

Impact of Fatigue on Emergency Physicians' Decision-making for Computed Tomographic Scan Requests and Inpatient Referrals: An Observational Study from a Tertiary Care Medical Centre of the Sultanate of Oman

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ABSTRACT

Objective: Multiple factors contribute to decision fatigue experienced by emergency physicians (EPs). This study examines the association between decision fatigue and the frequency of computed tomographic (CT) scan requests and inpatient referrals among EPs.

Methods: This retrospective database analysis was done for 3 months. Scans and inpatient referral requests were coded and analyzed to assess the impact of physician fatigue on decision-making. Subsequently, the outcomes were evaluated.

Results: The majority of patients ($n = 481$; 51.1%) had a CT brain request. Among these requests, the morning shift (8:00 a.m.–3:00 p.m.) accounted for the highest number ($n = 400$; 42.5%), followed by the evening shift (3:00–11:00 p.m.) ($n = 345$; 36.7%). Approximately one-third of the patients ($n = 301$; 31.9%) had positive CT scan findings. Statistical analysis comparing the first and the second halves of each shift did not reveal significant variations in the percentage of negative CT results (p -value: 0.093). Inpatient referral was necessary for over half of the patients ($n = 1048$; 52.7%), and the majority of these referrals ($n = 778$; 74.2%) were deemed necessary for treatment under various surgical or medical specialties. There was a statistically significant difference in the proportion of negative inpatient referrals between the first and the second halves of the afternoon shift (p -value < 0.001).

Conclusions: Fatigue among EPs was observed, leading to more frequent consultations without inpatient admission during the latter half of the afternoon shift. However, the study found no significant impact of decision fatigue on CT scan decision-making.

Keywords: Computed tomography, Decision-making, Emergency medicine, Emergency physicians, Fatigue, Shift work schedule.

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INTRODUCTION

The emergency department (ED) serves as the primary point of contact for many patients in a medical center, with emergency physicians (EPs) playing a crucial role in providing round-the-clock medical care. Emergency physicians perform a range of tasks, from academic and administrative duties to providing critical care to severely ill or injured patients.^{1–3} However, research indicates that EPs may experience higher rates of negative work outcomes, including burnout, turnover, and fatigue, compared with other medical specialties. The demanding nature of their work, characterized by unpredictable schedules and unscheduled patient visits, high patient volumes, critical illnesses, complex injuries, concurrent patient management, frequent interruptions, and high-risk decision-making, increases their susceptibility to decision fatigue.⁴

Decision fatigue is a psychological concept based on the finite capacity of humans for higher-order mental functions such as self-regulation and behavior modification. The repetitive process of decision-making can exhaust the mind and have a negative impact on subsequent decisions, particularly when faced with complex or challenging choices. Decision fatigue has been associated with the use of cognitive shortcuts, decreased executive functioning, reduced reasoning capacity, and diminished physical stamina.^{4,5} Literature also describes decision fatigue as a factor contributing

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to behaviors such as procrastination, avoidance, passivity, lack of persistence, and impulsivity.^{4,5}

In the context of the emergency room, EPs often face uncertainty regarding patients' medical histories, including the nature and timing of symptoms preceding their visit. This requires them to make rapid decisions about emergent treatment plans, diagnostic tests, further management within the ED, and potential

hospitalization. While evidence-based medicine ideally informs these decisions, the busy ED environment sometimes necessitates choices based on the EP's clinical judgment and expertise.⁶ Radiological imaging, particularly computed tomographic (CT) scans, is a commonly used diagnostic tool in the ED. However, the unnecessary use of CT scans has been reported in the literature, indicating that many patients undergo this imaging test when it may not be required.⁷⁻⁹ Similarly, some non-critical patients can be effectively managed by EPs and discharged with conservative care and outpatient follow-up. Nevertheless, fatigue may influence EPs to opt for an inpatient referral before finalizing patient disposition.^{10,11} During the COVID-19 pandemic, the busy ED encountered a multitude of substantial challenges. The overwhelming surge in patients seeking medical attention, coupled with the need to implement stringent infection control measures, put immense strain on the EPs. Despite these daunting circumstances, the ED's dedicated healthcare professionals persevered, providing essential care to patients while navigating through the unprecedented challenges posed by the pandemic.^{12,13}

This study aims to examine the association between EP decision fatigue and their requests for CT scans or inpatient referrals during their daily shifts. It is the first study of its kind to explore this relationship, providing valuable insights into the decision-making processes of EPs in the context of fatigue.

