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IMPACT OF NIGHT-FLOAT ROTATION ON SLEEP, MOOD, AND ALERTNESS: THE RESIDENT'S PERCEPTION

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ABSTRACT

Night-float rotations were designed to alleviate the workload of residents on night call and thereby improve patient safety. However, the impact of the night float on residents is yet to be surveyed. We assessed the impact of the night-float rotation on pediatric residents using an anonymous questionnaire that covered topics, based on recall, about sleep, mood, alertness, adjustment, and others. The study was conducted in a major tertiary pediatric teaching hospital in the United States. Participants were pediatric residents who had completed one or two night-float rotations and were in active training at our teaching hospital at the time of the study. Fifty-two of 60 eligible residents (87%) responded. Sleep duration during the night-float rotation was shorter than during day-shift work in 24 residents (46%), longer in 20 (38%), and unchanged in eight (15%). A higher proportion of residents took longer to fall asleep, had more difficulty falling asleep, had more sleep interruptions, and felt less rested upon awakening. Twenty-four residents (46%) felt that their bodies never adjusted to the night shift. Also, 22 residents (43%) felt moody or depressed in contrast to seven (14%) who felt depressed during the daytime rotation ($p = 0.0001$). Twenty-one residents (41%) felt they were slower in their thinking during the night float than daytime rotations. The results suggest that disturbances of sleep and mood and decreased alertness,

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typical of night shift, are present in the night-float rotation. Residency programs should monitor closely the impact of the night-float rotation on resident well being and patient safety. The impact of night-shift work should be considered in the design of night-float schedules, and teaching should be provided for residents to learn coping strategies for night-shift work. (*Chronobiology International*, 19(5), 893–902, 2002)

Key Words: Circadian rhythm; Medical residents; Night-float shift; Shift work

INTRODUCTION

Night-float rotations are utilized in many residency-training programs in an effort to reduce housestaff stress and performance problems related to sleep deprivation and sleep disturbance.^[1] Doctors in training (residents) usually provide around-the-clock coverage for patient care in teaching hospitals. Generally, the residents on inpatient ward rotations provide patient care during the daytime. In addition, they provide overnight coverage as “on-call” residents every 3–5 nights. Until the late 1980s, the on-call resident covered patients already hospitalized and also admitted new patients who required hospitalization during the night. The workload during the call night usually prevented the resident from getting enough rest before resuming usual daytime duties commencing the next morning. Resultant resident fatigue leads to impaired performance and serious errors in patient care.^[2,3] The death of a patient and the ensuing lawsuit led training programs to acknowledge the residents’ excessive workload and sleep deprivation.^[4] Consequently, the night-float rotation was created and adopted by many training programs. This rotation consists of night-shift coverage performed by residents who do not have any daytime duties and provides coverage of inpatient services in addition to the “on call-resident” who is a daytime worker. Inherent in the night-float rotation is an abrupt reversal of the sleep–wake cycle.

The advent of night-float rotations has had a positive impact on residency training programs, with residents reporting increased satisfaction with on-call responsibilities and increased sleep during on-call nights.^[1,5] However, the impact of the night-float experience, particularly the sudden reversal from daytime to nighttime activities, on the residents has not been evaluated. Shift work has been associated with sleep disturbances, mood alteration including irritability and depression, and diminished alertness^[6–8] that may have serious consequences. We report results of a study designed to investigate residents’ perception of the impact of the night-float rotation on their sleep, mood, and alertness.

METHODS

The Institutional Review Board approved the study and participation was entirely voluntary. The study consisted of an anonymous pencil and paper



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questionnaire distributed on a single day to all available pediatric residents in training at that time. All 60 pediatric residents, who had completed at least one night float and were actively in training at the time of the study, were eligible to participate. Hence, all first and second-year residents who had not done a night float rotation were excluded. Included were second, third, and fourth-year residents who had done the night-float rotation during the second year of training. A voucher for an ice cream at the hospital diner was given to each resident who returned a completed questionnaire.

