Factors Contributing to Medical Errors and Incidents among Hospital Nurses —Nurses' Health, Quality of Life, and Workplace Predict Medical Errors and Incidents—

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Abstract: The purpose of this study was to examine the correlation of medical incidents and errors among nurses with factors describing their lifestyle, health, and work environment. We analyzed questionnaires completed by 6,445 female hospital nurses engaged in shift work in Japanese hospitals with general wards of more than 200 beds. Logistic regression analysis indicated that the risk for medical incidents/errors was predicted by being under treatment, absence due to sickness in the past 6 months, workplace, break times during night shift, bodily pain, and role (emotional). These results indicate that to prevent the occurrence of medical incidents/errors, it is necessary to regard current/recent illness, bodily pain, and role (emotional) as a nurse's personal problems and break times during the night shift and workplace as administrative problems.

Introduction

A number of recent studies have estimated that, in the United States alone, tens of thousands of patients die each year as a result of accidents in medical settings[1–4]. Factors contributing to such incidents include the characteristics of individual medical personnel, the patients, and the overall medical system[5–9]. Increasing numbers of medical facilities have begun to reevaluate their systems in order to address these issues and reduce the number of medical incidents[10].

It is crucial to examine the personal and professional characteristics of nurses, since they form the majority of medical personnel in hospitals and are responsible for providing medical care to patients. Shift scheduling, in particular, appears to have a heavy influence on the performance of nurses. Previous research has shown that medical staffs are more likely to make errors when their work time is extended by 24 h, is irregular, or consists of night shifts[11, 12]. Nurses working on night shifts tend to experience more frequent and severe disruptions of their sleep, whereas nurses working on rotating shifts are more likely to fall asleep while driving to/from work and have to the highest rate of sleep-related errors and incidents[14]. While daytime sleepiness significantly predicts the number of mistakes made by nurses[13], other factors such as mental health and age can also influence error rates[12].

It is important to note that not all errors result in accidents, since a multitude of preventive measures are in place at every level of the health care system[15]; nevertheless, it is inevitable that some errors will be made. Errors made by hospital nurses include mistakes stem-

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ming directly from errors in judgment and errors caused by the influence of their working environment. Thus, to be able to create an environment that reduces errors and ensures improved safety in medical institutions, it is necessary to examine the factors associated with the nurses themselves and their work environment. For this purpose, a large-scale study is needed to evaluate comprehensively the various factors related to shift work by using systematic sampling in accordance with specified standards. Further, there are more reported cases of medical errors than of accidents in general[16, 17]; thus, to evaluate the number of total mistakes that occur in hospitals, it is important to document events in both of these categories.

We examined the correlations of shift work, health, and lifestyle of nurses with reports of medical errors and incidents. Data were collected via a questionnaire-based survey distributed among nurses working in the Kanto region of Japan.

Subjects and Methods

Subjects

We requested the participation of 99 hospitals, all with general wards of at least 200 beds, in the Kanto region (Tokyo, Saitama, Chiba, Kanagawa, and Gunma prefectures), Japan. The heads of the nursing divisions of 93 of these hospitals agreed to participate in this investigation. In July 2005, 10,600 self-administered questionnaires were mailed to the 99 participating hospitals with instructions to return the completed forms anonymously to a collection box provided in each hospital. By the end of the study in August 2005, 8,328 questionnaires (a retrieval rate of 78.6%) had been received. Completed questionnaires were excluded from the analysis if the nurses did not work on night shifts or reported their official positions to be other than regular nurses (e.g., midwives, public health nurses, and practical nurses); further, nurses who had worked for less than 6 months were also excluded. With these excluded questionnaires, the final sample consisted of surveys from 6,445 nurses.

Questionnaires

The questionnaires were designed to assess the number of medical incidents and errors that had occurred during the previous 6 months as well as to collect information about the nurses' work environments, general health, and lifestyles.

Defining errors and incidents. "Incidents" were defined as cases in which treatment was not affected because the errors had been detected in a timely manner and/or where corrective measures had been taken. "Errors" were defined as non-negligent events or events without adverse side effects[8].

