Effect of Duty Schedule on Emergency Medicine and Internal Medicine Residents in Training with Early, Intermediate and Late Chronotypes on Attention, Alertness and Reaction Time

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ABSTRACT

Physicians have been practicing in a shift-work environment since the early days of medicine. What has changed is the recognition of how much shift work can affect the physical and mental performance of physicians. The recent mandatory reduction in the work hours in residency was a first attempt to mitigate the effects of shift work and sleep deprivation on residents' performance and education[1]

The objective of this study is to compare the changes in the level of attention, alertness, reaction time of Emergency and Internal Medicine undergoing 12 hours and 33 hours duty shift respectively in relation to their chronotype. This is a prospective-cross sectional study conducted in a private training hospital from July to September 2014 consisting of 58 residents in training under the Emergency Medicine and Internal Medicine departments. Their attention, alertness and reaction time were evaluated and compared using the following tests: Morningness- Eveningness Questionnaire; Standford Sleepiness Scale; Stroop test or the Color and Word Test; Digit Span Performance; and Symbol Search Performance. Participants were tested at the start of their duty, in the middle and at the end of their duty period.

Results showed that chronotypes correlated with the degree of constraints on sleep experienced on the morning, or evening shifts. As a result of such constraints, late types showed significantly higher social jetlag than early types on the morning shift and vice versa.

When tested across the duty period, chronotype did no longer associate with the degree of social jetlag, indicating that, overall, the different chronotypes experience the same degree of constraints as do rotating worker, meaning that lack of sleep, stress and hectic schedule would take a toll on the resident by midshift as shown by decreasing attention, alertness, reaction time by the different tests.

Augmentation of workforce is recommended at midshift to counteract the decreasing level of attention, alertness and reaction time experienced by the residents to minimize medical errors.

Lastly, for the ER group, it is recommended that those morning chronotypes would be assigned to an AM shift and those late chronotypes to the PM shift. Also workforce should be added during morning shift, since results showed a declining pattern of measures.

KEY WORDS: Alertness, attention, reaction time, work schedule, residency training

INTRODUCTION

Physicians have been practicing in a shift-work environment since the early days of medicine. What has changed is the recognition of how much shift work can affect the physical and mental performance of physicians. The recent mandatory reduction in the work hours in residency was a first attempt to mitigate the effects of shift work and sleep deprivation on residents' performance and education[(1)].

The search for the "perfect" work schedule for physicians continues, and the challenges are abundant. The optimal balance between work hours on one hand and training and education on the other is unknown. The new regulations have raised concerns about the fragmentation of patient care and a breakdown in communication during shift changes[(1)].

Since the introduction of the ACGME (Accreditation Council for Graduate Medical Education) resident work hours, numerous studies have been made comparing the effect of those physicians on the new work hour regulations versus those on the traditional duty schedule of more than 80 hours per week in terms of performance, cognition, safety of physicians and patient complications and mortality.

In 1990, Residency Review Committees (RRCs) that accredited resident education in the individual specialties established a limit for Emergency Medicine of 72 hours. This was to allow flexibility in terms of the different requirements that would accommodate patient care, safety, education needs within the specialty.

Ideally, studies about the effects of such limits would have been gathered and show positive trends toward patient care as well as physician well being. However, this information does not exist. Studies predominantly consisted of opinion surveys without the power to demonstrate effect[(2)].

Thus this study aims to explore the effect of the work schedule of ER and Internal Medicine residents in terms of level of attention, alertness and reaction time during the course of their duty.

OBJECTIVES OF THE STUDY

General Objectives

To investigate the changes in the level of attention, alertness and reaction time of Emergency Medicine(ER) residents with early, intermediate and late chronotype undergoing 12 hours duty shift

To investigate the changes in the level of attention alertness and reaction time of Internal Medicine residents (IM) residents with early, intermediate and late chronotype undergoing 33 hours duty shift

Specific Objectives

To determine the degree of sleepiness using the Stanford Sleepiness Scale and compare among the different follow up points within a shift (baseline, 6^{th} and 12^{th} hour for the ER residents and; baseline, 16.5^{th} and 33^{rd} hour for the IM residents).

To determine the level of reaction time using the "On line reaction time test" and compare among the different follow up points within a shift (baseline, 6th and 12th hour for the ER residents and baseline, 16.5^{th} and 33th hour for the IM residents).

To determine the degree of attention, concentration and mental control using the "Digit Span" Working Memory subtest of WAIS IV and compare among the different follow up points within a shift (baseline, 6th and 12th hour for the ER resident; baseline, 16.5^{th} and 33^{rd} hour for the IM residents).

To determine the degree of visual perception/analysis and scanning speed using the "Symbol Search" Processing Speed subtest of WAIS IV and compare among the different follow up points within a shift (baseline, 6th and 12th hour for the ER residents and; baseline, 16.5^{th} and 33^{rd}hour for the IM residents)

To determine the degree of attention, processing speed and response inhibition using the Stroop test and compare among the different follow up points within a shift (baseline, 6th and 12th hour

for the ER residents and; baseline, 16.5th and 33rdhour for the IM residents)

A prospective cross-sectional study was conducted in a private training hospital from July to September 2014 which consisted of 18 Emergency Medicine and 40 Internal Medicine residents.

Approval was obtained from the Institutional Review Board (IRB). An IRB approved informed consent was administered by the researcher or research assistant to the residents and written informed consent was obtained. This study was done in accordance with the ethical principles of the Declaration of Helsinki and the National Ethics Guidelines for Health Research.

ER residents were chosen because of their particular schedule of undergoing 12 hour duty schedule for 3 days followed by a 24 hour rest period. ER residents in this tertiary hospital undergo 2 shifting schedule, the AM (0700-1900H) and PM shift (1900-0700 the next day). ER residents usually have a random shifting of schedule in order to meet the needed number of residents to go on duty. The most hectic schedule is for a resident to have 3 consecutive AM or PM shift with 12 hours rest period in between. After the 3 consecutive duty period, Emergency Medicine residents would usually have a 24 hour rest period and then they would undergo random change in shifting schedule or be on a 3 consecutive am or pm shift again.

For the procedure, the examiner asked for the monthly schedule from the chief resident of the ER department and from there, determined the resident who has a 3 consecutive am or pm duty shift. The resident was then informed ahead of time that he/she would be tested on the 3rd day of his/her duty shift.

For the procedure, the examiner visited the Emergency Department and the available resident that consented and met the criteria was tested (whether AM or PM shift). For the AM shift, tests were done before or at start of their duty (0600-0800H), at the 6th hour (1300H-1400H) and at the end of duty period (1900H-2000H). For the PM shift, tests were done before or at the start of their duty (1800H-2000H), at the 6th hour (0100H-0200H) and at the end of their duty period (0700H-0800H).

ER residents were tested on the 3rd day of their 12th hour duty period, which was the day prior to their 24 hour rest period. This was on the basis that on the 3rd day of their duty, the effect of work, stress, lack of sleep were at its peak.

Internal Medicine residents were chosen because they were the most numerous among the resident population and usually had a greater work load. Tests were also administered three times (at the beginning, middle and at the end of duty period) in a duty shift

Internal Medicine residents would usually be on Duty every 3 days. (Ex: if the resident would be on Duty status on the 1st day, start of day would be at 7:00am and would end 7 am the next day; from 7 am onwards to 4pm on the 2nd day, status would be "From duty". From duty residents are usually still within the vicinity of the hospital doing their respective work. On the 3rd day, the "Pre duty status", residents start at 7 am and would end at 4 pm. Subsequently, on the 4thday, the resident would be "on Duty" status again and the cycle repeats itself.

