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Original

LEVELS OF FORMALDEHYDE, PHENOL AND ETHANOL IN DISSECTION ROOM AIR AND MEASURES FOR REDUCTION

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Abstract

Cadavers are conventionally stored for dissection in formaldehyde (FA) at medical and dental universities. However, FA requires careful handling and protection against exposure as it is thought to cause sick building/house syndrome. We measured the levels of FA and phenol in dissection room air during cadaver dissection during the 2002 academic year at Kyorin University School of Medicine. We collected air samples twice each month, and measured FA levels as cadaver dissection progressed. We measured FA levels in air samples about 30 min. after cadaver dissection started, according to the method prescribed by the Ministry of Health, Labor and Welfare. We found that FA evaporating from cadavers tended to be associated with a higher level of FA in the dissection room. Levels of FA in the dissection room were high at the start, and decreased with the progression of cadaver dissection, but exceeded the Health, Labor and Welfare Ministry's guidelines for indoor chemical concentrations in specified workplaces by 0.25 ppm on all days of measurement except the last day of dissection. The FA levels could not be reduced to below the guideline presumably because of evaporation from cadavers, suggesting the need for further measures.

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—Key words—
Formaldehyde，Phenol，Guidelines for specified workplaces by the Ministry of Health, Labor and Welfare

Introduction

The so-called "sick house syndrome" or chemical hypersensitivity has been attributed to exposure to formaldehyde (FA) or other volatile organic compounds[1)~3)]. Public concern has resulted in guidelines being established by the Ministry of Health, Labor and Welfare, particularly to control FA. These guidelines state that the upper limits of FA levels in domestic rooms and in specified workplaces using FA should be 0.08 and 0.25 ppm, respectively[3)4)]. Cadavers are usually stored for dissection at medical and dental universities in FA, and substitutes remain unavailable. Students develop chemical hypersensitivity during cadaver dissection, or complain of disorders due to irritation of the mucous membranes of the eye and nose[5)~7)]. Under these circumstances, the Ministry of Education, Culture, Sports, Science and Technology issued an administrative directive regarding "improvement of the environment of gross anatomy dissection for medical and dental students" in April 2001, requiring that national, prefectural, municipal, and private medical and dental universities take measures to reduce FA levels in the dissection room[8)]. Thus, Kyorin University School of Medicine assessed the dissection room environment and the area around the exterior exhaust opening, and then followed the time courses of FA, phenol, and ethanol levels during cadaver dissection in the 2002 academic year.

Subjects and Methods

1. Solutions for treatment and storage of cadavers at the Department of Anatomy, Kyorin University School of Medicine

Cadaveric arteries are injected with a fixative comprising 4.8% formalin, 4.8% phenol and 33.3% ethanol. Cadavers are then stored in a mixture of 2.4% formalin, 2.4% phenol, 16.7% ethanol and 2.4% glycerin. In addition, cadavers are covered with a white cloth soaked in 1% phenol to prevent fungal growth during dissection.

2. Schedule of cadaver dissection

The gross anatomy dissection course (except for the brain) is delivered to second-year students for 12 weeks from the third week of April through the second week of July (except for the first week of May). Cadaver dissections proceed for 4 days each week from Mondays through Thursdays, with an average of about 4 hours a day from 1: 00 p.m. to 5: 15 p.m. with a 30-minute break. Cadaver dissection involves dissection of the skin from the entire body, followed by that of the superficial and deep layers of the body. Skin dissection is completed during the second week of the course. The dates of measurements below are expressed as numbers of days after the start of cadaver dissection.

