

Utilization of Predictive Analytics for ED RN Schedule Optimization

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Purpose

To develop and implement an **AI-driven nurse scheduling optimization platform** that aligns staffing levels with predicted ED volume and acuity while improving staff autonomy, schedule fairness and operational efficiency.

Background

- Emergency Department nurse staffing is increasingly complex as static staffing schedules fail to reflect fluctuating volume, acuity, and seasonal demand.
- Rising ED boarding adds further staffing challenges.
- Manual scheduling is time-intensive for leaders and risked perceived bias.
- Emergency Departments face high risk for turnover with the work environment being a driving factor¹.
- Staffing shortages and increased workloads contribute to ED nurse turnover and burnout².

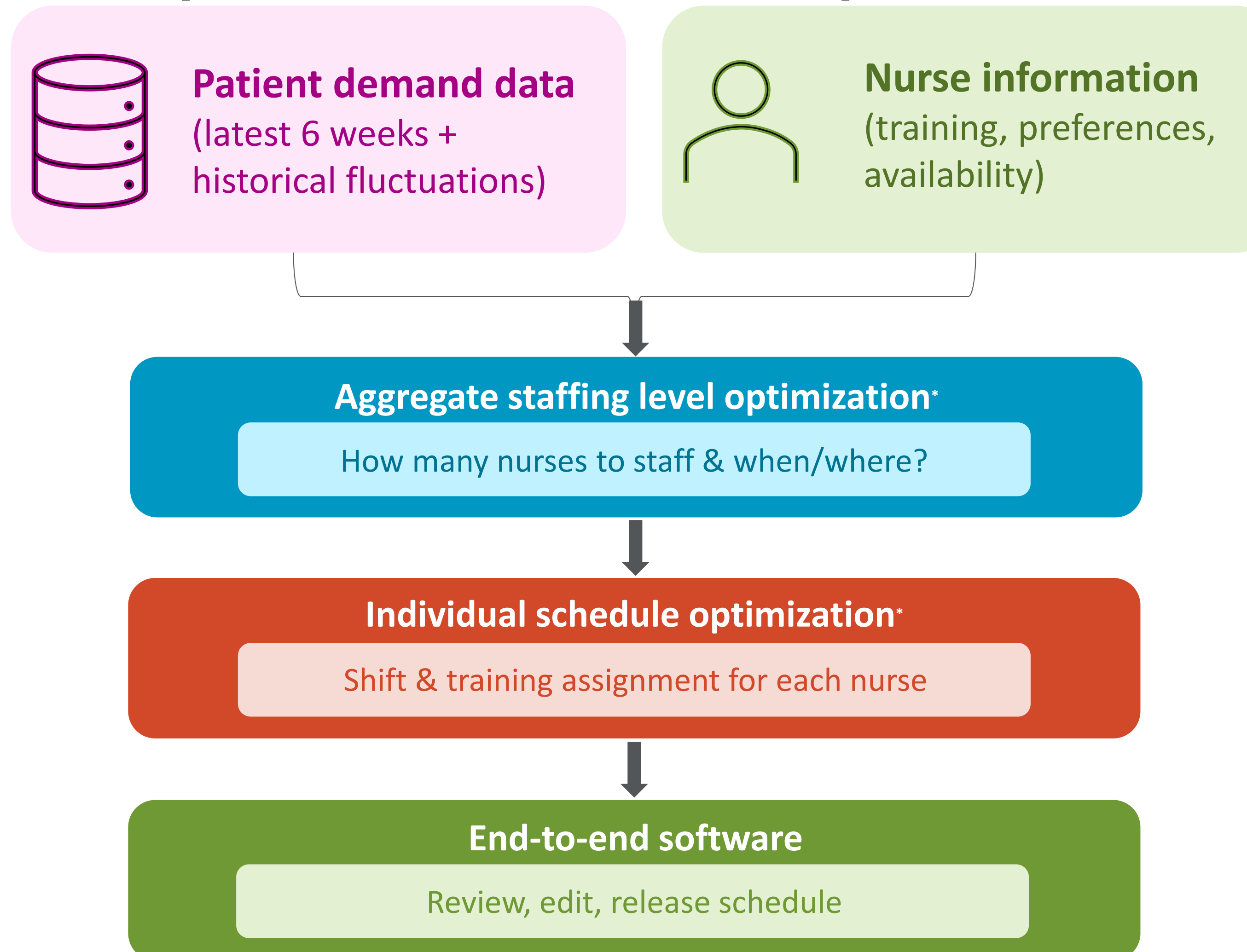
Setting

- Level I Trauma Center ED with 110,000+ annual visits
- Staff of approximately 200 nurses with varied levels of training/competency
- FY22 to FY 24:
 - ED visits: +2.94%
 - Inpatient boarding: +30.14%
- Opportunity arose to partner with Massachusetts Institute of Technology to develop AI-driven solution

Methods

- Developed predictive ED volume model using historical patient data
- Applied a robust optimization model using mixed-integer problems that integrated nurse qualifications and preferences³
- Built a software platform with individualized nurse scheduling profiles
- Manager profiles allow for utilization of configurable constraints
- Generated multiple optimized schedule options
- Nurse leaders select and publish the optimal schedule

Optimization + Software Implementation



*Satisfying all staffing constraints: feasibility, qualifications, minimum staffing levels, budgeted hours

Results

Reduction

50.31% reduction in overtime utilization

- Daily shift shortage reduction
- 91.67% decrease in bonus incentive pay utilization
- Weekend/holiday overage reduction

Improvement

Rotated through ≈2.4 pods weekly

- Increased diversity & equity of assignments
- Shift preferences honored at 90% on average
- 5% increase in granted scheduled PTO

Optimization

>90% reduction in leaders' time spent building schedule

- Accelerated training timelines for specialty areas
- Shift time alignment to peak hours to optimize resources to demand

- Utilization of this optimization software allowed for data-driven decisions to right-size total FTE budget allocations based on patient demand, improving resource management.
 - 77.57% reduction in nurse vacancy rate
- While multifactorial, these improvements are strongly supported by the optimized schedules rectifying overages/insufficiencies and by program-generated data to support baseline budgetary adjustments to match volumes.

Conclusion

- Strategic nurse staffing is essential for patient safety, staff satisfaction, and operational efficiency.
- With the uncertainty of the headwinds facing the healthcare industry, organizations must evolve to adapt technology that produces dynamic solutions to barriers faced.
- AI-enabled platforms provide scalable, data-driven solutions that improve operational outcomes, reduce administrative burden, and support sustainable workforce models in an evolving healthcare environment⁴.

References

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⁴Pranata, A., & Yudhanegara, R. (2023). Strategic Human Resource Allocation in Healthcare Institutions Using AI-Enabled Workforce Analytics and Predictive Modeling. *International Journal of Theoretical, Computational, and Applied Multidisciplinary Sciences*, 7(12), 1-24. <https://iitc.ams.in/index.php/IITCAMS/article/view/202312-04>