For the procedure, the examiner conducted the test to the "On Duty "residents before or at the start (600H to 800H), at the 16.5th hour (2330H-0030H) and at the end/dismissal from "From duty" status (1600H-1700H)

IM subjects were brought in a quiet room where the tests were administered by the researcher or research assistant.

These tests were administered only three times per resident because during these procedures, the examiner pulled them out from their respective posts hampering patient care if tests were administered more frequently. In addition to, doing tests more frequently would cause procedural bias.

The examiner did these tests in one ER or one IM resident per duty shift to ensure that the staff would not be depleted. In addition to, only those residents that were available at that particular time of the said examination can be tested.

Demographic data were taken as well as some data that would be of use in the study (which include: amount of coffee taken, hours of sleep, activities prior to duty, medication/drug taken prior).

Consenting residents would complete following questionnaires (please see appendix): Morningness-Eveningness Questionnaire which is a 19 point questionnaire about daily sleep wake habits and time of day preference of certain activities. This would assess the chronotype of each participant. Stanford Sleepiness Scale (SSS) which is a seven point self rating scale that quantifies progressive steps in sleepiness, ranging from a score of 1 denoting high alertness to a score of 7 indicating imminent sleep. The Stroop test or the Color and Word test. (please see appendix for official instructions). This test measures selective attention, cognitive flexibility and brain processing speed. It is used as a tool in the evaluation of executive function and response inhibition. The Digit Span Performance, a part of Working Memory subtest of WAIS IV. This test is used to measure attention, concentration and mental control. It is composed of 3 parts (forward, backward and sequencing), 8 items each. The "Symbol Search Performance", a part of processing Speed Index of WAIS IV is a 60 item test that would measure the level of visual perception/analysis and scanning speed of the individual. Computer based test include: Online reaction time test (recording response to a visual stimulus: red spot turning green in milliseconds). Throughout the procedure, the researcher or her assistant would be present to facilitate the different test procedures. These tests were chosen upon the recommendation of the co-investigators and were freely given for use for this study.

STATISTICAL ANALYSIS

Qualitative and categorical variables were represented using descriptive statistics—mean, standard deviation, median and range

ETHICAL CONSIDERATIONS

The study was conducted after approval was obtained from the Institutional Review Board (IRB). Informed consent was obtained from every participant before conducting the research. The protocol was implemented in accordance with the ethical principles of the Declaration of Helsinki and the National Ethics Guidelines for Health Research.

Participants joined the study voluntarily with clear understanding that there is no obligation to do so and there is no negative consequence for them if they do not assist in the research. Each respondent was assigned codes to protect their identity and given the utmost confidentiality. Results will be revealed only to participants who wanted to know the outcome of their individual participation.

RESULTS

1. General characteristics

There were a total of 58 residents who participated in the study. Forty (40 of 58, 69%)) residents were from the Department of Medicine while 18 (31%) were from Emergency Medicine. Female respondents dominated both the ER group and IM group at 61% and 57.5% respectively. The average ages for the two groups were almost similar—30 years old for the ER group and 28 years old for the IM group.

The ER group had two sets of shifting and 28% of them belonged to the AM Shift, while 72% comprised the PM Shift.

Among the ER residents, 33% were first years, 33% second years, 32% third years and 11% in their fourth year. On the other hand, for the IM residents, most of them were senior residents belonging to the 3rd and 2nd year levels at 40% each while the 1st years were 20%.

For the number of hours slept, the IM group had a longer median sleeping duration of 6 hours (4-9) compared to the 5 hours (3-6) for the ER. Both groups had equal amount of coffee intake.

Most of the residents were not taking any medications at the time of testing- 89% for the ER and 75% for the IM group. While lesser percentages

of them reportedly were taking vitamins—11% of the ER group and 12.5% for the IM group; incidentally 12.5% of the IM group had revealed to be taking other medications.

For the activities done one day prior to testing, 78% of the ER group reported not doing any physical/strenuous activity while 17% did some reading/studying and 6% performed exercises. The IM group reported that 65% also did not do any physical/strenuous activity, while 20% did some reading/studying, 7.5% performed exercises, and 5% doing other activities such as malling/shopping.

Of the five classifications for MEQ, the resident respondents mostly belonged to the Intermediate, Moderate Morning, and Moderate Evening types. Table 1 shows the general characteristics and MEQ classes of the resident respondents

Table 1. Sociodemographic profiles and MEQ classification of ER and IM residents respondents (n=58)

	ER	IM
Age	29.94± 1.85	28.33 ± 1.91
Gender		
Male	7 (39%)	17 (42%)
Female	11(61%)	23 (57.5%)
Shift		
AM Shift	5 (28%)	NA
PM Shift	13 (72%)	NA
Year Level		
1st	6 (33%)	8 (20%)
2nd	6 (33%)	16 (40%)
3rd	4 (32%)	16 (40%)
4th	2(11%)	NA
No of hours slept prior to duty	5 (3-6)	6 (4-9)
Amount of Coffee taken in cups	1 (0-3)	1 (0-2)
Current medications		
None	16 (89%)	30 (75%
Vitamins	2 (11%)	5 (12.5%)
Others	0 (0%)	5 (12.5%)
4th	2(11%)	NA
Activities done the night prior to duty		
None	14(78%)	26 (65%)
Reading/Studying	3 (17%)	8 (20%)
Exercise	1 (6%)	3 (7.5%)
Others	0(0%)	2 (5%)
Morningness or Eveningness Classification (MEQ)		
Definite Evening	0 (0%)	1 (3%)
Moderate Evening	4 (22%)	8 (20%)
Intermediate	7 (39%)	19 (48%)
Moderate Morning	7 (39%)	11 (28%)
Definite Morning	0 (0%)	0 (0%)

1. Stanford Sleepiness Scale (SSS)

Internal Medicine residents (33 hours duty shift)

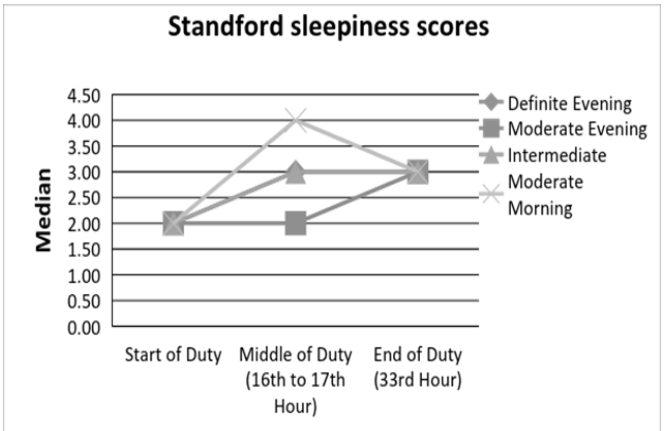
Residents of the moderate morning chronotype had increased median sleepiness scores by two points at the mid-shift then decreased sleepiness at the end of the shift. A similar pattern was presented by both the definite evening and intermediate chronotypes showing an increased degree of sleepiness by one point by mid-shift but remained at the same level by the end of the shift. The moderate evening group showed a different trend by maintaining the same score from baseline to middle of the shift then increasing sleepiness at the end of the shift. Trends in the change of median SSS scores among the four chronotypes of IM residents were determined (Figure 1).

