

The Impact of Shift Work and Sleep Breathing Disorders on the Employee

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Introduction

Concerning the normal changes of circadian rhythm, sleep physiology and social factors, of the human being it is of natural to work at day time and rest at night. Approximately one fifth of all employees are engaged in a night shift in western countries. For more profit, employers frequently ask the employee to increase working hours instead of hiring new manpower for an increasing working demand at night. Evidence showed that shift workers have a huge impact on their physical and mental health. They have lower life and sleep quality. They frequently suffered from “fatigue” at working hours. They have a higher incidence of mental abnormality such as anxiety, depression and neuroticism. There is also increasing evidence that shift workers have a higher cardiovascular events and possibly higher gastrointestinal disorders. Female shift workers also suffer from a higher incidence of spontaneous abortion, low birth weight, and prematurity. More than the personal health, shift workers were also noted to have a higher risk of accidents on working place and on traffic. Working performance and productivity are also lower in the shift workers.

Sleep breathing disorders (SBD), a prevalent sleep disorder with severe consequence, were proved to have influence on the performance on work, increase the risk of accident and absenteeism, and decrease the quality of life and sleep. How the shift work schedule associated with SBD influences the shift workers is also an important

issue for study.

The workers in Taiwan face the increasing demand and problems from shift work schedule. From the report of the Institute of Occupational Safety and Health (IOSH) of Taiwan, the workers in Taiwan sleep 7.3 hours on a weekday and 8.4 hours on weekend. Shift workers are increasing rapidly with the social and commercial development in recent years. 16.8% of employees have to work on a night shift or rotating shift. In these shift workers, more than 30 % of the employees complain insufficient sleep. Female (33.4%) and so called white-collar workers (34.4%) have a higher percentage to complain of insufficient sleep. Service section has less sleep than the plant company. High education and more professional workers also suffered from insufficient sleep than others.

The Taiwan Occupational Survey

To evaluate the impact of night shift associated with SBD on the general health and sleep quality, we cooperated with the IOSH to design the following research to survey the health condition of the shift workers in Taiwan.

1. *Validation of the evaluation tools.*
 - a. Chinese version of Epworth Sleepiness Scale, Chinese version of Snore Outcome Survey was validated according to the standard procedure: forward, backward, and pretest steps for instrument translation. Test-retest reliability, internal consistency, validity and responsibility were all performed for these tools before evaluation. All these validated results were also published in an international journal.
 - b. Chinese version of Sleep quality (Pittsburg Sleep quality Index) was chosen as another screening tool to evaluate the sleep quality of the workers. We also

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requested for the permission from those who have the authority to use it.

2. *Development of a screening model:* to predict the possibility and severity of sleep disordered breathing by these validated tools.
 - a. Owing to the time and labor consumed by the standard procedure-overnight PSG, we believe that a stepwise approach with proper risk stratification strategy can overcome the limitation of individual screening tools to optimize effectiveness of the whole prediction algorithm. A two-tier screening model for adults with sleep-disordered breathing using the basic information, these validated tools and pulse oximetry were developed.
 - a. In the 1st-tier screening, we formulated the basic clinical information (gender, age, and body mass index-BMI), Epworth Sleepiness Scale (ESS), and Snore Outcome Survey (SOS) with an aim to maximize screening sensitivity; patients with low risk for sleep apnea will be exempted from PSG-testing.
 - b. In the 2nd-tier screening, we applied the pulse oximeter to identify patients with high risk for severe sleep apnea by maximizing screening specificity. The objectives of this 2-tier screening strategy are to exclude patients at low risks of sleep apnea, and to prioritize patients at high risks of severe sleep apnea for early PSG testing.

We tested our hypotheses in this study to investigate whether this 2-tier screening algorithm can achieve its goals to fulfill the demands for large-scale community or occupational screening in the future.

- c. Tier-1: 355 patients with symptomatic sleep problems (312 males and 43 females) were included. Patients all received standard overnight in-lab polysomnography (Nicolet, Nicolet Inc. Madison, WI) to obtain at least 6 hours of sleep data recording. The sleep respiratory disturbance index (RDI) obtained from polysomnography is used as the golden standard for data analysis. All the information mentioned above was obtained. A multivariate regression model was applied to investigate the association between RDI and various OSAS-related factors. Using RDI of 5 episodes/hour as threshold to define "OSAS". A logistic regression model was applied to investigate the probability of various OSAS-related factors in predicting OSAS. We used

receiver operating characteristic (ROC) curve to determine the diagnostic thresholds for SOS and ESS that are more likely to differentiate "OSAS" from "non-OSAS". The area under curve (AUC) was demonstrated. The sensitivity, specificity, positive and negative predictive values (PPV and NPV) of different possible SOS and ESS combinations was calculated. Using the boot-trap technique to identify the cut-off point, the optimal SOS and ESS combination would maximize the sensitivity of this model to include as many OSAS patients as possible. The aim of this step was maximize the model sensitivity.

