Proceedings of the 2019 Winter Simulation Conference
N. Mustafee, K.-H.G. Bae, S. Lazarova-Molnar, M. Rabe, C. Szabo, P. Haas, and Y.-J. Son, eds.

PATIENT CARE MANAGEMENT FOR PHYSICIANS: REDUCING HANDOFFS IN THE ED

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ABSTRACT

The Emergency Department (ED) is an environment prone to high error rates with severe consequences. Prior studies report that miscommunication contributes to 80% of the serious medical errors. Handoffs, transfer of patient care from one physician to another, are a common occurrence and predisposed to errors as a result of interruptions and high workload. Moreover, the Institute of Medicine reported that a majority of treatment delays are a result of communication errors associated with shift change. A simulation model was developed to test various physician to patient assignment policies to minimize the number of handoffs and reduce the workload at the end of a shift. Using a policy that restricts a physician from receiving high acuity patients in the last two hours of the shift, as well as limits the maximum number of patients per physician to five, the number of handoffs can be reduced by as much as 22%.

1 INTRODUCTION

The Emergency Department (ED) is a critical division in a health system where patients receive care for a wide variety of conditions including life-threatening emergencies, injuries, chronic ailments, and non-urgent situations. This diverse nature of ED visits and the Federal government mandate ED to provide screening and stabilizing care to all the patients regardless of their ability to pay makes it an entry point for the patients without any other medical access (Laxmisan et al. 2007; McDonnell et al. 2013). Emergency Department perils of overcrowding have been a public health problem for the past few decades, especially in the United States (Trzeciak and Rivers 2003; Hoot and Aronsky 2008). Although temporary improvements were observed, the growing number of ED visits and insufficient access to in-hospital beds are still contributing to overcrowding (Di Somma et al. 2015). ED overcrowding and lengthy patient evaluations have many consequences that affect patient safety, including longer wait times, poor patient outcomes, increased frustration among caregivers, higher number of handoffs and errors (Derlet and Richards 2000; Cheung et al. 2010).

According to the Institute of Medicine's (IOM) seminal article, To Err is Human: Building a Safer Health System, ED's are prone to high error rates with severe consequences (Kohn et al. 2000). Poor communication or miscommunication among the medical providers is one of the principal causes of medical errors. Emergency Department patient handoff involves the transition of patient care from one physician to another. Although handoffs are intrinsic to ED, it is a complex process involving significant information transfer. Because of the complex environment of the ED, these transitions are often fraught with interruptions, communication breakdown, and loss of information resulting in increasing the chances of medical errors (Dahlquist et al. 2018). A study that investigated handoff sessions involving 992 patients reported that 58.2% of the cases had an examination error or omissions (Maughan et al. 2011). Additionally, according to the Joint Commission, a group that sets safety standards and accredits healthcare organizations, 80% of serious medical errors involve miscommunication between caregivers during the transfer of patients

978-1-7281-3283-9/19/$31.00 ©2019 IEEE

and communication errors were considered to be the root cause in 20% of sentinel events (Joint Commission Perspectives 2012; Schumacher 2015). A study that investigated claims involving missed ED diagnosis that harmed patients reported that 24% of the cases involved inadequate handoffs (Kachalia et al. 2007). Apart from the consequences of medical errors, miscommunication among caregivers is a significant cause resulting in treatment delays. According to IOM, 84% of the treatment delays were because of the communication errors, and 62% of these were a continuum of care issues associated with the shift change (Kohn et al. 2000).

The ED working environment requires the providers to multitask because of the overwhelming volume of patients and acuity of events. This multitasking results in burdening the physician's working memory leading to a higher cognitive load (Laxmisan et al. 2007). There are multiple consequences associated with working under high cognitive load including psychological stress, tendencies to make errors, loss of information, etc. (O'Shea 2016). Prior studies have observed that working under stress results in making unsystematic decisions, failing to consider all options, narrowing attention and increasing distraction (Pines 2017). Typically during an ED shift, the number of patients under a particular physician's care increases as the shift progresses, resulting in a higher cognitive load (Pines 2017). Moreover, prior studies have reported that the physician's productivity decreases as the shift progress, and a longer shift results in poor decision making and higher chances of error (Jeanmonod et al. 2008; Silverman 2011).

