	Patient & Family Advisory Board (PFAB)
Marian Grace Boxer, MD	Professor, Internal Med., Hematology/Oncology
Corinne Hardecki, RN	Clinical Care Coordinator, Infusion
Madalina Jiga	Nursing Student
Jennifer Mathie	Supervisor, Department of Pathology
Jonathon McCormick	Industrial and Operations Engineering

The Team

Carol McMahon, RN	Nurse Supervisor, Infusion
Harry Neusius	Manager, Department of Pathology
Donald Richardson, Ph.D Pre-Candidate	Industrial and Operations Engineering
Stephanie See, RN	Nursing Graduate
Renee Stoklosa	Associate Supervisor, Department of Pathology
Brooke Szymanski, RN	Nursing Graduate
Irene Turkewycz, RN	Nurse Manager, Infusion
Carolina Typaldos, MHSA	Operations Manager, Infusion
Alon Zadok Weizer, MD, MS	Medical Director, UMCCC
Jonathan Zhou	Pre-Medical Student

Cancer Statistics

– Second leading cause of death in the United States

– In 2015, there will be an estimated 1,658,370 new cancer cases diagnosed and 589,430 cancer deaths in the US.

Source:
Centers for Disease Control and Prevention (2015) http://www.cdc.gov
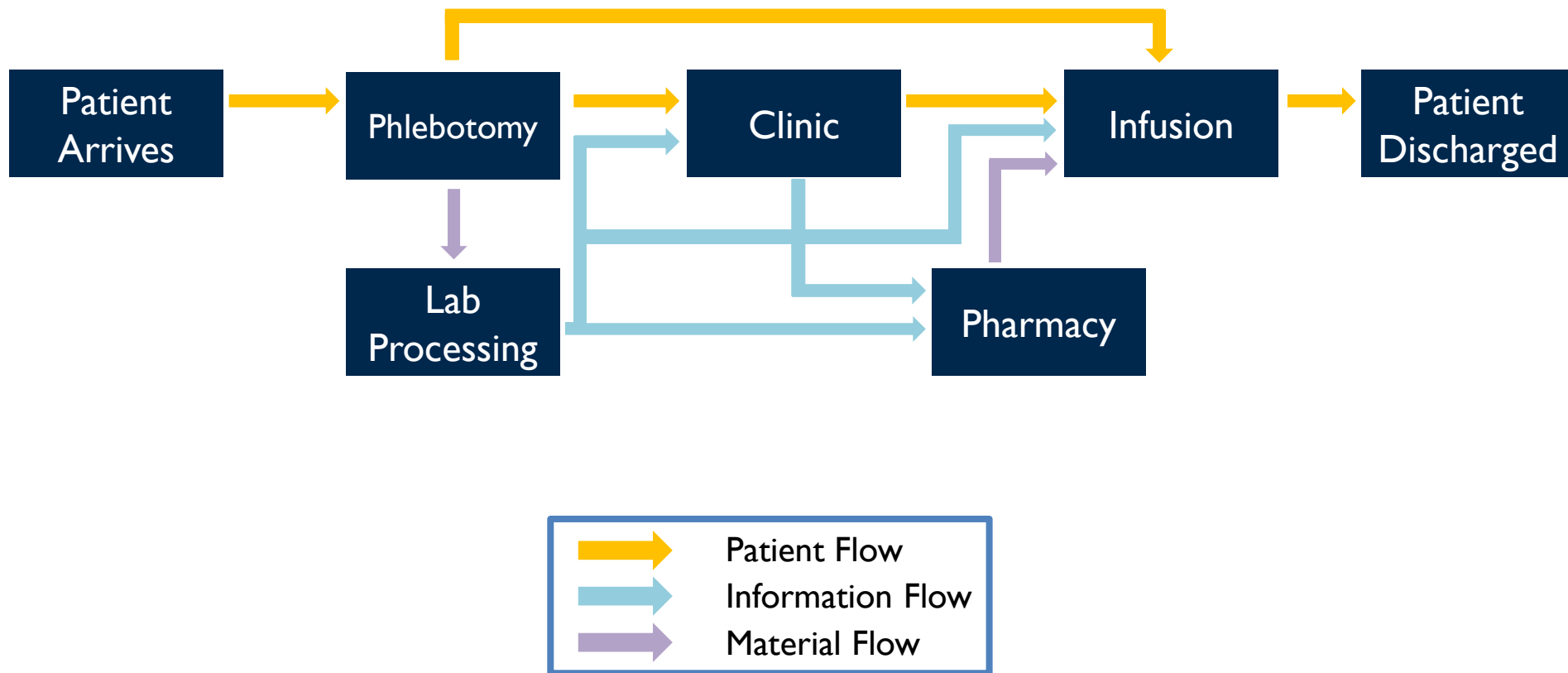American Cancer Society (2015) http://www.cancer.org

– In 2014, over 50% of outpatient visits in the UMCCC resulted in chemotherapy infusion treatments:

- 97,147 outpatient visits
- 58,419 infusion treatments

– Variable infusion treatment times (30 min – 8 hr)

Source:
U of M Comprehensive Cancer Center (2015)
http://www.mcancer.org

Infusion Overview

Process flow diagram:

Patient Arrives → Phlebotomy → Clinic → Infusion → Patient Discharged

Phlebotomy → Lab Processing (Material Flow)

Lab Processing → Clinic (Information Flow)
Lab Processing → Pharmacy (Information Flow)
Clinic → Pharmacy (Information Flow)
Clinic → Infusion (Information Flow)
Pharmacy → Infusion (Material Flow)
Phlebotomy → Infusion (Patient Flow, top loop)

Legend:
- **Patient Flow** (yellow)
- **Information Flow** (light blue)
- **Material Flow** (purple)