METHODS

Study Design and Setting

This was a retrospective longitudinal cohort study conducted in the ED of a tertiary care teaching hospital located in Muscat, Sultanate of Oman. Our ED consists of two resuscitation beds, four bay beds for red cases, 12 cubicle beds for yellow cases, and four triage beds, totaling 22 current active beds, with an average occupancy rate of around 88% depending on the time of day. We cater to the needs of more than 150 patients per day, with a comparable number of patients arriving during night shifts (51.4%), followed by evenings (34.0%). On average, 15 to 18 patients necessitate admission to various intensive care unit, high-definition unit (HDU), and general ward beds depending on their hemodynamical stability. This ED has been accredited and awarded the Platinum Level of Accreditation Canada International.

Study Period

The study was conducted for 3 months (September 1 to November 30, 2019).

Participants

The study included all adult patients aged 18 years and above who presented to the ED during the defined study period and underwent a CT scan (with or without contrast) or required an inpatient referral from the ED. Patients' medical charts with incomplete or missing data were excluded from the study to ensure data accuracy and reliability.

Study Protocol

A data collection form created using Microsoft Excel Version 16.72 was utilized to extract relevant data from the hospital's computerized database. The extracted data included the date and time of the emergency CT scan request, the symptoms mentioned on the CT scan request form, and the final CT scan report. To assess the potential impact of physician fatigue on decision-making, the

timing of the CT scan requests was categorized based on the shift intervals in which they were made, considering that all EPs at our center work standardized 8-hour shifts. This methodology was also applied to group the requests for inpatient referrals according to their frequency and timelines. Inpatient referrals from ED are usually made based on the patient's presenting complaints and hemodynamic stability. Among them are patients whose clinical status demands immediate life-saving interventions, often involving resuscitation and advanced life support (blue or red cases). This category of patients with severely compromised vital signs necessitate definitive admission under different surgical or medicine teams. Another group comprises patients with urgent complaints, where the possibility of deterioration exists, but there is no immediate threat to life. These cases may involve acute-onset illnesses or acute exacerbations of chronic conditions, necessitating timely investigation and medical and/or procedural or surgical interventions, and usually requires admission in the HDU or different medical, surgical, or gynecological wards.

To identify potential markers of physician fatigue, each shift was divided into two equal halves, representing distinct shift intervals. Typically, a team leader is designated in each shift, who can be either a senior consultant, consultant, or senior specialist. This team leader is accompanied by a specialist and a minimum of three post-graduate residents from various disciplines such as emergency medicine, internal medicine, anesthesia, or obstetrics and gynecology. Additionally, the team includes one or more students from the General Foundation Programme and one or more internship trainee junior doctors. It was hypothesized that physician fatigue would be more pronounced during night shifts due to circadian rhythm desynchronization, as well as during the last 4 hours of each shift, attributable to general physical and cognitive weariness. By examining the distribution of CT scan requests and inpatient referral requests across these shift intervals, we aimed to explore any potential associations between physician fatigue markers and decision-making patterns.

Outcome Measures

All CT scan requests made by the EPs and all inpatient (ED) referral requests for specialist team evaluation were included in the analysis. Positive CT scan findings were identified when the results provided relevant information that supported the initial request. Similarly, positive inpatient referrals were identified when patients were admitted to the hospital based on the evaluation by the specialist team. To determine the frequency of each outcome, the number of positive CT scan findings and positive inpatient referrals was calculated as a proportion of the total number of patients seen during each shift. This allowed for an assessment of the relative occurrence of these outcomes within the context of the overall patient population encountered during each shift.