In the past few years, research has been done to identify the optimal length of an ED shift to reduce the workload, medical errors and improve the throughput. Similarly, research has focused on improving the handoff by providing dedicated space for handoff, implementing bedside handoff, standardizing handoff language and format and using different technologies (Dingley et al. 2008; Dahlquist et al. 2018). A recent study which investigated the efficacy of overlapping shift in the ED reported a decrease in handoffs compared to the traditional non-overlapping shift (Yoshida et al. 2019). Our research adds to these approaches through the use of a simulation model to test different policies that may reduce the number of handoffs during an overlapping shift and possibly reduce the mental demand experienced at the end of the shift.

2 DATA

Data used in this study (average door to physician time, wait time in the ED, treatment time, and total time in the system) was obtained from the publicly available National Hospital Ambulatory Medical Care Survey (NHAMCS) 2011 and 2015. NHAMCS is a Centers for Disease Control and Prevention (CDC) initiative to collect data on the utilization and provision of ambulatory care services in hospital emergency and outpatient departments and ambulatory surgery locations. Findings are based on a national sample of visits to these departments. The data regarding the shift schedule, the capacity of the ED, the number of physicians available for a shift, etc. were obtained from the ED of the partner hospital, Greenville Memorial Hospital (GMH) in South Carolina. The research team included an ED physician working in the GMH, SC for guidance and developing the policies which are discussed later in the paper.

We first introduce Figure 1, which represents the total time spent by a patient in the system based on the data from the NHAMCS mentioned above. From Figure 1 we split the data into evaluation time and additional care time, as shown in Table 1. Evaluation is the time spent by a physician observing the patient (direct contact with the patient), whereas additional care is the time spent by a nurse (running tests, providing meds, etc.) or time spent with a consulting physician if requested. As seen in the table, the total evaluation time for a patient is comparatively lower than the total time spent providing additional care, which is consistent with prior studies (Hollingsworth et al. 1998; Hill et al. 2013) and observations from the GMH ED. The evaluation time and time for additional care were split based on the severity of the patient. In the case of level one patient where the condition is critical, physicians spend more time during the first evaluation trying to stabilize the patient. Whereas in cases two and three the physician initially runs a few tests to comprehend the ailment; hence the initial evaluation is lesser than the second evaluation. For case four and five which are comparatively less severe, the physician spends almost the same time for the first and second evaluation. In general, the total evaluation time contributed to 30-50% of the total time.