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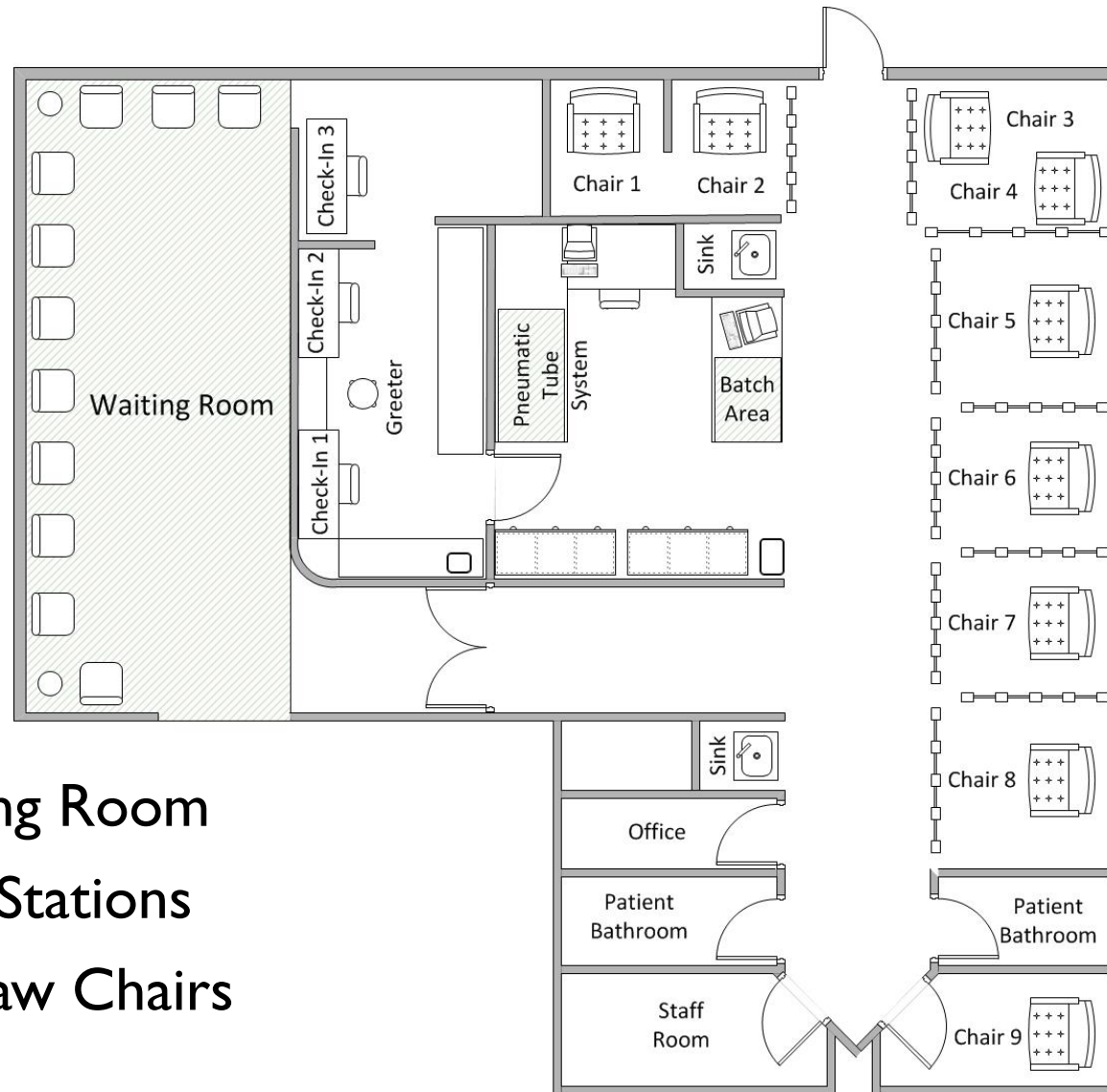UNIVERSITY OF MICHIGAN

Phlebotomy

Lab results needed within **1 hour** window by:

- by **provider** before clinic appointment to assess patient
- by **pharmacy** to initiate drug preparation
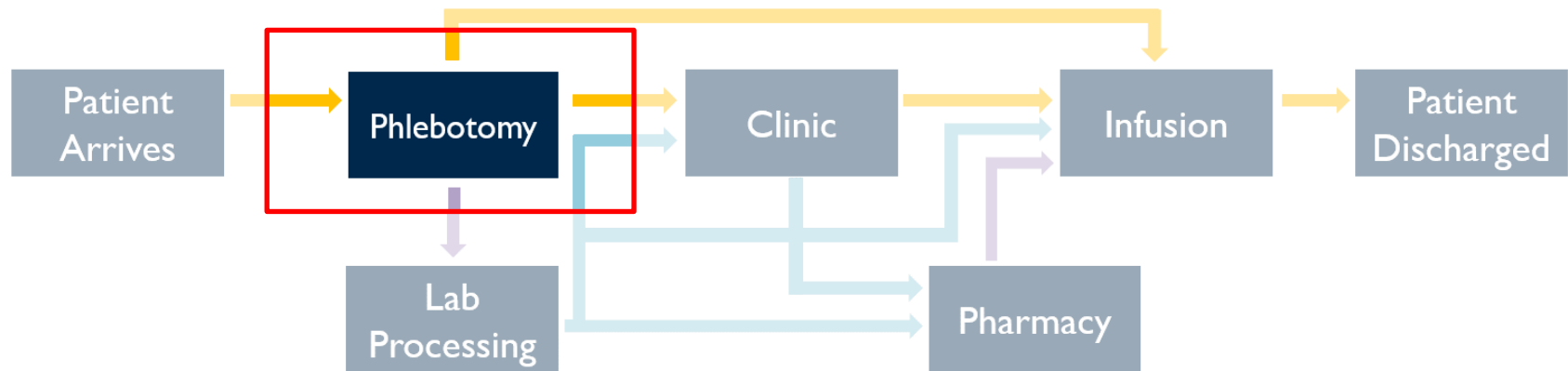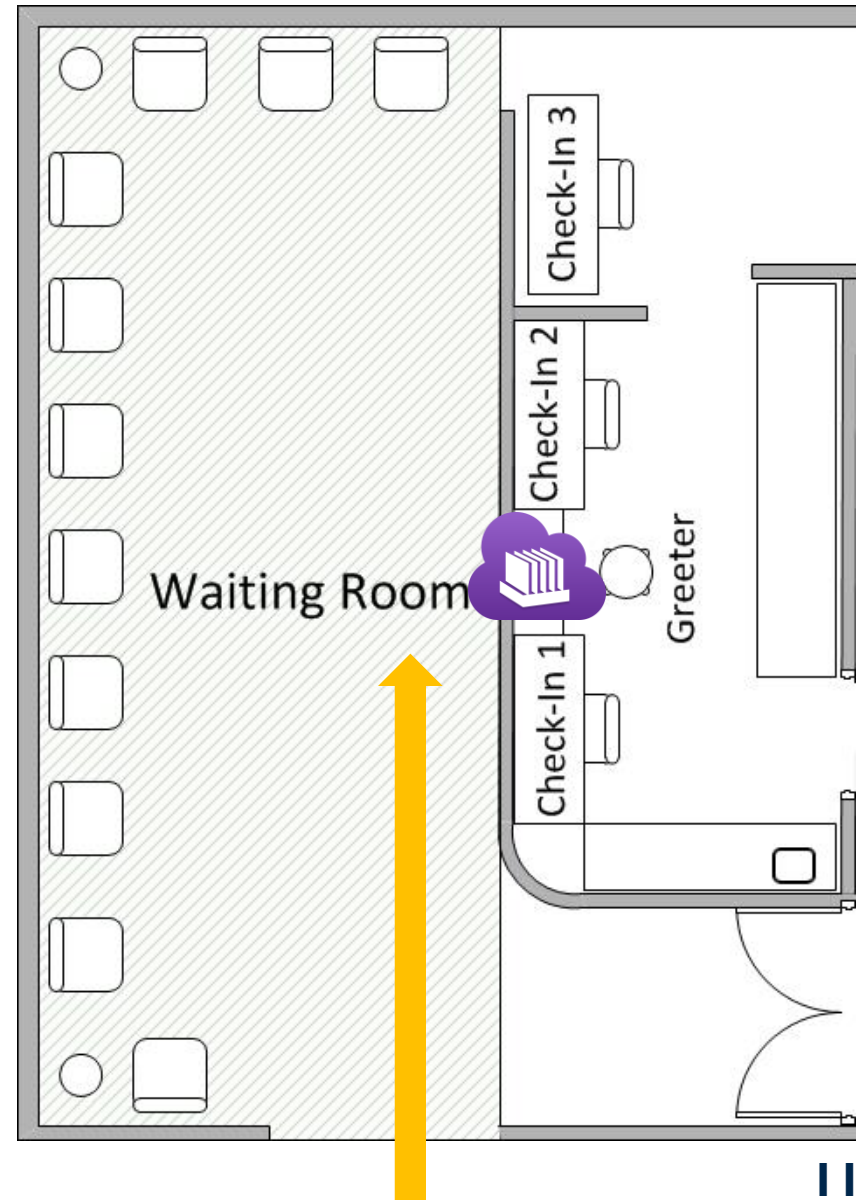
Current Layout

- Large Waiting Room
- 3 Check-In Stations
- 9 Blood Draw Chairs

Phlebotomist Roles

- Official (rotating schedule):

