

# Cognitive and Psychomotor Function Changes Among Anesthesiology Residents After 12 Working Hours in Elective Anesthesia Service

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## Abstract

**Background:** The practice of anesthesia requires good awareness, parallel decision-making and fine motor skills. The duration of working hours of anesthesiology residents is often more than 12 hours.

**Objectives:** This study aimed to measure cognitive and psychomotor functions of anesthesiology residents after 12 working hours.

**Patients and Methods:** This was an observational study on anesthesiology residents who underwent 12 working hours. Each subject, who fulfilled inclusion and exclusion criteria, had their cognitive and psychomotor functions tested at 0 and 12 hours. The cognitive function was measured by "Cognitive Stimulation" test, while the psychomotor function was measured by the grooved pegboard. Statistical analysis was conducted to compare the results between 0 and 12 hours.

**Results:** Cognitive Stimulation" test revealed statistically significant decrease at sequential image frequency stimulation ( $P = 0.035$ ). Other stimulation tests did not show any statistically significant result. Grooved pegboard test showed statistically significant decrease in psychomotor function from 0 to 12 hours ( $P = 0.037$ ).

**Conclusions:** There was a decrease in cognitive function, including attention, visual memory, naming, and executive function, as well as psychomotor function among residents of Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Indonesia, who underwent 12 working hours.

**Keywords:** Anesthesiology, Executive Function, Psychomotor Performance

## 1. Background

Anesthesiology remains one of the occupations with high risks. Anesthesiologist is closely related with patient, medical equipment, surgeon and other health personnels in the operating theatre. Therefore, they need to have a constant awareness, ability to take decision and good motor skills. The working duration of anesthesiologist often lengthens. This long duration of work might lead to both physical and mental stress, which lead to fatigue (1-3).

Fatigue may lead to decreased effectivity, attention span, reaction time as well as awareness. These conditions may lead to dangerous misconduct, which leads to threatened patients safety. Previous studies mentioned that the risk of misconduct might increase exponentially every hour after 9 continuous working hours (1, 3).

Rogers et al. studied the association between duration of work between hospital nurses and patient safety. He mentioned that mistakes occurred three times higher after 12.5 working hours (2). Additionally, Trinkoff et al. mentioned that occupational hazard increased after 12 working hours among hospital nurses (4). Karanovic et

al. mentioned that cognitive and psychomotor functions decreased after 24 hours shift in comparison to those who worked in regular working hours (1).

Fatigue contributes to 60% of malpractice cases among anesthesiologists and 80% of anesthesia mismanagement cases. The Australian Incident Monitoring Scheme reported that fatigue among anesthesiologists contributed to 3% of incidence related to drug mismanagement, accidental needle puncture, unfocused monitoring and mistake during equipment check-up (2). Currently in Cipto Mangunkusumo Hospital, there is no occupational hazard in relation to fatigue. The residents in the Department of Anesthesiology and Intensive Care, Faculty of Medicine Universitas Indonesia, work from 7.00 am performing anesthesia service in the elective operating theatre based on the schedule given earlier. On January 2014, Operating Theatre in Cipto Mangunkusumo Hospital obtained anesthesia service for 18 days of 20 working days with average duration of more than 12 working hours/day. Heavy work load of anesthesiology residents in Cipto Mangunkusumo Hospital was influenced by the

amount of cases handled by this hospital as a national referral center. This meant that residents were expected to conduct anesthesia service for more than 12 working hours/day.

## 2. Objectives

This study aimed to compare cognitive and motoric functions of anesthesiology residents before and after working for more than 12 hours during elective anesthesia service.

## 3. Patients and Methods

This study was a prospective cohort conducted in Cipto Mangunkusumo Hospital from December 2014 to February 2015. This study obtained ethical approval from Ethics Committee of Faculty of Medicine Universitas Indonesia.

Study population was all residents in Department of Anesthesiology and Intensive Therapy, Faculty of Medicine Universitas Indonesia. Total sampling method was used to obtain sample. Therefore, the researcher obtained sample from all population using inclusion and exclusion criteria. Inclusion criteria included those who were in independent clinical posting, worked in Operating Theatre of Cipto Mangunkusumo Hospital daily for more than 12 working hours and willing to sign the informed consent. The exclusion criteria were anesthesiology residents who were in clinical posting outside Cipto Mangunkusumo Hospital, ICU clinical posting and endoscopy clinical posting. The drop out criteria included history of any illness in central nervous system (head injury, intracranial infection, stroke and brain tumor), diabetes mellitus, hypertension, severe depression, using recreational drugs, working hour less than 12 hours, resting time more than 1 hour, previous night shift and any disabilities or trauma on their dominant hands. The sample included were those who fulfilled inclusion and exclusion criteria.

The researcher obtained training in Department of Neurology Faculty of Medicine Universitas Indonesia/Cipto Mangunkusumo Hospital to study "Cognitive Stimulation" and grooved pegboard tests. Subject was asked to fulfill baseline demographic data. Both identity and re-

sult of the test would be concealed.

