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Assessment of Affective States during a 12 Hour Work Cycle in Student Nurses

Kamayani Mathur
Gujarat University, Ahmedabad

S. R. Tripathi and S. K. Bhattacharya
. National Institute of Occupational Health, Ahmedabad

The present communication is an attempt to ascertain whether the level of affective states sustains as the day prolongs in affective states that are relevant to nursing care. A group of 70 student nurses, 18-20 years of age, randomly allocated to one of the 7 equal sized groups were tested every 2 hours from 0800-2000 hours following a 7X7 latin square design spread over 3 different days. The subjects thus served as their own controls, in so far as the variation in the levels of the affective states over different times of day were concerned. The personal habits like sleep pattern, diet intake and menstrual cycle were recorded during the study period. Pulse rate was monitored. An affective states questionnaire containing five visual analogue scales for alertness, wakefulness, mental freshness, anxiety and physical freshness was administered on the subjects. Statistical analysis of the Latin Square design indicated increase in pulse rate as the day advanced with it's peak reaching 1800-2000 hours and then gradually falling off. Amongst the affective states measures wakefulness of the subjects were significantly higher at 1000, 1200 and 1600 hours, mental freshness at 1000, 1600 and 1800 hours and the alertness of the subjects was found to increase early morning, noon and early evening hours. Anxiety and physical freshness of the subjects were not statistically significant as they were influenced by order of time of day and time of day. Significant negative correlation co-efficience of pulse rate with alertness, wakefulness and mental freshness during different hours of day were obtained. Further research in this virgin area is suggested.

Investigations carried out hitherto on shift work and human performance have established beyond doubt the existence of performance rhythm during different times of waking day. Folkard and Monk (1979) have advanced the idea that as with physiological rhythm, there is more than one performance rhythm with different phases and rates of adjustment. In developed countries and particularly in developing countries, shift work has seen quantum jump and has become almost invincing to provide round the clock services in the health sector such as medical care in hospitals, amongst other equally important sectors like transportation, security, industry with continuous process operations and also economy with optimal use of invested capital in costly machinery. This has led to the improvement in quality of life of society as a whole though, it is achieved with the possible health risks of the individual worker and his family members.

Colquhoun (1971) provided convincing evidence supporting the view that the basal arousal level (sleepiness) changes over the extended waking day and beyond, following a 24 hour cycle. The variations in human efficiency can therefore, be seen as a product of cyclic changes in the arousal level over the course of day (Hockey & Colquhoun, 1972). Mathur et al. (1995) have shown a significant rise in oral temperature as the day progressed with the peak during 1600-1800 hours, which however gradually decreased thereafter. Arousal level is also shown to parallel changes in the body core temperature and different times of day (Monk, 1982). Bhattacharya and Tripathi (1989), in one of their studies, have observed superior performance in reaction time (choice) and memory (backward) in the evening and on associative recall in the morning. Effect of biorhythms considerably influences on characteristics of operators' activities (Timofeev et al., 2000). It was also seen that longer work duration increased the risk of errors and near errors and decreased nurses' vigilance (Scott et al, 2006). Nurses working rotating day/evening/night shifts reported a longer working day as a more stressful risk factors with gastrointestinal and musculoskeletal symptoms (Sweindottir et al., 2006). Regarding safety and productivity, it has been shown and both may be compromised at night with safety declining over successive night shifts, with increasing hours on duty and between successive rest breaks (Folkard & Tucker, 2003.)

The key to success in nursing care lies in the fact that the nurses must be sensitive enough to respond to even minimal changes in patients' health conditions so that appropriate clinical assessment is done timely, accurately and expediently. This is possible only when affective states of student nurses on duty are optimally aroused over different times of day, which in turn, are thought to be conducive to enhance patients' safety. However, very little is known in this regard. The present investigation was aimed at examining the pattern of change in the levels of some affective states (alertness, wakefulness, mental freshness, physical freshness and anxiety) in the light of biorhythm of pulse rate and also determine if an association exists between the former and the latter.

