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STUDY OF AUDITORY & VISUAL REACTION TIME BETWEEN DIFFERENT PROFESSIONALS (RESIDENT DOCTORS, STAFF NURSES & SECURITY GUARDS) DURING SHIFT WORKING IN K. E. M. HOSPITAL

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ABSTRACT: BACKGROUND: Shift work is an integral part of life for most of the working population. Reaction time determines the alertness, so it may vary during shift work among different professionals. **AIMS:** To compare the auditory reaction time (ART) and visual reaction time (VRT) in security guards, staff nurses and resident doctors during shift work and also between these professionals. **SETTINGS AND DESIGN:** Comparative prospective experimental study in a tertiary care teaching hospital. **MATERIALS AND METHODS:** ART and VRT were studied in 104 security Guards, 142 staff nurses and 40 resident doctors during day and night shift in the age group of 20 to 60 years with research reaction timer. Subjects were presented with two auditory and two visual stimuli. **STATISTICAL ANALYSIS USED:** Standard error of difference between two means, 'z' test. **RESULTS:** ART (214.49 ± 52.50) and VRT (223.16 ± 33.29) in Security guards were less than ART (233.93 ± 45.05) and VRT (239.02 ± 29.92) in nurses during day shift and was significant. ART (219.31 ± 53.73) and VRT (229.01 ± 34.69) in security guards were less than ART (237.64 ± 44.32) and VRT (240.92 ± 31.96) in nurses during night shift and was significant. ART (218.44 ± 29.34) and VRT (227.18 ± 20.41) during day shift and ART (221.67 ± 29.08) and VRT (229.39 ± 21.96) during night shift in resident doctors, were significant on comparison with staff nurses during day and night shift, but not significant between security guards and resident doctors. In all three professionals, ART and VRT were not significant between day and night shift. **CONCLUSION:** The present study shows that ART and VRT in nurses were greater than security guards and resident doctors during day and night shift, and the difference was found statistically significant. It means that different professions have impact on determining reaction time. Reaction time is more during night shift as compared to day shift but the difference were not significant.

KEYWORDS: Shift work, auditory reaction time, visual reaction time, security guards, staff nurses, resident doctors.

INTRODUCTION: Reaction time, the time interval between the onset of stimulus and the initiation of response under the condition that the subject has been instructed to respond as rapidly as possible^[1] is a measure of function of sensorimotor association^[2] and performance of an individual.^[3] It has physiological significance and is a simple and non-invasive test for peripheral as well as central neural structures.^[4] Reaction time is crucial for our everyday lives and requires intact sensory skills, cognitive processing and motor performance. It determines the alertness of a person because how quickly a person responds to a stimulus depends on his reaction time and therefore it must be lesser in certain occupation e.g. drivers, sportsmen, police, military, nursing staff, doctors, security guards in their profession always. Pathak et al^[5] observed in their study that the menial group were the most

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sluggish and gave persistently longer time than the more intelligent groups, viz. teaching staff. Statistically significant decrease in visual and auditory reaction time were found after 4 weeks of pranayamic breathing exercises^[6] and 12 weeks of yoga training.^[7] In one study,^[8] decrease in visual reaction time and auditory reaction time was found after one cigarette due to stimulant action of nicotine on the nervous system. Reaction time is of concern to industrial and sports psychologists and ergonomists.^[9]

Whereas most of the community sleeps by night and works by day, an appreciable fraction of the working population either occasionally or permanently works for hours in the night or sleeps in the day time. The exact proportion of work force involved in shift work varies from country to country between different types of work and work forces of different sizes.^[10] Shift work is an integral part of life for most of the working population and continues to affect a growing proportion of workers. Ramifications of this scheduling system are important to emergency physicians (EPs), not only because of their own routine exposure to shift work, but also because many of their patients may be shift workers.

Strong association between shift work and peptic ulcer disease, coronary heart disease and diabetes and pregnancy outcome in terms of miscarriage, low birth weight and preterm birth.^[11] 12 – h night shift work has significant cardiovascular effect as elevation of blood pressure and heart rate and heart rate variability, associated with delayed blood pressure recovery.^[12] Psychologic disturbances during night shift work were associated with altered cardiovascular and endocrine responses in healthy nurses.^[13] One study^[14] showed that there was increased risk of endometrial cancer among obese female nurses working during night shift. Older night workers are more adversely affected than younger night workers.^[15] Nurses' smoking has close and complicated relations with sleep problems or night shifts.^[16]

It is well known that total sleep deprivation increases reaction time.^[17] But only few studies have been done to establish the relationship between shift work and reaction time. The present study seeks to determine performance of different professionals (security guards, staff nurses and resident doctors) in a hospital during shift duty and also among these different professionals.