Data were collected through questionnaire for cognitive function using "Cognitive Stimulation" test. Cognitive function was assessed twice, at zero hour and twelve hours. Meanwhile, psychomotor function was assessed using grooved pegboard test. Similarly, grooved pegboard test was conducted twice, at zero hour and twelve hours. The result was displayed as numerical data and analyzed comparatively.

Data was collected manually using research form and transferred to electronic database for further analysis. Data was analyzed using Statistical Package for Social Sciences version 17.0 (manufactured by International Business Machines Corporation, United States of America). Numerical data with normal distribution was displayed as mean and its standard deviation. However, data with abnormal distribution was displayed as median and its minimum-maximum values. If data was normally distributed, paired t-test was used. Meanwhile, if data was abnormally distributed, Wilcoxon test was used. The result was considered significant if P-value was less than 0.05.

## 4. Results

This study was conducted in Department of Anesthesiology and Intensive Care of Cipto Mangunkusumo Hospital from December 2014 to February 2015. There were 34 subjects agreed to participate in this study with no drop out. Baseline characteristics, as shown in Table 1, revealed that all subjects aged 26 - 35 years and most were male (61.8%). During cognitive function assessment, all 34 subjects were able to finish the "Cognitive Stimulation" test at 0 and 12 hours. Nonparametric test was conducted for abnormal distribution data. However, there was no significant result. For placement orientation stimulation, all samples obtained 100% test result at 0 and 12 hours. Therefore, the comparison test could not be conducted. The results are shown in Table 2.

Meanwhile, for psychomotor function assessment, all subjects completed grooved pegboard test at 0 and 12 hours. The result is shown in Table 3 below. Paired t-test is shown in Table 4.

**Table 1.** Baseline Characteristics of Research Subjects

Characteristics	Values <sup>a</sup>
Age, years <sup>b</sup>	29 (2) <sup>c</sup>
<b>Gender</b>	
Male	21 (61.8)
Female	13 (38.2)
<b>Level</b>	
Level 1	21 (61.8)
Level 2	13 (38.2)

<sup>a</sup>Values are presented as No.(%).

<sup>b</sup>Normality test was performed using Shapiro-Wilk test.

<sup>c</sup>Median (Interquartile range).

**Table 2.** Cognitive Stimulation” Test at 0 and 12 Hours

Stimulation	0 Hour	12 Hours	P Value
Single flashlight, ms <sup>a</sup>	261.38 ± 66.79	247.44 ± 43.78	0.261
Double flashlight, ms <sup>a</sup>	392.79 ± 50.56	390.12 ± 45.89	0.055
Random number, ms <sup>a</sup>	317.41 ± 89.87	327.82 ± 89.78	0.614
Image frequency, % <sup>b</sup>	80 (40)	80 (20)	0.061
Sequential image frequency, % <sup>b</sup>	80 (40)	60 (25)	0.035
Orientation	100	100	N/A
Association, % <sup>b</sup>	80 (20)	80 (40) <sup>b</sup>	0.386

<sup>a</sup>Data are presented as mean ± SD; tested using paired t-test.

<sup>b</sup>Data was served as median (interquartile range); tested using Wilcoxon test.

**Table 3.** Grooved Pegboard Test Results at 0 and 12 Hours<sup>a</sup>

Age	0 Hour		12 Hours	
	Subjects (s)	Reference (s)	Subjects (s)	Reference (s)
Aged 20 - 29 years	53.69 ± 4.9	63.4 ± 7.9	56.15 ± 4.2	63.4 ± 7.9
Aged 30 - 39 years	53.98 ± 8.3	62.95 ± 8.4	55.78 ± 6.8	62.95 ± 8.4

<sup>a</sup>Data are presented as mean ± SD.

**Table 4.** Paired T-test for Psychomotor Function Changes

Subjects	0 Hour (s)	12 Hour (s)	P Value
All subjects	53.80 ± 6.3	56.01 ± 5.23	0.037 <sup>a</sup>

<sup>a</sup>Paired t-test.

## 5. Discussion

Research subjects in this study included all residents in the Department of Anesthesiology and Intensive Care, Faculty of Medicine Universitas Indonesia, who fulfilled the inclusion and exclusion criteria. The mean age of all subjects was 29.24 years and most of them were male (61.8% male vs. 38.2% female). Similarly, Karanovic et al. mentioned in their study that most subjects were male and aged 35 - 50 years old (1). The subjects in this study were all in level 1 (61.8%) or 2 (38.2%), because these residents were in their independent clinical posting in Department of Anesthesiology and Intensive Care, Faculty of Medicine Universitas Indonesia.

Single flashlight stimulation during “Cognitive Stimulation” test measured attention and visual motor reaction. Meanwhile, double flashlight stimulation measured attention, visual capability and visual motor reaction. Random number stimulation measured visual memory and visual motor reaction. For all components of “Cognitive Stimulation” test, there was no significant difference between 0 and 12 hours ( $P > 0.05$ ).

