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# The Impact of Fatigue on Medical Error and Clinician Wellness: A Vignette-Based Discussion

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## Abstract

Fatigue-induced medical errors and complications spark concern in patients, clinicians, and policy makers, as documented by the Institute of Medicine report in 1999 that approximately 100,000 Americans die annually secondary to potentially avoidable injurious events. Over the last 2 decades, multiple organizations have advocated for the implementation of labor hour restrictions to redress physician in training fatigue and enhance patient safety. Advocates for duty hour caps in physician training programs cite the potential for improvements in patient safety, whereas adversaries allege that curtailing duty hours compromises medical education and readiness for solo practice. Sleep deprivation impairs multiple aspects of cognition, function, and capacity, including many aspects essential to the practice of medicine, e.g., cognizance, recollection, and dexterity. Resident physicians' traditional extended duty shifts for 24–30 consecutive hours pose significant hazards not only to patients but also to the physicians in training themselves. Burnout among physicians in training occurs commonly and results from work-related stress characterized by emotional prostration, depersonalization manifest as cynicism and detachment toward patients, and diminution of personal esteem. Curtailed shift duration correlates best with improved patient care of the strategies for managing physician fatigue. Adequate supervision of residents and medical students has the potential to improve resident education and further patient safety. Night float shifts improve resident's well-being in terms of acclimating to a consistent nocturnal schedule. Data supporting capping physician work hours demonstrates evidence of amelioration of fatigue, thereby improving physician's quality of life; evidence supporting duty hour restriction for enhancing patient safety, decreasing medical errors, and physician training, including surgical, is mixed and more nuanced.

**Keywords:** fatigue, burnout, sleep, graduate medical education

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## 1. Clinical vignette demonstrating the impact of physician fatigue

An exhausted resident, on 17 hours of a busy 24-hour trauma shift, has participated in six trauma-alert cases in the last 4 hours. The senior resident signed out 3 hours ago, and he and his attendants have responsibility for the entire trauma service. Notification of an oncoming trauma alert indicates that three critically injured motor vehicular trauma victims will arrive within minutes. The trauma attending, finishing an exploratory laparotomy in the operating room, instructs the trauma resident to manage the first trauma and she will arrive as soon as possible to facilitate the management of the oncoming trauma victims.

As the worn-out resident walks to meet the first trauma, he continues getting paged with issues from the floor as one patient in particular has become increasingly agitated. He reads the page quickly just as the trauma-alert patient, with signs of chest wall trauma, comes through the door. The trauma-alert victim has decreased breath sounds on the right with chest wall crepitus. A cursory completion of the primary and secondary survey identifies no other obvious injuries. As the resident prepares to place a right-sided chest tube thoracostomy, he calls out for the patient to receive vecuronium 10 mg intravenously to sedate the patient. On questioning from the nurse, the resident proceeds to shout for vecuronium 10 mg intravenously for sedation stat. The intimidated nurse proceeds to administer vecuronium 10 mg intravenously. Arriving a minute later, the trauma-attending resident notes the patient's pulsox that has decreased from 95% on oxygen to 50% and that the patient has apneic respirations. The patient subsequently undergoes endotracheal intubation and chest tube thoracostomy without complication. During debriefing afterward, the resident notes that in his fatigued condition, he meant to say valium not vecuronium.

The trauma resident gets another page about the same agitated patient and decides that the patient requires chemical sedation. He orders 5 mg of haloperidol from a workstation computer when he gets an urgent call about a patient in the CT scanner. Feeling weary and defeated, the resident answers yet another page. This nurse on the floor wants to know why haloperidol has been ordered for a calm cooperative 45-year-old female awaiting elective cholecystectomy in the morning? When the resident goes back over his orders, he realized that he ordered the haldol on the wrong patient. With tears threatening, he orders the medication on the correct patient before he goes up to the floor to write some patient care notes.

At the end of his long shift, the resident drives home for dinner and to sleep in his own bed. At a stoplight, he proceeds to fall asleep and his car crashes into the car in front of him causing a multicar pileup.

