European Journal of Molecular & Clinical Medicine

ISSN 2515-8260 Volume 09, Issue 01, 2022

TO STUDY THE EFFECT OF NIGHT DUTY ON AUDITORY AND VISUAL REACTION TIME IN MEDICAL PERSONNELS

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Abstract

Background:

Reaction time (RT) is a measure of the response to a stimulus. Reaction time provides an indirect index of the processing ability of Central Nervous System and also a simple means of determining sensory-motor performance. It is the time interval between the onset of stimulus and the initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as rapidly as possible and is a simple and non-invasive test for peripheral and central neural structures with a physiological significance. Factors that can affect the average human RT include age, sex, left or right hand, central versus peripheral vision, practice, fatigue, fasting, breathing cycle, personality types, exercise, and intelligence of the subject.

Aim:

The aim was to compare visual Reaction time (VRTs) and auditory Reaction time (ARTs) on the basis of gender of nursing staff.

Materials and Methods: The present study was conducted in the SMS Medical College & attached hospitals, Jaipur. The study was done after getting approval from institutional human ethical committee. The study was conducted on 80 healthy normal nursing staff [males& females] of 20-35 years old. Reaction Time was recorded with the help of Audio-visual Reaction Time apparatus, supplied by Medi system, Yamuna Nagar. It had display accuracy of 100% and resolution 0.01 second. Statistical analysis was done.

Results: In both the sexes' Reaction time to the auditory stimulus was significantly less ($P < 0.001$) as compared to the visual stimulus. Significant difference was found between Reaction time of male and female nursing staff($P < 0.001$)

Conclusion: The effect of night shift duty stress on auditory reaction time in males and females shows that males have significantly better auditory reaction time than females. Similar results were found for Visual reaction time indicating that males can tolerate night shift duty stress better than females. Females are unable to adjust to shift duties due to the family problems, resulting into shift work intolerance and thus prolongation of audio-visual reaction time. The

ART is faster than the VRT in nursing staff. Furthermore, male have faster RTs as compared to for both auditory as well as visual stimuli.

Keywords: Auditory reaction time, visual reaction time, nursing staff, night shift.

INTRODUCTION

Reaction time is the voluntary response of an individual to react to an external stimulus. Reaction time provides an indirect index of the processing ability of Central Nervous System and also a simple means of determining sensory-motor performance (Geraidine 1981).It is the time interval between the onset of stimulus and the initiation of appropriate voluntary response under the condition that the subject has been instructed to respond as rapidly as possible (Teichner WH et al 1954) and is a simple and non-invasive test for peripheral and central neural structures with a physiological, significance.

Reaction time is found to the altered by a no: of factors both physiological and pharmacological. Factors affecting the reaction time like arousal, age, gender, left v/s right hand practice, fatigue, fasting, distraction, personality type punishment, stress, exercise and intelligence of subjects, excessive workload, shift duties. The fatigue or stress could be due to inadequate sleep which may result from the shift duties.

Reaction time can be divided into three parts. The first part is perception time which is the time for the application and perception of stimulus. Second part is decision time, which signifies time for giving a suitable response to the stimulus and the third part is motor time which is the time for the compliance to the order received. Many researchers have confirmed that mean reaction time to sound is faster (140-160 msec) that reaction to light (180-200 msec) (Galtons 1899). This shows that reaction to auditory stimuli is faster than visual stimuli and it can be explained by mechanism of sound entering the ear which can reach appropriate receptors with particular no loss of time. For visual reaction time the rods and cones are not excited by light directly and the intervening photochemical process takes appreciable time. A number of studies have identified sleep disturbances, IHD, Peptic ulcer, Reproductive hazards and Hypertension to be the main health problems of shift workers.

Reaction time can be taken as a parameter to measure the efficiency of shift workers in day and night duties. One study shows that sleep deprivation increases reaction time (Corsi-Cobrera M et al 1996). Older night workers are more adversely affected than younger night workers (Pires MLN et al 2009).

Individuals differ in terms of how they tolerate shift work, with effects on sleep and other health parameters varying correspondingly. Gender, age and personality traits such as diurnal type (morning /evening, i.e. preference for going to bed and getting up early/late), circadian type (flexibility, i.e. ability to sleep and work at odd times, and languidity, i.e. lacking the ability to overcome drowsiness) and hardiness (resilience against environmental stressors) have been related to how, as well as the degree to which, individuals tolerate shift work [Saksvik IB et al 2011].

