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Healthcare

Transformation Services

Utilizing operations research and analytics to **optimize the workforce for a multi-hospital healthcare** system in the US

A workforce optimization white paper

Introduction

Traditional approaches to staffing and scheduling are often ineffective in delivering efficient and effective nursing resources on schedule and within budget. Staff deployment must provide the right nurse at the right time for the right cost. As hospital merger activity increases, this exercise is further complicated by the need to rationalize staffing across multiple enterprises and to standardize systems and processes.

Looking to optimize staffing at the unit and enterprise levels, an 11-hospital health system, one of the largest healthcare providers in the Midwest USA, asked Philips to provide strategic support and tactical direction for a comprehensive workforce optimization program.

After acknowledging that nursing alone could not execute successful resource planning and deployment, a coordinated and interdisciplinary effort was undertaken. Representatives from human resources (HR), information technology (IT), finance, clinical education, and clinical leadership – together known as the 'Staffing Ecosystem' – provided program support and engagement. (See Figure 3.)

Leveraging operations research methodologies, advanced statistical modeling, and targeted analytics, the Staff Ecosystem team collaborated to create and implement an enterprise-wide nurse resourcing strategy/model, which has increased staff efficiency and satisfaction, and reduced costs.

As a result, the health system was able to reinvest a portion of the savings to develop improved staffing models, which provided sufficient non-productive coverage and patient-driven ratios to eliminate over/under staffing. This new staffing reinforced the health system's recognition that adequate resource planning and deployment is critical to the culture of safety.

Moving towards increased standardization

Traditional approaches for addressing the challenges of clinical staffing and scheduling are not always as effective as necessary in today's complex and ever-changing environment. Lengths of stay in acute care settings are short yet require a high intensity of services and nursing resources. As effective implementation of population health strategies decrease hospital admissions and the transition to value-based care models drives changes in operations, traditional staffing systems are becoming less effective.

With mergers and acquisitions on the rise, Chief Nursing Executives (CNEs) need to standardize staffing policies, procedures, and practices across newly formed systems and partnerships. And geographically-proximate organizations are developing float pools or product line-oriented staffing models to optimize clinicians and expertise across facilities – requiring further standardization of methodologies, compensation plans, and personnel policies to be effective.

This Midwest health system client was no different. Not unlike other rapidly evolving healthcare systems, they recognized that there would be an intentional reduction in inpatient utilization across the enterprise requiring deliberate and preemptive resource planning. They set about re-conceptualizing the inpatient-staffing model to create a more flexible workforce. They constructed agile models to provide the administrative infrastructure for staff movement within and across hospitals and eventually into alternative settings as inpatient utilization declines. Over time, fewer and more flexible resources are expected to be required in the acute care settings.

Furthermore, the health system had been growing significantly and it was recognized that standardization of staffing and scheduling practices, procedures, and workflows was a fundamental requirement in building a flexible nursing workforce.

Leveraging the Philips co-create methodology

Utilizing a multidisciplinary and iterative co-create methodology, the Staff Ecosystem team collaborated with the Philips consulting team to redesign and standardize all relevant policies, procedures, and processes across the enterprise. Additionally, demand-based staffing models were created for each unit and robust Clinical Resource Units (CRUs, float pools) created for each organization while the infrastructure was built to support regional resource units.

A clinical issue requiring a logistics solution

In order to address an optimization project of this magnitude and complexity, the health system's nursing leadership researched effective methodologies from outside of healthcare. There was recognition that while the challenge itself was clinical in nature – providing the right nurse with the right skills, at the right time, and for the right cost – it was in fact, a logistics challenge. Industries that rely on logistics science to manage the flow of goods, information, and people include the military, airlines, package delivery, and procurement and supply chain. There are two types of logistics involved – one that optimizes the steady flow of materials through a network of transportation and storage nodes and a second that coordinates a sequence of resources such as human capital. (See Figure 1.)