## 2. Introduction

Fatigue-induced medical errors and complications spark concern in patients, clinicians, and policy makers, as documented by the Institute of Medicine report in 1999 that approximately 100,000 Americans die annually secondary to potentially avoidable injurious events [1, 2]. The calamitous Exxon Valdez oil spill and its associated public relations uproar demonstrated the

public's focus on fatigue-induced adversity in the workplace [3]. Research demonstrates that progressive exacerbations in sleep deprivation induce slower reaction times and inferior workplace performance in many vocations including medicine [4]. Current physician in training labor hour restrictions developed to address issues raised in the Libby Zion case, a young woman who died as a result of unrecognized serotonin syndrome exacerbated by concurrent medications administered during night shift by on-call resident trainee. This case received press notoriety after Libby Zion's father faulted the inadequacy of resident supervision compounded by excessive work hours worked by physicians in training [5], and ultimately spurred the formation of the Bell Commission, which created and encouraged fatigue-combatting remedies for physicians in training [5, 6].

### **3. History of extensive duty hours for graduate medical education in the United States**

Graduate medical education (GME) exposes medical students and physicians in training to the realities of medical care, including long work hours and a set of professional expectations that often place patients' needs above the practitioner's own [7, 8]. Traditionally, physician training programs in the United States extolled extensive work hours in order to facilitate learning and professional socialization of physicians. Furthermore, until the last two decades, the culture of residents and training programs promulgated a culture of resilience to sleep deprivation and the irrelevance of fatigue [9, 10]. Arduous multi-day shifts extending throughout the night or weekend exacerbated fatigue, the potential for medical errors, and risks to resident physicians, including motor vehicle crashes, occupational injuries, and deleterious effects on well-being [11, 12]. Graduate medical education has lagged behind fatigue management strategies by other industries, such as transportation, aviation, and the military, which have recognized fatigue as an occupational threat [9]. Prior to 2003, no national regulations existed in the United States regarding the frequency, duration, or total number of hours that physician trainees could work [13].

### **4. Medical commissions advocate for duty hour restrictions**

Over the last two decades, multiple organizations have advocated for implementation of labor hour restrictions to redress physician in training fatigue and enhance patient safety [2, 5]. Multiple North American medical commissions have advocated for duty hour circumscriptions including the Bell Commission, which instituted New York State's limit on resident work hours, the Institute of Medicine, the Accreditation Council for Graduate Medical Education (ACGME), and Canada's National Steering Committee on Resident Duty Hours. In 2003 and 2011, the ACGME placed constraints on labor hours by physicians in training mandating a maximum 80-hour work a week, dictating compulsory time off between shifts, and circumscribing on-call periods [14]. In developing the ACGME's 2011 directives, policy makers sought to enhance the safety of patients and to foster learning environments that nurture physicians' professional development by promoting resident respite, wellness, and empathy [7].

## 5. Critiques of GME duty hour restrictions

The debate over duty hours focuses on contending outcomes: physician-in-training patient management throughout the duration of the patient admission and residents' attainment of cognitive and clinical skills under supervision to prepare for independent practice [7]. To demonstrate the advantages of duty hour caps, research has centered on the relationship between residents' work schedules and adverse events [4, 6]. Despite publication of empirical studies and meta-analyses, the impact of resident duty hour caps on patient care and physician quality of care remains opaque [10]. Meta-analysis of duty hour restriction trials does not demonstrate uniform benefit, some demonstrate no benefit, and others demonstrate unfavorable impact on patient care and resident education [10]. Critics of duty hour restrictions note that multiple transitions of care, utilization of mid-level providers, and abridged clinical exposure impair the quality of physician training and patient care [5]. Advocates for duty hour caps in surgical training programs cite the potential for improvements in patient safety, whereas adversaries allege that curtailing duty hours compromises medical education and readiness for solo practice [2]. Multiple peer-reviewed systematic reviews of the duty hour restriction literature demonstrated mixed benefits and failed to clarify the impact of duty hour restrictions on patient safety, resident education, and resident wellness [10]. The implementation of reliable multi-institutional data documenting the effects of the duty hour limitations on training or patient care represents a limiting factor in evaluating the effect of duty hour restrictions [15].

