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Sleep, Mental Health Status, and Medical Errors among Hospital Nurses in Japan

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Abstract: Medical error involving nurses is a critical issue since nurses' actions will have a direct and often significant effect on the prognosis of their patients. To investigate the significance of nurse health in Japan and its potential impact on patient services, a questionnaire-based survey amongst nurses working in hospitals was conducted, with the specific purpose of examining the relationship between shift work, mental health and self-reported medical errors. Multivariate analysis revealed significant associations between the shift work system, General Health Questionnaire (GHQ) scores and nurse errors: the odds ratios for shift system and GHQ were 2.1 and 1.1, respectively. It was confirmed that both sleep and mental health status among hospital nurses were relatively poor, and that shift work and poor mental health were significant factors contributing to medical errors.

Key words: Medical errors, Mental health, Nurse, Shift work, Sleep problems

Introduction

Tiredness and sleepiness are known to be associated with the incidence of accidents. A report by the Association of Professional Sleep Societies concluded that nighttime operator fatigue and sleepiness contributed to some of the most serious incidents worldwide, including the Chernobyl, Three Mile Island and Challenger disasters[1)]. These accidents are considered to have been linked to tiredness in staff caused by shift work patterns.

Compared to non-shift workers, shift workers have poorer quality of sleep, are less likely to feel refreshed after waking and often complain of sleeping difficulties or sleepiness[2)]. Several surveys of shift workers have found that those who work night shifts are more likely to complain of sleepiness at work[3–5)]. Sleep after night work tends to be shorter than sleep after day work, leading to greater cumulative sleep deprivation[3, 6)]. Alertness while at work is also affected, with employees showing less alertness during night shifts[7)]. In addition, shift workers tend to perform less well on reasoning and unstimulating tasks than non shift workers[4, 5)].

Nurses need to have good concentration, sound judgment and quick reaction times, particularly in emergency situations. Any deterioration of attention, memory or coordination may affect performance and lead to errors. Accordingly, research into the signs, prevalence, and impact of sleep deprivation and the associated problem of sleepiness is important if medical errors linked to sleep deprivation are to be effectively decreased or prevented.

Gold and colleagues administered a questionnaire to nurses at a large academic hospital and found that, compared with nurses who predominantly worked day shifts, those nurses who worked a rotating schedule generally got less sleep and were more likely to fall asleep at work. Moreover, they were nearly twice as likely to report committing a medication error[8)]. Excessive daytime sleepiness has been cited as an important occupational health issue in hospital nurses[9)], and it has been suggested that the tiredness and sleepiness brought about by sleep disorders might be associated with occupational accidents[10)].

Sleep disorders are also linked to depression. Nurses experience depression more frequently than employees

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in other occupational sectors[11]. Pilcher *et al*. demonstrated that mood is more affected by sleep deprivation than either cognitive or motor performance[12], and Kripke also reported an association between sleep duration and depression[13]. Indeed, Suzuki *et al*. have demonstrated that the mental health of hospital nurses is relatively poor (as revealed by a relatively high mean General Health Questionnaire (GHQ)-12 score) and that mental health is a factor that appears to be associated with occupational accidents among nurses[14]. Thus, depressed mood can also be seen as one of the important factors contributing to occupational accidents.

Medical error involving nurses is a critical issue since nurses' actions will have a direct and often significant effect on the prognosis of their patients. To investigate the significance of nurse health in Japan and its potential impact on patient services, a questionnaire-based survey was conducted amongst nurses working in hospitals, with the specific purpose of examining the relationship between shift work, mental state and self-reported medical errors. The intention was to test the hypothesis that medical errors might be the result of nurses' poor mental health and/or sleep problems linked to shift work.

Subjects and Methods

Subjects and method of data collection

The subjects of this study were nursing staff working at two general hospitals located in Shiga Prefecture, Japan. The hospitals are classified as middle-scale hospitals in Japan, with 338 and 549 beds, respectively. We conducted surveys on the sleep patterns and mental health status of the nurses and the occurrence of occupational accidents in which they were involved. The survey was conducted for one month at each location; during October 2005 at one of the hospitals and during February 2006 at the other hospital. Out of a total of 583 nurses surveyed, 454 answered all the survey questions, for an effective response rate of 77.9%. In one of the hospitals, nurses working shifts worked the 3-shift system (08:30–17:00, 16:30–01:00 and 01:00–08:30), while in the other hospital, nurses worked either the 2-shift system (16:30–09:20, including a 2-h nap) or the 3-shift system (08:30–16:50, 16:30–00:50 and 00:30–08:50).