System objective: Build a flexible nursing workforce and improve staffing allocation

Why?	How?
To account for increasing variation in patient needs and decreasing inpatient utilization and emergency department visits as hospitals target population health goals	Mathematically-optimize staffing based on demand, clinical requirements, and work practices and processes for 110 inpatient units and EDs across 11 hospitals
To calculate required core staff and grow flexible staff, which will eventually serve the entire enterprise	Utilize big data to understand the complexities of supply and demand across time and across all of the individual hospitals
To provide the appropriate staffing at each hour of the day through a patient-centric solution	Standardize staffing practices, procedures, and scheduling workflows across the enterprise
To aid the health system's goal of supporting a safe enterprise	

In studying the experiences of other logistics-oriented industries, several unique planning approaches were identified. Organizations spent a great deal of time studying and modeling their demand and core business processes; specifically those that drive revenue or conversely, those that account for an appreciable proportion of expense. This analysis, of both supply and demand, suggests that these are not static variables, but they rather fluctuate in predictable and unpredictable ways (Fitzpatrick & Brooks, 2010).

When applied to the clinical environment, consideration must be given as to how patient demand fluctuates by month of the year, week of the month, day of the week, and even hour of the day. Arguably, in highly transaction-oriented units such as operating rooms and emergency departments, understanding demand at the 15-minute increment may be required.

But demand, in and of itself, is not sufficient to drive the staffing model. In order to correctly budget and plan for required human capital, the processes, practices, and procedures which determine the availability of resources must also be considered. These include staffing and scheduling practices, time off policies, vacancy and turnover patterns, human resource positions, time-to-fill data, and when appropriate, labor contract terms just to name a few. The antiquated technique of applying an hours per patient day (HPPD) target against an average daily census, often marked at midnight, does not meet the evolving needs of today's environment. A simple practice such as a weekend work requirement may lead to a significantly different model result - an organization which requires every third versus every other weekend will have significantly different resource requirements and will require a different configuration of positions to deliver adequate staffing while minimizing overstaffing.

To develop a workforce optimization model that best met the business objectives of the health system, the Philips team created two distinct levels of optimization modeling. In the first, they solved to the optimal number and exact configuration of staff required to meet both the demand and the exacting system constraints or standard staffing practices. The second optimization exercise produced mathematically optimal schedule patterns, mindful of the various system constraints and variables.

How optimization modeling works

The multifaceted staffing challenges that this health system faced could not be solved using staffing averages or simple algebra. There are multiple dimensions to each staffing sub-process that interact with or are somehow impacted by other existing processes. Powerful mathematical models are required to simulate solutions for these complex staffing and deployment problems, allowing for examination of the interactions in a more dynamic manner.

Optimization modeling based on linear programing is a computational methodology that not only solves difficult problems with a single solution, but also provides the ideal solution from a myriad of possibilities. Based on work described by Fitzpatrick and Brooks (2010), the process of modeling is best described as mathematically representing every nuance or constraint and variable in the scheduling process including demand – at least at the hourly level.

To mathematically represent the staffing business problem, the Philips Workforce Optimization Model (See Figure 1.) includes the following:

- Business objectives including achieving coverage at the desired nurse-to-patient ratio while reducing costs
- Decision variables such as skill mix, demand fluctuations, and cost differences
- Business constraints such as staff availability, time off requirements, and various staffing and scheduling practices