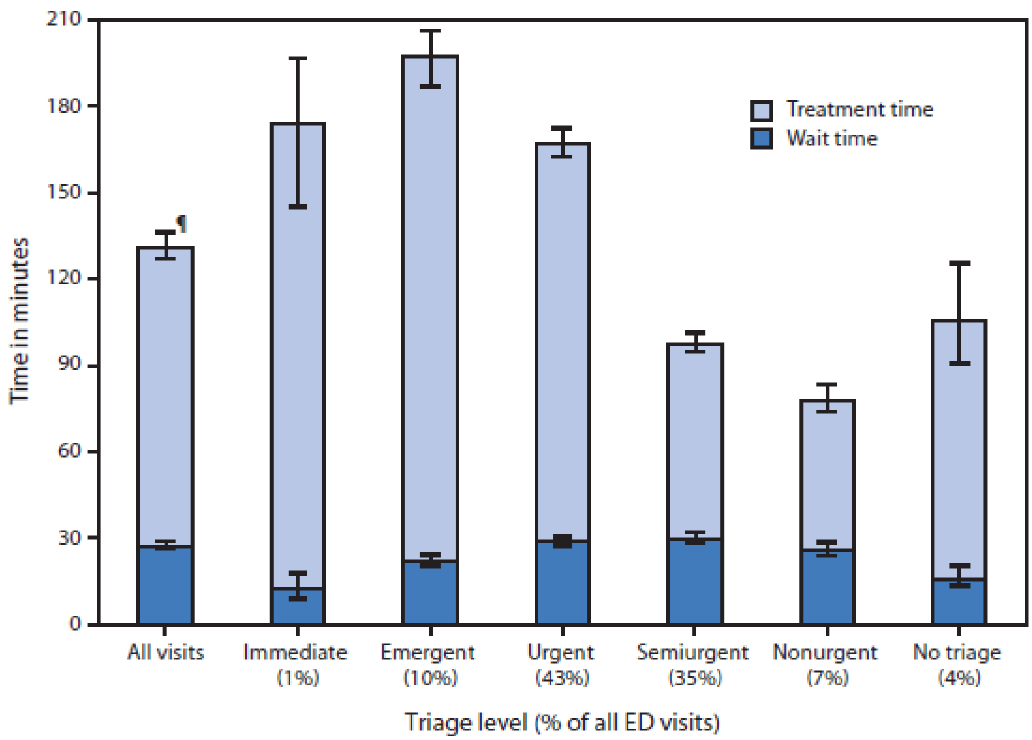

Figure 1: Patient time spent in the ED for different triage levels.

Table 1: Time spent by a patient in the ED.

	Severity				
Activity	**1**	**2**	**3**	**4**	**5**
Evaluation 1	TRIA(33,35,37)	TRIA(13,15,17)	TRIA(8,10,12)	TRIA(12,14,16)	TRIA(8,10,12)
Additional Care 1	TRIA(28,30,32)	TRIA(28,30,32)	TRIA(23,25,27)	TRIA(23,25,27)	TRIA(20,22,24)
Evaluation 2	TRIA(23,25,27)	TRIA(23,25,27)	TRIA(20,22,24)	TRIA(6,8,10)	TRIA(6,8,10)
Additional Care 2	TRIA(28,30,32)	TRIA(38,40,42)	TRIA(18,20,22)	TRIA(21,23,25)	TRIA(8,10,12)
Evaluation 3	TRIA(20,22,24)	TRIA(11,13,15)	TRIA(8,10,12)	**N/A**	**N/A**
Additional Care 3	TRIA(21,23,25)	TRIA(20,22,24)	TRIA(18,20,22)	**N/A**	**N/A**
Evaluation 4	**N/A**	TRIA(8,10,12)	TRIA(8,10,12)	**N/A**	**N/A**
Additional Care 4	**N/A**	TRIA(18,20,22)	TRIA(18,20,22)	**N/A**	**N/A**

A recent study which implemented a two-hour overlapping physician's schedule showed a reduction in handoffs (Yoshida et al. 2019), and we include a similar physician shift schedule in our study as the baseline schedule. The specific shift data is presented in Table 2 (next page). Notice that shifts 1, 3, and 5 have a two hour overlap with the subsequent shift to accommodate the need for information transfer and patient handoff, as well as to avoid a physician working beyond the prescribed shift length to complete patient handoffs.

Patient arrivals are represented in Figure 2 (next page) based on the data from a previous study (Alvarez et al. 2009). Note that activity is low in the early morning hours, but there is a steady increase from 7:30am until 12:00pm, at which point patient arrivals remain consistent until 5:00pm.

Table 2: Physician Shift timing in the ED.

Shift No.	Time
1	1:00 am - 9:00 am
2	7:00 am - 3:00 pm
3	9:00 am - 5:00 pm
4	3:00 pm - 11:00 pm
5	5:00 pm - 1:00 am
6	11:00 pm - 7:00am