Method

Sample:

The sample consisted of 70 female students, drawn randomly from the students register of the school of nursing with due approval from senior authorities. They were in the age range of 18-20 years. All of them were unmarried at the time of the study.

Tools:

***Pulse rate*:** The number of pulse beats at the wrist for 30 seconds.

***Affective states questionnaire*:** The affective states questionnaire contains a set of five affective states, viz. alertness, wakefulness, mental freshness, physical freshness and anxiety, each being represented by a visual analogue scale (VAS) which is a 10 cm long scale with two opposing words at either extreme. The meanings of the words, as appropriate as possible, were given in brackets beneath each word. The scales provide a reliable and valid measure of the affective states representing the normal range of subjects' impression in them (Folstein and Luria, 1973). A low numerical value indicates a favorable affective state.

***Sleep chart*:** A sleep chart, designed and developed by Tune (1969) was used to record the sleep pattern of the subjects for a fortnight preceding the day of testings.

***Diet chart*:** A diet chart was used by subjects to record the food eaten during different times of the day over a period of a fortnight preceding the experiment.

***Menstrual cycle chart*:** Menstrual cycle for different days was recorded by subjects using the chart.

Experimental design:- Subjects were randomly allocated to one of the 7 equal sized groups. They were tested every two hours from 0800 hours to 2000 hours, spanned over three different days. The pulse rate of the subjects was taken. The subjects of each group were administered affective states at each time of day once and once only so as to avoid asymmetric carry-over effects from one session to the next. A 7 (seven) groups X 7 (seven times of day) latin square design balanced for residual effects of immediately preceding treatments was followed (Winer, 1971). The subjects served as their own controls insofar as the variation on performance over different times of day were concerned. In successive presentations of the affective measure questionnaire, the opposing words at the right hand and left hand extremes of the visual analogue scales were randomly altered and also the ordering of each dimension of the affective states randomized so as to minimize the 'halo' effect (Woodworth & Schlosberg, 1971) in rating the affective states and also to maximize the subject's motivation in responding to the questionnaire. Further, the subjects rated their current level of affective states by indicating a mark on the scale, thereby recording their response anywhere along the line instead of being forced to respond to a particular point on the scale (Mosner & Kolton, 1977). In addition, systematic monitoring of subjects with regard to certain factors such as their dietary habits, sleep pattern and menstruation cycle was made so as to minimize its influence on the physiological measure of pulse rate and affective states rating (Colquhoun, 1971).

Procedure:

The subjects rested in chairs for 15 minutes before the experiment started so as to reduce fatigue. They were then briefed about the purpose and nature of the study. Any questions they had were answered. They were assured of the privacy of their responses. They were however, allowed to discontinue their participation if they wished. The subjects' pulse rate were counted at the wrist for 30 seconds. It was ensured that they did not take any hot or cold drinks or any eatables before the pulse rate was collected. The Visual Analogue scales were explained to them depicting the level of several affective states and it was then administered to them. Examples were demonstrated by indicating a mark on the scale to represent the level of affective state at that point of day. They were than asked to put a mark on the scales to express their feelings along the continuum at the time of testing. The subjects who had menstruation on that day or were due were not included for that day, but tested on a second occasion when they were no longer menstruating. The dietary habit and sleep pattern of the subjects were collected through the respective charts. The affective measures were scored with a standard scale in centimeters by placing it in the Visual Analogue Scale and reading it up to the mark indicated by the subjects from the favorable end of each of the affective states.