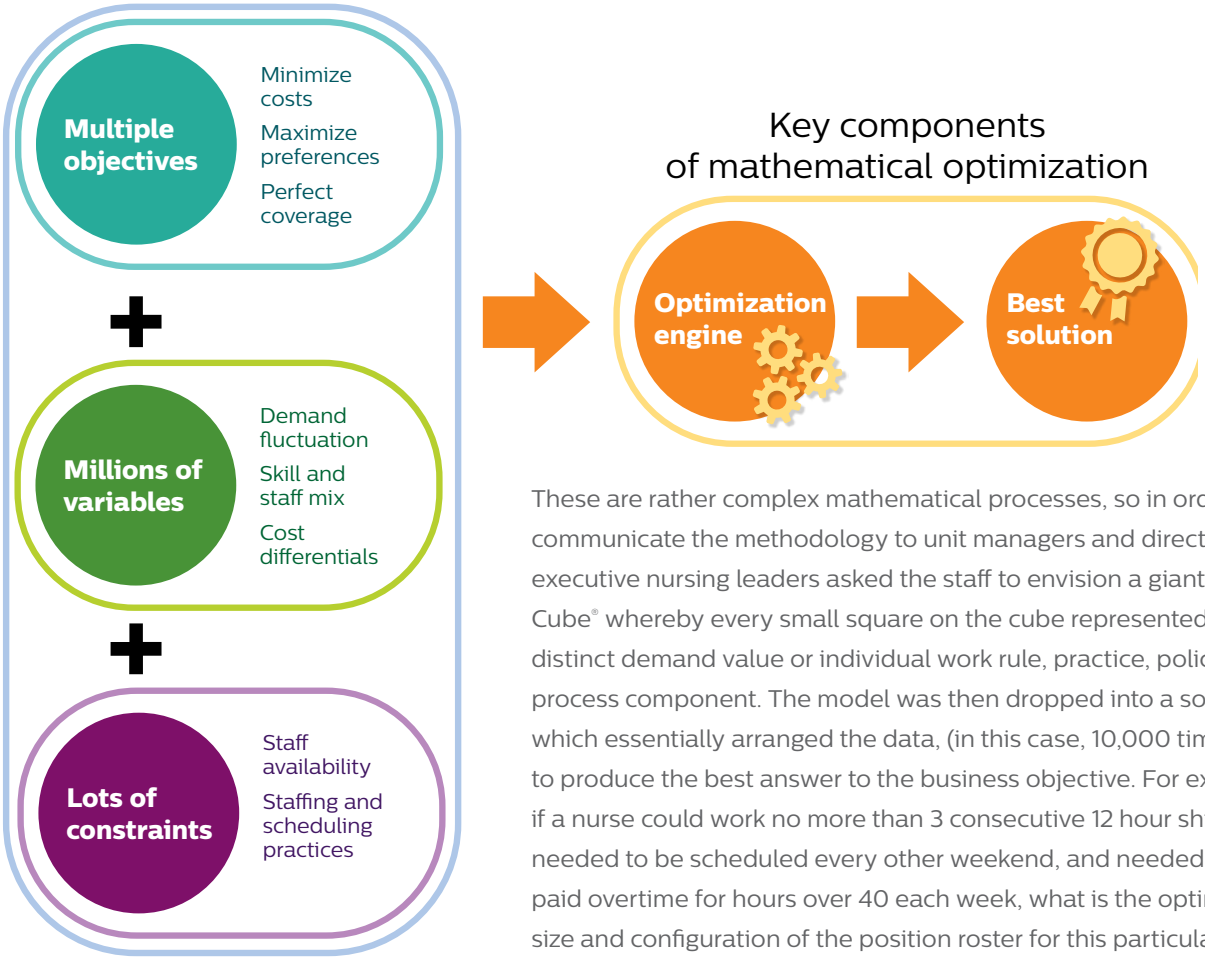


Figure 1. Workforce Optimization Model.

These are rather complex mathematical processes, so in order to communicate the methodology to unit managers and directors, executive nursing leaders asked the staff to envision a giant Rubik's Cube® whereby every small square on the cube represented a distinct demand value or individual work rule, practice, policy, or process component. The model was then dropped into a solver, which essentially arranged the data, (in this case, 10,000 times/unit) to produce the best answer to the business objective. For example, if a nurse could work no more than 3 consecutive 12 hour shifts, needed to be scheduled every other weekend, and needed to be paid overtime for hours over 40 each week, what is the optimal size and configuration of the position roster for this particular unit? Imagine the complexity of the model when considering the variation in hourly census.

Step 1 – **Creating the model**

The actual problem is defined as a set of mathematical equations. (See Figure 2.) All of the inputs, requirements, assumptions, and constraints as well as the objectives of the solution are defined. As an example, when modeling for the optimal numbers of staff to schedule for a particular period, the inputs would likely include the desired nurse-to-patient ratio or staffing target, weekend rotation requirements, unit's non-productive utilization, staff preferences, etc. In this case, the requirement was defined as an optimal and work rule compliant schedule, which met the patient demand at the hourly level.

