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Working Condition Factors Associated with Time Pressure of Nurses in Japanese Hospitals

Yukiko SEKI

Faculty of Education, Saitama University, Japan

Abstract: Working Condition Factors Associated with Time Pressure of Nurses in Japanese Hospitals: Yukiko SEKI. Faculty of Education, Saitama University—In Japan, the most common reason for medical errors is a lack of cross-checking. To prevent errors, efforts to strengthen cross-checking behaviors are being adopted. However, time pressures also lead to errors, and increasing cross-checking activities leads to an increased workload and even greater time pressures. The purpose of this study was to identify working conditions that lead to time pressure for nurses, and to find ways to reduce time pressure and prevent subsequent errors. Self-reporting questionnaires were distributed over 10 days to 416 nurses working in 17 wards at two hospitals; 357 nurses (85.8%) responded anonymously, providing data on 2,150 person-days. In multivariate analyses, medical support services and the number of nurse calls answered were associated with subjective assessments of time pressures and nursing service delays due to busyness. Moreover, working the "evening-day shift" (when a nurse works a day shift after working the evening shift with no days off in between) led to a high level of fatigue before work and was associated with nursing service delays due to busyness. Reducing time pressures and preventing errors requires an adequate number of nurses, shift plans that consider rest periods and order of rotation, increased task discretion for nurses, and the prevention of chronic fatigue.
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Key words: Nurses, Time pressures, Working conditions, Medical errors, Japan

Medical accidents have long been recognized as an increasing social problem in Japan. Despite efforts by medical institutions and workers, medical accidents continue to occur. According to a report by the Japan Council for Quality Health Care Medical Accident Prevention Center[1], over a 3-month period from July 1 to September 30, 2006, 375 medical accidents (medical actions that harmed patients) were reported. Most of these actions were committed by doctors, followed by nurses. This report also showed that, in the 3-month period from January 1 to March 31, 2007, 1,273 hospitals reported 42,753 incidents (medical actions that were not actually taken but would have harmed patients if performed, or that were actually made but did not harm patients or required follow-up observation); nurses committed 76.4% of these errors. The most frequent cause of medical accidents and incidents was a lack of cross-checking.

The cause of errors most frequently cited by nurses themselves, however, is busyness[2, 3]. Nurses, therefore, feel that reducing busyness is the most important means of preventing medical errors. Previous reports show that busyness or time pressures are an important contributing factor to errors[4–6], and previous studies have shown that time pressures due to excessively heavy workloads contribute to a lack of cross-checking[7]. Taking into consideration working conditions such as fatigue or lack of sleep, knowledge or ability, workload, and busyness, there was a strong correlation between the occurrence of errors and nursing service delays due to busyness[8]. Nursing service delays are a major factor that cause nurses to feel a sense of time pressure.

However, current medical accident prevention measures being implemented in Japan tend to address the causes of accidents and are focused mainly on combating the lack of cross-checking. Measures to address busyness—an area that nurses strongly desire to be addressed—are not being implemented, and workloads are actually increasing due to the increased efforts to implement cross-checking activities. Moreover, research on accident prevention primarily focuses on identifying the causes of errors; there is virtually no research dealing with identifying working conditions that affect nurses' busyness, in particular the time pressures placed on them.

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Correspondence to: Y. Seki, Faculty of Education, Saitama University, 255 Shimo-ohkubo, Sakura-ku, Saitama-shi, Saitama 338-8570, Japan (e-mail:yseki@health.edu.saitama-u.ac.jp)

Similarly, no studies have focused on changing working conditions to reduce time pressures and subsequently prevent errors. The purpose of this study was to identify the working conditions that lead to time pressures on nurses, and to create measures to change these working conditions and thus prevent medical errors.

Methods

Subjects and study design

A total of 416 staff nurses working in 17 wards at one public hospital and one private hospital (800 and 600 beds, respectively) were surveyed.

The surveys were conducted sequentially, one ward at a time, between 2001 and 2003. The anonymous self-report questionnaires were distributed to and collected from the participating nurses via managers at the participating hospitals. A period of 10 consecutive days was established as the survey period in each ward at the participating hospitals. Subjects were asked to fill out the survey based only on the conditions they faced on the days they worked during that period. Valid responses were anonymously received from 357 (85.8%) of the 416 nurses surveyed. Data for 2,320 person-days were reported by these 357 respondents. Of these responses, person-days with missing answers, unusual work shift patterns, and special work situations, such as training that started during the survey period, were excluded. The remaining 2,150 person-days were analyzed (valid response rate: 92.7%).

Ethical considerations

This study was approved by the epidemiologic ethics committee of the institution to which the author belonged. The study was explained both in writing and orally to managers at each of the participating facilities, and written approval was obtained to conduct the survey. Subjects were informed in writing about the purpose of the study and the methods used, and were informed that their privacy would be maintained. Subjects were asked to respond only if they agreed to participate voluntarily in this study. This survey did not determine the gender of the respondents, as there were few male nurses in the hospitals.

