

[Original]

## A Study on Halitosis and Ward-stench of Severely Handicapped Patients.

### 1. Examination of Sampling and Analytical Method

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#### Abstract

A characteristic stench or odour in a ward for the mentally and physically handicapped persons which is one of the problems that require environmental improvement. It was found that it could be reduced by the care of oral conditions of the subjects.

To prove this, the method of sampling and analysis of the stench of the expired air of the patients and ward odour of the institution was examined.

1) To collect the expired air, a vacuum jar connected with a teflon mouth piece was most effective for the non-co-operative patients.

2) Both the expired air and the ward odour collected in the vacuum jar or TEDLAR bag were analyzed with GLC-FPD after concentration under  $-183^{\circ}\text{C}$  and instantaneous vaporization.

3) The retention time of peaks and the pattern of the chromatogram from certain expired air samples of the subjects and the ward odour were quite similar, suggesting a close relationship between both stenches.

**Key words** : Handicapped person, sampling, GLC analysis, expired air, ward air

#### Introduction

A characteristic stench in the ward of an institution for the severely handicapped patients were assumed to arise from halitosis of unhealthy oral cavity and the untreat-

ed dental diseases of the subjects.

We have co-operated with the staff of an institution in Sapporo in a dental-care program for several years. The guidance of the tooth-brushing after meals and complete treatment for the dental caries or periodontal diseases, and conservative treatment of the tooth crown under the general anesthesia was conducted. The improvement of the periodontal condition with the calculus-removing or the gingivectomy for the inflamed or proliferated gingiva, and the extraction of the severely decayed tooth were also conducted. These dental treatment improved the halitosis of the mentally handicapped person and reduced the stench of the ward of the institution.

The reduction of the stench in the ward was noticed by the staff of this institution and visitors. These results had a strong bearing on the personnel of the institute to complete our dental care program, and obtained favorable effects for the administration of the handicapped person after the dental treatments.

Since the proper dental-care for the severely handicapped inmates cured halitosis, and diminished the stench in the ward, we attempted to analyze the odour or stench substances both in the expired breath and the ward air with the gas-liquid chromatography.

There are several studies of the stench substances from the halitotic expired air with the gas-liquid chromatographic analysis<sup>1~11)</sup> by the periodontologists. The analytical methods for the air pollution are also developed by public hygienists to prevent related pollutions. We studied the patient breath and the ward air from the severely handicapped patients with the gas-liquid chromatography with regard to the aforesaid problems.

### Method

#### 1) Sampling of breath and the ward air

The breath air and the ward air were collected with the 2 or 5 l of the sampling bag connected to an air-pump or the 1 l sampling vacuum jar. Two types of the sampling inlet of the bag was used for expired air collecting. The suction tube connected to air-pump was directly inserted into the mouth of the supine patients if the patient was co-operative and could hold his mouth open (Fig. 1). The anesthetic mask connected to the air-pump and the sampling bags was lightly attached to the mouth of other patients who had difficulties (Fig. 2).

The sampling of the ward air was done by the same method in the ward hall which is used as the living space and training area for the inmates.

The used sampling vacuum jars were shown in Fig. 3. The cloth-covered 1 l jars were mainly used to avoid injuries and for easy handling.

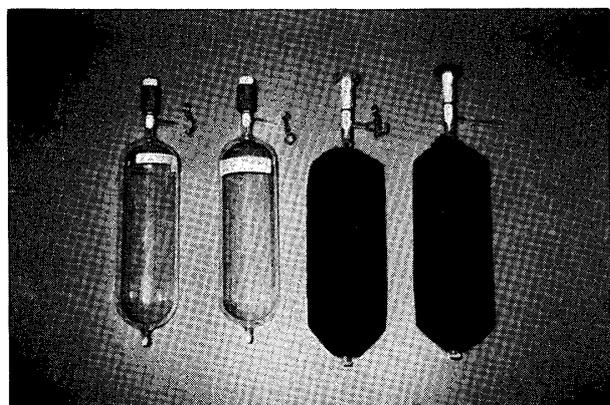
The sampling vacuum jar was prepared to reduce the pressure to 740 mm Hg with vacuum pump. A teflon tube was connected to the inlet of the jar to maintain suction to avoid biting (Fig. 4). The expired air is instantaneously collected by this jar by