Demographic data. The nurses were asked to provide the following demographic data: age, marital status, number of children, and busyness in their general daily life. Busyness was determined using the Visual Analogue Scale (VAS), where higher scores indicate busier daily schedules.

Health. To evaluate the general health of the nurses, information on the following variables was extracted from the questionnaires: weight, height, whether they were receiving treatment due to sickness, whether they were absent due to sickness during the past 6 months (yes or no), alcohol intake (none, seldom, everyday, or within 5 working days), smoking status (yes or no), number of meals per day, diet (balanced or not), and menstrual cycle (regular or irregular).

Sleep health. The sleep habits of the 6,445 nurses were evaluated using the following characteristics: satisfaction with sleeping hours, limitations to daily activities due to sleep deprivation, and the use of sleeping pills. The first two variables were ranked using a VAS, where higher scores indicate higher satisfaction and greater limitation, respectively.

Quality of life. Health related quality of life (QOL) was evaluated using the Medical Outcome Study 36-Item Health Survey (SF-36)[19] that consists of 36 questions across 8 categories: physical functioning, role (physical), role (emotional), social functioning, mental health, bodily pain, general health perception, and vitality. Each category is evaluated on a scale from 0 (very bad) to 100 (very good). SF-36 has been reported to be a highly reliable scale for the comprehensive evaluation of an individual's health status[20, 21].

Work environment. The work environment was evaluated on the basis of the following variables: heaviness of workload during night shifts (using a VAS, where higher scores indicate increased workload), normal hours of work during a night shift, frequency of breaks during a night shift, number of persons working together on a night shift, most number of night shifts per month, stress due to night shifts (using a VAS, where higher scores indicate more stress), type of night shift (where two-shifts was defined as day 08:00–20:30 plus night 19:00–9:30 shifts and three-shifts was defined as day 08:30–17:00 plus evening 16:30–01:00 plus night 0:30–9:00 shifts), frequency of no overtime hours of work during the night shift (all the time, most of the time, or overworked), years of experience as a nurse and of working on night shifts, and workplace (ward or outpatient department).

Analysis

The χ^2 test was used for the categorical comparison of the data, and *t* test was used to evaluate differences in the means of the continuous variables. To demonstrate statistical significance among the parameters and medical errors or incidents, a criterion of $p<0.20$ was adopted for univariate analysis. We adopted this reduced level of significance because there would have been a risk of overlapping of important factors if the level of significance had been limited to $p<0.05$. Logistic regression analysis was performed to determine the correlation between medical errors or incidents and the correlates[22], a criterion of $p<0.05$ was considered to indicate statistical significance, and all the tests were two-tailed. All statistical analyses were performed on a personal computer using the statistical package SPSS for Windows (Version 14.0 SPSS).

Ethical considerations

This study was conducted with the approval of the Ethics Committee of Tokyo Medical and Dental University. All subjects were informed about the objectives and methods of the study, protection from discrimination, privacy, anonymity, and confidentiality. Each subject consented to participate in the survey by signing and returning the consent form attached to the questionnaire.

Results

General overview of the study subjects

Of the 6,445 nurses who were selected as the subjects in this study, 5,112 (79.3%) reported that they had made medical errors or experienced medical incidents, while 980 (15.2%) had not; the remaining 413 (6.4%) subjects did not respond to this question. Tables 1 and 2 show the backgrounds of the subjects. The age of the nurses was 31.2 ± 8.2 yr (mean ± SD), and their length of nursing experience was 8.9 ± 7.1 yr (mean ± SD). Among the subjects, 3,013 (46.7%) worked on a two-shift system, while 3,136 (48.7%) nurses worked on a three-shift system.

Table 2 provides an overview of the classification, characteristics, days of admittance, number of general beds, number of full-time nursing staff in the general ward, number of general wards, designated working hours of full-time nursing staff, working hours per week of full-time nursing staff, night shift system, working hours on night shifts, and the degree of satisfaction of the nursing division directors regarding the current night shift environment in the 93 hospitals to which our study subjects were affiliated.

