**Executive Summary**

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**Problem Statement and Significance**

The demand for Nurse Practitioners (NPs) is increasing (U.S Bureau of Labor Statistics, 2021) at time when U.S. nursing schools are declining graduate admissions due to lack of available preceptorships (AACN, 2020). This situation results in a bottleneck with respect to both available NPs for practice and NP student preceptorships for education. Simultaneously, the literature reports NP student preceptorships are impacted by the following barriers: (1) provider time and productivity constraints, (2) lack of healthcare administration support and remuneration (Staples & Sangster-Gormley, 2018), and (3) concern surrounding patient dissatisfaction with wait times (Xie & Or, 2017). Compounding this situation, a literature gap exists regarding how NP preceptorships impact daily NP workflow and associated EHR documentation time. The purpose of this study, therefore, is to utilize a simulation approach to compare the patient throughput and wait times associated with nurse practitioner preceptorship models in a primary care setting while acknowledging the impact of EHR documentation. Three scenarios were examined in this study: (1) NP only (control), (2) NP paired with one NP student (NPS) (traditional model), and (3) NP paired with two students where students see separate patients (two-student model).

**Methodology**

In order to systematically model each preceptorship scenario three research activities were required for this study: (1) construct a model representing the steps in which a nurse practitioner and/or a nurse practitioner student(s) engage during a patient encounter, (2) simulate times for patient encounters, and (3) conduct a discrete event simulation to compare the three preceptorship scenarios of interest. Four outcome measures were used to compare scenarios: NP non-patient face-to-face time, patient wait time, service time, and patient duration. All simulations were run in Microsoft Excel. According to Law (2015), spreadsheet simulation via Microsoft Excel provides a valid measure of simple data structures such as those representing patient encounters in a primary care setting.

**Results**

Significant differences were found for each preceptor scenario and outcome measures. ANOVA results suggest that NP non-patient face-to-face time is highest in the two-student model. Additionally, patient wait time and duration time were not prolonged with the one or two student preceptorship models and were the lowest with the two-student model. Of note, when the NP does not have a student and is required to finish EHR charting prior to seeing the next roomed patient, the patient wait and duration times were found to be significantly higher as compared to the other preceptor scenarios. Service time was found to be the highest with the one student model.

**Discussion**

Results of this study support considering a two-student NP preceptorship model to expand NP preceptorship opportunities. This study demonstrated the two-student model doubled the NP non-patient face-to-face time while decreasing patient wait times as compared to the traditional one-student model. The NP non-patient face-to-face time accounts for the time the NP is not directly with the patient. This time may be used to complete (1) administrative tasks/enhance productivity (lab/diagnostic review, complete pending billing & EHR documentation) and (2) engage in precepting responsibilities (engage in collaborative learning experiences, review student EHR documentation & complete required preceptor documentation). As a result, NP preceptors who accept two students may not experience productivity constraints.

Furthermore, completing administrative tasks specifically EHR documentation, may minimize EHR time spent outside of normal clinic hours. Current literature reports EHR documentation completed outside of normal clinic hours is contributing to provider burnout (Eschenroeder et al., 2021). Interestingly, the NP only control scenario resulted in patient wait time and duration time significantly higher than both student preceptorship models. This discovery highlights the time burden associated with finishing EHR documentation in real-time, prior to the next patient encounter. More research is warranted to understand how providing NP preceptorships may offset preceptor EHR documentation time burden.

The NP non-patient face-to-face time in the two-student model was significantly higher as compared to the one-student model. This finding suggests preceptors in the two-student model may have more precepting time while simultaneously increasing the number of preceptorships. Protecting this time for required administrative and educational tasks, versus using it to increase patient encounters, is warranted. Increasing NP workload in this situation may increase the risk for provider burnout and result in NP turnover, thus worsening the current provider supply and demand imbalance. As a result, healthcare systems may benefit from adopting renumeration policies and contracts which account for NP precepting time. Additionally, as we seek to expand preceptorship opportunities that break from the traditional model, written guidance from the National Organization of Nurse Practitioner Faculties (NONPF) is needed. Standards for clinical curriculum will need to be developed by NONPF to support two-student preceptorship models to ensure quality NP clinical education is delivered.

**Systems**

To achieve the purpose of this study, simulation was used to compare the following three scenarios: (1) NP only (control), (2) NP paired with one NP student (NPS) (traditional model), and (3) NP paired with two students where students see separate patients (two-student model). The term “Simulation” has multiple meanings depending on your field of expertise. In nursing education, simulation is often synonymous with a teaching methodology valued for its ability to provide realistic clinical based experience. These experiences are delivered in a safe environment or simulation center which provides access to standardized patients, low and high-fidelity mannequins and virtual care patient care scenarios. Our study however, utilized systematic simulation approaches drawn from an array of disciplines including industrial engineering, statistics, operation research and management science. This type of simulation is used to examine complex systems, conduct “what if” analyses of real-world problems and generate computational solutions that may facilitate data-driven managerial decision making.

