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RESEARCH ARTICLE

A comparative study on the effects of night shift on psychomotor vigilance and mathematical abilities of the nurses of different chronotypes

Parth R Nayak, Anupkumar M Vegad

Department of Physiology, GMERS Medical College, Junagadh, Gujarat, India

Correspondence to: Anupkumar M Vegad, E-mail: dranupvegad@yahoo.com

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ABSTRACT

Background: Individuals have different preference of doing certain work at certain hours. This preference is called chronotype and it can have influenced on shift workers. The work of nursing profession in demanding and the long shift work, especially the night shift work, can impact one's vigilance and mathematical abilities which can result in increased risk of patient's safety. **Aims and Objectives:** The present study was undertaken to observe the effects of night shift on psychomotor vigilance and mathematical abilities of the nurses of different chronotypes. **Materials and Methods:** A total of 50 nurses working at various hospitals of Junagadh city were studied for their chronotype. Their psychomotor vigilance and mathematical abilities near the end of their night shift and morning shift were studied. **Results:** Psychomotor vigilance and mathematical abilities of morning chronotype were highly affected by the night shift while they were at their best after the morning shift. Evening chronotype was affected by both the morning and night shift; however, their performance did not decrease drastically like morning chronotypes. **Conclusion:** Ten hours night shift and lack of conducive environment at home for the naps might have resulted in inability to cope up with the interference in circadian cycle by the night shift. Reduction in the shift length might improve the performance of morning chronotypes after the night shift and evening chronotypes after the morning shift.

KEY WORDS: Night Shift; Psychomotor Vigilance; Nurses; Chronotypes

INTRODUCTION

The night shift can greatly affect the sleeping pattern, especially when there is a mix of day and night shift.[1] Disruption in sleeping cycle can cause sleepiness, lack of alertness, slow response to visual stimuli, and decrease in mathematical abilities.[2-5] Chronotype means preference of people to do certain task during certain hours. Chronotype depends on genetics and age.[6] Persons with morning chronotype do well in the early morning but struggle with sleepiness during late night. Persons with evening chronotype are able to work up to late night, but they find it difficult to wake up early.[7] Hence, it is expected that the nurses with the morning chronotype might struggle during the night shift, especially when they have not developed coping mechanism. Nursing is a demanding profession which requires a constant monitoring of the patient, alertness, and numerical abilities to calculate the doses. Irregular work schedules can result in lapses of vigilance which can endanger patients' safety.[8] Long shifts of the health-care professionals and its effects on the performance have been debited from long time.[9] In this study, we have compared the effect of night shift in psychomotor vigilance and mathematical ability of nurses of different chronotypes at various hospitals of Junagadh where 10 h night shifts are regular.

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MATERIALS AND METHODS

Between June 2019 and July 2019, nurses having mix of day and night shift at various hospitals of Junagadh city from Gujarat were studied. Written informed consent was obtained from all the participants. Confidentiality of the data was ensured. They were given a questionnaire to assess their chronotype and sleeping behavior. "Munich chronotype questionnaire for shift workers ($MCTQ^{shift}$)" was used to decide the chronotype. During the past 2 h of their shifts, they were given 5 min psychomotor vigilance task (PVT) and 5 min two-digit addition test (TDAT). The night shift starts at around 10:00 pm and ends at around 8:00 am, the morning shift starts at around 8:00 am and finishes at around 2:00 pm. Desktop version of "Psychology Experiment Building Language" version 0.14 was used for the 5 min PVT test and TDAT.[10] The data collected were processed using GraphPad Prism online version.[11]

Instruments

The $MCTQ^{shift}$

The chronotype of nurses was decided using $MCTQ^{shift}$ which has shown the relation with morningness-eveningness questionnaire,[12] daily sleep diaries, and actimetry.[13] Questions in $MCTQ^{shift}$ are related to average sleep duration before the morning shift, before the night shift, after the night shift, and on free days. Participants gave rating to the average sleep quality on a scale of 1–10.

The mid-sleep time was calculated using the sleep onset time and total sleep duration of the sleep. Mid-sleep time on free days was corrected for sleep debt during the weekdays as referred by Vetter *et al,*[14] when the total sleep time exceeded the total sleep time on working days. Mid-sleep time on free days at 3.30 separated morning chronotypes and evening chronotypes.[7] The difference between mid-sleep time on working day and that on the free day is referred as social jet lag by Wittmann *et al*.[15] Evening chronotypes experienced sleep debt due to the morning shifts.