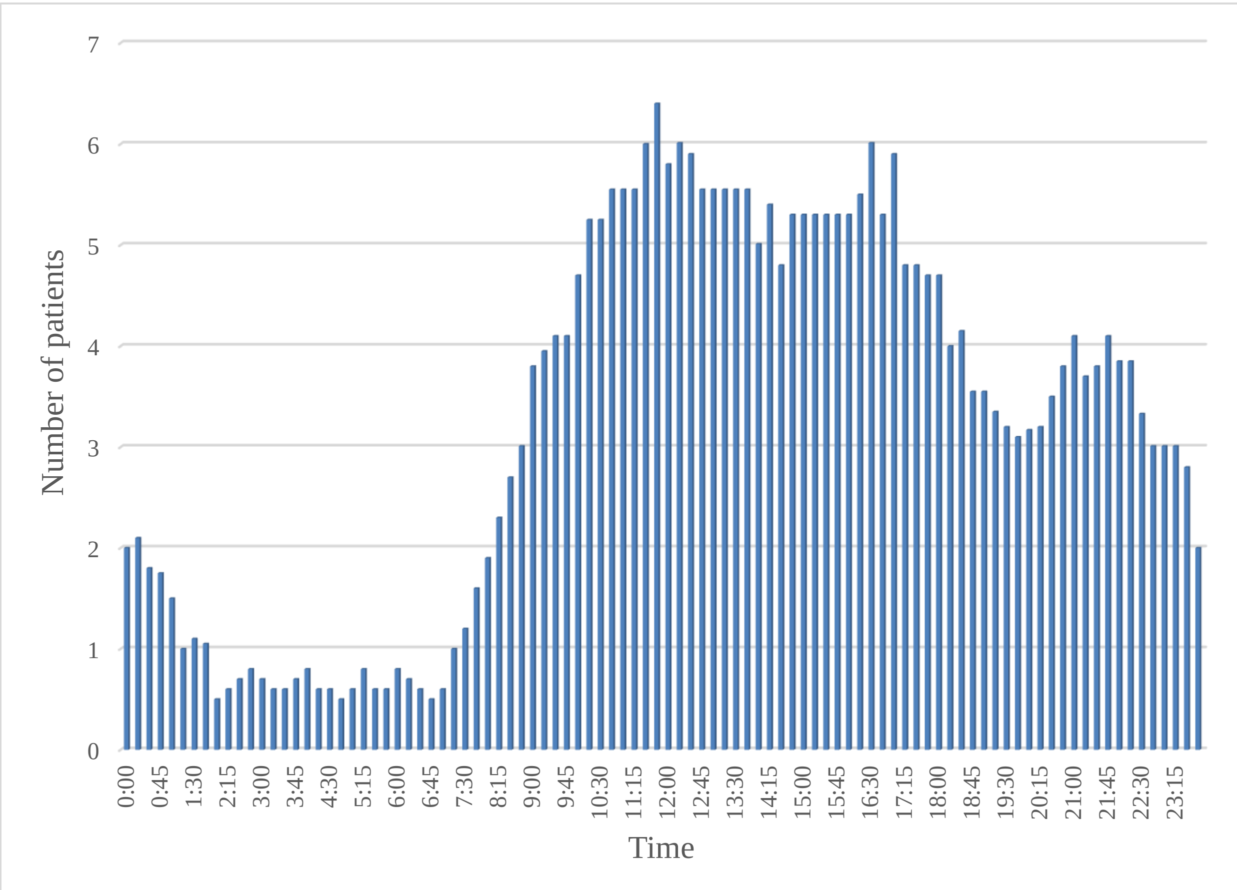

Figure 2: Patient arrival rate to the Emergency Department.

3 SIMULATION MODEL

In this paper, the ED physician-patient assignment simulation model to minimize the handoff was created in Arena using a discrete event modeling approach. This approach was preferred over other methods as prior studies have proved the efficacy of DES in simulating an ED effectively (Connelly and Bair 2004; Komashie and Mousavi 2005). However, unlike the modeling approach adopted in most of the previous research, which considered the physicians as a resource and the patient as an entity receiving treatment, this simulation model considers the physician and the patient as two different entities that flow in the ED. Under this modeling method, physicians and patients carry unique attributes and can contribute to their own actions and the actions of others. This modeling approach provides the flexibility of replicating physician activities in the ED such as searching and accepting a patient, interacting with patients based on their severity, performing patient handoffs, and charting, which would be difficult to accommodate if physicians were modeled only as a resource.

Figure 3 (next page) represents the process flow of the ED built using Microsoft Visio. The model is initialized by creating patients and physicians. Upon patient arrival, the severity of a patient is assessed on a level of 1-5 by a triage nurse where 1 demands immediate attention and 5 is considered the least urgent. The patient is next registered into the hospital electronic health record and waits in the waiting room where they are prioritized based on the initial triage-severity level assigned. The ED nurse collects the patients from the waiting room based on their severity level, availability of a physician and ED rooms. In the case of patients with a severity level of 1, they are taken to the trauma bay rather than to the normal ED room as shown in Figure 3, in the case of unavailability of a trauma bay they are moved to the next pod. The ED rooms and trauma bays are modeled as resources where the capacities of these resources are the same as their capacities in the GMH ED.