The results of the bivariate analysis

The comparison of those who did or did not experience medical incidents/errors is summarized in Table 3. These two groups show differences in marital status, number of children, age, workplace, frequency of no overtime hours during the night shift, experience as a nurse, heaviness of workload during night shifts, number of persons working together on a night shift, most number of night shifts per month, stress due to night shifts, satisfaction with sleeping hours, limits to daily life due to sleep deprivation, being under treatment, absence due to sickness during the past 6 months, role (physical), role (emotional), social functioning, mental status, bodily pain, general health perceptions, and vitality.

The results of the logistic regression analysis

The logistic regression analysis indicated that the following variables best predicted the occurrence of medical incidents/errors: increase in break time during night shifts, treatment for illness, absence due to sickness in the previous 6 months, working in wards, role (emotional), and bodily pain (Table 4).

Discussion

We found that being under treatment, absence due to sickness in the past 6 months, workplace, break times during night shift, bodily pain, and role (emotional) were correlated with the occurrence of medical errors and incidents among female hospital nurses.

Logistic regression analysis indicated that nurses who were being under treatment experienced 1.20 times more medical incidents/errors than healthy nurses, and nurses reporting an absence due to sickness during in the past 6 months experienced 1.50 times more medical incidents/errors than healthy nurses. This suggests that it is important to devise a work environment that minimizes the occurrence of health-related issues. For those who do become ill, it may be necessary to consider temporary transfers to sections of the clinic/hospital where there is a lower risk of causing medical accidents, e.g., the outpatient department.

The results show that the occurrence of incidents/errors slightly increases when the break times during night shifts increases by 1 min (odds ratio: 1.00); however, Kaneko *et al*.[23] suggested that errors or near misses occur 0.98 times more frequently when the break times for a service increases by 1 min. It can be inferred that this difference is derived from the difference in the study methods: the present study focused only on the break times during night shifts, while Kaneko *et al*. focused on the break times per service.

Table 1. Personal and professinal characteristics of survey nurses

Variables		Category	n	%
Demographic data		married	2,003	31.1
	Marital status	single	3,816	59.2
		no answer	626	9.7
	Number of children	none	4,070	63.1
		one or more	2,092	32.5
		no answer	283	4.4
	Age (yr)	(Mean ± SD)	(31.2 ± 8.2)	
	Busyness in general daily life (points: range, 0–100)	(Mean ± SD)	(57.6 ± 25.1)	
	BMI	(Mean ± SD)	(20.3 ± 47.6)	
Work environment				
	Workplace	ward	5,837	90.6
		outpatient	261	4.0
		no answer	347	5.4
	Frequency of breaks during night shifts	regularly	3,577	55.5
		seldom or none	2,744	42.6
		no answer	124	1.9
	Type of night shift	two-shift	3,013	46.7
		three-shift	3,136	48.7
		no answer	296	4.6
	Frequency of no overtime hours of work during the night shift	all or most of time	2,770	43.0
		overwork	3,559	55.2
		no answer	116	1.8
	Experience as a nurse (yr)	(Mean ± SD)	(8.9 ± 7.1)	
	Years of working on night shift (yr)	(Mean ± SD)	(7.3 ± 6.8)	
	Heaviness of workload during night shifts (points; range, 0–100)	(Mean ± SD)	(71.7 ± 21.5)	
	Normal hours of work during a night shift (h)	(Mean ± SD)	(12.2 ± 4.0)	
	Break times during night shift (min)	(Mean ± SD)	(82.9 ± 59.8)	
	Number of persons working together on a night shift (persons)	(Mean ± SD)	(2.8 ± 1.0)	
	Most number of night shifts per month (times)	(Mean ± SD)	(4.4 ± 1.7)	
	Stress due to night shifts (points; range, 0–100)	(Mean ± SD)	(77.6 ± 19.6)	
Sleep health				
		not taken	5,587	86.7
	Use of sleeping pills	sometimes, everyday	801	12.4
		no answer	57	0.9
	Satisfaction with sleeping hours (points; range, 0–100)	(Mean ± SD)	(42.1 ± 26.6)	
	Limits to daily life due to sleep deprivation (points; range, 0–100)	(Mean ± SD)	(46.0 ± 26.5)	
Health				
		none	3,659	56.8
	Being under treatment	under treatment	2,786	43.2
	Absence due to sickness during the past 6 months	none	4,499	69.8
		yes	1,685	26.1
		no answer	261	4.0
	Menstrual cycle	regular	4,323	67.1
		irregular	1,606	24.9
		no answer	516	8.0
	Alcoholic intake	none, seldom	5,050	78.4
		everyday, within 5 working days	1,325	20.6
		no answer	70	1.1
	Smoking status	no	4,845	75.2
		yes	1,534	23.8
		no answer	66	1.0
	Number of meals per day	3 meals	3,795	58.9
		more than 3	2,517	39.1
		no answer	133	2.1
	Balanced diet	balanced	4,313	66.9
		not balanced	2,070	32.1
		no answer	62	1.0
Quality of life				
	Physical functioning	(Mean ± SD)	(87.2 ± 14.0)	
	Role (physical)	(Mean ± SD)	(76.7 ± 33.9)	
	Role (emotipnal)	(Mean ± SD)	(68.8 ± 38.1)	
	Social functioning	(Mean ± SD)	(68.1 ± 38.1)	
	Mental status	(Mean ± SD)	(55.7 ± 18.9)	
	Bodily pain	(Mean ± SD)	(61.4 ± 23.5)	
	General health perceptions	(Mean ± SD)	(59.0 ± 17.6)	
	Vitality	(Mean ± SD)	(40.0 ± 19.7)	

