

EFFECTS OF ON-CALL SHIFTS ON PHYSICIANS' COGNITIVE PERFORMANCE, LEVEL OF ALERTNESS, MOOD, AND SAFETY: A REVIEW ARTICLE

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ABSTRACT

A hospital physician's work demands high cognitive performance, quick judgment, prompt and flawless decision making, a high concentration level, and fine motor skills. However, physicians frequently experience periods of acute sleep deprivation due to the extended on-call shift lengths. This may affect cognitive functions, alertness, and mood; therefore, the overall performance. This article will review the effects of long shifts (on-call hours) and the result of sleep deprivation on physician affecting their general performance and safety, as well as the implications of such effects on patient care. Recommendations and suggestions proposals will be presented for consideration by the training boards, the Saudi Commission for Health Specialties, to improve physicians' performance and assure patients' safety without jeopardizing the trainees' post graduate education

Keywords: On-call, Sleep Deprivation, Alertness, Performance, Mood, Safety

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INTRODUCTION

The most important and significant function of sleep is to restore the sleeper's feelings of freshness and alertness in order for the tasks to be completed at a high cognitive and physical performance levels without significant effort, even on boring or monotonous situations. Sufficient sleep is not measured in absolute hours of sleep obtained, but rather in terms of an individual's ability to maintain cognition and physical ability when awake. The amount of sleep required appears to be genetically determined, and although the average is 7.5 to 8 hours, healthy adults may normally require anywhere from 4 to 10 hours of sleep^[1].

Sleep deprivation (SD) is associated with a variety of adverse consequences, which are often not fully appreciated by patients or clinicians, and can potentially be life threatening^[2]. Furthermore, sleep deprivation due to extended work hours and sleep rhythm variance (circadian disruption) has long been a concern among healthcare personnel^[3]. As junior physicians are assigned to work long shifts (on-call hours), the necessary high levels of psychomotor performance, cognitive function, and emotional equilibrium become difficult to maintain^[4]. Scheduled on on-call shifts are often 24 to 30 hours long^[5], during which time sleep is often limited and fragmented, leading to acute SD. This article will review the effects of long shift lengths and the consequences of SD on physician performance, level of alertness, mood, and safety. In addition, the article will examine the effects of such phenomena on overall patient care.

EFFECT OF ON-CALL SHIFTS ON PHYSICIAN COGNITIVE FUNCTION AND PERFORMANCE

The lack of proper sleep can result in significant changes in cognitive function and mental status; these changes may resemble clinical depression and anxiety, and can significantly impair short-term memory^[6]. Consequently, SD may significantly affect physician performance and endanger patient safety^[4,7-9]. Many researchers have studied the effect of long on-call hours on cognitive function and performance^[5,10-12]. Robbins *et al.*^[4] administered four standard tests of cognitive function to 23 university hospital staff members. Tests were administered at rest, following one night on call, and after another night of recovery sleep. Statistically, significant deterioration occurred in 3 out of 4 tests after the on-call night. The results of this and other studies indicate that when physicians are stressed by acute SD and prolonged fatigue^[1], consequently reduces alertness and the concentration level leading to prolonged decision-making processes, suboptimal decisions, and cloudiness of judgment. All of which jeopardizes the patient safety and causes other safety issues as well as performance-related problems for physicians and their staff^[4,9,13-16].

Many studies within the past decade have analyzed the deleterious effects of SD on trainees and highlighted the increased rate of serious medical errors^[17]. One study revealed that interns caused 36% more serious medical

errors when working more than 76 hours per week than when working an average of 65 hours per week^[8]. On the other hand, Howard *et al.*^[18] used a realistic simulation environment to study the effects of SD on the psychomotor and clinical performance of twelve anesthesia residents. These residents performed a 4-h anesthetic on a simulated patient the morning after a sleep-extended (EXT) period (allowing an increase in nocturnal sleep time) and after a total SD period, in which subjects were awake at least 25 hours. Psychomotor tests revealed progressive impairment in alertness, mood, and performance in the total SD condition when compared with EXT, confirming the negative impact of SD on physician performance^[18]. Nevertheless, overall clinical performance in terms of medical errors was similar between the two conditions, contrary to the above quoted study^[8,18]. More recently, in a prospective non-randomized interventional study, Erie *et al.*^[19] measured the effect of acute SD on a surgical performance using a computer simulator. Nine ophthalmology residents were tested on an eye surgery simulator on 3 occasions: pre-call (≥ 7 hours of sleep in the previous 24 hours), post-regular working hours (8 hours/day and ≥ 7 hours sleep in the previous 24 hours), and post-call or sleep-deprived (< 3 hours sleep in the previous 24 hours). Despite acute SD and signs of sleepiness in the post-call residents, no detectable difference in technical performance of surgical tasks among the 9 residents was observed over the three occasions^[19]. Therefore, although the latter two studies confirmed the effect of acute SD on psychomotor performance, they observed no negative impact on the clinical skills and performance of residents under study. In general, literature concerning the effect of acute SD on physicians' clinical performance is not only scanty with regard to heterogeneous methodology, but the results are contradictory.