Quantitative components of the model

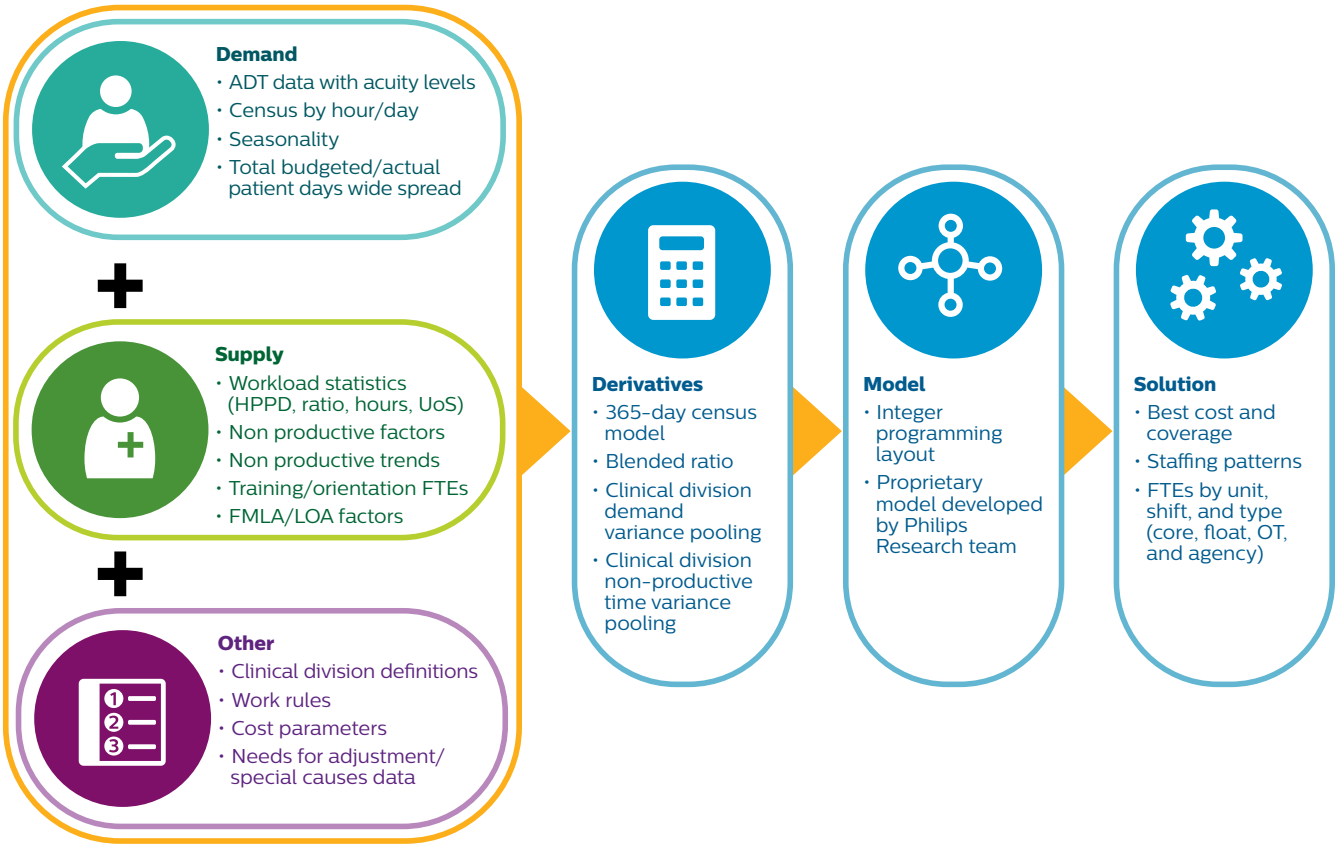


Figure 2.

Step 2 – **Creating a standardized solution**

110 individual nursing units were optimized as part of this work. An individual model was created for each unit and facilitated through the standardization of staffing and scheduling processes across the enterprise. The model utilized advanced optimization algorithms and solver technology, which permitted the ability to run 10,000 scenarios per unit. Without such advanced mathematical modeling capability, this would not have been humanly possible and a solution would have been produced which did not account for all variables. Producing the best solution from the start eliminates much of the chaos managers and staffing offices would experience correcting scheduling errors and unfilled shifts.

Step 3 – **Interpreting the solution**

Once the solution is produced, it is then interpreted by each unit's leadership. The unit managers possess unique knowledge regarding the operations of their particular department – therefore it is critically important for them to review the results of the model, balancing the mathematical results with their real world expertise. The benefit of creating the model is the ability to run multiple alternative scenarios with different assumptions and to understand the financial and coverage impact of each.