Statistical Analysis

Data analysis was performed using the Statistical Package for the Social Sciences (IBM Corp., Armonk, NY, USA). Continuous variables were summarized using means, standard deviations, or medians, while frequencies and percentages were utilized to summarize categorical variables. A comparison between continuous variables in two groups was conducted using an independent samples *t*-test. Associations between categorical variables were examined using a Chi-squared test. The influence of predictor factors on the results was assessed through multivariate binary logistic regression analysis. Statistical significance was determined by a *p* value of less

than 0.05. This statistical analysis facilitated a thorough examination of the data, enabling a better understanding of the variables and their respective characteristics.

Ethical Considerations

This study received approval from the Medical Research and Ethics Committee of Sultan Qaboos University, following a careful assessment of the research protocol. It should be noted that all patient record data utilized in the analysis had been thoroughly anonymized and de-identified to protect patient confidentiality. To ensure the utmost confidentiality, special identification documents were implemented, and password-protected data entry software was utilized, which had limited access restricted to authorized personnel only. Given the retrospective nature of the study and the maintenance of patient anonymity, a waiver of consent was obtained from the institute’s review board. All study procedures and processes were performed per the ethical principles of the Helsinki Declaration.

RESULTS

During the 3-month study period, our ED attended to a total of 2,065 patients. Among these patients, a CT scan was performed for 941 individuals (47.3%), while an inpatient referral was requested for 1,048 patients (52.7%). The breakdown of these cases and their corresponding percentages can be observed in Figure 1, as represented by the strengthening the reporting of observational studies in epidemiology diagram.

Regarding the specific types of CT scans requested, the majority of patients (n –481; 51.1%) underwent CT scans of the brain, followed by CT scans of the renal system (n –212; 22.5%). The distribution of CT scan requests across different shifts is as follows: the morning shift (8:00 a.m.–3:00 p.m.) accounted for the highest

number of requests (n –400; 42.5%), followed by the evening shift (3:00 p.m.–11:00 p.m.; n – 345; 36.7%), and the night shift (11:00 p.m.–7:00 a.m.; n – 196; 20.8%). Positive CT scan findings were observed in approximately one-third of patients (n –301; 31.9%). The distribution of CT scan requests by shift interval can be visualized in Figure 2, and a comprehensive analysis of CT results based on shift time and interval is provided in Table 1. Notably, there were no statistically significant differences in the percentage of negative CT results when comparing the first and the second halves of each shift (p-value: 0.093).

In terms of inpatient referrals, more than half of the patient cohort (n – 1,048; 52.7%) required such referrals, with the majority of cases (n – 778; 74.2%) warranting treatment under various surgical or medical specialties. The distribution of referral requests across different shift times is illustrated in Figure 3. Although no significant differences were observed in the shift times at which referrals were made, a statistically significant discrepancy was found in the proportion of negative inpatient referrals between the first and the second halves of the afternoon shift (p-value < 0.001). A comprehensive summary of inpatient referral outcomes based on shift time and interval is provided in Table 2.

DISCUSSION

Our study investigated the potential influence of fatigue on CT decision-making and inpatient referrals among EPs working at an academic tertiary care ED. We hypothesized that there would be an increase in the frequency of CT scan requests and inpatient referrals toward the end of each shift, indicating a potential bias towards safer and easier decisions due to fatigue. By examining

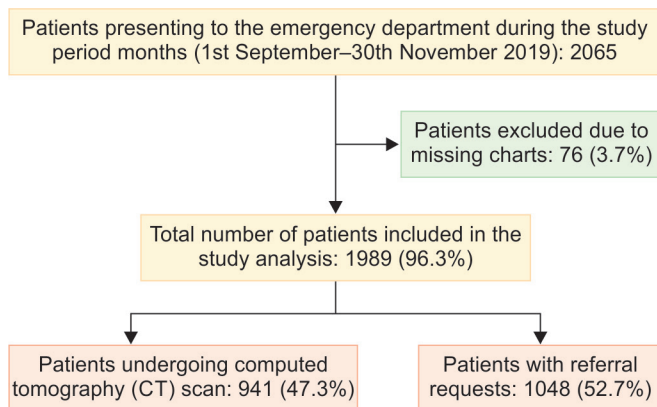


Fig. 1: The strengthening the reporting of observational studies in epidemiology diagram