N=6,445.

Table 2. Overview of the 93 hospitals

Variables	Category	n	%
Hospital classification	General hospital	88	94.6
	Regional medical hospital	3	3.2
	Others	2	2.2
Characteristics of the hospital	Hospitals for acute conditions	71	76.3
	Hospitals for chronic conditions	3	3.2
	Mixed care hospital	11	11.8
	Rehabilitation hospital	2	2.2
	Others	5	5.4
	Missing	1	1.1
Days of admittance	(Mean ± SD)	(18.3 ± 7.4)	
Number of general beds	(Mean ± SD)	(322.2 ± 127.3)	
Number of full-time nursing staff in the general ward	(Mean ± SD)	(173.8 ± 98.9)	
Number of genral wards	(Mean ± SD)	(6.8 ± 2.9)	
Designated working hours of full-time nursing staff	All the same	71	76.3
	Several	15	16.1
	Missing	7	7.5
Working hours per week of full-time nursig staff	(Mean ± SD)	(39.4 ± 1.3)	
Night shift system	Fixed system	7	7.5
	Rotation system	30	32.3
	Irregular	54	58.1
	Others	1	1.1
	Missing	1	1.1
Types of working hours on night shifts	1 type	35	37.6
	2 type	40	43.0
	3 type	17	18.3
	4 type	1	1.1
Degree of satisfaction of nursing division directors regarding current night shift environment	Satisfied	22	23.7
	Not satisfied	60	64.5
	Missing	11	11.8

N=93.

Nurses who work in outpatient departments experience incidents/make errors 0.56 times more frequently than those who work in wards. According to the 2010 annual report of the "Project to collect medical near-miss/adverse events information"[24], incidents most frequently occurred when medical treatment was provided, while errors occurred most frequently during medication-related tasks. It can be inferred that the odds ratio of the nurses working in wards was higher than that of nurses who work in outpatient departments because the former have to conduct medical treatment and medication-related tasks more frequently than the latter. According to the 14th Summary and Analysis Results

conducted by the Project for Summary, Analysis, and Sharing Medical Incidents/Errors Cases[25], there were 42,869 medical incidents/errors cases during the three-month long investigation period. Of these, 23,868 (55.7%) cases occurred in patients' rooms and 4,534 (10.6%) occurred in nurses' stations. However, because of the number of nurses working in wards, we need to compare those working in wards with those working in outpatient sections on a per nurse and per working hour basis. Those data are not available in this survey.

