problems can be reduced to some degree by psychosocial interventions. Graves et al. [2] reported very high levels of distress in a large sample of patients with lung cancer, as well as a fairly large interest among those patients in receiving help with the distress and/or symptoms. Recently, papers have been published on psychometrics of measures of quality of life, pain, and denial in the area of lung cancer [3–6].

Quality of life is a concept that traditionally has been used in oncology to cover the functional effects of cancer and its treatment, as perceived by the patient. The number of publications on "quality of life AND lung cancer" (i.e., 3375 on 28 August 2010) reflects the quite impressive body of knowledge that is available. More recent studies on behavioural aspects of lung cancer, however, tend to go beyond the concept of quality of life. Modern theory and their clinical applications in psychology as applied to medicine focus on self-management and self-regulation. The Self-Regulation Model (SRM), developed by Leventhal et al. [7] encompasses illness perceptions and coping as determinants of quality of life. In essence, the SRM maintains that persons/patients respond to a threat or an illness by forming perceptions about that threat or illness, as well as a coping plan to deal with the consequences of the threat or illness. Illness perceptions can be categorized into empirically supported dimensions: *identity* (i.e., the complaints a patient attributes to his/her illness, such as fatigue, shortness of breath), *consequences* (i.e., consequences on the patient's life; the way others see the patient; difficulties for those close to the patient), *causes* (i.e., stress; weather; air pollution), *cure/control* (separated into personal control, and treatment control, i.e., chemotherapy; surgery; complementary medication; prayer), *timeline* (i.e., acute versus chronic illness versus cyclical illness; curable versus incurable, etc.) [8]. Recently, *coherence* (i.e., the degree to which the patient feels she/he can make sense of the threat or illness) and *emotional consequences* (i.e., distress; anxiety; depression) have been added as additional dimensions [9].

Illness perceptions can be assessed with standardized questionnaires (e.g., IPQ [8], IPQ-R [9], and B-IPQ [10]) and/or drawings [11]). In a recent meta-analysis of research on illness perceptions it was shown how illness perceptions predict outcomes in various categories of chronic physical disorders [12]. The first intervention studies applied cognitive-behavioural methods to elicit and change illness perceptions, and demonstrated the effectiveness of this approach in producing positive behavioural and psychological outcomes in patients with a myocardial infarction [13], pain [14] or SLE [15].

In lung cancer, illness perceptions have been examined only recently. A 26 August 2010 literature search in PubMed on "illness perceptions AND lung cancer" identified 38 references, 15 of which represent empirical studies on illness perceptions proper [3,16–29]). Excluded were papers that did not report empirical data on the topic or that reported on views of health care providers about living with lung cancer. Papers not in English were also excluded. A summary of the15 studies on illness perceptions in patients with non-small-cell lung cancer is presented in Table 1.

Sample sizes vary between 9 and 170 patients, with eight studies combining patients with small-cell lung cancer and non-small-cell lung cancer. About half of the studies have a cross-sectional design, the others have a prospective design. Qualitative methods (i.e., interviews) were the dominant method with which data were collected. Findings show a wide range of emotional and cognitive consequences in the patients. Over time, patients tend to report less perceived control and more emotional worries. Finding meaning in the illness, its treatment, its outcome, and relationships between the patient and loved ones and health care providers were other themes.

There is evidence that illness perceptions and quality of life are influenced by cultural background, and Dein, among others, highlighted the cultural determinants of symptom perception and symptom attributions [30,31]. However, in an earlier study we found that Japanese and Dutch patients with various types of cancer (breast, colon, lung, and prostate) responded in a quite similar way to a fairly large set of quality of life questionnaires; differences were found mainly on the social dimension of quality of life [32].

The primary aim of our paper, therefore, was to explore illness perceptions in Dutch and Japanese patients with non-small-cell lung cancer (NSCLC), and to examine differences in illness perceptions between Japanese and Dutch patients. Secondly, we examined potential differences between Japanese and Dutch non-small-cell cancer patients in their self-reported quality of life scores. These two aims follow from our earlier collaborative research project on QOL in Japanese and Dutch patients [32], and include the subject of illness perceptions in the current study. The longitudinal design in the current study allowed the examination of changes in QOL over time in both patient groups.

2. Patients and methods

This prospective study was performed in 22 Japanese and 2[illegible] Dutch patients, whose medical data are reported in Results. Patients provided informed consent, after having been identified during clinical meetings of the treating physicians, and having received a pathologically confirmed diagnosis of non-small-cell lung carcinoma. Clinical data were collected by nurse-practitioners and research associates. Patients were informed that the purpose of the study was to explore reactions of patients with non-small-cell lung cancer to their illness and its treatment. Patients in both the Netherlands and in Japan were informed about their diagnosis by their physician. Patients with evident psychiatric illness, according to the physicians treating the patient, and patients unable to fill out the questionnaires due to low health literacy were excluded. Their NSCLC was in stage 3 or 4.

Patients filled out a questionnaire booklet before their first chemotherapy cycle, 1 week after their first chemotherapy cycle, and 8 weeks after the start of chemotherapy. The booklets contained several questionnaires, including the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire (EORTC QLQ-C30; [33]) and the Brief Illness Perception Questionnaire (B-IPQ [10]). In addition, several clinical data were collected.

The EORTC QLQ-C30 is a quality of life questionnaire contai[illegible] ing 30 questions organized into a number of scales, including a global health status scale, 5 functional scales, and 9 symptom scales. The scores are expressed on a 0–100 scale. For the general health and functional scales, higher scores indicate better general health and functioning. For the symptom scales, higher scores indicate worse symptoms. The Japanese version of the EORTC QLQ-C30 was developed following rigorous EORTC translation procedures and has been validated [32–37].

The B-IPQ consists of 8 questions that measure 8 dimensions of illness perception (see Introduction) on a scale of 1–10. The Japanese version was adapted from www.uib.no/ipq, Japanese B-IPQ.

Physicians rated the Karnofsky scores of the patients before the first chemotherapy cycle.

Statistical analyses pertain to comparing the two samples within and between three assessment times. Student *t*-tests and repeated measures analysis of variance (ANOVAs) were applied.

The research project was approved by the Medical Ethical Committee of the Leiden University Medical Centre, and by the Internal Review Board of the Saitama International Medical Centre, Hidaka City, Japan. The study protocol was used in both locations in an identical fashion.

Table 1
Summary of 15 studies on illness perceptions in patients with non-small-cell lung cancer and small cell lung cancer.

First author Year of publication Country of origin Reference	Number of patients; Type of cancer[a]	Study design	Major results
Browning 2009 USA [3]	52 Mixed	Prospective 1-group descriptive longitudinal; IPQ-R at baseline, 2–4 weeks, 6 months	'Identity' and 'timeline' increased over time; 'personal control' and 'treatment control' decreased over time
Buchanan 2010 UK [16]	170 Mixed	Prospective observational	Increased worry in patients is associated with patient perceptions of increased anxiety in their social network
Chapple 2004 UK [17]	45 Mixed	Qualitative: narrative interviews	Patients experienced high levels of stigma because of the association of lung cancer with smoking. Concealing the illness was a coping strategy that patients used
Dias 2006 Brazil [18]	11 Mixed	Qualitative: exploratory interviews	Patients resented the glorious image of smoking cigarettes. Cancer outcome was attributed to other respiratory illnesses, and to mystical, religious factors
Downe-Wamboldt 2006 Canada 19]	85 NSCLC	Cross-sectional; interview data from patients and family members	Perception of illness manageability determines quality of life mainly. Considerable concordance in illness meaning in patients and their family members
day 2007 USA [20]	122 NSCLC	Prospective observational	Cancer related risk perception predicted post-cancer diagnosis smoking patterns
Lai 2007 Hong Kong [21]	11 NSCLC	Qualitative: in-depth interviews	Characteristics of dyspnea, dyspnea impact, dyspnea managing strategies, and the nurses' role in dyspnea management were the major themes in the patients. Patients reported dissatisfaction with health care practitioners' role in assisting with dyspnea
Leveälahti 2007 Sweden [22]	37 Mixed	Narrative analysis of qualitative interviews	Symptoms leading to diagnosis varied widely. Biographical disruption quite often associated with allowing for integration of past and present aspects of patients' lives (biographical continuity)
Lobchuk 2008 Canada [23]	100 Mixed	Cross-sectional study on attributions for lung cancer in patients and their partners	Patients and support persons ascribed more negative attributions toward oneself, and more positive attributions towards their partner
Porter 2002 USA [24]	30 Mixed	Interviews on concordance between patients and primary family care givers regarding their perceptions of patients' self efficacy for managing pain and other symptoms	Considerable variability in degree of concordance. A poorer quality of relationship between caregiver and patient, high levels of patient-rated symptoms, and high levels of caregiver strain were associated with caregivers overestimating patient self-efficacy
Salander 2007 Sweden [25]	23	Repeated interviews throughout the course of the disease	Smoking was not seen as the prime cause of cancer in the patients
anders 2010 USA [26]	109 Mixed	Cross-sectional study on prevalence and correlates of intensity of supportive care needs	High prevalence of unmet needs in the physical, daily living and psychological domain. Higher levels of supportive care needs are associated with more difficulties regarding the illness
Sarna 2005 USA [27]	217 NSCLC	Qualitative: in-person interviews	Serious disruptions in psychological and social aspects of quality of life. Negative meaning of illness, depressed mood, distress, family distress, sexual problems were highly prevalent
Sharf 2005 USA [28]	9 NSCLC	Qualitative: in-depth interviews	Patients refusing physicians' recommendations emphasized self-efficacy, minimizing threat, distrust of medical authority
Yardley UK 2001 [29]	13 Mixed	Qualitative: semi-structured interviews	Communication, family/community issues, reaction to diagnosis, views on treatment and prognosis, and suggested improvements were the five themes identified

[a] Non-small-cell lung cancer (NSCLC) and small cell lung cancer = mixed.