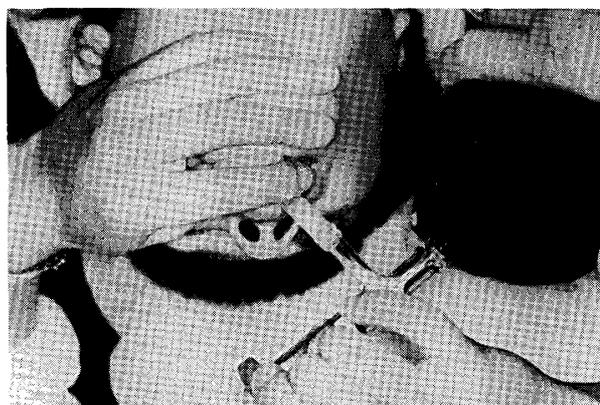
**Fig. 1** Sampling of the expired air from handicapped persons by inserting the suction tube of the air pump directly into the mouth of the handicapped person.



**Fig. 2** Sampling of the breath air holding the anesthetic mask at the handicapped person's mouth. The breath air was suctioned with an air pump.



**Fig. 3** The vacuum sampling jars for collecting the expired air and the ward air.



**Fig. 4** The expired air was collected in the vacuum sampling jar. The handicapped person was allowed to the supine and the inlet of the jar was inserted into his mouth.

the opening of the stopcock of the jar.

## 2) Concentration of the stench substances

The collected air samples were concentrated with the concentration apparatus for the stench substances (Fig. 5, 6).

The stench substances in the bag or the jar were suctioned into a U-shaped concentration tube and refrigerated to  $-183^{\circ}\text{C}$  with liquid oxygen via the vacuum pump. This suction is continued for 30 min. to 740 mm Hg. The suctioned jars used to collect samples again.

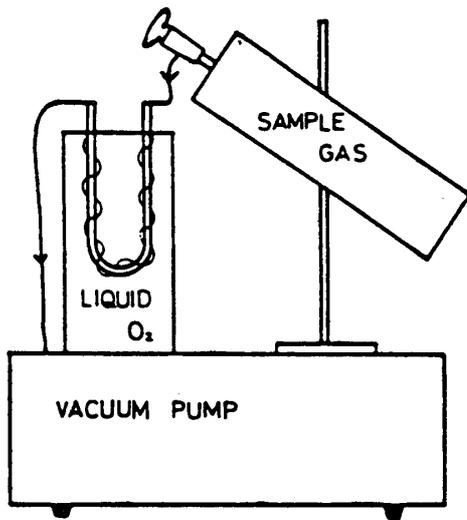


Fig. 5 The schematic diagram of the concentration of the stench substances. The substances were cooled and trapped in the U-shaped concentration tube immersed in liquid oxygen, suctioned from the vacuum sampling jar with a vacuum pump.

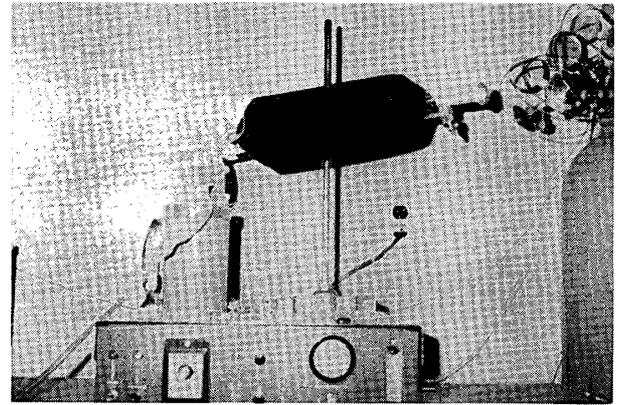


Fig. 6 The apparatus for concentration.