Moreover, the results show that the odds ratio slightly decreases when bodily pain and role (emotional) scores increase. The increase in the bodily pain score indi-

Table 3. Correlation between variables and the occurrence of medical incidents/errors

Variables	Category		Not experience with medical incidents/errors n=980		Experience with medical incidents/errors n=5,112		p
			n	%	n	%	
Demographic data							
Marital status	single		551	58.6	3,261	66.9	<0.0001
	married		389	41.4	1,614	33.1	
Number of chilren	none		663	68.5	3,710	73.9	0.001
	one or more		305	31.5	1,307	26.1	
Age (yr)		(Mean ± SD)	(32.32 ± 8.34)		(31.20 ± 8.12)		<0.0001
Busyness in general daily life		(Mean ± SD)	(58.51 ± 25.27)		(57.46 ± 24.89)		0.250
BMI		(Mean ± SD)	(19.59 ± 5.55)		(20.56 ± 53.38)		0.577
Work environment							
Workplace	ward		839	92.7	4,674	96.2	<0.0001
	outpatient department		66	7.3	185	3.8	
Frequency of breaks during a night shift	regularly		557	57.7	2,818	56.1	0.376
	seldom or none		408	42.3	2,203	43.9	
Type of night shift	two-shift		465	50.0	2,381	48.5	0.391
	three-shift		465	50.0	2,533	51.5	
Frequency of no overtime hours of work during the night shift	all or most of time		497	51.9	2,142	42.5	<0.0001
	overwork		461	48.1	2,897	57.5	
Experience as a nurse (yr)		(Mean ± SD)	(9.92 ± 6.94)		(8.96 ± 7.00)		<0.0001
Years of working on night shift (yr)		(Mean ± SD)	(8.02 ± 5.36)		(7.33 ± 7.04)		0.112
Heaviness of workload during night shifts (point)		(Mean ± SD)	(69.30 ± 20.85)		(72.34 ± 21.65)		<0.0001
Normal hours of work during a night shift (h)		(Mean ± SD)	(12.14 ± 4.10)		(12.20 ± 3.94)		0.748
Break times during night shift (min)		(Mean ± SD)	(79.50 ± 49.52)		(83.45 ± 61.67)		0.078
Number of persons working together on a night shift (persons)		(Mean ± SD)	(2.76 ± 0.97)		(2.83 ± 0.98)		0.043
Most number of night shifts per month (times)		(Mean ± SD)	(4.32 ± 1.63)		(4.48 ± 1.64)		0.006
Stress due to night shifts (points)		(Mean ± SD)	(75.15 ± 20.19)		(78.17 ± 19.29)		<0.0001
Sleep health							
Use of sleeping pills	not taken		852	87.6	4,426	87.3	0.833
	sometimes, everyday		121	12.4	646	12.7	
Satisfaction with sleeping hours (points)		(Mean ± SD)	(44.70 ± 27.57)		(41.61 ± 26.42)		0.001
Limits to daily life due to sleep deprivation (points)		(Mean ± SD)	(41.98 ± 26.07)		(46.69 ± 26.57)		<0.0001
Health							
Being under treatment	none		596	60.8	2,822	55.2	0.001
	under treatment		384	39.2	2,290	44.8	
Absence due to sickness during the past 6 months	none		794	81.8	3,622	71.2	<0.0001
	yes		177	18.2	1,466	28.8	
Menstual cycle	regular		639	72.0	3,484	73.7	0.282
	irregular		249	28.0	1,242	26.3	
Alcoholic intake	none, seldom		765	78.6	3,991	78.8	0.898
	everyday, within 5 working days		208	21.4	1,072	21.2	
Smoking status	no		734	75.6	3,857	76.1	0.743
	yes		237	24.4	1,210	23.9	
Number of meals per day	3 meals		572	59.4	3,015	60.2	0.666
	more than 3		391	40.6	1,995	39.8	
Balanced diet	balanced		664	68.4	3,435	67.7	0.708
	not balanced		307	31.6	1,636	32.3	
Quality of life							
Physical functioning		(Mean ± SD)	(87.69 ± 14.32)		(87.05 ± 13.94)		0.191
Role (physical)		(Mean ± SD)	(82.80 ± 31.24)		(75.77 ± 34.16)		<0.0001
Role (emotipnal)		(Mean ± SD)	(77.28 ± 34.80)		(67.43 ± 38.53)		<0.0001
Social functioning		(Mean ± SD)	(72.47 ± 23.32)		(67.64 ± 23.21)		<0.0001
Mental status		(Mean ± SD)	(58.88 ± 19.06)		(55.43 ± 18.59)		<0.0001
Bodily pain		(Mean ± SD)	(65.66 ± 24.41)		(60.47 ± 23.22)		<0.0001
General health perceptions		(Mean ± SD)	(61.56 ± 17.87)		(58.52 ± 17.45)		<0.0001
Vitality		(Mean ± SD)	(42.84 ± 20.77)		(39.60 ± 19.32)		<0.0001