3. Results

Respondents consisted of 22 Japanese patients (17 males, 5 females; mean age and standard deviation (SD): 63.0 ± 6.64 years) and 24 Dutch patients (16 males, 8 females; mean age and SD: 63.3 ± 9.69 years). Table 2 summarizes clinical data for both samples, including type of cancer, TNM stage of cancer, and Karnofsky ratings by physicians. The preponderance of male patients is worth noting, and is common in lung cancer studies. As the distribution of males/females is virtually identical ($\chi^2 = 0.637$; $p = 0.425$), differences observed between the two samples in the outcomes being assessed cannot be attributed to gender differences. Differences

Table 2
Summary of clinical data of Japanese ($n=22$) and Dutch ($n=24$) patients.

Variable	Categories	Japan	The Netherlands
Type of cancer	Adeno	17 (77.3%)	11 (45.8%)
	Squamous	5 (22.7%)	13 (54.2%)
TNM stage of cancer	IIIA	5 (22.6)	7 (29.2)
	IIIB	7 (31.8)	7 (29.2)
	IV	10 (45.5)	10 (41.6)
Karnofsky score by doctor (mean ± SD)	0 = deceased 100 = no complaints	87.37 ± 12.40	91.43 ± 8.54

for age and Karnofsky score were tested by means of t-tests. The resulting p-values were 0.907 and 0.241, respectively, indicating no significant differences. Type of cancer differed for Japanese and Dutch patients ($\chi^2 = 4.697$; $p = 0.030$), with relatively more adeno cancer among the Japanese patients, and more squamous cell cancer among the Dutch patients. For stage of cancer no differences were found ($\chi^2 = 0.708$; $p = 0.40$).

Chemotherapy protocols were identical in both countries and followed international guidelines [38]. All Japanese patients underwent platinum based therapy except 1 patient who had a platinum allergy reaction and 2 patients who received newer biological agents. In the Dutch sample it is unknown how many patients received other treatments than platinum base therapy.

Table 3 reports the means and standard deviations (SDs) of the Japanese and Dutch patients on the subscales of the EORTC QLQ-C30 for the three assessment points. This table also displays the means and SDs of a reference group of non-small-cell lung cancer patients, reported in the 2008 reference value manual of the EORTC QLQ-C30 with the lists and the scale and item value for a great variety of cancer types, among which NSCLC [34]. As can be seen, for most of the subscales the means of the Japanese and Dutch patients are relatively close to those of the reference group. However, in the Dutch patients 12 of the 18 means on the general health and functional scales are more favorable than those of the reference group, compared to 3 out of 18 in the Japanese patients. A similar result was obtained for the symptom scales: 17 out of 27 means of the Dutch patients indicated less severe symptoms than the reference group, compared to 12 out of 27 in the Japanese patients. This difference is statistically significant ($\chi^2 = 4.455$; df = 1, $p < 0.05$).

Repeated measures ANOVAs using lower-bound sphericity estimates were run on the Country by Occasion data of the 15 EORTC scales. As 8 Japanese patients had missing data on one or two occasions, the results are based on 14 Japanese and 24 Dutch patients. Significant differences between the Japanese and the Dutch patients were found on global health status ($p = 0.008$), emotional functioning ($p = 0.005$), social functioning ($p = 0.001$), constipation ($p = 0.012$), and financial difficulties ($p < 0.001$), with the Dutch patients having significantly more favorable average scores on all five variables (Fig. 1).

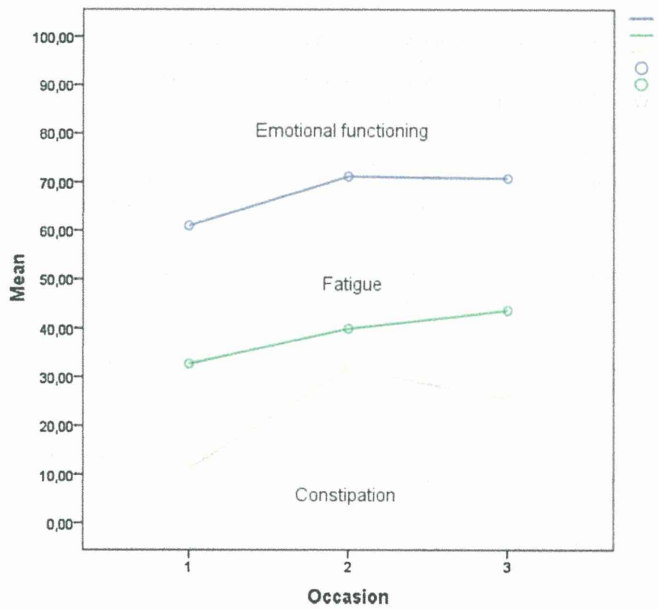


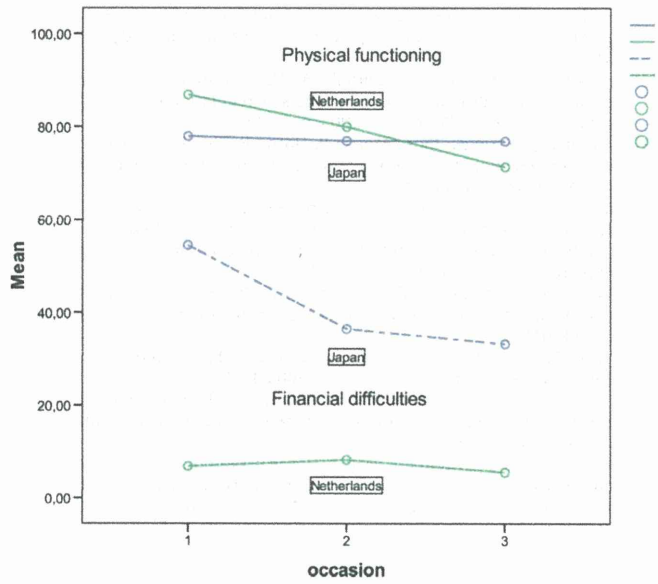
Fig. 1. Mean values of emotional functioning, fatigue, and constipation for t... Japanese and Dutch patients combined, on three measurement occasions.

Differences over time were observed for physical functioning, ($p = 0.027$), emotional functioning ($p = 0.030$), fatigue ($p = 0.038$), constipation ($p = 0.007$), and financial difficulties ($p = 0.017$). For physical functioning, and financial difficulties, the time effect reflected an interaction between country and time (see Fig. 2 and below). For emotional functioning, fatigue, and constipation, the average scores on the first measurements were significantly different from the means on the following two occasions. This shows that symptoms of fatigue and constipation increase after chemotherapy. At the same time, emotional functioning improve

Table 3
Means and SDs of reference standard, and Japanese and Dutch patients on the EORTC-QLQ-C30 subscales, at three occasions.