As seen in Figure 3, upon a physician's arrival on shift, the physician who will be leaving the ED must transfer his patients to the arriving physician. As mentioned earlier this process of transferring the care of a patient is defined as a handoff. Post handoff, the physician decides on taking a new patient depending on the current number of cases handled. In current practice, it is not common for the oncoming physician to check how many patients the other physicians are currently handling. Thus, the physician only considers whether or not he can accommodate another patient instead of trying to balance workload among physicians.

If the physician accepts a new patient, the physician meets the patient in the ED room for the first evaluation, after which the physician returns to the station to document in the medical record, order tests, medicines, consult, etc. The nurse then completes their required documentation, physician ordered tasks, medication administration and run bedside tests or ordered interventions. Patient care often includes diagnostic imaging that may require the patient to be moved out of the ED to the radiology suite. Following the drug administration, imaging, and diagnostic testing, the physician returns to the patient for the subsequent evaluation, and the physician remains focused on that patient until clinically stabilized. After the evaluation, the patient is either discharged or admitted as an inpatient to the hospital, and the physician may take on a new patient. Although patient time of day arrival is relatively predictable, the variability of patient acuity is not. Thus, the ED physician work load and the need to take on a new patient is influenced by triage severity level regardless of the number of patients currently on the physicians care.

As mentioned earlier our primary goal in this research was to reduce the number of handoffs and hence our focus was to replicate the physician's behavior in the ED successfully. The modeling approach adopted was able to successfully satisfy this goal. Although we do not consider the triage nurses, nurses, consults and in-hospital bed placement as specific entities or resources in the simulation model, the delays associated with each process were incorporated as probability distributions. This approach was adopted as it does not affect the efficacy of the model to replicate the physician behavior in the ED.

4 POLICIES

To comprehend the best policy to reduce the number of handoffs in the ED the current GMH physician-patient assignment policy was considered as the baseline policy. To make sure that ED performance was not influenced under new policies the following performance measures were used along with the number of handoffs:

- Patient length of stay
- Throughput
- Treatment time

These measures were selected based on the prior studies which used the same to review and measure the performance of an ED (Welch et al. 2006; Sørup et al. 2013).

