

# “The Quintessential Residents Sleep” Sleep Deprived Cognitive Impairment in Residents of a Large Teaching Hospital

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**Abstract:** ***Importance:** “Sleep Deprivation” is the most severe problem for residents in training which extends to experienced physicians and nurses. Called the ‘Achilles heel’ of the medical profession, resulting from extended work hours and circadian rhythm disruptions. **Objective:** To assess the level of attention deficit and information processing efficiency before and after duty cycles (Day & Night) among residents of anaesthesiology and other clinical specialties. To suggest recommendations based on the study findings, if any, to improve the working environment and efficiency of the residents. **Design & Setting:** A simple prospective observational study was performed in a 1200 bedded tertiary health facility and a teaching hospital. A total of 75 residents from departments of Anaesthesiology & Critical Care, Surgery, Medicine & Pediatrics were randomly included in the study. They were assessed for their cognitive functions at different time intervals using subjective and objective tests. **Main Outcomes:** Residents treating critical subjects were stressed as compared to those managing stable patients, causing a significant deterioration in their cognition. Those working in high dependency and critical units suffered more in terms of their cognitive deficit with passing duty hours and sleep deficit. Also the Female gender handled stress better. Meals in between duty hours offered a better prospect compared to those who skipped meals as far as their information processing efficiency was being judged. For the safety of the residents and their dependent patients, we need a serious consideration of this topic to provide a safe and comfortable environment for our patients and their doctors.*

**Keywords:** Cognitive functions, Residents, Sleep deprivation, stress

## 1. Introduction

Few people realize how important sleep is. Deficits in daytime performance due to sleep loss are experienced universally and associated with a significant social, financial and human cost. Fatigue may contribute to the human error component of medical errors.<sup>1-3</sup>The problem is most severe for residents in training. Sleep deprivation is a recognized hazard in aviation, aero-space, trucking, and the military and other industries.

Given this awareness, it is difficult to explain why physicians world over continue to work hours that far exceed the usual norms. The health profession needs to consider current accepted principles of human sleep requirements, the consequences of sleep loss, the regulations presently in force and some possible solutions.

Our simple, prospective, observational study (after prior approval of the college ethical committee) was performed in a 1200 bedded tertiary health facility and a teaching hospital.

Our Aim was to objectively, assess the level of attention deficit and information processing efficiency before and after duty cycles (Day & Night) among residents of anaesthesiology and other clinical specialties. To suggest recommendations based on the study findings, if any, to improve the working environment and efficiency of the residents.

## 2. Methods

### *Patient population*

A total of 75 residents from major clinical departments at a tertiary care centre and teaching hospital at Pune were randomly included in the study (2012 – 14). They were all working in the Intensive care units namely the Surgical ICU, Medical ICU, Paediatric ICU and the Neonatal ICU. They were introduced to the study design and the various tests for evaluation were conducted only after an informed consent.

### *Exclusion Criteria*

- Residents of non-clinical specialties
- Also individuals suffering from any neurological morbidity, on sedative medications or past head injuries were excluded from this study.

### *Methodology of Sample Processing/ Conduct of study*

The concerned residents were approached at three different time slots based upon their duty rosters in their respective intensive care or high dependency units in the hospital. They were assessed for their cognitive functions at the under mentioned time intervals:-

- 1) At the time of joining morning duty (returning fresh from home after a night’s undisturbed sleep).
- 2) After a full day duty starting from 0730hrs in the morning to 1700hrs in the evening.
- 3) After a full night duty when the resident was leaving back for his home the next morning.

They were given subjective questionnaires prior to the objective tests to know their demographic details. The questionnaires are attached as Appendix – ‘A’ to follow. After filling up the questionnaire, the following objective tests were performed