ART and VRT is affected by many factors;^[1]

- i) Stimulus-receptor factor (sense modality stimulated, number of sense organs stimulated, number of receptors stimulated, location of the stimulation in the visual field, intensity of stimulus, duration of stimulus, onset and cessation of stimulus).
- ii) Central and motor factors (age – general shortening of both ART and VRT until age 30 after which latencies began to grow longer, sex – controversial report –more in female,^[5] less in female.^[2])

Many more factors affect ART and VRT, there are no baseline parameters available, and each study is having different result. For our study group no previous study was available.

MATERIAL AND METHODS: The study was carried out in the premises of a tertiary care teaching Hospital. Prior consent was sought from the Dean of the institute, the Heads of concerned departments and Ethical committee. This study was conducted from March 2005 to September 2005. This study was comparative prospective experimental study. Inclusion criteria for the study, those who were doing hospital duties in shift, not retired, aged between 20 to 60 yrs, without any hearing difficulty as tested by tuning fork, without any visual difficulty as tested by snellen's chart and

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jaegger's chart, without any muscular disorder. Exclusion criteria for the study, those left handed, having h/o diabetes or any other major illness, h/o consumption of alcohol or tobacco in any form.

All security guards, staff nurses and resident doctors working in the hospital in shift duties were informed by written letter to their in charge about our study and one introductory speech was given to all three categories in their group. Then we went to their place of working and searched for quiet room. Every second person coming voluntarily was selected for study and they were screened for any other major illness and regarding consumption of alcohol and tobacco in any form. The subjects were briefed about the study protocol and informed consent in their language was obtained from them. Detailed history about past illnesses, present illnesses and personal history were taken and examination of higher functions, specially about acuity of hearing were tested by tuning fork and visual acuity by snellen's chart and jaegger's chart. Those who fulfilled the above criteria were included for study, so selection bias was minimized. Those who were not fulfilling the above criteria were excluded from the study. All the subject were taken as control as day shift and cases as night shift. In the earlier studies, sample size were less (79,^[2] 105,^[3] 13,^[4] 50,^[5] 9,^[17]), as the minimum sample size should be 30, we have taken more than 30 in each profession (maximum sample size was taken to minimize error and maximize precision). So finally 286 hospital employees (104 security guards, 142 staff nurses and 40 resident doctors) physically normal, without any hearing, visual or muscular disorder in the age group of 20 to 60 years, who were working in shifts, were selected randomly for study.

Portable research reaction timer with two response choices has been used in this study. It was manufactured in March 2004. Specifications of this instrument: Inbuilt chronoscope – 4 digit chronoscope with least count of 1/1000 seconds and worked on – 230 volts AC.

Visual Reaction Time (VRT) and Auditory Reaction Time (ART) could be measured by this instrument.

All the subjects were given time to practice with the apparatus and the readings were taken in a quiet room. Three practice trials were given every time before taking the reading. The four stimuli i.e. red & green light and high & low pitch sound was then presented at random. Shift work in the Hospital is divided in 3 shifts of 8 hour system i.e. morning (7am to 3pm), afternoon (3pm to 11pm) and night (11pm to 7am), shift changes every month. We have taken 2 readings each of the same employee during the morning shift which is from 7a.m to 3p.m and 2 readings during the night shift of the same employee which is from 11p.m to 7a.m, the time when the readings were taken were just after beginning of the duty and just before the end of the duty which was convenient to the hospital employees. Readings of ART to high pitch and low pitch sound stimuli were averaged for calculating ART, in the same way VRT to red and green light stimuli were averaged for calculating VRT.

STATISTICAL ANALYSIS: To test whether there was any significant difference during day and night duty in security guards, staff nurses & resident doctors with reference to Auditory reaction time (ART) and Visual reaction time (VRT), standard error of difference between two means were applied. The statistical difference was determined by 'Z' test.

A comparison was made between:

- i) ART and VRT in security guards, nurses and resident doctors during day and night shift.
- ii) ART and VRT during day and night shift among security guards, staff nurses and resident doctors.
- iii) ART and VRT during day and night shift between Medical professionals and security guards.

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RESULTS: Table 1 shows the result of ART and VRT in 286 hospital employees (104 security guards, 142 staff nurses and 40 resident doctors) during day and night shift:

- i) There was no statistically significant difference between ART during day and night shift in security guards; although ART were more during night in security guards. In the same way, there was no statistically significant difference between VRT during day and night shift in security guards; although VRT were more during night in security guards.
- ii) There was no statistically significant difference between ART during day and night shift in staff nurses; although ART were more during night in nurses. In the same way, there was no statistically significant difference between VRT during day and night shift in nurses; although VRT were more during night in nurses.
- iii) There was no statistically significant difference between ART during day and night shift in resident doctors; although ART were more during night in resident doctors. In the same way, there was no statistically significant difference between VRT during day and night shift in resident doctors; although VRT were more during night in resident doctors.
- iv) There was no statistically significant difference between ART during day and night shift in all combined (security guards, staff nurses and resident doctors); although ART were more during night in all combined. In the same way, there was no statistically significant difference between VRT during day and night shift in all combined; although VRT were more during night in all combined.