Table 2. Stanford sleepiness Scale of IM residents expressed in median (range)

MEQ results	Start of Duty 7:00 AM	Middle of Duty (16.5 to 17.5 Hour) Approximately 11:00 PM	End of Duty (33rd Hour) 4:00 PM the following day
Definite Evening (n = 1)	2 (2-2)	3 (3-3)	3 (3-3)
Moderate Evening (n = 8)	2 (1-3)	2 (2-6)	3 (2-6)
Intermediate (n = 19)	2 (1-3)	3 (2-6)	3 (1-6)

SSS scores correspond to 1 = feeling active, vital, alert, or wide awake; 2 = functioning at high levels but not peak, able to concentrate; 3 = awake, relaxed, responsive but not fully alert; 4 = somewhat foggy, let down; 5 = foggy, losing interest in remaining awake; slowed down; 6 = sleepy, woozy, fighting sleep, prefer to lie down

Figure 1. Stanford sleepiness scale scores of IM residents during their 33 hours shift



Emergency Medicine residents (AM and PM shift)

The Emergency Medicine residents belonged only to three chronotypes, and were divided according to AM or PM shifts. For the AM shift, which started at 7:00 AM, the intermediate group had the lowest sleepiness scores at the start of duty but increased by 2 points by midhshift and increased another point by the end of the duty shift. The sleepiness scores of the three chronotypes were similar at midshift (1:00 PM). By the end of duty shift, both the moderate evening and intermediate chronotypes increased by one point in the degree of sleepiness

For the PM shift, which started at 7:00 PM, the moderate morning chronotypes had the lowest sleepiness scores at the start until the end of the shift. The moderate evening showed a steady increase in sleepiness scores from baseline, middle to the end of the shift, while the intermediate evening only had an increase in sleepiness at the end of the shift.

Table 1. Sociodemographic profiles and MEQ classification of ER and IM residents respondents (n=58)

			AM Shift		PM Shift	
MEQ	Start of Duty 7:00 AM	Middle of Duty (6th Hour) 1:00 PM	End of Duty (12th Hour) 7:00 PM	Start of Duty 7:00 PM	Middle of Duty (6th Hour) 1:00 AM	End of Duty (12th Hour) 7:00 AM
Moderate Evening (n = 4)	3 (3-3)	3 (3-3)	4 (4-4)	2 (2-2)	3 (1-3)	4 (2-6)
Intermediate (n = 7)	1 (1-1)	3 (3-3)	4 (4-4)	3 (2-3)	3.5 (2-5)	4.5 (3-5)
Moderate Morning (n=7)	2 (1-2)	3 (1-3)	3 (2-3)	2 (1-3)	2 (2-5)	2.5 (2-6)

SSS scores correspond to 1 = feeling active, vital, alert, or wide awake; 2 = functioning at high levels but not peak, able to concentrate; 3 = awake, relaxed, responsive but not fully alert; 4 = somewhat foggy, let down; 5 = foggy, losing interest in remaining awake; slowed down; 6 = sleepy, woozy, fighting sleep, prefer to lie down

Figure2. Stanford Sleepiness Scale of ER residents on AM shift

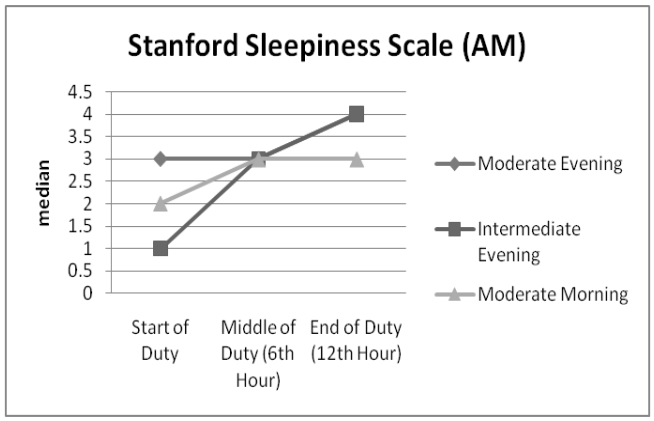
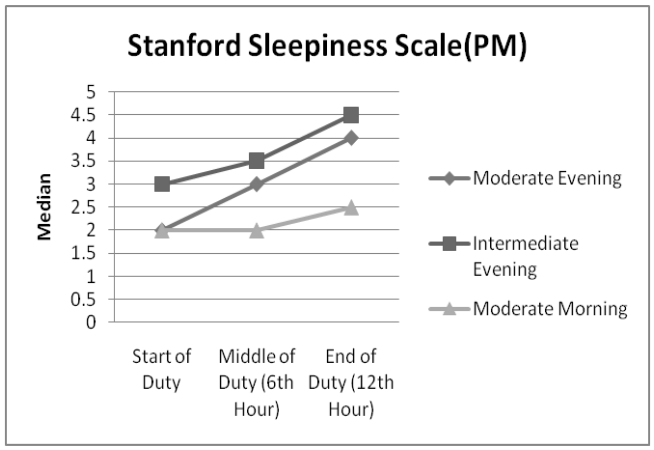


Figure 3. Stanford Sleepiness Scale of ER residents on PM shift



2. Symbol Search Performance of Wechsler Adult Intelligence Scale, 4th edition (WAIS-IV)

Internal Medicine residents (33 hours shift)

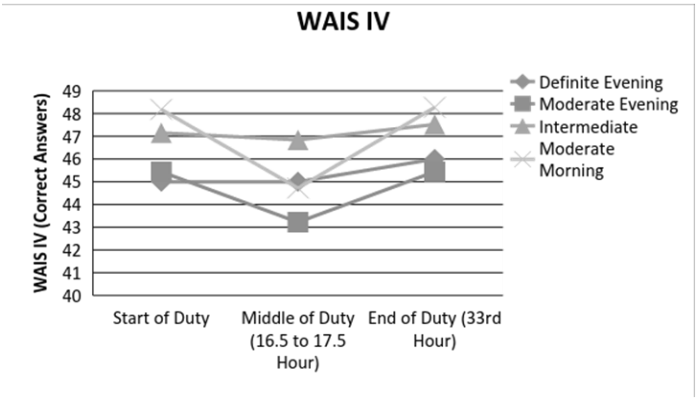
The moderately morning chronotypes had the highest score at the start of duty period while the definitely evening and moderately evening showed the lowest scores.

The moderate evening, intermediate, and moderate morning chronotypes all showed a decrease in WAIS-IV Symbol Search scores at mid-shift, which generally returned to baseline at the end of the tour of duty. The definitely evening chronotype on the other hand showed no change in score by midshift and increased by one point by the end of duty.

Table 4. Symbol Search Performance of Wechsler Adult Intelligence Scale, 4th edition by IM residents

MEQ	Start of Duty 7:00 AM	Middle of Duty (16.5 to 17.5 Hour) Approx 11:00 PM	End of Duty (33rd Hour) 4:00 PM
Definite Evening (n = 1)	45 ± 0	45 ± 0	46 ± 0
Moderate Evening (n = 8)	45.44 ± 6.54	43.22 ± 8.91	45.44 ± 8.63
Intermediate (n = 19)	47.15 ± 7.06	46.84 ± 7.65	47.52 ± 7.72
Moderate Morning (n=11)	48.18 ± 5.58	44.72 ± 7.95	48.27 ± 4.56

Figure 4. Symbol Search Performance of Wechsler Adult Intelligence Scale, 4th edition (WAIS-IV) by IM residents during their 33 hours duty



Emergency medicine residents (AM AND PM shift)

For the AM shift, the moderately evening chronotypes showed the lowest score, while both the intermediate and moderately morning chronotypes had similar score at the start of duty period.

