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Brief Reports

DOES MY EMERGENCY DEPARTMENT DOCTOR SLEEP? THE TROUBLE WITH RECOVERY FROM NIGHT SHIFT

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☐ Abstract—Background: Previous research has shown that emergency physicians have an increased risk of shift work sleep disorder, potentially compromising their health, wellness, and effectiveness as a physician. Objectives: This study explores the effect of shift work on sleep in emergency doctors. The hypothesis of the evaluation is that daytime sleep onset would lead to the poorest sleep, implying poor recovery after a night shift. Methods: Sleep patterns were examined in emergency physicians in an academic emergency department. Twenty-seven individuals completed data collection, wearing wrist actigraphy devices over 3 months. Time of sleep onset was categorized as falling into 1 of 3 ranges: interval 1—day sleepers (6:00 AM–2:00 PM), interval 2—evening sleepers (2:00 PM–10:00 PM), or interval 3—night sleepers (10:00 PM–6:00 AM). Data from each interval were analyzed for median duration, sleep latency, and night-time interruptions. Results: Daytime sleep sessions had a median total sleep duration of 5.3 ± 2 h, much less than 7.3 ± 1.8 h (interval 2—evening), and 7.0 ± 1.1 h (interval 3—night). Interval 2 sleepers experienced the highest number of nightly awakenings (1.5) and the longest sleep latency (36.5 min). Day sleepers (interval 1), assumed to be predominantly physicians recovering from night shifts, had significantly less sleep than both evening and night sleepers ($p < 0.01$), experiencing a 23.0% decrease in overall median sleep duration. Conclusions: This study provides statistical findings that those working the night shift experience significantly less sleep than emergency physicians working other shifts.

☐ Keywords—alertness; emergency medicine; shift work; shift work sleep disorder; sleep

INTRODUCTION

Optimal sleep hygiene represents a critical component of a healthy lifestyle. Previous evaluations have established that the lack of sleep among training emergency physicians is associated with poorer quality of life and sleeping while driving (1,2). Physicians who advocate for comprehensive health in their patients still find quality sleep elusive (1–3). Emerging evidence on the detriments of night shift and sleep deprivation points candidly at the compromise of the health and wellbeing of shift workers—leaving emergency physicians, especially, at increased risk (2,4–6).

Night shift workers as a whole are at risk for excessive sleepiness or insomnia denoting shift work sleep disorder (4,6). This is characterized as sleep disruption or excessive fatigue for ≥1 month associated with a work schedule out-of-phase with the typical circadian rhythm. Workers suffering from this condition are at risk of

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serious lapses in alertness and of falling asleep involuntarily while at work or while driving (4,6). In a survey of emergency physicians, 34% stated that they fell asleep driving at least once over a 3-month interval (2).

A recent study evaluated on-call internal medicine residents using wrist actigraphy to measure sleep disruption of physicians in relation to extended call shifts (3). This evaluation revealed an increased likelihood of chronic sleep restriction in interns who were completing extended overnight shifts (3). Although similar studies have used sleep-tracking devices for analyses of call shifts, no such measure has been applied to emergency physicians (representing health care shift work rather than a call schedule).

This study explores the effect of emergency shift work on sleep by evaluating sleep quality and quantity indexed by time of sleep onset, using wrist actigraphy. Given previous research, the hypothesis of the evaluation is that emergency physicians would have suboptimal sleep duration and quality with sleep onset during daytime hours (connoting poor night shift recoverability).

METHODS

Study Design

We analyzed sleep patterns in emergency medicine residents and attending physicians to decipher which time of sleep onset was associated with the greatest disruption in quality and quantity of sleep. In order to follow nightly patterns the study used a wrist actigraphy device (UP2; Jawbone, San Francisco, CA) that was provided to subjects free of charge through an internal departmental research fund. The study evaluators were blinded to the wearers of the devices and subjects could opt out at any time.