Survey method

The director of nursing in charge of the survey at each hospital explained the purpose of the study and requested the cooperation of the person responsible for each ward of the hospital, who in turn asked for the cooperation of his or her nursing staff. The distribution and collection of questionnaires was also performed by the director of nursing. An anonymous, self-administered questionnaire was used in order to protect the privacy of the subjects and also to obtain the most candid responses possible. It was stated clearly in the questionnaire that the completed questionnaires would not be seen by the staff of the institutions at which they worked and that they would be collected in sealed envelopes. Prior to its commencement, the survey was approved by the Ethics Committee of each hospital.

Questionnaire

Identical anonymous self-administered questionnaires were used at the two participating hospitals. Questions concerning the demographic and occupational status of the participants were as follows: (1) gender and age; (2) duration of employment; (3) duration under a shift-work system; (4) drinking habit; (5) smoking habit; (6) shift system (day shifts only/2-shift system/3-shift system); (7) frequency of evening and night shifts under the 3-shift system, or frequency of night shifts under the 2-shift system; (8) working section (inpatient nurse/outpatient nurse/operating nurse/other); (9) working on a surgical ward/internal ward among inpatient nurses; (10) hours of overtime worked; (11) workload (whether or not the nurses felt they had too much work); (12) hours of leisure on weekdays; and (13) involvement in a traffic accident during the past 12 months.

In addition to the above questions, the subjects were asked if they had caused or been responsible for a "medical error" in the past month. This information was based on the nurses reporting if they had experienced an "accident" or an "incident". An "accident" signified medical action that actually harmed a patient, while an "incident" signified medical action that was not actually taken but would have harmed a patient if performed or action that was actually taken but did not harm the patient or require follow-up observation[15]. The term "medical error" was defined as committing an incident and/or an accident. In this study, we did not classify the type of medical error, so the term "medical error" includes drug administration errors, incorrect operation of medical equipment, needle stick injuries, surgical errors and patient falls. The nurses answered that they had committed a medical error if they were responsible for the error and had submitted written explanations to the hospital. The subjects who answered either "with accident" or "with incident" were assigned to the "with errors" group, and those who answered neither "with accident" nor "with incident" were assigned to the "without errors" group.

Sleepiness, mental health status, and sleep quality were assessed using the Epworth Sleepiness Scale (ESS), the 28-item GHQ (GHQ-28) and the Pittsburgh

Sleep Quality Index (PSQI). The ESS is a questionnaire intended to measure daytime sleepiness and can be helpful in diagnosing sleep disorders associated with hypersomnia. A cut-off point of 10/11 was employed for this study[16]; higher scores of more than 11 reflect the possibility of excessive daytime sleepiness. The GHQ-28 questionnaire was developed by Goldberg in the United Kingdom as a screening test for nonorganic and non-psychotic mental disorders. From the GHQ-28 questionnaire, a 4-factor structure (somatic symptoms, anxiety/insomnia, social dysfunction, and depression) was obtained. In this study, a cut-off point of 6/5 was used[17]. The PSQI, one of the most widely used standardized measures to assess subjective sleep quality, obtains scores for seven parameters—subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction—over the past one month. Subjects self-rated each of these seven areas of sleep; the range of each subscale was from 0 to 3. The sum of these seven component scores yields the global score of subjective sleep quality (range, 0–21); higher scores represent poorer subjective sleep quality. The developers advise a cutoff score of 5/6 to separate good from bad sleepers[18].

Analyses

Univariate analyses and multiple logistic regression analyses were conducted with regard to questions about medical errors committed in the past one month. A comparison between the two groups ("with errors" and "without errors") was conducted and the risk factors for medical errors were evaluated by using multiple logistic regression analyses.

We used the χ^2 test for categorical comparisons of the data. Difference in the means of continuous measurements was tested using a *t*-test. Significant predictors in the univariate analyses were included in a forward, stepwise multiple logistic-regression model in order to identify the most important risk factors for medical errors. We used the method of imputation of missing values, namely, mean substitution. A *p*-value of <0.05 was considered to indicate statistical significance; all tests were 2-tailed.