For most healthcare organizations, the time between operational best practice knowledge discovery and broad adoption is often measured in years. Lack of a systematic approach can hinder an organization's ability to execute on known best practices and achieve desired outcomes. In order to effectively migrate to the optimal mix of core and flexible RN staff as determined by the models, and to effectively build and deploy local and enterprise float or CRU staff, standardization of key staffing and scheduling practices is required.

For the health system, a multi-disciplinary design team was formed including system and local site representatives from each part of the Staffing Ecosystem (See Figure 3.) including clinical leadership, finance, HR, IT, and clinical education. This design team met in three eight-hour sessions and worked to standardize practices in scheduling and staffing for the entire system using current literature as a foundation for decision-making as well as looking to improve employee work-life balance wherever possible. 350 disparate practices became 75 standardized practices to support a systematic approach that will assist in ensuring that organizational change happens and is sustained over time.

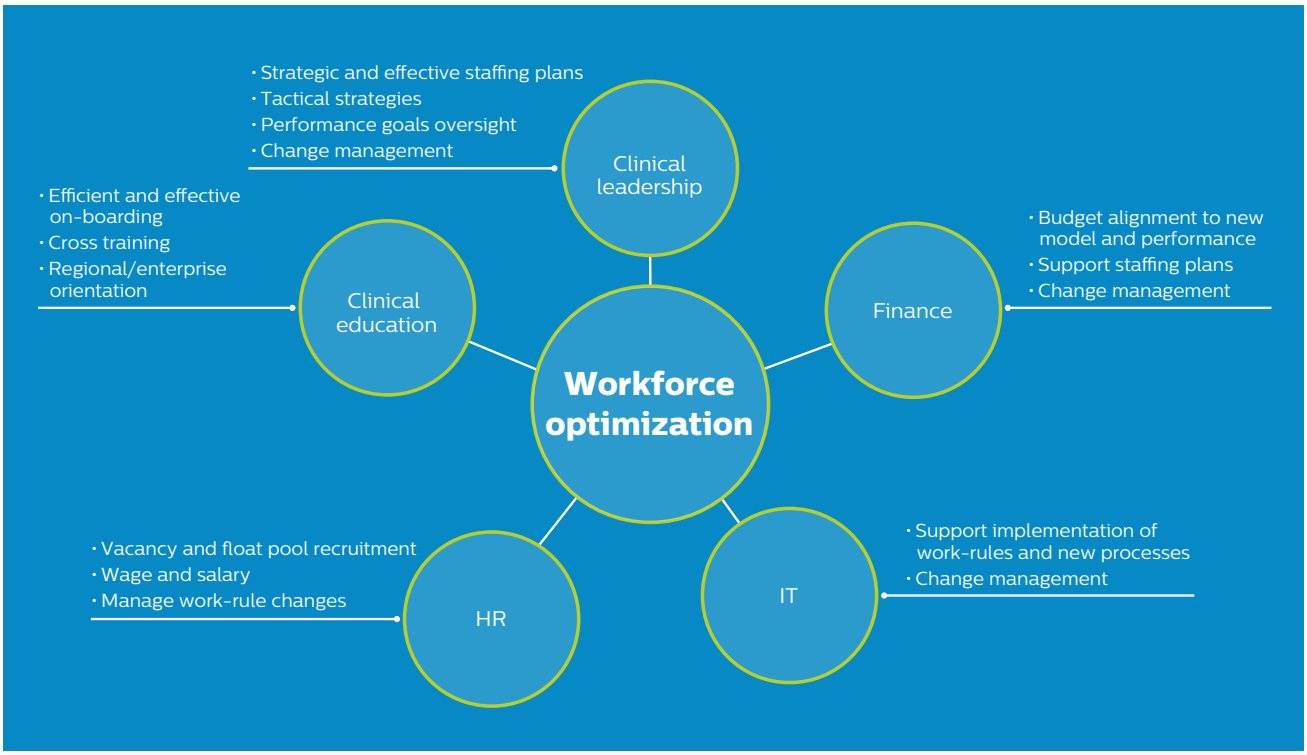


Figure 3.