The WAIS IV Symbol Search scores for the 3 chronotypes showed a drop in scores by midshift and further dropped by the end of duty for both the moderately evening and moderately morning chrnonotypes

For the PM shift, the intermediate chronotypes started with the lowest score and the moderately morning chronotypes had the highest score. All of them exhibited an increase in score from midshift to end of duty period.

Table5. WAIS IV items (Symbol Search) answered correctly by ER residents

		AM Shift			PM Shift	
MEQ	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)
Moderate Evening	50 ± 0	48 ± 0	42 ± 0	45.66 ± 2.3	48 ± 7.54	49.33 ± 4.16
Intermediate	54 ± 0	50 ± 0	50 ± 0	43.33 ± 4.8	44.16 ± 4.87	49.66 ± 5
Moderate Morning	54 ± 9.54	47.33 ± 9.29	46 ± 8.18	47 ± 8.24	47.75 ± 6.65	50.75 ± 4.85

Figure 5. WAIS IV items (Symbol Search) answered correctly by ER residents (AM shift)

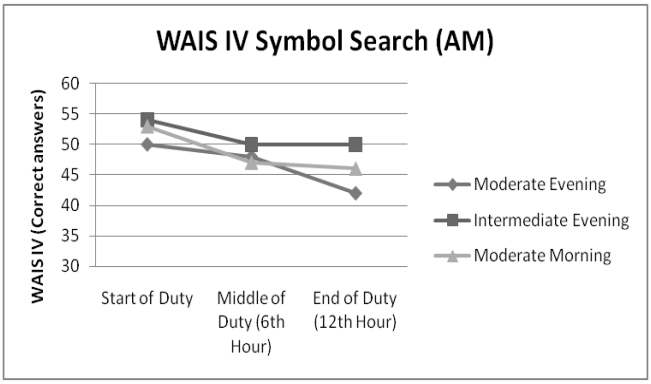
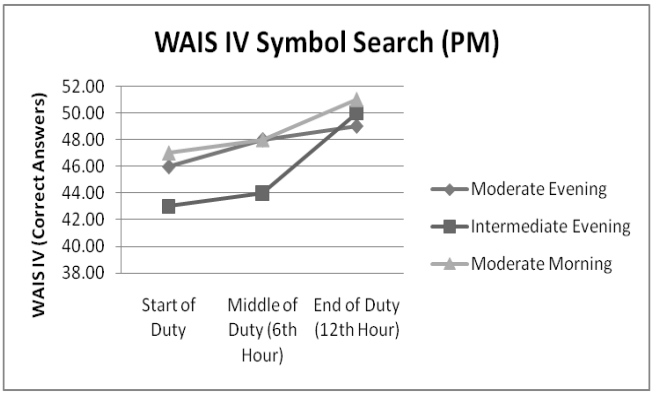


Figure 6. WAIS IV items (Symbol Search) answered correctly by ER residents (PM shift)



3. Digit Span test

Internal Medicine residents (33 hours duty shift)

For the Digit Span Forward scores, the definite evening chronotypes revealed an obvious different pattern from the rest of the types. It started at a high score at 14 then had a steep drop by three points at the middle of the shift. It recovered by one point at the end of the shift. The moderate evening, intermediate and moderate morning chronotypes exhibited a steady pattern of scores from middle of duty until the end of duty period.

For the Digit Span Backward scores, the moderate evening, intermediate, and moderate morning chronotypes had higher scores compared to the definite evening chronotype. Aside from having the lowest scores, definite evening chronotype maintained the same score from the start, middle and by the end of duty shift.

Among the three, the intermediate and moderate morning had similar line graphs. Both maintaining their baseline scores to the middle of the shift, their scores had minimal drop by the end of the shift. Notably, the moderate evening chronotypes showed a steady increase of its scores from the baseline, middle and towards the end of the shift.

For the Digit Span Sequence scores, the definite evening chronotype exhibited the initial low score compared to other chronotypes, this further decreased by 2 points in the middle of the shift and did not recover by the end of the shift. The remaining three chronotypes, namely the moderately evening, intermediate and moderately morning showed a slight decline in their scores by the middle of the shift, with the moderately morning showing the highest decline among the three. However, the moderately morning chronotypes was able to recover by the end of the shift while the remaining two remained the same.

Table 6. Digit Span Test Scores of IM residents (maximum score = 16)

MEQ	Start of Duty 7:00 AM	Middle of Duty (16.5th to 17.5th Hour) Approx 11:00PM	End of Duty (33rd Hour) 4:00 PM
Forward			
Definite Evening (n = 1)	14 ± 0	11 ± 0	12 ± 0
Moderate Evening (n = 8)	12.11 ± 2.52	12.66 ± 2.69	12.33 ± 2.69
Intermediate (n = 19)	11.78 ± 2.14	11.31 ± 1.88	11.57 ± 2.11
Moderate Morning (n = 11)	11.9 ± 1.81	11.9 ± 1.97	11.81 ± 1.94
Backward			
Definite Evening (n = 1)	8 ± 0	8 ± 0	8 ± 0
Moderate Evening (n = 8)	11.44 ± 3.08	11.66 ± 2.95	12 ± 2.06
Intermediate (n = 19)	10.94 ± 2.04	11.05 ± 2.29	10.78 ± 2.14
Moderate Morning (n = 11)	10.63 ± 1.85	10.81 ± 2.04	10.36 ± 2.33
Sequence			
Definite Evening (n = 1)	10 ± 0	8 ± 0	8 ± 0
Moderate Evening (n = 8)	10.11 ± 0.92	9.88 ± 1.83	9.22 ± 1.85
Intermediate (n = 19)	10.26 ± 1.75	9.47 ± 2.45	9.63 ± 1.64
Moderate Morning (n = 11)	11 ± 2.04	9.63 ± 2.24	10.72 ± 1.55