    - Check-In

    - Greeter

    - Draw

    - Clinic Sweep

Current Workflow

✓ Patient arrives to check-in area

✓ Places ID in a rack at the check-in desk

Current Workflow

- ✓ Patient goes to waiting area

- ✓ Available phlebotomist gets first card/slip on the rack

- ✓ Reviews patient information and prints information

- ✓ Reviews orders and prints labels

- ✓ Puts documents in the next queue
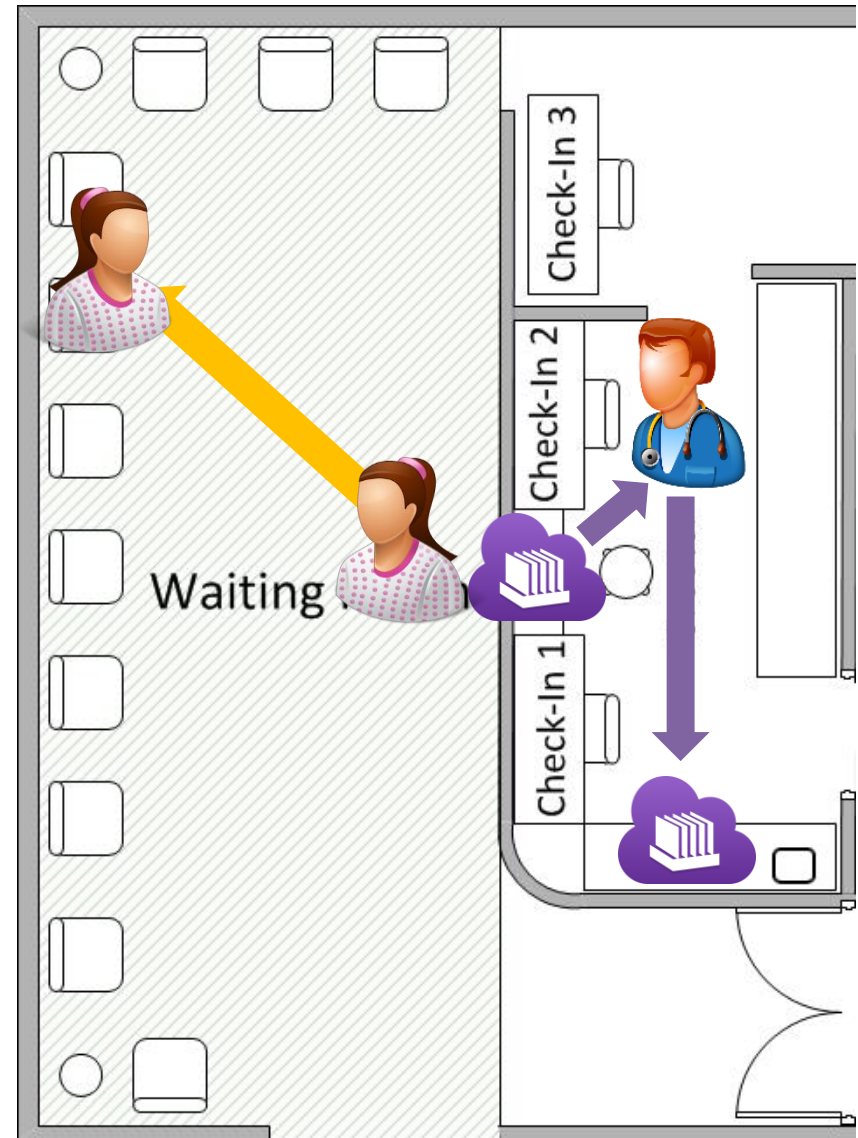
Current Workflow

- ✓ Documents in 2nd queue are picked on a FIFO basis by a phlebotomist

- ✓ Patient is called and walked to the back

- ✓ Draw blood

- ✓ Patient leaves

- ✓ Phlebotomist wraps up, labels tubes, places tubes in a bin
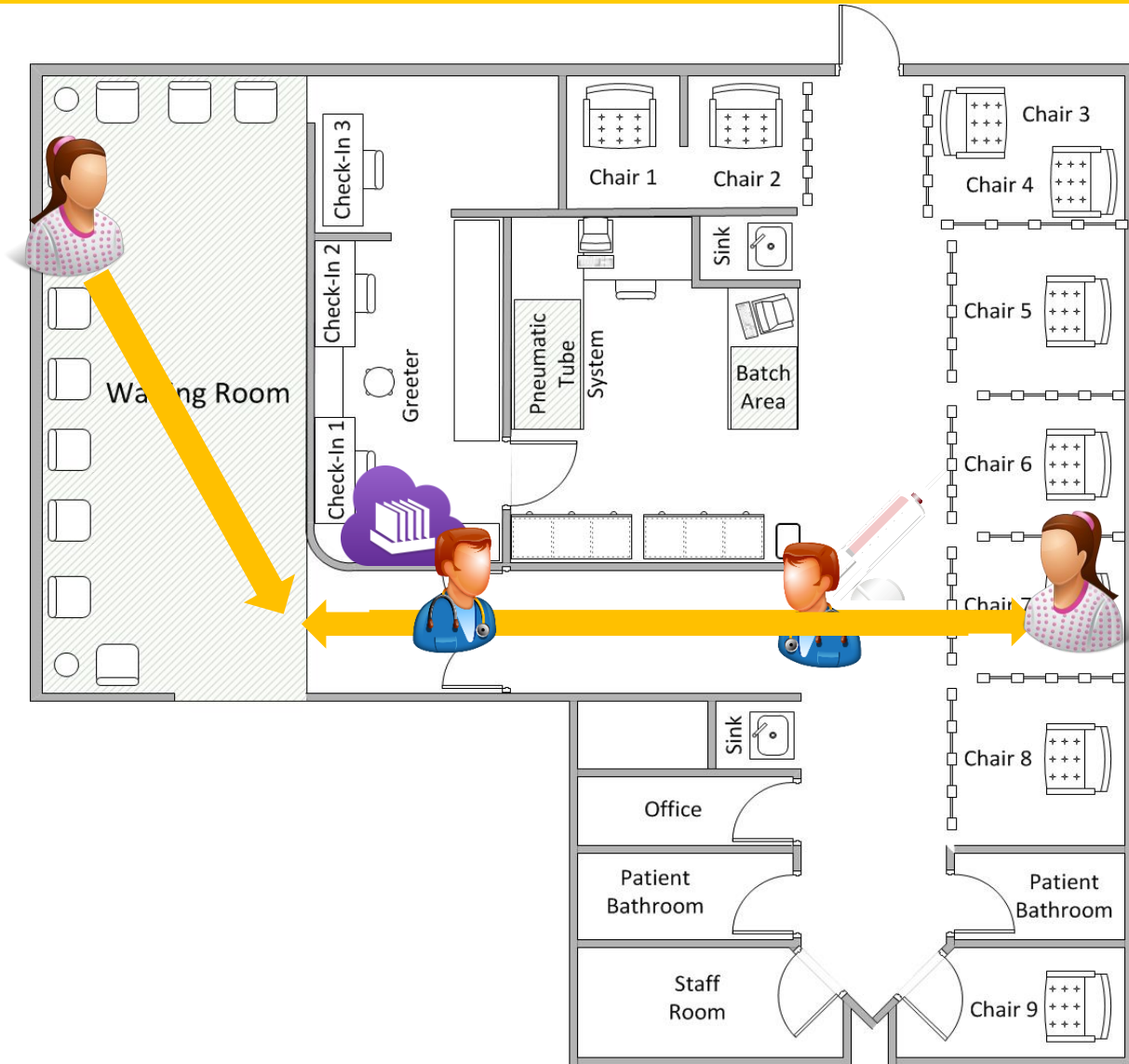
- Special cases:

  - Patients can request specific phlebotomists
  - Staff dynamically rotate through roles
  - Staff can be interrupted to complete unofficial roles:
    - Stock Stations
    - Send Samples

Motivation

- Patient perspective:
  - Lack of interaction with phlebotomists at check-in
  - Long waiting times

- Phlebotomist perspective:
  - Stress
  - Privacy concerns

- Clinic and Infusion perspective:
  - Late patient arrivals
  - Late lab results

Value Stream Map (2014)

Value Stream Map for Processing of CBCD STAT Specimens from the Cancer Center
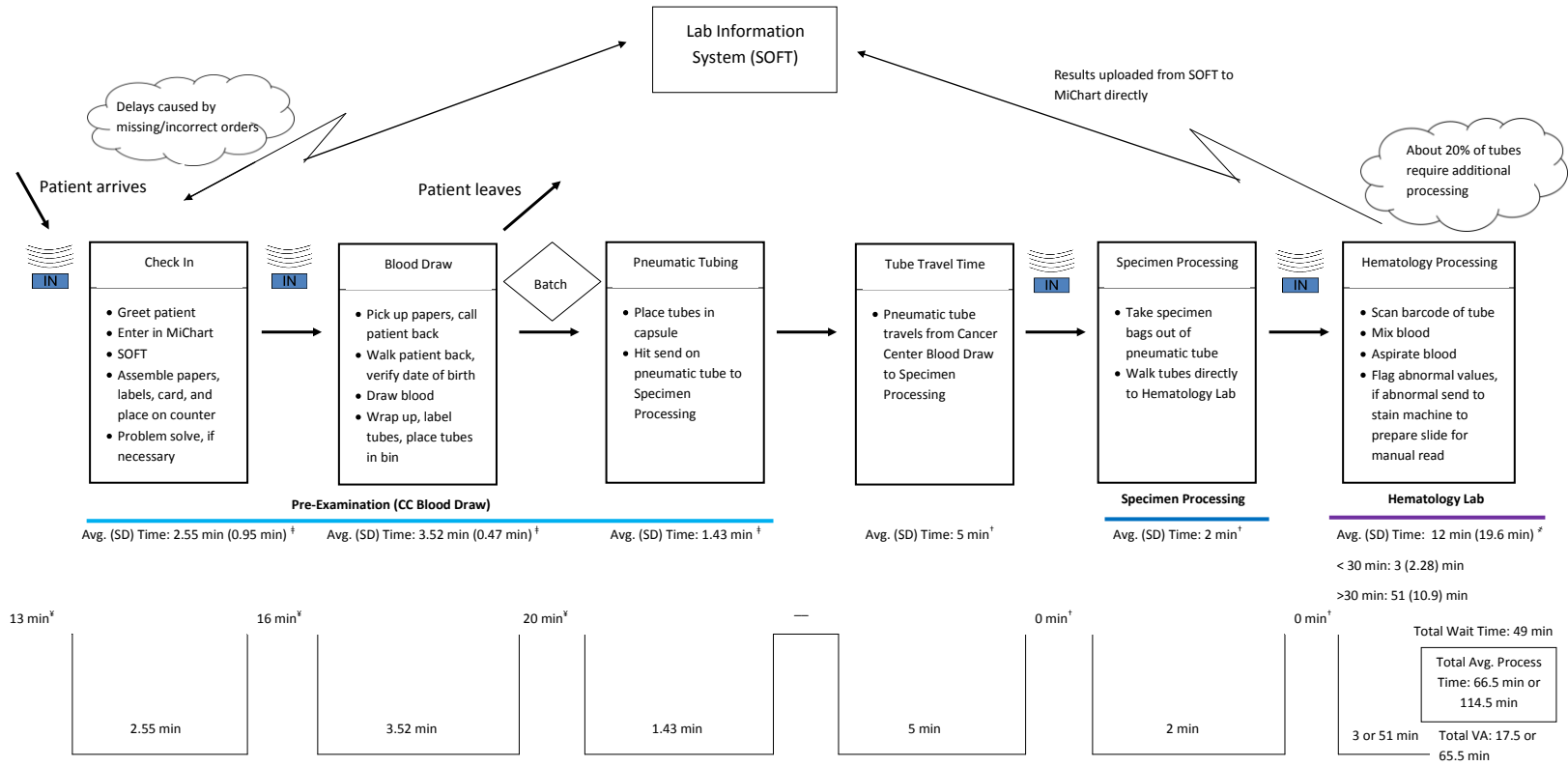
Last Updated: 9/5/2014

Data Sources:
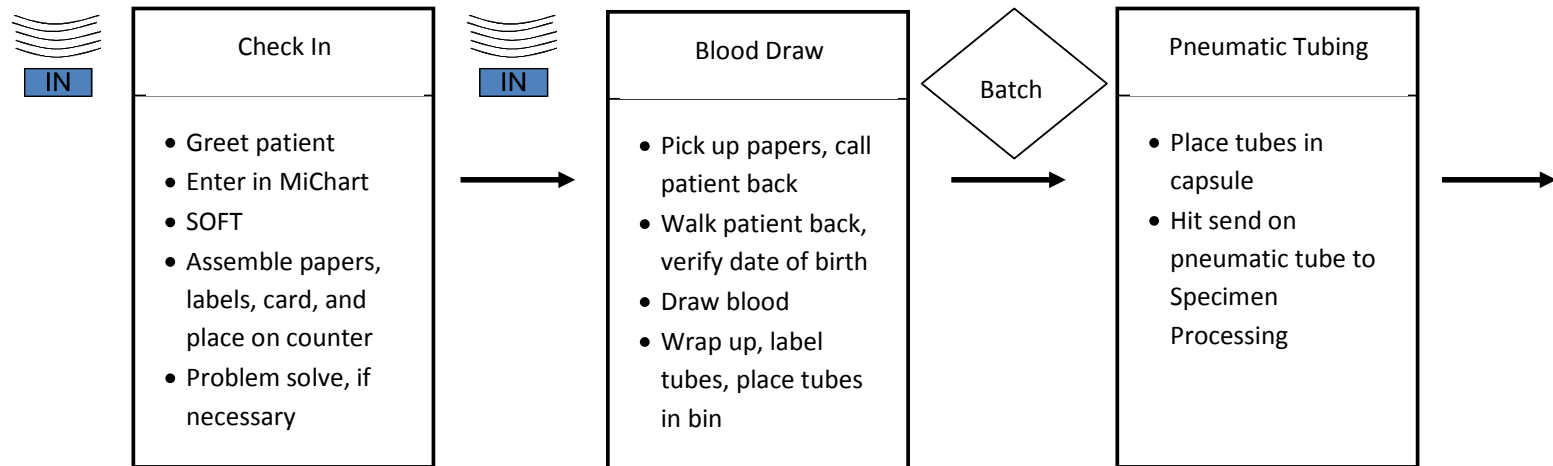
‡: Time study performed by Corrie Pennington-Block

†: Time study performed by Sarah Bach

⚡: Hematology TAT data (Aug 2014)

¥: Cancer Center Blood Draw TAT Data (July 2014)

Lab Information System (SOFT)