- 1) **Digit Repetition test**<sup>4</sup>- To assess the basic level of attention deficit
  - a) Digit repetition of up to 05 alphabets = Taken to be normal attention span were labeled as “NO ERRORS” in the tabulation of the results.
  - b) Inability to repeat more than five words = Taken to be an attention deficit and were labeled as “ERRORS at > 5” in the tabulation of results.
- 2) **Random Letter test**<sup>5-7</sup>- To assess the level of sustained attention
  - a) No error of any kind during the test was taken to be a normal level of sustained attention and vigilance.
  - b) Any error of omission, commission or preservation in the test = Taken to be a deficit in sustained attention or vigilance of the subject.
- 3) **Trail Making A and B**<sup>8-11</sup>- To assess the information processing efficiency
  - a) Both the tests were carried out after explaining to the subjects in details about the tests and all were timed using a standard stopwatch in seconds.
  - b) The time scores (in seconds) for both Trail making A & B in Part A of evaluation were taken as a standard control reading for the same individual and his following test scores for both these tests were compared to this initial score to assess the degree of deficit in the information processing efficiency over time.
  - c) In the tabulation of the results, the subsequent test timings were compared as a percentage increase from the baseline timings and were analyzed as a < 20% or a > 20% deviation from the standard individual timings (Appx – ‘B’).

### 3. Statistical Analysis

The data collected was entered using Microsoft Excel software. It was then analyzed using Epi – info package. The test results (DR, RL, TMA and TMB) were considered as outcome variables which were then cross tabulated with other parameters such as duty hours, rest hours, etc. (like cause effect analysis).

Proportion test (chi square test) was used to check the difference between percentages and appropriately interpreted. Non parametric test – Wilcoxon signed rank test was used to check the difference in scores of DR and RL between before and after comparison, eg: – before duty starts and after 8 hours of duty etc.

### 4. Results

Most of the residents were young doctors aged between 27-32 years with more Male residents (18) than Females (57). They were analyzed on the basis of

- The kind of patients they were dealing with during the course of their duties (**Stable Vs Critical**)
- The place of rendering their duties (**Acute wards/ ICUs/ OTs**)

- Their subjective assessment of how busy they were during the course of their duty (**Hectic vs Comfortable duty**)
- The various demographic subheads of **Gender differences**  
**Meals skipped or not**  
**The marital status of the sample residents**

#### Overall Error Trends

The level of attention deficit among the sample residents showed an increasing trend of committing errors as the duration of duty hours increased. It was statistically significant with p value of 0.011 and 0.0085 at the end of an 8h and a 36h duty respectively (Fig 1A).

The level of sustained attention or vigilance deficit among the sample residents, showed an increasing trend of committing errors as the duration of duty hours increased. It was statistically significant with p values of 0.0024 and 0.0245 at the end of an 8h and a 36h duty respectively (Fig 1A).

#### Stable Vs Critical Patients to Manage

Residents managing critical patients showed a continuous deteriorating trend in their attention spans after an 8h and further more after 36h duty, with significant p values of 0.049(Fig 1C). On the contrary, residents managing stable patients showed consistent attention levels even at the end of a 36h duty. They however had a dip in their attention levels at the end of an 8h morning shift (Fig 1B).

Residents who actively managed critical patients showed an incremental amount of vigilance deficit (Random Letter Test) as the duty hours prolonged with a significant p value of 0.018(Fig 1C). Those residents who managed stable patients however showed a dip in their vigilance levels after their initial 8hs duty. They however showed increased vigilance levels after a 36h duty (Fig 1C).

Residents managing critical patients showed deterioration in their information processing efficiency and executive functions after an 8h duty. This deficit further deteriorated after a 36h long duty (Fig 1C). On the contrary, the residents rendering medical care to the stable patients showed a marked deterioration too after an 8h and a 36h duty but the extent was limited as compared to those managing critical patients (Fig 1B).

#### Hectic Vs Comfortable Duty Hours

Results on account of subjective views on the type of duty the residents rendered, hectic or comfortable, showed a comparable level of deterioration in their attention deficits at the end of an 8h and a 36h duty. They were both equally impaired after their night duties (Fig 1D&1E).

Residents who subjectively had a comfortable duty showed no deterioration of their vigilance levels over increased duty timings. Their vigilance levels in fact improved as the duty hours prolonged (Fig 1D).

To the contrary, residents who had a hectic duty showed increased levels of vigilance deficit at the end of an 8h duty

and a further increase in the level of the deficit at the end of a 36h duty. This increase showed a significant p value of 0.0196 (Fig 1E). Evaluating our residents by the TMT A& B painted a similar picture as in the previous tests.