Variables

The various working conditions that could affect busyness and medical errors were drawn from previous reports on medical errors[3, 9, 10]. Thus, subjects were asked about the following variables for this analysis: their shifts, work experience, fatigue, sleep, workload, and time pressures.

Shifts: The hospitals of the participants used a three-shift system over a 24-h period: the day shift, evening shift, and the night shift. The day shift can be one of two shifts: the "evening-day shift" (when a nurse works a day shift after working the evening shift with no days off in between) and the "normal day shift" (when a nurse works a day shift after a day shift or a day off). Almost all night shifts were "day-night shifts" (when a nurse works a night shift after completion of a day shift). Therefore, we asked subjects whether they were working the evening-day shift, normal day shift, evening shift, or night shift. When subjects worked unusual shifts that did not fit into any of the above four categories, they were asked to indicate their work hours. If their work hours could not be classified into any of the three categories, their responses were excluded from the analysis.

Work experience: Years of experience as a nurse and years of experience in the current ward were asked.

Fatigue: The subjective fatigue of each nurse was measured immediately before starting work using a 100-mm visual analogue scale (VAS). The level of fatigue was expressed by drawing a vertical line on a horizontal line whose left edge indicated "no fatigue" and whose right edge indicated "severe fatigue"[11, 12].

Sleep: Sleep duration before work was assessed. Nap hours were included in sleep duration. The level of sleepiness before work was also measured using a VAS with "no sleepiness" along the left edge and "severe sleepiness" along the right edge[13].

Workload: In Japan, there are two nursing services: medical support services (the part of the medical examination and treatment that nurses do under the instructions of a doctor), and nursing care (care of a patient undergoing medical treatment), as stipulated in the Public Health Nurse, Midwife, and Nurse Law. Medical support services were measured by categorizing patients based on medical and nursing treatments[14], using 24 items, including "number of patients admitted," "number of patients with intravenous hyperalimentation or being given infusions requiring minute adjustments," and "number of patients having a tracheotomy on the day of the survey." A weighting system of 1–10 points was applied to each item, and the total score was calculated. Nursing care was measured by the 16 activities shown in Appendix 1, which were provided at the hospitals but were not included in medical support services. These activities and the point allocation was based on the Toranomon Nursing System (TNS)[15]. The total score was used to analyze the amount of nursing care provided. Subjects were asked to answer these workloads based only on the patients to whom they were assigned on the day of the survey. We also asked about the number of nurse calls answered, which is an important nursing responsibility. The subjects could use the personal handy phone system handsets of the nursing call system to answer the calls. Because subjects indicated that it was difficult to accurately remember the exact number of calls they answered, this item was measured

using a Likert scale, where 1=0–3 calls, 2=4–6 calls, 3=7–10 calls, 4=11–14 calls, and 5=15 or more calls.

Time pressures: Subjective time pressures during each shift were measured using a VAS. We asked "to what extent did you feel rushed (or had a specified deadline or were under time pressure)." The left side of the VAS represented "no time pressure" and the right side represented "severe time pressure." Because nursing service delays due to busyness are closely related to the occurrence of errors, we also asked "Was there a delay in your nursing services because of busyness?"[8)]

Statistical analysis

First, analysis of variance, the t-test, and chi-square analyses were used to explore associations among variables by shift, hospital, and ward. To determine the variables related to time pressures, bivariate and multivariate analyses were conducted using time pressure measured by VAS as the dependent variable and the other working conditions as independent variables. Because data were taken from repeated measurements in which each nurse in each ward answered more than once, a generalized linear mixed model that considered the intra-individual correlations in each ward and each nurse was used[16)] in the multivariate analyses. To examine the associations of variables with nursing service delays due to busyness, bivariate and multivariate analyses were conducted, with the presence or absence of a nursing service delay as the dependent variable (absent=0, present=1), and other working conditions as independent variables. To consider intra-individual correlations in each ward and nurse, parameter estimation in the logistic regression analysis was performed using generalized estimating equations[17)] in multivariate analyses. Statistical analyses were performed using the SAS software packages (SAS for Windows, Version 8.0). The level of statistical significance was set at 5%.

Results

Overview of the respondents and their working conditions and busyness by shift

Responses from 357 subjects were analyzed. Their mean (SD) age was 36.5 (16.3) yr, with 17.6 (17.6) yr of nursing experience, and 2.1 (2.7) yr in the current ward.