Shift work disorder (SWD) is a sleep disorder characterized by sleepiness and insomnia, which can be attributed to the person's work schedule. The diagnostic criteria for SWD, as defined by the American Academy of Sleep Medicine (AASM)'s International Classification of Sleep Disorders-2 (ICSD-2) [AASM 2005], include: (i) complaints of insomnia or excessive

sleepiness temporarily associated with a recurring work schedule in which work hours overlap with the usual time for sleep, (ii) symptoms must be associated with the shift work schedule over the course of at least one month, (iii) sleep log or actigraphic monitoring for ≥7 days demonstrates circadian and sleep-time misalignment; (iv) sleep disturbance is not better explained by another sleep disorder, mental disorder, a medical or neurological disorder, medication use or substance use disorder [AASM 2005].

Shift work is unavoidable because of a need of continuous availability of essential services like medical, police, military, transport, electricity, etc. Night workers are required to stay awake when their circadian rhythms are preparing them for sleep, and to sleep when preparing for wakefulness. People who work at night often complain of symptoms that arise due to immediate change in time zone, one's internal clock which is slow to adjust to change in schedule as a result one feels tiredness, wants to sleep at the wrong time, unable to sleep at the new night time feels irritable, along with appetite and GIT dysfunction which are similar to those of "jet lag syndrome symptoms" and the cause is believed to be the same.

With continued night work, some workers find the inconvenience and malaise unacceptable and so leave night work permanently (Waterhouse JM et al 1985). Twelve hour night shift work has significant cardiovascular effect as elevation of blood pressureand heart rate variability, associated with delayed blood pressure recovery (Su TC et al 2008). Psychological disturbances during night shift work were associated with altered cardiovascular and endocrine responses in healthy nurses (Munakata M et al 2001).

Doctors are key players in health care system with night shift doctors having a special role in the provision of health care. Night shift doctors are responsible for patient care with little support(Campbell A et al 2008, Nilsson K et al 2008, Oleni M et al 2004) in a difficult working environment under conditions of fatigue(Brookes I et al 2002, Fitzpatrick J et al 1999, Hughes R et al 2004, Muecke S et al 2005.

Doctors , irrespective of their shift duties are under constant stress from staff shortages, aging workforce, more complex patient needs, continued technological progress and exponential advances in knowledge (Fitzpatrick J et al 1999, Bowles C et al 2005, Bushy A et al 2005, Craft Morgan J et al 2009, Gabrielle S et al 2008, Gregory DM et al 2007, Hegney D et al 2004, ICN Report 2007-2009, Purdy N et al 2010, Sullivan C et al 2002 &West E et al 2007). As a consequence of these and other factors, doctors experience a reduction in work satisfaction while the organisation suffers from ineffective and inefficient practices (Craft Morgan J et al 2009, Ahmad N et al 2010, Aiken L et al 2002, Curtis E et al 2007, Ferlise Petal 2009, Halm M et al 2005, Hayes B et al 2010, Nemcek M et al 2007, Ning S et al 2009& Ruggiero J et al 2005).

As health care progresses into the twenty first century with rising financial costs and constraints on expenditure; increasing demands and expectations for high quality patient care; worker safety and welfare issues; and ever increasing technology, it is imperative that the linchpin of health care system, doctors, are appreciated and their potential maximised.

Doctors form a substantial proportion of the health care workforce with night shift doctors covering nearly 42% of daily hours within 24 hour service facilities. Given the critical importance of night shift doctors, it is essential to understand factors that give meaning to their work and how both individual doctors and the organisation within which they work can benefit from their contribution to health care provision.

Nurses and doctors as a group of health personnel engaged in shift work, and the nature of their work demands a 24-hour duty. Since no person can work round the clock without sleep,

such jobs that demand a 24-hour duty have to be covered by a system of shift duties by different people leading to a shift in duty arrangement. This shift has been identified by Gordon and Henifin (1980) as stressful and may lead to negative health effects. Shift duty has been known to disturb body physiology, which in man has been developed to run as circadian rhythm. As such, it may be assumed that shift work may result in biological disorder in man (Gordon and Henifin 1980).