EORTC QLQ C30 subscale	Reference standard[a]	Japan Occasion			The Netherlands Occasion		
		1 $n=22$	2	3	1 $n=24$	2	3
Global health status[b]	58.8 (22.5)	50.8 (22.4)	50.0 (18.4)	51.8 (30.7)	71.2 (24.2)	66.3 (20.7)	61.6 (23.8)
Physical functioning[b]	78.4 (19.3)	78.0 (16.2)	77.0 (17.9)	76.9 (17.6)	86.9 (14.1)	80.0 (17.9)	71.4 (17.5)
Role functioning[b]	60.7 (33.1)	62.9 (32.9)	57.9 (24.5)	60.0 (28.0)	76.4 (25.5)	68.8 (25.2)	56.3 (27.3)
Emotional functioning[b]	68.1 (24.2)	61.1 (25.7)	69.0 (17.5)	70.0 (11.9)	60.8 (28.3)	73.3 (27.3)	71.5 (25.3)
Cognitive functioning[b]	84.0 (21.1)	71.2 (27.3)	77.0 (16.2)	76.7 (21.6)	81.9 (21.4)	83.3 (20.9)	83.3 (23.1)
Social functioning[b]	73.6 (28.9)	47.7 (40.6)	59.5 (31.0)	54.8 (31.6)	86.1 (21.8)	83.3 (24.6)	75.7 (28.2)
Fatigue[c]	40.4 (27.0)	38.4 (25.6)	38.1 (22.4)	42.2 (20.7)	26.9 (23.4)	41.7 (21.8)	44.9 (27.3)
Nausea and vomiting[c]	9.7 (18.3)	4.5 (10.5)	18.3 (28.3)	8.9 (13.9)	4.9 (12.5)	15.3 (26.4)	20.1 (27.4)
Pain[c]	29.7 (30.3)	33.3 (29.5)	30.2 (25.1)	17.8 (20.4)	17.4 (24.3)	18.1 (25.0)	15.3 (25.0)
Dyspnea[c]	38.5 (31.7)	24.2 (23.4)	14.3 (16.9)	24.4 (19.8)	30.6 (32.5)	29.2 (26.6)	36.1 (32.5)
Insomnia[c]	32.4 (32.7)	37.6 (34.6)	42.9 (31.9)	22.2 (20.6)	26.1 (31.7)	27.8 (32.1)	29.2 (31.6)
Appetite loss[c]	27.9 (33.5)	22.7 (31.5)	46.0 (37.2)	33.3 (41.8)	23.6 (37.4)	27.8 (36.3)	29.2 (33.1)
Constipation[c]	17.4 (27.9)	16.7 (24.7)	41.3 (33.2)	35.6 (29.5)	5.6 (16.1)	22.2 (27.2)	15.3 (26.0)
Diarrhoea[c]	6.8 (17.4)	15.2 (24.6)	3.2 (10.0)	8.9 (15.3)	9.7 (18.3)	6.9 (13.8)	13.9 (25.9)
Financial difficulties[c]	12.8 (25.8)	54.5 (31.8)	36.5 (34.8)	33.3 (29.2)	6.9 (17.0)	8.3 (22.5)	5.6 (16.1)

[a] From the EORTC QLQ-C30 reference value manual [34, p. 203].
[b] Higher scores indicate better health and functioning.
[c] Higher scores denote more pain and symptoms.



. 2. Interaction of country and occasion for physical functioning and financial ..ıficulties.

as well. It appears that, after chemotherapy, the patients adjusted somewhat to the emotional upset related to the diagnosis of lung cancer.

Interactions between country and time were found for physical functioning ($p = 0.034$) and financial difficulties ($p = 0.026$). These interactions are shown in Fig. 2. The significant interaction effect for physical functioning is probably due to the decrease of the Dutch patients on Occasion 3 ($p = 0.010$), which breaks the parallel time pattern of the two groups. The interaction on financial difficulties is reflects the lower means on Occasions 2 and 3 for the Japanese patients, while the Dutch patients had continuously low mean scores on all measurements.

Table 4 displays the means, SDs and standard errors of the means (SE) of the Japanese and the Dutch patients on the 8 dimensions of the B-IPQ. High means on consequences, timeline, and concern indicate that the patients were fully aware of the seriousness of their illness. *t*-Tests showed that Japanese patients perceived more personal control and more treatment control than did their ..utch counterparts ($p = 0.047$ in both cases). Dutch patients showed ..ore variability on Personal control and coherence ($p = 0.022$ and $p = 0.003$, respectively). For the other IPQ-B dimensions the scores of both groups are remarkably similar.

4. Discussion

A major finding of this theory-driven, empirical study on 'illness perceptions' is the greater sense of psychological and medical control and impact that Japanese patients report compared to Dutch patients. On all B-IPQ subscales, the Japanese patients had higher means (although not significantly so, except in two cases). The significantly higher mean on treatment control of the Japanese patients seems to reflect the greater sense of trust in (bio)medical care for lung cancer, and possibly, in health care in general in Japan compared to the Netherlands [30]. Scores on the EORTC QLQ-C30 questionnaire showed a more or less similar pattern of impact of chemotherapy on QOL in both samples. Over the course of the chemotherapy sessions, scores on EORTC QLQ-C30 indicated significant impairment on most subscales immediately after the first course of chemotherapy, followed by a minor improvement on some subscales. Overall, the QOL impact was similar between the two samples.

The observation of some of the improvements in QOL-scores was confirmed during the (telephone) contacts the first, third and fifth author had with most patients to remind them to complete the questionnaires. Patients appeared relieved and almost happy that medical treatment had been initiated, and reported having high expectations of its effects. We would note that this expressed optimism sometimes appeared to reflect some degree of denial as well [6]. Our observations are consistent with those of Murray et al. where the different trajectories of (psychological) symptoms are described in patients with advanced lung cancer [39].

The Self Regulation Model provides the conceptual basis of our exploratory study [7,12]. Illness perceptions and outcomes such as quality of life figure prominently in that model. Together with the studies reviewed in Table 1, our work adds to the empirical tests of the model. The studies that are summarized in Table 1 illustrate that our study compares quite well with the extant literature: the number of patients, design and methods used to assess patient-reported outcomes are similar in a broad sense to the studies reviewed in Table 1.

Dutch patients reported a better quality of life than Japanese patients on the EORTC QLQ-C30 dimensions, and somewhat lower levels of symptomatology. This may reflect differences in response style in Dutch and Japanese culture. It may also reflect differences

Table 4
Means, standard deviations (SDs), and standard errors of the means (SE) of the scores of the Japanese and Dutch patients on the eight dimensions of the IPQ-B.

IPQ-B dimension	Japan		The Netherlands		*p*-Values	
	N	Mean ± SD SE	*N*	Mean ± SD SE	Differences between means*	Differences between SDs
Consequences	22	7.82 ± 2.938 0.626	24	7.50 ± 2.859 0.584	0.712	0.628
Time line	22	7.50 ± 2.304 0.491	23	6.13 ± 2.702 0.563	0.074	0.664
Personal control	20	5.75 ± 2.425 0.542	24	3.88 ± 3.603 0.736	0.047*	0.022*
Treatment control	20	8.30 ± 2.080 0.465	22	6.82 ± 2.594 0.553	0.047*	0.427
Identity	21	4.40 ± 3.113 0.679	23	3.70 ± 3.052 0.636	0.563	0.869
Concern	22	8.32 ± 2.147 0.458	24	7.83 ± 2.632 0.537	0.496	0.435
Coherence	22	6.77 ± 1.926 0.411	24	5.58 ± 3.450 0.704	0.153	0.003*
Emotional response	22	5.82 ± 3.065 0.653	24	5.21 ± 3.092 0.631	0.506	0.737

* $p < .05$.

in how health care providers and the health care system respond to patients' suffering.

The topic of cross-cultural comparisons, methodologies, patient response styles and physicians behaviour deserves a concise discussion. Culture determines how persons/patients respond to illness [31,40]. Gotay et al. reported on differences between Caucasian and Japanese respondents' attitudes to disclosing the diagnosis of 'cancer', and found that "... Japanese respondents expressing a personal preference to be told if they themselves were diagnosed with cancer, as did virtually all US respondents" (p. 665). The Japanese senior physicians involved in our study embraced western values regarding "telling the truth" to their patients about their diagnosis. In a previous paper they also demonstrated how socioeconomic factors impacted on cancer survivor's worries and QOL [41]. Further research into these issues clearly is warranted.

The two samples in our study were relatively small, and the follow-up period was relatively short. Future studies with larger sample sizes and longer follow-up periods are needed. Larger studies could also resolve the potential problem of limited statistical power in the current study.

Recent papers have discussed the effects of psychosocial interventions designed to improve the QOL of patients with non-small-cell lung cancer [26,42–44]. They have assessed supportive care needs [26,43], have used a rehabilitation format [42], or a group psychotherapy approach intended to give meaning to the illness [44]. Clearly, this type of research is in its infancy in patients with non-small-cell lung cancer. In other diagnostic cancer categories, researchers have addressed the issue of whether interventions aimed at influencing patient-reported outcomes translate into gains in longevity [45,46]. A recent paper demonstrated that patients who received early palliative care for metastatic non-small-cell lung cancer had less aggressive care at the end of life but longer survival [47]. Clearly these provocative findings require replication.

Recent research also points to the relevance and importance of the way in which health care services are organized in decisions that patients take regarding surgery for lung cancer [48], and in tracking the well-being and distress in family care givers of patients with lung cancer [49]. A biopsychosocial approach to patients with various types of lung cancer appears to hold promise for the future.

Conflict of interest

None declared.

Acknowledgements

The authors are very grateful to two anonymous reviewers for their constructive comments on an earlier version of the paper.

Supported by an unrestricted grant from Pfizer Japan Health Research Trust.

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DETECTION OF PATIENT'S SIGN OF FALLS

Maki Takeda, Nagisa Sasaki, Kayo Yoshimoto, Takeshi Ando, Sachiko Shimizu, Kenji Yamada and Yuko Ohno

Department of Health Sciences, Graduate School of Medicine, Osaka University

ABSTRACT

Falls of inpatient is one of the most critical incidents of hospital management. However, it is difficult to predict falls from the bed using conventional sensors. We proposed new system for detecting a sign of falls using video sensor. The results in the experiment for the young normal subjects showed the availability of the system detecting the characteristics of various behaviors. It would be possible to detect patient's sign of falls and to predict falls.

