Introduction

The shortage of anesthesiologists has become a concern for surgeons [1, 2], and is now considered to be a social problem. In Japan, there are only 3.9 anesthesiologists per 100,000 people in 2004 [3], compared to 13.8 in the United States [4]; in the European Union and the United Kingdom these numbers are 9.2 and 4.6, respectively [5, 6]. There is also a large difference in the number of anesthesiologists between regions and facilities in Japan, Mizuno et al. [3] reported that the number of anesthesiologists per 1,000 beds in Mie Prefecture was only 1.6, whereas that in Tokyo was 5.3. According to the member list published by the Japanese Society of Anesthesiologists, the number of members differs significantly between regions, indicating the uneven distribution of anesthesiologists in Japan.

The lack and mal-distribution of anesthesiologists increase workload and work-related stress [7], and a vicious circle may be created as anesthesiologists leave their work due to the heavy workload. Therefore, it is important to clarify the relationship between workload and stress in anesthesiologists. However, the actual working time of anesthesiologists in surgery has not been established, because in part many anesthesiologists have roles in pain clinics, palliative medicine, ICU, critical care, and hospital management, and so it is difficult to obtain data for workload for individual anesthesiologists. In addition, there are many physicians who do not work as anesthesiologists although they are qualified to do so. Therefore, collection of data on workload and background of individual anesthesiologists is required to clarify the current workload and to assess stress. An understanding of differences in workload among medical facilities and the working burden is also important for evaluation of labor shortages and stress among anesthesiologists. This study was aimed to investigate the relationship between workload and stress in anesthesiologists.

Subjects and Methods

Subjects

The study was performed among members of the Japanese Society of Anesthesiologists (JSA) who work as full-time anesthesiologists at acute care hospitals. #acute care hospitals, in which university hospitals (including associated hospitals) were excluded. In addition, physicians who were members of JSA and employed in a Department of Anesthesia of an acute care hospital (excluding trainee physicians) were defined as anesthesiologists. After obtaining agreement from JSA, we selected 1,010 members about 1 out of every 9 anesthesiologists from the list (web version) of JSA which was published in August 2005 and included approximately 9,000 members in total. If an anesthesiologist who worked at a university hospital was initially selected, the next listed anesthesiologist who worked at acute care hospitals was chosen instead. Self-administered anonymous questionnaires were sent to the selected anesthesiologists by mail, together with a written explanation of the questionnaire, the objectives of the questionnaire, methods, and a request for voluntary participation. Return of the questionnaire was considered to indicate an agreement to participate in the study.

Methods

This study was performed after obtaining permission from the ethical committee of Kyoto University Graduate School of Medicine. The questionnaire was sent to the anesthesiologists in October 2005 with a request that answers should be returned using an enclosed envelope by December 31, 2005. A postcard was also sent to each anesthesiologist 2 weeks after distribution of the questionnaire to remind them to send back their answers.

The survey requested information on the personal background, medical facility, workload of anesthesia in surgery and stress. The personal background included sex, years of

experience, major work, duty/on-call system, and work other than anesthesia in surgery. Regarding the medical facility, questions were asked about the number of full-time and part-time anesthesiologists and the number of anesthesia per year. To investigate weekly workload of anesthesia in surgery, the subjects were requested to record the starting and completion times of anesthesia in each surgery every day during a week: the week starting on October 3, 2005, or the previous week if the designated week was not representative due to holidays of staff members or participation in an academic meeting. Stress was investigated using 12 mandatory questions selected from the Japanese version of the Job Content Questionnaire (See Appendix) and the answers were recorded as scores using a " Diagram for measuring occupational stress", with reference to the "Study on Prevention of Work-related Diseases" performed from 1995 to 1999 by the Ministry of Labor [8,9]. This approach allows data to be obtained for stress related to "psychological demands" and "decision latitude" (hereinafter referred to as work stress) and to "support of superiors" and "support of colleagues" (hereinafter referred to as no-support stress). The each stress score was interpreted by calculating stress-related health problems as the "health risk," assuming an average score of 100 for the standard group (an average score was calculated from 25 thousand workers); thus, a score of 120 indicates an increase of 20% in development of health problems.

Statistical Analysis

The results were presented as mean, standard deviation (SD), 25, 50, 75th percentile, or percentage.