Many studies have been conducted on Audio-visual reaction time in healthy subjects of different age groups, athletes and sport persons , smokers, drivers, but study of effect of Audio-visual reaction time on medical personnels on night duties in SMS medical college and attached hospital jaipur district has not been undertaken . Hence the present study was conducted to assess the influence of night duty on audio visual reaction time in the medical personnels.

MATERIAL AND METHODS

The present study was conducted in the SMS Medical College & attached hospitals, Jaipur. The study was done after getting approval from institutional human ethical committee. The study was conducted on 80 healthy normal medical personnels [males& females] of 20-35 years old.

METHOD: - The process of screening included: -

- History
- General Physical Examination
- Application of criteria for inclusion and exclusion

Inclusion Criteria:

- Age: 20-35 years, male & females
- Apparently healthy
- Normal vision (by self-report)
- Adequate hearing for completing the study protocol.
- Able to understand and speak Hindi / English / Local.

Volunteers meeting the inclusion criteria will enrol as participants after giving their informed consent.

Exclusion Criteria:

- Acute / chronic disease.
- Physical / Mental illness
- Untreated Hearing / Visual disorder
- Alcoholics
- Any drug (Antihistamines).

Two groups having 40 subjects each are taken in the present study. Three readings of audio-visual reaction time have been noted on:

1st reading- 1st day of morning duty,

2st reading -1st end of night duty, and

3rd reading –end of three consecutive night duties.

REACTION TIME APPARATUS: -

Reaction Time was recorded with the help of Audiovisual Reaction Time apparatus, supplied by Medisystem, Yamunanagar. It had display accuracy of 100% and resolution 0.01 second. The apparatus has two modes of stimulus: -

1. Auditory
2. Visual

In this system there are two sides - one is operator's side & the other is trainer's side. In operator side 2 switches for two lights (Red & Green) & 2 other switches for 2 audio tones (High and Low frequency) to start. Same show is on trainer side to stop. The switches in operator's side are responsible to glow the lights while the switches in trainer's side are to turn off the lights. Glow any light quite a sudden & ask the trainer to react to the action & turn off the light immediately from it's side. The time taken by the trainer is called reaction time which is displayed on the screen. Similarly in the 2^{nd} mode there are 2 different melodies /tones. The operator will start any sound & the trainer is to turn it off immediately in the shortest time. Thus the operator can operate any function from light or sound & trainer is to react very fast to turn the same off.

THE STUDY VARIABLES

The variables studied were:-

- Auditory Reaction Time (ART)
- Visual Reaction Time (VRT)

PROCEDURE

In present study, we used Red light for visual stimulus and low frequency sound for auditory stimulus. Subjects were asked to respond to stimuli by pressing the response key with the index finger of their dominant hand. The display indicated the Reaction Time (RT) in seconds.

After familiarising the subjects with the instrument and after three trials, three readings for each stimulus were noted. The interval between the stimuli was randomly varied from 2 to 5 seconds. The least reading of three was taken as the value for reaction time .

Statistical Analysis:

Analysis will be done by unpaired 't' test to compare difference between males and females regarding Auditory Reaction Time & Visual Reaction Time. Anova test for the comparison between Reaction time for 1^{st} day, after 1st night and after three consecutive night duties. $P < 0.05$ will be taken as significant.

Outcome Variables

- Auditory Reaction Time
- Visual Reaction Time

OBSERVATION AND RESULTS

TABLE: 1.
AUDITORY REACTION TIME AS PER DAYS IN MALES (msec)

Groups	N	Mean	Std Dev
ART (1ST Day duty 8:00 AM)	40	201	11.5
ART after 1st night duty	40	205.3	12.2
ART after 3 consecutive night duties	40	223.8	10.3

P = 0.000 (ANOVA) (< 0.05 is significant, < 0.001Highly significant)

Table No.1 shows that effect of night duty causes increase in the mean of Auditory reaction time. It is highly significant statistically.