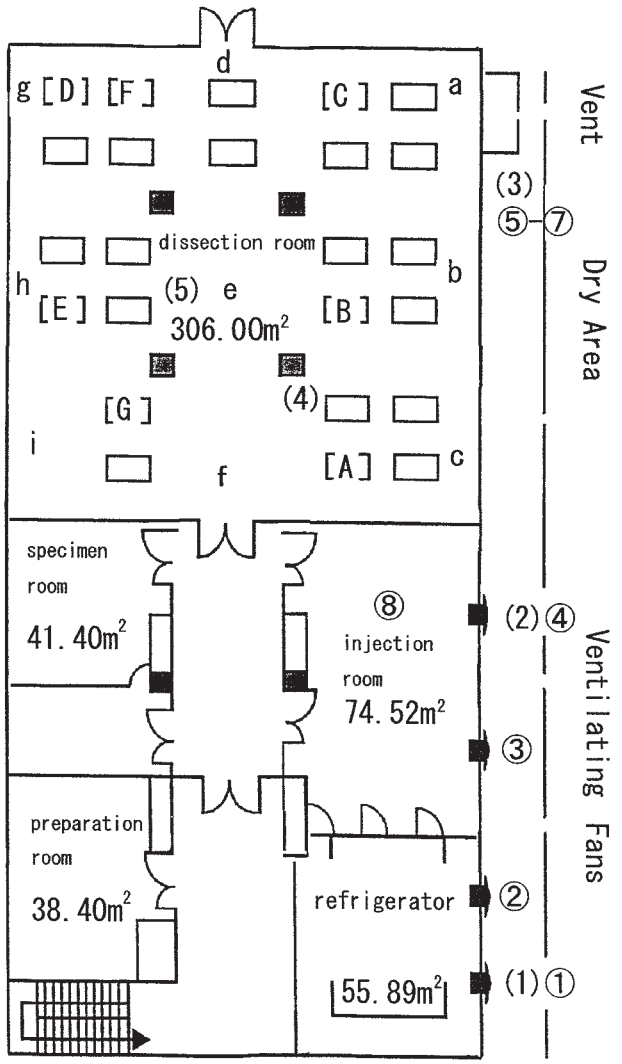

Fig. 1 Layout of the cadaver dissection room
points of FA conc. measure: S company; (1)–(5), T company; ①–⑧, a–i, A–E
points of Phenol conc. measure: F–G

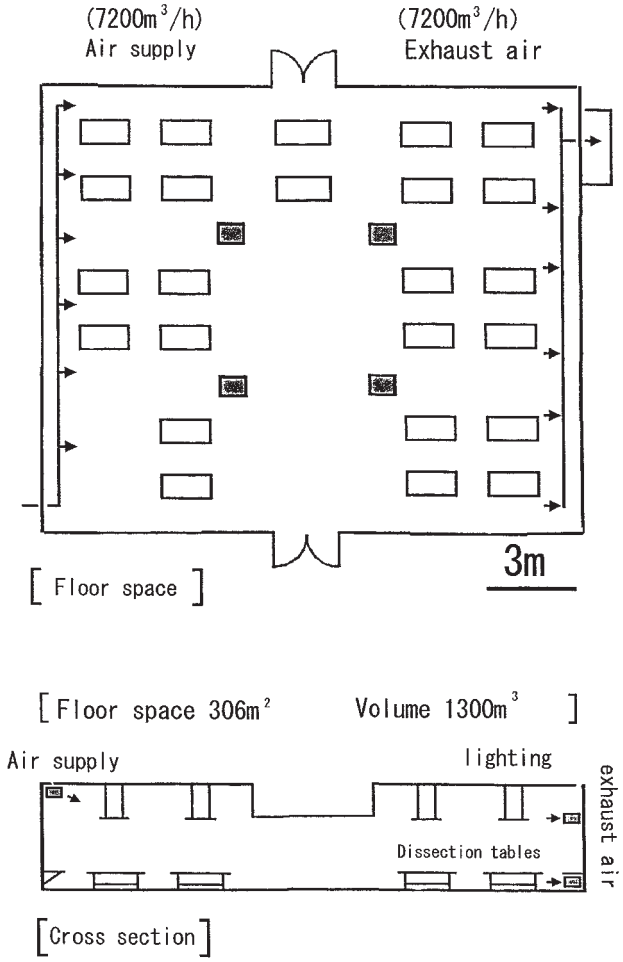

Fig. 2 Cross & horizontal section of cadaver dissection room

3. Structure of cadaver dissection room

Fig. 1 shows the layout of the cadaver dissection room and Fig. 2 shows the ground plan and sections (Fig. 2). The cadaver dissection room has a total floor space of 306 m^2 and a volume of 1,300 m^3, with 6 ventilation openings and 6 exhaust vents, allowing ventilation at a rate of 7,200 m^3/h at a frequency of 5.5 times/h during cadaver dissection. Exhaust air is discharged to an external dry area through a collective exhaust hole fitted with an active carbon filter to adsorb FA and release air, thereby reducing FA discharge. In addition, an air conditioning and heating system has been installed in the dissection room to maintain the room temperature at 22–26°C and humidity at 50–60% during dissection. Levels of FA, phenol and ethanol were measured while the ventilation system was in operation.