Statistical design: The pulse rate was averaged over the subjects and standard deviation were computed. The numerical values of the affective states were arcsine transformed (Winer, 1971) to avoid clustering of data at either extreme of the scale. Mean values for the arcsine transformed affective states scores were calculated and the standard deviations were computed. Latin Square design with repeated Analysis of Variance (F) technique was then applied to examine the possible differences in pulse rate and affective state between different times of day. Newman-Keuls test (Winer, 1971) was also applied to identify statistically significant differences on these measures between different times of day. Pearson product moment correlation coefficients (Garrett and Woodworth, 1973) were also computed between pulse rate and the affective state measures.

Results and Discussion

The quantity and quality of food intake of the subjects was nearly the same and thus the influence of calorie intake was negligible with regard to their performance rating of the affective states. Further, the performance rating in this study is independent of the effects of menstruation cycle of subjects due to discontinuation of their participation during the said period but resumption of the same during the post-menstruation period. In addition, the average hours of sleep enjoyed by the subjects was about 7-8 hours daily, that average human adult is supposed to take, thereby rejecting it's possible consequence on the affective states.

It is interesting to note that the F-values for 'groups' for pulse rate, alertness, wakefulness and mental freshness did not reach statistical significance, implying that inter-group differences were absent. Further, the main effects of 'order of times of day' as also the interaction effect of the 'times of day' and their 'order of the times of day' were not statistically appreciable, indicating that the asymmetric carry over effects of affective states from one testing session to the other was absent.

However, for 'anxiety', the main effect of 'times of day' was significant F(6,378)=3.27) and the interaction effect of 'times of day' with the order of presentation of 'times of day' were also statistically favorable, F(30,378)=2.12, P d" 0.05. Similarly the main effect of 'times of day' on 'physical freshness' was significant, F(6,378)=6.17, P d" 0.01. Also the interaction effect was highly favorable, F(30,378)=6.17, P d" 0.01. In addition, the F-values for between groups were also significant for 'anxiety', F(6,63)=2.36, P d" 0.05 and 'physical freshness', F(6,63)=4.89, P d" 0.01. This suggests that the groups ceased to be homogeneous insofar as these affective states are concerned. Also the interaction effect contributed to the carry over effects of performance between testing sessions which precluded further analysis of data for these two affective states.

The main effect of pulse rate F(6,378)=5.44, P d" 0.01 was statistically significant for the 'times of day' with other sources of variations being not of any concern. Further analysis suggests that there was a rise in pulse rate as the day extended, although there was a slight fall at 2000 hours (Fig. 1)

More precisely, pulse rate was significantly higher from 1200 hours to 2000 hours compared to 0800 and 1000 hours. The findings thus supports the view that rise in pulse rate is conducive to enhance basal arousal level (non sleepiness) of the subjects (Colquhoun, 1971). However, it may be noted that the pulse rate of the subjects were within the normal range.

'Alertness' of the subjects were noteworthy as indicated by the statistical significance F(6,378)=3.44, P d" 0.01 for the main effect of 'times of day'. It was not influenced either by differences in performance between groups or by the order of presentation of times of day or by the interaction of the two. It is seen that alertness of the subjects was higher at 0800, 1200 and 1800 hours in comparison to 1000, 1400 and 1600 hours (Fig. 2)

Also, in comparison to 2000 hours it was significantly higher at 0800 and 1800 hours. This finding could be explained by the fact that the rise in circadian biorhythms (pulse rate) influenced the alertness aspect of affective state of the subjects (Timofeev at al, 2000). 'Wakefulness' of the subjects was significantly acceptable for the 'times of day' effect only, F(6,378), P d" 0.05, suggesting superiority at certain times with the day progressing. Fig. 3 shows it was higher at 1000 hours, 1200 hours and 1600 hours compared t0 0800 hours, 1400 hours and 2000 hours.