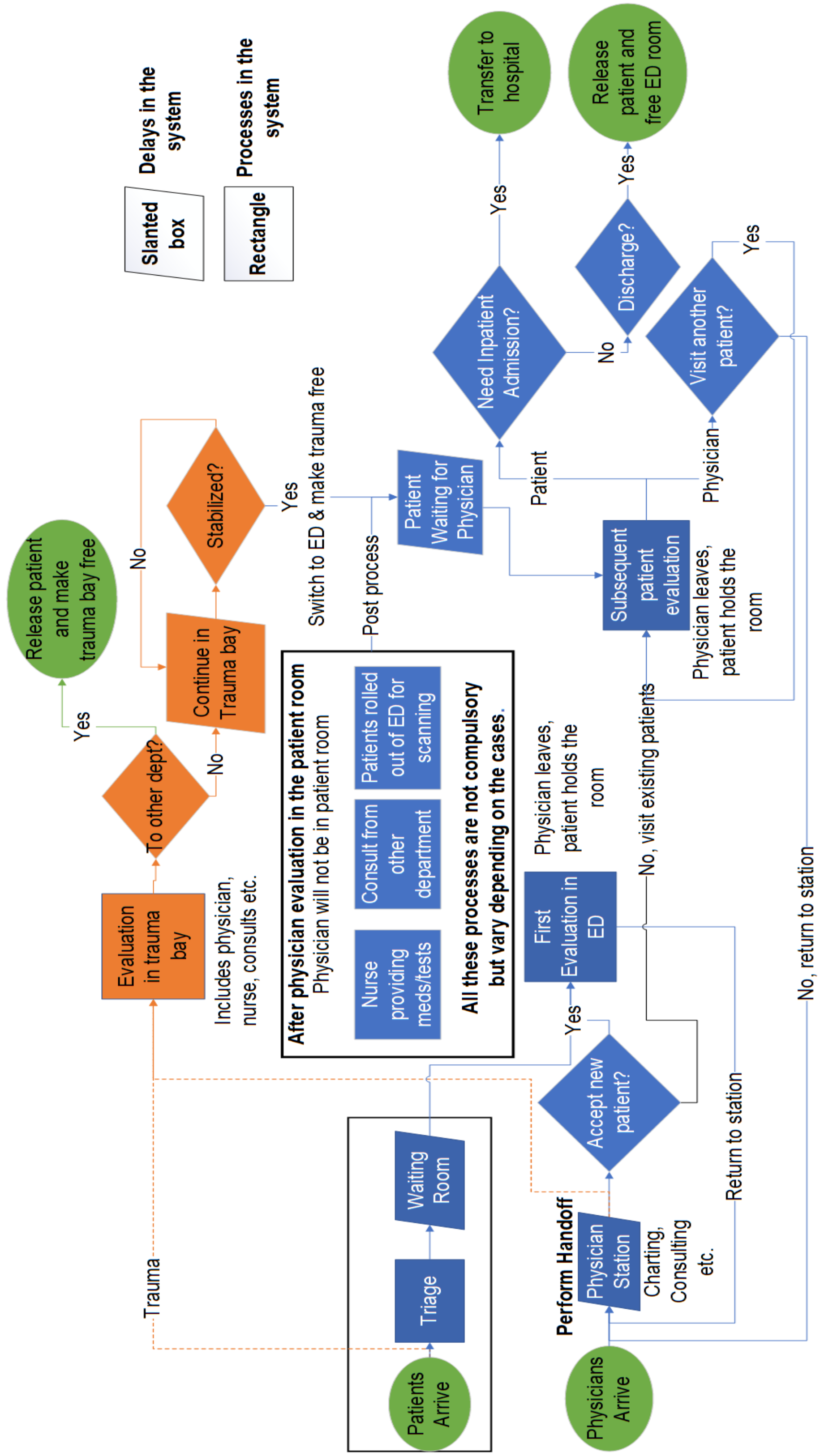

Figure 3: Physician and patient flow in the ED.

Table 3: Performance measures.

Performance measures	Definition
Number of handoffs	Number of patients transferred b/w physicians
Throughput	Total number of patients discharged
Treatment time	Time between first physician contact and patient disposition discharge or admission to hospital
Length of stay	Time between arrival to the ED and patient disposition discharge or admission to hospital

4.1 Policy 1 (Baseline policy)

This policy depicts the current policy adopted by the physicians working in GMH for patient management in the ED. As described in Table 2, the arriving ED physician has a minimum of a two-hour overlap with physicians working on the prior shift. Hence, upon a physician's arrival, they wait for the physician who is leaving in the physician station for the patient handoffs. In this model, a physician after their arrival waited for 5 minutes on average in the physician station for the departing physician to arrive and start the handoff. Post handoff, depending on the number of patients managed, the physician decides on taking a new patient or evaluating an existing patient. In this policy, a physician handles no more than six patients at a time and new patients can be accepted only after discharging an existing patient. In the present scenario, after receiving a new patient, the physician evaluates the patient in the ED room and returns to the physician station to document in medical record, order tests, medicines and consult depending on the situation. For the subsequent visits to a patient, the physician may not necessarily return to the physician station after each evaluation. However, the physicians working also make sure that they return to the station and take new patients so that the ED rooms are not left vacant. Although this policy maintains a restriction regarding the maximum number of patients that a physician could manage at a time, it does not restrict the physicians from receiving the patients irrespective of the time remaining in their shift.

4.2 Policy 2

In this policy, we restrict the physicians from signing up a new patient during the last 15 minutes of the shift. Additionally, to reduce the possibility of handoffs, we restrict the physician from accepting high acuity cases (level 1, 2 & 3) that needs longer treatment time and reduce the maximum number of patients that can be managed by a physician to four for the last 120 minutes. Moreover, another reason for restricting physicians from accepting high acuity patients is based on prior studies which have proved that physician's productivity decreases as the shift progress and increases the chances of errors (Jeanmonod et al. 2008; Silverman 2011).