The night-float rotation at the Children's Hospital Medical Center, Cincinnati, Ohio is a consecutive 2wk rotation during the second year of pediatric residency. This rotation consists of night-shift work from 24:00 to 08:00h, without any daytime work obligations, giving residents the opportunity to sleep during the day. During this 2wk period residents get scheduled time off, usually a 2d weekend block plus a separate single day. These off periods are usually spaced to occur once in the middle and once towards the end of the rotation. Generally, residents revert to night sleep during these off work periods. The night-float residents have direct responsibility for inpatient admissions, management of these patients throughout their shift, and sign-out of the patients to the inpatient ward resident team in the morning. Most residents do two night-float rotations, usually separated by several months time.

Other rotations during the training program consist mostly of daytime duties, generally starting at 07:00h and lasting until 16:00–18:00h. During certain daytime rotations, residents also have night-call duty at least every four nights. On these days, they work the usual day shift and remain on site on night call until the next morning. They are then in charge of admissions to their service until 24:00h, when the night-float resident assumes the task of new admissions. However, the "on-call" daytime residents continue to be responsible for the patients admitted to the service before 24:00h. Hence, the amount of sleep they get during the "on-call" night is variable, depending on patient load, the severity of medical conditions, and related intercurrent problems during the night.

The questionnaire was anonymous and consisted of 52 items related to six main categories: demographics, sleep, mood, alertness, adjustment to change from daytime shift to night shift, and voluntary written comments (Table 1). The questionnaire relied on participants' recall; the time lapse from the experience in question to the day of completion of the survey instrument varied from a few weeks to several months. Most questions were categorical multiple-choice, some open-ended, and some yes/no type. Some questions related to the night-float rotation, others to representative daytime rotations during the same academic year, and others related to the resident's experience during night-float vs. daytime rotations. We pre-tested the questionnaire for clarity with a few residents. The full questionnaire is available upon written request to the corresponding author.

We used the SAS program version 8.20 for data analysis applying published methodologies.^[9] Frequencies of responses were calculated as percentages. When applicable, comparisons of responses between night-float and daytime rotations were made by analysis of variance techniques (ANOVA). Relationships between

Table 1. Questionnaire Topics

Demographics
Age
Sex
Current residency year
Number of completed night float rotations
Sleep
Duration of main sleep event
Difficulty falling asleep
Time to fall asleep
Number of spontaneous sleep interruptions
Feeling rested after main sleep event
Use of prescription/nonprescription sleep medication
Adjustment to change from daytime to night-float shift
Overall experience of night float
Eventual overall adjustment
Number of days for body to adjust
Need to readjust to night-float shift following weekend off
Mood
Feeling depressed or moody
Difficulty interacting with nursing staff
Difficulty interacting with peers
Alertness
Perception of mental "quickness"
Perception of proficiency with procedures
Voluntary written comments

responses were tested with the χ^2 procedure, McNemar's test for paired samples, or test of symmetry. Multi-factorial interactions were tested using logistic regression technique.

RESULTS

Participants: Fifty-two of the 60 eligible residents (87%) responded. Seventeen were male and 35 female. Some 41 residents were between 25 and 30 yr of age, eight were 30–35 yr of age, and three were 35–40 yr of age. Fifteen residents had completed one night float, and 37 had completed two night-float rotations. At the time of the study, 21 residents were in the second year of training (PL-2), 28 were in the third year of training (PL-3), and three were chief residents (PL-4).

Complete data are available for 51 of the 52 responders and partial data for one, because this resident did not complete eight questions due to inadvertently skipping one page of the questionnaire. Data analysis took into account the number of responses to each question. Results are given as mean \pm SD.