Index Terms—Falls, Prediction, Patient's room

1. INTRODUCTION

The accident in hospital is a serious problem. Especially, falls and fall-related injuries are the most common and serious medical errors. Various sensors were proposed in order to prevent falls. However, it is difficult to catch the sign before accidents because it can only make binary judgments; stand or not/sit up or not et al.

In this paper, we propose a system to detect a sign of falls using video sensor. Proposed sensor is non-contact and it can catch the whole patient's behavior unlike conventional sensors. For falls prevention, first of all, it is necessary to classify various behaviors leads to falls from bed. We detect characteristics to classify behaviors from video image. Secondly, we evaluate the probability of fall using characteristics to be able to adapt to individual difference.

2. METHOD

The schematic diagram of our proposed system is showed in Fig.1. We used six different color markers which placed head, waist, right and left hands and feet for tracking. The color markers were tracked by selecting the pixels with the specified colors and calculating the center of gravity color-by-color from video image. We assumed that the probability of fall would be increasing when patient tried to sit up. Sitting-up position was seen as his or her distance between head and waist, because it would be shorter than that of supine position. Therefore, we calculated the distance from the center of gravity of head to waist by the frame. The observed pixel region was divided into four areas and we assumed the degree of fall in each area based on expert opinion. Finally, we calculated the probability of fall that multiply the each color's position by the degree of risk.

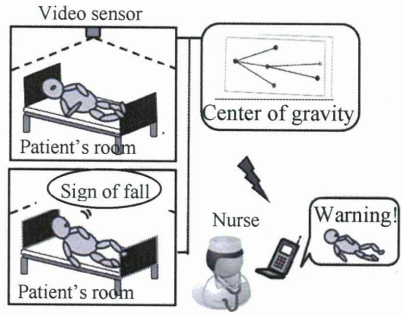


Fig.1 Schematic diagram of proposed system.

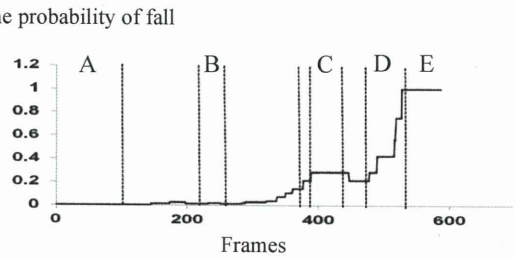


Fig.2 The probability of fall by frame.

3. EXPERIMENT

Experimental trial were conducted in the laboratory where imitated the patient's room in the hospital with normal subjects. We set up video sensor on the ceiling to sense participant's behavior totally. The subjects performed many situations in patient's room and the scene was recorded.

Fig. 2 shows the probability of fall as one example of the result. Subject's behaviors of A~E in Fig.2 means as follows: A: Supine position, B: Long sitting position, C: Sitting square, D: Standing and E: Falling. With each change in subject's behaviors, the probability of fall showed characteristic changes and rose toward fall.

4. CONCLUSION

This paper discussed a system for detecting patient's sign of falls. We calculated the probability of fall by the center of gravity and the distance from head to waist. It showed that the probability underwent a characteristic change when subjects came close to falling. We suggested a new system that it is possible to predict falls by monitoring patient's behavior.

DETECTION OF ABNORMAL EVENT IN TOILET

Kayo Yoshimoto, Maki Takeda, Nagisa Sasaki, Takeshi Ando, Sachiko Shimizu, Kenji Yamada, and Yuko Ohno

Department of Health Sciences, Graduate School of Medicine, Osaka University

ABSTRACT

Falls and fall-related injuries are the most common and serious medical errors. This paper proposes a non-contact system to detect abnormal event in the toilet by using image processing. In the experiment which simulated five scenarios by healthy subjects, the test system could distinguish between normal and abnormal condition in the toilet. This result suggests that the proposed system is possible to detect abnormal event in the toilet.

Index Terms— Abnormal Detection, Monitoring, Toilet

1. INTRODUCTION

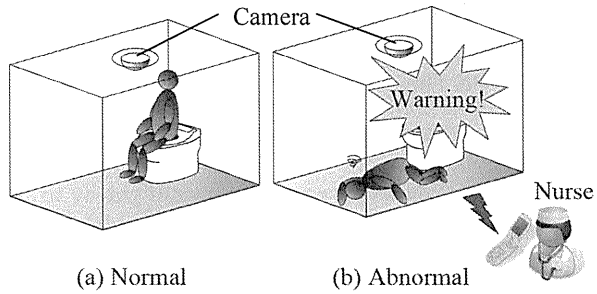
Falls are common in patients [1]. Especially, in the privacy space, patient falls are likely to delay detecting. The toilet in Japan is a closed space peculiarly which every toilet door has no gap between the door and the door frame, and the toilet activity has a high risk of falls. This paper proposes a non-contact system to detect abnormal events in the toilet by using camera images. The proposed system can monitor detailed behavior unlike other sensors [2] and protect patient's privacy by using image processing data. For detecting abnormal event, it is necessary to distinguish between normal and abnormal condition of patient. Therefore, we examine whether the system can distinguish the patient's condition by the experiment simulated behaviors of the patient in the toilet.

2. PROPOSED SYSTEM OVERVIEW

Figure 1 shows a schematic view of our system. The camera monitors a patient in the toilet by using image processing. When detects abnormal event in the toilet, our system alerts nurse to it by PHS. We assume two abnormal situations; patient falls in the toilet and losing consciousness on the toilet seat.

3. METHOD

The camera (128×128pixel, 43frame/sec) is installed on the ceiling in the disabled-accessible toilet. Figure 2 shows the experimental setup. The size of the toilet room is W2.0m×D2.3m×H2.4m and the brightness is 250lx. We simulate five different kinds of scenarios; a series of normal action from entering to leaving the toilet without fall, three types of fall action from entering to falling on the floor, and



(a) Normal (b) Abnormal

Fig.1 Schematic view of proposed system

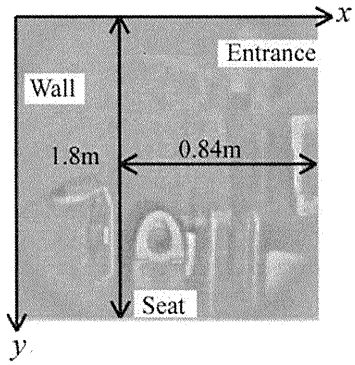


Fig.2 Camera's image in the toilet

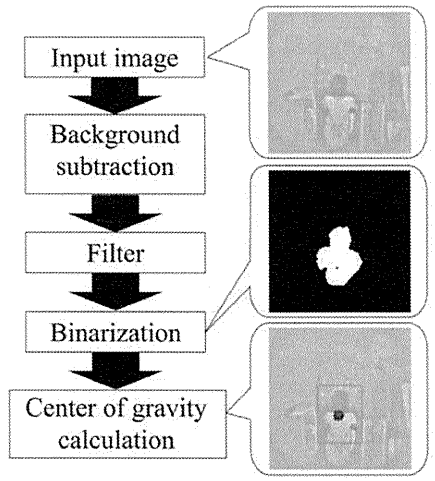


Fig.3 The flow for calculating the patient's center of gravity

unconscious action from entering to losing consciousness on the toilet seat. Three types of fall scenarios are the forward falling when rising from seat, the slipping from seat, the falling soon after enters toilet. Healthy subjects are required to act five kinds of scenarios of three times.

The position of patient could be steady both when abnormal situations and the normal situation we assumed. Therefore, the patient's center of gravity is determined by calculating the silhouette image obtained from background subtraction and binarization of camera image. Figure 3 shows the flow for calculating the patient's center of gravity. We consider distinguishing between normal and abnormal condition of the patient by the position of center of gravity under the static state.

4. EXPERIMENTAL RESULTS

Figure 3 (a)-(c) shows the *x*-axis of center of gravity *xc* and the *y*-axis of one *yc* during the experiment where the healthy subject acts a normal action, a forward fall one, and an unconscious one, respectively. The center of gravity is nearly steady during sitting on the toilet seat, after falling on the floor, and after losing consciousness. Indication as to whiter the patient's position is steady or not is useful to detect abnormal events in the toilet.

Figure 4 shows the average of center of gravity under the steady state. It can be seen that sitting states are located on the seat, fall states are located on the floor, and unconsciousness states are located around the seat. As shown in Fig. 4, the sitting state and fall state are able to distinguish distinctly by the position of center of gravity under the state that the position is steady. And, the sitting state and the unconsciousness state could be distinguished. As a result, the normal and abnormal condition of patient could be distinguished by the position of center of gravity under the state that the position is steady.

5. CONCLUSION

This paper proposed a non-contact system to detect abnormal event in the toilet by using camera images. The experimental results showed that the proposed system could distinguish the patient condition by using the position of center of gravity. Our findings supported that the proposed system is possible to detect abnormal event.

In the future research, we would like to consider the effect of individual variability and improvement of more privacy.

