More than half require chemotherapy
~1.6 million estimated cases in 2015

Phlebotomy Processing

What is Pre-mix policy

Determining an Optimal Schedule for Pre-Mixing Chemotherapy Drugs

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Problem Statement

• Cancer
  – Second leading cause of death in the U.S.
  – ~1.6 million estimated cases in 2015
  – More than half require chemotherapy treatment
• Infusion centers
  – Increased outpatient demand leads to undesirable outcomes such as:
    • Increased patient waiting times
    • Overworked staff

Probability of Wasting a Drug

Let \( \text{Prob(Deferral/no show)} = p \)
Assume \( m_d \) = patients scheduled to receive drug \( d \) on a given day
Then the probability of wasting the \( n \)-th dose of the drug \( d \) is given by

\[
P_d(n) = \sum_{i=1}^{m_d} (1-p)^{n-1} p^{m_d-n+1}
\]

What if the probability of deferral or no show depend on age, sex, treatment, type of cancer, etc.? Let \( \text{Prob(Deferral/no show of patient } i = p_i \)
Let \( S_d \) = set of patients scheduled to receive drug \( d \)
\( S_d = \{1,2,...,m_d\} \)

\[
\text{Prob(Wasting 1st dose)} = \prod_{i=1}^{m_d} p_i
\]

\[
\text{Prob(Wasting 2nd dose)} = \prod_{i=1}^{m_d} (1-p_i) \prod_{j \neq i} (p_j) + \prod_{i=1}^{m_d} p_i
\]

\[
\text{Prob(Wasting 3rd dose)} = \prod_{i=1}^{m_d} (1-p_i)(1-p_j) \prod_{k \neq i,j} (p_k) + \prod_{i=1}^{m_d} (1-p_i) \prod_{j \neq i,k} (p_j) + \prod_{i=1}^{m_d} p_i
\]

Model

Sets
\( D \) = set of drugs (e.g. 50 mg of Tamoxifen)
\( x_d^t \) = 1 if we mix the \( n \)-th dose of drug \( d \) at time \( t \) or \( n \)th
\( x_d^t \) = 0 if we don’t mix the \( n \)-th dose of drug \( d \) or no

Parameters
\( q_d \) = the reward or savings for mixing drug \( d \)
\( T \) = the total time units for the proctor period
\( c_d \) = the cost of drug \( d \)
\( N_d \) = the number of doses needed for each drug based on the scheduled patients
\( L \) = pro-mix capacity for any pro-mix period
\( M \) = a very large number
\( E^w \) = (waste cost) = \( c_x p_x \)
\( \max \sum d \sum t \left( \frac{q_d}{x_d^t} - E^w \right) x_d^t \)

Objective
Maximize the difference between our expected reward and waste cost

Constraints
\[
\sum d x_d^t = 1 \quad \forall d, n, t \quad (1)
\]

\[
\sum d x_d^t \leq T \quad \forall d, n, t \quad (2)
\]

\[
\sum d x_d^t \leq M \cdot y_d^t \quad \forall d, n, t \quad (3)
\]

\[
\sum d x_d^t \leq L \quad \forall t \quad (4)
\]

\[
\sum d x_d^t \leq 1 \quad \forall d, n, t \quad (5)
\]

(1) Relates our auxiliary variable to the decision variable
(2) If you don’t make the previous dose you can’t make the next
(3) Does ordering
(4) Only make \( L \) at a time
(5) Can only make the \( n \)-th dose of a drug once

Future Work

Static Model

• Include the hang-by time for each drug
• Include the preparation time for each drug
• Continue working with data collection to run logistical regression
• How to categorize various types of patients

Dynamic Model

Goal: To find an optimal drug-mixing schedule throughout the day and update as we observe patient deferrals

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