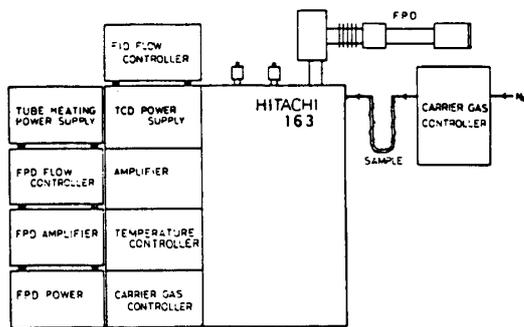


Fig. 7 The schematic diagram of GLC-FPD.

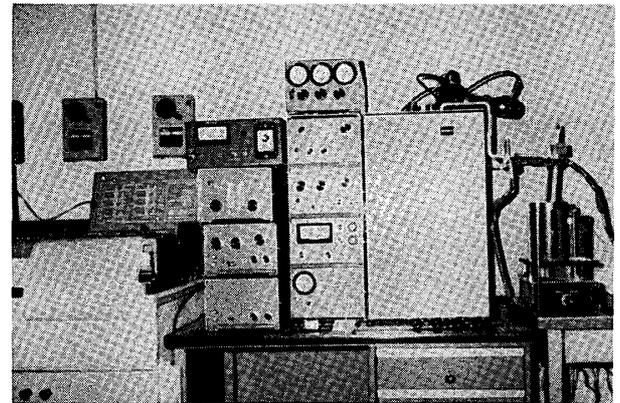


Fig. 8 The apparatus for GLC-FPD.

### 3) Analysis of stench substances

The concentrated samples in the U-shaped tube were analyzed with the gas-liquid chromatography (GLC) attached to a flame photometric detector (FPD) (Fig. 7, 8).

The U-shaped tube refrigerated in liquid oxygen is connected to the inlet of GLC column through which the carrier gas ( $N_2$ ) was allowed to flow.

The refrigerated and retained substances were instantaneously vaporized by heating up to  $160^\circ C$  within 2 minutes with a heater rolled on the U-shaped tube at the same time to remove the liquid oxygen. The substances separated with GLC column were detected with FPD and recorded.

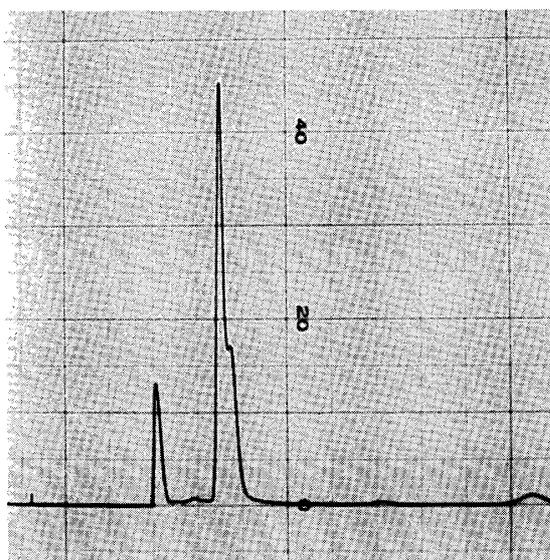
These conditions for analysis are shown in Table 1.

**Table 1** Analytical conditions

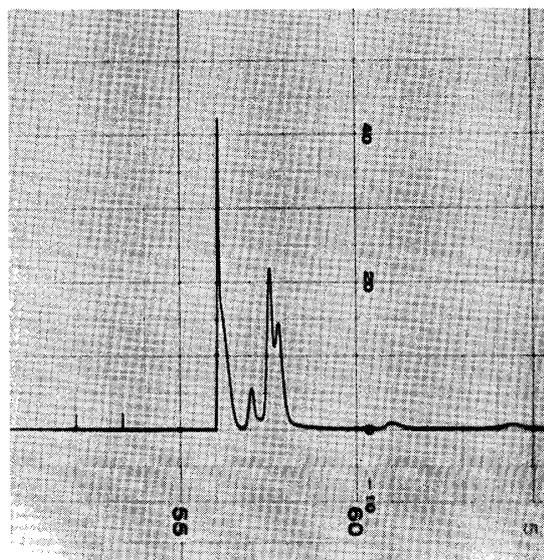
Carrier gas	30ml/min
Flow rate	
H <sub>2</sub>	80ml/min
O <sub>2</sub>	20ml/min
N <sub>2</sub>	50ml/min
Chart speed	10mm/min
Sensitivity	64×10 <sup>3</sup>
Apparatus	HITACHI 163
Detector	FPD (Filter S. 397nm)
Temperature Column	70° C
Injection	130° C
Used Column	5 % Polyphenylether on Chromosorb W. AW (DMCS) (80/100)mesh 3. φ 6 m (teflon)

