SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

This study aimed to explore the possibility of providing design or operational solutions to emergency department challenges using DES techniques.

Leveraging discrete event simulation modeling to evaluate design and process improvements of an emergency department

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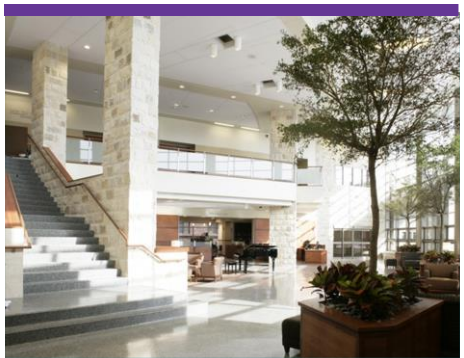
Key Concepts/Context

Research shows that emergency departments (EDs) are frequently challenged by high patient volumes, unpredictable surges, and emergency care providers who may be at increased risk for burnout and mental distress. Furthermore, longer wait times have been associated with an increased potential for adverse events and patient mortality. Discrete event simulation (DES) is a way to evaluate emergency department resource utilization by examining patient flow through the department, arrival times, locations, and staffing resources.

Methods

The setting was a new emergency department in the process of being designed for a suburban region of North Carolina. Processing time for patients, staffing schedules, and staff input from two existing emergency departments (EDs) were used as benchmarks to inform the new facility. The researchers used simulation modeling to incorporate the feedback, recommendations, and observations from the existing sites into the new design. To inform the simulation model, 20,336 unique patient visits collected from July 1, 2020 to June 30, 2021 were used. Although no identifiable information from the patients was collected for this study, patient-level visit data was available for ED, lab, and radiology subprocesses.

Visit information included over 24 variables, including arrival time, Emergency Severity Index (ESI) level, process timestamps, last ED room, ED disposition, and ED departure. Process timestamps recorded: 1- arrival to triage; 2- arrival to registration; 3- arrival to first bed; 4- arrival to the first provider; 5- arrival to first disposition selected; 6- arrival to first admit order; 7- arrival to first bed; 8- arrival to ready to discharge. Differences between timestamps were applied as processing times for registration, triage, lab specimen collection, radiology process, ED time with the provider, ED wait for bed, and ED bed assignment.



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Different proportions extracted from the data included acuity, final disposition, and lab or imaging orders. The model outputs, such as length of stay (LOS), wait for provider, or time with the provider, were compared with the current ED benchmarks for validation purposes. Physicians' and nurses' schedules were used to define staffing levels. The DES was developed with some assumptions pertaining to staffing schedule, movement characteristics of patients, and patient arrival schedule. The researchers worked on this simulation model for six months, and the data collected for the first two days were eliminated as they were days that were used for initial baseline training and testing the computer programs.

Findings

The goal of the study was to identify efficient and achievable physical environment or workflow strategies to improve throughput and reduce ED LOS. The first scenario explored was a rapid-admission process, and the second explored the initiation of a results-pending area for patients of low ESI/acuity.

For the admission scenario, a standard flow based on the processes from the existing facilities was as follows: physician assessment, diagnostic orders, results posted in the electronic health record (EHR), bed requested, bed assigned, and patient admitted. The rapid-admission scenario included the following steps: physician assessment, inpatient bed request and diagnostic orders, results posted in EHR, bed assignment, and inpatient admission. The standard and rapid-admission scenarios were compared regarding patient's LOS, arrival to request for an inpatient bed, and arrival to inpatient bed assignment. The median length of stay decreased by 16% for admitted patients and 6% for discharged patients. The arrival to request for a patient bed metric improved by 57% and arrival to assigned patient bed metric improved by 37%.

The study also examined the inclusion of a results-pending area for those patients of low ESI/acuity. The modified flow began at physician assessment, which resulted in the ordering of a diagnostic test (lab/imaging). The patients then waited for those results in a separate area furnished with 11 seats. Once the results were reported in the electronic health record, the patient was escorted to an examination or triage room for further evaluation. For low-acuity discharge patients in the results-pending model, there was a 32% reduction in length of stay across all ESI levels: ESI 1 = - 20%, ESI 2 = - 20%, ESI 3 = - 37%, and ESI 4 = - 50%. The modification to a fast-admission model improved exam room availability by 22% compared to the base model.

Limitations

The findings from this study are based on observations from only two locations and therefore would not support generalizability. Although simulation modeling is an efficient way to test operational scenarios, the method relies on pre-determined datasets or databases, which may not reflect real-world situations and may be limited in the prediction of actual ED throughput. While the outcomes measured may have suggested an association, they do not confirm the cause of the findings.

Design Implications

ED facilities designed to support rapid admission protocols and results pending strategies may reduce boarding times and overall length of stay for patients, which both may aid in decreasing patient overcrowding. The reduction of patient overcrowding lends to higher patient and provider satisfaction as well as heightens the possibility of enhanced workflow efficiency.