## 6. Relationship between physician fatigue and medical error

Sleep deprivation impairs multiple aspects of cognition, function, and capacity, including many aspects essential to the practice of medicine, e.g., cognizance, recollection, and dexterity [13, 16]. Weariness impairs reasoning comparable to alcohol intoxication; specifically, research has demonstrated that mental capacity deteriorates following 17 hours of intense cognition and wakefulness mirroring blood alcohol concentrations of 50 mg/dL [13]. Meta-analysis demonstrates that sleep paucity compromises physicians' clinical acumen and vigilance. Furthermore, progressive exacerbations in sleep disturbance hamper reaction times and hinder surgical residents' operative performance [4]. Residents with insufficient sleep and prolonged duty hours engender depression, which heightens the risk of medical gaffes [17]. The odds of reporting at least one fatigue-related clinically significant medical event increase sevenfold for months during which residents work >5 overnight shifts, in comparison with months without overnight responsibilities. Barger et al. note that fatigue-related medical errors increase fourfold with up to 4 extended shifts per month and eightfold with 5 or more extended shifts in a month [18]. Residents working >5 extended shifts per month reported increased incidence of underperformance during lectures, rounds, and clinical activities when compared to residents working fewer hours [3]. Fatigue after working extended and/or overnight shifts have heightened risk of percutaneous needlestick injuries [19]. Extended shifts exacerbates fatigue-related miscues of the years of training done by the resident physicians, who complied with graduate medical education standards of weekly work hours of 65 hours [18].



## **7. Initiating duty hour restriction to counter fatigue**

In an effort to address issues stemming from potentially unsafe working conditions at US residency programs, the ACGME and the Institute of Medicine have advocated for and implemented progressive work hour restrictions to improve resident training [1, 2]. As US teaching hospitals handle increasing admissions, care for older and/or sicker patients, and discharge patients more rapidly than in the past, residents' workloads have intensified despite work hour restrictions [15]. Attributing physician in training exhaustion only to hours of continuous duty and total duty hours over-simplifies the issue of physician fatigue. Workload, circadian rhythm disruption, tolerance of sleep loss, and work shift intensity also play roles in physician's fatigue [4]. The ACGME and the Institute of Medicine advocate for duty hour restrictions in addition to expanded supervision and sleep enhancement in order to enhance patient safety [10]. Of note, 55% of studies included "quality of life" as an outcome parameter, with 45% of them demonstrating some degree of improvement [2]. Drolet et al. in a national survey of trainees from across all specialties showed that nearly half of all respondents disapprove of 16-hour "call maximums" and only about one in five respondents supported the move to 16-hour in-house call limits. Such restrictions were perceived as deleterious to resident quality of life, education, and supervisory engagement [20].

## **8. Impact of fatigue on physician's well-being**

Resident physicians' traditional extended duty shifts for 24–30 consecutive hours pose significant hazards not only to patients but also to the physicians in training themselves [12, 21]. Residents report more somatic symptoms with a 24-hour shift schedule than with shorter duration shifts [21]. After transitioning from medical school to internship, average nightly sleep decreased by almost an hour, with shorter sleep during internship correlating with escalated risk of depression [17]. Internship initiates a demanding transition from student to physician marked by extended labor hours and sleep loss. Interns have significant risk of depression, which correlates with increased likelihood of self-documented and supervisor noted medical errors [17]. The risk of an internal medicine resident reporting a major medical error increases from 15 to 28% as fatigue, depression, or both increase [1]. Research indicates that resident duty hour restrictions in various medical and surgical residencies resulted in enhanced resident well-being, fatigue, and burnout after the implementation of the 80-hour rule, closely corresponding to the 2003 ACGME mandate [20, 22]. Conversely, teaching faculty reported increased workloads and job dissatisfaction after implementation of work hour restrictions [22].