Figure 7. Digit Span Forward scores of IM resident during their 33 hours duty

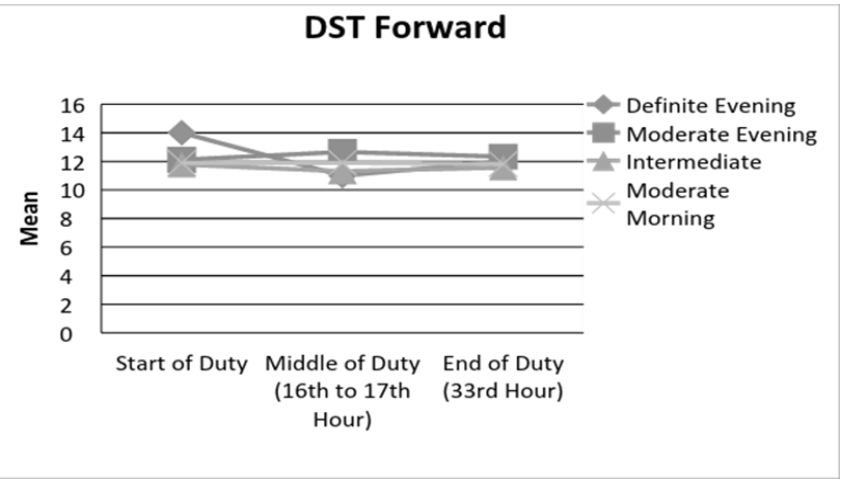


Figure 8. Digit Span Backward scores of IM residents during their 33 hours duty

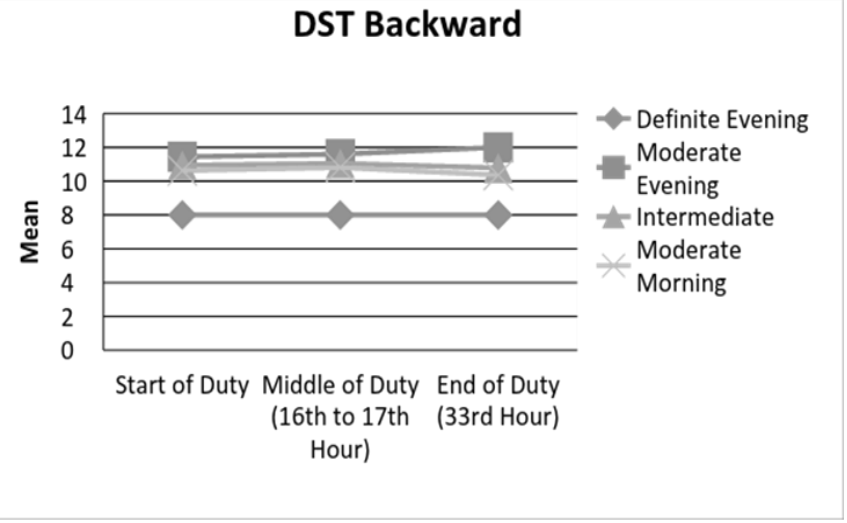
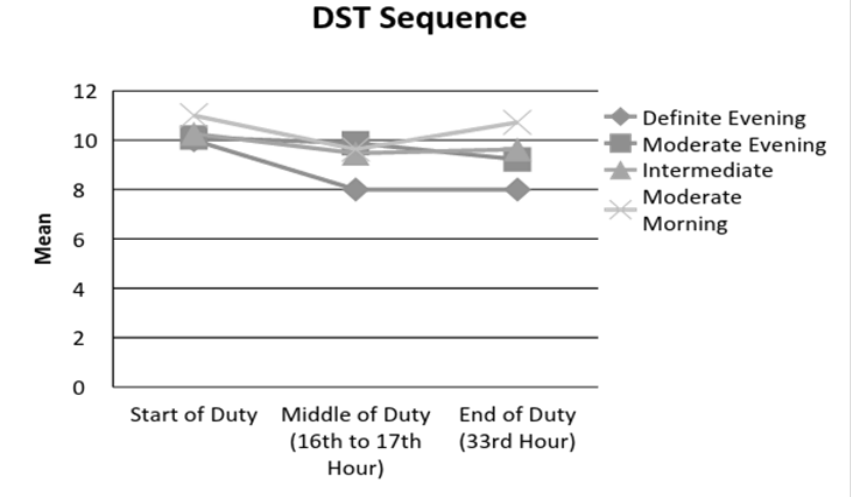


Figure 9. Digit Span Sequence scores of IM residents during their 33 hours duty



Emergency Medicine residents (AM and PM shift)

For the Digit Span Forward test: AM group: the moderately evening chronotypes showed the initial low score at the start of duty period compared to other chronotypes. By the middle of duty period, the moderately evening and intermediate chronotypes showed no change in the score compared to their baseline/1st score however, the scores dropped by the end of duty. The moderately morning chronotypes showed a 1 point drop in scores by the middle of the shift however was able to maintain the same score by the end of the duty shift.

For the PM shift: the intermediate chronotypes showed the initial low score at the start of duty compared to other chronotypes. By the middle of the duty shift, both the moderately evening and intermediate chronotypes showed 2-3 points increase in scores. The moderately morning showed a drop in score by the middle of the duty shift. By the end of the duty shift, both the moderately evening and moderately morning chrnonotypes showed a decrease in score while the intermediate chronotypes showed a slight increase in score.

Table 7. Digit Span Forward scores of ER residents

		AM Shift			PM Shift	
MEQ	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)
Moderate Evening	10 ± 0	10 ± 0	8 ± 0	11 ± 3	13.33 ± 2.88	10.33 ± 3.21
Intermediate	14 ± 0	14 ± 0	11 ± 0	9.83 ± 1.16	11.33 ± 1.36	11.5 ± 2.34
Moderate Morning	13.33 ± 1.15	12.66 ± 1.15	12.66 ± 1.15	12 ± 1.82	11.25 ± 3.09	10.75 ± 0.95

Figure 10. Digit Span Forward scores of ER residents during AM shift

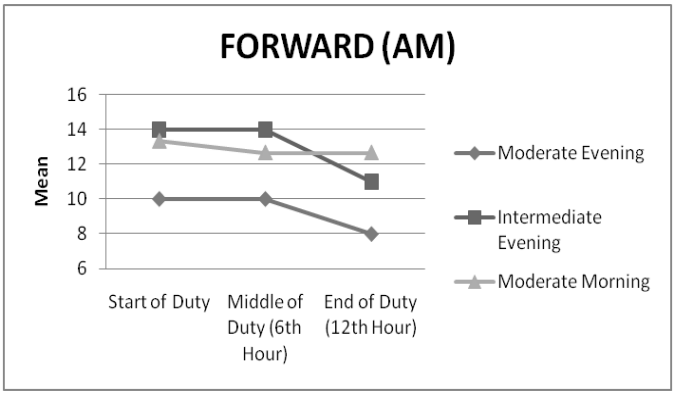
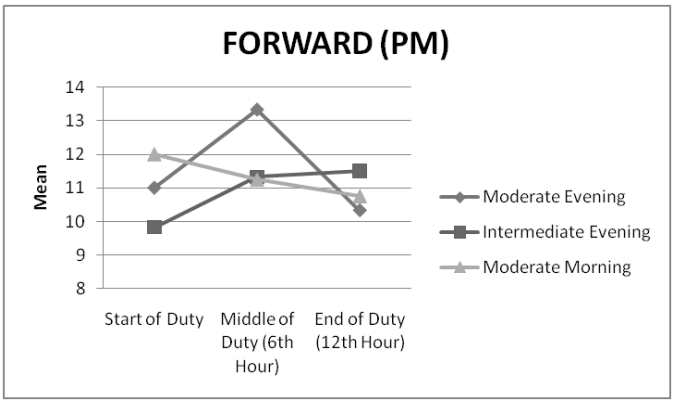


Figure 11. Digit Span Forward scores of ER residents during PM shift



For the Digit Span Backward test: AM shift: The moderately evening chronotypes showed the initial low score at the start of the duty period. The score was maintained throughout the duty period. Both the moderately evening and the moderately morning chronotypes showed no change in score by the middle of the duty shift while the intermediate chronotypes exhibited a 2 point decrease in score. By the end of duty period, the intermediate chronotypes regained the 2 points back. The moderately morning chronotypes showed a slight decline in score.

For the PM shift: The intermediate chronotypes exhibited the initial low score compared to other chronotypes at the beginning of the duty shift. The moderately evening chronotypes showed a slight decline in score by the middle of the shift while the intermediate and moderately morning showed a slight increase in score by the middle of the duty shift. By the end of the duty shift, the moderately evening and the moderately morning exhibited a decline in score while the intermediate chronotypes showed a slight increase in score.