4. Sites of measurement

During the 2002 academic year, 99 students participated in the dissection of 24 cadavers. With the cooperation of the S and T Companies, we measured levels of FA in dissection room air, in the immediate vicinity of the cadaver (at the level of the student's face, 100 to 200 mm from the cadaver), and near the outside exhaust opening once before the start of the dissection course (T Company), and on ten occasions during the course (S Company on six occasions; T Company on four occasions). On each of the ten occasions, the S Company measured the levels of FA once each before and during cadaver dissection. We measured the levels of phenol at the same sites on seven occasions (S Company on six occasions; T Company on one occasion) (Fig. 3). Sampling sites were selected so as to represent the average work environment based on air flow, and not to hinder cadaver dissection. Fig. 3 shows the locations of the exhaust hole in the dry area and of the air vents of the cadaver storage and treatment rooms.

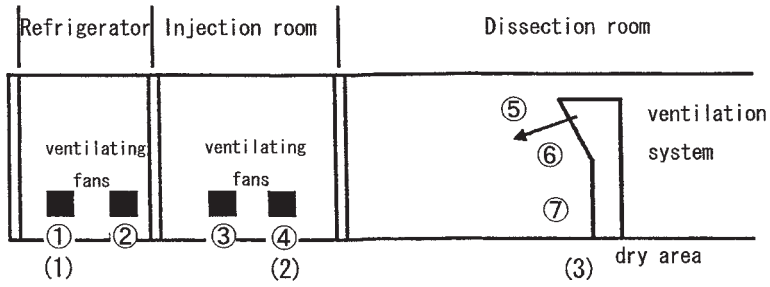

Fig. 3 Points of air sampling in dry area

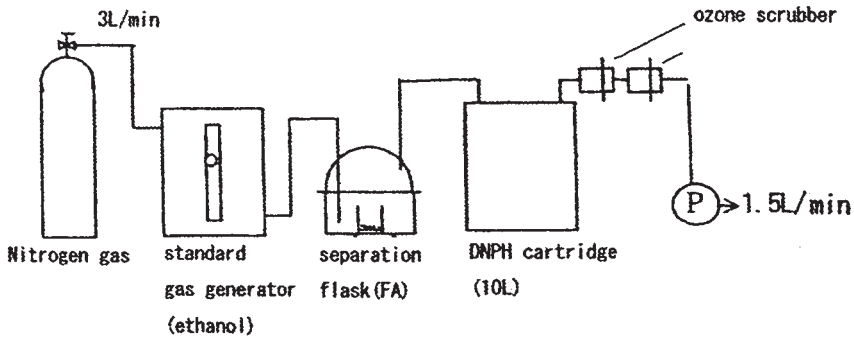

Fig. 4 Schematic diagram of DNPH method

5. Methods of measurement

The levels of FA and phenol in room air were measured as follows.

a) FA (DNPH method)

The S Company measured FA levels according to the method prescribed by the Ministry of Health, Labor and Welfare[9]. Specifically, the method involves the passage of a known volume of air through a DNPH-collecting cartridge to collect FA, which is then eluted with acetonitrile and analyzed by high-performance liquid chromatography (HPLC). The T Company collected and analyzed 500 ml of air using a Kitagawa vacuum gas-collecting system (manual piston pump, AP-20; Komyo Rikagaku Kogyo KK) fitted with a 171SC Kitagawa gas detector tube (measurement range, 0.1 to 4.0 ppm for FA).

b) Phenol

The S Company measured phenol levels according to the standards of the Occupational Safety and Health Administration (OSHA), U.S. Department of Health[10]. The method involved the passage of a known volume of air through a cartridge (ORB0–47) to collect phenol, which is then desorbed with methanol and analyzed by gas chromatographic-mass spectroscopy (GC-MS). The T Company collected 200 ml of air using a Kitagawa vacuum gas-collecting system (manual piston pump, AP-20; Komyo Rikagaku Kogyo KK) fitted with a 183U Kitagawa gas detector tube with a measurement range of 0.5 to 25.0 ppm for phenol.

6. Measurement of FA levels in the presence of ethanol (DNPH method)

The injected fixative and storage solutions contain ethanol, so we performed a pilot study to determine the effects of ethanol on the determination of FA levels. Fig. 4 shows a schematic diagram of the experimental apparatus. A standard gas generator (PD-1B, G Company) was filled with ethanol to create an environment that would generate a known concentration of ethanol, which was then introduced into a 250-ml separation flask containing solid FA to prepare a gas mixture of ethanol and FA. The gas mixture was collected in a DNPH cartridge fitted with an ozone scrubber, and the FA level was measured. To generate a known quantity of FA and ethanol, nitrogen gas was supplied from a gas cylinder at a flow rate of 3 L/min. The gas mixture was collected using a pump at 1.5 L/min for 5 min. The ozone scrubber was fitted with a bag to pool the generated gas that escaped collection. Ethanol gas was generated at concentrations of 1 and 12 ppm, and experiments proceeded under three conditions including a blank.