4.3 Policy 3

In this policy, we reduce the maximum number of patients that can be handled by a physician to five and we restrict the physicians from signing up a new patient during the last 15 minutes of the shift. However, no specific measures were adopted to restrict physicians from accepting high severity patients during the end of their shift.

4.4 Policy 4

In this policy, we reduce the maximum number of patients that can be handled by a physician to five and we restrict the physicians from signing up a new patient during the last 15 minutes of the shift. Additionally, we restrict the physician from accepting high acuity cases (level 1, 2 & 3) that needs longer treatment time and reduce the maximum number of patients that can be managed by a physician to four for the last 120 minutes.

5 RESULTS

The four policies were tested and compared using a simulation model. The model performance under each policy was tested using the performance measures detailed in Table 3. As explained earlier, the changes in the policies included the maximum number of patients a physician could handle and restrictions regarding accepting a new patient. For testing purposes, the simulation was run for a week and over 600 replications such that a half width of 5 minutes on length of stay was achieved (as seen in Table 4). Note that handoffs were reduced considerably under each of the alternative policies compared to the first policy. All other performance measures also improved or stayed the same under the new policies.

Table 4: Initial results.

	Performance Measures (Half width)				
Policy	#Handoffs per day	Throughput per physician	Length of Stay (mins)	Treatment time (mins)	#Patients remaining in triage
1	47.8 (1.8)	6.3 (1.6)	358.5 (3.5)	246.5 (1.1)	6.1 (0.4)
2	41.1 (1.5)	6.2 (1.6)	388.3 (3.9)	262.0 (0.8)	8.9 (0.7)
3	42.3 (1.5)	6.4 (1.7)	316.1 (3.2)	212.7 (1.1)	6.0 (0.2)
4	37.4 (1.3)	6.3 (1.6)	323.1 (2.5)	226.5 (0.9)	6.0 (0.1)

From Figure 4, the handoff decreased by 21.8% in policy 4 compared to policy 1. Even though we introduced various restrictions into the policy, the throughput per physician showed slight improvement under the third and fourth policy where we reduced the maximum number of patients handled by a physician. This restriction to accept new patients requires the physicians to evaluate and discharge the existing patients thereby increasing the throughput. Moreover, in the second policy where we restrict a physician from handling high acuity cases in the last 120 minutes, a reduction in the number of handoffs is observed. However, policy 4 shows the most reduction in handoffs where we restrict the maximum number of patients a physician can manage to 5 and further restrict it to four during the last 120 minutes where the physician handles only level 4 and level 5 patients. These observations are also consistent with the performance measures in Figure 5 (next page), which displays a decreasing patient length of stay and treatment time. The treatment time under policy 4 decreased by 8.1% compared to the current policy and the length of stay decreased by 9.9%. This is because the maximum number of patients a physician can manage is higher in the first two policies.

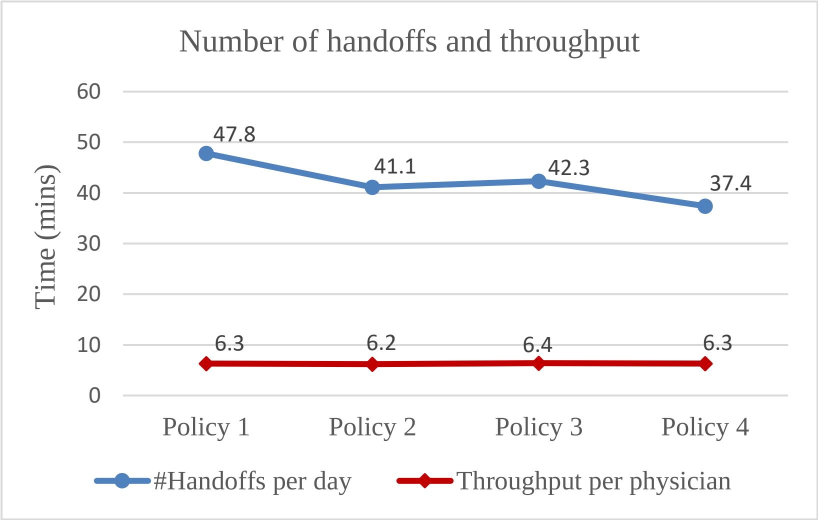

Figure 4: Average number of handoffs and throughput per physician.

