SARS Risk Perceptions in Healthcare Workers, Japan

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In coping with severe acute respiratory syndrome (SARS), infection control measures are a key aspect of protecting healthcare workers. We conducted a survey concerning perception of risk and countermeasures for SARS in 7 tertiary hospitals in Japan from July through September 2003, immediately after the SARS epidemic in neighboring countries. Based on 7,282 respondents out of 9,978 questionnaires administered, we found the perception of risk to be relatively high and the perception of countermeasures at the institutional level to be relatively low. Knowledge of preventive measures, concept of (opinions regarding) institutional measures, and perception of risk differed substantially among the 3 job categories, notably between physicians and nurses. The concept of institutional measures was the most important predictor of individual perception of risk. In view of the potential for future epidemics, planning and implementing institutional measures should be given a high priority.

Severe acute respiratory syndrome (SARS) has been reported in 30 countries with a total of 8,096 probable cases and 774 deaths as of July 31, 2003. A large proportion of these SARS outbreaks occurred in hospitals, and 21% of probable SARS cases involved healthcare workers (1). Protecting healthcare workers is essential from the standpoints of both public and occupational health. Experience in hospitals has suggested that appropriate infection control measures, including use of personal protective equipment, personal hygiene, and environmental measures, such as area isolation, protect healthcare workers from SARS (2,3). During the SARS epidemic, hospitals in affected areas emphasized training and issued guidelines on infection control and use of personal protective equipment (4–6). To prepare for future potential outbreaks of SARS and other emerging infectious diseases, implementing appropriate infection control measures in healthcare settings and assessing the efficacy of those measures in the postepidemic period are necessary.

Japan was one of the few Asian countries to be spared from the SARS epidemic in 2003. Although Japan did not experience cases of SARS, healthcare workers in Japan likely felt insecure in their work environment because of the situation in neighboring countries. Quah et al. (7) reported that the anxiety level of the general population in Singapore was low at the height of the SARS epidemic (55% of the respondents reported a low anxiety level). In contrast, Nickell et al. (8) reported that, in a teaching hospital in Toronto, the SARS outbreak had substantial psychological effects on healthcare workers, whose General Health Questionnaire scores suggested that "a probable case of emotional distress" was more than double the level of the general population. However, the level of anxiety (i.e., perception of risk) among healthcare workers has yet to be evaluated in Japan. Infection control measures and other administrative support also must be examined at the institutional level, which may influence the perception of risk among healthcare workers.

Another point of interest is the comparison between the overall preparedness of Japan for SARS and the preparedness of other countries. Thus, we joined an international collaborative effort to study the perception of risk and countermeasures for SARS among healthcare workers and conducted a survey concerning those issues among healthcare workers in Japan. The objective of the present analysis was 2-fold: 1) to assess healthcare workers' perception of risk, knowledge of preventive measures, and perception of infection control measures at the institutional level and 2) to evaluate the interrelationships among these factors, with a focus on institutional measures.

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Materials and Methods

Study Population

The study population comprised 9,978 healthcare workers working at 7 tertiary-level hospitals distributed throughout Japan; 4 of the hospitals are university-affiliated, 2 are municipal, and 1 is private. The study participants held a wide range of jobs in each institution. The questionnaire was administered from July through September 2003. Overall, 7,463 healthcare workers responded to the questionnaire (crude response rate 74.8%). After missing or invalid responses for sex, age, or job category were excluded, 7,282 were finally analyzed (valid response rate 73.0%) (Table 1).

Table 1. Demographic characteristics of respondents*

Variable	n (%)
Age, y (mean 35.6 ± SD 11.2)	
<35	3,963 (54.4)
≥35	3,319 (45.6)
Sex	
Women	5,077 (69.7)
Men	2,205 (30.3)
Job category	
Physicians	1,370 (18.8)
Nurses	3,274 (45.0)
Others†	2,638 (36.2)
Tenure at this job, y (mean 11.1 ± SD 9.6)	
<10	3,884 (54.1)
≥10	3,292 (45.9)
Type of facility	
University hospitals (4 facilities)	5,163 (70.9)
Municipal hospitals (2 facilities)	1,344 (18.5)
Private hospital (1 facility)	775 (10.6)
Total	7,282 (100.0)

*SD, standard deviation.
†Others include nursing assistant, social worker, pharmacist, clinical and radiologic technologist, physical therapist, occupational therapist, speech therapist, managerial staff, clerk, educational and research staff, building maintenance staff, cleaner, nutritionist, and licensed cook.