Sleep duration: During typical daytime rotations in the PL-2 year, when not on night-call, the group mean sleep duration on weeknights was 6.9 ± 0.8 h. Most residents 41/52 (79%) tended to sleep longer on off-work weekends. The group

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mean sleep duration on these weekend nights was 8.6 ± 1.3 h, which was significantly different from the sleep duration on weeknights ($p < 0.0001$; ANOVA). During the night float the group mean sleep duration was 6.8 ± 2.1 h on days following night-shift work, which was not significantly different from the sleep duration of the weeknights during daytime rotations ($p = 0.63$; ANOVA). Of note, compared to their daytime rotations, 20 residents (38%) reported they slept longer during night float while 24 (46%) slept less during night float, and only eight (15%) reported no appreciable change. This comparison had a high concordance of 75% with the average sleep duration that the residents reported for their daytime and night-float shifts.

Difficulty falling asleep: During typical daytime rotations in the PL-2 year when not on call, most residents, 46/51 (90%), reported difficulty falling asleep no more than once a week, and only five residents (10%) reported difficulty falling asleep two or more times a week. In contrast, during the night float 38 residents (75%) reported difficulty falling asleep in the first 1–5 d of the night float, and 13 (25%) reported difficulty falling asleep most days (McNemar's test: night-float vs. daytime rotations: $p = 0.02$).

Sleep onset latency: During typical daytime rotations when not on call in the PL-2 year, 24/52 residents (46%) took less than 10 min to fall asleep, 24 (46%) took 10–30 min, and only four (8%) took longer than 30 min. In contrast, during the night float fewer residents, 16 (31%), took less than 10 min to fall asleep, 24 (46%) took 10–30 min, and 12 (23%) took longer than 30 min (test of symmetry—night float vs. daytime rotations: $p = 0.055$). The questionnaire also inquired if sleep aids were used when working daytime rotations; 51/52 residents responded. None ever took prescription sleep medications, and only five took nonprescription sleep medication twice a week or less. Unfortunately, inquiry about sleep medications use during the night-float rotation was inadvertently excluded from the questionnaire.

Spontaneous sleep interruptions: During typical daytime rotations when not on call in the PL-2 year, 44/51 residents (86%) awoke spontaneously no more than once a night and only seven (14%) awoke more than once a night. In contrast, during the night float 30 (59%) spontaneously awoke only once from daytime sleep while 21 (41%) awoke more than once (McNemar's test: night float vs. daytime rotation: $p = 0.001$).

Feeling rested: During typical daytime rotations in the PL-2 year when not on call, 24/52 residents (46%) felt rested most of the time upon awakening while 28 (54%) felt rested only sometimes or rarely. In contrast, during night-float work only 11 residents (21%) felt rested upon awakening while 41 (79%) felt more tired compared to their daytime rotations ($p = 0.007$; McNemar's test).

Sleep duration and fatigue: Of the 32 residents who slept about the same duration or less when on the night float than daytime rotations, five (16%) felt well rested upon awakening during the night float while 27 (84%) felt more tired. Of the 20 residents who reported longer sleep duration when on the night float than daytime rotations, six (30%) felt well rested upon awakening during night float

while 14 (70%) felt more tired upon awakening compared to daytime rotations ($p = 0.22$; χ^2 test).

Adjustment to night-float rotation: Almost half the residents, 24/52 (46%), felt their bodies never adjusted to the night-float shift. The average number of days it took to adjust to the first night-float rotation was up to 2 d in 14 residents (27%), 3–7 d in 27 (52%), and 8 or more days in 11 (21%). These figures were similar for the second night-float rotation that had been completed by 37 residents. Moreover, 33 residents (63%) felt that they had to readjust again to the night-float schedule after the 2d weekend off period at mid-rotation.

Feeling depressed: Overall, during the daytime rotations in the PL-2 year, 44/51 residents (85%) never or rarely felt depressed while only seven (14%) felt depressed about half the time, and none felt depressed most of the time. In contrast, during the night-float shift 29 (57%) residents never or rarely felt depressed or moody while 22 (43%) felt depressed or moody (McNemar's test—night-float vs. daytime rotations: $p = 0.0001$). Moreover, 19 of the 44 residents (43%) who were never or only rarely depressed overall during the PL-2 year reported feeling depressed during night float.