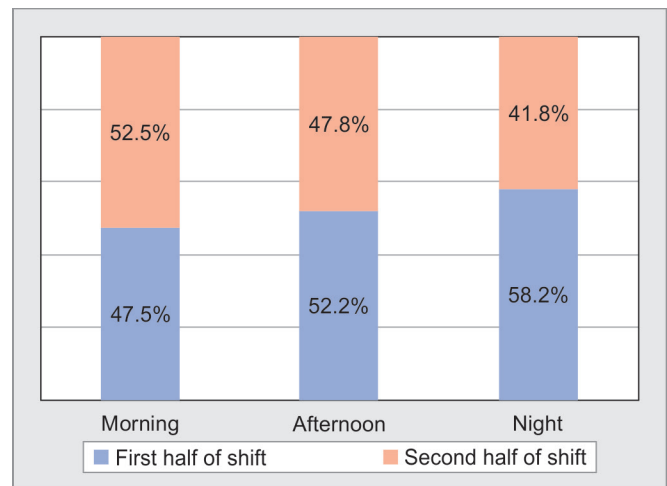


Fig. 2: Illustration of the number of CT scans requested in each shift interval

Table 1: Comprehensive analysis of the CT scans requested and their corresponding results, categorized by shift time and interval

Outcome	Shift timing and interval: n – 941 (%)					
	Morning shift		Afternoon shift		Night shift	
	First half	Second half	First half	Second half	First half	Second half
Positive	57 (14.3)	71 (17.75)	64 (18.6)	42 (12.2)	37 (18.9)	30 (15.3)
Negative	133 (33.3)	139 (34.75)	116 (33.6)	123 (35.7)	77 (39.3)	52 (26.5)
Total	190 (47.5)	210 (52.5)	180 (52.2)	165 (47.8)	114 (58.2)	82 (41.8)



the relationship between shift timing and interval as markers of fatigue, we aimed to shed light on the decision-making patterns in this context.

In the field of Emergency Medicine, diagnostic imaging plays a vital role. However, concerns have arisen regarding the excessive and inappropriate utilization of these resources, which can result in increased hospital costs, unnecessary referrals due to incidental findings, heightened radiation exposure, and a higher risk of contrast-induced reactions. Our study did not reveal any statistically significant relationship between fatigue and decision-making of CT scans in the first and the second intervals of any shift. This may be attributed to the presence of specialists or consultants in our ED, who aided each EP in making decisions. Moreover, our hospital practice mandates that the clinical need for a CT scan be validated by an on-call radiologist before its commencement, which helps minimize the number of unnecessary scans. However, our findings contradict those of a study conducted by Zheng et al., who observed a significant decrease in the rate of head and abdomen CT scans (p -value < 0.001) during the first and the last hours of an 8-hour shift, suggesting the presence of decision fatigue. In contrast, our findings diverge from a study conducted by Zheng et al., which reported a significant decrease in the rate of head and abdomen CT scans (p -value < 0.001) during the first and the last hours of an 8-hour shift. Specifically, the scan rates decreased by 3.6% and 2% as the shift progressed.¹⁴ Nonetheless, they concluded that the EP's judgments regarding patient disposition remained consistent throughout the shift. After assessing the EPs for signs of decision fatigue over an 8-hour duration, no discernible indications of fatigue were detected.¹⁴ Strobel et al. similarly reported that although imaging decisions by EPs were influenced by the duration of their shifts, these variations did not impact the rate of subsequent

"bounce backs" to the ED.¹⁵ Additionally, Matz et al. found that while there was a non-significant inclination toward increased scan usage by individual EPs on high-volume days compared with low-volume days, there were no significant changes in the overall rate of scans requested by EP on high-volume days (p -value: 0.25).¹⁶ According to Charbonneau et al., there was no evidence to suggest that the levels of ED crowding and the timing at the end of a shift had any impact on the decision-making of EPs regarding the ordering of investigations or the provision of treatment to patients.^{17,18}

In our study, we observed indications of fatigue among EPs after an 8-hour shift regarding referrals for inpatient care. Specifically, we found a higher number of negative inpatient referrals in the second half of the afternoon shift compared with the first half. This discrepancy may be attributed to a greater proportion of inpatient referral requests being made during the latter part of the afternoon shift (65% vs 35%).