The main effect of time of day on mental freshness was statistically superior F(6,378)=4.28, P d" 0.05 further, it is seen from the mental freshness profile (Fig. 4) that did

Fig.1 - Pulse rate over different times of day

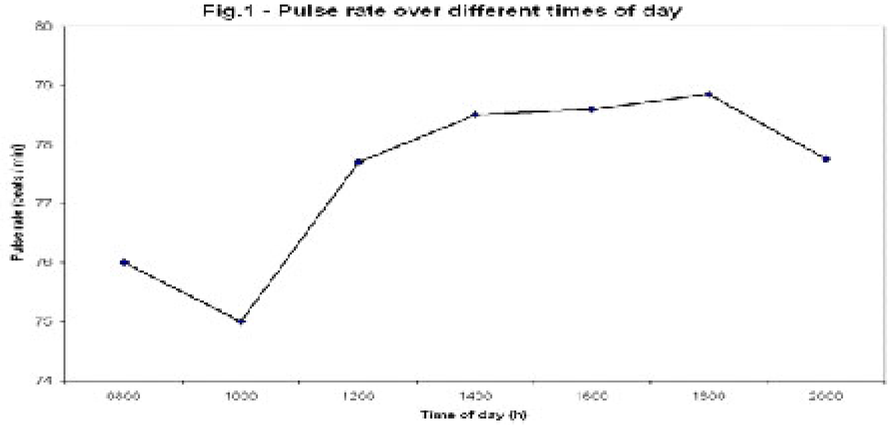

Fig.2 - Alertness over different times of day

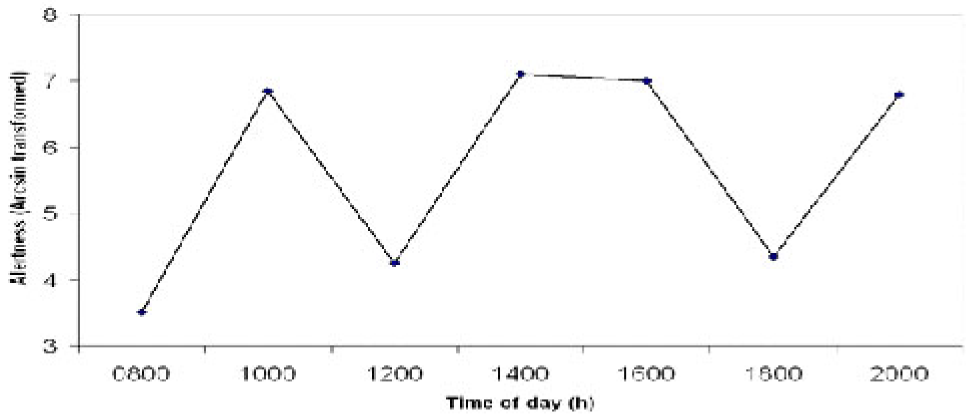

Fig.3 - Wakefulness over different times of day

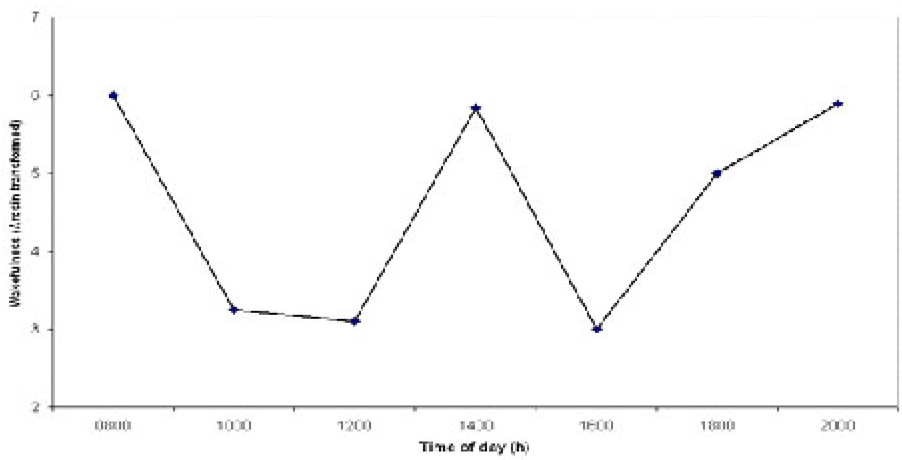

Fig.4 - Mental freshness over different times of day

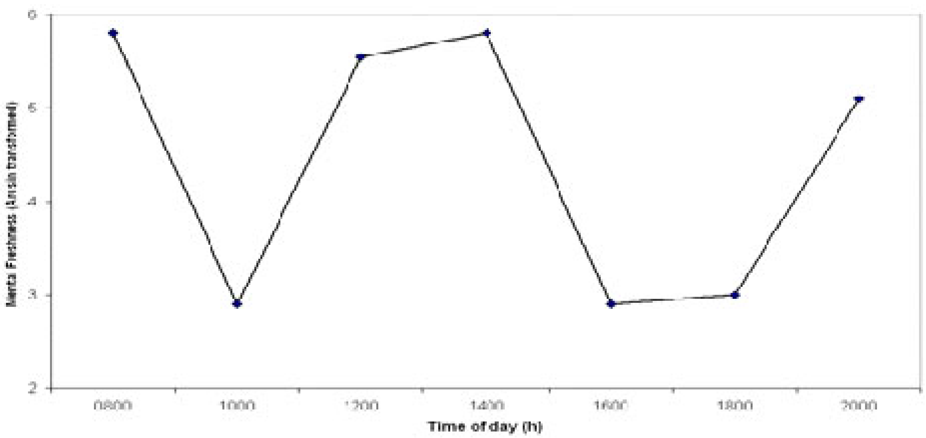

Table 1

Pearson Product Moment Correlation Coefficient (r ± Standard Error) Of Pulse Rate With Other Measures Over Different Hours Of Day (n=70)

Measures	Hours of Day			
	1200	1400	1600	1800
Alertness	-0.22 ± 0.11	-	-	-0.28* ± 0.11
Wakefulness	-0.32** ± 0.10	-	0.19 ± 0.11	-
Mental Freshness	-	-	-0.39** ± 0.10	-0.28* ± 0.11

* $p \leq 0.05$ | ** $p \leq 0.01$ |

not reflect a definite trend, with high and low levels from 0800 hours to 2000 hours. Significant differences existed between different times of day, which reflected mental freshness was appreciably high at 1000, 1600 and 1800 hours in comparison to 0800, 1200 and 1400 hours. Mathur (1991) has shown that the speed components of performance on reasoning ability and letter cancellation was favorably high at certain hours when wakefulness and mental freshness of the subjects were also high. So it indicates that superior performance on these tests would result at times when the subjects are more wakeful with high level of mental freshness.

Thus it has reflected significant favorable changes of biorhythm (pulse rate) and affective states along the time of day continuum. It is seen that pulse rate and affective states were superior at certain hours of time of day. But it is of interest to find out whether any association exists between pulse rate and affective states. To understand this, Pearson Product Moment Correlation Coefficients were examined between the two measures, especially at those hours at which mean values were found to be significant (Table-1). It may be seen that correlation coefficents of pulse rate were statistically significant with alertness at 1800 hours, wakefulness at 1200 hours and mental freshness at 1600 and 1800 hours. However all the correlation coefficients were in the negative direction, suggestive of the view that the levels of affective states increased with the pulse rate showing an upward trend but within the normal range.

In conclusion, it can be emphasized that biorhythm of pulse rate could be an indicator of favorable affective states. Pulse rate increased with passage of time of day, reaching it's peak during 1800 to 2000 hours and gradually falling off thereafter. Alertness of the subjects was found to be higher early morning, noon time and early evening hours. Wakefulness was superior at 1000, 1200 and 1600 hours, whereas mental freshness was appreciably high at 1000, 1600 and 1800 hours. Significant negative association of pulse rate with alertness, wakefulness and mental freshness were obtained during different hours of day.