### Results

The chromatograms of some experiments are shown in Fig. 9—12. The heating time of U-shaped tube is marked at 2 mm height on the recording paper as a starting



**Fig. 9** A chromatogram of the air of the ward hall collected with a 5 l TEDLAR bag connected to air pump.



**Fig. 10** A chromatogram of an expired air collected with a 5 l TEDLAR bag connected to the air pump.

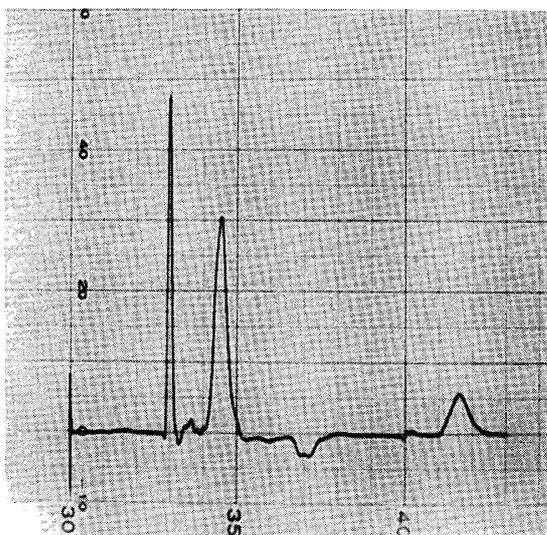


Fig. 11 A chromatogram of an expired air collected with a 1 l vacuum sampling jar.

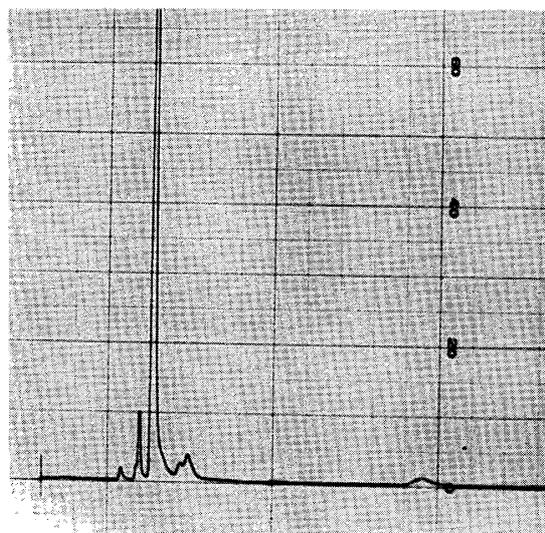


Fig. 12 A chromatogram of the air of the ward hall collected with a 1 l vacuum sampling jar.

point of the chromatogram. The chart speed of the record was 10mm/min. The retention time of the detected substances is read from these charts.

Fig. 9 shows the results of the air from the ward hall with 5 l sampling bag connected to the air pump. Remarkable peaks found at 2 min. 50 sec. and 5 min. after the heating of concentration tube. The traces of peaks are also found at 4, 5, 7, 11 min. Fig. 10 is a chromatogram of the expired air of a patient collected with the same method and analyzed under the same conditions. The obtained results show the resembling main peaks of the same retention time which suggests the relationship between halitosis and the stench in the ward hall. Fig. 11 and 12 are expired air and the ward air collected with 1 l vacuum jar. There is some difference in the peak pattern causing the difference of the content ratio.

These results suggest the relationship between halitosis and the ward stench.