#### ***Duties in ICU Vs Acute Wards/ OPDs Vs Operation Theatre***

We selected residents working in the high dependency units like ICUs and compared them to those working in the Operation Theatres and the acute wards/outpatient departments. Results after an 8h duty highlighted an increased attention deficit among residents working in the acute wards/ OPDs as compared to those in the ICUs and the OTs. However, after a 36h duty, the level of attention deficit in the ICU residents overshoot those working in the Acute Wards and OPDs. They were both much higher than the residents who were in the OTs. Residents in the acute wards/OPDs showed a significant drop in their vigilance levels over an 8h duty period. The residents in the ICUs also showed a similar deterioration in the vigilance scores after an 8h duty. However, our residents in the OTs did fairly well in their vigilance scores after an 8h duty. These results were almost on the same lines as those of the Digit Repetition tests. After a 36h duty, our residents showed an exactly similar amount of vigilance deficit affecting majority of the residents working in the acute wards/ OPDs and the ICUs. Residents working in the OPDs/ Acute wards showed a greater and more significant amount of information processing inefficiency, poor scanning power and poor decision making at the end of a 36h duty. They offered a decent performance for the first 8hs of their duty but after a full 36h duty, they showed an appreciable amount of deficit.

#### ***Gender Differences***

Our evaluation showed that males had a progressive and significant deterioration of their attention spans as the duty hours increased from eight to thirty-six hours. Female residents on the other hand also had an attention deficit with prolonged duty hours, but showed better results when compared to their male counterparts.

Our analysis of the gender behavior on handling stress and sleep debt in terms of vigilance levels showed the ladies again to be the clear leaders at least for the first 8hs of duty. Their vigilance levels plummeted after completion of a 36h duty and they fared worse than the male counterparts did. On the contrary, the male residents showed a continuous and gradual deterioration of their vigilance levels after an 8h duty followed by a 36h duty. The study showed the female residents to be extremely blunted in terms of their information processing efficiency and executive inefficiencies after an 8h duty. This was exaggerated after a full 36h duty. Males on the other hand, showed no amount of deterioration at the end of a 36h duty in trail making A but showed a relevant amount of deterioration in the information processing skills in the Trail making test B.

#### ***Marital status***

Not much of a difference for both the category of samples. Both married and unmarried residents showed an equal amount of attention deficit after the end of an 8h and a 36h duty. The unmarried residents maintained their levels of vigilance though the course of their 36h duty. However, the

married residents showed a continuous deterioration in their vigilance levels over an 8h and then though the 36h duty period. Marital status had an effect on the stress and fatigue tolerance of our residents who showed an impaired information processing efficiency and poor executive powers amongst the married residents after a 36 h duty period.

#### ***Meals or No Meals***

Attention deficit among residents who skipped their major meals (lunch or dinner) during the course of their duty hours were compared to those who had adequate and timely meals during their duties. It was observed that residents who had their meals on time were more impaired after an 8h duty and further more after a 36h duty with a significant p value of 0.0327 as compared to their counterparts.

Analysis of the resident vigilance deficit taking into account their meal status showed results similar to those seen in the Digit Repetition test earlier. The residents who had meals showed a significant increase in errors after an 8h duty. It remained the same after 36h of duty. The effect of having or skipping major meals on information processing efficiency of our residents who were on prolonged duty hours were contrary to expectations. Residents who had their major meals on time showed much better results for information processing efficiency, scanning, decision making and executing functions when tasked. Their counterparts who had skipped their meals did land up with poor cognitive functions and slower reaction times too.

## **5. Discussion**

The overall error trends hinted at degraded performance by the residents including sustained attention or vigilance, decision-making, memory, reaction time, concentration and mood.<sup>12-13</sup> Low arousal produced by sleep loss is a major effect too.<sup>12</sup> Residents managing critical patients showed a consistently increasing deficit as the duty duration increased. Probably being on duty over an extended period does bring about some amount of execution problems amongst the workers but it probably multiplies if you tend to be on your toes managing critical patients who need constant support and observation round the clock. In general, regardless of the task, cognitive performance becomes progressively worse when time on task is extended; this is the classic "fatigue" effect, which is exacerbated by sleep loss.<sup>14-15</sup> Residents managing stable patients showed a dip in cognition after an 8hr routine but recovered after a 36hr duty. This was probably due to the hectic morning routine in a ward with ongoing rounds and fresh patient orders by the consultants. They probably recuperated from their cognitive deficit over the rest of the day and were back to their baseline levels of cognitive functions the next morning after their 36h duty.