Working environment at medical facilities was determined as the estimated annual cases managed by an anesthesiologist. This estimation was made by dividing the number of anesthesia per year at each institution by the number of full-time and part-time

anesthesiologists at that institution.

The workload of an anesthesiologist in surgery was determined as the total anesthesia time per week, the on duty (times/month), on-call (times/month). The stress was determined as work stress and no-support stress.

To examine the characteristics of anesthesiologists with a heavy workload of anesthesia in surgery, the group who had a total anesthesia time per week above the 75th and 95th percentiles were recorded for the background, working environment at the medical facility and stress.

To examine relationships of work stress with background, work environment, workload and no-support stress, with the subjects divided into 2 or 3 groups based on each factors. Differences in work stress between pairs of groups were tested statistically using a Dunnett test.

To examine relationships of work stress, multiple linear regression analysis was performed with work stress used as the objective variable, as the explanatory variables, sex and years of experience were used to define the characteristics of individual anesthesiologists; the number of beds to define the medical facility; work in an ICU/critical care department and the number of duties/on-call work to define the personal working environment; the total anesthesia time per week and estimated annual cases managed by an anesthesiologists to define personal workload; and no-support stress to define support at work.

All analyses were performed using SPSS for Windows ver.11.0, with a level of 5% used to define significance (two-sided test).

Results

Questionnaires were sent to 1010 anesthesiologists, but 65 were returned as wrongly addressed. Of the 945 effective mailings, answers were obtained from 415 subjects. The overall response rate was 43.6%, but showed a regional difference (26.1% in the Tokyo area, compared to 51.9% in Kyushu). The number of responses obtained from full-time anesthesiologists (the subjects of this study) was 383.

The background of the 383 subjects, estimated annual cases managed by an anesthesiologist, workload, and stress are shown in Table 1. Average values of 114.3 for work stress score and 100.5 for no-support stress score were obtained from the stress questionnaire.

The backgrounds of subjects, estimated annual cases managed by an anesthesiologist and stress score for anesthesiologists with the top 25% ($\geq$ 32.6 hours, n=99) and top 5% ($\geq$ 47.0 hours, n=17) in total anesthesia time per week are shown in Table 2.

The subjects were divided into 2 or 3 groups based on individual factors and differences in work stress were examined among these groups. As shown in Table 3, significant differences were found for hospital beds, total anesthesia time per week, estimated annual cases managed by an anesthesiologist, and no-support stress, indicating that these factors have an association with work stress.

The results of multiple linear regression analysis using these factors are shown in Table 4. The factors with a significant association to stress, in descending order of standard regression coefficient, were as follows: "no-support stress" (standard coefficient, $\beta = 0.21$, $p < 0.01$); "years of experience" (with experience < 10 years considered as the reference; 10-19 years: $\beta = -0.18$, $p = 0.02$, $\geq$ 20 years: $\beta = -0.15$, $p = 0.04$); "total anesthesia time per week" ($\beta = 0.18$, $p = 0.02$); "hospital beds" (with a hospital with $\leq$ 299 beds considered as the reference, hospitals with $\geq$ 500 beds: $\beta = 0.15$, $p = 0.04$); and "estimated annual cases managed by an

anesthesiologist," $\beta = 0.12$, and $p = 0.04$. Regarding "hospital beds," work stress was higher in hospitals with ≥ 500 beds than in hospitals with ≤ 299 beds. Regarding years of experience, work stress was lower in anesthesiologists with experience of "10-19 years" and "≥ 20 years" than in those with experience of "<10 years." In these models, the determination coefficient was 0.12.

Discussion

The results of the survey of randomly selected anesthesiologists working at acute care hospitals in Japan provide clarification of the workload related to anesthesia in surgery and work stress associated factors. The average work time for anesthesia was 23.6 hours per week. We minimized the item number of questions in the survey to increase the response rate, and questions regarding the workload for anesthesia (anesthesia time) were limited to anesthetic management. Therefore, the average anesthesia time per week of 23.6 hours does not include related work such as preoperative consultation, preparation of the operation room, and postoperative follow-up. In addition, as clearly shown in Table 1, many anesthesiologists are involved in work other than anesthetic management, such as in intensive care, critical care and pain clinics, as well as treatment, training and administration, which leads to a large total workload.