Table 2 shows the result of ART and VRT during day and night shift among 104 security guards, 142 staff nurses and 40 resident doctors:

- i) There was statistically significant difference of ART and VRT during day shift between security guards and staff nurses. In the same way, there was statistically significant difference of ART and VRT during night shift between security guards and staff nurses. Security guards had lesser reaction time than staff nurses.
- ii) There was statistically significant difference of ART and VRT during day shift between staff nurses and resident doctors. In the same way, there was statistically significant difference of ART and VRT during night shift between staff nurses and resident doctors. Resident doctors had lesser reaction time than nurses.
- iii) There was no statistically significant difference of ART and VRT during day shift between security guards and resident doctors. In the same way, there was no statistically significant difference of ART and VRT during night shift between security guards & resident doctors. Although ART and VRT were lower in security guards than resident doctors.

Table 3 shows the result of ART and VRT during day and night shift between Medical professionals and security guards, there was statistically significant difference of ART and VRT during day shift between Medical professionals (staff nurses and resident doctors combined) and security guards. In the same way, there was statistically significant difference of ART and VRT during night shift between Medical professionals (staff nurses and resident doctors combined) and security guards. Security guards were having lower ART and VRT than Medical professionals.

DISCUSSION: In the present study, there was no significant difference in ART during day & night shift and VRT during day & night shift in security guards, staff nurses, resident doctors and all combined

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(Table 1). It shows that Shift work has no effect on Reaction Time (Auditory and Visual), in other words it has no effect on sensorimotor performance. This finding is consistent with study of Bartle EJ et al^[18] (1988), that acute sleep deprivation of less than 4 hours alters mood state but does not change performance in test situations in which concentration, clear thinking, and problem solving are important.

Binks et al^[19] found that 34-36 hours of total sleep deprivation did not affect performance on any of the cognitive tests. The results of Pilcher et al^[20] confirm that sleep deprivation has a significant effect on human functioning and mood was much more affected than either cognitive or motor performance.

In contrast, McCarthy et al^[21] revealed significant effects of sleep deprivation on both cognitive and physiological measures including reaction time. Their findings indicated that sleep deprivation decreased subject's attention responsively to new information and simultaneously reduced the efficiency of their cognitive processing.

Our findings could be explained on the basis adaptation to reduce sleep is possible. Various factors modulate adaptation to shift work. Perceived adaptation ^[22] distinguished shift workers reporting fewer problems in health and wellbeing from those reporting more problems. Workers who choose shift work for reasons such as schooling, childcare, or pay differential are likely to adapt more easily. However Individuals vary in their ability to adjust to shift work. Many individuals suffer few or transient problems. Some are unable to adjust at all; a phenomenon termed as shift work intolerance. Two studies^[23,24] showed that modified night shift with restful power naps alleviated subjective fatigue, and improved physiological function which are often adversely affected by night workload.

In the present study, there was significant difference in ART and VRT during day shift between security guards and staff nurses as well as between staff nurses and resident doctors; in the same way, there was statistically significant difference in ART and VRT during night shift between security guards and staff nurses as well as between staff nurses & resident doctors (Table 2). There was significant difference in ART and VRT during day shift between Medical professionals (staff nurses and resident doctors combined) and security guards; in the same way, there was statistically significant difference in ART and VRT during night shift between Medical professionals (staff nurses and resident doctors combined) and security guards (Table 3) while, there was no statistically significant difference of ART and VRT during day shift between security guards and resident doctors; in the same way, there was no statistically significant difference of ART and VRT during night shift between security guards and resident doctors (Table 2).

Our study shows that profession is having great impact on reaction time. Security guards jobs require alertness, hence though not well educated but their reaction time is less than staff nurses and resident doctors, because resident doctors also require concentration in their job so their reaction time is lower than nurses. It may be because of staff nurses are preoccupied from their household activities and problems, which may be a reason of longer reaction time. Doctors have to concentrate on one patient at a time while nurses have to manage many patients at a time. Doctors have to do proper tentative diagnosis and immediately decide the first line of treatment which is important and nurses just have to follow the instructions given by doctor regarding first line of treatment.