Study Setting and Population

All faculty and residents of an urban academic emergency medicine program were invited to wear fitness trackers for sleep measurement. The demographic breakdown of the participants was as follows: 85% white, 7% Indian, and 7% African American. No subjects were on a dedicated night shift. The program runs an alternating schedule of day, evening, and night shifts, in a clockwise rotation. Researchers were successfully blinded from participants' data by an independent coordinator, and each participant's data were assigned a random number. Wrist tracking devices were worn consistently from July 1, 2016, through September 30, 2016. Informed consent was collected from all participants, and the Institutional Review Board and the Human Subjects Protection Program Office at the University of Louisville approved this investigation.

Study Protocol

Subjects were instructed to wear their devices at all times (or as much as possible). As an incentive to participate, those that completed the evaluation were invited to keep the fitness trackers. The native software to the Jawbone UP2 was used for data acquisition. Data were downloaded directly from devices to a computer to perform evaluations of sleep as cataloged automatically by the internal accelerometers.

Time of sleep onset was categorized into 3 ranges: interval 1—day sleepers (6:00 AM–2:00 PM), interval 2—evening sleepers (2:00 PM–10:00 PM), or interval 3—night sleepers (10:00 PM–6:00 AM). Interval 1 corresponded predominantly to those working the night shift, assuming that most participants would try to obtain sleep in the 8 h after the end of their shift.

Measurements

Wrist actigraphy devices have been validated in previous investigations for sleep measurement (3,7). Wrist actigraphy, as measured by the accelerometer, has been shown to be a valid marker of sleep phases, as well as demonstrating strong correlation to endogenous circadian rhythms (7).

For this evaluation we used prebuilt native tracking variables of the actigraphy device, which were measured using the internal solid-state accelerometer (in seconds). We evaluated sleep onset, duration, interruptions, and latency.

Data Analysis

Each night of primary sleep from the investigation timeframe (July 1, 2016–September 30, 2016) was treated as an independent measurement for each individual. These sleep data points were then combined for each participant individually before comparison and combination with the whole, because no 2 subjects were guaranteed to exhibit identical innate chronotypes.

"Secondary" sleep was defined as any sleep happening in a 24-h window that is shorter in duration than another body of sleep ("primary"). The separation of primary and secondary sleep is native to the device. This study did not evaluate secondary sleep (i.e., naps).

The Jawbone internal sleep onset variable (s_asleep_time) was selected to be time initial ($t = 0$). Latency, internally recorded as the variable (s_awake), is defined as the time between initially getting into bed (s_bedtime) and sleep onset (s_asleep_time)—i.e., the amount of time it took for a participant to fall asleep.

Using the sleep onset variable, each night was broken into 3 groups: those who fell asleep during interval 1—day sleepers (6:00 AM–2:00 PM), interval 2—evening sleepers (2:00 PM–10:00 PM), or interval 3—night sleepers (10:00 PM–6:00 AM). Data from each interval were analyzed for latency, awakenings, and duration. The intervals only restricted the time of sleep onset (i.e., any participant falling asleep between 6:00 AM–2:00 PM would be assigned to interval 1, even if they awoke after 2:00 PM).

Using a python script (Python Software Foundation, https://www.python.org/, v. 2.7.1 – compiled with IPython, using packages NumPy and pandas), all results from participants were analyzed. Each participant's data were individually analyzed to derive a sleep duration median for each of the 3 intervals, for each participant separately. Finally, a median of the 27 individual medians (27 participants) was obtained for sleep duration for each of the 3 intervals. Ultimately, all 3 sleep onset intervals were compared and trends were observed. An analysis of variance (ANOVA) with Hochberg's GT2 post hoc analysis was applied to all data to determine significance using SPSS software (SPSS Inc., Chicago, IL).

RESULTS

Twenty-seven individuals completed this study. The results from the primary sleep evaluation are summarized in Table 1. Unless otherwise indicated, all values are displayed as medians, and times are noted in hours.

Daytime sleep sessions had median total sleep duration of 5.3 ± 2 h, much less than 7.3 ± 1.8 h for interval 2—evening, and the 7.0 ± 1.1 h for interval 3—night. Evening sleepers experienced the longest sleep latency, while simultaneously having the most sleep interruptions.