The National Committee on Physician Manpower in Canada in the 1970's recommended that the ratio of anesthesiologists to the total population should be 1:13,742, based on a working time of 54.4 hours/week [10]. In 2006, just after the current study was performed, the number of anesthesiologists in Japan was estimated to be approximately 7,000 and the national population to be about 120 million. This gives a ratio of 1:17,142 anesthesiologists per population, which is considerably smaller than that recommended by the National Committee on Physician Manpower. This suggests that the working time of anesthesiologists

at acute care hospitals in Japan in 2006 was longer than 54.4 hours/week.

We used the "estimated annual cases managed by an anesthesiologist" as a marker of the working environment at medical facilities. This number was determined by dividing the number of cases of surgery in a year at each facility in which anesthesia was performed by the number of anesthesiologists, and reflects the environment for anesthesia in surgery at each facility. A mean of 388.2 cases/anesthesiologist/year was obtained, compared with values of 464.7 and 351.4 cases/anesthesiologist/year in ex-national hospitals and public hospitals, respectively, found in a preliminary study in 2002 [11]. The differences between the results may be due to the limit of target hospitals to those with 500 beds or more and inclusion of part-time anesthesiologists in the 2002 study.

In the current study, the average work stress of full-time anesthesiologists was 14.3% higher than the standard group, and the incidence of work-related health problems in approx. 25% of the anesthesiologists was 30% higher than the standard group, indicating a high-risk work situation. An investigation of health conditions of workers performed by the Ministry of Health, Labor, and Welfare showed that the stress of workers in Japan has increased, and that the percentage of workers with "severe anxiety, troubles, and stress in their work and occupational life" increased from 50.6% in 1982 to 61.5% in 2002. In overseas reports, anesthesiologists have also been found to have more stress than other physicians [12, 13], with the reasons for such severe stress including less satisfaction in their work, long working hours, on-call work, fear of court case, and problems with relationships with physicians of other departments [14-16]. An investigation performed by the American Society of Anesthesiologists in 1991 indicated that the greatest stress was caused by on-call work at night, in addition to stress due to the requirement for anesthesia for patients at high risk, work responsibilities, and a heavy workload [17]. Based on our data, it appears likely that stress among anesthesiologists at acute care hospitals in Japan is considerable, although we have no

evidence that this stress is higher than that of other physicians.

Predictably, workload (total time of anesthesia per week and estimated annual cases managed by an anesthesiologists) was significantly associated with stress, but other factors (years of experience, support from other staff members, and hospital-related factors such as hospital beds) might also be associated to stress. There was a significant difference in work stress between anesthesiologists with experience of 10 years or less and 10 years or more. This suggests that anesthesiologists with experience of 10 years or more may have less stress due to improved anesthetic techniques, even with the same workload. In addition, Dean et al. [18] have suggested that social support (defined as no-support stress in this study) may decrease stress related to "psychological demands" and "decision latitude" (defined as work stress in this study). It has also been reported that stress is affected by social support from superiors or colleagues (that is, human relationships at work sites) [19] and our results suggest that work stress may decrease with increased support (decreased no-support stress) even with the same workload. The hospital beds were also associated to work stress. Workload for anesthesia increased in larger hospitals, but this does not simply mean that workload will increase in larger hospitals because of increased work burden. Rather, an anesthesiologist may have a larger technical burden in larger hospitals, since the various types of surgery performed at a large-beds hospital may require special anesthesia techniques, work stress may also emerge from other work (for example, education, administration), because this association was confirmed even after adjustment for workload.

In this study, the possible bias caused by lack of responses could not be neglected and the findings may not be generalizable to all anesthesiologists. However, the response rate was higher than that for past questionnaire surveys for physicians. The associations of work stress with factors such as workload, years of experience, hospital beds and support from other staff members were moderate and considered to be limited. However, the information collected in

this study has not been reported previously, and thus we consider that the results provide a useful insight into the actual situation of anesthesiologists in Japan. We suggest that countermeasures based on the stress-related factors identified in this study should be taken to create a less stressful environment that will allow retention of the required number of anesthesiologists.