In this study, nurses who had made errors in the past month were assigned to a "with errors" group and those who had not were assigned to a "without errors" group. We took "with errors" and "without errors" as dependent variables, and the ESS, PSQI and GHQ-28 scores, hours of leisure, number of sleep hours the subjects needed, section (inpatient/outpatient/operating/other) and too much work (yes/no) as independent variables. The ESS, PSQI and GHQ-28 scores, hours of leisure, and amount of sleep the subjects needed were used as continuous variables, and section and too much work were used as dichotomized variables in logistic regression. SPSS for windows Version 11.0 was used for statistical processing.

Results

A total of 454 nurses responded to the questionnaire, for a response rate of 77.9% (Table 1). Of those nurses who responded, 420 were female. The mean age, dura-

Table 1. Gender and work distribution of initial cohort and analyzed subjects (SD)

Gender	
Male	34
Female	420
Age (yr)	36.4 (10.8)
Duration of employment (yr)	13.4 (9.8)
Duration of working under a shift-work system (h)	10.2 (8.5)
Shift system	
Number of 3-shift workers	290
Number of 2-shift workers	36
Number of day workers	128
Frequency of evening/night shift	
Mean frequency of evening shifts under a 3-shift system per month	3.9
Mean frequency of night shifts under a 3-shift system per month	3.7
Mean frequency of night shifts under a 2-shift system per month	4.5
Working section	
Number of nurses working on wards	307
Number of nurses working in other sections	147
Sleep length (h)	6.3 (1.0)
Sleep latency (min)	23.5 (23.7)
ESS score	7.3 (4.1)
GHQ score	8.7 (5.7)
PSQI score	6.8 (2.9)

tion of employment and duration of working under a shift work system among all respondents were 36.4 yr old, 13.4 yr and 10.2 yr, respectively. The numbers of 3-shift workers, 2-shift workers and day workers were 290, 36 and 128, respectively. The mean frequencies of evening shifts under a 3-shift system, night shifts under a 3-shift system and night shifts under a 2-shift system were 3.9, 3.7 and 4.5 times per month. The number of nurses working on wards was 307 and that in other sections was 147. The mean sleep length and sleep latency were 6.3 h and 23.5 min, respectively. Sleep length and sleep latency obtained from the PSQI were used for the analysis. Since the PSQI was answered according the status in the past one month, the subjects answered the mean sleep length and sleep latency over the past one month. The mean ESS, GHQ and PSQI scores were 7.3, 8.7 and 6.8, respectively.

The numbers of subjects in the "with errors" group and "without errors" group were 227 and 227, respectively. As shown in Tables 2 and 3, univariate analyses revealed significant differences between the "with error" and "without error" groups with respect to shift sys-

Table 2. Characteristics of nurses in the "with errors" group compared with those in the "without errors" group (*t*-test)

	Errors		*t*-value	*p*-value	95%CI
	With N=227	Without N=227			
Age (yr)	35.9	36.5	0.6	0.55	0.98–1.01
Duration of working (yr)	12.4	14.1	1.8	0.069	0.96–1.00
Leisure on weekdays (h)	3.0	2.4*	–2.0	0.048	1.00–1.20
Frequency of night duty in the past month	1.9	1.7	–0.5	0.59	0.95–1.10
Duration under shift work system (yr)	9.6	11.0	1.4	0.15	0.95–1.01
Frequency of late shift under 3-shift system	4.1	4.0	–0.5	0.61	0.88–1.24
Frequency of night duty under 3-shift system	4.0	3.6	–1.8	0.70	0.99–1.35
Frequency of night shift under 2-shift system	5.0	4.6	–0.5	0.63	0.73–1.69
Amount of overtime worked (min)	605	530	–1.0	0.31	0.99–1.00
Sleep latency (min)	24.9	21.6	–1.5	0.15	0.99–1.02
Amount of sleep (min)	379	382	0.4	0.71	0.99–1.00
Amount of sleep subjects needed (min)	463	449*	–0.2	0.040	1.01–1.41
ESS score	8.1	6.7*	–3.4	0.001	1.03–1.14
GHQ score	10.2	7.4*	–5.0	<0.001	1.06–1.14
somatic symptoms	3.5	3.0*	–2.8	0.007	1.01–1.27
anxiety/insomnia	3.4	2.7*	–3.6	0.001	1.09–1.35
social dysfunction	2.0	1.2*	–4.6	<0.001	1.15–1.46
depression	1.3	0.8*	–3.0	0.004	1.06–1.34
PSQI score	7.2	6.4*	–2.7	0.008	1.03–1.19

*: $p<0.05$; CI: Confidence interval.