Image frequency stimulation test showed abnormally distributed data. Therefore, nonparametric test was conducted. Image frequency stimulation test measured visual memory, naming and executive function. Similarly, sequential image frequency stimulation test, which mea-

sured attention, visual memory, naming and executive function, showed abnormally distributed data. This study found significant differences for sequential image frequency between 0 and 12 hours for all subjects ( $P = 0.035$ ).

Orientation stimulation measured visual memory and visuospatial. All subjects generated 100% results for 0 and 12 hours. Therefore, the comparison test could not be conducted. Association stimulation, which measured association and memory strategy function showed abnormally distributed data. Nonparametric test showed no significant difference between 0 and 12 hours.

Based on “Cognitive Stimulation” test, only sequential image frequency test showed significant decrease between before and after working hours. This stimulation had the most functions measured compared to other stimulation tests. To compare with image frequency stimulation test, sequential image frequency test had enhanced attention function. Therefore, this stimulation was more complex compared to other stimulation tests. Executive function covered initiation capability, planning, problem solving, decision making, idea, perception and abstraction. Accordingly, anesthesiologists required skills including constant awareness as well as making appropriate decision.

The subjects in this study obtained 100% results for orientation stimulation. Visuospatial function measured in this stimulation meant the ability to measure the space or environment orientation, including visual construction ability (drawing or stacking images/shapes), spatial attention and visual recognition. Visual attention was more activated by right hemisphere. Stimulus obtained by primary visual cortex in occipital lobe would be associated to dorsal pathway at the posterior parietal cortex for object orientation and ventral pathway at the inferior temporal cortex for shape, color and texture identification. This stimulus would be stored as working memory in the prefrontal cortex. This study found that the visual memory and visuospatial did not change after 12 working hours.

Karanovic et al. also mentioned significant cognitive function decrease among anesthesiologists who worked in 24 hours shift. Differently, this study used computer program called Complex Reactionmeter Drenovac (CRD), which measured perceptive ability (visual orientation, spatial visualization, detection and identification), memory, operative and convergent thinking ability, problem solving, attention and functional deficit (agitation, rigidity, regression and preservation) (1).

This study measured psychomotor function using grooved pegboard test. This test required more complex visual and motoric coordination compared to any other pegboard test. The present study mentioned that subjects aged 20 - 29 years and 30 - 39 years obtained faster results compared to the reference score. The subject who finished the grooved pegboard test the longest was still within the standard deviation of the reference score. Therefore, all subjects in this study finished the grooved pegboard test with duration within the reference score of the grooved pegboard test. This showed that psychomotor function of all subjects was relatively decent even after 12 working hours.

Statistical examination using paired t-test showed significant decrease between 0 and 12 hours with dominant hand ( $P < 0.05$ ). Similarly, Lederer et al. found significant decrease in psychomotor function among anesthesiologists who finished 24 hours shift (5). Karanovic et al. also mentioned statistically significant decrease in psychomotor function among anesthesiologists who worked for 24 hours. They also mentioned that the decrease of psychomotor function happened after 7 hours of working (1).

Even though, there was a significant psychomotor function decrease, all the results from the subjects were still within the reference score. This showed that psychomotor function of all residents after working for more than 12 hours was still appropriate for work. Further studies should be conducted to assess which work duration subjects had declined psychomotor function. There was no standardized reference score of grooved pegboard test for anesthesiologist.

The limitation of this study was that the "Cognitive Stimulation" test was not the diagnostic instrument to measure cognitive function. Additionally, there was no standardized reference value to detect any decreased cognitive function. One of the alternative instruments that could be

used to measure cognitive function objectively was P300 as used by Medvidovic et al. (6). This study did not measure external factor, such as caffeine consumption, which might serve as a potential bias. Phillip et al. mentioned that consumption of 200 mg caffeine decreased error during driving in highway (7). This study did not include psychological stress of each subjects. This was because depression might decrease cognitive function (8).

There was a decrease in cognitive function, including attention, visual memory, naming and executive function, as well as psychomotor function among residents of Department of Anesthesiology and Intensive Care, Faculty of Medicine, Universitas Indonesia, who worked for 12 hours.

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## Footnotes

**Authors' Contribution:** Study concept and design: Aries Perdana, Alfian Mahdi Nugroho, Ade Ariadi, and Diatri Nari Lastri; analysis and interpretation of data: Aries Perdana, Alfian Mahdi Nugroho, Ade Ariadi and Diatri Nari Lastri; drafting of the manuscript: Aries Perdana, Alfian Mahdi Nugroho, and Ade Ariadi; critical revision of the manuscript for important intellectual content: Aries Perdana, Alfian Mahdi Nugroho, Ade Ariadi, Diatri Nari Lastri; statistical analysis: Aries Perdana, Alfian Mahdi Nugroho, Ade Ariadi.

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