- d. Tier-2: 100 patients were randomly selected (83 males and 17 females) from the predicted positive population (RDI \geq 5) of the 1st tier screening. Patients underwent overnight (at least 6 hours) pulse oximetry monitoring and recording. Desaturation of oxygen by 2,3, and 4% (oxygen desaturation index of 2,3, and 4%; DI2, DI3, and DI4) were defined as an episode of respiratory disturbance in this study. Patients received pulse oximeter examination simultaneously with in-lab polysomnography. We used receiver operating characteristic (ROC) curve to determine the most accurate diagnostic desaturation thresholds to differentiate "severe OSAS" from "non-severe OSAS". We found DI3 to have the best predictive values for the gold standard-RDI in PSG. Using RDI as dependent variable, and using DI3 as independent variables; a multivariate regression model is applied to investigate the association between RDI and DI3. The aim of this step is to maximize the model specificity.
3. *Developing the software:* software was developed for data collection, screening and automatic calculation and automatic reporting.

A Microsoft Access base data banking software is development according the procedure to collect the data from the worker. All the evaluation questionnaire and basic information were automatically collected into to the database after inputs from the employee. The data from pulse oximetry were also automatically retrieved into the software by the technique of data mining. The estimated RDI and the probability of developing sleep apnea were calculated by the software. Reports for the whole company were automatically developed and the interpretation was done by the sleep specialist and suggestion also supplied to the company for a better shift work schedule. A pooling of data and the distribution of

the individual employee was also produced and an individualized report was also automatically created and a suggestion was given. The software was shown in the presentation.

4. *A petroleum company was selected for the evaluation.* They have oil trunk drivers, employees working at high tower and high temperature environment. They also have employees working in the office on a normal daily schedule. The questionnaires in the computer were issued to all the 5 branches of the company.

5. Results

a. General information of the participants

All the workers of the petroleum company were invited to participate the survey. 1020 out of 1796 workers agreed to be included into the study. Informed consent was given in advance. The mean age was 44.5 ± 7.7 years. The mean body mass index is 24.4 ± 2.8 . 985 (96%) workers are male.

- b. Comparison between shift workers with daytime workers was done

General Data

Comparison was done of the basic information between shift workers with the daytime workers. The shift workers were younger than the daytime workers (44.2 ± 7.3 vs. 45.3 ± 7.7 $p=0.03$). Shift workers also had higher percentage of male workers. The Body mass index (BMI) was the same in the two groups. Shift workers had a lower educational level than the daytime workers.

General Health Information

Shift workers had a higher systolic blood pressure than day workers. They also had higher incidence of hyperlipidemia, hyperuricemia, and pulmonary disorders. Shift workers took more drinks with caffeine. They also had significantly higher numbers of traffic accidents. About the subjective life quality, shift workers carried a less satisfactory quality of life.

Sleep Quality

Shift workers also faced a worse sleep quality as assessed by sleep questionnaire evaluation (PSQI): They experienced worse subjective sleep quality, longer sleep

latency, shorter sleep duration and poor sleep efficiency. They felt more disturbances during sleep and have worse daytime function.

Other Subjective Evaluation: (ESS and SOS)

Employees of shift work schedule also felt sleepier and snored more severely than the employees with daytime schedule.

The Severity of Sleep Disordered Breathing

By using the predicting model that we developed, shift workers had a higher percentage of severe sleep disordered breathing. The estimated RDI in the shift workers was significantly higher than the daytime workers.

c. The Impact of the Rotating Pattern of Shift Work on the Sleep Quality

Further analysis of different rotating schedule (day workers vs. 2-5 days shift vs. more than 5 days shift), we found that workers of 2-3 days shift workers suffered the worst sleep quality (by PSQI). All domains in PSQI including subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication and daytime dysfunction were lowest in the 2 to 5 days shift workers. The 2-5 days shift worker also had a higher score of sleepiness (ESS) and worse score of snoring (SOS). Also, shift workers of 2-5 days rotating schedule have a higher percentage to suffer from severe sleep breathing disorders.

d. The Association of Shift Working with SDB

Both Shift schedule and sleep disordered breathing have huge impact on general health and sleep quality of the subjects. It is interesting to put these two factors together into consideration. So we divided these workers into four groups: group 1: day time workers with low estimated RDI (<30), group 2 day time workers with high RDI (>30), group 3: night shift workers with low RDI, and group 4: night shift workers with high RDI. We found the worker with night shift along with severe

SDB (estimated RDI >30) had a significantly worse general health than the other group. Workers of group 4 took more medicine for refreshing and drink containing caffeine. Workers of group 4 also experienced higher chance of traffic accidents.

General Health

In systolic (SBP) and diastolic (DBP) blood pressure, group 4 is significantly higher than group 1 and 3, group 2 also having a higher SBP than group 1. Workers of group 1 had a significantly lower level of fasting sugar than groups 2 and 4. In subjects reporting chronic disease, workers of group 4 had a higher percentage of hypertension, cardiac arrhythmia, hyperlipidemia, hyperuricemia, peripheral vascular disease and pulmonary disease.

Sleep Quality

As observed in shift workers, the workers of group 4 had the worst sleep quality in all domains of PSQI. When comparing the sleepiness scale, group 4 had the higher scale in ESS, than the other groups. Workers of group 2 also had a higher ESS score than the groups 1 and 3.

Conclusion

Shift work is frequent and necessary in the modern society. Shift workers suffer from a worse sleep quality than day workers. 2 to 5 days rotating shift is the worst schedule for the workers to tolerate. They have the worst health and sleep quality. The employee working in a shift schedule is associated with a high possibility of SDB, exposed to a higher risk of developing poor general health and sleep quality. It is important to understand the impact of shift schedule and sleep breathing disorders on the worker's general and mental health. A better shift schedule and coping strategy are very important to improve the general health of the employee and the productivity of the company.