Descriptive statistics showed differences in median sleep duration by sleep interval. To examine if these differences were significant, data were entered in SPSS and an ANOVA was implemented for each sleep cycle treated as a piece of data for this study. Figure 1 shows the relative amount of data that each of the 27 individuals (IDs) contributed to the whole data set for the ANOVA (each contributed between 0.9–5.1% of the total). A total of 1704 pieces of data were included in the analysis, corresponding to 95% of the original data before removing outliers.

First, the test of homogeneity of variances was not significant ($p = 0.259$), indicating equal variances across levels of sleep interval, therefore, to continue with analysis. ANOVA results showed that type of sleep interval was significantly associated with duration of sleep ($F_{2,1704} = 35.1$, $p < 0.01$). Next, Hochberg's GT2 post hoc analysis was conducted to examine if there were significant differences within each sleep interval. Interestingly, results showed that physicians in interval 2 (evening sleepers) experienced significantly more sleep quantity than physicians in interval 3 (night-time sleepers), yet evening sleepers had the greatest number of interruptions of any interval and the longest latency—potentially implying poor quality sleep. Ultimately, doctors sleeping in interval 1—day sleepers experienced significantly less sleep than both other groups ($p < 0.01$), which confirmed the aforementioned hypothesis.

DISCUSSION

In previous investigations, poor sleep and severe sleep deprivation were found to be independent variables associated with poor quality of life (1). In this study, daytime sleep sessions had a median total sleep duration of 5.3 h, a 23.0% decrease in sleep duration when compared with the overall median sleep duration. This daytime period—representing the most likely time of recovery after a night shift—signifies that the night shift, for an emergency physician, is associated with the least sleep among

Table 1. Results of the Primary Sleep Evaluation

	Interval 1—Day Sleepers (6:00 AM–2:00 PM)*	Interval 2—Evening Sleepers (2:00 PM–10:00 PM)*	Interval 3—Night Sleepers (10:00 PM–6:00 AM)*
Median sleep duration, h	5.3	7.3	7.0
Interquartile range of sleep duration	2.0	1.8	1.1
Range of physicians' median primary sleep duration† h	3.1–7.4	2.8–11.1	5.8–8.9
Nightly interruptions/awakenings, n	0.8	1.5	1.0
Nightly sleep latency, min	24.9	36.5	22.3

* Interval of time that a person started sleeping (e.g., if subject A fell asleep at 1:45 PM their sleep for that day was included in measurements of interval 1; falling asleep at 2:05 PM would place subject A in interval 2).

† Represents the 27 medians of total primary sleep duration for the measured emergency doctors (e.g., in interval 1, the least amount of median sleep a single physician experienced was 3.1 h). Each median is taken over the entire study period (3 months) for each individual physician.

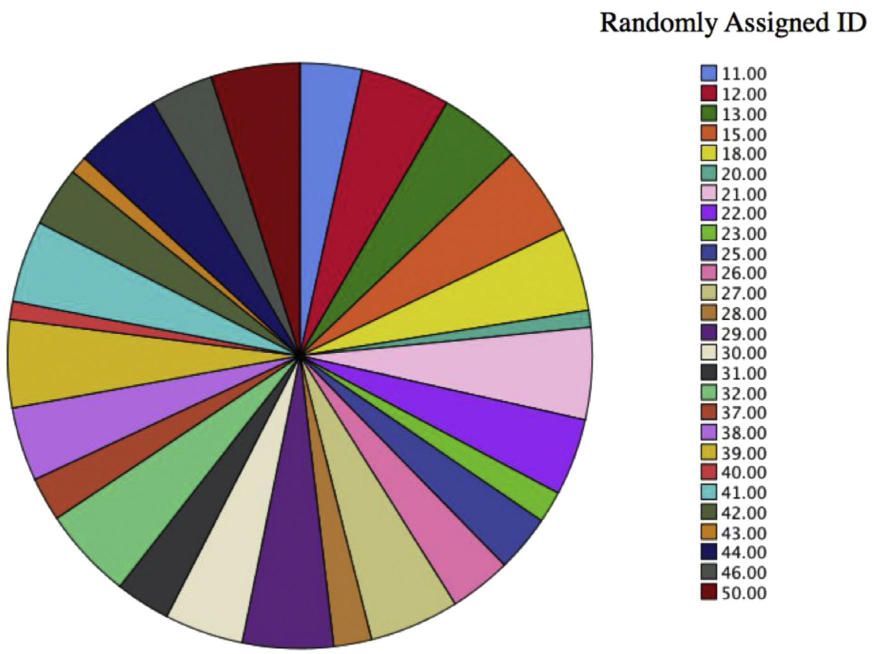

Figure 1. Participant contribution by individual.