Table 1 shows the working conditions, subjective time pressures, and the nursing service delays due to busyness that occurred during each shift. Because most night shift nurses had also worked the day shift on the same day, sleep duration was short (3.26 [2.5] h). Sleepiness and fatigue were higher during the night shift than during the other shifts. Because the number of nurses working the night shift was only one third or one fourth of that working the day shift, the number of patients for which each nurse was responsible was higher during the night shift. As a

Table 1. Working condition variables for each shift (N=2,150 persons-days)

		Day shift			Evening shift	Night shift	
		Evening-day shift (n=207)	Normal day shift (n=1,027)	*p*	(n=465)	(n=455)	*p*
Fatigue	Subjective fatigue before work[1) 2)]	70.13 ± 22.50	59.65 ± 23.01	***[8)]	54.09 ± 23.18	73.6 ± 19.15	***[6)]
Sleep loss:	Sleepiness before work[1) 3)]	67.91 ± 25.26	57.46 ± 23.99	***[8)]	47.28 ± 24.07	74.97 ± 21.50	***[6)]
	Sleep duration before work (h) [1)]	5.10 ± 1.73	6.38 ± 1.60	***[8)]	8.38 ± 2.22	3.26 ± 2.50	***[6)]
Nursing	Medical support services[1) 4)]	30.93 ± 28.57	32.68 ± 21.13	NS[8)]	59.32 ± 34.20	63.49 ± 40.21	***[6)]
workload:	Nursing care[1) 4)]	18.87 ± 18.79	19.19 ± 16.06	NS[8)]	33.92 ± 24.13	43.79 ± 36.24	***[6)]
	Number of nurse calls answered			NS[9)]			***[7)]
	0–3 calls	16.92	18.27		13.71	21.14	
	4–6 calls	24.57	27.92		19.33	28.86	
	7–10 calls	33.74	34.01		30.79	28.18	
	10–14 calls	13.90	9.64		19.10	11.82	
	≥15 calls	10.88	10.15		17.08	10.00	
Subjective time pressure[1) 5)]		65.59 ± 22.48	62.77 ± 23.61	NS [8)]	63.58 ± 23.73	64.29 ± 24.27	NS[6)]
Nursing service delay due to busyness (percentage "yes")		33.58	30.81	NS[9)]	32.70	27.18	NS[7)]

***p<0.001, not significant (NS).

1) Mean ± SD. 2) Measured by VAS. 0=no fatigue to 100=severe fatigue. 3) Measured by VAS. 0=no sleepiness to 100=severe sleepiness. 4) Higher score indicated more workload. 5) Measured by VAS. 0=no time pressure to 100=severe time pressure. 6) Results of one-way analysis of variance among four shifts. 7) Results of chi-square test among four shifts. 8) Results of t test between two day shifts. 9) Results of chi-square test in evening-day shift and normal day shift.

Table 2. Effects of working conditions on "subjective time pressure" (bivariate analysis[1])

		Day shift		Evening shift	Night shift
		Evening-day shift	Normal day shift		
		r	*r*	*r*	*r*
Work experience:	Years of experience as a nurse	0.06	–0.15***	–0.05	–0.05
	Years of experience at the current ward	–0.03	–0.02	0.04	–0.10*
Fatigue:	Subjective fatigue before work[2]	0.34***	0.28***	0.23***	0.26***
Sleep loss:	Sleepiness before work[3]	0.23**	0.26**	0.14**	0.18***
	Sleep duration before work (h)	–0.14	–0.04	–0.02	–0.07
Nursing workload:	Medical support services[4]	0.28**	0.17***	0.27**	0.21***
	Nursing care[4]	0.26**	0.08*	0.15**	0.08
	Number of nurse calls answered[5]	0.09	0.15***	0.24***	0.37***

*p<0.05, **p<0.01, ***p<0.001.

1) Pearson product-moment correlation coefficient. Dependent variable: sense of time pressure (Measured by VAS: 0=no time pressure to 100=severe time pressure). 2) Measured by VAS. 0=no fatigue to 100=severe fatigue. 3) Measured by VAS. 0=no sleepiness to 100=severe sleepiness. 4) Higher score indicated more workload. 5) Number of nurse calls answered 1=0–3 calls, 2=4–6 calls, 3=7–10 calls, 4=10–14 calls, 5=≥15 calls.

Table 3. Effects of working conditions on "subjective time pressure" (multivariate analysis[1])

	Day shift						Evening shift			Night shift		
	Evening-day shift			Normal day shift								
	E[2]	SE[3]	F value	E	SE	F value	E	SE	F value	E	SE	F value
Work experience:												
Years of experience as a nurse	0.10	0.20	0.23	–0.12	0.13	0.80	–0.18	0.18	0.95	–0.02	0.16	0.02
Years of experience at the current ward	–1.00	0.82	1.46	–0.10	0.37	0.07	0.56	0.60	0.86	–0.53	0.45	1.35
Fatigue:												
Subjective fatigue before work[4]	0.28	0.15	3.27	0.11	0.05	4.29*	0.21	0.07	8.30*	0.12	0.08	2.30
Sleep loss:												
Sleepiness before work[5]	0.10	0.13	0.58	0.13	0.05	6.17**	–0.08	0.07	1.39	0.07	0.07	1.03
Sleep duration before work (h)	1.49	1.16	1.65	–0.09	0.54	0.02	0.03	0.54	0.00	–0.25	0.45	0.31
Nursing workload:												
Medical support services[6]	0.28	0.11	6.36**	0.22	0.05	22.34***	0.14	0.04	9.64**	0.12	0.04	9.08**
Nursing care[6]	0.10	0.12	0.70	–0.01	0.07	0.02	0.02	0.07	0.05	–0.07	0.04	2.93
Number of nurse calls answered[7]	0.95	1.58	0.36	2.25	0.83	7.28**	5.22	1.22	18.18***	6.30	1.07	34.91***

*p<0.05, **p<0.01, ***p<0.001.