Depressed mood and fatigue: Of the 41 residents who were more tired during night-float than daytime rotations, 22 (54%) reported feeling depressed or moody during the night float while 19 (46%) reported not feeling depressed or moody. In contrast, of the 11 residents who were well rested during night float, only one (9%) reported being depressed or moody during night float while 10 (91%) were not depressed or moody (McNemar's test: $p = 0.033$).

Depressed mood and demographics: When on the night-float rotation, 19/41 (46%) of those feeling depressed or moody were younger than 30 yr of age, and 4/11 (36%) 30 yr of age or older (χ^2 test: $p = 0.55$). There was no significant relationship between depressed mood during the night float with gender (χ^2 test: $p = 0.37$) or with overall adjustment to the night-float rotation (χ^2 test: $p = 0.38$). Logistic regression procedure for depressed mood during the night float also showed there was no significant relationship with adjustment to night float ($p = 0.15$), age ($p = 0.27$), depressed mood during overall during the PL-2 year ($p = 0.37$), gender ($p = 0.82$), or sleep duration during the night-float vs. daytime rotations ($p = 0.62$).

Alertness: Compared to daytime rotations in the PL-2 year, during night-float work 21/52 residents (41%) felt their thinking was slower. Only 9 (17%) felt that their thinking was slower during the night float than on night-call during daytime rotations.

Performance: Compared to daytime rotations in the PL-2 year, 9/51 (18%) of the residents experienced slower speed of performance of procedures during the night-float shift. Three residents (6%) experienced slower speed in performance of procedures during the night float than when on night-call during daytime rotations.

Personal interactions: Compared to typical daytime rotations in the PL-2 year, most residents reported their interactions during the night float were not more difficult with peers (96%) or with nursing staff (88%).

Overall rating: Two of the 52 residents (4%) rated the overall experience of the first night-float rotation as terrible, 11 (21%) as bad, 17 (33%) as indifferent, 16

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(31%) as good, and six (12%) as great. The distribution of the ratings was similar for the second night-float rotation completed by 37 of the same residents.

Voluntary remarks: Twenty-four residents offered 25 written comments. Ten comments described sleep problems and fatigue during the night-float shift. Some comments consisted of statements about feeling tired all the time during the night float, and others described never adjusting to the night float, including one resident who took 2 wk to readjust to the daytime work schedule. Some described strategies to combat these problems, e.g., keeping the room dark for daytime sleep, taking a nap before the night shift, and going to sleep immediately after the end of the night shift. Six comments were positive about the night shift; one resident described himself as a “night owl.”

DISCUSSION

The present study provides insight into a previously unexplored aspect of residency training. Even though there is general awareness of the negative impact of night-shift work, potential problems were not taken into account when the night-float rotation was created. Possibly, training programs assumed that the transient nature of the rotation would obviate the negative effects of night-shift work. The present results, however, show the night-float rotation is indeed accompanied by sleep problems, mood change, decreased alertness, and overall poor adjustment to the inverted wake-sleep schedule. These problems are common in night-shift workers in many services and industries.^[8,10–13] The potential repercussions of these problems are severe. For example, night work has been associated with increased rate of accidental exposure to blood-borne pathogens among residents,^[14] and sleep deprivation has been associated with increased risk for motor vehicle accidents among residents^[15,16] and nurses.^[17]

The present study was based on subject recall. As noted in the presentation of the results, there was good internal consistency for the questions related to sleep duration. Although memory about past events may change over time, there was no trend related to year of training in the responses given. The study warrants follow-up prospective studies utilizing objective measures. Strong points of this study include the high completion rate (87%), the comprehensive and extensive set of questions related to the topics under investigation, and the source of respondents—a large and well-established pediatric residency training program with a longstanding, stable night-float rotation. Even though the participants of this study were pediatric residents, the problems are not specific to pediatrics, and thus the conclusions of this study may be applicable to other training programs that utilize a night-float system.