Results uploaded from SOFT to MiChart directly

Delays caused by missing/incorrect orders

About 20% of tubes require additional processing

Patient arrives

Patient leaves

Check In	Blood Draw	Batch	Pneumatic Tubing	Tube Travel Time	Specimen Processing	Hematology Processing
• Greet patient • Enter in MiChart • SOFT • Assemble papers, labels, card, and place on counter • Problem solve, if necessary	• Pick up papers, call patient back • Walk patient back, verify date of birth • Draw blood • Wrap up, label tubes, place tubes in bin		• Place tubes in capsule • Hit send on pneumatic tube to Specimen Processing	• Pneumatic tube travels from Cancer Center Blood Draw to Specimen Processing	• Take specimen bags out of pneumatic tube • Walk tubes directly to Hematology Lab	• Scan barcode of tube • Mix blood • Aspirate blood • Flag abnormal values, if abnormal send to stain machine to prepare slide for manual read

Pre-Examination (CC Blood Draw)

Specimen Processing

Hematology Lab

Avg. (SD) Time: 2.55 min (0.95 min) ‡

Avg. (SD) Time: 3.52 min (0.47 min) ‡

Avg. (SD) Time: 1.43 min ‡

Avg. (SD) Time: 5 min †

Avg. (SD) Time: 2 min †

Avg. (SD) Time: 12 min (19.6 min) ⚡

< 30 min: 3 (2.28) min

>30 min: 51 (10.9) min

Total Wait Time: 49 min

13 min ¥

16 min ¥

20 min ¥

—

0 min †

0 min †

| Total Avg. Process Time: 66.5 min or 114.5 min |

2.55 min

3.52 min

1.43 min

5 min

2 min

3 or 51 min

Total VA: 17.5 or 65.5 min

Blood Draw Phase

Check In

- Greet patient
- Enter in MiChart
- SOFT
- Assemble papers, labels, card, and place on counter
- Problem solve, if necessary

IN

Blood Draw

- Pick up papers, call patient back
- Walk patient back, verify date of birth
- Draw blood
- Wrap up, label tubes, place tubes in bin

IN

Batch

Pneumatic Tubing

- Place tubes in capsule
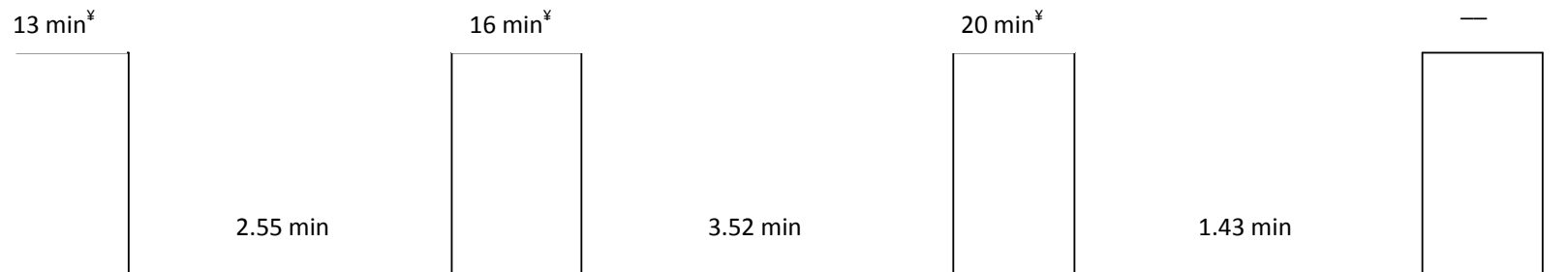- Hit send on pneumatic tube to Specimen Processing

Pre-Examination (CC Blood Draw)

Avg. (SD) Time: 2.55 min (0.95 min) [‡]   Avg. (SD) Time: 3.52 min (0.47 min) [‡]   Avg. (SD) Time: 1.43 min [‡]

13 min[¥]   16 min[¥]   20 min[¥]   —

2.55 min   3.52 min   1.43 min

Lab Processing Phase

Tube Travel Time		Specimen Processing		Hematology Processing
• Pneumatic tube travels from Cancer Center Blood Draw to Specimen Processing	IN	• Take specimen bags out of pneumatic tube • Walk tubes directly to Hematology Lab	IN	• Scan barcode of tube • Mix blood • Aspirate blood • Flag abnormal values, if abnormal send to stain machine to prepare slide for manual read

Specimen Processing

Hematology Lab

Avg. (SD) Time: 5 min[†]

Avg. (SD) Time: 2 min[†]

Avg. (SD) Time: 12 min (19.6 min) [*]

< 30 min: 3 (2.28) min

>30 min: 51 (10.9) min

0 min[†]　　　　　0 min[†]

Total Wait Time: 49 min

5 min　　　　2 min

3 or 51 min

Total VA: 17.5 or 65.5 min

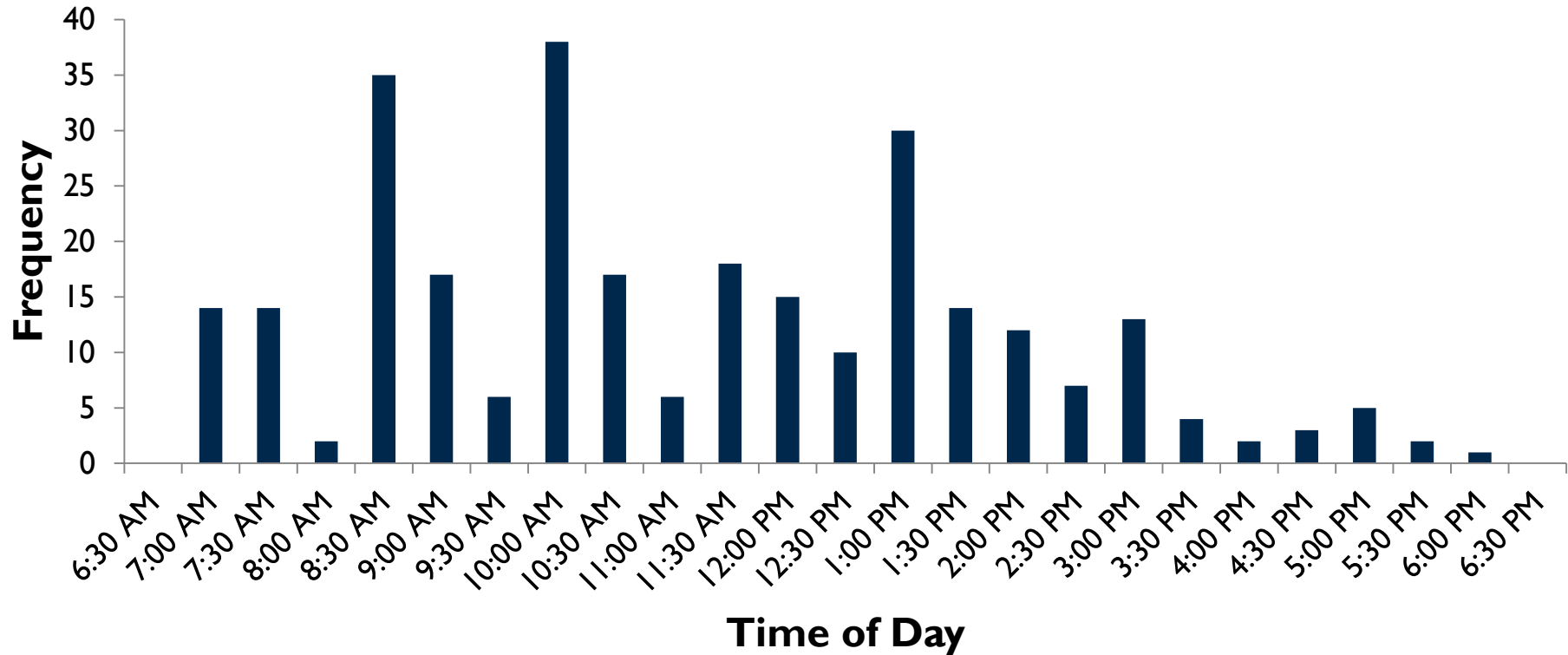**Total Avg. Process Time: 66.5 min or 114.5 min**

Improve workflow and reduce wait times in blood draw phase.