Questionnaire

This study formed part of an international collaborative study involving healthcare workers in Singapore, China, Taiwan, Canada (Toronto), and Japan. The questionnaire was developed in English at the National University of Singapore, translated into Japanese, and adapted to accommodate background conditions (i.e., no outbreak). The questionnaire was anonymous, and procedures involving human participants were approved by the institutional review board of the University of Occupational and Environmental Health, Japan.

The questionnaire included 24 items regarding knowledge of preventive measures (15 items), concept of (opinion regarding) institutional measures (4 items), and perception of risk (5 items) (online Appendix 1 available from http://www.cdc.gov/ncidod/EID/vol11no03/04-0631_app1.htm). These 24 items were measured on a 7-point scale for responses (strongly agree, agree, probably agree, probably disagree, disagree, strongly disagree, and not applicable). In the statistical analyses, we dichotomized this scale into positive response (strongly agree, agree, and probably agree) and negative response (strongly disagree, disagree, and probably disagree) after excluding "not applicable."

To assess knowledge of preventive measures, we analyzed responses to questions regarding the effectiveness of measures to avoid contracting SARS (personal protective equipment, personal hygiene, environmental measures). The 15 items are shown in Appendix 1. The correct response to each item was designated on the basis of World Health Organization (WHO) guidelines (2) and other findings. The correct responses for the 15 items were a positive response for all items except "paper mask" and "gauze mask," which required a negative response. To assess concept (opinion) of institutional measures, we used 4 items regarding "clear policies and protocols," "specialist available," "adequate training," and "effectiveness." To assess perception of risk, we used 5 items regarding "avoidance of patient," "acceptance of risk," "little personal control," "fear," and "job change," as indicators (Appendix 1).

We quantified the degree of concept of institutional measures and that of knowledge of preventive measures by calculating the institutional (I) and knowledge (K) scores. The I-score was defined as the total number of positive answers to the 3 specific questions regarding "clear policies and protocols," "specialist available," and "adequate training"; the maximum possible I-score was 3 points. "Effectiveness" was excluded from the calculation of the I-score because it could be looked upon as a combined, general concept of institutional measures. The K-score was defined as the total number of correct (either positive or negative) answers to the 15 questions regarding the knowledge of preventive measures; thus the maximum possible K-score was 15 points. The K-score was categorized as high (11–15 points), middle (6–10 points), or low (0–5 points). Cronbach's α was 0.87 for the K-score and 0.76 for the I-score, which indicated a high degree of internal consistency for each score.

Statistical Analysis

The chi-square test was used to evaluate differences in the proportion of respondents according to job category (physician, nurse, and other), sex, age, and type of facilities. The Student *t* test was used to evaluate differences in the mean value between 2 groups, and analysis of variance was used to evaluate differences in the mean value among 3 groups. Logistic regression analyses were used to identify factors associated with the overall concept of the effectiveness of institutional measures ("effectiveness") and

perceptions of risk ("avoidance of patient" and "acceptance of risk") as the dependent variables. The independent variables were the I-score (0, 1, 2, and 3 points), the K-score (low, middle, and high), age (<35 years old, ≥35 years old), sex (men, women), fear (–, +), and type of facility (nonuniversity hospital, university hospital). The logistic regression model was applied to each of the 3 job categories and to all participants. Spearman's correlation coefficients among 6 independent variables were <0.26, and no strong correlations were seen among them. Data were analyzed by using SPSS, version 11.5J (SPSS Inc., Chicago, IL, USA) for Windows and SAS V8 (SAS Institute Inc., Cary, NC, USA). All reported p values are 2-tailed, and $p < 0.05$ was considered statistically significant.