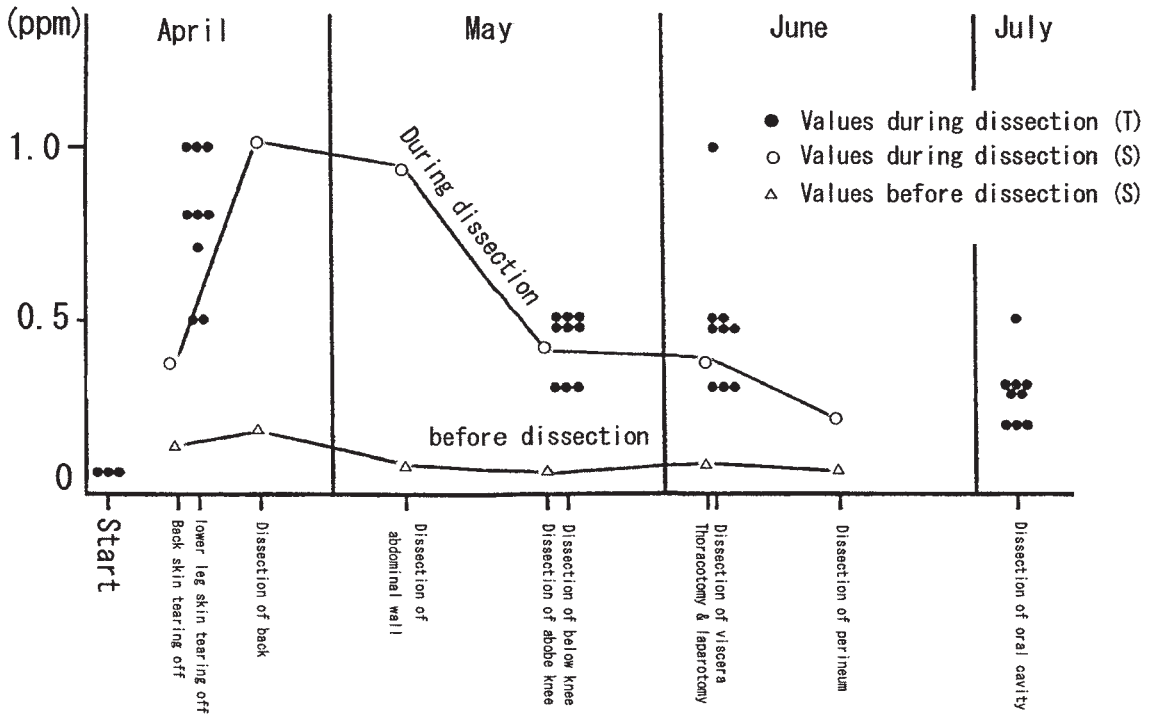

Fig. 5 FA levels in the cadaver dissection room

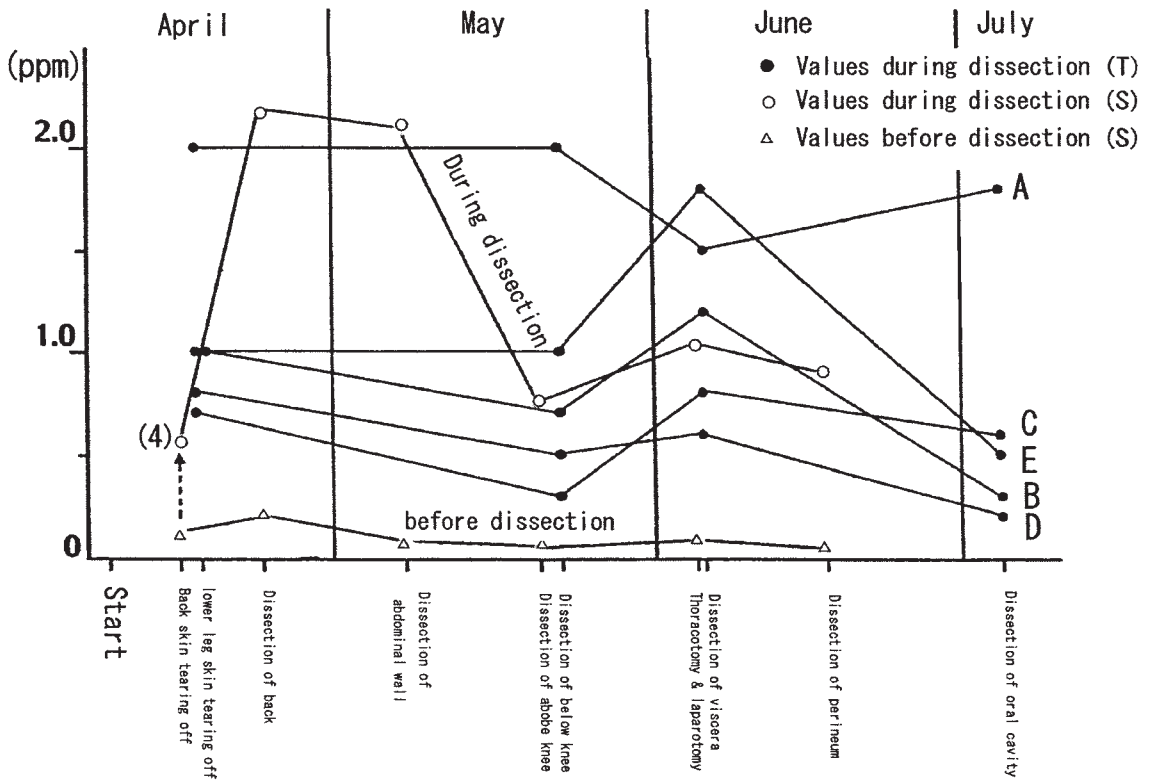

Fig. 6 FA levels in the immediate vicinity of cadavers

Results

Levels of FA in the presence of ethanol (DNPH method)

The FA level in the absence of generated ethanol (0 ppm) was 0.68 ppm, but 0.69 and 0.67 ppm in the presence of 1.1 and 12.1 ppm of ethanol, respectively. The FA levels remained unchanged at an ethanol concentration

range of 0–12.1 ppm .

Levels FA in the cadaver dissection room

Figures 5 and 6 illustrate the daily fluctuations in FA levels in the cadaver dissection room and in the immediate vicinity of the cadaver. Before the start of dissection, the levels of FA in dissection room air and in the immediate vicinity of the cadaver fluctuated below the Health, Labor and Welfare Ministry's guideline level of 0.25 ppm in specified workplaces.

The levels of FA in dissection room air during cadaver dissection work were high, and coincided with the dissection of the skin and the superficial layers during the first and second weeks of the course. Levels measured by the S and T companies were 0.20–1.01 and 0.2–1.0 ppm, respectively. The levels of FA in the dissection room air during cadaver dissection peaked (1.0 ppm) 8 days after the start of cadaver dissection, and then gradually decreased to the guideline level of 0.25 ppm for specified workplaces on and after day 63. The levels of FA in the immediate vicinity of cadavers, which are measured at point (4) by S Company and points A-E by T Company in Fig.1, varied with the numbers of cadavers. The S company found a level of 0.76–2.18 ppm for 1 cadaver undergoing dissection and the T Company found levels of 1.5–2.0, 0.3–1.2, 0.3–0.8, 0.2–0.8 and 0.5–1.8 ppm for 5 cadavers during dissection. These findings confirmed that cadaver skin dissection was associated with an increase in FA