TABLE: 2.
VISUAL REACTION TIME AS PER DAYS IN MALES(msec)

Group	N	Mean	Std Dev
VRT(1ST Day duty 8:00 AM)	40	223.5	9.5
VRT after 1st night duty	40	230.8	11.2
VRT after 3 consecutive night duties	40	237.3	19.9

P = 0.000 (ANOVA) (< 0.05 is significant, < 0.001Highly significant)

Table No.2 shows that effect of night duty causes increase in the mean of Visual reaction time. Itis highly significant statistically.

TABLE: 3.
AUDITORY REACTION TIME AS PER DAYS IN FEMALES (msec)

Group	N	Mean	Std Dev
ART (1ST Day duty 8:00 AM)	40	219.5	7.1
ART after 1st night duty	40	223.8	8.4
ART after 3 consecutive night duties	40	230.8	11.2

P = 0.000 (ANOVA) (< 0.05 is significant, < 0.001Highly significant)

Table No.3 shows that effect of night duty cause increase in the mean of Auditory reaction time. It is highly significant statistically.

TABLE: 4.
VISUAL REACTION TIME AS PER DAYS IN FEMALES (msec)

Group	N	Mean	Std Dev
VRT (1ST Day duty 8:00 AM)	40	237.5	17.8
VRT after 1st night duty	40	240.8	6.2
VRT after 3 consecutive night duties	40	245.5	5

P = 0.008 (ANOVA) (< 0.05 is significant, < 0.001Highly significant)

Table No. 4 shows that effect of night duty cause increase in the mean of Visual reaction time. It is highly significant statistically.

DISCUSSION

Reaction time provides an indirect index of the processing ability of Central Nervous System and also a simple means of determining sensory-motor performance

In the present study Table no. 1 shows significant increase in auditory reaction time in males after 1st night duty and after 3 consecutive night duties in comparison to 1st day duty. Similarly Visual reaction time was also significantly prolonged after 1st night duty and after 3 consecutive night duties in comparison to 1st day duty (Table no.2).

Similar results for auditory reaction time and Visual reaction time were found for females. Table no. 3 shows significant increase in auditory reaction time in females after 1st night duty and after 3 consecutive night duties in comparison to 1st day duty. Similarly Visual reaction time was also significantly prolonged after 1st night duty and after 3 consecutive night duties in comparison to 1st day duty (Table no.4).

The effect of night shift duty stress on auditory reaction time in males and females shows that males have significantly better auditory reaction time than females. Similar results were found for Visual reaction time indicating that males can tolerate night shift duty stress better than females. Females are unable to adjust to shift duties due to the family problems, resulting into shift work intolerance and thus prolongation of audio-visual reaction time.

It means that night shift duty stress caused increased auditory reaction time and Visual reaction time. These findings are similar to the findings of Williams C 2008who found that night shift workers showed more stress than daytime workers thus having negative impact on physiological health and social lives.

Waters WF 1997 who revealed significant effects of sleep deprivation on both sensoriomotor performance and physiological measures including reaction time. Their findings indicated that sleep deprivation decreased subject's attentional responsivity to new information and simultaneously reduced the efficiency of their sensoriomotor performance.

Kubo et al 2008 showed similar results could have attributed to prolongation of auditory and visual reaction time and found that anxiety, stress and sleep deprivation in medical personnels working at night-time shifts. They reported that level of anxiety is correlated with sleep disorders.

Higher levels of anxiety are expected in shift-workers due to longer periods of work, physically and socially negative working conditions, alteration of sleep-wake cycle, sleepiness

and fatigue after working in night duty (Takahashi M et al 2011). Several authors described night working system as causing sleep deprivation (Bonnet M et al 1995,).

Kahn-Greene et al 2007 reported that temporary anxiety and depression were seen after sleep deprivation are due to reduced cerebral blood flow in prefrontal cortex.

Working at night in shift-work system may also impair sensoriomotor performance. Sarıcaoğlu et al 2005, compared sensoriomotor performance and anxiety levels of 15 anesthesiology residents working at day shift and 18 working at night shift, they found significant reduction of sensoriomotor performance after the night shift. However, significant difference of anxiety levels was found between the two groups.

Similarly, in another study done to investigate the impact of shift-work of nurses on state-trait anxiety levels. "state anxiety" level was found higher at nurses working at night shifts (Demir A 2005).