Acknowledgements

We express our deep appreciation and gratitude to the anesthesiologists for their cooperation with this study despite their heavy work schedule. Summaries of the study were presented at the 53rd and 54th General Meetings of JSA at Kobe (2006) and Sapporo (2007).

References

1) Kobayashi K. Shortage of manpower in anesthesiologists (in Japanese). Nippon Geka Gakkai Zasshi (Journal of Japan Surgical Society). 2005; 106 : 457.

2) Takeda J. The Proposal of correspondence to shortage of manpower in anesthesiologists from Japan Society of Anesthesiologist (in Japanese). Nippon Geka Gakkai Zasshi (Journal of Japan Surgical Society). 2005; 106 : 53.

3) Mizuno J, Yokoyama T, Ueki M, Fukushima T, Suzuki T, Hanaoka K. Regional Differences in the Numbers of Anesthesiologist in Japan (in Japanese with English abstract). Masui (Jpn J Anesthesiol). 2004; 53 : 443-49.

4) Moyers JR. The evolution of human resource needs in the USA. Best Pract Res Clin Anaesthesiol. 2002; 16 : 423-41.

5) Rolly G, McRae WR, Blunnie WP, Dupont M, Scherpereel P. Anaesthesiological manpower in Europe. Eur J Anaesthesiol. 1996; 13 : 325-32.

6) Scherpereel P, Sondore A. The evolution of human resource needs in Europe. Best Pract Res Clin Anaesthesiol. 2002; 16 : 443-57.

7) Tushima M. The problem of regional Differences in the Numbers of Anesthesiologist in Japan (in Japanese). Nihon Rinsyoumasui Gakkaishi. 1996; 16 : 9-11.

8) Kawakami N, Kobayashi F, Araki S, Haratani T, Furui H. Assessment of job stress dimension based on the job demands-control model of employees of telecommunication and electric power companies in Japan : reliability and validity of the Japanese version of the Job Content Questionnaire. Int J Behav Med. 1995; 2 : 358-75.

9) Kawakami N. Manual of " Diagram for measuring occupational stress" (in Japanese). In: Kato M, editor. The report of the "Study on Prevention of Work-related Diseases" by the Ministry of Labor. Tokyo: Tokyo Medical University Department of Preventive Medicine and Public Health; 2000. p.11-26.

10) Neil D, Ian WC, Lisa S, Claudia AS. Canadian anesthesia physician resource planning – is it possible? Can J Anaesth. 1995; 42 : 348-57.

11) Yagishita Y, Shimizu Y, Takasawa T, Nomoyama S, Yamane K, Takeda K, Miyazaki H. Survey of condition of anesthesiology department at national centers for advanced and specialized medical care, national hospitals and national sanatoriums ; study of the causes of anesthesiologist shortage ; and suggested reform measures. (in Japanese with English abstract) IRYO. 2002; 56 : 745-50.

12) Kain ZN, Chan KM, Katz JD, Nigam A, Fleisher L, Dolev J, Rosenfeld LE. Anesthesiologist and Acute Perioperative Stress : A Chohort Study. Anesth Analg. 2002; 95 : 177-83.

13) Morais A, Maia P, Azevedo A, Amaral C, Tavares J. Stress and burnout among Portuguese anaesthesiologists. Eur J Anaesthesiol. 2006; 23 : 433-39.

14) Jackson SH. The role of stress in anaesthetists'health and well-being. Acta Anaesthesiol Scand. 1999; 43 : 583-602.

15) Gaba M., Howard S, Jump B. Production pressure in the work environment. Anesthesiology. 1994; 81 : 488-500.

16) Seeley HF. The practice of anesthesia: a stressor for the middleaged? Anaesthesia.1996; 51 : 571-74.

17) Simpson LA, Grant L. Sources and magnitude of job stress among physicians. J Behav Med. 1991; 14 : 27-42.

18) Dean BB, Robert AK. Occupational Stress. In: Barry SL, David HW, editor. Occupational Health : Recognizing and Preventing Work-Related Disease, 3rd ed. Boston: Little, Brown; 1995. p.381-405.

19) Ruberman W, Weinblatt E, Goldberg JD, Chaudhary BS. Psychosocial influence on mortality after myocardial infarction. New England Journal on Medicine. 1984; 311 :

552-59.