## **9. Relationship between fatigue and physician burnout**

Numerous reports document that burnout among physicians in training occurs commonly and results from work-related stress characterized by emotional prostration, depersonalization manifest as cynicism and detachment toward patients, and diminution of personal esteem. Burnout corrodes professionalism, contributes to errors in medical practice, features

in substance abuse and relationship difficulties, and can result in physician attrition, depression, and suicidal ideation [19, 23]. Medical students and physician trainees report depression more frequently than similarly matched and aged segments of the US population [19]. To ameliorate burnout and emotional exhaustion, graduate medical education programs have implemented wellness programs and work hour limitations in recent years [23]. Despite work hour caps intended to promote adequate rest for medical trainees, both medical students and physicians in training continue to commonly report fatigue, which suggests that the solution to physician fatigue and burnout requires a multifactorial approach that does not solely focus on duty hour caps [19].

## **10. Impact of duty hour restrictions on resident education and skill development**

Limiting work resident's work hours by using cross-coverage or shift work has impacted on residents' training experiences and job satisfaction, resulted in loss of continuity of patient care, and potentially resulted in hospital adverse events and complications [3]. Inherent to more restrictive resident work hours, frequent shift changes can reduce the trainee's ability to effectively engage in continuity of care education/learning, any associated clinical observations, and the recognition of deviations from an expected recovery course and/or postprocedural morbidity [20]. A 16-hour limit on continuous duty attributed the beneficial outcomes to increased involvement and coverage of first-year residents' work by more senior residents and faculty [11]. Traditionally, medical training has relied on long work hours to help facilitate the proper acquisition of procedural skills and to foster the long-held concept of "patient ownership" [22]. Among the most debated topics in relation to the restriction of duty hours and surgical training were, unexpectedly, continuity of care and trainee operative experience [22]. Many European surgical training programs have limited resident surgical work hours to less than 60 per week while still exposing their residents to acceptable amounts of operating-room experiences to ensure adequate training [22]. Implementation of duty hour restrictions has resulted in an increase in overall operative case volume in multiple high-quality studies, while in comparison, other reports on surgical specialties have documented no change or decrease in surgical caseload volume [2, 22]. Despite evidence to the contrary, surgical faculty reports negative effects with respect to resident training, quality of patient care, and continuity of patient care [22]. Finally, although not a direct clinical outcome metric, duty hour restrictions have not negatively impacted board certification scores [22].

## **11. Impact of duty hour restrictions on medical error and patient safety**

Curtailed shift duration correlates best with improved patient care of the strategies for managing physician fatigue, although the evidence does not demonstrate universal beneficial effect [10]. Enactment of resident work hour constraints has abated provider-induced aftereffects and morbidity-signaling-enhanced patient safety [24]. A recently published study conducted

in the critical care setting found that elimination of extended-duration work shifts, defined as >24 hours, actually reduced the rates of significant medical errors and polysomnographically documented attentional failures [18]. Studies that failed to demonstrate patient care benefits secondary to physician duty hour restrictions, mostly in high-acuity critical care patient neurosurgical and cardiac surgery populations, attribute these outcomes secondary to the increased transfers of care of patient care responsibilities [20]. The increased frequency of patient handovers can fragment care and result in the loss of crucial patient information [20]. Intensive care unit staff reported perceptions that physicians in training know fewer clinical and social details about their patients and make lower quality decisions when working in a shorter schedule [21]. In addition, surgical educators in the future should consider focusing more attention on new technologies and didactic tools (e.g., simulation and web-based learning) to optimize the learning experience in surgery training programs [22].