The sleep problems associated with the night-float rotation encompassed difficulty falling asleep after the night shift, prolonged sleep onset latency, and increased number of spontaneous sleep interruptions. It is unknown whether residents resorted to sleep medications when assigned to the night float; however, their use was rare when on daytime rotations. Interestingly, during the night-float rotation many

residents did not feel rested upon awakening regardless of whether they slept less or more than during daytime shifts. This finding is consistent with the complexity of physiological changes that occur with inverted sleep–wake schedules. It is possible that residents also were sleep-deprived during their daytime rotations since they reported only 6.9 h of sleep per night on average. The nature of the present study precludes further inquiry into this issue, and prospective studies are needed to determine whether sleep-deprivation constitutes a problem during residency training overall, despite the creation of the night-float rotation.

Another striking finding is that during the night-float rotation almost half the residents felt moody or depressed while few residents reported depressed mood during their daytime rotations. Depressed mood and increased fatigue may be linked, at least in part, to sleep deprivation. In fact, a study of first-year residents in internal medicine showed a significant relation of sleep-deprivation with higher mood scores (depression) on a self-report inventory of mood state.^[18] Sleep deprivation, however, may not be the main cause of fatigue or mood change during the night float. The effect of night-shift work on mood and fatigue is multifactorial, insomnia being just one of the contributing factors.

The overall impact of an inverted sleep–wake schedule has far reaching effects on biological functions other than sleep and mood. They include disruptions in hormonal secretions, cardiovascular and digestive system dysfunction, etc.^[6,11,12,19] The global manifestations of maladjustment are well captured in the residents' response to the present survey in which almost half the group felt their bodies never adjusted to the work-shift change. Abrupt change from day to night-shift work causes desynchronization of the activity/sleep schedule from the internal circadian system. Generally, it takes about 1 wk for complete adjustment of the circadian time structure to the inverted schedule, although many workers never adjust completely.^[19,20] The designation of weekend off time in the middle of the night-float rotation may have contributed to or even aggravated the adjustment problems because residents usually reverted to night sleep then. Hence, the residents had to undergo an adjustment phase to night shift not only at the beginning of the rotation, but also after the weekend off in the middle of the rotation.

The night-float rotation did not alter the residents perceived performance despite their self-rating of decreased alertness compared to daytime shifts in almost half the residents. This finding is at variance with the reported effects of night-shift work on alertness and performance in services and industries. In fact, the most vulnerable period of the 24h day is between 01:00 and 08:00h, during which catastrophes related to fatigue and decreased performance are more likely to occur.^[7,14] Perhaps, the residents overestimated their performance in this survey. Alternatively, one might propose that because of their responsibilities, physicians in training have higher motivation to maintain a high performance level in contrast to night-shift workers that perform other types of activities. This explanation is supported by studies of physicians in training. For example, a study of surgery residents who were sleep-deprived by frequent night-calls during dayshifts showed that sleep-deprivation did not affect cognitive or motor performance

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evaluated by psychometric tests.^[21] Another study reported only relatively mild cognitive impairment of internal medicine residents who were sleep-deprived because of night-call during daytime rotations in comparison to nonsleep-deprived residents.^[18] One must note, however, that cognitive and motor tests may not reflect actual work performance capability of on-call physicians. Moreover, studies of sleep-deprived residents on daytime rotations cannot be extrapolated to the night-float rotation, because as stated earlier the overall effect of sleep-wake schedule reversal is broader than sleep-deprivation alone.

In summary, the present report suggests the night-float rotation may have important negative impact on residents. In all likelihood, night-shift work, a necessity in many spheres of modern society, particularly health care, will remain an integral component of many residency-training programs. Currently, much research is in progress aiming at strategies to enhance adaptation to sudden shift change.^[22-24] In the future, such strategies may become applicable to night-float rotations. Meanwhile, training programs should acknowledge this problem and consider a design of night-float schedules that minimizes the negative impact of shift work on residents.^[20] In addition, they should instruct residents on strategies to cope with the required shift work.^[25,26]

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