Improving Patient Flow in an Outpatient Infusion Center

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**Background:**
- Lab results needed: (1) by provider before clinic appointment to assess patient and (2) by pharmacy to initiate drug preparation/infusion process
- Concerned about (1) patient waiting time (2) balanced workload (3) lab results being available during clinic appointment
- **Possible Solution:** “Uncoupling” patient visits (labs done at least one day prior to clinic appointment at any MLab Facility)

**Methods:**
- Analyzed previous time study data of phlebotomy and pathology
- Analyzed patient travel times

**Findings:**
- Processing time for labs (CBCD, CMP, Type and Screen) exceeds one hour threshold
- Conclusion: Potential to uncouple visits for patients within close proximity to a lab facility (more convenient and better flow)

**Lab Process Analysis**

<table>
<thead>
<tr>
<th>Driving Duration</th>
<th>% of Patients to Closest Lab Facility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 15 min</td>
<td>32%</td>
</tr>
<tr>
<td>15 – 30 min</td>
<td>20%</td>
</tr>
<tr>
<td>30 – 60 min</td>
<td>23%</td>
</tr>
<tr>
<td>1 – 2 hours</td>
<td>15%</td>
</tr>
<tr>
<td>2 – 4 hours</td>
<td>7%</td>
</tr>
<tr>
<td>Over 4 hours</td>
<td>3%</td>
</tr>
</tbody>
</table>

**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
- **Possible Solution:** Evaluate trade-offs of improved wait/workload vs. risk of drug waste, determine which drugs can be prepared in advance

**Methods:**
- Collected and analyzed data on prices, treatment times, deferral rate, etc.
- Developing mathematical formulation of tradeoff (in progress)

<table>
<thead>
<tr>
<th>Input</th>
<th>Effect on Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug cost</td>
<td>Low cost ➔ Higher priority</td>
</tr>
<tr>
<td>Probability of deferral or dosage change</td>
<td>Low probability ➔ Higher priority</td>
</tr>
<tr>
<td>Number of patients receiving drug</td>
<td>Higher number of patients ➔ Higher priority</td>
</tr>
<tr>
<td>Drug shelf life (hang by/expiration)</td>
<td>Long shelf life ➔ Higher priority</td>
</tr>
<tr>
<td>Drug compounding time</td>
<td>Possibly short compounding time ➔ Higher priority</td>
</tr>
<tr>
<td>Appointment time</td>
<td>Early appointment time ➔ Higher priority</td>
</tr>
<tr>
<td>Length of infusion</td>
<td>Long infusion ➔ Higher priority</td>
</tr>
</tbody>
</table>

**Chemotherapy Infusion Scheduling**

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

**Methods:**
- Developed stochastic optimization model and solution algorithms that can generate appointment schedules, validated with (discrete-event) simulation
- **Stochastic Optimization Model:**
  - **Minimize:** Trade-off between expected patient wait time and expected overtime
  - **Subject to:**
    - Patients are assigned to a time and a chair
    - Patients wait until a nurse and a chair are available
    - Uncertain treatment times (Sample Average Approximation method)
      - The day ends when the last patient is discharged
  - **Findings:**
    - Allowing extra time for highly variable treatments and increasing appointment lengths in the middle of the day help to prevent and recover from propagating delays
    - **Next Steps:** Incorporate patient acuity into model, develop and implement scheduling guidelines

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