Results

Levels of knowledge of preventive measures, concept of institutional measures, and perception of risk are shown in Table 2 (complete data are available in online Appendix 2 from http://www.cdc.gov/ncidod/EID/vol11no03/04-0631_app2.htm). The proportion, mean score, or both were calculated for each item or category according to job category (physician, nurse, and other), sex, age, and type of facility, as well as the total. As shown in Table 3, the distribution of job categories was significantly different between the 2 types of facility (university hospitals and nonuniversity hospitals), with a higher proportion of physicians and lower proportion of nurses in university hospitals. The corresponding proportion did not differ substantially between municipal and private hospitals, so we categorized the 2 types as nonuniversity hospital for further analyses.

For knowledge of preventive measures, the overall correct response rates were, in descending order, area isolation (98.1%), hand washing (98.0%), alcohol rubs (93.3%), prominent notices (89.9%), N95 mask (86.9%), gloves (79.3%), gowns (67.0%), surgical masks (64.2%), temperature checks (60.9%), hair cover (59.7%), paper mask (59.0%), goggles (56.2%), gauze mask (54.5%), shoe cover (53.3%), and limiting visitors (35.3%). The

Table 2. Knowledge of preventive measures, concept of institutional measures, and perception of risk by job category, sex, age, and type of facility*

	Job category			Sex		Age		Type of facility		
Questionnaire item	Physicians	Nurses	Other	Men	Women	<35 y	≥35 y	University	Nonuniversity†	Total
Knowledge of preventive measures										
Area isolation	96.0	99.3	97.8	96.3	98.9	98.1	98.2	97.8	98.9	98.1
Hand washing	95.6	99.2	97.8	96.0	98.9	98.1	97.9	97.8	98.7	98.0
Alcohol rubs	87.0	94.6	95.1	89.8	94.9	93.2	93.5	93.2	93.6	93.3
Prominent notices	86.8	91.2	89.9	86.1	91.6	89.7	90.2	89.5	91.0	89.9
N95 mask	86.2	89.5	83.8	85.7	87.5	86.4	87.6	85.6	90.1	86.9
Gloves	73.7	82.6	78.2	74.8	81.3	78.0	81.0	77.3	84.3	79.3
Gowns	63.5	74.5	58.8	62.0	69.1	65.8	68.5	63.9	74.4	67.0
Surgical mask	64.5	62.5	66.4	63.6	64.5	64.6	63.8	63.8	65.1	64.2
Temperature checks	51.2	61.5	65.4	58.1	62.2	61.6	60.1	60.5	61.9	60.9
Hair cover	55.1	63.9	56.6	56.3	61.1	56.9	63.1	56.1	68.3	59.7
Paper mask	64.3	62.3	51.6	61.5	58.0	56.9	61.8	59.5	57.9	59.0
Goggles	57.7	56.3	55.3	56.7	56.0	51.9	61.7	52.9	64.2	56.2
Gauze mask	58.5	58.6	46.7	54.4	54.5	51.5	58.3	54.3	54.8	54.5
Shoe cover	50.6	55.5	51.9	50.7	54.4	50.7	56.5	49.4	62.6	53.3
Limiting visitors	29.9	41.3	30.5	31.6	36.9	33.4	37.6	32.6	41.9	35.3
Concept of institutional measures										
Clear policies and protocols	62.8	70.6	59.4	62.6	66.4	61.6	69.7	62.8	71.2	65.2
Specialist available	42.6	59.6	50.4	45.4	56.5	48.8	58.3	49.0	62.8	53.0
Adequate training	29.4	48.9	31.9	31.7	42.4	35.2	43.8	35.7	47.1	39.1
Effectiveness	27.2	34.0	29.5	30.6	31.7	28.1	34.6	28.4	37.6	31.1
Perception of risk										
Avoidance of patient	86.9	93.4	92.1	87.3	93.7	93.1	90.0	91.1	93.3	91.7
Acceptance of risk	69.5	64.7	60.9	67.0	63.1	62.3	66.6	64.0	64.8	64.3
Little personal control	59.8	61.7	59.8	59.2	61.3	60.6	60.7	60.5	61.1	60.6
Fear	48.9	60.6	52.1	48.7	58.2	55.8	54.7	52.2	62.9	55.3
Job change	14.3	34.1	24.7	15.7	31.9	30.7	22.5	24.1	33.8	27.0

*Data are presented as percentages, number of positive responses divided by number of respondents answering each question (except for paper mask and gauze mask, where negative responses were counted). Positive responses include "probably agree," "agree," and "strongly agree"; negative responses are "probably disagree," "disagree," and strongly disagree." Detailed information, including n's, distribution of scores, and p values (based on chi-square test for difference in proportion, *t* test for difference in 2 means, and analysis of variance [ANOVA] for differences in 3 means), is available in the full table in online Appendix 2.
†Nonuniversity includes municipal hospitals (2 facilities) and private hospitals (1 facility).