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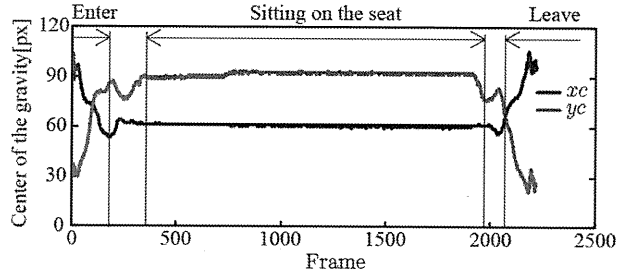
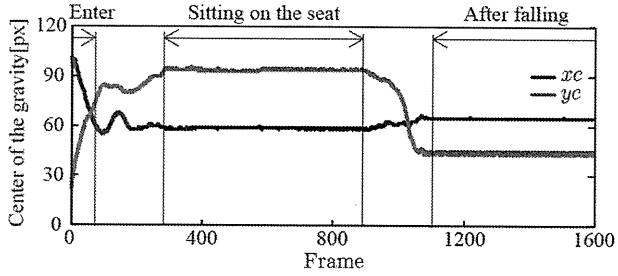
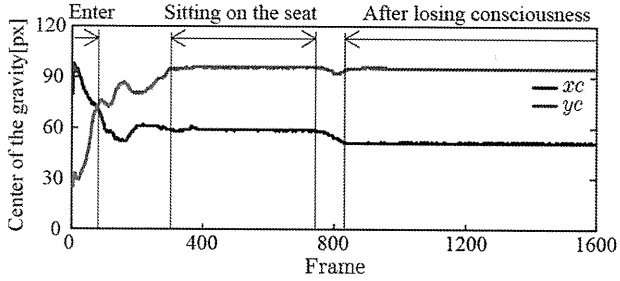


(a) normal action



(b) forward fall action



(c) unconscious action

Fig.4 The center of gravity during three different scenarios

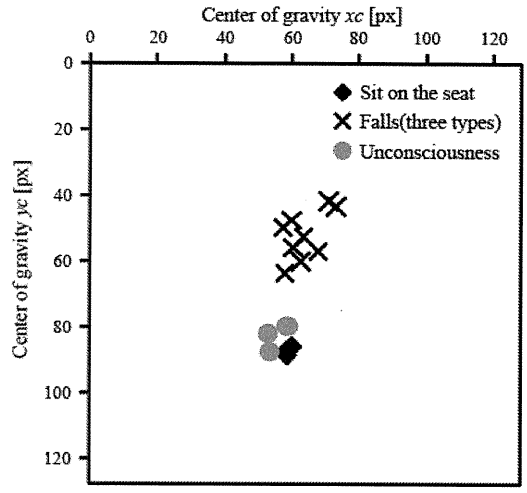


Fig. 5 Average of center of gravity under the static state

Original technical note

Research into the Symptoms of Sick House Syndrome and/or Multiple Chemical Sensitivity Patients and Indoor and Outdoor Air Quality

Tamami Suzuki[1)], Yuko Ohno[2)], Yoshiko Bai[2)], Masao Inoue[3)]

1) Gumma PAZ College, Faculty of health science
2) Osaka University, Graduate School of Medicine, Health Sciences
3) IAQ Research Associate

In order to clarify the subjective symptoms of Sick House Syndrome (SHS) and/or Multiple Chemical Sensitivity (MCS) and the air quality in their surroundings, as well as to investigate countermeasures and future challenges, 2 patients showing SHS and/or MCS were selected. A preliminary study was conducted via mail using a questionnaire composed of the Quick Environmental Exposure and Sensitivity Inventory and our own questions, and this was followed by interviews. Air quality was evaluated using the active method. Subjective symptoms differed between subjects A and B. The indoor air quality for subject B, who had received an early confirmed diagnosis and relevant treatment, was good, and her subjective symptoms tended toward improvement. The early confirmed diagnosis in subject B (after 3 months) was based on the presence of SHS and/or MCS patients in the surrounding area. Consequently, proactive information gathering was possible, and the cooperation of Indoor Air Quality (IAQ) specialists was obtained, thus assisting in the consideration and renovation of new homes. If one is able to access accurate information, then early diagnosis and early treatment are possible. Therefore, a need exists for the transmission of accurate information relating to patients with SHS and/or MCS. When compared to the outdoor reference values of C, the outdoor air quality for subject A was poor, with Total Volatile Organic Compounds (TVOC) at 22.2 times higher, toluene at 5.7 times higher, ethyl benzene at 4 times higher and xylene at 8 times higher. This suggests that indoor air quality improvement measures alone would be of little help, and that government intervention based on environmental health concepts would be necessary for outdoor air quality. Within a feasible scope, we wish to provide support and guidance, and strive to improve symptoms of MCS.

Key Words
Multiple Chemical Sensitivity, Sick House Syndrome, Air quality, Volatile Organic Compounds, QEESI

1. Introduction

Typical examples of chemical substances thought to cause Sick House Syndrome (SHS) are Volatile Organic Compounds (VOCs) such as formaldehyde, toluene and xylene, which are present in materials such as plywood, furniture, coatings and adhesives. The series of wide-ranging conditions brought about by VOCs diffusing around the home is collectively referred to as SHS, a term which is said to characterize the fact that the symptoms lessen as one moves away from problematic homes[1)]. If an individual continues to reside in problematic house, or is unable to avoid the problem, the condition can develop into Multiple

27. 6. 2011 Recieved, 25. 9. 2011 Accepted
1-7-1, Tonyamachi Takasaki City Gunma Pref. 370-0006 JAPAN
Tel: +81-27-365-3366
Gumma PAZ College, Faculty of health science
suzuki@paz. ac. jp
Tamami SUZUKI

Chemical Sensitivity (MCS) which originates in "Sick Houses", but causes symptoms of sensitivity to a wider range of chemical substances on an everyday level. Cullen defines MCS as being caused by high-level exposure and long-term low-level exposure. He describes it as a disorder in which, even at low levels, a condition is reached after long-term exposure, of sensitivity to either the same or a variety of chemical substances, and that provokes symptoms in multiple internal organs due to exposure to extremely low levels that would not ordinarily provoke symptoms[2]. The causes of MCS in Japan include 60% by SHS and 20% by agricultural chemicals and pesticides[3], both of which correspond to long-term low-level exposure. Clear definitions of SHS and MCS have been debated among large numbers of researchers[4)-7)], and remain ambiguous.

The specific difficulties with MCS go beyond the complex and wide-ranging complaints, and extend to problems in treatment and everyday life. Specifically, the difficulties include the fact that diagnosis is not simple[8], that there are only a small number of specialist hospitals offering diagnosis and treatment, that drug treatments cannot be easily selected[9], and that problems with indoor air quality in hospitals prevent the receipt of treatment. Although coatings and paints have an odor, herbicides and agricultural chemicals have been made odorless; patients may perceive them via the weight of the air or via physical discomfort, but by the time they have done so, they may have already succumbed to airway edema or another life-threatening condition.

Current SHS measures include the July 2003 enactment of the Revised Building Standard Law, in which ventilation equipment, and building materials restrictions were incorporated (total prohibition of chlorpyrifos as an anti-ant insecticide, and usage restrictions on formaldehydes). The indoor concentration levels for individual VOCs established by the Ministry of Health, Labour and Welfare in its guidelines for indoor air pollution included 13 substances and 1 advisable value in 2002 (the only ones for which penal rules were provided in the Building Standard Law were formaldehydes and chlorpyrifos)[10]. These guideline levels were established based on the determination that even if an individual had been exposed to a certain chemical substance below the designated level for their entire life, there would be no harmful effects on their health. However, it has been reported multiple times in the case of MCS, that health disturbances appear even below the designated levels. The number of adult MCS patients in Japan is estimated to be 700,000[11], and yet the demand for efficiency and convenience means an abundance of chemical substances are present in everyday life. Crises in air, water and food safety, problems with environmental hormones, and similar issues, are expected to lead to an increase in SHS and MCS cases in the future, necessitating urgent countermeasures.

In the present study, our objective was to clarify the subjective symptoms of SHS and/or MCS patients and the quality of the air in their surroundings, and to investigate countermeasures and future challenges.

2. Research method

(1) Selection of subjects and investigation summary

We requested the cooperation of an NPO for MCS/SHS, and selected eight female patients who agreed to the details of the study and wished to be interviewed, and to have air

quality accurately measured. After the return of the mail questionnaires, the interviews were conducted. Among them, we chose two patients: the patient who is the shortest/longest length of the duration until confirmed diagnosis. The questionnaires were made up of the Quick Environmental Exposure and Sensitivity Inventory (QEESI) and some survey items drawn up separately by the researchers. QEESI was developed by Miller et al. of the University of Texas[11] and was translated by Ishikawa et al., with accuracy confirmed by Hojo et al.[12)–18)], and is currently used both in MCS specialist hospitals and in screening. The areas surveyed cover 5 items: Q1. Chemical Exposure (CE); Q2. Other Exposure (OE); Q3. Symptoms (SY); Q4. Masking (MA); and Q5. Impact of Sensitivity (IS). These items are scored using the 4 assessment levels of Miller and Prihoda: Very Suggestive (VS); Somewhat Suggestive (SS); Problematic (PR); and Not Suggestive (NS). Q3. Symptoms (SY) covers 10 items that are assessed in 10 levels: Head-related symptoms (HEAD); Cognitive symptoms (COG); Affective symptoms (AFF); Neuromuscular symptoms (NM); Musculoskeletal symptoms (MS); Skin-related symptoms (SKIN); Genitourinary symptoms (GU); Gastrointestinal symptoms (GI); Heart/chest-related symptoms (COR); and Airway or mucous membrane-related symptoms (ARI/MM).