Pathak et al^[5] observed in their study that the menial group were the most sluggish and gave persistently longer reaction time than the more intelligent groups, viz. teaching staff. Not many

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studies have been done with reference to profession on reaction time. Our results indicate that Auditory and Visual Reaction time in nurses was greater than security guards and resident doctors during day shift and night shift, and the difference was found statistically significant. It means that different professions have impact on determining reaction time. Reaction time is more during night shift as compared to day shift but the difference is not significant. This study has been done taking larger sample size than earlier studies. Study has answered the question correctly that shift work has no effect on reaction time if shift will not change frequently. Limitation of the study was that we have taken two readings in every shift just after beginning of the duty and just before the end of the duty which was convenient to the hospital employees, but not taken midway between the shift work. If further study with taking reading in midway of shift work would be done, that would add more specific information to this field. Another limitation of this study is that age and gender may influence the interpretation, as age and gender has their complex effect on reaction time so we have not segregated these factors.

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TABLE 1 Comparison of ART and VRT (msecs)(Mean $\pm$ SD) in different professionals (Security guards, Staff Nurses and Resident doctors) during day and night duty.

	During day duty	During night duty	S.E. of diff.	Z value	P value
<u>Security Guards(n=104):</u>					
ART	214.49 $\pm$ 52.50	219.31 $\pm$ 53.73	7.37	0.65	> 0.05
VRT	223.16 $\pm$ 33.29	229.01 $\pm$ 34.69	4.71	1.24	> 0.05
<u>Staff Nurses(n=142):</u>					
ART	233.93 $\pm$ 45.05	237.64 $\pm$ 44.32	5.30	0.70	> 0.05
VRT	239.02 $\pm$ 29.92	240.92 $\pm$ 31.96	3.67	0.52	> 0.05
<u>Resident Doctors(n=40):</u>					
ART	218.44 $\pm$ 29.34	221.67 $\pm$ 29.08	6.53	0.49	> 0.05
VRT	227.18 $\pm$ 20.41	229.39 $\pm$ 21.96	4.74	0.47	> 0.05
<u>Total(n=286):</u>					
ART	224.69 $\pm$ 46.95	228.74 $\pm$ 47.01	3.93	1.03	> 0.05
VRT	231.60 $\pm$ 30.93	234.98 $\pm$ 32.27	2.64	1.28	> 0.05

TABLE 2 Comparison of ART and VRT (msecs)(Mean $\pm$ SD) during day and night duty among different professionals (Security guards, Staff Nurses and Resident doctors).

	Security Guards (n=104)	Staff Nurses (n=142)	Resident Doctors (n=40)
<u>During Day Duty:</u>			
ART	214.49 $\pm$ 52.50 (6.93/0.57/>0.05) [†]	233.93 $\pm$ 45.05 (6.39/3.04/<0.05) [*]	218.44 $\pm$ 29.34 (5.98/2.59/<0.05) ^{**}
VRT	223.16 $\pm$ 33.29 (4.59/0.88/>0.05) [†]	239.02 $\pm$ 29.92 (4.12/3.85/<0.05) [*]	227.18 $\pm$ 20.41 (4.09/2.89/<0.05) ^{**}
<u>During Night Duty:</u>			
ART	219.31 $\pm$ 53.73 (6.99/0.34/>0.05) [†]	237.64 $\pm$ 44.32 (6.45/2.84/<0.05) [*]	221.67 $\pm$ 29.08 (5.91/2.70/<0.05) ^{**}
VRT	229.01 $\pm$ 34.69 (4.86/0.08/>0.05) [†]	240.92 $\pm$ 31.96 (4.33/2.75/<0.05) [*]	229.39 $\pm$ 21.96 (4.39/2.63/<0.05) ^{**}
[†] (S.E./Z value/P value between Security guards and Resident doctors). [*] (S.E./Z value/P value between Security guards and Staff Nurses). ^{**} (S.E./Z value/P value between Staff Nurses and Resident doctors).			

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TABLE 3 Comparison of ART and VRT (msecs)(Mean $\pm$ SD) during day and night duty between Medical professionals (Staff Nurses and Resident doctors combined) and Security guards.

	Medical professionals (n = 182)	Security guards (n = 104)	S.E. of diff.	Z value	P value
<u>During Day Duty:</u>					
ART	230.52 $\pm$ 42.52	214.49 $\pm$ 52.50	6.04	2.65	< 0.05
VRT	236.42 $\pm$ 28.48	223.16 $\pm$ 33.29	3.89	3.41	< 0.05
<u>During Night Duty:</u>					
ART	234.13 $\pm$ 41.90	219.31 $\pm$ 53.73	6.12	2.42	< 0.05
VRT	238.39 $\pm$ 30.38	229.01 $\pm$ 34.69	4.08	2.30	< 0.05

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