PVT

PVT measures reaction time and the number of lapses is to a visual stimuli.[16] PVT has been validated to check the neurocognitive performance in number of studies.[17-20] In this test, the participants are supposed to press the keyboard button as soon as the red dot appears on the screen having black background. The red dot appears on the screen randomly during every 2–10 s. The timer gets reset and the red dot gets cleared after the reaction or 5 s absence of reaction. The reaction time is recorded. The reaction time of more than 500 ms is considered a lapse in reaction. In our study, we used PVT of 5 min.

TDAT

To check the numerical ability of the participants, we used TDAT. In this test, the participants were given the task of adding two random numbers of two digits. Participants were asked to solve as many problems as they can correctly in 5 min. Reaction time to solve the problem and the number of lapses were recorded. Wrong answers and reaction time of more than 10 s were considered lapses.

Statistics

Reaction time of PVT and TDAT was analyzed using two-tailed *t*-test to compare the means between the groups such as different chronotypes and different shifts. Lapses in PVT and TDAT of two or more were compared using the Fisher's exact test.

RESULTS

Prevalence of Chronotype

A total of 50 nurses were studied, of which 31 were found of the evening chronotype and 19 were of the morning chronotype. By Fisher's exact test, this difference between morning and evening chronotypes was statistically significant [Table 1].

Sleep Duration

Compared to free days, both morning and evening chronotypes got lesser amount of sleep before the morning shift and after the night shift. Both chronotypes took naps after the night shift. Morning chronotypes, compared to evening chronotypes, finished higher percentage of their sleep before the morning shift. Evening chronotypes tended to take short nap after the morning shift. Morning chronotypes without the children at home tended to take short nap before the night shift, but the individuals of morning chronotype who were married and having children were unable to take the naps.

Performance in PVT and TDAT

Comparison of the PVT and TDAT of morning chronotype and evening chronotype after the morning and night shift was done using unpaired *t*-test while the lapses of PVT and TDAT were compared by Fisher's exact test [Table 2]. After the night shift, average reaction time for both PVT and TDAT was significantly higher in morning chronotypes than the evening chronotypes. After the night shift, the number of lapses in PVT and TDAT was significantly higher in morning chronotypes. After the morning shift,

Table 1: Nurse profile

Items	Evening chronotype	Morning chronotype	*P* value
Prevalence	31	19	0.0201
Age	29.74	28.58	0.3955
Sex (male)	12	8	1.0000

Table 2: PVT and TDAT results

Variables	After night shift	After morning shift	*P* value
PVT RT			
Evening chronotype (*n*=31)	407.65	391.00	0.2281
Morning chronotype (*n*=19)	429.11	388.21	0.002
PVT lapses ≥2			
Evening chronotype (*n*=31)	19	15	0.4443
Morning chronotype (*n*=19)	15	8	0.0448
TDAT RT			
Evening chronotype (*n*=31)	6180.35	5534.71	0.1461
Morning chronotype (*n*=19)	6843.84	5083.58	0.0002
TDAT lapses ≥2			
Evening chronotype (*n*=31)	17	12	0.3087
Morning chronotype (*n*=19)	12	4	0.0201

PVT: Psychomotor vigilance task, TDAT: Two-digit addition test, RT: Reaction time,