Table 3. Characteristics of nurses in the "with errors" group compared with those in the "without errors" group (χ^2 test)

	Errors		χ^2value	*p*-value	95%CI
	With	*Without*			
Gender (male/female)	21/182	12/206	3.4	0.069	0.24–1.06
(With/Without) drinking habit	46/156	49/168	0.002	0.96	0.63–1.56
(With/Without) smoking habit	39/164	48/166	0.7	0.42	0.76–1.95
Importance of leisure (important/not important)	183/18	195/21	0.07	0.79	0.47–1.77
Amount of leisure time (sufficient/insufficient)	47/145	45/145	0.2	0.64	0.56–1.43
(With/Without) traffic accident in the past l2 months	24/177	25/190	0.01	0.92	0.54–1.76
Section (inpatient nurses/other)	148/52	136/82*	6.5	0.011	1.13–2.61
Shift system (day nurse/2-shift or 3-shift)	40/140	75/123*	10.9	0.001	1.34–2.84
Too much work (yes/no)	109/94	79/137*	12.4	<0.001	1.36–2.97

*: $p<0.05$; CI: Confidence interval.

Table 4. Multiple logistic regression analyses regarding factors related to occupational accidents in the past month

	Odds ratio	95%CI
GHQ	1.1*	1.0–1.1
Shift system (2-shift or 3-shift/day nurse)	2.1*	1.2–3.9

*: $p<0.05$; CI: Confidence interval.
Control variables entered into the model were the ESS, PSQI, hours of leisure, amount of sleep subjects needed, section and too much work.

tem (day nurses/2-shift vs. 3-shift: 40/140 vs. 75/123), section (inpatient nurses/other: 148/52 vs. 136/82), too much work (109/94 vs. 79/137), ESS score (8.1 vs. 6.7), GHQ score (10.2 vs. 7.4), PSQI score (7.2 vs. 6.4), hours of leisure time on weekdays (3.0 vs. 2.4) and number of hours sleep that the subjects needed (463 vs. 449 min). However, no significant difference was observed with respect to age (35.9 vs. 36.5 yr).

Table 4 shows the results of multivariate analysis, demonstrating that the following factors were significantly associated with the reported occurrence of error: shift system (2- or 3-shift/day nurse: odds ratio, 2.1; 95% confidence interval, 1.2–3.9) and GHQ score (1.1 odds ratio; 95%CI, 1.0–1.1).

Discussion

Few surveys have been conducted on the association between mental health or sleep problems and occupational accidents among nurses in Japan. In the present study, we investigated various contributing factors to medical errors among nurses working in hospitals in order to confirm or refute the hypothesis that medical errors might be the result of nurses' poor mental health and/or sleep problems linked to shift work. The data from multivariate analyses support the hypothesis that poor mental health and shift work are significant factors contributing to medical errors.

There are a couple of reports on the association between shift work and medical errors among nurses. Gold *et al*. reported that in comparison to nurses who worked only day/evening shifts, rotators were twice as likely to report an accident or error related to sleepiness[8]. Suzuki *et al*. also reported that the strongest association with experience of medical errors was night/irregular shift work among nurses[14]. The results of the present study are in accord with these findings.

With respect to mental health, 65% of the nurses surveyed had a GHQ-28 score above 6, which is considered to be indicative of poor mental health. In the study by Suzuki *et al*., the percentage of those considered as having poor mental health was 68.8%[14], a similar finding to our own. These results suggest that the mental health of the sample group was relatively poor, which is indeed a matter for concern since the deterioration of attention, memory or coordination brought about by poor mental health in nurses may affect performance. Dugan *et al*. demonstrated that a relatively strong relationship exists between a hospital unit's score on the Stress Continuum Scale (SCS), which is a self-assessment of stress, and the occurrence of patient incidents such as medication errors and patient falls[19]. In a comparison of stress due to work schedules in women working in hospitals and that of other salaried women, women working in hospitals were exposed to a higher level of stress due to their schedules. In their research, Dugan *et al*. reported that women working in the hospitals showed a higher frequency of work—more than 100 nights a year, early morning work or late afternoon work—compared to other salaried women[19]. Therefore, it is crucial that attention is paid to the fact that stress is caused by a high frequency of work and night/irregular shift work.

