INDOOR ENVIRONMENT OF THE CHEMICAL SENSITIVITY (CS) PATIENT HOUSE AT ASAHIKAWA, JAPAN

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ABSTRACT
A chemical sensitivity (CS) patient house was built at Asahikawa, Japan in 2001. The objectives for the house are to study the CS mechanism, the relationship between indoor environment and the symptoms, as well as care of the patients. It is expected that CS patients will recover and return to normal life through their temporary stay at the CS patient house. In this paper, the baseline data results of the indoor environment measurements since the construction are described. The formaldehyde concentration in each room was less than 20 ppb just after the construction and since then. VOC levels were also low. We feel the indoor environment of the house is good for CS with regard to chemical contamination, although we have discovered another environmental problem: biological contamination. This research will be continued to establish good standards for the indoor environment to prevent CS occurrence.

INDEX TERMS
Chemical Sensitivity, Indoor Environment, Recuperation

INTRODUCTION
The city of Asahikawa is located in Hokkaido, a northern island of Japan. The chemical sensitivity (CS) patient house was built at Asahikawa for care of CS patients and for studying CS from various perspectives such as mechanism of CS, effect of recuperation, relationship between indoor environment and CS, establishment of a support system for CS patients, etc. A medical facility for chemical sensitivity has been established at the Kitasato Institute Hospital in Tokyo, Japan (Tsuchimoto, 1999). The purpose of the facility is to provide both diagnosis and medical care specificity. The CS patient house is the first facility in Japan for recuperation of CS patients through their daily life. The city of Asahikawa planned this project (2001) and a study group was established. Members of the group include physicians, environmental scientists, NPO staffs for CS patient support, the building company, and local government officers. It is expected that CS patients will recover and return to normal life through their temporary stay at the CS patient house. In addition, experience at Asahikawa will be helpful for the construction of another facility and establishment of a support system for CS patients.

Our goals are to (1) measure and maintain the indoor environment, (2) investigate the

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relationship between the indoor environment and the change in health status of CS patients who will temporarily stay at the CS house for recuperation , and (3) establish good standards for the indoor environment to prevent CS occurrence. In this paper, the baseline data results from the indoor environment measurements since the construction are described.

METHODS

House Characteristics

The house is built at Saito ranch in the city of Asahikawa. The ranch has offered a piece of land for the CS patient house. No pesticides are used at the ranch. Air pollution levels are also very low.

The CS patient house was donated by Kinoshiro Taisetsu Corporation, a member of the study group. It is a three-story house, built with a wall panel skeleton system (Figure 1). The total floor area is 172.16m^2. Chemical substances such as adhesive are mostly unused in the building process. There are six rooms: one room (room 1) on the 1st floor, two (room 2,3) on the 2nd floor, and three (room 4-6) on the 3rd floor. There is also a living room on each floor, and a kitchen and bathroom are on the 2nd floor. The equivalent leakage ratio is 6.27cm^2/m^2, which was measured by the blower door method with depressurization.

Figure 1. Appearance of CS patient house

Measurement of indoor environment just after construction

The house was completed on January 5, 2001. We measured the indoor environment on January 11, 2001. All doors were closed for 24 hours before measurement. Measurement locations were in the 6 rooms and the living rooms on the 1st and 3rd floors. Formaldehyde was measured using a DNPH cartridge for 30 minutes (sampled at 1.0L/min), which was eluted with acetonitrile and analyzed by HPLC. Samples of VOCs were collected on PEJ-02 tube for 30 minutes (sampled at 20mL/min) and the chemical analysis was carried out by the thermal desorption GC/MS method. The temperature and relative humidity in the rooms during the sampling were also measured.

Longitudinal measurement of indoor environment

A few CS patients have been living on probation in the house since the spring of 2001. The purpose of this probation stay is to check the house condition for anything not conducive to healthy CS patient life. The patients temporarily living in the CS house are volunteers. They maintain the house, point out problems, and measure the indoor environment throughout their stay.

VOCs, aldehydes, temperature, and relative humidity were measured. We changed the

measurement method in January, since some patients started their temporary stay on probation. A passive gas tube for organic solvents (Sibata Scientific Technology Ltd., No.8015-066) is used to analyze for VOCs and a Sep-Pak XPoSure aldehyde sampler (Waters Corporation, No.047205) is used for aldehyde sampling. Each sampler is placed in each room and living room, and outdoors. The measurement period is one week per month. VOCs, extracted from activated charcoal by CS_2, are analyzed with GC-MS. Aldehydes are eluted with acetonitrile and analyzed by HPLC. Temperature and relative humidity during VOC and aldehyde sampling are measured using HOBO (Onset computer corporation). The monitoring of the indoor environment of the CS patient house will be continued for not less than one year, even after CS patients start their treatments.

RESULTS

The results of the indoor environment measurements just after the construction of the CS house are shown in Table 1. Measurements were conducted in the afternoon. Outdoor temperature was -4.2°C and relative humidity was 62% at 16:30. The formaldehyde concentration at each sampling location was less than 20 ppb. Measured VOC levels were also relatively low, and were far less than Japanese guidelines for indoor formaldehyde and VOCs (Ikeda, 2001).