Understanding decision fatigue in a clinical setting is a complex matter that poses challenges in characterization. Based on the author's experience, it is suggested that the most critical decisions made by EPs are likely to be influenced by fatigue. Further investigations in this field could involve physicians working in different ED settings, longer or overlapping shifts, to explore variations in clinical decision-making. Examining similar outcomes in other local contexts would also be of interest. Additionally, assessing different clinical outcomes that may be impacted by overall weariness or decision fatigue would be valuable. Although some evidence suggests that shift time or interval may influence the ordering of investigations and inpatient referrals by EPs, there is a lack of literature demonstrating any impact on patient outcomes in terms of disposition or treatment.

LIMITATION OF OUR STUDY

Shift structures can vary significantly across different ED settings. In this analysis, we specifically excluded overlapping or split shifts, which are shifts longer than 8 hours where an EP starts in one section of the department and switches to another midway. One of the main limitations of our study was that it was a single-center study and retrospective in nature. As a consequence, the results could not be generalized to other facilities. Nevertheless, the statistics obtained from our research are valuable in providing insight into the general demeanor of EPs during their shifts. The limited sample size of our study may have contributed to the lack of statistical significance regarding the request for a CT scan.

CONCLUSION

Despite the evidence of EP fatigue observed in this study, as indicated by the higher frequency of negative inpatient consultations during the second half of the afternoon shift, no significant impact of fatigue on CT ordering or decision-making was found. It is important to note that the absence of an effect on

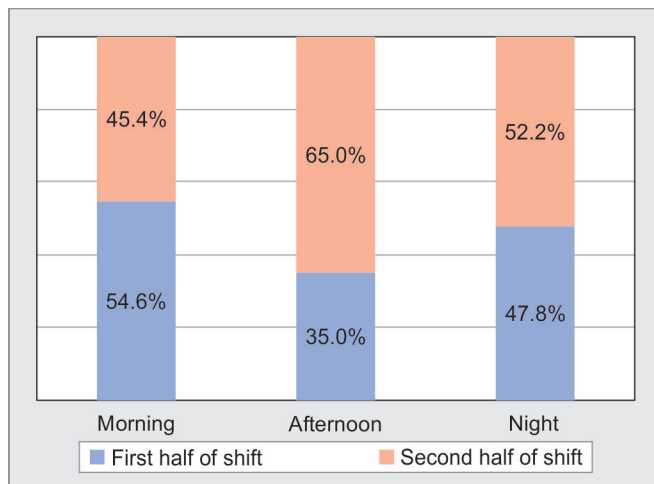


Fig. 3: Illustration of the number of inpatient referrals requested in each shift interval

Table 2: Comprehensive analysis of inpatient referrals requested and their corresponding results, categorized by shift time and interval

Outcome	Shift timing and interval: $n = 1,048$ (%)					
	Morning shift		Afternoon shift		Night shift	
	First half	Second half	First half	Second half	First half	Second half
Positive	155 (41.7)	135 (68.9)	93 (27.6)	158 (46.9)	111 (32.7)	126 (37.2)
Negative	48 (24.5)	34 (17.3)	25 (7.4)	61 (18.1)	51 (15)	51 (15)
Total	203 (54.6)	169 (45.4)	118 (35)	219 (65)	162 (47.8)	177 (52.2)

CT decision-making does not negate the presence of fatigue in other aspects of clinical practice. Future research should explore whether fatigue influences CT decision-making and other clinical decisions among EPs who work extended hours or have different shift structures.

ETHICAL APPROVAL

The authors of this publication declare that this scientific work follows the EQUATOR Network's reporting quality, formatting, and reproducibility requirements. The authors further state that this clinical study was initiated after approval from the Institutional Evaluation Board/Ethics Committee review. We also certify that the contents of this submission have not been plagiarized and that we have conducted a Plagiarism Check.

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