1) Generalized linear mixed model was used to estimate model parameters. Dependent variable: sense of time pressure (Measured by VAS: 0=no time pressure to 100=severe time pressure). 2) Estimate. 3) Standard Error. 4) Measured by VAS. 0=no fatigue to 100=severe fatigue. 5) Measured by VAS. 0=no sleepiness to 100=severe sleepiness. 6) Higher score indicated more workload. 7) Number of nurse calls answered 1=0–3 calls, 2=4–6 calls, 3=7–10 calls, 4=10–14 calls, 5=≥15 calls.

result, the medical support services and nursing care workload were relatively heavier than during the other shifts. Sleepiness and fatigue were significantly higher during the night shift than during the other shifts. Compared with the normal day shift, fatigue, sleepiness, and sleep duration before work were higher during the evening-day shift. There was no difference in subjective time pressures and nursing service delays due to busyness between shifts.

Working conditions that correlate with time pressures

Table 2 shows the correlations between working conditions and subjective time pressure by shifts. A higher level of fatigue before work, a higher level of sleepiness before work, and a higher medical support services workload were correlated with a higher subjective time pressure. Furthermore, subjective time pressure was correlated with nursing care workload during the evening-day shift, the normal day shift, and

the evening shift, and number of nurse calls answered during the normal day shift, the evening shift, and the night shift.

Table 3 shows the results of the multivariate analysis for subjective time pressure. To consider intra-individual correlations in each ward and nurse, a generalized linear mixed model was used in the analysis. For all shifts, a higher medical support services workload was associated with higher subjective time pressure. During the normal day shift, the evening shift, and the night shift, a greater number of nurse calls answered were associated with higher subjective time pressure. Subjective time pressure increased during the normal day shift when nurses reported a higher level of fatigue before work and higher sleepiness before work, and during the evening shift when nurses reported higher levels of fatigue before work.

Work conditions correlating with delays in nursing services due to busyness

Table 4 shows the results of the bivariate analysis of the relationship between work conditions and nursing service delays due to busyness by shifts. For all shifts, with higher medical support services workloads, the respondents reported significantly more nursing service delays. During the normal day shift and the night shift, significantly more nursing service delays were reported when there were higher nursing care workloads. A greater number of nurse calls answered was associated with nursing service delays during the normal day shift, the evening shift, and the night shift. Furthermore, nursing service delays were associated with higher levels of fatigue before work during the evening-day shift, the normal day shift, and the night shift, and higher levels of sleepiness before work during the evening-day shift and the normal day shift.

Table 5 shows results of the multivariate analysis on the presence of nursing service delays and working conditions. To consider intra-individual correlations in each ward and nurse, generalized estimating equations were performed. During all shifts, nursing service delays were reported with higher medical support services workloads. Furthermore, nursing service delays were reported with a greater number of nurse calls answered during the normal day shift and the night shift. A higher level of fatigue before work was significantly associated with nursing service delays during the evening-day shift.

Discussion

Effects of nursing services

For all shifts, the medical support services workload was correlated with subjective time pressures and nursing service delays. The medical support services reviewed in this study were all conducted at designated times that could not be changed at the discretion of a nurse. People who are in jobs with high demands and low levels of control, such as nurses, are considered to be at high risk for developing stress[18]. To reduce the time pressure on nurses and the occurrence of nursing service delays, it is important to consider the level of discretion that could be exercised by nurses. It is possible that allowing nurses some discretion on when to perform certain duties may help reduce time pressures and nursing service delays.

Of course, to determine how best to reduce time pressures, it is necessary to investigate the nursing workload that can be handled by a single nurse. The number of hospitalized patients per nurse is extremely high in Japan compared with other countries[19]. Medical advances, the level of complexity in medicine, and the sharp drop in the average hospital stay due to medical insurance have resulted in a marked increase in the per-nurse workload of nursing services performed in conjunction with medical treatments. The medical reimbursements paid for nurse deployment were revised in April 2006, and an increasing number of hospitals have hired more nurses to increase their income. This has resulted in nationwide competition for nurses. A growing number of hospitals are unable to stay in business because their nurses are being hired by other hospitals[20]. However, in hospitals that have increased their nursing staff, the nurses are now able to implement medical safety policies, and their working conditions have improved; for example, nurses at these hospitals are able to take breaks during the night shift[21]. Studies need to be done to determine whether an increased number of nurses contributes to the provision of safer nursing services based on the changes in the nurses' workloads and reductions in subjective time pressures and nursing service delays. To calculate the appropriate level of labor power, it is essential to develop a nursing workload measurement tool. Studies have been conducted in Japan to determine the nursing necessity[22]. However, a tool with proven convenience, reliability, and validity has yet to be developed. To prevent medical accidents, researchers urgently need to develop a tool that can measure nurses' workloads in a manner that is congruent with the Japanese medical system. This tool could be used to calculate the amount of nursing labor needed to staff medical facilities.