## **12. Duty hour restriction alternatives for combating physician fatigue**

Devising schedules to reduce resident physician fatigue, enhance education, and boost continuity of care represents a core goal of program directors throughout the United States [15]. In Canada, the National Steering Committee on Resident Duty Hours proposed fatigue-management strategies as a promising alternative to prescriptive “one-size-fits all” restrictions on resident duty hours [9]. Multiple organizations in the US and Canada have advocated for new accreditation standards that would require residency programs to develop, maintain, and enhance fatigue risk management plans [9]. In considering alternative strategies to limiting duty hour restrictions, the impact of fatigue during extended shifts needs consideration within the broader context of patient and work schedule factors such as patient illness severity, patient length of stay, cross-coverage, distribution of rest hours, etc. Efforts to address the negative impact of shortened work hours, particularly the 16-hour limit for first-year residents instituted in 2011, have included night float, providing protected time for sleep during the night shift, improved handoff procedures, and attending teaching interactions during the night shift [10, 11]. Although no schedule system alone can protect against overnight fatigue or burnout, judicious scheduling in combination with abbreviated duty hours can ameliorate the trade-offs between residents’ learning requirements, fatigue, and measures of patient safety [21]. Although often neglected relative to work hours despite being a critical component of the landmark New York regulations, adequate supervision of residents and medical students has the potential to improve resident’s education and further patient safety [3]. Because of the association between adverse events and extended shifts, restrictions on extended shifts, not just weekly duty hours, should be considered when designing residents’ schedules [3, 18]. Fatigue-related injury prevention, including the avoidance of driving while drowsy, should be incorporated into medical school curricula and reinforced during residency and actively supported by graduate medical education leadership and hospital administration. Hospitals should consider providing transportation to trainees who report being too tired for safe driving. Additionally, although consecutive work periods should not exceed 16 hours, hospitals should provide transportation for all resident physicians who, because of unforeseen reasons or emergencies,



work for >24 hours continuously. Under such circumstances, transportation should be readily available and provided to house staff accordingly and should not require self-identification or request [25], except perhaps employee status verification.

### **13. Impact of night float to achieve duty hour restrictions**

Night float involves a clinical staffing system in which dedicated physicians work throughout the night and not during the day covering their fellow physicians' patients [10]. Night float implementation has necessitated more frequent handoffs of clinical duties in teaching hospitals in order to comply with applicable rules governing resident work hours; for example, the "night float" trainee may admit patients during the evening shift and transfer them to another clinical team in the morning [15]. Typically, these night float duty periods last for 12–16 hours in North America [21]. Data supporting efficacy of night shift for ameliorating resident fatigue and improving patient safety demonstrates mixed results. While some evidence substantiates night float shifts improvement in resident's well-being in terms of acclimating to a consistent nocturnal schedule, other data suggest that night float impairs resident's well-being through isolation from other clinical care teams and hospital consultants available during the daytime shifts [10, 11, 13].

### **14. Strategic protected sleep time during prolonged shifts**

Protected sleep time involves residents transferring their clinical duties to other clinical personnel, such as patient admissions, carrying out procedures, and managing patient care issues, for a defined time interval just prior or during their night work shift in order to obtain rejuvenating, uninterrupted sleep [11]. Prior work in nonphysician populations has demonstrated that taking naps improves tasks involving memory and learning [9]. For residents, regardless of their nocturnal work schedule, weariness and torpor most likely manifest at 4 am, consistent with the notion that circadian rhythms of nocturnal laborers and time of day exert more impact on fatigue than duration of shift [21]. Strategic protected sleep time during prolonged nocturnal shifts and educational seminars about enhancing sleep hygiene practices have demonstrated inconsistent impact on physician recuperation [9]. However, data substantiate the benefits of strategic napping prior to nocturnal shifts and at midpoints during nocturnal shifts in terms of attentiveness and cognitive performance [13].

### **15. Conclusion**

Exhaustion, somnolence, lassitude, melancholia, and impaired quality of life correlate independently with an increased risk of medical errors and poor patient outcomes [1]. Support for caps on hours for physicians in training comes from data that indicate beneficial effects of restfulness on vigilance and performance [7]. Data supporting capping physician work hours

demonstrates evidence of amelioration of fatigue, thereby improving physician quality of life; evidence supporting duty hour restriction for enhancing patient safety, decreasing medical errors, and physician training, including surgical, is mixed and more nuanced [2]. Enhancing physician training should proactively address burnout, resident fatigue, and any other forms of distress in an effort to preserve trainee's well-being and patient safety [1]. Future studies are warranted to address the impact of duty hour restrictions on other measures of competency, such as professionalism, humanism, and/or communication skills, and such efforts will certainly benefit medical education. The net effect on patient safety hinges on the balance between exhaustion and continuity of care [21]. Public health stratagems such as improving quality of sleep both out of and in the hospital, examination of individual and environmental factors impacting fatigue, and injury prevention models focusing on adverse events and injuries provide promising frameworks for understanding fatigue-related adverse events in the context of physician training [3].

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