Building the models

Once the practices and processes were standardized and stabilized, leaders within the 11 hospitals began building the models by thoroughly assessing various qualitative elements within the Staffing Ecosystem. These qualitative characteristics included information on unit demographics, clinical education processes which influence orientation cycles, and current patient populations. In fact, the physical layout of the unit was also considered as geography has a significant impact on staffing. Key to the optimization process was the identification of the current model of care including the expected nurse-to-patient ratios for the respective population on each unit.

Functional areas within the Staffing Ecosystem assessed included clinical leadership, finance, IT, HR, and clinical education. Each of these has a significant impact on the ability to effectively staff a nursing unit. Whether that impact was a cultural expectation or an operational decision, the focus was on discerning those qualitative elements that created barriers to effective staffing.

Combined with the quantitative historical demand data, a powerful and holistic model was created. The ability to accurately predict the future behavior of a system or process is best facilitated through the analysis of past performance, and more data is better than less, presuming a reasonably stable process. Accordingly, in an effort to understand and better predict future performance, the decision was made to analyze three years of hourly demand and payroll data for each of the 110 units across the 11 organizations. This "big data" approach involved more than 1 terabyte of data. Although more than a trillion bytes of data may have appeared overwhelming at first, it would have been impossible to plan resources across an enterprise of this size and complexity without a thorough understanding of the interplay of supply and demand holistically.

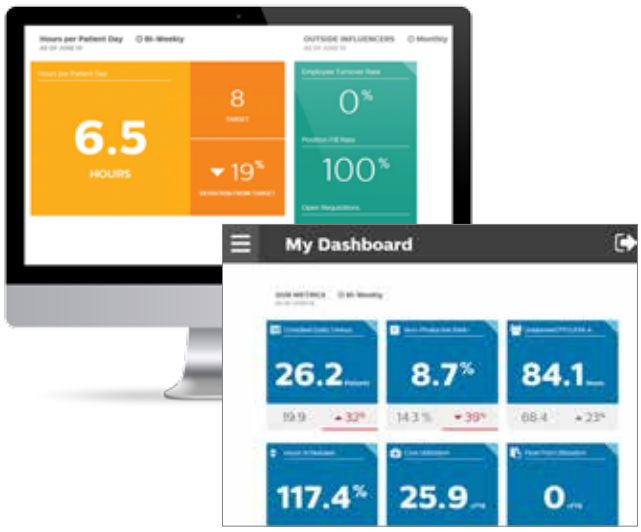
In preparation for implementing the optimal models and new processes, the staffing office functions at each of the facilities, as well as the extent of integration between the units and staffing office were examined and standardized. Understanding the current approach to staffing and scheduling allowed for the project team to determine the magnitude of change that would be required to migrate to the new optimized model.

A fundamental goal of this work was the production of schedules without gaps, which were compliant with the objective functions described through standardized staffing and scheduling practices/ procedures. This was essentially migrating staffing and scheduling precision upstream thereby minimizing the daily chaos related to staffing. This meant a more proactive and collaborative role for the staffing offices.

Performance Dashboard

A Nurse Workforce Optimization Performance Dashboard was created – an application to track ongoing nurse-centric performance analytics as well as a data modeling tool. Leveraging advanced linear programming algorithms, the tool utilizes the health system's unique demand patterns (census) to develop a mathematically optimized nursing labor force plan incorporating enterprise-specific work rules. Results from the model are used to track performance and identify potential performance issues through root cause analysis.

The Nurse Workforce Optimization Performance Dashboard combines advanced data science methodologies with decades of executive nursing experience to empower nursing management, from the Nurse Manager to the Chief Nursing Officer, in making data-driven decisions for staffing challenges.



Effective monitoring of model implementation

In addition to the standardization of practices, work processes, and tools, oversight teams were formed at each organization to support a systematic approach as well as achieve and sustain the targeted outcomes. A Workforce Optimization Executive Ecosystem Oversight team was chartered at each hospital, led by the hospital CNE. Its membership includes each hospital's VP of Human Resources, VP of Finance, Director of Nursing Finance, and Clinical Education Leader. The teams' responsibilities were to meet monthly and to ascertain that all elements of the Staffing Ecosystem were achieving their functions requirements to support optimally staffed patient care units.