Table 1. Background of subjects (n=383)

	Mean (SD)	percentile 25th	50th	75th
Background				
Years of experience (year)	16.9 (7.9)	11	17	22
Male	67.2%			
Hospital with ≥ 500 beds	33.2%			
Intensive care	30.5%			
Critical care	21.7%			
Pain clinic	43.9%			
Education	51.4%			
Research	6.3%			
Administration	49.1%			
Working environment at medical facilities				
Estimated annual cases managed by an anesthesiologist (cases/anesthesiologist)	388.2 (172.6)	297.5	375	479
Workload for anesthesia in surgery and on duty/on-call				
Total time of anesthesia per week (hours)	23.6 (14.1)	15	23	33
On duty (times/month)	2.1 (2.8)	0.1	1.1	3.5
On-call work (times/month)	11.0 (10.2)	3.0	8.8	17.8
Stress				
No-support stress	100.5 (39.9)	72	97	127
Work stress	114.3 (30.2)	93	111	131

Table 2. Background, working environment at medical facilities, and stress in subjects with the top 25% and 5% total anesthesia time per week

	Total anesthesia time	
	≥ 75th percentile (≥ 32.6 hours) Mean (SD)	≥ 95th percentile (≥ 47.0 hours) Mean (SD)
	(n=99)	(n=17)
Background of subjects		
Years of experience (year)	14.8 (7.6)	13.9 (7.1)
Male (%)	72.0	73.7
Work at a hospital with 500 beds or more (%)	45.9	44.4
Working environment at medical facility		
Estimated annual cases managed by an anesthesiologist (cases/anesthesiologist)	459.4 (197.5)	519.2 (179.5)
Stress		
No-support stress	103.8 (40.0)	119.8 (48.6)
Work stress	125.9 (30.3)	141.4 (36.0)

Table 3. Relationship between work stress and individual variables

	Work stress value (SD)	P value
Years of experience		
≤ 10 years (n=87) †	120.3(31.5)	
10 -19 years (n=175)	113.2(29.4)	0.12
≥ 20 years (107)	111.4(30.2)	0.07
Sex		
Male (n=269)	114.9 (33.8)	
Female (n=129)	111.7 (21.3)	0.33
Hospital beds		
≤ 299 beds (n=110) †	105.7 (30.7)	
300 - 499 beds (n=140)	115.5 (28.3)	0.02
≥ 500 beds (n=124)	120.3 (30.4)	0.01
Work at ICU or critical care department		
Yes (n=148)	115.2 (30.2)	
No (n=221)	113.8 (30.3)	0.66
Number of work on duty/on-call per month		
0 - 8 times (n=140) †	111.2 (31.4)	
9 - 16 times (n=119)	119.3 (29.2)	0.06
≥ 17 times (n=108)	113.0 (29.6)	0.86
Total anesthesia time per week		
0 - 18 hours (n=129) †	107.9 (28.9)	
18.1 - 29 hours (n=124)	110.6 (27.4)	0.69
≥ 29.1 hours (n=116)	125.5 (31.8)	< 0.01
Estimated annual cases managed by an anesthesiologist		
≤ 312 cases (n=116) †	107.4 (31.0)	
312.1 - 433 cases (n=117)	112.4 (25.0)	0.34
≥ 433.1 cases - (n=120)	123.1 (33.0)	< 0.01
No-support stress		
≤ 100 (n=202) †	111.5 (27.3)	
101 - 150 (n=110)	118.2 (32.5)	0.11
≥ 151 (n=38)	125.1 (35.4)	0.02

† Indicates the category used as the reference

Table 4. Relationship between work stress and explanatory variables (multiple linear regression analysis)

	Nonstandard coefficient	Standard error	Standard coefficient	p value
Years of experience (10 - 19 years)	-10.80	4.40	-0.18	0.02
Years of experience (≥ 20 years)	-9.96	4.91	-0.15	0.04
Sex (male)	-0.26	3.70	-0.00	0.95
Hospital beds (300 - 499 beds)	3.65	4.23	0.06	0.39
Hospital beds (≥ 500 beds)	9.45	4.59	0.15	0.04
Work at ICU/critical care department	1.05	3.48	0.00	0.99
On duty/on-call (times/month)	-0.04	0.18	-0.02	0.80
Total anesthesia time per week	0.43	0.14	0.18	0.02
Estimated annual cases managed by an anesthesiologist (cases/year)	0.02	0.01	0.12	0.04
No-support stress	0.16	0.04	0.21	< 0.01