Table 8. Digit Span Backward scores of ER residents

		AM Shift			PM Shift	
MEQ	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)
Moderate Evening	8 ± 0	8 ± 0	8 ± 0	11.33 ± 1.52	11 ± 3.6	10.66 ± 4.04
Intermediate	12 ± 0	10 ± 0	12 ± 0	9.5 ± 1.87	10.16 ± 3.25	11 ± 3.52
Moderate Morning	13 ± 1	13 ± 0	12.66 ± 0.57	11 ± 2.44	11.25 ± 2.06	10.5 ± 2.64

Figure 12. Digit Span Backward scores of ER residents during AM shift

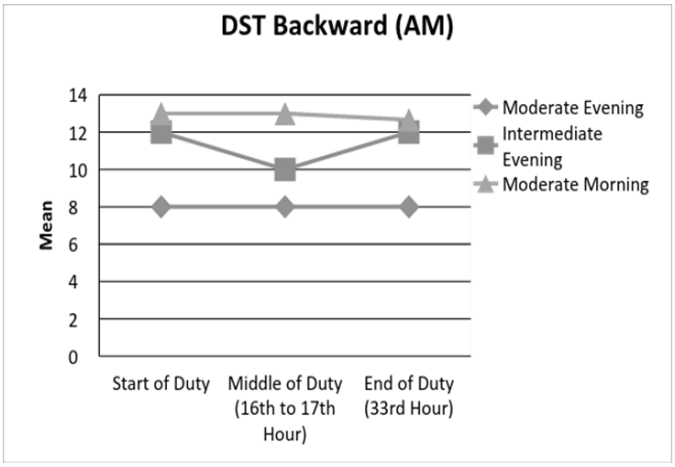
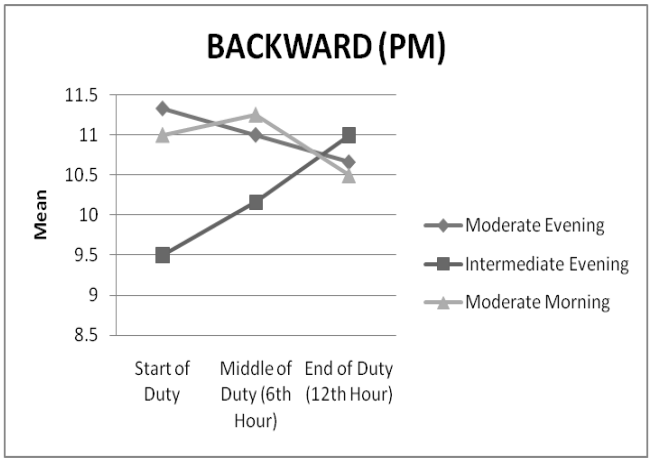


Figure 13. Digit Span Backward scores of ER residents during PM shift



For the Digit Span Sequence Test: AM shift: The moderately evening group had the initial low score at the beginning of the duty shift. The group did not also exhibit any changes in score until the end of duty. The intermediate and moderately morning chronotype showed a decline in scores during the middle and end of duty shift. chronotypes showed a decline in score.

PM shift: The intermediate chronotypes had a low initial score at the start of duty which showed a slight decline by the middle of the duty period and was maintained by the end of duty shift. The moderately evening and moderately morning chronotypes exhibited increased scores by the middle of the duty shift. By the end of duty shift, the moderately morning chronotypes showed a decline in score.

Table 9. Digit Span Sequence scores of ER residents

		AM Shift			PM Shift	
MEQ	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)
Moderate Evening	8 ± 0	8 ± 0	8 ± 0	9.33 ± 1.52	11 ± 2	11 ± 2.64
Intermediate	14 ± 0	13 ± 0	11 ± 0	8.5 ± 2.81	8.16 ± 2.63	8.5 ± 2.88
Moderate Morning	11.33 ± 3.05	11 ± 2	10.66 ± 1.52	9.75 ± 2.36	11 ± 2.3	10 ± 2.94

Figure 14. Digit Span Sequence scores of ER residents during AM shift

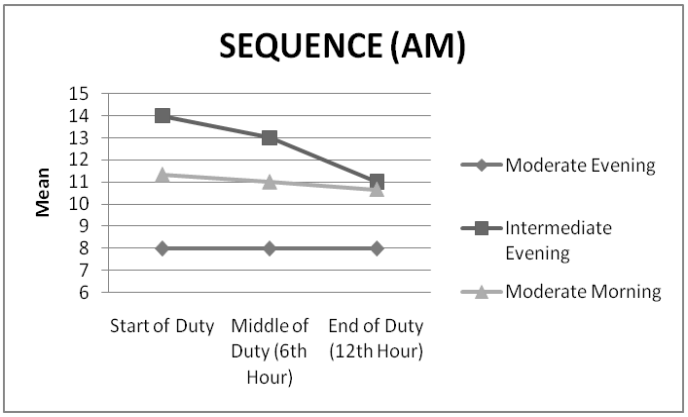
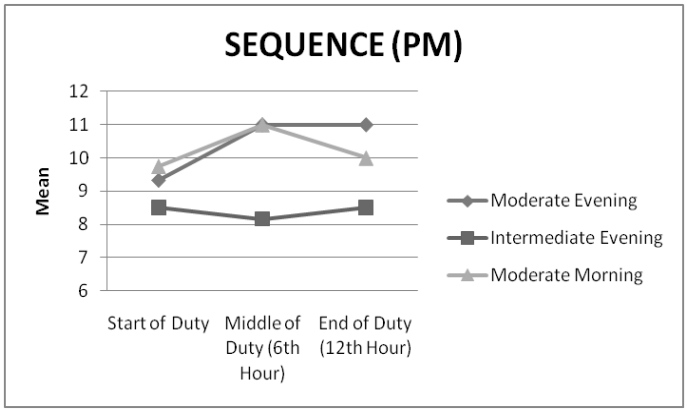


Figure 15. Digit Span Sequence scores of ER residents during PM shift



4. Online Reaction Test

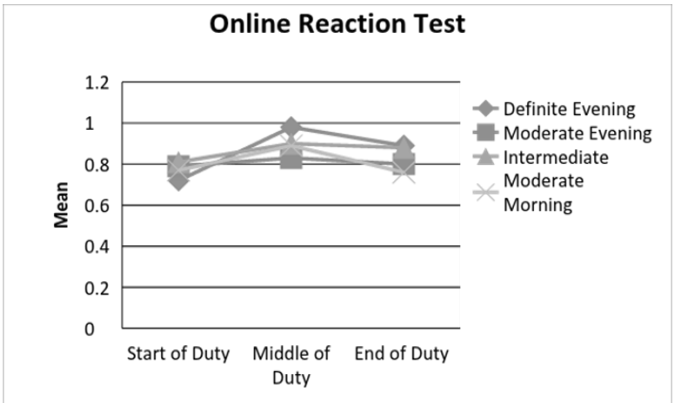
Internal Medicine residents (33 hours duty shift)

For the online reaction test, all four chronotypes of the IM residents consistently registered reaction times less than one second, slightly slowing down during mid-shift, and recovering by the end of duty. The moderate morning chronotypes was able to recover with a faster mean reaction time at 0.76 seconds compared to baseline**.**

Table 10. On line reaction test of IM residents

MEQ	Start of Duty 7:00 AM	Middle of Duty (16.5 to 17.5 Hour) Approx 11:00 PM	End of Duty (33rd Hour) 4:00 PM
Definite Evening (n = 1)	0.72 ± 0	0.98 ± 0	0.89 ± 0
Moderate Evening (n = 8)	0.79 ± 0.11	0.83 ± 0.11	0.8 ± 0.1
Intermediate (n = 19)	0.81 ± 0.11	0.9 ± 0.2	0.88 ± 0.1
Moderate Morning (n = 11)	0.77 ± 0.11	0.89 ± 0.21	0.76 ± 0.11

Figure 16. On line reaction test of IM residents



Emergency Medicine residents (AM and PM shift)

The moderate morning, intermediate, and moderate evening chronotypes all had increasing online reaction times for the AM shift.