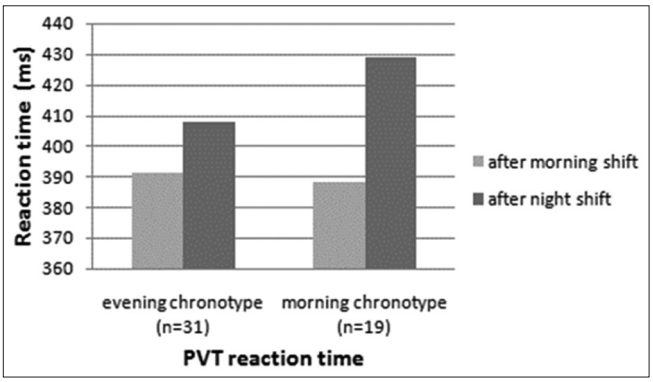

Figure 1: Psychomotor vigilance task reaction time

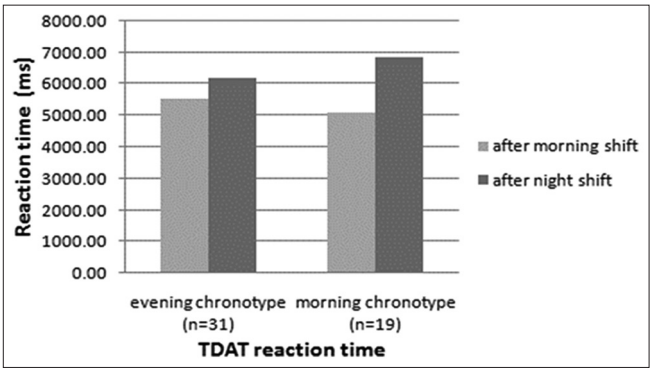

Figure 2: Two-digit addition test reaction time

the performance of evening chronotypes was poor than the morning types; however, the average reaction time and the lapses of both PVT and TDAT were not significantly higher.

DISCUSSION

The prevalence of morning and evening chronotypes was skewed toward the evening chronotype. There could be a variety of reasons for such results such as being married or single, having children at home, or other lifestyle factors. One of the factors strongly responsible for this could be the location of Junagadh where the geographical local time is around 48 min late than the legal Indian Standard Time. Junagadh is also near the Tropic of Cancer and the test was done during June and July. Hence, the increase in the day length could have influenced it as well. Compared to morning chronotype, the performance of evening chronotypes was poor after the morning shift. This could be due to the sleep debt [Figure 1]. They had due to the shift being started at 8:00 am while finishing at 3:00 pm. Hence, they had a tendency of having sleep after the morning shift. The performance of both morning and evening chronotypes got poorer at the end of night shift which suggests that the length of the night shift being 10 h is affecting the performance. However, the difference between the performance of evening chronotypes after the morning shift and after the night shift was not significant. On the other hand, the difference between the performance of morning chronotypes after the morning shift and after the night shift was statistically significant which shows that morning chronotypes are not adapted enough for the night shift. A short nap before the night shift might help them, but they have acknowledged that the lack of conducive environment at home does not allow them to do so. On the other hand, the performance of morning chronotypes at the end of morning shift shows that they are very well adapted for the morning shift [Figure 2]. Performance of evening chronotypes shows that both the morning and night shift affect their performance; however, they are adequately adapted to make sure that their performance is not less than certain mark.

A study by Ayas *et al.*[21] has shown the relation between long night shift work and increased risk of injuries in young physician due to lapses in concentration and fatigue. In the study of the nurses of 12 European countries has shown that the nurses working for 12 h duty done by Griffiths *et al* reported lower quality of care and safety compared to the nurses working for 8 h.[22] Varieties of studies have shown that the sleep deprivation and disturbance in circadian rhythm result in lapses of concentration and increased reaction time.[2,3] Performance of our sample of nurses shows the result in accordance with the above studies. Working at the night shift will inevitably affect the performance as it interrupts circadian cycle. However, the effect can be greatly reduced by shortening the shift duration which allows other coping mechanisms such as sleeping before the night shift.

Strength and Limitation of Study

Strength of the study is that, in our study, we found that reducing shift length improves vigilance and numerical abilities of nurses which is important for patient safety. Hence, we can apply this thing on another health professional also. Limitation of the study is that the sample size of the present study was moderate and, therefore, the results obtained could not be directly applied to the general population. Further studies on a large sample size with inclusion of doctors and other health professionals are indicated.

CONCLUSION

We found that the reaction time of evening chronotype for both PVT and TDAT remained high after the night and morning shift; however, it was never above certain mark and the difference between the morning and night shift performance was not significant. Morning chronotypes, on the other hand, showed very good (low) reaction time after the morning shift; however, their performance was significantly poor after the night shift. By comparing with the other studies, the long shift duration and lack of coping mechanisms such as napping could be the reason for decreased vigilance and mathematical abilities. The goal of future research should be to include the medical officers doing the shift work as well because the nurses are the first line in the detection of patient's well-being, the medical officers are the first line in analyzing the data collected by the nurses or by the instruments. Hence, their vigilance and numerical abilities are extremely important for patient safety, especially in intensive care unit and emergency situations.

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