Simulation use in complex healthcare systems has merit as it can identify, for example, under or over-utilization of resources and unforeseen bottlenecks that may be hindering a system’s throughput (Ozcan, 2017). More importantly, simulation offers healthcare administrators the opportunity to evaluate or test new system designs with no disruption to existing clinic operations. Several types of simulation approaches are available. In this study, Monte Carlo and discrete event simulation are utilized (see Appendix A for a detailed explanation of these two types of simulation).

The outcomes generated in this study indicate that the two-student model had no increase in NP time burden and patient wait times as compared with the traditional one-student model. Additionally, a bottleneck within clinic operations was exposed in the NP control scenario as patient wait times were significantly higher. This bottleneck may be attributed to the assumption embedded in the simulation programming requiring all EHR documentation to be completed prior to the next patient encounter. Often providers will move on to the next patient encounter prior to finishing EHR documentation for the current patient to avoid increasing patient wait times. In order to examine the impact of EHR time burden, the assumption that all EHR documentation is completed prior to the next patient encounter was applied across all three scenarios. These findings suggest more studies are needed to understand, (1) the EHR time burden on NP workflow and (2) the impact of EHR documentation while providing NP preceptorships.

**Economics**

This study has significant economic implications. It is important to acknowledge the current supply and demand imbalance of available NPs and NP preceptorships. To reiterate the severity of this situation, future projections from the U.S. Department of Health and Human Services (2016) predict the 2025 demand for primary care providers will exceed supply at a national level. In order to combat the worsening provider supply and demand imbalance, more NP preceptorships are needed to generate more providers. To that end, innovate solutions must be mindful of current barriers to providing NP preceptorships often reported in the literature.

Two frequently reported barriers include (1) provider time and productivity constraints (Staples & Sangster-Gormley, 2018) and (2) concern about patient dissatisfaction and wait times (Xie & Or, 2017). These barriers carry economic consequences as they directly influence provider and healthcare system reimbursement. In this study, the two-student model resulted in no increase in NP time burden and patient wait times. As a result, NP preceptors can accept two students without experiencing productivity constraints. This in turn could generate additional NP preceptorships combating the provider supply and demand imbalance.

Concern surrounding longer patient wait times remains a top barrier to providing NP preceptorships. Longer patient wait times have been correlated with increased dissatisfaction of care provided (Xie & Or, 2017). Increased patient dissatisfaction scores are linked to decreased reimbursement in today’s complex healthcare payment landscape (Hayward, de Reise, & de Reise, 2020). This study demonstrated the two-student model decreased patient wait times significantly when compared to both the NP only (control) and one-student (traditional) models. As a result, providers and healthcare administrators, expanding NP preceptorship opportunities within their practice may anticipate no increasing patient wait times and decreasing reimbursement.

**Practice**

Practice implications for this study are centered around the significant increase in NP non-patient face-to-face time found in the two-student model. This study demonstrated the two-student model doubled the NP non-patient face-to-face time while decreasing patient wait times as compared to the traditional one-student model. The NP non-patient face-to-face time accounts for the time the NP is not directly with the patient. This time may be used to complete (1) administrative tasks/enhance productivity and (2) engage in precepting responsibilities.

The two-student preceptorship model may increase NP time for administrative tasks. Increased time for administrative tasks can be utilize by the NP to complete pending EHR documentation. Completing EHR documentation during clinic hours will minimize EHR time spent outside of normal clinic hours. Decreasing EHR documentation time completed outside of normal clinic hours is important as it is linked in the literature to provider burnout syndrome (BOS) (Eschenroeder et al., 2021). Burnout Syndrome is described as syndrome of emotional exhaustion resulting in significant practice implications including: poor quality of patient care, increased provider turnover, decreased productivity and diminished provider well-being (West, Dyrbye, & Shanafelt, 2018). A recent study conducted by Harris and colleagues (2018) reported approximately one in five advanced practice registered nurses across all specialties reported one burnout symptom. They also explained insufficient time for documentation was the strongest predictor of burnout (Harris et al., 2018). As we seek to expand preceptorship models, more research is needed to understand the relationships between preceptor and student EHR documentation time burden and potential association with BOS.

The increased NP non-patient face-to-face time in the two-student model can also be used by NP preceptors to maximize curriculum content through collaborative learning experiences. Collaborative learning instructional methods encourage students to work together to achieve a common educational goal through active engagement and accountability during the learning process (Zhang & Cui, 2018). Additionally, Zhang and colleague (2018) reported collaborative learning in the clinical nursing education setting was a useful strategy for improving the quality and efficiency of clinical instruction.