In contrast, the moderate evening and intermediate types had shorter average reaction times as the PM shift progressed. The moderate morning chronotypes had a longer reaction time at mid-shift (1:00 AM), compared to baseline and end of duty.

Table11. On line reaction test of ER residents

		AM Shift			PM Shift	
MEQ	Start of Duty 7:00 AM	Middle of Duty (6th Hour) 1:00PM	End of Duty (12th Hour) 7:00 PM	Start of Duty 7:00 PM	Middle of Duty (6th Hour) 1:00 AM	End of Duty (12th Hour) 7:00 AM
Moderate Evening (n = 4)	0.82 ± 0	0.83 ± 0	0.92 ± 0	0.92 ± 0.32	0.86 ± 0.24	0.7 ± 0.15
Intermediate (n = 7)	0.68 ± 0	0.86 ± 0	0.92 ± 0	0.88 ± 0.18	0.79 ± 0.06	0.78 ± 0.09
Moderate Morning (n = 7)	0.69 ± 0.05	0.73 ± 0.1	0.82 ± 0.02	0.81 ± 0.18	0.84 ± 0.16	0.82 ± 0.16

Figure 17. On line reaction test of ER residents during AM shift

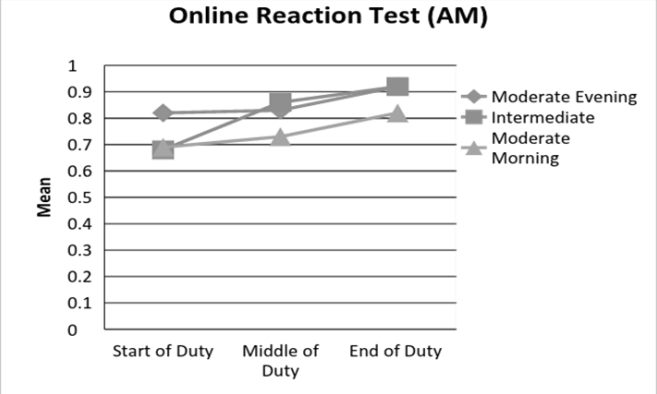
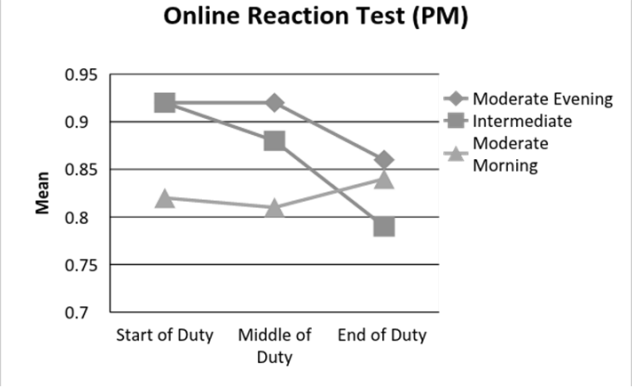


Figure 17. On line reaction test of ER residents during PM shift



5. Stroop test

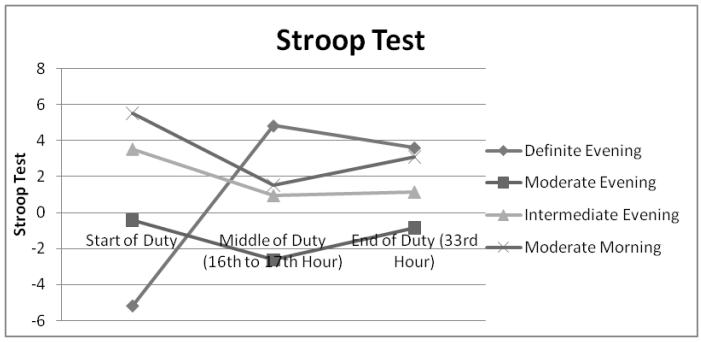
Internal Medicine residents

The three chronotypes—moderate evening, intermediate and moderate morning, although having different initial Stroop test scores- -0.43, 3.52 and 5.51 respectively, they had similar graphs. Their scores dropped during the middle of the shift but recovered by the end of their shift. These mean that their ability to sustain attention, inhibit responses and brain processing speed by recognizing and differentiating colors and words in contained in the test decrease as they approach the middle of the shift but eventually regained to some extent by the end of the shift. Only the definite evening displayed a different pattern that started with the lowest score of – 5.16 then gained a very steep rise by 9 points during the middle with only a minimal decrease in score at the end of his shift.

Table 12 Stroop test of IM residents

MEQ	Start of Duty	Middle of Duty (16.5th to 17.5th Hour)	End of Duty (33rd Hour)
Definite Evening	-5.16 (-5.16 to -5.16)	4.83 (4.83 to 4.83)	3.61 (3.61 to 3.61)
Moderate Evening	-0.43 (-8.74 to 8.81)	-2.63 (-4.64 to 10.48)	-0.84 (-6.43 to 7.88)
Intermediate	3.52 (-8.21 to 12.32)	0.94 (-8.63 to 12.6)	1.14 (-9.44 to 9.47)
Moderate Morning	5.51 (-2.6 to 19.76)	1.53 (-4.78 to 9.79)	3.09 (-4.54 to 14.14)

Figure 17. Stroop test-IM residents



Emergency Medicine Residents (AM and PM shift)

For the morning shift residents, the three chronotypes displayed decreasing scores for the Stroop test during the span of their duty as represented by the line graphs slopping down. However, the moderate morning type had the steepest graph with an average of 5 points from start to the middle of the shift then 6 points by the end of the shift. These showed that their ability to sustain attention, inhibit responses and brain processing speed were decreasing, with the number of correct recognition of colors and words contained in the test of as their tour of duties progressed

For the afternoon shift residents, the three chronotypes had decrease in scores of correct recognition of color and words contained in the test as they approached the middle of the shift with recovery with rise in scores by the end of the shift

Table 13. Stroop test off ER residents (AM and PM shift)

		AM Shift			PM Shift	
MEQ	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)	Start of Duty	Middle of Duty (6th Hour)	End of Duty (12th Hour)
Moderate Evening	1.17 (1.17 to 1.17)	-0.17 (-0.17 to -0.17)	-3.43 (-3.43 to -3.43)	7.6 (5.47 to 8.82)	4.56 (3.18 to 5.84)	0.33 (-3.12 to 7.78)
Intermediate	5.37 (5.37 to 5.37)	6 (6 to 6)	-0.31 (-0.31 to -0.31)	-2.475 (-6.33 to 5.63)	-4.12 (-21.11 to 8.81)	-2.635 (-9.38 to 17.29)
Moderate Morning	12.12 (11.33 to 17.81)	7.49 (5.4 to 8.6)	1.53 (-0.47 to 8.28)	4.845 (0.57 to 12.94)	1.25 (-2.59 to 16.27)	3.545 (-7.56 to 14.92)

Figure 18. Stroop test (ER-AM shift)