The number of nurse calls answered was also a factor that led to higher subjective time pressures during the normal day shift, evening shift, and night shift, and it led to nursing service delays due to busyness during the normal day shift and night shift. Answering nurse calls requires that nurses stop what they are doing to answer the call[6]. If the nurse does not resume the activity that was interrupted, it could lead to errors of omission[4, 23], as nurses may unintentionally neglect to perform certain tasks. Cross-checking is one of the nursing services that might end up being omitted[7]. When time pressures and nursing service delays occur, cross-checking may be skipped. This results in the occurrence of errors due to a

Table 4. Effects of working conditions on "nursing service delays due to busyness" (bivariate analysis[1)])

	Nursing service delays	Day shift: Evening-day shift Mean ± SD	t value	Day shift: Normal day shift Mean ± SD	t value	Evening shift Mean ± SD	t value	Night shift Mean ± SD	t value
Work experience:									
Years of experience as a nurse	No	10.82 ± 8.21	0.83	10.37 ± 8.27	2.00	10.31 ± 8.42	1.77	10.72 ± 8.10	–0.27
	Yes	9.64 ± 9.29		9.05 ± 9.16		8.84 ± 6.92		11.00 ± 8.98	
Years of experience at the current ward	No	3.25 ± 2.67	–0.10	3.35 ± 3.31	2.10	3.33 ± 2.55	0.48	3.87 ± 3.23	2.43 *
	Yes	3.29 ± 2.34		2.89 ± 2.68		3.20 ± 2.23		3.09 ± 2.43	
Fatigue:									
Subjective fatigue before work[2)]	No	66.64 ± 22.99	–2.94 **	57.46 ± 22.09	–3.43 **	53.58 ± 23.24	–0.32	72.00 ± 19.49	–2.40 **
	Yes	77.02 ± 20.15		63.04 ± 23.98		54.34 ± 23.11		77.10 ± 18.19	
Sleep loss:									
Sleepiness before work[3)]	No	64.66 ± 26.06	–2.34 *	55.58 ± 24.09	–2.87 **	47.52 ± 24.21	0.83	74.11 ± 21.88	–1.47
	Yes	74.11 ± 23.79		60.36 ± 23.75		45.44 ± 23.97		77.59 ± 19.90	
Sleep duration before work (h)	No	5.21 ± 1.75	0.76	6.41 ± 1.54	0.58	8.48 ± 2.25	0.78	3.25 ± 2.31	0.39
	Yes	5.00 ± 1.74		6.34 ± 1.62		8.30 ± 2.10		3.15 ± 2.67	
Nursing workload:									
Medical support services[4)]	No	26.77 ± 30.97	–2.70 **	30.52 ± 19.36	–4.45 ***	53.71 ± 30.05	–4.76 ***	58.35 ± 36.52	–4.13 ***
	Yes	39.07 ± 20.25		37.44 ± 23.47		70.42 ± 39.22		78.89 ± 46.87	
Nursing care[4)]	No	16.64 ± 16.35	–1.55	17.54 ± 14.40	–3.53 ***	32.36 ± 23.05	–1.85	40.50 ± 33.51	–2.57 **
	Yes	21.02 ± 19.88		21.56 ± 17.20		36.93 ± 24.59		50.79 ± 39.33	
Number of nurse calls answered[5)]	No	2.56 ± 1.12	–0.93	2.63 ± 1.19	–4.89 ***	2.95 ± 1.25	–3.27 *	2.37 ± 1.15	–5.48 ***
	Yes	2.74 ± 1.26		3.03 ± 1.16		3.21 ± 1.30		3.09 ± 1.25	

*p<0.05, **p<0.01, ***p<0.001.

1) Results of t test. 2) Measured by VAS. 0=no fatigue to 100=severe fatigue. 3) Measured by VAS. 0=no sleepiness to 100=severe sleepiness. 4) Higher score indicated more workload. 5) Number of nurse calls answered 1=0–3 calls, 2=4–6 calls, 3=7–10 calls, 4=10–14 calls, 5=≥15 calls.

