Vignette Three:

Using Linear Programming to Flex Nursing Staff

By Angelica Wang
Typical Cost Distributions for a hospital

Labor Costs (Salaries, Benefits, and Contract Labor) = 59%
Two thirds of labor costs are clinical
Nurse scheduling is a multi-objective problem

* Compliance issues
* Internal policies
* Nurses’ personal preference: vacation time, work shift etc.
* Different skill mix required for patient care
* Patient acuity level and nurse qualifications
* Staff turnovers
Using Linear Programming to Optimize Staff Scheduling

- Linear Programming can be used to create a scheduling spreadsheet to assign nurses to different shifts and meet staffing requirements.
- Based on projected census over a period of time (several weeks), assign nursing staff and react to last-minute staffing changes.
What is Optimization?

- **Loosely** – Finding the “best” solution to a problem
- **More precise** – Finding the answer to a problem that minimizes (maximizes) some objective or goal of a decision maker while taking into account business constraints
- **Mathematical version** – Finding the values of a set of decision variables that minimizes (maximizes) some objective function subject to constraints (equations or inequalities) on the decision variables
What Can LP Help You Accomplish?

- Reduce annual staffing costs;
- Force each level of nurse to be optimally productive by focusing on tasks specific to their expertise;
- Assign accountability more efficiently as the nurses adhere to their specific duties;
- Linear programming can be used to solve capacity problems for just about any staffing situation, provided the model is indeed linear.
When Linear programming (LP) is employed, it helps to determine the effective combination of nurses that would allow for all weekly clinical tasks to be covered while providing the lowest possible labor cost to a nursing department.
Staff Budgeting and Planning

- Annual or as needed
- Planned capacity
- Staffing/scheduling policies

Operational staffing/scheduling
- Every 2-6 weeks
- Target staffing levels
- Create employee schedules for core staff

Staff schedule

Realized shortages and surpluses

Daily allocation
- Ongoing
- Reacting to staffing variances
- Floating staff, overtime, contract staff, agencies
Minimize \[ \sum_{j=1}^{N} c_j x_j \]

(Total staffing cost)

\[ c_j = \text{cost of shift } j \]
\[ x_j = \# \text{ of people working shift } j \]

Subject to:

\[ \sum_{j=1}^{N} A_{ij} x_j \geq d_i \quad \text{for } i = 1, 2, \ldots, P \]

(Staffing coverage in each period (e.g. hourly))

\[ d_i = \text{demand for staff in period } i \]

\[ A_{ij} = \begin{cases} 
1 & \text{if shift } j \text{ call for work in period } i \\
0 & \text{otherwise} 
\end{cases} \]

\[ x_j \geq 0 \text{ and integer, for } j = 1, 2, \ldots, N \]
Staffing Plan Example

### Staffing Plan FY 2016
**Oncology**

In the event of a severe emergency, the minimal staffing required to operate this unit would be 1RN and 1CNA.

$.5 = 6hrs

### Budgeted Statistics
- ADC: 16
- Patient Days: 5,840

### Staffing Plan Statistics
- Direct WHPPD: 8.98
- Indirect WHPPD: 1.18
- Total WHPPD: 10.15

#### Census Table

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#### Worked FTEs Required at Budgeted Census
- RN: 18.90 66.3% 0.35
- PCP/LPN: 0.00 0.0% 0.35
- PCT/CNA: 6.30 22.1%

**Total DIR:** 25.20 88.4%

**Total FTEs:** 28.75

**Labor Standard:** 10.15
**Direct:** 8.98
**Indirect:** 1.18

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