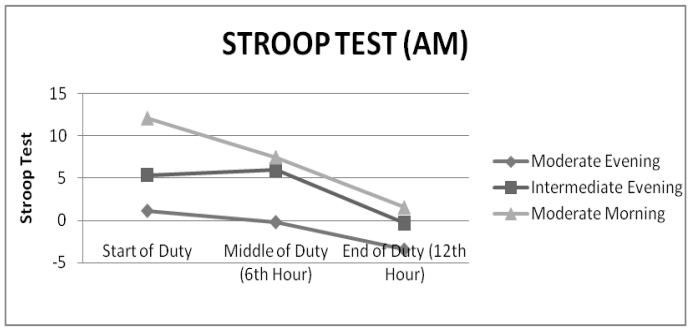
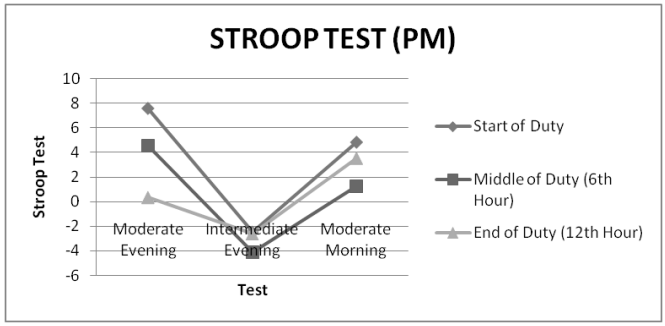


Figure 18. Stroop test (ER-PM shift)



DISCUSSION

Based on the results, the different chronotypes correlated with the degree of sleepiness of the residents. Late chronotypes tend to be sleepier at the start of the duty with little or no variation by the midshift and subsequent maintained the degree of sleepiness or had a slight increase sleepiness by the morning. Early chronotypes was noted to be more active at the start of duty then would lag behind by have an increase in the degree of sleepiness by mid duty followed by a little improvement by the next morning.

The level of visual perception/scanning speed of the IM residents as measured by the Symbol Search subtest of the WAIS IV showed that irrespective of chronotype, most of them would have a decrease speed by the midshift and the residents would regain back their ability by the end of duty shift.

For the ER, AM shift: Results showed that the ability of the residents to visually process information decreased until the end of the duty irrespective of chronotypes. In contrast, for the PM shift, late chronotypes had improved visual perception by midshift and was maintained until the end of duty. The early chronotypes on the other hand showed no change in scores by midshift and subsequent improvement by the end of duty.

The level of attention, concentration and mental control as measured by the Digit Span Working Memory subtest showed that, for the Digit Span Forward and Backward category, scores were almost the same throughout the duty period for the IM group except for the definite evening (very late chronotype) which showed a decline in score by midshift and a one point increase toward the end of duty. However, it should be remembered that the only one IM resident belonged to the definitely evening group, thus a generalized statement cannot be concluded regarding the very late chronotypes. For the Digit Span Sequence category, results showed that the late chronotypes had the lowest scores at the start of duty in the morning while the early chronotypes having the highest scores. By the midshift, regardless of chronotype, all showed a declining pattern. The late chronotypes while the intermediate and the early chronotypes showed slight improvement in scores.

For the ER AM shift, results consistently showed that baseline scores for all Digit Span subcategories, it was lowest for the late chronotypes and was highest either with the intermediate or early chronotypes. Late chronotypes maintained their score by midhshift for all subcategories while the early chronotypes showed a slight decline. By the end of duty period, scores for the backward and sequence test was maintained for the late chronotypes while showing a decline for the forward test. By the end of duty shift, early chronotypes again showed a minimal decrease in scores for the backward and sequence scores while no change was noted for the forward scores. No specific pattern was noted for the PM shift, sometimes late chronotypes would have the initial high score and vice versa with the early chronotypes.

The level of reaction time, as measured by the On line reaction test showed that IM residents reaction time decreased by midhshift and returned to near baseline level by the end of duty shift.

For the ER AM shift, all chronotypes showed decreasing level of reaction throughout the duty period. For the PM shift, late and intermediate chronotypes had improved reaction time during their tour of duty. The early chronotypes was noted to have decreased reaction time by midhshift which gradually improved by the end of duty.

For the Stroop test, results for the IM residents showed that late chronotypes have a lower initial/baseline scores compared to the early chronotypes. Stroop test also revealed that for all 3 chronotypes, namely, the moderate evening, intermediate and moderate morning chronotypes, they all experienced a decreased level of processing speed, sustained attention and response inhibition by midhshift. Exception again would be the very late chronotype (definitely evening) which showed an improved degree of attention and cognitive flexibility by midshift. However, because only one resident belonged to the very late chronotype, a general statement cannot be made regarding very late chronotypes. By the end of the duty period, all 3 chronotypes gradually showed a

slight improvement of their Stroop scores however scores did not return to their baseline levels.

For the ER residents on AM shift, results revealed that similar to the IM residents, late chronotypes had lower baseline scores compared to the early chronotypes. Both early and late chronotypes showed a decline in sustained attention, processing speed and response inhibition by the end of duty. For the ER residents on PM shift, results showed the opposite, late chronotypes had the high baseline score compared to the early chronotypes. All of them showed a declining pattern by midshift however, by the end of duty, the early chronotype was able to show slight improvement.

CONCLUSION

As predicted, chronotypes correlated with the degree of constraints on sleep experienced on the morning, or evening shifts. As a result of such constraints, late types showed significantly higher social jetlag than early types on the morning shift. Early types, on the other hand, revealed significantly higher constraints on the night shift compared to late types on the night shift. This was reflected with the different tests done wherein early chronotypes garnered a higher score at the start of the day, and with the late chronotypes having a lower score. Likewise, chronotype correlated with subjective well-being during night work, with early types feeling significantly less well than late types. Also, early types reported lower well-being on the night shift than on the morning shift, while the opposite could be observed for late types.

However, when tested across the duty period, chronotype did no longer associate with the degree of social jetlag, indicating that, overall, the different chronotypes experience the same degree of constraints as do rotating worker, meaning that lack of sleep, stress and hectic schedule would take a toll on the resident by midshift as shown by decreasing attention, alertness, reaction time by the different tests. Few instances from the results showed that during midshift, late chronotypes had a lesser drop in terms of attention, alertness and reaction time compared to the early chronotypes.

RECOMMENDATION

Not all IM and ER residents were included in the study. Some IM residents were rotating in the ER and thus was excluded, others only have a half day during from duty thus was also excluded. For the ER residents, some of them are rotating with other department, hence was excluded. Some residents were also not in a three day AM or PM shift, thus was not tested. It would be beneficial to the training institution involved if all were included as subjects so that the researcher can conclude appropriately if there would be a significant drop in terms of the different measures tested such that the Department concerned can be alerted to prevent medical errors.

At the middle of the duty period when the level of alertness, reaction time and attention decreased, it would be appropriate if medical workforce would be added to augment the medical team and mimimize medical errors.

For the ER group, it is recommended that those morning chronotypes would be assigned to an AM shift and those late chronotypes to the PM shift. Also workforce should be added during morning shift, since results showed a declining pattern of measures.

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APPENDIX:

Informed consent (English and Tagalog)

Gantt chart

Methodology

Data information sheet

Morningness and Eveningness Questionnaire

Stanford Sleepiness Scale

Stroop test

Online reaction time

Symbol Search" Processing Speed subtest of WAIS IV

"Digit Span" Working Memory subtest of WAIS IV