EFFECT OF ON-CALL SHIFTS ON DAYTIME ALERTNESS

Wilhelm and colleagues^[20] studied 34 physicians and looked at daytime sleepiness after one on-call night, using subjective sleepiness scales and the Pupillographic Sleepiness Test. They concluded that even partial SD after physicians' night duty, results in significantly reduced alertness levels on subjective and objective tests^[20].

Reddy *et al.*^[21] also reported that residents working in a medical intensive care unit had severe sleepiness during post-on-call days when measured subjectively and objectively. Despite adherence to the guidelines set by the Accreditation Council for Graduate Medical Education (ACGME), responsible for the accreditation of postgraduate medical training programs within the United States^[22]. In addition, researchers have pointed out that chronic SD among residents causes daytime sleepiness, as evidenced by relatively short pre-on-call night sleep times and shortened average sleep latency in some of the participants^[21]. This probably reflects a common sleep disorder, chronic sleep deprivation, which is by far the most common cause of excessive daytime sleepiness

in modern societies^[23]. In the same study, it is interesting to note that post-call sleepiness assessed subjectively by the Stanford Sleepiness Scale (SSS) showed no correlation with objective assessment as measured by modified multiple sleep latency tests (MSLT). Hence, suggesting that residents may have a poor understanding of sleepiness during post-call days, possibly, resulting in underestimation of needs and dangers^[21].

EFFECT OF ON-CALL SHIFTS ON PHYSICIAN MOOD

Studies examining mood status in relation to SD in physicians are particularly scarce^[24,25]. In addition to studies of cognitive performance, one Singapore study using questionnaires looked at the effect of on-call shifts on interns' mood^[26]. The authors reported that night calls were found to adversely affect mood 89.5% of the time, while daytime sleepiness was frequently observed to be proportional to the time spent at work after call-nights^[26].

Differences in the nature of work performed by physicians on call needs to be considered carefully when interpreting these studies. In one study^[27], twelve medical house officers were tested on a battery of memory, concentration, and work related tasks under three different conditions: a night spent off duty, a night spent on-call, and a night spent admitting emergency cases. Short-term recall was impaired after the night of emergency admissions; however, concentration and work-related abilities were not affected. Self-reported mood scores showed that house officers were more deactivated (indicating a lack of vigor and drive) after nights of emergency admissions but not after nights on-call. Significant differences between subjects were found in five of the eight cognitive tests utilized. The study's the authors suggested, that while loss of sleep and long hours of work have an effect on memory and mood, individual differences among doctors may be the main source of discrepancies in task performance^[27].

EFFECT OF ON-CALL SHIFTS ON PHYSICIAN SAFETY

Marcus and Loughlin^[28], reported that 50% of interns frequently fall asleep at the wheel, and that 90% of such events occurred on the post-on-call periods. In contrast, only 13% of faculty members, who were rarely disturbed at night, reported falling asleep at the wheel ($p < 0.001$)^[28]. Barger *et al.*^[9] conducted a prospective nationwide, web-based survey and concluded that extended-duration work shifts pose safety hazards for interns. In months in which interns worked five or more extended shifts, the risk that they would fall asleep while driving or while stopped in traffic was significantly increased (OR = 2.39 and 3.69, respectively)^[9]. Furthermore, every extended work shift per month resulted in a 16.2% increase in the monthly risk of a crash occurrence during an intern's commute^[9].

WORK HOURS LIMITATIONS (WHLs)

Restrictions on hours worked by medical trainees have been implemented in the United Kingdom since 1996 and across the United States since 2003. ACGME mandated a work-hour reduction as follows: (1) the maximum number of hours a resident physician is allowed to work is limited to 80 per week, averaged over four weeks; and (2) continuous duty time is limited to 24 hr^[22]. The ACGME standards also require rest periods between duty shifts, and that resident be given one day in seven, to be free of training program responsibilities^[22]. Similarly, and in an effort to limit the impact of fatigue and sleepiness on residents in training in Saudi Arabia, the Saudi Commission for Health Specialties (SCHS) in 2004 issued a statute that mandated work hour limitations (WHLs)^[29]. However, the effect of such WHLs on patient safety is far from being conclusive. In the study quoted previously by Reddy *et al.*, adherence to WHLs reported as not to prevent excessive daytime sleepiness on post-on-call duties. In contrast, other studies showed that reducing trainee work hours not only improves alertness, but also leads to a reduction in medical errors^[4,5]. In addition, Goitein *et al.*^[13] conducted a self-administered survey of internal medicine residents in a university-based residency training program that showed that residents approve of WHLs overall and report benefits to their well-being. Nevertheless, they also reported negative effects on patient care and resident education^[13].