In a study conducted by Clark, Kent and Riesner (2018) a collaborative learning method consisting of a two-student to one-preceptor model was utilized in a primary care setting with family nurse practitioner students. In this study, nurse practitioner preceptors reported the two-student model was beneficial for student growth and encouraged collaborative practice. The details of student-patient pairing and workflow were not identified in Clark et al. (2018) study. Our results build on Clark and colleague’s findings and demonstrated the two-student model increased the NP non-patient face-to-face time thus potentially increasing the amount of precepting time. As a result, preceptors and students may have additional time to engage in collaborative learning experiences and maximize curriculum content.

**Policy**

The results of this study refute the claim providing NP preceptorships increases NP time burden and patient wait times, specifically when the two-students seeing patients independently preceptorship model is implemented. These findings have policy implications at the national, state and healthcare system levels. Nationally, organizations such as the National Organization for Nurse Practitioner Faculties (NONPF), must seek and support innovative strategies to combat the supply and demand issues facing NP preceptorships. Clinical curriculum standards will need to be developed by NONPF to support collaborative learning experiences expanding preceptorship models to ensure the delivery of quality NP clinical education.

Lack of remuneration and productivity constraints remain key barriers in providing NP preceptorships. Local policy initiatives are needed at the state and healthcare system level to

(1) compensate NPs for daily workload that incorporates time spent providing NP education and (2) protect precepting time. Currently, state tax credits/deductions exist in four states within the U.S (Barnes et. al., 2019). These incentives are providing direct financial payment for providing preceptorships in an effort to diminish the growing provider supply and demand imbalance. State nursing associations play a crucial role in providing a platform to advocate for such tax legislation. In addition, state nursing associations must continue to develop and provide policy advocacy education to help NPs advocate locally for legislation to support expanding preceptorship opportunities.

Accounting for precepting time in daily workload will ensure clinical competencies are being met while also being mindful of productivity outcomes. Our study demonstrated, the two-student model increased NP non-patient face-to-face time. This time should be protected and encompass administrative or precepting time and should not be used to increase patient encounters. Increasing NP workload in this situation may increase the risk for BOS as discussed in the practice section and result in NP turnover, thus worsening the current provider supply and demand imbalance. As a result, healthcare systems may benefit form adopting renumeration policies and/or contracts which account for NP precepting time.

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**Appendix A**

Explanation of Simulation

*Monte Carlo*

The Monte Carlo simulation approach uses random sampling and statistical modeling to estimate outcomes for static systems and the probability of when those outcomes will occur (Lawson & Lemis, 2008). For this study, a Microsoft Excel Monte Carol simulation template based on Queuing Theory and developed by Ozcan (2017) was used to generate patient encounter times. Queuing theory is relevant within this context as solutions are mathematically formulated based on arrivals rates, service rates per server, waiting time, and number of patients within a system. Examining wait times within healthcare systems has become a priority for healthcare administrators as long wait time have been linked in the literature with increased patient dissatisfaction and reimbursement (Xie & Or, 2017). The randomly generated patient encounter times from the Monte Carlo simulation were fed into the discrete event simulation to examine how patient encounters evolve over time.

*Discrete event*

Discrete event simulation is used as the encounters can be broken down into logically separate processes that progress linearly over time (Lawson & Lemis, 2008). Each event occurs when a specific process completes and is assigned a timestamp. The model workflow steps and corresponding assumptions for this study, described in Appendix B, depict how the discrete event simulation was constructed in Microsoft Excel for in this study. The outcomes from running this discrete event simulation, in combination with the patient encounter times from the Monte Carlo simulation, assist in replicating patient and provider (NP and NP student) daily workflow in a primary care setting. This will in turn, help identify bottlenecks within clinic operations.

**Appendix B**

*Model workflow steps and corresponding assumptions*

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| --- | --- | --- | --- | --- | --- |
| Workflow  Steps | Description | Assumptions | NP Only  Control | 1 NPS Model | 2 NPS  Model    Students  See patients Independently |
| Patient arrives | Patient arrives at clinic | Patients seen in order of appointment schedule | x | x | x |
| Patient Roomed | Patient roomed instantly | Patient roomed instantly when room is free (previous patient exits) | x | x | x |
| NP/NPS  Chart Review (3min) | EHR chart review prior to entering patient’s room | NP/NPS is available AND patient is in room | x | x | x |
| NP/NPS Enters Room | Once chart review complete NP/NPS enter patient’s room |  | x | x | x |
| Patient Encounter  (18min) | NP/NPS perform History and Physical Exam & Discuss Plan of Care | NP/NPS performs patient exam and discusses plan of care with patient | x | x | x |
| In Room Chart  (2min) | Any EHR documentation occurring during Patient Encounter | NP documents required charting in student model | x | x | x |
| Conference  (10min)  (Student Models Only) | NP/NPSs discuss patient encounter& Plan of Care | NP is available from start to finish of the conference  NP performs patient exam to validate exam findings and plan of care | n/a | x | x |
| Patient Exit | Once Pt encounter finished and in room charting completed Patient exits |  | x | x | x |
| Finish Chart  (4.5 min) | NP/NPS finishing EHR charting | NP/NPS finish charting prior to seeing next patient | x | x | x |