Repeated or chronic challenges of the HPA axis by environmental stressors may cause alterations in HPA axis activity leading to small diurnal variations and flattening of the diurnal cortisol curve as a consequence of significant reductions in awakening cortisol accompanied by a rise in evening cortisol (Dallman MF1933). Miller GE et al 2007showed a meta-analysis presented a similar argument that following a stress the HPA axis exhibits initial activation in the form of elevated cortisol release. Cortisol is secreted according to a well-defined circadian rhythm (Pruessner JC et al 1997), and generally morning cortisol level increases rapidly following awakening with the peak level occurring 15 to 30 min after waking. The HPA-axis response to shift work is probably highly variable and may be associated with several confounding factors including job stress, individual characteristics, the type of work, duration of work hours, and intervals between shifts (Copertaro A et al 2011).

Night shift work as a stressor may influence future health risk indirectly through changing health behaviours (e.g. unhealthy eating, less exercise, poor sleep, etc.) and therefore understanding the extent to which these changes in health behaviours influence awakening cortisol secretion and pattern are important in estimating the independent effect of shift work.

on the basis of varying level of sex steroids during different phases of menstrual cycle which have sodium and water retaining effect. This retention of salt and water could modify the axonal conduction. It is also suggested to alter the availability of the neurotransmitter at the synaptic level. This modulation of neurotransmitter coupled with altered rate of impulse transmission due to fluctuation in the levels of hormones which affect the sensory motor association with the processing speed at the Central Nervous System in the auditory and visual pathways

Research indicates that shift work may lead to disruption of circadian rhythms (Machi MS et al 2012) and adverse health outcomes including metabolic disorders and cardiovascular disease (CVD)(Wang XS et al 2011). In fact, long-term shift work, particularly night or rotating shift work, has been linked to chronic stress with possible adverse consequences on the neuroendocrine-immune systems(Shields M et al 2002). Consequently, nursing staff are shown to have higher rates of CVD and CVD risk factors compared to the general population (Franke WD et al 1998). Following acute stressors, the activation of the hypothalamic-pituitary adrenal (HPA) axis and the subsequent increase in cortisol secretion is a known physiologic stress response (Kudielka BM et al 2009). both, high and low waking cortisol levels have been reported among shift workers..In an experimental study of healthy young men (Griefahn B et al 2008), cortisol concentrations upon awakening were significantly higher in morning than in evening-

oriented subjects. A study (Kudielka BM et al 2007) reported that implementation of night work in former day workers initially lead to blunted cortisol profiles that normalized after a short period of adjustment.

Many researchers have confirmed that mean reaction time to sound is faster (140-160 msec.) than reaction to light (180-200 msec) (Welford et al. 1980). This is because auditory stimulus only takes 8-10 msec. (Kemp et al. 1973) whereas visual stimulus takes 20-40 msec. (Marshall et al., 1943) to reach the brain.

In people who have to work at night due to shift work are more prone to stress disorder , cerebrovascular disease ,coronary artery disease ,hypertension ,diabetes and other health problems than the people working regularly during day time (Dochi M et al 2008).Depression and anxiety disorders are highly prevalent at shift workers accompanied by sleepiness, fatigue and cognitive disorders including memory and concentration impairment.(Akerstedt T et al 2009).

Hence the results of present study reveal that there is indication of certain amount of sensorimotor slowing and delaying CNS processing in medical personnels doing night duties as suggested by the increase in the auditory and visual reaction time. This could be attributed to impairement in cognitive functions like attention and executive functions, sleep deprivation resulting into fatigue, stress with difficulty in multitasking, in constitent performance .

Our study has a few limitations. First of all, implementation at a single hospital, relatively small sample size suggest the need of careful interpretation of the generalization findings.

So, there is strong need for new studies like ours done to describe problems due to shift-work correctly and to take precautions such as selecting people suitable for night working hours .

Conclusion

In conclusion, working at night shifts may disrupt circadian rhythm which is regulated by inner and outer stimuli. For this reason, several physical and sensoriomotor performance problems such as fatigue, stress, sleep deprivation symptoms occur thus reducing the quality of life .

Hence, finally it is concluded from this study that there was significant differences in ART and VRT in the medical personnels after night duties and also shows that females are affected more than the males after the night duties

There is strong need for new studies like ours done to describe problems due to shift-work correctly and to take precautions such as selecting people suitable for night working hours .

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