Table 5. Effects of working conditions on "nursing service delays due to busyness" (multivariate analysis[1])

	Day shift		Evening shift	Night shift
	Evening-day shift	Normal day shift		
	OR (95%CI)	OR (95%CI)	OR (95%CI)	OR (95%CI)
Work experience:				
Years of experience as a nurse	1.003 (0.956–1.051)	0.996 (0.975–1.017)	0.979(0.941–1.019)	1.014(0.975–1.054)
Years of experience at the current ward	1.025 (0.833–1.262)	0.967(0.907–1.030)	1.021(0.890–1.171)	0.902(0.801–1.016)
Fatigue:				
Subjective fatigue before work[2]	1.050 (1.014–1.087) **	1.008(0.999–1.018)	1.003(0.985–1.020)	1.007(0.986–1.028)
Sleep loss:				
Sleepiness before work[3]	0.970 (0.940–1.002)	0.996(0.988–1.005)	0.991(0.974–1.007)	1.006(0.988–1.025)
Sleep duration before work (h)	1.108 (0.843–1.457)	1.016(0.969–1.066)	0.949(0.840–1.072)	1.006(0.916–1.106)
Nursing workload:				
Medical support services[4]	1.051 (1.021–1.082) ***	1.009(1.004–1.015)***	1.016(1.007–1.025)**	1.009(1.000–1.018)*
Nursing care[4]	0.987 (0.960–1.014)	0.998(0.991–1.004)	0.998(0.985–1.011)	0.998(0.989–1.007)
Number of nurse calls answered[5]	1.111 (0.776–1.591)	1.315(1.166–1.483)***	1.069(0.843–1.356)	1.576(1.236–2.010)***

*p<0.05, **p<0.01, ***p<0.001.

1) The generalized estimating equation method was used to estimate model parameters. Dependent variable: Delay of nursing services due to busyness (absent=0 present=1). 2) Measured by VAS. 0=no fatigue to 100=severe fatigue. 3) Measured by VAS. 0=no sleepiness to 100=severe sleepiness. 4) Higher score indicated more workload. 5) Number of nurse calls answered 1=0–3 calls, 2=4–6 calls, 3=7–10 calls, 4=10–14 calls, 5=≥15 calls.

lack of adequate cross-checking. Therefore, it is necessary to consider the adoption of a nurse call system, which adapts the nursing delivery system into team nursing or primary nursing activities and triggers messages that are sent directly to the primary care giver. The introduction of this type of system shortens nursing activities and make it possible to perform quick and adequate patient services[24]. Furthermore, the number of nurse calls must be assessed to ensure that nurses can meet the needs of patients, which can be difficult to anticipate. However, when there are frequent nurse calls, it becomes difficult for nurses to meet the needs of all patients. A decrease in nurse calls can reduce work interruptions, improve the nurses' subjective time pressures and nursing service delays, and also help prevent errors. Given this observation, studies are needed to determine why patients use their nurse call button, the characteristics of patients who tend to use their nurse call button, and whether enough labor power is being made available to provide nursing care.

The problem of shift work

In same day shifts, the factors associated with subjective time pressure and nursing service delay due to busyness were different between the evening-day shift and the normal day shift. During the normal day shift, subjective time pressure was significantly correlated with fatigue before work. The result was similar for the evening shift. Unlike the evening-day shift or the night shift, nurses can get enough sleep in the normal day shift or the evening shift. However, there were some nurses who had excessive fatigue before work, and they felt more time pressure during these shifts. Considering that mean fatigue before work in the evening-day shift and the night shift was more than 10 mm higher than for the other shifts, it is possible that the difference in fatigue level was not associated with subjective time pressures in the evening-day shift and the night shift. It is also possible that the sample size might not have been large enough to detect differences because F values were relatively high. Therefore, it is possible that subjective time pressure was associated with fatigue before work during all shifts, and further examination is necessary.

In terms of nursing service delays due to busyness, these delays were significantly correlated with subjective fatigue before work during the evening-day shift but not during other shifts. Even during the day-night shift, like the evening-day shift, during which there are only several hours between shift end time and next shift start time, nursing service delays due to busyness were not correlated with subjective fatigue. The evening-day shift is a back rotation shift, which allows work times to gradually shift to earlier hours and works against circadian rhythms for both nurses and patients. However, the day-night shift is a back rotation for nurses, but a forward rotation for patients. Therefore, the evening-day shift is more likely to disturb circadian rhythms, causing fatigue[25, 26]. Because fatigue reduces a nurse's ability to work, even normal workloads become excessive, resulting in nursing service delays and errors caused by a lack of accuracy in

work performance[9, 10, 27–30].

The shift work system in which one nurse works three shifts repeatedly in 1 week is peculiar to Japan. All staff nurses are requested to work a 24-h shift-work system in the hospital, and this system is the root cause of chronic fatigue. In other countries, however, nurses can choose work shifts according to their lifestyles. According to the International Council of Nurses, employers should be required to introduce approaches to reduce the harmful effects of shift work, such as individualized time schedules, decreased hours per week for evening and night shifts, and use computer programs to develop objective work rosters[31]. Therefore, it is necessary to consider the introduction of the individualized shift schedules in Japan.