Questions

- Do we have enough check-in stations and draw chairs?

- Is the layout efficient?

- Is the phlebotomist workflow optimal?

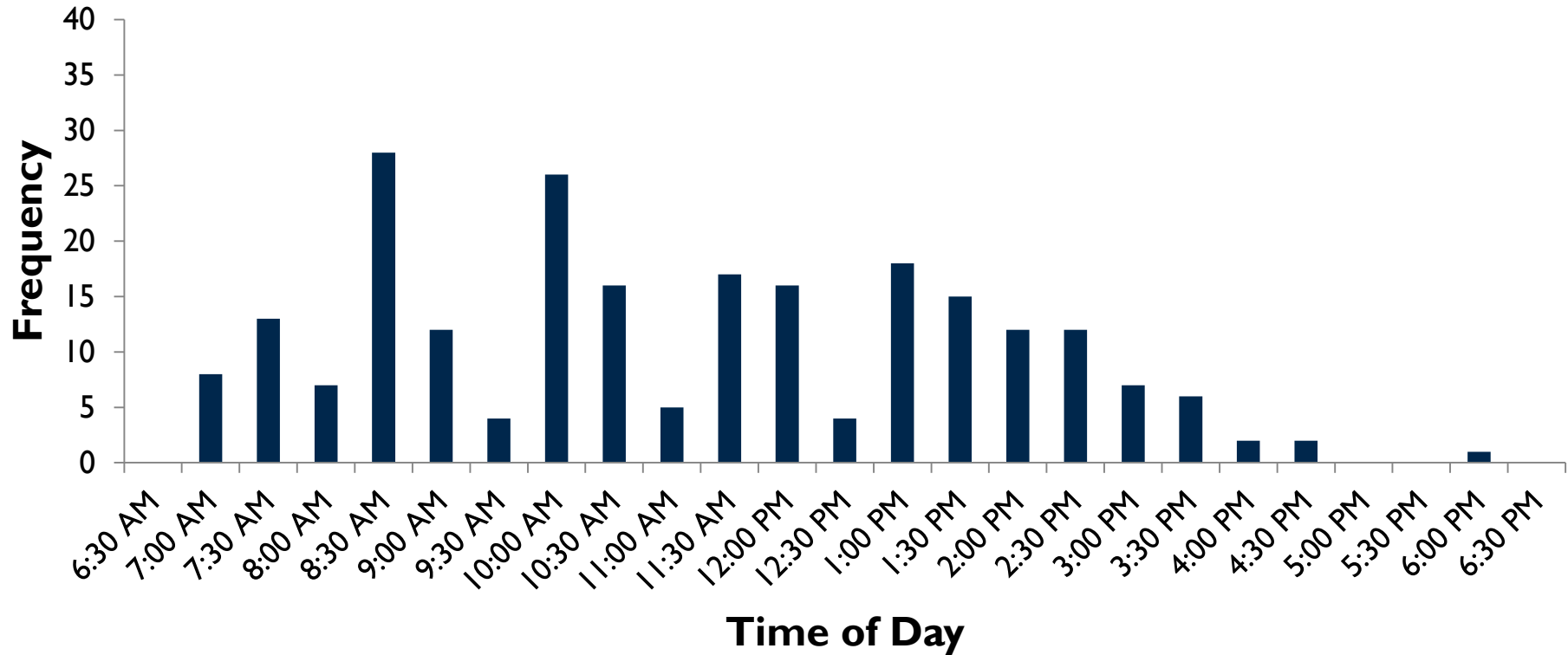- Do we have enough staff at the right times?
  - Morning vs. afternoon?

Need to collect data
to answer these questions
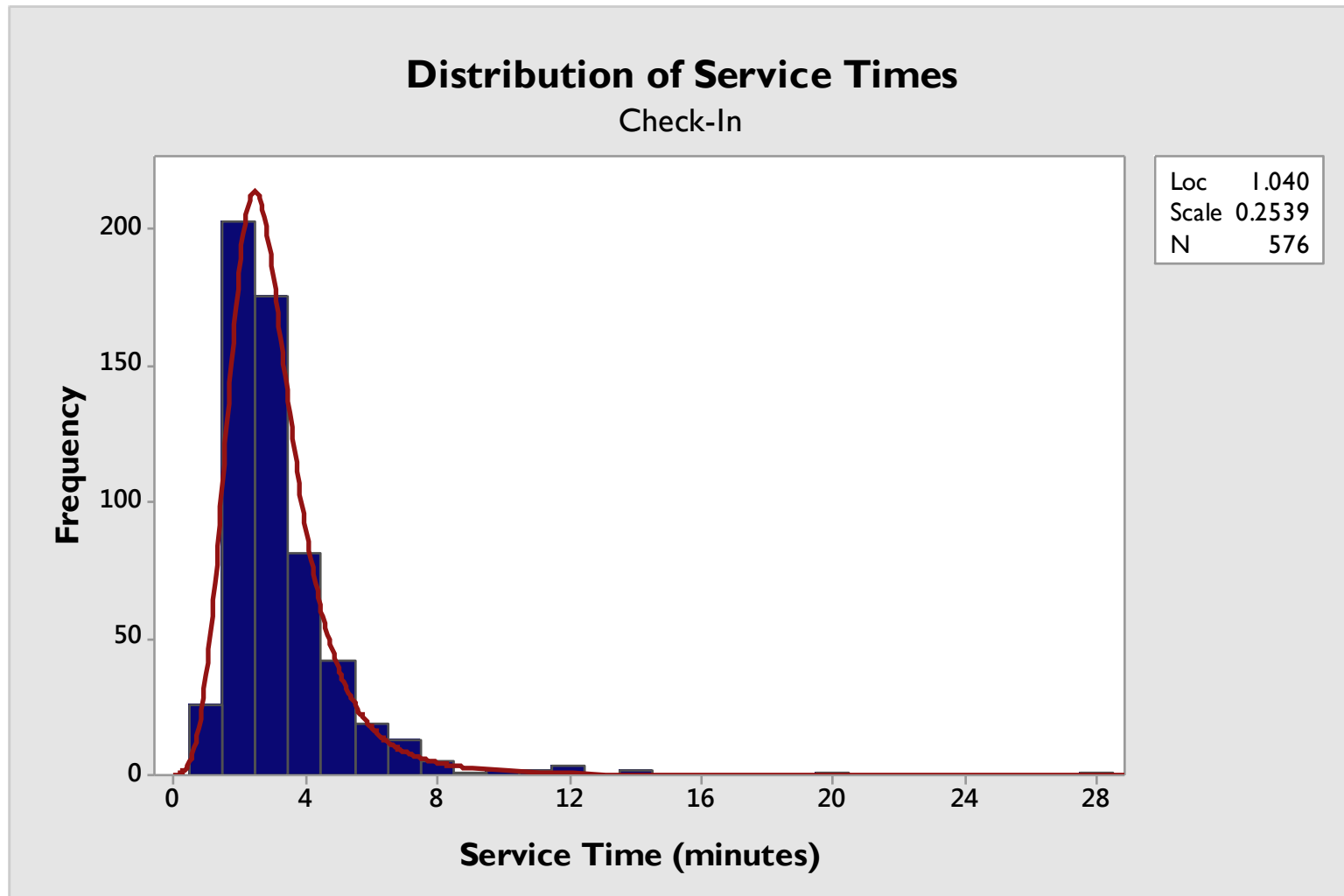
Tuesday