Table 3. Job categories by type of facility

Type of facility	Physicians, n (%)	Nurses, n (%)	Others, n (%)	p value*	Total
University hospital (4 facilities)	1,116 (21.6)	2,225 (43.1)	1,822 (35.3)	<0.001	5,163 (100.0)
Nonuniversity hospital (3 facilities)	254 (12.0)	1,049 (49.5)	816 (38.5)		2,119 (100.0)
Municipal hospital (2 facilities)	153 (11.4)	688 (51.2)	503 (37.4)		1,344 (100.0)
Private hospital (1 facility)	101 (13.0)	361 (46.6)	313 (40.4)		775 (100.0)

*p value based on chi-square test between university and nonuniversity hospitals.

correct response rate differed significantly among job categories for all items except for goggles. As a general trend, physicians ranked third for 9 items, nurses ranked first for 10 items, and others ranked second for 7 items. The K-score distribution and mean indicated the highest score for nurses, intermediate for physicians, and lowest for others. The correct response rate differed significantly between men and women for all items except goggles, gauze mask, and surgical mask. As a general trend, women ranked higher than men for 13 out of 15 items. Accordingly, the K-score distribution and mean indicated a significantly higher score for women. This trend was observed in physicians but not in nurses when the analysis was conducted separately for each group (data not shown). The correct response rate differed significantly between the 2 age categories for 8 items. As a general trend, older workers (≥35 years old) ranked higher for 12 of the 15 items. However, neither the K-score distribution nor the mean K-score indicated a higher score for older workers. The correct response rate differed significantly between the 2 types of facilities for 9 items. As a general trend, nonuniversity hospital ranked higher for 14 of the 15 items. Accordingly, the K-score distribution and mean indicated a significantly higher score for nonuniversity hospital.

For concept of institutional measures, the overall proportion of positive responses were, in descending order, clear policies and protocols (65.2%), specialist available (53.0%), adequate training (39.1%) (concept of respective institutional measures), and effectiveness (31.1%) (overall concept of effectiveness of institutional measures). For all items, the positive response rate differed significantly among the 3 job categories, with nurses consistently ranked the highest. The I-score distribution and mean indicated the highest score for nurses, intermediate for physicians, and lowest for others. For all items except for the overall concept of effectiveness, the rate of positive responses was significantly higher for women than men. The I-score distribution and mean indicated a higher score for women than men. For all items, the positive response rate was significantly higher for older workers than younger workers. Accordingly, the I-score distribution and mean indicated a significantly higher score for older workers than younger workers. For all items, the positive response rate was significantly higher for nonuniversity hospital than university hospital. Accordingly, the I-score distribution and mean indicated a significantly higher score for nonuniversity hospital than university hospital.

For perception of risk, the overall positive response rates were, in descending order, avoidance of patient (91.7%), acceptance of risk (64.3%), little personal control (60.6%), fear (55.3%), and job change (27.0%). The positive response rate differed significantly among the job categories for all items except little personal control. Nurses ranked highest for avoidance of patient (93.4%), whereas physicians ranked highest for acceptance of risk (69.5%). Nurses showed the highest level of fear (60.6%) and physicians the lowest (48.9%). Nurses had the highest tendency to consider job change (34.1%) and physicians the lowest (14.3%). The positive response rate differed significantly between men and women for all items except little personal control. Compared to men, women had a significantly higher proportion of positive responses to avoidance of patient (93.7% vs. 87.3%, $p < 0.001$), fear (58.2% vs. 48.7%, $p < 0.001$), and job change (31.9% vs. 15.7%, $p < 0.001$) and lower proportion of positive responses to acceptance of risk (63.1% vs. 67.0%, $p = 0.002$). The positive response rate differed significantly between the 2 age categories for all items except little personal control and fear. Compared to younger workers, older workers had a lower proportion of positive responses to avoidance of patient (90.0% vs. 93.1%, $p < 0.001$) and job change (22.5% vs. 30.7%, $p < 0.001$), and a higher proportion of positive responses to acceptance of risk (66.6% vs. 62.3%, $p < 0.001$). The positive response rate differed significantly between university hospital and nonuniversity hospital for all items except acceptance of risk and little personal control. Compared to university hospitals, nonuniversity hospitals had a significantly higher proportion of positive responses to avoidance of patient (93.3% vs. 91.1%, $p = 0.002$), fear (62.9% vs. 52.2%, $p < 0.001$), and job change (33.8% vs. 24.1%, $p < 0.001$).