the intervals investigated. This is consistent with previous investigations of emergency physicians and night shift workers (2,4,8). Unfortunately, there seems no way around the sleep deprivation associated with a night shift because sleep problems persist despite the scheduling strategy applied, including both permanent night shift workers and those on shift rotation schedules (9).

In a recent survey of emergency physicians and residents, 91% stated that night shift was associated with the greatest fatigue, and 75% felt that sleepiness impaired their effectiveness as a physician (2). Further aggravating the issue, adaptation to the night shift work schedule is not common (4,8). Recovery from the night shift can be just as difficult, as observed in an evaluation of internal medicine residents who did not recover until the fourth day of improved sleep after a single night of call (10).

In this investigation, sleep latency seemed to mirror night-time awakenings/interruptions—both greatest during the evening sleep onset period. Alternatively, the least sleep latency occurred when individuals fell asleep at night—aligning with the typical circadian rhythm.

In a review of 6 studies evaluating night shift adaptation through internal circadian rhythms, <3% of permanent nightshift workers demonstrated complete adjustment to nightshift (8). Surprisingly, most (72%) demonstrated no adaption of endogenous melatonin (8). This suggests that permanent night shifts offer no reprieve to the preponderance of fatigue and poor sleep among night shift workers, because most people are incapable of adjustment to a nocturnal rhythm.

Limitations

This was a single-center study and the results may not represent the average because of specific work requirements of the residents and faculty. As a single-center study of a specific location, considering sun exposure driving circadian rhythms, results may vary by latitude. From an individual participant standpoint, compliance with the device (wearing and maintaining an electrical charge) is also a source for lost data—those subjects more compliant with the device may contribute more episodes of data. This was evaluated, however, and the results are shown in Figure 1, demonstrating that for the ANOVA, the maximum amount of data from a single participant was 5.1%.

In addition, secondary sleep (napping), although a much smaller data subset, was not evaluated in relation to sleep duration or sleep onset. Previous evaluations have questioned the reliability of wrist actigraphy devices in measuring deep versus light variations in sleep (particularly light sleep)—therefore, we did not report light versus deep sleep, but the device will track this information (11). Other evaluations have demonstrated high consistency between devices, though total sleep time can be overestimated (12). Given the interdevice reliability (12), we chose Jawbone actinography devices simply for the battery life, cost, and the observed ease of data extraction capabilities.

CONCLUSIONS

Participants had the least difficulty falling asleep during night hours while sleeping the least amount of time during morning hours—overall, in congruence with a typical diurnal rhythm. These results suggest poor adaptability of emergency physicians to night shift, indicating that shift work sleep disorder may be common in emergency medicine.

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ARTICLE SUMMARY

1. Why is this topic important?

Poor sleep compromises the health and effectiveness of the emergency medicine provider. The adaptability to the night shift and conversely the prevalence of shift work sleep disorder among emergency physicians is underinvestigated.

2. What does this study attempt to show?

This study seeks to establish any differences that may exist in sleep duration and quality among various sleep onset times to infer any circadian rhythm disruption (poor shift schedule adaptation) among emergency physicians. This is the first study to investigate the sleep of emergency physicians using wrist actigraphy.

3. What are the key findings?

Daytime sleepers (those recovering from night shift) demonstrated a 23% reduction in total sleep and significantly less sleep than both evening and night sleepers ($p < 0.01$). This suggests overall poor adaptation to night shift.

4. How is patient care impacted?

Numerous studies have indicated that fatigue originating from circadian disruption has negative implications for both worker safety and patient care. This study indicates that fatigue is likely prevalent among emergency physicians because of highly disrupted sleep.