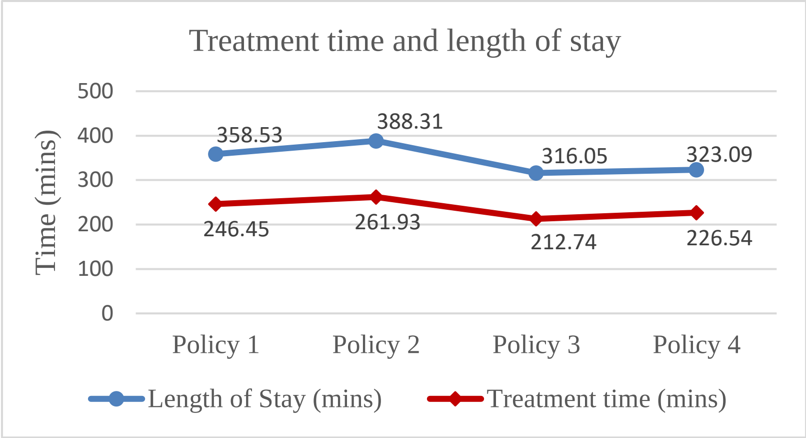

Figure 5: Average treatment time and length of stay for a patient.

This conclusion can be also supported by observing Figure 6 where the number of patients remaining in the system at the end of the simulation run is high for policy 1 and 2 comparatively which results in higher treatment time and patient length of stay.

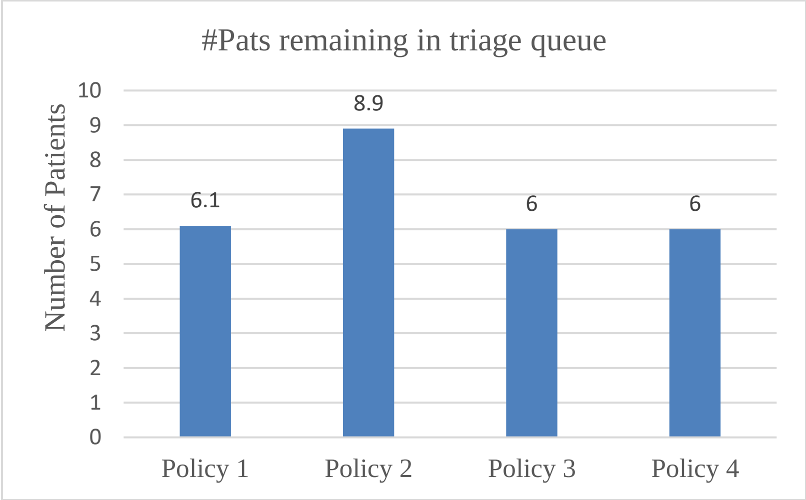

Figure 6: Number of patients in the triage queue.

6 CONCLUSIONS

Chances to make errors/mistakes in the interruption-driven ED environment places great concern on patient safety. Prior studies have observed that a major cause of errors is miscommunication or failure to communicate. The complexity and variety in the cases handled in the ED require the ED staff to communicate within and outside the department, which is necessary for patient care. However, handoff which is a common phenomenon in the ED where the patient care is transferred between physicians, the chances of communication errors are high. Hence it is crucial to minimize the number of handoffs in an ED.

The simulation modeling framework enabled the testing of multiple policies on patient care management, identifying the potential for reducing handoffs in the ED by over 22% when compared to the current practices. This research could address the current concerns of handoff errors inherent to the ED and the patient safety associated with it. Additionally, the reduction in the number of handoffs also helps in reducing the delays associated with handoffs.

In this model, we only consider the ED physician's role in interacting with the patient. We do not specifically model the influence of other care provider resources as a constraint in the system. Additionally, we do not consider the provider's insurance, which could also play a role in physician handoffs. In future work, we plan to collect data appropriately represent secondary care and processes. Further, we plan to incorporate objective measures including different physiological measures to comprehend the physician performance and mental demand during a shift.

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