evaporation. Overall, the FA levels in dissection room air from first day of cadaver dissection to about the 60th day, and those in the immediate vicinity of the cadaver throughout the period of the course exceeded the guidelines of 0.25 ppm. Thus, the FA levels in the immediate vicinity of the cadaver were about double those in dissection room air. Levels of FA in room air tended to decrease from about 20 days after the course started, but tended to increase again from about day 40 when students began to open the chest and abdomen, indicating the release of FA that had been enclosed in the body cavities. All FA levels after the start of dissection were higher than those beforehand (when cadavers were wrapped in vinyl bags). The daily fluctuations in FA levels around cadavers undergoing dissection and in dissection room air tended to be similar.

Levels of FA around the exterior exhaust opening

The S Company found that levels of FA in the dry area near the exterior exhaust opening ranged from 0.15–0.58 ppm, while those at other sites in the dry area were 0.01–0.48 ppm during cadaver dissection. The T company found similar results during cadaver dissection: 0.1–0.48 ppm around the exhaust opening and 0.1–0.4 ppm at other sites in the dry area.

Phenol levels in the cadaver dissection room

The levels of phenol before the start of cadaver dissection were 0.11–0.38 ppm in room air and 0.15–0.34 ppm in the immediate vicinity of the cadaver. These levels increased during dissection to 0.24–0.49 and 0.88–1.46 ppm, respectively. Throughout the course, levels of phenol in the dissection room fluctuated below 0.5 ppm. On the other hand, levels of phenol in the immediate vicinity of the cadaver at the start of dissection when students mainly dissected the skin and superficial layers fluctuated around 1.0 ppm. However, these levels increased as they began to open the chest and abdomen.