Residents who had a hectic duty, showed a gross deterioration in their vigilance quotients, information processing efficiency, mental flexibility, scanning and executive functions after a 36h duty. Their counterparts on the other hand also showed deteriorated cognitive faculties but to a lesser extent after an 8h duty and a 36h duty. But either of the residents reflected a poor level of attention

deficit after a 36h shift. Residents offering service to HDUs/ ICUs/ OTs showed a deteriorating trends in their attention deficit, vigilance levels & information processing efficiency compared to those working in the acute wards, with the increasing duty hours. Our Anaesthesiology residents in the OTs however showed effective vigilant levels after an 8h shift compared to other residents.

Since our sample residents comprised of only 12 female residents among the total 50 residents being studied, it did not show significant p values but gave us an idea of the likely trend that is occurring. Further study on this aspect of gender tolerance towards cognitive impairment at work is needed. We noticed that female residents were tolerant towards an initial stress period but the males were ultimately more vigilant as the duty hours kept passing by. They indeed handled stress and their fatigue better than the female residents did as the duration of the duty hours increased. A larger gender equal sample size would be necessary for a more conclusive result. Probably our ladies were good in terms of attention spans but they were really poor in terms of carrying out or executing their jobs and scanning and recollecting things after a 36h duty when compared to their male counterparts.

Marriage status did not seem to affect the attention spans of our sample residents significantly. Probably it was the domestic commitments of everyday life, which actively played a part in the vigilance deficit experienced by the married residents. Our unmarried residents were performing well in terms of a better recollection, scanning and information processing. Probably the marital status did play an important part in the efficient working of our residents over prolonged duty hours.

Those who skipped meals also committed errors but were better than those who had eaten their meals. Apparently snacking was acceptable, but major meals caused the residents to become obtunded in terms of their attention spans. Those who skipped meals also showed deterioration but were less than their counterparts were. Probably a postprandial increase in the splanchnic circulation was responsible for this result, which made them sleepier and less vigilant during the course of their duties. Probably out here, the postprandial slowness was outdone by the brain receiving an adequate amount of blood glucose for its metabolism and smooth proper functioning. Those who provided poor nutrition to their brains without food were slow with an impaired cognitive response.

## 6. Conclusion

Sleep is quintessential to our lives and is a vital necessity. Though we all have different sleep patterns, sleep different amounts, and the quality of our slumber varies greatly, sleep is literally necessary to stay alive. Strangely, it is just as important as breathing.<sup>16</sup>

This study markedly compared the working of residents at their place of duty and the environment to which they were tasked. However, we evaluated a small sample size of residents, but it showed trends which require further evaluation using an appropriate sample size. May be a

change would help, but again, despite many anecdotes about errors that were attributed to fatigue, no study has proved that fatigue on the part of health care personnel caused errors that harmed patients. This particular area of interest needs further exploration and study.

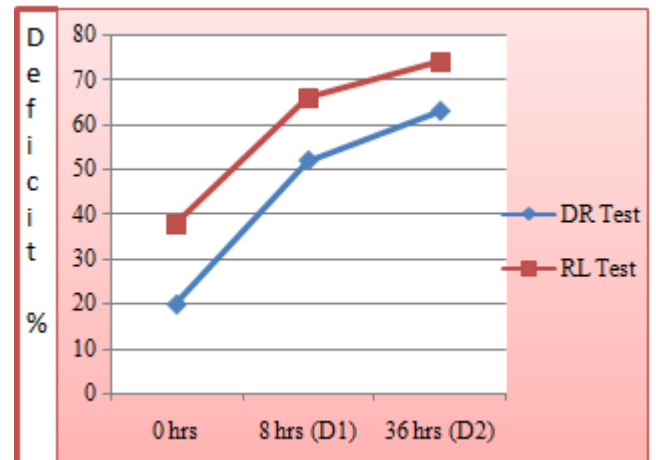


Figure 1 (A): Duty Duration (Day 1/ Day 2)