As shown in Table 4, logistic regression analyses indicated that effectiveness (as overall conception of effectiveness of institutional measures) was positively associated with the I-score in all 3 job categories and with age in 1 job category (others). Effectiveness was negatively associated with fear in 2 job categories (physicians and others) and with type of facility in 2 job categories (nurses and others). Avoidance of patient was positively associated with fear in all 3 job categories, with gender in 1 job category (others), and with K-score in 1 job category (physicians).

Table 4. Factors associated with concept of institutional measures (effectiveness) and perception of risk (selected factors) by job category

Variable*	OR (95% CI)†			
	Physician (N = 1,370)	Nurse (N = 3,274)	Other (N = 2,638)	Total (N = 7,282)
Effectiveness				
I-score (0,1,2,3)	1.87 (1.65–2.13)	1.83 (1.69–1.98)	2.02 (1.84–2.22)	1.90 (1.80–2.01)
Age (≥35 year)	1.23 (0.93–1.62)	1.19 (0.99–1.41)	1.42 (1.15–1.74)	1.25 (1.11–1.41)
K-score (low, middle, high)	0.89 (0.72–1.10)	1.01 (0.88–1.17)	0.96 (0.82–1.11)	0.97 (0.88–1.06)
Type of facility (university)	0.82 (0.59–1.15)	0.71 (0.60–0.84)	0.75 (0.60–0.92)	0.74 (0.65–0.83)
Sex (women)	0.79 (0.53–1.18)	0.63 (0.38–1.06)	0.97 (0.79–1.18)	1.00 (0.88–1.14)
Fear (+)	0.61 (0.46–0.80)	0.90 (0.76–1.06)	0.58 (0.47–0.70)	0.72 (0.64–0.81)
Avoidance of patient				
Fear (+)	1.91 (1.33–2.76)	2.56 (1.89–3.48)	2.32 (1.66–3.24)	2.31 (1.91–2.80)
K-score (low, middle, high)	1.42 (1.10–1.84)	1.01 (0.78–1.30)	1.23 (0.98–1.56)	1.19 (1.03–1.37)
Sex (women)	1.27 (0.76–2.13)	1.95 (0.91–4.21)	2.05 (1.50–2.82)	1.93 (1.59–2.33)
Age (≥35 year)	1.00 (0.70–1.42)	0.58 (0.42–0.79)	0.84 (0.60–1.17)	0.81 (0.67–0.97)
Type of facility (university)	0.91 (0.57–1.43)	0.83 (0.59–1.16)	0.75 (0.52–1.08)	0.82 (0.66–1.01)
I-score (0,1,2,3)	0.80 (0.68–0.94)	0.87 (0.75–0.99)	0.80 (0.69–0.93)	0.81 (0.75–0.88)
Acceptance of risk				
I-score (0,1,2,3)	1.26 (1.11–1.42)	1.08 (1.01–1.16)	1.24 (1.14–1.35)	1.18 (1.12–1.24)
Age (≥35 year)	1.05 (0.81–1.36)	1.27 (1.06–1.51)	1.11 (0.93–1.33)	1.10 (0.99–1.22)
Fear (+)	1.01 (0.78–1.30)	1.14 (0.97–1.33)	1.44 (1.21–1.71)	1.21 (1.09–1.34)
Sex (women)	1.01 (0.71–1.43)	0.65 (0.38–1.12)	0.85 (0.71–1.02)	0.82 (0.73–0.92)
K-score (low, middle, high)	0.90 (0.74–1.10)	1.05 (0.92–1.20)	1.04 (0.91–1.18)	1.03 (0.95–1.12)
Type of facility (university)	0.81 (0.58–1.14)	0.98 (0.83–1.15)	1.20 (0.99–1.45)	1.04 (0.93–1.17)

