Optimizing Float Pool Configurations to Address Unpredictability in Medical-Surgical Nurse Staffing

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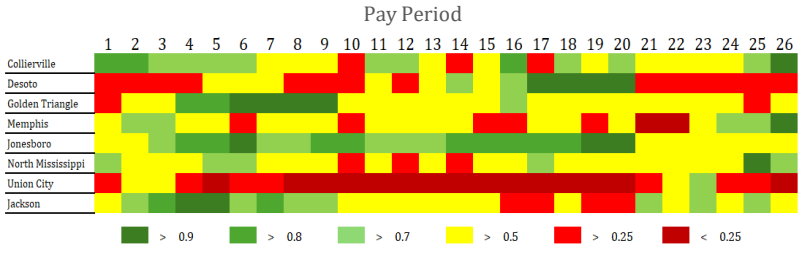
Baptist Memorial Healthcare Corporation

Baptist Memorial Healthcare Corporation (BMHCC) is a non-profit network of healthcare facilities headquartered in Memphis, Tennessee, serving the Mid-South. Our focus is on the 17 hospitals with Medical-Surgical (Med/Surg) units. Med/Surg nurses are highly skilled and vital for patient care in their unit(s) – which emphasize providing excellent care to pre- and post-operative and sick patients.

Medical-Surgical Nurse Staffing

Since Covid-19, nurse shortages have caused difficulties predicting demand and accurately staffing nurses in Med/Surg units. The scheduling managers in these units currently determine the staffing level in each 6-week scheduling period based on an annualized budget from a previous year's total average patient census. BMHCC strives to maintain nurse-to-patient ratios of 1:6 and, when the patient census exceeds the expected value or nurses are absent, scheduling managers may access more expensive, short-term staffing solutions. Conversely, when patient census is much lower than anticipated, BMHCC sends nurses home. BMHCC currently uses nurses who float between like units in a single hospital in 8 of the 17 hospitals with Med/Surg units to supplement in-unit staffing levels. Many BMHCC hospitals are underutilizing these float nurses, a metric that BMHCC seeks to improve in the proposed float pool configuration.



Utilization Rate

Float Pool Configuration

BMHCC's goal was to establish float "pools" — groups of nurses who can float between the Med/Surg units of multiple BMHCC hospitals. These float pools allow for a more dynamic float nurse supplementation of in-unit staffing, enabling these float nurses to help BMHCC meet its missing shift coverage and float nurse utilization goals (80% and 70%, respectively). We first identified every feasible float pool including single and multi-hospital pools using distance and policy considerations outlined by BMHCC. We then developed an optimization model which uses the demand for float nurses that covers 80% of missing shifts in each pool and chooses which float pools to select in the final configuration by minimizing the total number of nurses serving all float pools.

Sets J: set of hospitals

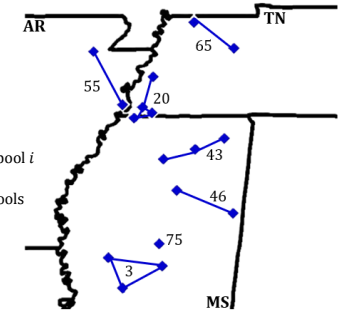
I: set of float pools

Parameters $p_{i,j} = \begin{cases} 1 \text{ if pool } i \text{ includes hospital } j \\ 0 \text{ otherwise} \end{cases}$

d_i = demand for float pool nurses in pool i

m = upper limit on number of float pools

Decision Variable $x_i = \begin{cases} 1 \text{ if pool } i \text{ is selected} \\ 0 \text{ otherwise} \end{cases}$



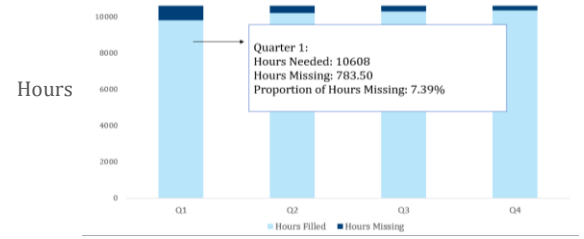
Objective Function $\min \sum_{i=1}^{75} x_i \times d_i$ (minimize the total number of float nurses)

Constraints $\sum_{i=1}^{75} x_i \times p_{i,j} = 1 \ \forall j = 1,2,\dots,17$ (each hospital must be in exactly one pool)

$\sum_{i=1}^{75} x_i \leq m$ (upper limit on number of pools)

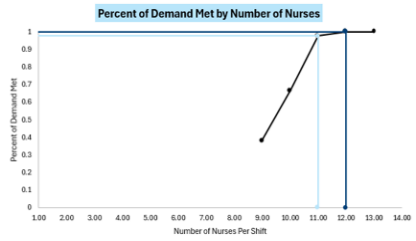
Nurse Absence Predictions

To aid in allocating supplementation efforts, BMHCC was also interested in predicting missing shifts throughout their scheduling periods. Using one year of nurse absence data, we determined the quantity of missing shifts relative to the current staffing levels and applied this proportion to the staffing level determined by the method we developed.

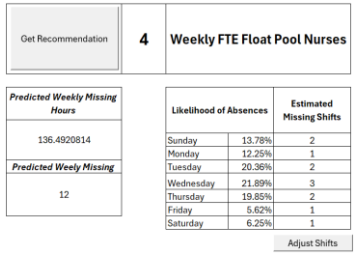


Staffing Decision Support Tool

We developed a tool for BMHCC's scheduling managers which lets users choose their hospital and floor and input scheduling period dates and historical census data. A Newsvendor model is run in the background to display the optimal staffing level over the scheduling period. Users can also view float nurse staffing recommendations and adjust the predictions for any real-world trends they experience in their unit.



Newsvendor In-Unit Recommendation



Float Pool Usage Recommendation