Phenol levels around the exterior exhaust opening

The levels of phenol near the exterior exhaust opening in the outside dry area were below 0.01 ppm before starting dissection, but 0.24–0.43 ppm during dissection. Those at other sites in the dry area were 0.01–0.26 ppm. Unlike the FA levels, the phenol levels did not fluctuate daily, and increased after dissection started under all measurement conditions.

Summary

1. Ethanol

Levels of FA remained unchanged at an ethanol gas concentration range of 0–12.1 ppm. Therefore, the presence of ethanol in the injected fixative and in the storage solutions probably did not influence FA evaporation.

2. Formaldehyde

a) The levels of FA in dissection room air increased (to a maximum of 1.01 ppm) with skin dissection, and then tended to gradually decrease with the progression of dissection.

b) The levels of FA in indoor air during cadaver dissection exceeded the Health, Labor and Welfare Ministry's

guideline level of 0.08 ppm for indoor air throughout the course, and remained above the guideline of 0.25 ppm for specified workplaces until the latter half of the course.

c) The evaporation of FA from the cadaver varied with the state of fixation. The FA levels fluctuated daily, tending to increase at the time of skin dissection (maximum, 2.18 ppm) and of opening the chest and abdomen (maximum, 1.8 ppm). The levels of FA in the immediate vicinity of the cadaver remained at about double those in indoor air, and both levels tended to vary similarly.

d) The maximum FA level in the exterior dry area was 0.58 ppm.

3. Phenol

a) Levels of phenol in dissection room air remained at about 0.5 ppm throughout the course and unlike the FA levels, did not significantly change.

b) Phenol evaporation in the immediate vicinity of the cadaver did not tend to decrease during the latter half of the course like FA, and fluctuated at around 1.0 ppm.

Discussion

The development of chemical hypersensitivity and multiple chemical hypersensitivity due to continuous low-level exposure to minute amounts of chemical substances has recently been questioned[1)~3)7)]. In July 2001, the Ministry of Health, Labor and Welfare designated 11 volatile organic compounds, including FA, as chemical contaminants in indoor air[9)].

The results of the present study suggested that the levels of FA and phenol in the dissection room can be reduced to some extent by properly maintaining and improving the ventilation system. The number of ventilations at our anatomy dissection room (5.5 times per hour) was sufficient to meet the reference values of 3 to 15 for the volume of ventilation required of attached rooms and facilities proposed by the Society of Heating, Air-Conditioning and Sanitary Engineers of Japan[11)]. However, the results also suggested that the amount of evaporation from the cadaver depends on the conditions of individual cadavers (injection fixative, storage solution and duration, and antifungal agents applied during dissection). The levels of FA throughout the course exceeded the guideline levels of 0.3 ppm (the American Conference of Government Industrial Hygienists, ACGIH)[12)] and 0.5 ppm (Japan Society for Occupational Health)[13)] for exposure to FA in the work environment. On the other hand, the Ministry of Health, Labor and Welfare guideline for FA in specified work environments has been established at 0.25 ppm[4)]. The indoor FA levels exceeded this value throughout the dissection course. The Ministry of Health, Labor and Welfare established an upper indoor limit for FA of 0.08 ppm based on the assumption that citizens in general are exposed to FA for long periods in customary environments such as the home, whereas the guideline FA levels in specified work environments assumes limited exposure of workers within a defined period[4)]. Therefore, cadaver dissection at medical and dental universities corresponds to work in a specified environment.

Accurate measurements of the amount of FA evaporation from cadavers requires them to be sealed in bags. The volume of formalin injected into the cadaver varies with body build and weight. Thus, the amount of FA evaporating from the average cadaver at 25°C can be estimated from the maximum FA level in the dissection room and the volume of ventilation as follows:

$M = (C \times Q \times m/V)/N = 3.7 \times 10^2$ (mg/h·body) (Maximum amount of FA evaporation per hour per body),

where C=maximum indoor FA level (1.0 ppm), Q=volume of ventilation per hour (7,200 m^3/h), m=molecular weight of FA (30), V=volume of 1 mol of gas at 25°C and 1 atmospheric pressure (24.4 l), and N=number of cadavers (24).

According to Environmental Health Criterion No.89 of the International Program of Chemical Safety (IPCS), the human health hazards of FA are as follows: ocular and respiratory irritation at 0.8 ppm, and discomfort between 0.08 and 0.24 ppm; aqueous solutions of FA above 2% cause skin sensitization, with long-term exposure resulting in allergic contact dermatitis[10)]. In addition, some concentrations of FA induce nasal and nasopharyngeal tumors and inhibit DNA repair *in vitro*. Thus, the results of the present study indicate that the FA level in the work environment in our cadaver dissection room is above that which causes discomfort.