Several factors may contribute to the limited anticipated success of the WHL policy. Poor adherence to WHL rules by physicians in training and loose application of the policy by residency programs are potential factors^[30]. Junior physicians may not be eager to compensate for their on-call sleep debt by sleeping for enough hours during their off-call days. This could be due to the desire to engage in social activities missed due to long work hours and on-call commitments. In fact, Reddy *et al.* confirmed this factor; the average duration of sleep for the two successive pre-on-call nights was around seven hours each, which is not long enough to make up for the sleep debt resulting from one on-call night^[21].

Another way of looking at this matter is that the WHL policy may not be adequate, or that the shift duration recommended may need further adjustment. The available evidence of the effect of on-call duration on healthcare provider performance and quality of patient care is insufficient and inconclusive, hence well-designed studies are needed^[14]. An early systematic review looking at effects of resident work hours on patient safety, which critically evaluated the evidence showing that adherence to ACGME standards would improve patient safety, concluded that such evidence is actually lacking^[31]. More recently, Reed *et al.* systematically reviewed the literature examining shift length, protected sleep time, and night float over the last two decades^[32]. Most of the 64 studies that met the inclusion criteria of the review were observational and were conducted in single institutions. Although most of these studies supported reductions of shift lengths, they did not adequately address optimal shift

durations. Hence, the authors reported that no conclusion could be drawn regarding specific recommendations of shift length. Of the 13 studies examining the relationship of shift length to patient outcomes, three examined mortality and showed no relationship. In addition, all six of the studies measured the relation of shift length to medical errors, suggested fewer errors were associated with shorter shifts; however, these studies had significant methodological limitations^[32]. In another systematic review, Moonesinghe and colleagues^[33] reviewed all studies that assessed the impact of a change in work hours on the postgraduate medical training, patient safety, or clinical outcome. 72 studies were eligible for inclusion: 38 reported training outcomes, 31 reported outcomes in patients, and three reported both. They concluded that restrictions of working hours, less than 80 per week had no negative impact on patient care and medical education. Reports on the impact of the European legislation limiting working hours to less than 56 or 48 a week are of poor quality, and offers conflicting results, indicating that firm conclusions cannot be made^[33].

In 2008, the Institute of Medicine (IOM), an independent, nonprofit organization that works outside of United States government to provide unbiased and authoritative advice to decision makers and the public, made recommendations for certain changes to the ACGME mandates, including a restriction of maximum shift length to no more than 16 hours^[34]. This is actually supported by anecdotal reports that suggested that on-call workloads and physical demands experienced by trainees are excessive even with current WHLs. Parshuram *et al.*^[15] measured the workload, the level of fatigue and the physical stress of 11 senior trainees during 35 shifts in the critical care unit in Ontario, Canada. Although the number of roistered hours was within current Ontario guidelines, the authors concluded that established Canadian guidelines expose trainees to significant on-call workload, physical stress, and sleep deprivation^[15].

There are, however, legitimate concerns regarding reduction of physician shift hours. These include poor continuity of patient care and a negative impact on postgraduate training. The previously cited systemic review by Moonesinghe *et al.* reinforces this point^[33]. In addition, the cost of providing adequate coverage and maintaining sufficient manpower would be remarkable. Actually, one study has estimated the cost of the recent IOM recommendations at 1.7 billion USD per year^[35]. However, in response to IOM recommendations, ACGME recently published new recommendation proposals, which may go into effect in July 2011^[36].

The recommendations by the ACGME aim to establish a humanistic on-call environment, and at the same time ensure optimum and safe patient care^[36]. In July 2010, a national survey of residency training program directors in the U.S. was conducted to evaluate their opinions regarding the new recommendations^[37]. Although the majority of program directors agree with the overall workload recommendations, they, however, disagree regarding the recommended duty period limit of 16 hours for first year residents. In the study's, authors also concluded that more work addressing the different needs of the various specialties and program types may be required to achieve broader agreement on and compliance with the newest recommendations^[37].

SUMMARY AND RECOMMENDATIONS

Despite heterogeneous and limited available data, acute sleep deprivation related to long on-call hours attributes to a significantly affect performance, levels of alertness, mood status, and safety of physicians in training programs. Such effects seem to be directly related to the severity of sleep deprivation. The current local regulations of physician shift lengths put forth by the SCHS warrant prospective evaluation with serious consideration for subsequent modification.

The paucity of rigorously designed studies analyzing the impact of duty hours on patient care and physician safety necessitates prospective multi-institutional studies on the present research topic. However, based on other societies' experiences and for the benefit of our society, the following recommendations need to be worth considering and implemented in recognized residency and fellowship programs in Saudi Arabia:

1. The number of on-call shifts must be limited to a maximum of 6 per month.
2. On-call duty hours must not exceed 20 hours.
3. Attendance of sign-out rounds from 1600 to 1630 must be mandatory for all physicians in training. This would guarantee optimum continuity of care and ensure patient safety.
4. Physicians in training must be strongly advised to use the morning hours prior to on-call shifts to enjoy extra hours of sleep.
5. Teaching activities must be scheduled as academic half-days, preferably in the morning, once every week, and must be mandatory for all residents, even those on-call or post-call.

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