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DATA-DRIVEN STAFFING DECISION-MAKING AT A LARGE EMERGENCY DEPARTMENT IN RESPONSE TO COVID-19

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ABSTRACT

Resource shortages and long waiting times across emergency departments (EDs) in the United States will likely worsen due to high volumes of COVID-19-like illness (CLI) patients. We build a discrete-event simulation model to capture a large ED's operations and examine the impact of CLI on the ED throughput. We statistically analyze large datasets of actual standard and CLI patient encounters to define the model's input and validate its output. We compare the performance of five different staffing options, focusing on length of stay (LOS) and number of left without being seen (LWBS), under multiple standard and CLI patient volumes. Interestingly, we find that including an additional provider floating between standard patient ED care spaces leads to the most robust decrease in LOS and LWBS rates for both discharged and admitted patients, whereas adding an extra provider to CLI-dedicated ED care spaces had a small impact compared to the baseline staffing.

1 INTRODUCTION

EDs were operating over-capacity even prior to the arrival of COVID-19, with an estimated 130 million visits annually, leading to significant delays in light of potentially high-risk diseases associated with high morbidity and mortality. With the reopening the economy and an associated increase in patients presenting to the ED, staffing models established prior to advent of COVID-19 will likely be inadequate to respond to both the increasing overall patient volume and the unique challenges and workflows necessary to evaluate patients in the COVID-19 era. Our objective was to identify whether LOS and LWBS rates are sensitive to physician staffing changes, specifically when simulating for both previous standard patient volume and the expected volume of patients presenting with CLI. Our research question sought to identify whether the addition of physicians to standard ED care areas, CLI-dedicated ED care areas, or some hybrid forms could significantly improve these throughput measures.

2 METHODS

Based on the actual layout of the ED and the information provided by key stakeholders, we first built a process map to represent the operations of the ED. Then, we built upon this process map to construct a discrete-event simulation model that captures the ED operations as well as patient, provider, and nurse flow throughout the system. We gauged the throughput of the ED using a set of Key Performance

Indicators (KPIs) identified by ED leadership and providers. To determine the model's input, we performed goodness-of-fit tests on large volumes (i.e., 28,454 standard and 1,693 CLI unique patient encounters) of Electronic Health Records (EHR) data, corresponding to study period of seven months of ED operations in 2019 (for standard patient encounters), and two months in 2020 (for CLI patient encounters). The model was validated by performing a face validity test with key stakeholders and ensuring the model's output replicated the statistical characteristics of the EHR datasets.

To assess the impact of CLI on the ED's throughput, we modified the validated simulation model to capture the capacity and features of both standard and CLI-dedicated care spaces. Further, we evaluated five different staffing options and compared their performance, measured in terms of LOS and LWBS rates, to that of a baseline staffing under 16 scenarios, where each scenario represented different volumes of standard and CLI patient encounters. Specifically, we analyzed the performance of each staffing option under different permutations corresponding to 100%, 75%, 50%, and 25% of the standard and CLI patient volumes observed during the study periods. We identified the staffing option that offered the most robust response to the high uncertainty surrounding CLI patient volumes.

3 RESULTS

We found that adding one provider floating between standard ED care spaces led to the highest average reduction in LOS with respect to the baseline staffing. For standard patient encounters, this reduction was equal to 24.34% or 96.36 minutes for discharged patients (LOS: 299.51 minutes, 95% CI: 299.05 – 300.00, n=100), under a mix of 75% (21,318) of standard patients and 100% (5,932) of CLI patients (Mix 1). For standard patient encounters and admitted patients, this reduction was equal to 13.91% or 88.34 minutes (LOS: 546.64 minutes, 95% CI: 545.25 – 547.70, n=100), under a mix of 100% (29,722) of standard patients and 100% (5,932) of CLI patients (Mix 2). This staffing option also led to the highest average reduction in LWBS rate with respect to the baseline staffing, equal to 84.57% or 50/week (LWBS: 9.12/week, 95% CI: 8.53 – 9.32, n=100), under Mix 1.

Furthermore, adding one provider floating between CLI-dedicated care spaces led to the largest average improvement in LOS for CLI patient encounters, equaled to 10.44% or 37.65 minutes for discharged patients (LOS: 323 minutes, 95% CI: 322.07 – 323.60, n=100), and 8.11% or 35.97 minutes for admitted patients (LOS: 407.74 minutes, 95% CI: 406.73 – 408.85, n=100), all under Mix 2. These CLI-area improvements were more modest than those achieved by adding one provider floating between standard care spaces, suggesting that the baseline staffing of a single provider per CLI-dedicated care area provided enough capacity to satisfy the CLI demand.

4 CONCLUSIONS

The objective of our research was to analyze whether LOS and LWBS rates are sensitive to physician staffing changes under multiple, different permutations of standard and CLI patient encounters. To this end, we first constructed a process map to capture the complexity of the operations of a large ED; then, we built upon this map to construct a discrete-event simulation model to gauge the ED throughput. We performed statistical analyses of EHR data, including large volumes of actual standard and CLI patient encounters, to define the model's input and validate its output. In order to identify the staffing option that offers the most robust response to an uncertain volume of standard and CLI patient encounters, we evaluated five different staffing settings, focusing on LOS and LWBS rates, under 16 scenarios. For each scenario, we compared the performance of each staffing option to that of a baseline staffing under a different mix of standard and CLI patient encounters. We found that adding one additional provider floating between standard patient ED care spaces lead to the most robust reduction in LOS and LWBS rates, for both standard discharged and admitted patients. Interestingly, the improvements of adding an extra provider to CLI-dedicated ED care spaces were much smaller when compared to the baseline staffing model. These results may be driven by the large proportion of standard patient encounters, which dominate the overall patient volume in the ED.