Recent reports have documented the health hazards of formalin[5)~7)14)~20)]. Takigawa et al. found that the exposure levels of FA and the urinary FA levels of 30 students who dissected cadavers did not correlate[19)]. Mizuki et al.

measured the levels of FA-specific and tick-specific IgE antibody in 90 medical students, and suggested that exposure to FA can aggravate existing allergy[2]. Furthermore, Ohmichi et al. investigated subjective symptoms as cadaver dissection progressed[6]. They found that the levels of FA in dissection room air increased as cadaver dissection progressed, but the ratio (%) of students with subjective symptoms gradually decreased. They speculated that acclimation to the odor resulted in the relief of subjective symptoms. The present study did not investigate the subjective symptoms of students, examine them for allergy, perform biological monitoring, or measure the levels of FA-specific IgE antibody. However, the levels of FA in dissection room air changed with the progression of cadaver dissection in a manner similar to those reported by others.

Tanaka et al. investigated the protective effects of masks and gloves, and reported that more students with a history of allergy noted a protective effect than students with no history of allergy[20]. From this finding, they concluded that motivating students with no history of allergy to wear masks and gloves is difficult. However, certain effects can be expected in students with a history of allergy. At our university, we explain the health hazards of FA to students before the start of cadaver dissection, and nearly all students wear masks and rubber gloves and, if necessary, other protective devices such as goggles.

In addition, we cover cadavers with a vinyl sheet to minimize FA evaporation. Measurements of indoor FA levels before and after cadaver dissection showed that the vinyl sheet was sufficiently effective to prevent FA evaporation. Nevertheless, the levels of indoor FA during most of the dissection course exceeded the Health, Labor and Welfare Ministry's guideline of 0.25 ppm in specified workplaces. Therefore, to reduce FA evaporation during dissection as well when cadavers are not covered with a vinyl sheet, dissection tables should be equipped with a formalin adsorber, walls should be covered with formalin-adsorbing and -degrading paint, and the composition of the injection fixative, cadaver storage solution and anti-drying agent should be reconsidered.

Although the anti-drying solution contains 1% phenol, the timing and volume of its use depend on the circumstances of the cadavers. This presumably produced differences in the daily fluctuations in the phenol levels in dissection room air and in the immediate vicinity of the cadaver.

Since forced ventilation alone merely discharges FA to the outside of the dissection room, it is also necessary to prevent FA release from the viewpoint of minimizing environmental pollution.

At Kyorin University School of Medicine, cremated remains are returned to the family within 2 years of body donation, and the period from fixative injection to the start of cadaver dissection is a maximum of 1 year and 8 months and a minimum of 6 months, with an average of 12 months. Considering the evaporation of FA from cadavers injected with fixative, a shorter period of storage might have been associated with increased FA evaporation. However, the storage period and the degree of FA evaporation did not correlate.

To create a safer and more comfortable dissection environment, the composition of the injection fixative, the cadaver storage and anti-drying solutions should be reconsidered, along with the volume of injection, method and duration of storage[15].

The function of the cadaver dissection room is primarily that of education, but it also has the aspect of industrial health for teaching and technical staff. The Ordinance on Prevention of Hazards due to Specified Chemical Substances has designated FA as a Class 3 specified chemical substance[13], and it is listed as a potentially carcinogenic, sensitizing substance by the Japan Society for Occupational Health[13]. Phenol is also designated as a Class 3 specified chemical substance, and it is listed as a biological exposure index by ACGIH[12]. Business establishments that handle these chemicals are required to strictly manage the work environment and the health of the employees under the Occupational Health and Safety Law.

We consider that unique work environments should be assessed not only in the academic anatomy department, but also on a nationwide scale, by analyzing individual exposure levels and biological monitoring.

Addendum

Kyorin University School of Medicine currently uses antium dioxide as an antifungal agent, and 5% ethanol containing salicylic acid as an anti-drying solution during cadaver dissection, and avoids the use of phenol.