Arrival Rates

Friday

Time Study
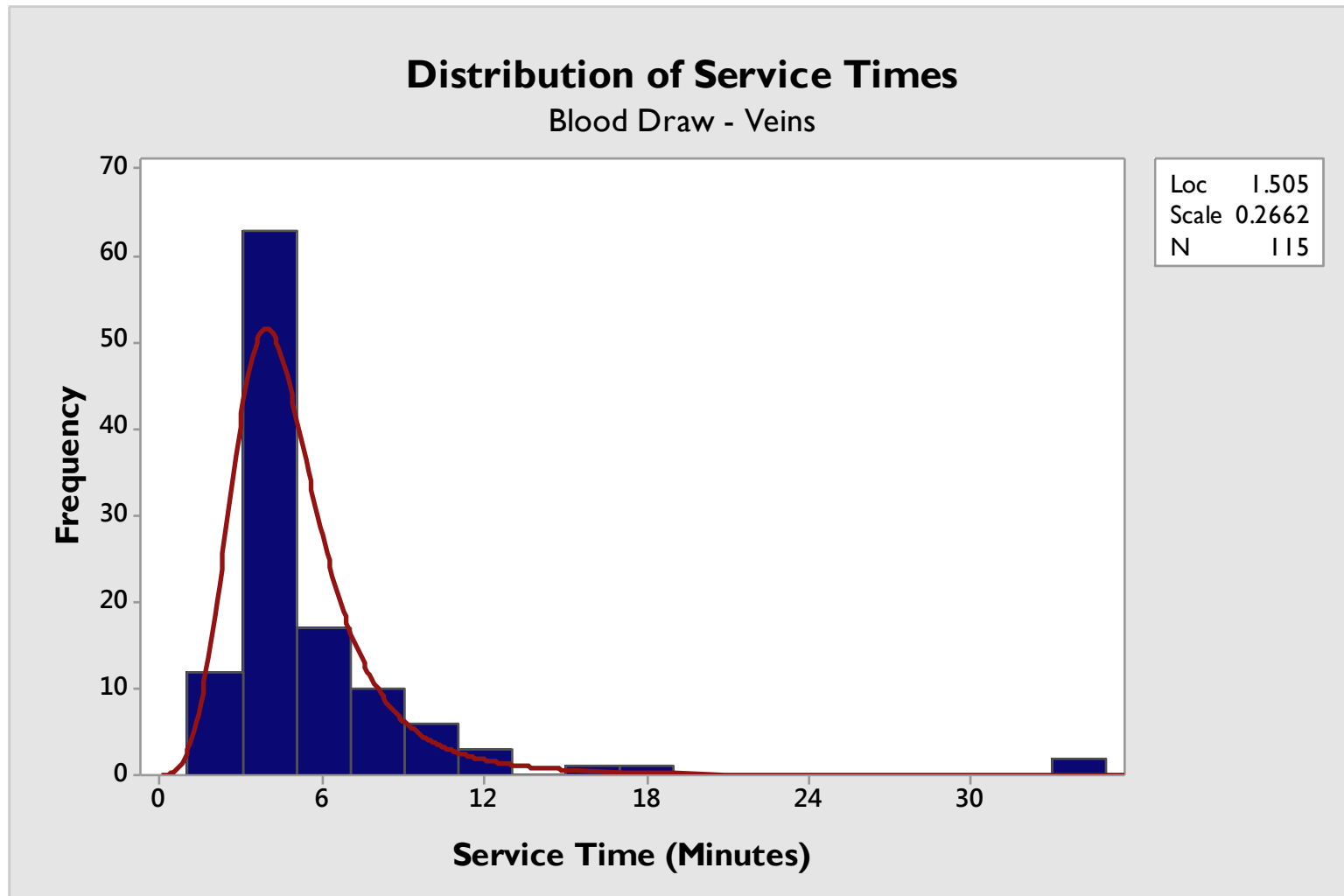
- Conducted from June to August of 2015
- Timestamps collected:
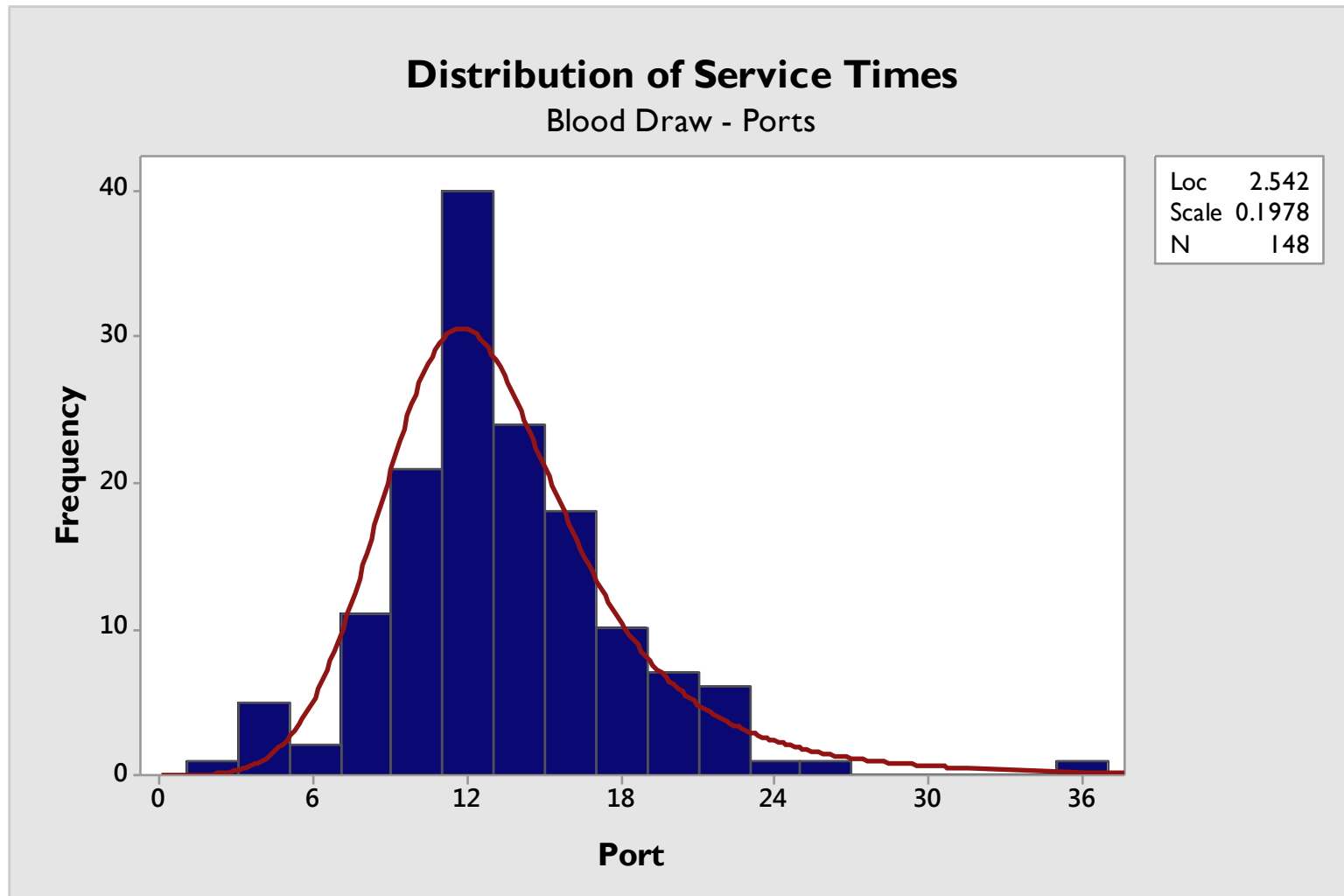 - Check-in
  - Blood draw
  - Batching of tubes