Nighttime shift work is reported to be associated with an increased prevalence of psychiatric disorders including mood disorders such as depression[20]. A previous study by Suzuki *et al*. reported a significant association between incidence of medical accidents over the past 12 months and being in poor mental health, working night/irregular shifts and age[14]. With the exception of the association between medical errors and age, our results are consistent with these findings.

In the present study, we conducted multiple logistic regressions to remove the potential confounding effects of these two factors and found that shift work and poor mental health were significantly associated with medical errors. Except for shift work or mental state, we could not find any significant association between medical errors and the other factors investigated, such as sleepiness assessed by ESS score, sleep quality assessed by PSQI score, and workload. One possible explanation is that associations with self-reported errors might be similar for shift work, sleepiness, sleep quality, and workload, and that these variables are related but distinct. Indeed, sleepiness and sleep quality have been reported to be a consequence of shift work[5, 21, 22]. West *et al*. also investigated various factors such as fatigue, sleepiness and distress with self-perceived major medical errors among resident physicians and found the associations of subsequent self-reported error with the Epworth Sleepiness Scale score, fatigue score, burnout, a positive depression screen and overall quality of life in univariate analyses[23]. After adjustment for burnout or depression, however, only the variables of fatigue and distress remained statistically significant and sleepiness no longer had a statistically significant association with errors.

The mean value of sleep duration of the subjects in this study was 6.3 h. The Japan Broadcasting Corporation has reported that the mean value of sleep duration in the general population of Japan in 2000 was 7.4 h. Therefore, the sleep duration of the subjects in this study is approximately one hour shorter than that of the general population. One possible explanation for the lower amount of sleep among nurses is the shift system under which they operate. Escriba *et al*. noted that night shift work led to a reduction in sleep duration and a deterioration in sleep quality[21]. Gold *et al*. described that nurses on a rotation system and night nurses reported fewer hours of sleep than day/evening nurses[8]. Physicians are also reported to get significantly less sleep when sleeping during the day compared with sleeping at night[3]. The reduction of sleep duration due to the shift work among nursing staff may result in reduced performance quality and problems of patient safety[24]. Reduced alertness is known to lead to clinical errors[25].

With respect to sleep quality, the mean PSQI score (6.8) was higher than the cut-off point (5.5), indicating that nurses are more likely to experience sleep problems than the general population. Previous reports on the association between night shift work and sleep problems among nurses have indicated that this is a worldwide problem. Gold *et al*. pointed out that, in comparison with day/evening nurses, night workers were 1.8 times more likely, and those on rotating shift times 2.8 times more likely, to report poor quality sleep[8]. They also reported that nurses working rotating shifts tended to have more accidents while working and also while driving, and made more errors during the course of their work[8]. In the present study, respondents were also asked whether they had been responsible for a traffic accident, but no significant association was found between traffic accidents and medical errors. The target group of nurses in our study worked under a 2-shift or 3-shift system. Suzuki *et al*. reported that the factor having the strongest association with the occurrence of medical errors was night/irregular shift work[14]. The results of our study are consistent with these findings.

There are several limitations to the present study. First, a self-administered questionnaire was used and, as such, there may be a reporting bias. In addition, the methods used for recognizing occupational accidents were subjective; therefore, more objective studies are warranted. The causal pathways through which mental health and sleep quality are related to nursing error have not been elucidated, and the question remains whether poor sleep (resulting from shift work) increases the risk of mental health problems or vice versa. Likewise, the path through which each of these factors is associated with error is not yet understood. Finally, because the definition of a medical error required that the nurse had filed a written report, it is possible that there was undercounting of errors; that is, accidents or incidents may have occurred that went unreported.

In this study, we demonstrated an association between medical errors, sleep problems and mental health deterioration in Japanese nurses. The study was cross-sectional, and consequently the possibility for the reversal of cause and effect exists. For this reason, further studies are required in order to clarify the relationship between these variables.

Conclusion

We conducted a questionnaire based survey of nurses working in hospitals in order to investigate the relationship between shift work, mental state and self-reported medical errors. We were able to confirm that both sleep and mental status among hospital nurses were relatively poor and that shift work and poor mental health were significant factors contributing to medical errors.

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