(2) Air quality measurement

a. Sampling method (Table 1)

For sampling, we used the active method[19]. The sampling tubes used for measurement were Tenax-TA (Sperco/TD) for VOCs and DNPH (GL Science) for aldehydes. Mitsubishi Chemical Analytech Co., Ltd., performed the analysis, and 51 substances were identified. In accordance with the Ministry of Health, Labour and Welfare's "Regarding Guideline Values of the Concentration of Chemical Substances in Indoor Air and a Standard Measuring Method for Such Substances" (No. 1093), air was collected for survey for 45-60 minutes (60 minutes in this study), and the concentrations of chemical substances were determined. The active method for collecting air using a pump, as compared to the passive method, is expensive and complicated. However, identification of 500 different substances is possible by gas chromatography, and so it was selected as the standard method based on the Ministry of Health, Labour and Welfare guidelines.

The equipment used included small, light-weight, portable, high-performance air suction pumps with built-in functions to measure integrating air flow, MP-Σ30 and MP-Σ300 (Sibata Scientific Technology Ltd.) for air collection.

Table 1 Details of accurate air measurement

	VOCs*	Aldehydes
Sampling pump	Sibata MP-Σ30	Sibata MP-Σ300
Sampler	PEJ-02	DNPH
Sampling time	30 minutes	30 minutes
Volume collected	3.0 L	30.0 L
Analysis(Dia Analysis Service Inc. Japan.)	Thermal desorption (GM-MS**)	Solvent extraction(HPLC***)

* VOCs: Volatile Organic Compounds
** Gas Chromatography-Mass Spectrometer
*** High Performance Liquid Chromatography

b. Active method measurement setup

In preparation for measurement when collecting indoor air, we began by opening all doors and windows for 30 minutes. To preserve the air environment, doors and windows that could exchange air with outside were then closed, and air conditioning and ventilation fans were switched off. Air was collected after this state had been retained for a duration of 5 hours.

(3) Ethical considerations

Among the ethical considerations for the subjects was the fact that participation in the study was voluntary, resulting in no disadvantage by either refusal of participation or withdrawal before study completion. We explained both verbally and in writing that anonymity would be maintained when the study was to be published, and that protection of privacy would be strictly observed. After the contents of the research had been understood, participants provided written informed consent. In addition, approval was obtained for the implementation of this research from the ethics committee of the Gunma Paz College, Faculty of Health Science.

3. Results

(1) Overview of subjects (Table 2)

Subjects A and B were both housewives in their 40s, living together with their husbands and children in a house. The fact that a confirmed diagnosis had been reached for subject B after only 3 months was largely due to the information gathered from acquaintances with similar symptoms. Both subjects A and B had the worst symptoms among the members of their respective families. The husband of A had mild SHS symptoms, and was treated via internal detoxicants, while the husband of B did not have SHS, and was in good health. The children had been treated as a result of the experiences of A and B, but their symptoms differed from the subjects themselves. Common features were observed between A and B in areas such as age, occupation, residence and family structure. There were also differences in the environments around their homes.

(2) QEESI results (Fig. 1, Fig. 2, Fig. 3, Table 3, Table 4, Table 5)

Table 3 lists the QEESI Results; criteria for low, medium and high scores on five scales, Q1 – Q5, A (76, 30, 61, 7, 34/total; 208 points), B (75, 63, 39, 1, 74/total; 252 points). It was determined during the interviews, based on observation and listening, that subject B's condition, was somewhat milder than subject A's, and that their main complaints were

Table 2 Subject overview

	A	B
Age (years)	40s	40s
Occupation	Housewife	Housewife
Family structure (living together) *diagnosed with SHS	Subject*, husband*, eldest son*, second son*	Subject*, husband, eldest son*
Duration until confirmed diagnosis	72 months	3 months
Number of hospitals visited until confirmed diagnosis	S: "Went to each and every department", "Visited too many hospitals to count on my fingers"	S: "Went to various departments"
Departments providing treatment at present	Internal medicine, neurology, psychiatry, obstetrics and gynecology	Allergology
Causes of symptoms	Moving house, formaldehydes, pesticides, herbicides, dioxins, tobacco (passive smoking)	Exhaust gases, moving house (with tatami room)
Home environment	No change in living environment causing symptoms. Region in which agricultural chemicals are dispersed in air, with nearby fields. Two-storey house with two golf courses and refuse disposal facility in vicinity.	Moved from apartment block causing symptoms to two-storey house in residential area with few main roads.
Main symptoms (5) in order from most severe	1. Lethargy 2. Heavy-headedness 3. Fatigue 4. Sleep disturbance 5. Back / shoulder stiffness	1. Headache 2. Sleep disturbance 3. Menstrual irregularity 4. Food allergies 5. Dermatalgia

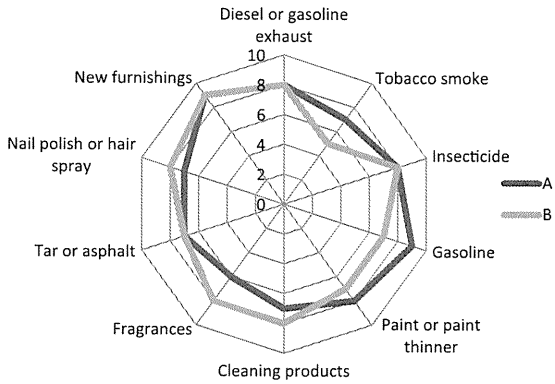


Fig1. Chemical Intolerances

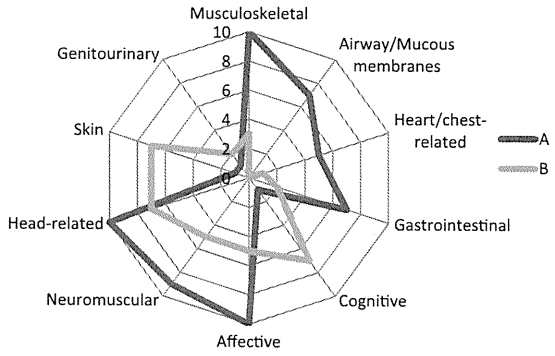


Fig2. Symptom Severity

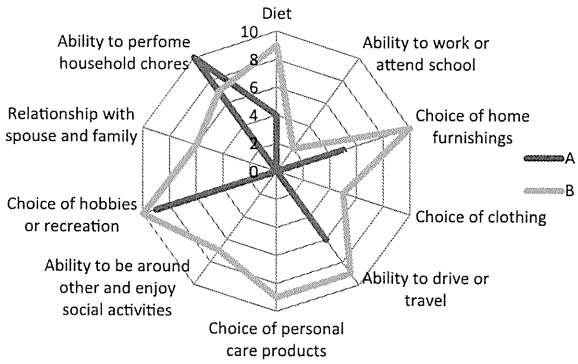


Fig3. Life Impact

different. The subjective symptoms in order of severity for subject A were lethargy, heavy-headedness, fatigue, sleep disturbance, and shoulder and back stiffness. Psychological and neurological symptoms were prominent, resulting in difficulties in performing everyday activities and hobbies. The main complaints of subject B were headache, sleep disturbance, menstrual irregularity, food allergies and dermatalgia. As she had sensitivity to odors and skin-related symptoms that occurred readily, discomfort was seen in areas such as cosmetics, movement, new products and food. The scores for both subjects A and B were high in QEESI Q1 Chemical Intolerances (Fig. 1), (76 points for A, 75 points for B), with no differences noted between them. On QEESI Q3 Symptom Severity (Fig. 2), A>B, at 1.77 times (69 points for A, 39 points for B). The scores for subject A were; Musculoskeletal symptoms (10 points), Affective symptoms (10 points), Head-related symptoms (10 points), Neuromuscular symptoms (9 points), with pronounced psychological and neurological symptoms. She was lethargic, and a suicide attempt was noted. The scores for subject B were; Cognitive symptoms (7 points), Head-related symptoms (7 points), Skin-related symptoms (7 points), with headaches being the most problematic among the subjective symptoms. On QEESI Q5 Life Impact (Fig. 3), A<B, at 2.18 times (34 points for A, 74 points for B). Scores for subject A were; Ability to perform household chores (10 points), Choice of hobbies or recreation (9 points), Ability to drive or travel (6 points), Ability to be around others and enjoy social activities (0 points). Lethargy led to difficulty in getting up, her eyes seemed slightly closed due to the side effects of medication, housework could not be performed, and it was impossible for her to foster interest in society. The scores were low for Choice of home furnishings (5 points), and Choice of personal care products (0). It was confirmed during the interview that the odors were being masked, and it was difficult to eliminate harmful things based on sense of smell or to prevent worsening of symptoms. Subject B experienced the worst symptoms when she lived in the problematic apartment block that brought about SHS and/or MCS. However, moving to a used house with a favorable