Acknowledgments

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References

1) Cullen MR : Multiple chemical sensitivities : Summary and directions for future investigators. Occup Med 2 : 801—804, 1987.
2) Hukatani M : Result of questionnaire on so-called sick-house syndrome. Japan Medical Journal 3884 : 41—44, 1998.
3) A sectional meeting of Healthy-house related standard, Dept. of living and sanitary, Ministry of Health and Welfare : A report of subcommittee of chemical substance, 1997.
4) Dept. of living and sanitary, Ministry of Health and Welfare : A guideline for indoor level and standard determination of a chemical substance in room air No. 1093, 2000.
5) Mizuki M, Tsuda T : Relationship between atopic factors and physical symptoms induced by gaseous formaldehyde exposure during an anatomical dissection course. Arerugi 50 (1) : 21—28, 2001.
6) Ohmichi K, Matsuno Y, kadota T, et al : Relationship between exposure to formaldehyde and symptoms of irritation during human-dissection course at Chiba University. Kaibogaku zasshi 79 (3) : 95—100, 2004.
7) Wantke F, Focke M, Hemmer W, et al : Exposure to formaldehyde and phenol during an anatomy dissecting course. Sensitizing potency of formaldehyde in medical students. Allergy 55 : 84—87, 2000.
8) Ministry of Education, Culture, Sports, Science and Technology (administrative directive regarding) : Improvement of the environment of gross anatomy dissection for medical and dental students 13—14, 2001.
9) Dept. of living nd sanitary, Ministry of Health and Welfare : A guideline for indoor level and standard determinatin of a chemical substance in room air No.1093, 2000.
10) Chemical Information Bureau, National Institute of Hygiene : Safety evaluation of a chemical substance, International IPCS environmental health criteria abridged translation. 1. Kagaku-kogyo-nipposha, 1995, pp 25—38.
11) Society of heating, Air-conditioning and sanitary engineering of Japan : HASS102 Ventilation requirements for acceptable indoor air quality. Tokyo, Maruzen, 1997. pp 25.
12) ACGIH : Notice of Intended Change-Formaldehyde. Sappl Occup Environ Hyg 7 : 852—874, 1992.
13) Japan Society for Ocucpational Health : Recommendation for occupational exposure limit (2003 ver.), Formaldehyde. JUOEH 46 : 147—157, 2003.
14) Andersen I : Formadehyde Toxicity. Hemisphere Publishing Co., Washington D.C., 1983, pp 154—165.
15) Coleman R : Reducing the levels of formaldehyde exposure in gross anatomy laboratories. Anat Rec 243 : 531—533, 1995.
16) Kunugita N, Nakashima T, Kawamoto T, et al : Exposure to formaldehyde during an anatomy dissecting course. JUOEH 26 (3) : 337—348, 2004.
17) Sasaki A, Tanaka K, Maeda T, et al : Exposure to Formalin in an anatomy dissecting course of medical students. J Natl Inst Public Health 52 : 64—69, 2003.
18) Stroup NE, Blair A, Erikson GE : Brain cancer and other causes of death in anatomists. J Natl Cancer Inst 77 : 1217—1224, 1986.
19) Takigawa T, Usami M, Yamasaki Y, et al : Reduction of indoor formaldehyde concentrations and subjective symptoms in a gross anatomy laboratory. Bull Environ Contam Toxicol 74 (6) : 1027—1033, 2005.
20) Tanaka K, Nishiyama K, Yaginuma H, et al : Formaldehyde exposure levels and exposure control measures during an anatomy dissection course. Kaibogaku Zasshi 78 : 43—51, 2003.

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解剖学実習室における空気中化学物質濃度の実測結果とその対策

白石 尚基

杏林大学医学部解剖学

—キーワード—
ホルムアルデヒド，フェノール，厚生労働省特殊作業環境下ガイドライン

従来，医歯系大学の解剖学実習では，遺体保存の目的でホルムアルデヒドが用いられている．しかし，ホルムアルデヒドはシックビルディング/ハウス症候群の原因物質とされ，その取り扱いや防護には注意が必要であるとされている．

今回著者らは，杏林大学での平成14年度解剖体実習において，解剖学実習室内空気中におけるホルムアルデヒド濃度およびフェノール濃度を実測した．サンプリングは月2回行い，実習の進行に伴うホルムアルデヒドとフェノール濃度の変化を測定した．サンプリング時間帯は実習開始約30分後とし，計測は厚生労働省の測定方法に準拠した．

その結果，実習遺体からの蒸散ホルムアルデヒド濃度が高い程，室内ホルムアルデヒド濃度が高値を示す傾向がみられた．実習室内のホルムアルデヒド濃度は実習初期に高く，実習の進行と共に低下したが，実習最終日を除く全測定日で厚生労働省特定作業場のガイドライン値0.25ppmを上回った．

ホルムアルデヒド濃度がガイドライン値以下に低減されない理由として，遺体から蒸散するホルムアルデヒドが一因と考えられ，より一層のホルムアルデヒド濃度低減対策の必要性が示唆された．