Table 4. Logistic regression for variables of medical incidents/errors

Factor		Odds Ratios	95%CI	*p*
Age (yr)		0.993	0.970–1.017	0.584
Experience as a nurse (yr)		0.993	0.967–1.019	0.580
Heaviness of workload during night shifts (points)		1.003	0.999–1.008	0.168
Break times during night shift (min)		1.003	1.001–1.005	0.008
Number of persons working together on a night shift (persons)		0.980	0.893–1.075	0.671
Most number of night shifts per month (times)		0.999	0.945–1.057	0.981
Stress due to night shifts (points)		1.001	0.995–1.006	0.818
Satisfaction with sleeping hours (points)		1.000	0.996–1.004	0.955
Limits to daily life due to sleep deprivation (points)		1.004	1.000–1.008	0.078
Quality of life				
Physical functioning		1.004	0.997–1.011	0.278
Role (physical)		0.998	0.994–1.001	0.211
Role (emotional)		0.996	0.993–0.999	0.007
Social functioning		0.997	0.993–1.002	0.275
Mental health		0.996	0.989–1.003	0.265
Bodily pain		0.995	0.991–0.999	0.011
General health perceptions		1.004	0.997–1.010	0.273
Vitality		1.002	0.996–1.008	0.502
Marital status	single	1.000		
	married	0.889	0.683–1.155	0.378
Number of children	none	1.000		
	one or more	1.035	0.770–1.392	0.821
Workplace	ward	1.000		
	outpatient department	0.565	0.431–0.740	<0.0001
Regularity of working hours during the night shift	all or most of time	1.000		
	overwork	1.169	0.975–1.401	0.091
Being under treatment	none	1.000		
	under treatment	1.205	1.013–1.433	0.035
Absence due to sickness during the past 6 months	none	1.000		
	yes	1.498	1.218–1.843	<0.0001

cates that bodily pain does not prevent the performance of a nurse's routine. Consequently, it can be expected that the occurrence of incidents/errors slightly decreases when there is no bodily pain. The increase in the role (emotional) score indicates that there are no emotional problems experienced while on duty or during usual activities; therefore, it can be expected that the occurrence of incidents/errors slightly decreases when there are no emotional problems. This result supports the study by Kaneko *et al*. that suggested that nurses with high emotional stress make errors or near misses 4.65 times more frequently than those with low emotional stress, and nurses with high bodily stress make errors or near misses 2.28 times more frequently than those with low bodily stress. Therefore, we conclude that nurses' emotional and physical problems affect the occurrence of incidents/errors.

It is important to note some limitations of this study. First, 6.4% of the surveyed nurses did not respond to the question about medical incidents/errors. Even among those who did respond, the answers may have been affected by a desire to provide a socially desirable response or to avoid punishment. Thus, our survey may not include data related to potentially serious medical errors. If possible, this issue should be addressed in the future. Additionally, the medical accidents documented in this study were not validated by direct observation. We sought to minimize this concern by including only medical incidents or errors accompanied by collaborating information; we believe it is unlikely that the nurses would fabricate reports; nevertheless, it remains possible that there has been significant under- or over-reporting of medical errors or incidents. Second, the nurses who participated in this study reflect only a small proportion of the total population of Japanese nurses. It is possible that nurses from other types of facilities in other regions may have responded differently; additionally, the volunteer nurses may have been more interested in these issues or were predisposed to being affected by particular work styles, thereby potentially biasing the results.

Conclusions

The frequency of medical incidents/errors was correlated with current/recent illness, break times during night shift, workplace, bodily pain, and role (emotional). These results indicate that to prevent the occurrence of medical incidents/errors, it is necessary to regard current/recent illness, bodily pain, and role (emotional) as a nurse's personal problems and break times during the night shift and workplace as administrative problems.

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