Each team will accomplish their mandate through the following activities:

- Develop and implement mechanisms to gauge progress towards successful implementation of the workforce optimization goals.
- Review the staffing issue trends from consolidated unit-based Root Cause Analyses, HR Vacancy Reports, the hospital's staffing configuration plan, and RN Associate Pulse Surveys regarding satisfaction with scheduling and staffing practices.
- Identify common cause vs. special cause variation which may necessitate remodeling, i.e. a significant change in demand, a sustained increase in the use of non-productive time, or a change in staffing model.
- Problem solve opportunities to remove barriers for Nurse Managers and Nurse Finance Directors to achieve optimized staffing.
- Effectively communicate the activities of the workforce optimization efforts to multiple internal audiences including the hospital and health system executive teams.
- Review the outcomes metrics for workforce optimization. Table 1 illustrates the metrics that will be reviewed at each of the Staffing Ecosystem meetings. The responsibility for each metric is outlined next and the leader of each function brought current and YTD results and additional information to that meeting as a means to explain variances to the target.

Metric	Assigned
% of time units are meeting targeted staffing grids	Leader of Nurse Staff Finance
Nursing cost per unit of service premium pay	VP of Finance
Nurse turnover Nurse vacancy rate Time to fill Associates satisfaction related to staffing	VP of HR
Inpatient mortality Failure to rescue events	CNE
Clinical Education Dashboard	System VP of Clinical Education

In addition to standard metrics and oversight team roles and responsibilities, standard work was designed for the Director of Nurse Finance and a standard agenda was created with critical information assigned to each leader within the Staffing Ecosystem. This provides a systematic approach to support optimal outcomes with staffing across the entire enterprise.

Developing a change management approach

The health system embarked on this enterprise-wide transformation to improve performance on staffing, build the workforce needed to meet present and future patient needs, and to thrive in today's changing health care landscape. A critical piece of the work to drive adoption of the models and deliver expected results across the enterprise was to have a standard change management approach. This process was developed by system Organizational Development (OD) leaders and deployed individually to each hospital. Through this process, the organization could align and address system and local hospital change management and transition needs focusing on:

- Standard staffing and scheduling practices
- Staffing model changes
- Shifting to a flexible workforce addressing potential changes in hiring, unit perception, and patient assignments

The standard change management process included three key sessions to prepare leadership to manage and HR to support the transformational changes around workforce optimization. The first session was a two-hour executive session where system OD leaders shared an overview of the standard change management and transition model with the CNE, VP HR, HR OD lead, and the Nurse Finance leader. During this time, the group reviewed the standard change management workbook, tools, communication plans, and presentations, and customized them to meet the needs of each individual hospital. A second one-hour session was devoted to the VP of HR and HR staff to identify their unique roles in supporting this change. The third was a three-hour CNE and VP HR co-led working session with nursing leaders to assist them in fully understanding workforce optimization changes, their role in leading these changes, identifying unit specific benefits and risks with the changes, and detailing a specific communication strategy and plan for each unit.

Conclusion

The health system has made an important and deliberate decision to place patient and associate safety at the epicenter of their leadership and strategic decision making, particularly in the planning and allocation of clinical resources. They recognized that they had a greater chance of long-term success if they looked for innovative solutions outside of healthcare. These solutions acknowledge the complexity of the contemporary environment while producing a balanced cost/quality outcome, as value for human capital investments evolves.

As environmental complexity intensifies and interdependencies within and between organizations and disciplines evolve, the methods of analysis and the magnitude of data required to make decisions must advance as well. Visualizing, querying, processing, and harnessing big data related to understanding supply and demand, is the first step in using predictive analytics and other advanced methods to extract value from that data. This will lead to more confident decision-making and result in improved operational efficiency, cost reduction, and risk reduction. While insurers and healthcare systems are now analyzing these big data sets to drive clinical decision-making, workforce optimization has demonstrated the impact of this level of sophisticated data analysis on the critical task of right-sizing, right-configuring, and deploying nursing resources.

The daily fire drills which occur in staffing offices are unnecessary and a misplacement of precious management time and effort. Precise and data-driven modeling will significantly improve these processes, permitting managers to refocus attention and expertise on the value-add activities important to patients and staff development. While we often discuss the necessity of clinical staff working to top of license, the health system is working to provide the same advantage to its leaders – allowing them to perform at the highest levels where their unique contributions will provide the greatest benefit to patients and staff.

Learn more

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