Table 1. Indoor environment parameters just after construction

	Room 1	Room 2	Room 3	Room 4	Room 5	Room 6	1F LV	3F LV
Formaldehyde (ppb)	8.0	14.0	13.0	13.0	16.0	12.0	13.0	12.0
Toluene ($\mu g/m^3$)	2.5	3.1	5.5	4.9	3.4	4.2	4.6	4.8
Ethylbenzene ($\mu g/m^3$)	1.1	0.9	1.3	2.7	1.8	2.3	2.0	4.0
Xylene ($\mu g/m^3$)	2.0	2.2	3.2	4.6	2.7	3.9	3.7	5.3
Styrene ($\mu g/m^3$)	0.4	0.5	0.9	0.8	0.6	0.7	0.8	0.9
α-Pinene ($\mu g/m^3$)	62.3	82.8	129.0	123.8	54.8	128.8	107.2	117.3
Limonene ($\mu g/m^3$)	9.1	10.0	14.6	11.3	13.2	17.3	12.6	10.7
Temperature (°C)	10.8	16.7	16.7	21.7	22.2	22.6	27.2	30.5
Relative humidity (%)	47	44	47	33	33	32	20	19

LV: Living Room

Figure 1 displays the results of formaldehyde and acetaldehyde concentrations during October and November 2001. All pollutant levels were less than 10 ppb. Most of VOCs were less than detection limits (data not shown). Even though some values were observed, the majority of the levels were nearly zero. Indoor aldehyde and VOC concentrations were also very low.

DISCUSSION

Indoor chemical pollutant levels in the CS patient house are very low. We feel the level is good for CS patients. However, although chemical pollution is not a concern, biological contamination may be a problem. Mold and mildew spread through the house in the summer of 2001, and the patients reacted to the odor. We measured indoor biological contamination levels (Table 2). Air-borne fungi levels were more than 1000 cfu/m^3 in all sampling locations except one. Hamada et al. (1995) has defined more than 1000 cfu/m^3 as 'polluted'. The relative humidity outside the home was high in the summer (about 80%, data not shown). With the windows open all day long, wet outdoor air came into the house, making the indoor

air fairly humid. Because few chemicals that could be poisonous to biological substances were observed, this indoor air might be a good environment for the development of fungi. Currently, the CS house maintains relatively low humidity, and biological problems are kept at a minimum. It should be necessary to keep both indoor chemical and biological pollutant levels low for the health of the CS patients and also the public.

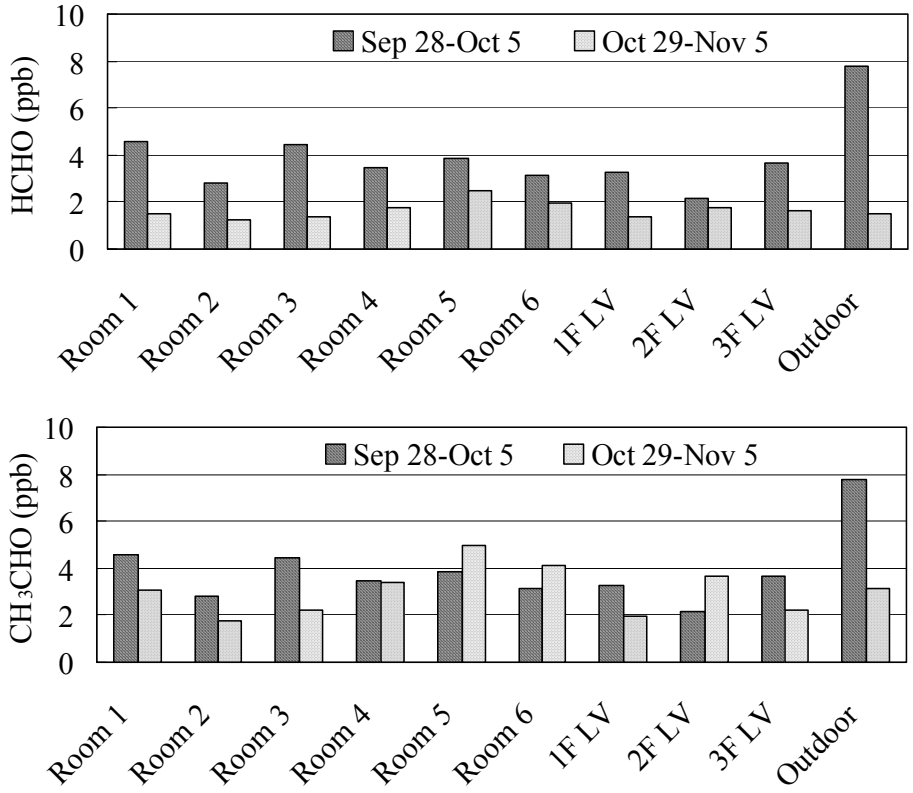

Figure 1. Aldehyde concentrations (October and November, 2001)

Table 2. Indoor biological contaminant levels

	Dust Mite Allergen ($\mu g/m^3$)	Airborne Fungi (cfu/m^3)			Fungal Index *	
Measurement period	Sep 3	Sep 3	Sep 28	Nov 7	Sep 3 - Sep 28	Sep 28 - Oct 26
Room 1	0.1	2210	630	350	11.5	ND
Room 2	1.2	1590	1050	730	18.5	ND
Room 3	0.2	1420	960	270	13.4	ND
Room 4	0.8	1350	500	280	2.2	ND
Room 5	0.2	750	570	190	ND	ND
Room 6	0.6	1120	540	310	2.7	ND
Bathroom	---	1450	580	230	16.1	ND
Boiler Room	---	1560	2340	240	>20	2.8
Entrance	---	---	480	460	>20	8

*: See Abe (2001) ---: not measured
cfu: Colony Forming Unit ND: not detected

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