Simulating Patient Flow through a Phlebotomy Clinic
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Context:
The University of Michigan Health System Comprehensive Cancer Center is a stage for ~97,000 outpatients visits and ~58,000 infusion treatments annually, with these numbers consistently increasing.[1] An outpatient’s experience consists of several interrelated stages. Among these stages, the steps conducted in the phlebotomy clinic can be a significant bottleneck for the center’s overall patient flow.

Problem:
Extensive waiting times in phlebotomy cause delays to ripple through a patient’s experience and negatively impact the entire hospital system.

Goal:
Develop a computer simulation to aid hospital management in instituting policy changes that would increase patient throughput at phlebotomy.

Solution Approach
1. Gather Data
Conduct time studies and discuss clinic operations with management

2. Build Model
Define elements of Discrete Event Simulation (DES)

3. Implement
Encode model with Visual C++ 2012

4. Load
Change custom parameters via several .txt files

5. Run
Simulate random patient arrivals and phlebotomist activity

6. Review
Examine patient and phlebotomist activity reports

Simulation Model
Premise:
Maintain a priority queue of events that will occur throughout the day, with the earliest events having the highest priorities.

<table>
<thead>
<tr>
<th>Event Type</th>
<th>Person ID</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Available for Check-In</td>
<td>0</td>
<td>07:53:00</td>
</tr>
<tr>
<td>Draw Phlebotomist Available</td>
<td>2</td>
<td>07:55:00</td>
</tr>
<tr>
<td>Patient Available for Draw</td>
<td>0</td>
<td>07:58:00</td>
</tr>
</tbody>
</table>

Simulation Logic:
While the event queue is not empty, extract the earliest event and process it.

Future Work
Our future work is geared towards incorporating hospital management feedback regarding the clinical environment and its daily operations. Some short-term goals include:
1. Queue rejection thresholds (reneging)
2. User-selected output metrics
3. User-interface enhancements
4. Expanded event and activity details

Inputs and Outputs
Inputs:
- Start/End time
- Daily patient arrival rates
- Phlebotomist schedule
- Check-In/Draw activity rates

Outputs:
- Number of patient arrivals
- Max/Min/Average wait times
- Phlebotomist activity summary
- More to come...

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