To improve health conditions of the workers engaged with 24-h shift-work, it is necessary to consider the number of nurses needed to meet patient/community needs and ensure patient safety[31]. Moreover, introducing a two-shift system (working two 12-h shifts with days off in between), as opposed to a backward rotation, such as the evening-day shift, may be a good way to protect shift workers' health. The two-shift system has some advantages, as it enables workers to take more days off, allowing them to improve their home and social lives, and increases the level of work satisfaction among nurses[32–35]. In Japan, hospitals are increasingly adopting the two-shift system. However, it has been pointed out that the two 12-h shift system adopted in other countries has led to chronic fatigue and errors due to long work hours[32, 34]. Nevertheless, many hospitals in Japan have introduced a 24-h rotation comprised of an 8-h shift and a 16-h shift[36]. Further investigation is needed to determine the kinds of work systems that allow nurses to stay healthy and provide safe, high-quality care.

Limitations and future research

The subjects of this study were nurses at 17 wards in two hospitals. The results of the survey might have differed if it had been conducted at other wards or hospitals that had different treatment regimens and work-shift systems. To improve working conditions most effectively, the survey and analyses should be performed for each medical institution and for each ward.

In conducting this study, busy nurses were asked to complete a survey, a task that only added to their workload. This placed a large burden on nurses at hospitals that do not regularly record nurses' workloads; thus, incomplete reports were submitted by many nurses. For this reason, the responses obtained in this survey could be biased towards data obtained from nurses who were aware of the nature and volume of the nursing services for which they are responsible.

Conclusion

Changes in several working conditions could lead to a reduction in time pressures and prevention of errors; these changes include having an adequate number of nurses, implementing shift plans that consider rest periods and order of rotation, expanding the discretion of nurses for completing tasks, and preventing chronic fatigue. Future research must focus on developing a convenient tool for measuring the workloads of nurses in Japan so that appropriate workloads can be calculated.

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References

1) Japan Council for Quality Health Care, Medical Accident Prevention Center. Iryo Jiko Jyoho Shushutou Jigyo Dai 7kai Hokokusho (The 7th Report of Medical Accident Information Collection Project). Tokyo: Japan Council for Quality Health Care, 2006 (in Japanese).
2) Tokyo Medical Worker's Unions Council. Iryo Jiko ni Kansuru Kangofu Anketo—Chukan Hokoku—(An Interim Report of Questionnaire Survey of Medical Accidents). Tokyo: Tokyo Medical Worker's Unions Council, 2000 (in Japanese).
3) Japan Federation of Medical Worker's Unions. Kango Genba Jittai Chousa—Chukan Hokoku—(An Interim Report of Actual Conditions of Nursing). Tokyo: Japan Federation of Medical Worker's Unions, 2000 (in Japanese).
4) Reason J. Managing the Risks of Organizational Accidents. Aldershot: Ashgate Publishing Limited, 1997.
5) Reason J: Human error: models and management. West J Med 172, 393–396 (2000)
6) Kawamura H: The approaches to factors which cause medication error—from the analyses of many near-miss cases related to intravenous medication which nurses experienced. Gan To Kagaku Ryoho 28, 304–309 (2001) (in Japanese)
7) Seki Y and Yamazaki Y: Prevention of adverse drug events II: error-producing conditions detrimental effect on defenses. The Japanese Society of Health & Medical Sociology 17, 1–13 (2005) (in Japanese)
8) Seki Y and Yamazaki Y: Effects of working conditions on intravenous medication errors in a Japanese hospital. J Nurs Manage 14, 128–139 (2006)
9) Krueger GP: Sustained work fatigue sleep loss and performance: a review of the issues. Work & Stress 3, 129–141 (1989)
10) Krueger GP. Fatigue, performance and medical error.