Table 3 Criteria for low,medium,and high scores on five scales.(Miller&Prihoda)

Scale	Score			Subject A	Grade	Subject B	Grade
	Low	Medium	High				
Q1 Chemical Intolerance	0-19	20-39	40-100	76	H	75	H
Q2 Other Intolerance	0-11	12-24	25-100	30	H	63	H
Q3 Symptom Severity	0-19	20-39	40-100	61	H	39	M
Q4 Masking	0-3	4-5	6-10	7	H	1	L
Q5 Life Impact	0-11	12-23	24-100	34	H	74	H

Table 4 Reaction of subject A to exposure to chemical substances. Details of complaints when score 5 or greater in QEESI Q3

QEESI Q3 item with score 5 or more Score of 0-10 shown inside ( )	S Data
1. Musculoskeletal symptoms; MS (10)	Extreme fatigue. Back stiff and feels as if painted in lead.
6. Affective symptoms; AFF (10)	I want to disappear, and want to die. Painful feelings in my heart. I asked my husband to cut my neck and my arm, to cut my neck with a saw. I told them in the psychiatric hospital that I wanted to die, and asked to be put in a room with a lock, as otherwise itwould happen sooner or later. I was at a loss for words as I was not a level where I wanted people to understand the pain I was in. As long as I am breathing I am suffering. Living is painful.
7. Neuromuscular symptoms; NM (9)	I cannot raise my elbows, so cannot wash my face or brush my teeth.
8. Head-related symptoms; HEAD (10)	I have a headache and feel heavy-headed all day long. My head hurts. It is a pain like pressure being applied from within my body.

Table 5 Reaction of subject B to exposure to chemical substances. Details of complaints when score 5 or greater in QEESI Q3

QEESI Q3 item with score 5 or more Score of 0-10 shown inside ( )	S Data
5. Cognitive symptoms;	Even washing my face is a chore, I cant even think about it.
6. Affective symptoms; AFF (5)	Living is painful - I feel like a caged bird.
8. Head-related symptoms; HEAD (7)	My head hurt so much it felt like it would split. It felt like something was building up at the back of the head. I was bedridden by the headache. It was rare to feel like I had a deep sleep. Staying awake was difficult.
9. Skin-related symptoms; SKIN (7)	A rash appeared on my hands. Skin symptoms would appear when I consumed fat. It was not possible to use cosmetics as my face broke out in a rash. It was extremely difficult to find skincare products that were suitablefor me, so I had to gather a range of information.

surrounding environment, and carrying out renovations had resulted in the symptoms improving. Consequently, she could recognize higher-level needs and inconveniences. Her scores were; Diet (9 points), Choice of home furnishings (10 points), Ability to drive or travel (9 points), Choice of personal care products (9 points), Ability to be around others and enjoy social activities (7 points), Choice of hobbies or recreation (10 points), Ability to perform household chores (7 points). It was confirmed in the interview, that cosmetics are necessary as they are used almost daily, and that she is active (with help from acquaintances) in appealing to society in relation to MCS. With regard to the Relationship with her spouse and family (0 points for A, 6 points for B), A's entire family had been diagnosed with SHS. Their symptoms were each different, but it was apparent that they understood one another. B's husband, however, did not have SHS, and B felt that she was not understood. These results were reflected in the scores.

Tables 4 and 5 show the QEESI Q3 Symptom Severity scores for subjects A and B, indicating the details of complaints in areas where scores were 5 or greater. Subject A felt that living itself was painful, and had repeatedly cut her wrists. Symptoms of depression were pronounced, and she occasionally lacked the strength to wash her face or brush her teeth. Subject B also complained of difficulties in living, but psychological and neurological symptoms were mild when compared to A. Hence, she demonstrated the vitality to face inconveniences and difficulties, and seek possible solutions.

(3) Indoor Air Quality and Outdoor Air Quality results (Table 6, Fig. 4, 5, 6)

The current home of subject B is not the dwelling that triggered her SHS and/or MCS. Rather, it is a used two-storey house that they moved to, from the "Sick House" apartment block. IAQ specialists investigated the house and provided guidance on renovations. It is in a quiet residential area, with no main road, and there are no large factories, refuse disposal facilities, large-scale agricultural sites, gas stations or car washes in the neighborhood. However, the house required renovation. Appropriate materials were carefully selected for these renovations. There were slightly high levels of terpenes in the air inside B's home, and there were high scores for TVOC, but these stem from the use of pure materials in the renovation. Symptoms are thought to be controlled by ventilation, through leaving windows open to enable wind to flow through the home. However, the air quality showed generally favorable results.

Subject A was living in the house that led to SHS and/or MCS symptoms. She moved in when the house was newly built, and has not yet renovated or intervened in any other way. In the surrounding environment is a factory, a refuse disposal facility, an industrial waste disposal plant, a golf course and large-scale agricultural sites (primarily rice and soybean farming). Esters, ketones and formaldehydes all display high levels. During our visit to A's home, her physical condition was evidently poor when exposed to the open air. We assumed there was a problem with the outdoor air quality and therefore took appropriate measurements.

Table 6 Indoor Air Quality and Outdoor Air Quality

	Reference values (Saitama Prefecture)	A (Gunma Prefecture)		B (Tokyo Metropolis)
	outdoor	outdoor(2nd floor veranda)	Western-style room	after renovation Western-style room
month/temperature/humidity	—	July/32℃ /65%	July/26℃ /53%	April/19℃ /38%
Aliphatic hydrocarbons	0.5	64	25	13
toluene [260]	1.7	8	26	5
ethyl benzene [3800]	<0.5	2	3	1
xylene [870]	<0.5	4	5	2
styrene [220]	<0.5	<0.5	2	<0.5
terpenes	<0.5	2	15	240
esters, ketones	5.6	36	263	24
TVOC	<50	1110	517	778
formaldehydes [100]	<10	—	100	10
acetaldehydes [48]	<10	—	45	13

[ ]:The indoor concentration levels for individual VOCs established by the Ministry of Health, Labour and Welfare in its guidelines for indoor air pollutionincluded 13 substances and 1 advisable value in 2002[10].

unit;μg/m^3

To effectively collect the air in question, we devised an approach involving the attachment of a glass funnel (φ-90) to the end of a sampling tube. The glass funnel was chosen as it would not influence the results of analysis, but we required a way to handle and fix it (Fig. 4). Specifically,

Fig4. External air sampling using glass funnel (φ-90). Glass funnel was attached to the end in order to effectively collect the air (φ-90) (Temperature: 32C°, Humidity: 65%).

Fig5. Indoor air sampling (Temperature: 31.7°C, Humidity: 56%).

*Gunma Prefecture is one of Japan's prefectures, located in the inland northwestern Kanto Mountains in the province has a vast natural abundance in the northern province, population density is 315 people per square meter . Subject A is located south of the Gunma Prefecture, the agricultural areas, industrial areas, residential areas are not divided, is also adjacent to several golf courses.

** Saitama Prefecture is central western interior of the Kanto region in the province to the north of Tokyo, population density is 1,900 people per square meter. Saitama Prefecture is an inland prefecture adjacent to Tokyo, is also thriving agriculture, thought it was appropriate as a reference value.

*** Tokyo is the capital of Japan, the population density is the number one in Japan, it' s 6030 people per square meter. Subject B is located in the southern part is divided in Tama, Tokyo Metropolis. Tama is a thriving business in the most southern of Tokyo, also has a college town.