*Goodness-of-fit was satisfactory: ranged from [goodness-of-fit statistics = 0.49 with 8 df (p = 0.99)] for (effectiveness) x (physician) to [goodness-of-fit statistics = 12.71 with 8 df (p = 0.12)] for (nurse) x (avoidance), except for [goodness-of-fit statistics = 18.98 with 8 df (p = 0.02)] for (nurse) x (effectiveness) and [goodness-of-fit statistics = 18.38 with 8 df (p = 0.02)] for (others) x (effectiveness).
†OR, odds ratio calculated by logistic regression; CI, confidence interval.

Avoidance was negatively associated with I-score in all 3 job categories and with age in 1 job category (nurses). Acceptance of risk was positively associated with I-score in all 3 job categories, with age in 1 job category (nurse), and fear in 1 job category (others). Hence, the I-score was a significant positive predictor of effectiveness (as overall conception of effectiveness of institutional measures) in all 3 job categories, a significant negative predictor of avoidance of patient in 2 job categories (physician and others), and a significant positive predictor of acceptance of risk in all 3 job categories.

Discussion

A substantial number of probable SARS cases were concentrated in Asian countries during the previous SARS epidemic (5,327 cases in China, 1,755 cases in Hong Kong, 346 cases in Taiwan, and 238 cases in Singapore as of July 31, 2003) (1). Accordingly, strict policies and administrative measures for infection control (e.g., mandatory quarantine and training of healthcare workers in infection control measures) were implemented in these countries (9–11). In contrast, no probable SARS cases were recorded in Japan, and thus administrative measures for infection control tended to be hypothetical (i.e., most countermeasures at the institutional level were voluntary) (12,13). As such, the Japanese situation is distinct from that in other Asian countries, and various aspects of knowledge, perception, and attitudes of healthcare workers regarding SARS are likely to differ between Japan and other Asian countries. To clarify this issue, we assessed the level of knowledge of preventive measures, concept of institutional measures, and perception of risk and their interrelationships in healthcare workers in Japan.

SARS Knowledge, Concept of Institutional Measures, and Perception of Risk

Regarding knowledge of preventive measures, most respondents assigned relatively high importance to hand hygiene and area isolation but saw personal protective equipment as being of relatively low importance. This finding may be partly due to healthcare workers' not having previously used some of the protective equipment recommended for use with SARS patients (3). The use of personal protective equipment as countermeasures for SARS has been rightly advocated by various authors (10,14,15). Thus, adequately training healthcare workers in the use of personal protective equipment is an important aspect of reducing the incidence of SARS infection.

Regarding the concept of institutional measures, 40% of respondents believed that they had received adequate training; for example, less than half felt that they had adequate training in the use of masks. During the SARS epidemic, medical institutions were required by authorities to provide adequate training to healthcare workers in affect-

ed countries (5,6,10,11). Because no outbreaks were in Japan, however, Japanese institutions have not been forced to implement sufficient measures to adequately cope with future outbreaks of SARS and other emerging diseases.

Regarding perception of risk, although we did not compare healthcare workers with an external group, more than half (55%) of the healthcare workers surveyed indicated that they were afraid. Furthermore, a high proportion of healthcare workers preferred to avoid the patient (92%), although almost two thirds accepted the risk (64%). When these 2 items were cross-classified, 55% of respondents showed a mixed attitude (i.e., avoidance of patient [+] and acceptance of risk [+]), 32% showed a disloyal attitude (i.e., avoidance of patient [+] and acceptance of risk [–]), and 6% showed a loyal attitude (i.e., avoidance of patient [–] and acceptance of risk [+]). These results indicate a high level of fear and anxiety with complex psychology in Japanese healthcare workers, even in the absence of an epidemic.

