Improving Outpatient Chemotherapy Access and Workload Using Optimization Modeling Approach

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Planning/Research Methods

The scheduling template design used an optimization approach to achieve smoothed daily workload, see graph. The steps were:

1. Understand scheduling volume and visit type distribution: appointment data was analyzed to determine the numbers of each patient type that should be dedicated in a scheduling template to meet patient preference and medical needs.

2. Define nursing resource constraints: three constraints were considered: (i) patient to nurse ratio of 2.5:1 at any time in a day; (ii) patient to nurse ratio of 1:1 for the first and the last 15 minutes of treatment; (iii) patient to nurse ratio of 1:1 during treatment in a 15-minute interval defined by medical necessity and experience.

3. Develop the constraint-based optimization model: the objective was to minimize nursing resource constraint violations with constraints of space, nursing staff, hours of operations, patient type mix, and patient volume.

4. Develop the leveling (smoothing) algorithm: the objective was to finalize template by utilizing minimal chair capacity while accommodating patient volume and the need to alleviate high patient volume during the peak hours.

Background

The chemotherapy infusion unit is the key operational unit of an outpatient hematology/oncology practice. Safe administration of chemotherapy is crucial, and thus optimally managing workfl ows is a primary concern. National shortages of chemo-trained nurses and the need to minimize overhead costs from treatment chairs both drive the need for efficient use of limited resources. A typical pattern of midday (10 am to 2 pm) peak volume has led to insufficient staffing to staff treatment chairs efficiently. Smoothing treatment operation variability and the required medical attention for each treatment across the complexity of appointment scheduling. Our team believed that an optimal scheduling template could potentially address these issues.

Objective

Although it was important to determine the number of nurses needed, it was foremost critical to allocate nursing resources where patients’ needs were during the infusion when designing a scheduling template. The objective was to minimize nursing resource constraint violations with constraints of space, nursing staff, hours of operations, patient type mix, and patient volumes.

Implementation Methods

To ensure smooth transitions from current practice, the following were executed:

- Create external and internal communications for patients, clinical providers, and allied health staff to understand the changes on what was changing, why the changes were needed, and what else patients and staff should know.

- Develop criteria for appointment scheduling that maximize efficiency while accommodating patient volume and need to alleviate high patient volume during the peak hours.

- Develop an appointment tracking system providing a visual on how patients were scheduled in a 10-day span to assist schedulers for patient placement and overbooking medical necessity and inevitable preference.

Results

The work is extending to other Mayo Clinic cancer infusion centers. The results for Rochester campus (45 chairs and average 150+ visits per day) are:

- Smoothed number of chemo chairs utilized throughout the day
  - More predictable, balanced, and safer workload for nurses
  - Consistently around 40 patients throughout a day
  - Reduced patient time in a chair by 15% allowing for chair utilization to drop from 75% to 60%

- Smoothing contributed to improved chemocentric volumes, productivity, and finances
  - Increased chemotherapy volume by 6.4% (increased patient access to care)
  - Increased chemotherapy productivity by 6.7% (30% higher than comparable external benchmark)
  - Delayed chemotherapy unit facility expansion at least five years

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