Although, the present investigation provided convincing evidence of the effects of the time of day on pulse rate and some affective states, it would be worthwhile to examine the time of day effects on a large spectrum of affective states and some more physiological measures such as blood pressure, psycho-galvanic responses, secretion of hormones etc. to demonstrate the findings more conclusively. This would lead to efficient job allocation for higher productivity. Added to this further research into the problems of time of day effect must also be oriented towards psycho-social aspects so that the results of the experiments become relevant to the needs of the student nurses.

References

Bhattacharya, S. K., & Tripathi, S. R. (1989). The effects of times of day on cognitive and visuo-motor performance efficiency, *Journal of Human Ergology, Japan, 18*, 23-31.

Colquhoun, W.P., (1971), Circadian Variations in mental efficiency, In W.P. Colquhoun, (ed.) *Biological rhythms and human performance*, London. Academic Press, 39-107.

Folkard S. & Monk, T.H. (1979) Shift work and Performance, *Human Factors, 21,* 483-484.

Folkard Simon and Tucker Philip (2003). Shift work, Safety and Productivity, *Occupational Medicine, 53*, 95-101.

Folstein, M. A., & Luria, R. (1973). Reliability, validity and clinical application of the Visual analogue mood scale, *Psychological Medicine, 3*, 479.

Garrett, H. E., & Woodworth, R. S. (1973). *Statistics in Psychology and Education*, Vakils, Feffer and Simons Private Limited, Bombay, India, 225-228.

Hockey, G. R. J., & Colquhoun, W. P. (1972). Diurnal variation in human performance. In: W.

P. Colquhoun (Ed.), *Aspects of human efficeincy, Diurnal rhythm and loss of sleep*, English Universities Press, London, 1-23.

Mathur, K, Bhattacharya, S. K., & Kashyap, S. K. (1995). Behavioural effects and body activity level in female hospital staff nurses during work hour, *Journal of Human Ergology, 24*, 1-11.

Mathur, K. (1991). Behavioural effects and Performance efficiency in relation to body activity level (oral temperature and pulse rate) over different times of day in nurses of the Civil Hospital in Ahmedabad City, Doctoral Thesis, Gujarat University.

Monk, T. H. (1982). The arousal model of time of day effects in human performance efficiency, *Chrono-Biologie, 9*, 49-54.

Mosner, C. A., & Koltan, G. (1977). *Survey methods in social investigations,* 2nd Ed. Heinemann Educational Books Ltd, London, 335-350.

Scott, L. D., Rogers, A. E., Hwong, W. T., & Zhang, Y. (2006). Effects of critical care nurses' work hours and vigilance and patients' safety, *American Journal of Critical Care, 15*, 30-37.

Sveindottir, H. (2006). Self assessed quality of Sleep, occupational health, working environment, illness experience and job satisfaction of female nurses working different combinations of shifts, *Scandinavian Journal of Caring Science, 20*, 229-237.

Tune, G. S. (1969). Sleep and wakefulness in a group of shift workers, *British Journal of Industrial Medicine, 26*, 54-58.

Timofeev, D. A., Onishehenko, A. N., Rusanov, S. N., & Romanychev, A. V. (2000). The effect of circadian rhythm on the body functional status and the work capacity in workers, *Voen Med Zh, 32,* 62-65.

Winer, B. J. (1971). *Statistical prinicples of experimental design,* McGraw-Hill Book Company, N. Y. Inc, 659-660.

Woodworth, R. S., & Scholsberg, H. (1971). *Experimental psychology* (Revised Edition), Oxford and IBH Publication Co., Calcutta, India, 216-225.

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Kamayani Mathur, PhD, Reader, Department of Psychology, Gujarat University, Ahmedabad.

S. R. Tripathi, PhD, Assistant Director, National Institute of Occupational Health, Ahmedabad

S. K. Bhattacharya, PhD, Formerly Deputy Director (Sr. Grade), National Institute of Occupational Health, Ahmedabad.