In: Bonger MS, ed. Human Error in Medicine. Hillsdale: Lawrence Erlbaum Association, 1994: 311–326.
11) Philip P, Sagaspe P, Taillard J, Moore N, Guilleminault C, Sanchez-Ortuno M, Akerstedt T and Bioulac B: Fatigue, sleep restriction, and performance in automobile drivers: a controlled study in a natural environment. Sleep 26, 277–280 (2003)
12) Philip P, Taillard J, Sagaspe P, Valtat C, Sanchez-Ortuno M, Moore N, Charles A and Bioulac B: Age, performance and sleep deprivation. J Sleep Res 13, 105–110 (2004)
13) Monk TH: A visual analogue scale technique to measure global vigor and affect. Psychiatry Res 27, 89–99 (1989)
14) Kawashima M. Kango Kanri Oboegaki (Memorandum of Nursing Management). Tokyo: Igakushoin, 1998: 38 (in Japanese).
15) Department of Nurse Toranomon Hospital. Toranomon Nursing System—Isogashisa no Shakudo to Kango Jinin Haichi (Toranomon Nursing System: TNS—Measuring of Busyness and Nurse Staffing). Tokyo: Medical Friend Co., 1990 (in Japanese).
16) Littell CR, Milliken AG, Stroup WW, Wolfinger DR. SAS for Mixed Models. North Carolina: SAS Institute, 2003: 159–203.
17) Stokes ME, Davis CS, Koch GG. Categorical Data Analysis Using the SAS System. North Carolina: SAS Institute, 2001: 469–550.
18) Karasek R, Theorell T. Healthy work: stress, productivity, and the reconstruction of working life. New York: Basic Books, 1990.
19) OECD Health Data. Bernan, 2004.
20) Japan Medical Association. Kango Shokuin no Jyukyu ni Kansuru Chosa (Report of supply and demand for Nursing staff). Tokyo: Japan Medical Association, 2007 (in Japanese).
21) Japanese Nursing Association. Kango Shokuin Kakuho ni Kansuru Kangaekata (Views of securing nursing staff). Tokyo: Japanese Nursing Association, 2006 (in Japanese).
22) Iwasawa K, Tsutsui K. Kango Hitsuyodo—Kango Sabisu no Aratana Hyokakijun—(Nursing necessity—New criterion of nursing service—). Tokyo: Japanese Nursing Association Publishing Company, 2003 (in Japanese).
23) Reason J: Combating omission errors through task analysis and good reminders. Qual Saf Health Care 11, 40–44 (2002)
24) Tamaki K: A study on a new function demanded from nurse call systems. JJMI 73, 200 (2003) (in Japanese)
25) Knauth P: The design of shift systems. Ergonomics 36, 15–28 (1993)
26) Minors DS, Waterhouse JM. Introduction to circadian rhythms: Chapter 1. In: Folkard S, Monk TH, eds. Hours of Work: Temporal Factors in Work-Scheduling. New York: John Wiley and Sons, 1985: 1–13.
27) Skipper JK Jr, Jung FD and Coffey LC: Nurses and shiftwork: effects on physical health and mental depression. J Adv Nurs 15, 835–842 (1990)
28) Rollinson DC, Rathlev NK, Moss M, Killiany R, Sassower KC, Auerbach S and Fish SS: The effects of consecutive night shifts on neuropsychological performance of interns in the emergency department: a pilot study. Ann Emerg Med 41, 400–406 (2003)
29) Smith-Coggins R, Rosekind MR, Hurd S and Buccino KR: Relationship of day versus night sleep to physician performance and mood. Ann Emerg Med 24, 928–934 (1994)
30) Coffey LC, Skipper JK Jr and Jung FD: Nurses and shift work: effects on job performance and job-related stress. J Adv Nurse 13, 245–254 (1988)
31) The International Council of Nurses. Guidelines on Occupational Health and Safety Management Programme for Nurses. Geneva: International Council of Nurses, 2007.
32) Smith L, Folkard S, Tucker P and Macdonald I: Work shift duration: a review comparing eight hour and 12 hour shift systems. Occup Environ Med 55, 217–229 (1998)
33) Mitchell RJ and Williamson AM: Evaluation of an 8-hour versus a 12-hour shift roster on employees at a power station. Appl Ergon 31, 83–93 (2000)
34) McGettrick KS and O'Neill MA: Critical care nurses—perceptions of 12-h shifts. Nurs Crit Care 11, 188–197 (2006)
35) Stone PW, Du Y, Cowell R, Amsterdam N, Helfrich TA, Linn RW, Gladstein A, Walsh M and Mojica LA: Comparison of nurse, system and quality patient care outcomes in 8-hour and 12-hour shifts. Med Care 44, 1099–1106 (2006)
36) Japanese Nursing Association. Nihon Kango Kyokai Chousa Kenkyu Houkoku (Japanese Nursing Association Research Report No. 59). Tokyo: Japanese Nursing Association Publishing Company, 2001 (in Japanese).

Appendix 1. Nursing care

		Points (A)	Number of patients (B)	Weighted score (A*B)
1)	Helping patients with movement for 21 min or more	5		
2)	Helping patients with movement for 20 min or less	2		
3)	Helping patients with bathing for 21 min or more	5		
4)	Helping patients with bathing for 20 min or less	2		
5)	Helping patients with feeding for 21 min or more	5		
6)	Helping patients with feeding for 20 min or less	2		
7)	Helping patients with excretions for 21 min or more	5		
8)	Helping patients with excretions for 20 min or less	2		
9)	Helping patients with face washing and oral care	2		
10)	Helping patients to change position	2		
11)	Helping patients by responding to patients' experiencing pain	2		
12)	Helping patients by responding to patients' having difficulty sleeping	2		
13)	Helping patients by responding to patients' experiencing depression or anxiety	2		
14)	Helping patients by explaining or providing guidance regarding surgery or tests	2		
15)	Helping patients by providing guidance and education regarding self-management of medications	2		
16)	Helping patients by providing lifestyle guidance and education needed for the self-management of the patient's disease or health	2		
	Total score			