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The Effects of 120-Minute Nap During Simulated 16-Hour Night Work: A Pilot Study

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Introduction

In Japan, many nurses work on two- or three-shift systems. In two-shift systems, there are two major forms of night shifts: 12-h shifts and 16-h shifts. In particular, sixteen-h night shifts, which are longer than 12-h night shifts, are also a burden for nurses both physically and mentally. Previous research has indicated that nurses on such schedules are troubled by morning sleepiness and fatigue, which can increase the risk of traffic accidents after work. People recover from the fatigue caused by the activity of sleeping at night when the body temperature is low.

There has been an interest in the effects of taking a nap during the night shift as a means of recovering from night shift fatigue. Informally, nursing staff at public hospitals are usually allowed to sleep or rest up to 2 h during 16-h night shifts and many nurses nap during the night shift. And it is common for nurses to nap between 22:00 and 06:00. However, the effects of napping have been shown depending on the starting time of the nap. A brief nap, with 60-min naps, there is a problem with residual sleepiness due to sleep inertia. Sleep inertia is the grogginess and disorientation we feel when first waking from a nap. To minimize sleep inertia, sleeping for 90 min (i.e., one cycle), is considered appropriate.

The purpose of this study is to systematically investigate, for the first time, performance and subjective sleepiness following a 120-min nap starting at 22:00, 00:00, or 02:00.

Methods

Sample and data collection

The participants were 14 females (mean age 21.7±0.9). They have no previous night shift experience, and the study took place during their summer vacations.

The participants were randomly assigned to either the nap condition. The participants conducted the experiment three times, each of which included 120-min nap at different times, and randomly assigned using counterbalancing. Participants were non-smokers, non-obese (body mass index ≤ 25), and consumed low amounts of coffee and alcohol. They had normal sleep patterns (habitual sleep ranged between 7 and 9 h), and were not under medication. Data collection began 2 days before the experiment, with an ActiGraph worn on the wrist and diary to record activity and sleep. This study was approved by the Ethics Committee for Epidemiologic Research at Okayama University Graduate School of Health Sciences. All participants provided informed consent prior to study involvement.

Study design

Participants resided in a windowless and sound-insulated sleep laboratory for 2 consecutive days (1 night).The measurements for one experiment were conducted over 2 days, between 16:00 and 09:00. The three conditions were 2-h naps from 22:00-00:00 (22:00-NAP), 00:00-02:00 (00:00-NAP), and 02:00-04:00 (02:00-NAP). At the start of the experiment, the participants were fitted with an Active Tracer and an ActiGraph. For each hour throughout the experiment, 20 min was measurement time in which the participants recorded their body temperature once, completed a VAS on sleepiness and fatigue for 10 min, and were asked to perform single-figure mental arithmetic tasks for 10 min. The next 20 min was free time, and the remaining 20 min was rest time. The Active Tracer AC-301 was removed at the end of the experiment, but the participants were requested to keep wearing the ActiGraph unit until they woke up the following day. Participants were randomly assigned to one of the three nap conditions with three participants in each night. There was an interval of at one month between different conditions.

Measurement

1) Performance test

Unless napping, participants performed single-figure mental arithmetic tasks for 10 min every hour. The number of calculations carried out in 10 min, which was considered to be the participant's workload at that time.

2) Subjective measures

Sleepiness and fatigue were assessed subjectively using a Visual Analog Scale (VAS).

3) Physiological measures

The circadian rhythm of body temperature is one of the most common indicators of circadian rhythmicity, and body temperatures is indicator of arousal level (i.e, temperature become low is increase sleepiness). Sublingual temperature was measured as an index of internal body temperature. The Active Tracer AC-301 (GMS Inc., Tokyo, Japan) was used for the electrocardiograph (ECG). In this study, heart rate variability (HRV) was obtained through autoregressive (AR) analysis of the R-R intervals measured from 16:00 to 09:00.

Statistical analysis

Demographic and response variables were described based on level of measurement. Mean and standard deviations were calculated for VAS. One-way analysis of variance tests (ANOVA) were used to compare variables between conditions. The analysis was done with the experimental period divided into 00:00-02:00, 02:00-04:00, or 04:00–09:00 time blocks.

In order to test the effect of a nap on neurobehavioral outcomes during the sleepiness and fatigue measurement period, a fully saturated, linear mixed-effects ANOVA) with a between-participants fixed effect of condition (22:00-NAP, 00:00-NAP, 02:00-NAP) and a within-participant fixed effect of time and random intercept were used. Within-condition comparisons were chosen in order to minimize the influence of individual differences. Statistical analyses were performed using IBM SPSS statistics software version 22.0J (IBM, Tokyo, Japan). The hypothesis rejection level for all tests was set at $p < 0.05$.

Results

There were no significant differences between conditions for baseline variables (at 21:00) on the day of the experiment.

During simulated 16-h night shifts (16:00 to 09:00), total sleep time, sleep latency, sleep efficiency and autonomic nervous system did not differ for the three nap conditions when naps were taken on various days.

However, among the 14 participants assigned to the nap condition, three participants in the 22:00-NAP and two participants in the 02:00-NAP could not sleep, and their sleep latency as measured by the ActiGraph was over 30 min.