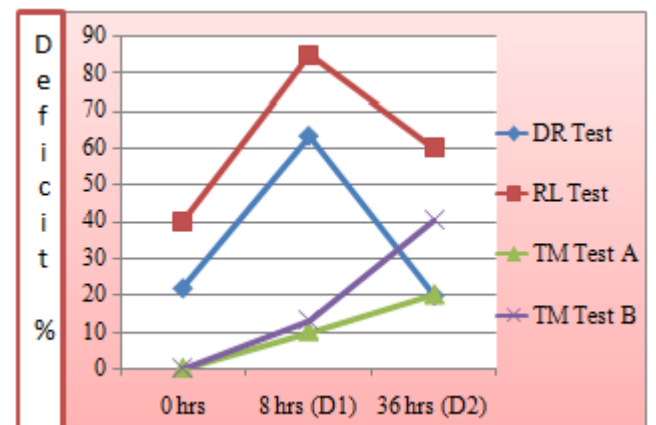


Figure 1 (B): Stable Patients-Duty Duration (Day1/Day2)

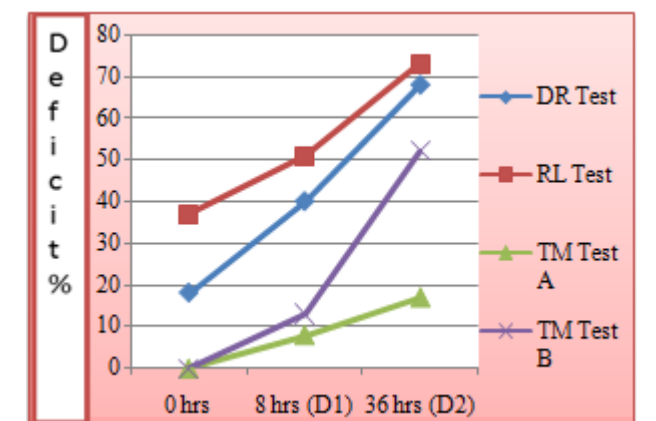


Figure 1 (C): Critical Patients - Duty Duration (Day 1/ Day 2)

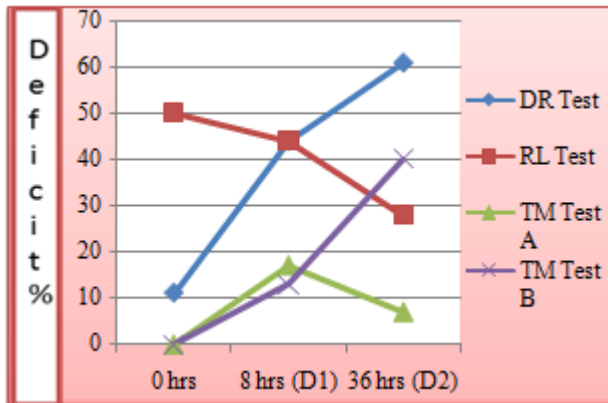


Figure 1 (D): Comfortable Duty hours (Day 1/ Day 2)

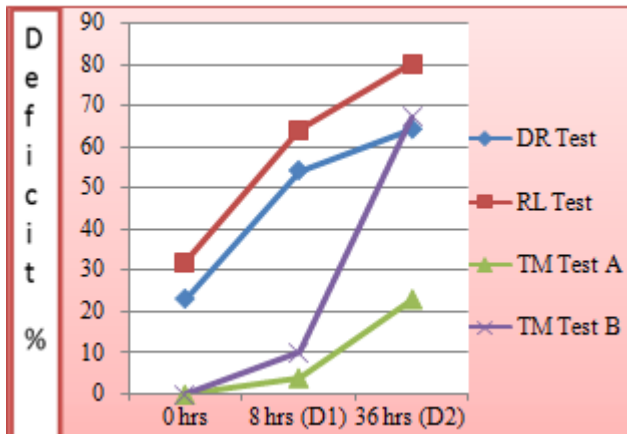


Figure 1 (E): Hectic duty hours (Day 1/ Day 2)

**Authors' Contributions**

Study concept and design: FBB  
 Application to ethics committee and authorities: AJ, FBB  
 Sample recruitment & Data acquisition : AJ, SJ  
 Data analysis and interpretation: AJ, FBB, SJ  
 Writing of the first draft of the manuscript: AJ, FBB  
 Critical revision of the manuscript for important intellectual content: FBB, SJ