Significant differences were seen in the level of knowledge and attitudes among the 3 job categories. Nurses showed the best knowledge of preventive measures and concept of institutional measures, while physicians showed the highest acceptance of risk. Both sex and job characteristics may have influences in this regard. Ninety-eight percent of nurses were women, whereas 84% of physicians were men. Quah et al. reported that, in Singapore, women showed better practice of SARS preventive measures than men among the general population (7). Similarly, our results indicated a higher level of knowledge regarding preventive measures for female physicians compared to male physicians. However, this trend was not observed within the nurse job category, although the number of male nurses was sufficiently small that separating the effect of sex was difficult. In terms of job characteristics, nurses may receive more official training in infection control than physicians, under the assumption that physicians are already knowledgeable. In fact, compared to physicians, nurses have higher levels of compliance with universal precautions (16) and hand-washing (17,18) in their respective countries. However, nurses tend to have higher job turnover rates than physicians, which reflect less stability or security in their profession. These factors directly and indirectly influence the response pattern among the 3 job categories.

Interrelatedness of Knowledge, Concept of Institutional Measures, and Perception of Risk

In the logistic regression model, K-score, an indicator of knowledge of preventive measures, was not a significant predictor of perception of either risk or concept of institutional measures. This finding implies that professional knowledge has little, if anything, to do with positive perception of risk (in terms of accepting risk and not avoiding patients) and concept of institutional measures. However, the importance of providing accurate knowledge cannot be discounted solely on this ground. In contrast, I-score, an indicator of concept of institutional measures, was a significant positive predictor of concept of effectiveness and acceptance of risk and a significant negative predictor of avoidance of patient. In other words, a collective assertion of 3 specific institutional measures (clear policies and protocols, specialists available, and adequate training) had the greatest effect on a person's 2 different aspects of perception of risk and concept of the effectiveness of institutional measures. These findings corroborate earlier studies reporting that administrative support enhances compliance with universal precautions (19–21) and hand washing (17,18). Therefore, we infer that perception of institutional measures affects perception of risk and related behaviors.

Fear was a significant negative predictor of concept of effectiveness in 2 job categories (physicians and others) and a significant positive predictor of avoidance of patient in all 3 job categories. These findings were in line with our expectations and signal the need to reduce fear as a practical goal. Older age was a significant positive predictor for the concept of effectiveness in 2 job categories (nurses and others). Among nurses, older age was also a significant negative predictor for avoidance of patient and a significant positive predictor for acceptance of risk. Age has previously been shown to be a positive predictor for practicing SARS preventive measures among the general population (7). Hence, older age seems to correlate with an increased ability to cope with emergency situations related to infectious diseases. Type of facility (university hospital) was a significant negative predictor for the concept of effectiveness in 2 job categories (nurses and others). Although confined to the 7 facilities studied, university hospitals may have been less stringent in the formulating or implementing infection control measures, which in turn affected the overall concept of effectiveness of measures among healthcare workers.

Limitations

Our study has several limitations. First, the cross-sectional nature of the study prevents assertion of cause and effect. Our conclusion, particularly on interrelationship among individual factors, is based on inferences. Second, responder bias may have been in play, i.e., only workers with a strong interest in SARS may have been motivated to respond, although the fairly high response rate counteracts this argument to an extent. Third, K-score may not accurately reflect knowledge of preventive measures. For example, workers who, in practice, had accurate knowl-

edge about shoe covers as personal protective equipment may have answered incorrectly because they had been taught conflicting information. In fact, the Infectious Disease Surveillance Center (IDSC), Japan, categorizes shoe cover as optional personal protective equipment (22). However, among the personal protective equipment considered in this study, only alcohol rubs (WHO) (2) and shoe cover (IDSC, Japan) (22) are considered optional, and the effect of conflicting information should not be strong. Fourth, we considered the difference in type of facility (university or nonuniversity) but did not consider differences by facility (hospital A or B) or type of unit (internal medicine, surgery, and others), which may be related to differences in job descriptions (even within the same job category) as well as the study variables. Such effects caused by affiliation constitute a separate theme worth further investigation, which will be pursued.

We found that the level of anxiety among healthcare workers in Japan was relatively high and that the implementation of preventive measures at the institutional level was not perceived to be sufficient. However, a collective assertion of 3 specific institutional measures stood out as the most important predictor for individual perception of risk, including avoidance of patient and acceptance of risk, as well as concept of general effectiveness of institutional measures. In view of the potential for future epidemics of SARS or other emerging infectious diseases, the planning and implementation of institutional measures should be given a high priority.

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