Adjusted $R^2 = 0.12$

Appendix. Stress Questionnaire

(1) You must work hard.	
(2) You must do a lot of work.	
(3) You cannot finish work on time.	
(4) You can work in your own time.	
(5) You can decide an order / a way of the work by yourself.	
(6) Your opinion can affect reflect a policy of the workplace.	
Can you talk with comfortably at work?	(7) with your superiors
	(8) with your colleague
When you run into trouble, will you be given a helping hand?	
	(9) your superiors
	(10) your colleague
If you talk about your personal problem, how much will give you a hand?	
	(11) your superiors
	(12) your colleague

Work Stress: Psychological Demand=(1)+(2)+(3), Decision Latitude=(4)+(5)+(6)

No-Support Stress: Superior Support=(7)+(9)+(11), Colleague Support=(8)+(10)+(12)

Each question had a 4-piont response ranging from 1 (strongly disagree) to 4 (strong agree).

Quality & Safety in Health Care

Fukuda H, Imanaka Y, Hirose M, Hayashida K

平成 21 年掲載予定

Impact of system-level activities and reporting design on the number of incident reports for patient safety

Abstract

Background: Incident reporting is a promising tool to enhance patient safety, but few empirical studies have been conducted to identify factors that increase the number of incident reports.

Objective: To evaluate how the number of incident reports are related to system-level activities and reporting design.

Methods: A questionnaire survey was administered to all 1,039 teaching hospitals in Japan. Items on the survey included number of reported incidents; reporting design of incidents; and status for system-level activities, including assignment of safety managers, conferences, ward rounds by peers, and staff education. Staff education encompasses many aspects of patient safety and is not limited to incident reporting. Poisson regression models were used to determine whether these activities and design of reporting method increase incident reports filed by physicians and nurses.

Results: Educational activities were significantly associated with reporting by physicians (53% increase, $p < 0.001$), but had no significant effect on nurse-generated reports. More reports were submitted by physicians and nurses in hospitals where time involved with filing a report was short ($p < 0.05$). The impact of online reporting was limited to a 26% increase in physicians' reports ($p < 0.05$).

Conclusion: In accordance with the suggestions by the past studies that examined staff perceptions and attitudes, we empirically demonstrate that to decrease burden to reporting and to implement staff educations may improve incident reporting.

Impact of system-level activities and reporting design on the number of incident reports for patient safety

INTRODUCTION

Despite emphasis by the Institute of Medicine on the importance of building a safer healthcare system,[1] study of effectiveness of safety programmes on patient safety has not yet accelerated. Because of lack of evaluation tools and difficulty in measuring rare outcomes over short time periods for small samples of patients with progressive diseases,[2-4] trials based on adverse events as the outcome can be extraordinarily difficult.[5] Instead, using systematic quality improvement, which has demonstrated success in non-medical industries, is a promising approach.[5,6]

As quality and safety enhancement involves the ability to learn from errors, which have emphasized consequences in high-risk industries,[7-9] incident reporting is a leading initiative proposed to improve patient safety.[1,10-12] Having a systematic collection of reports enables organisational learning by identification of sources of failure and thereby allows implementation of corrective actions. Underreporting, however, is inherently involved in incident reporting systems. Because underreporting of incidents has been estimated to range from 50% to 96%,[13-19] the frequency of reports likely does not represent true incidence of errors. Therefore, in using numbers of incident reports as the indicator of capacity of organisational learning, we must adjust barriers to reporting.

In the present study, we identified factors that increase the number of incident reports based on aspects of system-level activities for patient safety and design of incident reporting method.

METHODS

Data and sampling

We conducted our cross-sectional survey between December 2006 and May 2007, using all 1,039 teaching hospitals in Japan. Ownership structures of teaching hospitals vary widely in Japan, and our survey included university, national, municipal, public, and corporate models of ownership. Number of acute-care beds varied from 42 to 1,505 per hospital.

This study was approved by the Institutional Review Board at the Graduate School of Medicine of Kyoto University.