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**Appendix 'A'**

**Questionnaire PART - I**

1. Subject No: \_\_\_\_\_ Date: \_\_\_/\_\_\_/200\_\_
2. Age: \_\_\_\_\_ yrs Service: \_\_\_\_\_ yrs
3. Gender: Male / Female
4. Marital Status: Married/Unmarried, Spouse's Occupation: \_\_\_\_\_
5. Any Alcohol intake during past 24 hs?
6. Co- morbidities:
  - a. Head Injury / Seizures / Sedative Medication
  - b. Others \_\_\_\_\_

- 7. Last Night Sleep: Adequate / Inadequate;
- 8. How many hours: <3hs / 3 – 5hs / >5hs

**Questionnaire PART – II**

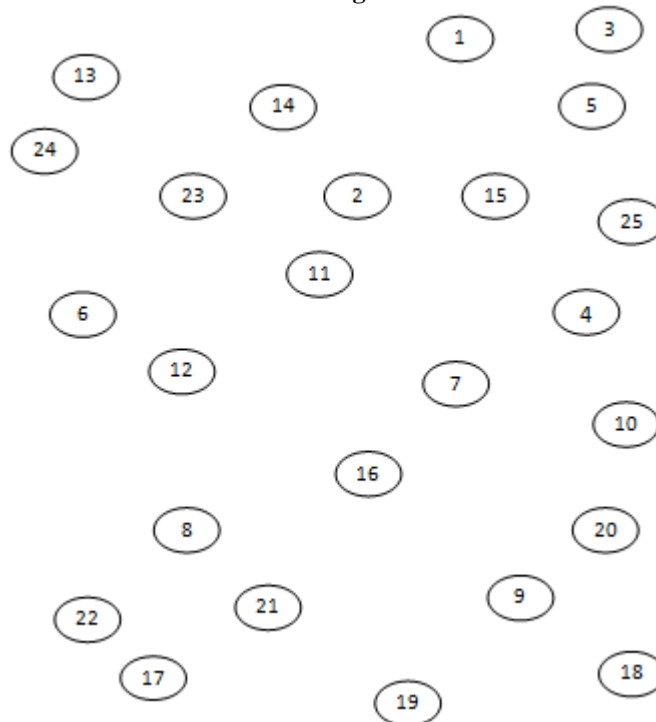
- 1. How was your duty today from 0800hs to 1600hs?  
Very Hectic / Hectic / Comfortable / Relaxed Duty
- 2. Where were you deployed for your duty today - Acute Ward / ICU / OT / OPD
- 3. How many patients did you see? \_\_\_\_\_
- 4. What was the predominant patient profile? Very Critical /Critical /Stable.
- 5. Did you get time for rest / break / Tea or coffee/ Lunch in between your work?  
- Yes / No
- 6. Did at any point of time you feel that you were stressed out and could no longer continue with your work? - Yes / No
- 7. Did you feel sleepy at any point of time? Yes / No
- 8. How are you feeling right now? - Sleepy/ Tired / Fresh / Active and energetic
- 9. If asked for right now do you feel you could continue duty for the night, or would it be a burden to you? - Yes / No

**Questionnaire PART – III**

- 1. Were you on duty last night? - Yes / No
- 2. Where were you deployed for your duty today? - Acute Ward / ICU / OT / OPD
- 3. How many patients did you see? \_\_\_\_\_
- 4. What was the predominant patient profile? Very Critical / Critical / Stable.
- 5. Was there any mortality? - Yes / No
- 6. Did you get to take a nap during your duty? - Yes / No,  
a. If Yes, for how Long? \_\_\_\_\_
- 7. Did you sleep continuously or interrupted? - Yes / No
- 8. Were you able to have your meals on time? - Yes / No  
b. If No, why not? \_\_\_\_\_  
c. Did you have a coffee break at some point of time? \_\_\_\_\_
- 9. Do you feel tired and stressed out after your duty today? - Yes / No
- 10. Do you feel sleepy? - Yes / No

**Appendix ‘B’**

**Trail Making Test - A**



Trail Making Test - B