Service Time Distributions

Distribution of Service Times
Check-In

Loc	1.040
Scale	0.2539
N	576

Service Time Distributions

Distribution of Service Times
Blood Draw - Veins

Loc 1.505
Scale 0.2662
N 115

Service Time Distributions

Distribution of Service Times
Blood Draw - Ports

Loc	2.542
Scale	0.1978
N	148

Simulation Design

- Discrete event model (C++)

- **Event Queue**
  - Initialized with patient arrivals and phlebotomist schedule
  - Events are created and added to queue during simulation
  - Events in the queue complete in order (priority queue)

- While there are still events in the queue, continue completing them

Simulation Design

- Three (3) main event types, each corresponding to an availability queue:

  - **Patient Available for Check-In**

  - **Patient Available for Blood Draw**

  - **Phlebotomist Available**

- As events occur, they are either completed or added to one of the availability queues

Simulation Design

Event Queue

Event Type	Participant ID	Time
PatientAvailCI	3948	7:03:42
PatientAvailCI	2084	7:06:12
PhlebAvail	0962	7:15:00
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time

Simulation Design

Event Queue

Event Type	Participant ID	Time
PatientAvailCI	3948	7:03:42
PatientAvailCI	2084	7:06:12
PhlebAvail	0962	7:15:00
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time

Simulation Design

Event Queue

Event Type	Participant ID	Time
PatientAvailCl	2084	7:06:12
PhlebAvail	0962	7:15:00
PatientAvailCl	5541	7:16:09
PatientAvailCl	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCl Queue

Participant ID	Time
3948	7:03:42

Simulation Design

Event Queue

Event Type	Participant ID	Time
PatientAvailCl	2084	7:06:12
PhlebAvail	0962	7:15:00
PatientAvailCl	5541	7:16:09
PatientAvailCl	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCl Queue

Participant ID	Time
3948	7:03:42

Simulation Design

Event Queue

Event Type	Participant ID	Time
PhlebAvail	0962	7:15:00
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time
3948	7:03:42
2084	7:06:12

Simulation Design

Event Queue

Event Type	Participant ID	Time
PhlebAvail	0962	7:15:00
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time
3948	7:03:42
2084	7:06:12

Simulation Design

Event Queue

Event Type	Participant ID	Time
PhlebAvail	0962	7:15:00
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33

Generate Service Time:
2 minutes 51 seconds

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time
3948	7:03:42
2084	7:06:12

Simulation Design

Event Queue

Event Type	Participant ID	Time
PatientAvailCI	5541	7:16:09
PatientAvailCI	8737	7:20:33
PatientAvailBD	3948	7:17:51
PhlebAvail	0962	7:17:51

PhlebAvail Queue

Participant ID	Time

PatientAvailCI Queue

Participant ID	Time
2084	7:06:12

Current and Future Work

- Simulation still under construction

- Verify and validate

- Evaluate potential alternative workflows

Table-Top Simulation

- Hands-on activity

- Engage the whole team

- Educational component

- Verification

- Brainstorm alternatives

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Thank you!
QUESTIONS?

CONTACT INFORMATION:

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Pamela Martinez Villarreal – mvpamela@umich.edu
Matt Rouhana – mrouhana@umich.edu

Appendix

- Phlebotomy – 253 patients per day

- Clinic (7 Total) – 311 patients per day

- Infusion – 123 patients per day

  – 20% of infusion appointments are coupled

Appendix

- Infusion:
    - Total of 51 infusion chairs
    - 123 patients per day
    - 20% of infusion appointments are coupled

Alternative Workflow A

|	Workflow A		
Description	Split current check-in process in two		
Pros	More patient interaction at check-in and no interruptions at order consolidation		
Cons	Additional space, change in layout, more hand-offs		

Alternative Workflow B

| Patient Arrives | → | Check-In | → | Lab Order and Blood draw |

Workflow B	
Description	Order review and blood draw in the same area
Pros	2x verification and interaction with patient, fewer hand-offs
Cons	Additional space and equipment/computers
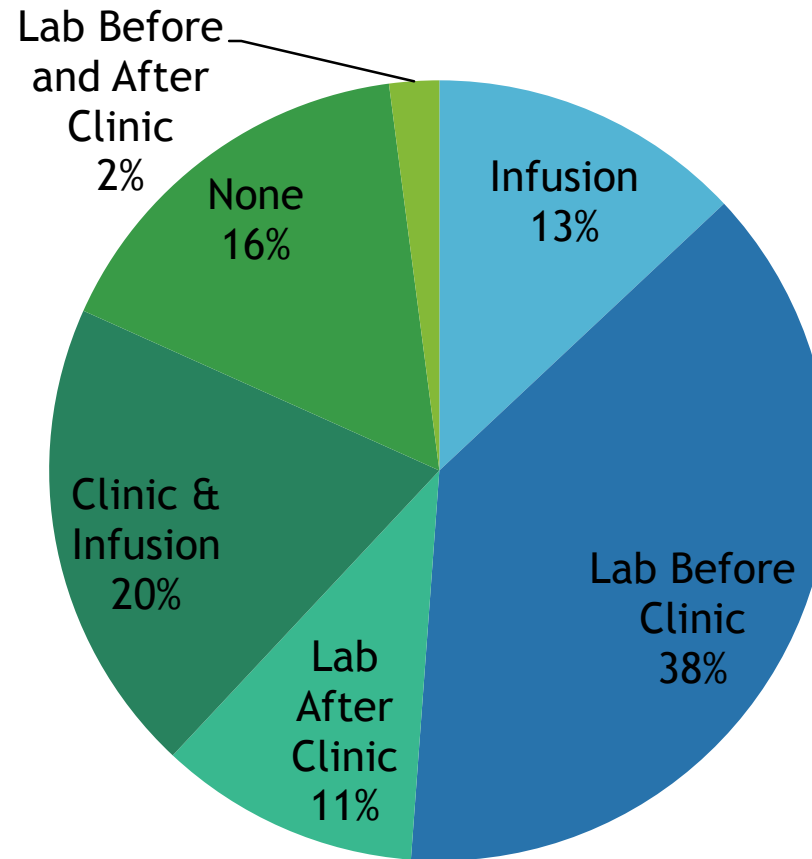
Cancer Center Lab Patient Population
Data Source: May & June 2014 Appointment Data (10,850 patients)

Appendix

- ## Staff Schedule

		630	700	730	800	830	900	930	1000	1030	1100
		2	10	12	13	13	13	17	17	17	16
	Front Desk	-2	-3	-3	-3	-3	-2	-2	-2	-2	-2
Totals do not include the Associate Supervisor	Greeter		-1	-1	-1	-1	-1	-1	-1	-1	
	Clinic Sweep				-1					-1	
	Breaks/Lunches					-1	-2	-2	-2	-2	-3
	Part Time/Day Off		-1	-1	-1	-1	-1	-1	-1	-1	-1
	Available to Draw	**0**	**5**	**7**	**7**	**7**	**7**	**11**	**10**	**11**	**10**

1130	1200	1230	1300	1330	1400	1430	1500	1530	1600	1630	1700	1730
16	15	15	15	15	15	15	14	7	5	4	4	4
-2	-2	-2	-2	-2	-2	-2	-2	-2	-1	-1	-1	-1
	-1				-1					-1		
-3	-3	-2	-3	-4	-2	-2	-2	-2				
-1	-1	-1	-1	-1	-1	-1						
10	**8**	**10**	**9**	**8**	**9**	**10**	**10**	**3**	**3**	**3**	**3**	**3**