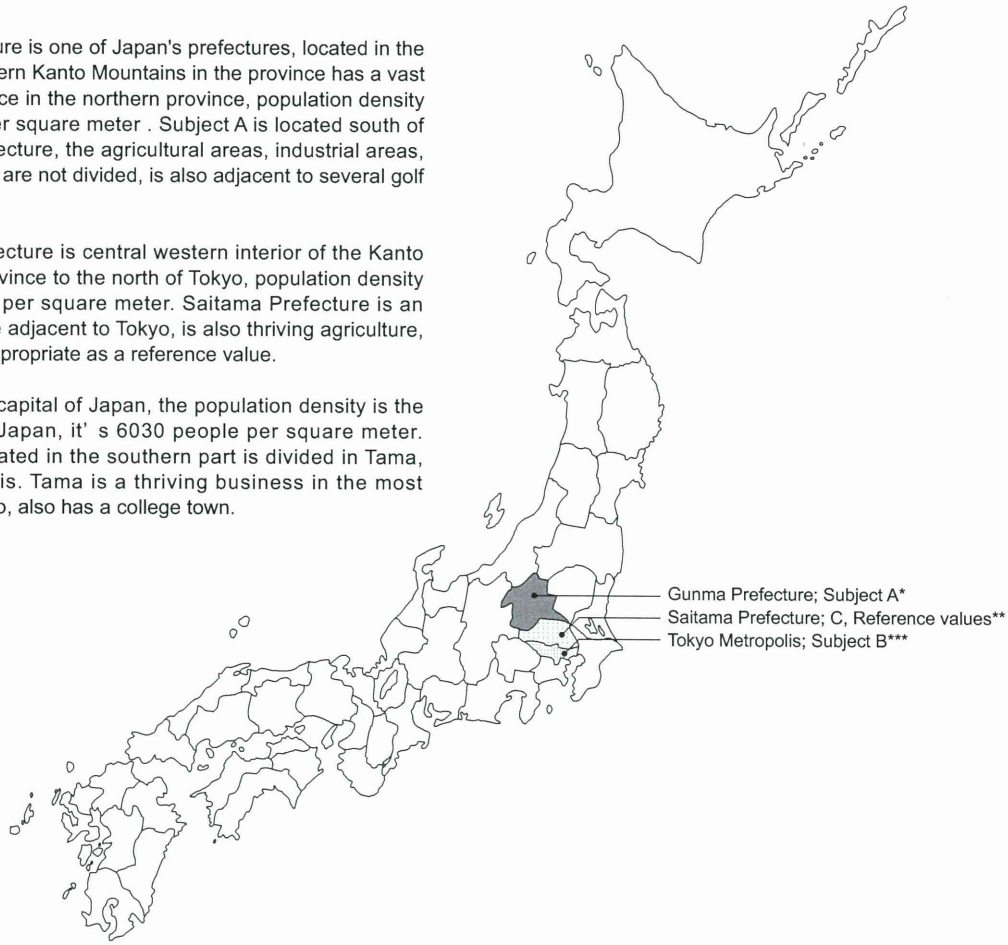


Fig.6 Map of Japan and descriptions of the Subject.

because the direct attachment of the glass funnel to the sampling tube was impossible, they were connected using a silicon tube, but as the silicon tube was flexible, it was fixed using a prop for support.

When we compared the outdoor air quality with the C outdoor reference values (Table6, Fig. 6), the results were inferior, with TVOC at 22.2 times higher (2.2 times a Western-style room), toluene at 5.7 times higher, ethyl benzene at 4 times higher and xylene at 8 times higher. Ventilation via window-opening was impossible.

(4) Handling activities

Subject A had visited a large number of hospitals before a confirmed diagnosis was reached. It took as long as 72 months, causing her to lose faith in the medical services to a certain extent. Her treatment consisted primarily of going to hospitals and taking internal medicines. There was a worsening trend in her symptoms, as family matters prevented her from moving away from the house causing the exposure symptoms. There is a refuse disposal facility in the surrounding area, as well as a golf course in front of the dwelling. The outdoor air quality is at its worst during times of herbicide usage, so even when inside, the windows cannot be used for ventilation. However, the indoor air quality cannot be considered good either (Table 6), and consequently she fell into a worsening physical condition, which made even housework impossible. For subject B, there were patients with SHS and/or MCS in the surrounding area, so a confirmed diagnosis was reached in 3 months. Accordingly, proactive information gathering was possible, and the cooperation of IAQ specialists was obtained for investigating and carrying out renovations for a potential home to move into. By moving away from the house causing exposure symptoms, and being mindful of both outdoor and indoor air quality, her symptoms are improving, and at the time of the study, treatment involved only vitamins and supplements, with no internal treatment or hospital visits. She was actively involved in community activities to raise concerns among the general public toward "sick houses", and was even increasing the scope of her activities.

4. Discussion

(1) Significance of combined use of QEESI and interview survey

The style of this study involved the use of a preliminary questionnaire survey performed by mail and composed of QEESI and our own questions, which was followed by interviews. The importance of backing up the significance of the QEESI point scores through careful interview examination was confirmed. The targets of our study, subjects A and B, had numerous similarities in areas such as age and family structure. The obstacle preventing improvement in A's symptoms was thought to be the external air pollution. Subject A's psychological and neurological symptoms shake the foundations of living itself, while the effect from agricultural chemicals was substantial. SHS is a condition that frequently affects females. This stems also from the fact that for housewives, the time spent in the house is greater than when compared to that of husbands. A's husband, however, worked within the same jurisdiction, and so even when he was not at home, he was exposed to the same outdoor air pollution during periods of agricultural chemical dispersal. B's husband tended only to return home to the "sick house" apartment block from time to time, and is thus thought to have avoided exposure to the "sick house" VOCs. It has been reported that MCS is more strongly

influenced than SHS by social psychological factors and that there is a deep involvement of psychogenic and psychiatric conditions[5], and it was noted strongly during the interview was that these factors had pushed the MCS patients to their psychological limits. Subject A talked of her experiences in being unable to control the problem by psychological treatment alone. This was reminiscent of a prior study that showed displayed anxiety is not a character factor, but rather stems from the present environment[20]. As for the finding that A<B by 2.18 times (34 points for A, 74 points for B) on QEESI Q5. Life Impact (Fig.3), one can assume that an accurate assessment of the circumstances giving rise to the situation indicated by these scores is not possible without work to understand the details through interviewing the subjects.

(2) Limit of indoor air quality control

"Sick house" and "sick building" problems suggest the importance of controlling indoor air quality. The situation is such that governmental guidance and interest among consumers is gradually increasing, and yet we learned from our subjects A and B on this occasion that it is difficult to improve the situation of SHS and MCS by controlling indoor air quality alone. The results measured by the active method are highly reliable, and it is significant that we were able to measure the outdoor air quality at subject A's home on this occasion. Insecticides and herbicides often have no odor, and not sensing them as bad odors can result in late avoidance, leading to steady exposure, and increasing the number of SHS/MCS patients. Consequently, obtaining actual data on air quality, and appealing to people with such data is important. However, even if concentrations don't exceed the guidelines for indoor air pollution, TVOC can be seen over 400 micrograms per cubic meter. Because more than tens of thousands of kind of chemical substances exist, it is important to identify causative substances by matching the material being used for housing to the category of organic compounds estimated by reading the peak of the boiling point.

Subject A is not able to control the outdoor air quality through her own efforts, and even if she closes the windows, external air would flow in from other places. In a situation such as this, it is not expected that A's physical condition would improve markedly, even with the improvement of her "sick house" by renovation. What are needed are drastic measures from the point of view of environmental health, such as ceasing the dispersal of agricultural chemicals in the air. This is not solely a problem facing subject A and her family. The truth is that there is a surge in patients diagnosed by hospitals specializing in SHS and MCS corresponding to times of agricultural chemical usage, with complaints including chest pains, palpitations, headaches, nausea and dizziness[21]. Throughout their daily lives, SHS and/or MCS patients exercise caution regarding such things as drinking water, meals, heating appliances and detergents, but it is control of the air that is said to be the most difficult. Although climate therapy and actually moving to a new house are known to be connected with a solution, there are many patients who cannot do so. As these are a group of disorders that cannot be resolved through self-help efforts alone, it is essential to recognize them as environmental illnesses and for the government to intervene.

(3) Importance of information sharing and education about SHS and MCS

It is difficult for the general public to sympathize with SHS and MCS patients, and one can even say that SHS and MCS

are not well understood by healthcare providers. This social situation isolates many patients, and even if they receive a diagnosis based on their symptoms, if the cause cannot be determined, they are labeled simply as patients with multiple unidentified complaints. It has been reported that female patients who have developed symptoms due to a "sick building" caused by renovation show worsening symptoms when they are not understood by their colleagues at their workplace[22]. Psychosocial factors exacerbate medical symptoms, and therefore knowledge about SHS and MCS can both protect the individual, and prevent patient anxiety. Furthermore, it has been confirmed that the level of exposure during everyday life by MCS patients is at a significantly lower range than healthy individuals with whom they live, and that patients should safeguard themselves by keeping their distance from places with bad air quality, which have a negative effect[23]. This also means also that activities of daily life can be impaired. We believe however, that symptoms may be prevented if measures to distance individuals from bad air are initiated while no symptoms are present.

MCS is unlikely to be evoked in patients via an allergy-like mechanism, and is difficult to explain via traditional medical models. Miller has described it using a new concept of Toxicant-induced Loss of Tolerance (TILT)[24], although there is a trend toward skepticism in the medical community. Nevertheless, MCS readily occurs in patients who possess allergic conditions, and the possibility that it elicits allergic conditions has been noted[25]. We expect that the focus of education and guidance on this point will make it easier to gain consensus. Among the impediments to everyday life caused by MCS, there are significant effects from outdoor environmental factors such as car exhaust gases, insecticides, herbicides and gasoline odors[26]. It is thus necessary to stress the importance of improving these factors in the external environment. The presence of SHS and/or MCS patients in the surrounding area ensured that subject B could readily discuss the problem, that necessary treatment could be carried out swiftly, and that she could avoid exacerbating her overall condition. This served to highlight the importance of sharing information on SHS and MCS. Decisive difference in the two patients is the difference between chemical exposure and duration of exposure. Early diagnosis and handling activities are important to MCS patients.

Acknowledgments

We would like to express our deepest gratitude to everyone from whom cooperation was obtained during this study. The study was conducted with the assistance of an FY2008 Grant-in-Aid for Scientific Research (Young Scientists (Start-up) Subject No. 20890213).