Temperature

From 04:00 to 09:00, the 22:00-NAP condition was significantly lower than the 00:00-NAP and the 02:00-NAP condition ($p < 0.05$). Comparing before and after nap, temperature became significantly lower after the 22:00-NAP and 02:00-NAP conditions ($p < 0.05$).

Subjective measures

For sleepiness, in the 02:00-NAP condition was significantly worse at 02:00 compared to at 00:00 ($p = 0.030$). There was no change across time for the 22:00-NAP condition. From 02:00 to 04:00, there were no significant change from 22:00-NAP condition and 00:00-NAP condition. From 04:00 to 09:00, for the 22:00-NAP, there was a significant worse from 06:00 to 09:00 ($p < 0.01$) compared with 04:00. The other hand, in the 00:00-NAP condition was worse at 09:00 ($p = 0.001$), and 02:00-NAP condition was obtained no significant worse.

For fatigue from 00:00 to 02:00 and 02:00 to 04:00, there were a no significant. However from 04:00 to 09:00, the 22:00-NAP condition was significantly worse than the 00:00-NAP and the 02:00-NAP condition ($p < 0.001$). Furthermore, at 08:00 and 09:00 were significantly worse than at 04:00 ($p < 0.01$).

With sleepiness and fatigue, comparing pre- and post-naps, there were no significant differences were observed with any of conditions.

Neurobehavioral measures

For number of correct responses on calculations. From 00:00 to 02:00 and 02:00 to 04:00, there were a no significant. From 04:00 to 09:00, the 22:00-NAP condition was significantly decrease than the 00:00-NAP and the 02:00-NAP condition ($p < 0.001$). Further, from 07:00 to 09:00 were significantly decrease than at 04:00 ($p < 0.05$).

With calculations, comparing pre- and post-nap, there were significant differences were observed all of conditions ($p < 0.01$).

Discussion

This is the first study to have investigated whether 120 min naps ending at 00:00, 02:00 or 04:00 result effect of sleepiness, fatigue and performance from 16:00 to 09:00.

In the 22:00-NAP condition, the temperature increased with at 03:00, and the sleepiness, fatigue, and performance worse at 04:00. The 22:00-NAP inhibited sleepiness and performance deterioration through 04:00. In the 00:00-NAP on the other hand, the effect of napping was sustained through 06:00. Between 06:00 and 09:00, the temperature was significantly lower in the 22:00-NAP than in other conditions, sleepiness and fatigue increased. The number of calculations performed was significantly better in the 00:00-NAP and the 02:00-NAP than in the 22:00-NAP, showing that performance was sustained during 06:00 to 09:00. Thus, the subjective fatigue at 02:00 to 06:00 suggests that a later nap will better sustain performance in the early morning compared to an earlier nap. Moreover, if decreases in sleepiness and fatigue and sustained performance are to be expected from 06:00 to 09:00 in the 22:00-NAP, it may be necessary to add a short nap between 04:00 and 06:00.

In workplace scenarios where there is an opportunity for long breaks (> 2 h), longer naps may produce benefits immediately and over longer times.

Title:
The Effects of 120-Minute Nap During Simulated 16-Hour Night Work: A Pilot Study

Keywords:
night shift worker, nurse and subjective performance

References:
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Abstract Summary:
In nursing education, I think it is important to protect nurses' health in shift work and to educate students on measures to prevent medical accidents during night shifts. I am going to provide information on construction of nursing system.

Content Outline:
Ⅰ. Introduction

A. The purpose of this study is to systematically investigate, for the first time, performance and subjective sleepiness following a 120 min nap starting at 22:00 (22:00-NAP), 00:00 (00:00-NAP) or 02:00 (02:00-NAP).

B. I will investigate whether sleep inertia can be seen after a 120 min nap.

Ⅱ. Body

A. Main Point ＃１. The effects of nighttime napping on sleepiness, fatigue, and performance during simulated 16 h night work.

1. Supporting point #1. The effects of nighttime napping on sleepiness and fatigue.
   a) Between 06:00 and 09:00, the temperature was significantly lower in the 22:00-NAP than in other conditions, sleepiness and fatigue increased. Thus, the subjective fatigue at 02:00 to 06:00 suggests that a later nap will better sustain performance in the early morning compared to an earlier nap.
   b) The number of calculations performed was significantly better in the 00:00-NAP and the 02:00-NAP than in the 22:00-NAP, showing that performance was sustained during 06:00 to 09:00.

B. Main point ＃2. The sleep inertia can be seen after a 120 min nap.

1. Supporting Point #2. Sleep inertia.
   a) Comparing before and after 120 min naps, in all of conditions, there were significant no increase in sleepiness and fatigue, but the performance were significant decrease.

Ⅲ. Conclution

A. It was suggested that the increased sleepiness and fatigue, and decreased performance observed from 06:00 to 09:00 in the 22:00-NAP condition. In the early morning, the 00:00-NAP and the 02:00-NAP condition, seemed to be effective than the 22:00-NAP condition.
B. In all of conditions, there were significant no increase in sleepiness and fatigue, but the performance were significant decrease. In other words, although after waking is not conscious of sleep inertia, it is suggested that work efficiency may decrease.

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Author Summary: As the number of shift workers increases, there are many fears that shift work presents a threat to workers' health. It has been shown that people working rotating shifts are more prone to health problems than those working regular daytime hours. I want everyone to know about the night shift fatigue and sleepiness mitigation measures so that nurses can work healthily.