### Discussion

The aims of this study are as follows ;

- 1) To establish an effective method or apparatus to collect samples from severely handicapped inmates.
- 2) To examine the sampling method from the ward where the inmates spend most of their time.
- 3) To examine the concentration method for the stench of the expired air or the ward air which has a relatively low concentration as the source of the stench.

4) To examine the analytical method for the stench substance from the expired air or ward air.

Our discussion follows these problems.

Many methods to collect the offensive stench odours are proposed and practised with various samples. The filter paper method or solvent absorption method are, for example, used by the public hygienists but these are not applicable for the analysis of our samples. The expired air donors are 1) severely handicapped persons, 2) hampered from living daily or social life to various extents, 3) lack of understanding of our communication and difficulty to carry out time consuming sampling. 4) The inmates sometimes show unexpected movement or suddenly close their mouth. We selected the sampling method in consideration to these conditions of the patients.

Aoki,<sup>5)</sup> Tsunoda,<sup>7,10)</sup> Kaizu<sup>8,11)</sup> analyzed the expired air with the direct introduction into GLC column without adsorbents. We chose the plastic sampling bag and the glass sampling jar. Many kinds of sampling bags of various size and make of various materials are available. We used the Tedlar bag (GASKRO KOGYO Co., Ltd.) which is made of polyvinyl fluoride film, one of the excellent water-proof and chemically stable material. They have it that the material has the least absorbability and permeability to gas.

For quick sampling of expired air, 1 l vacuum jars with the stopcocks were also effective. The sampling jar made by Hitachi covered with a protective case was better for our purpose. An air pump for breeding tank of tropical fish was used to collect the stench into the Tedlar bag. The teflon tube as a mouth piece was inserted directly into the mouth of patient who could hold his mouth open voluntarily to collect expired air samples. The anesthetic mask was lightly attached to the patients who were uncooperative. The sampling with the vacuum jar was much easier than with the bag. The teflon tube connected to the vacuum jar was considered safer to the mouth of the patient and the maintenance of the air-way if he should bite or gnash his teeth.

This was prepared to reduce the pressure to 740 mm Hg. The teflon tubing mouth piece was inserted into mouth of the patient and expired air was collected instantaneously with the stop-cock open. The expired air samples were collected from the patients who were judged to have halitosis by two dentists and two nurses. The sample of the ward air was collected at appropriate places in the ward by the same methods.

Kaizu<sup>8)</sup> suggested that the volatile sulfur-containing compounds such as methylmercaptane were presumed to be the main source of halitosis. Because the main stench substances are sulfur-containing and highly sensitive to the detection with FPD, we used GLC with FPD. The direct application to GLC of the expired air or ward air gave rise to the necessity of increasing the sensitivity and to increase of the interference of noise. Then concentration of the stench substances is necessary for the

clear identification and determination with GLC. We chose the concentration procedure with the decomposition and concentration apparatus for the stench samples (Hitachi 003-1581) trapping with the U-shaped tube under the refrigeration with liquid oxygen. Heating of the concentration tube from  $-183^{\circ}\text{C}$  up to  $160^{\circ}\text{C}$  was instantaneously done with the heating wire rolled on the concentration tube for the vaporization and the application of the concentrated sample to the GLC column.

The concentrated sample was measurable under the conditions noted in the Table 1.

The details of the natures and the identification of the analyzed samples will be discussed in the following paper.

### Conclusion

The sampling method for expired air of severely handicapped patients and ward air were described. The concentration method of the stench substances and the analytical method of those substances were examined and appropriate conditions were set forth.

1) The expired air from severely handicapped patients in an institute were collected with Tedlar bags (2 l or 5 l) or the vacuum sampling jar (1 l). The vacuum sampling jar was especially effective for the sampling from the non-co-operative severely handicapped patients.

2) A sufficient amount of ward air was collected with the Tedlar bag connected to the air pump. The use of the vacuum sampling jar was more effective for quantitative analysis.

3) The collected stench substances were analyzed with GLC-FPD after concentration with the decomposition and concentration apparatus for stench substances (Hitachi)

4) The chromatographic data from the expired air and the ward air were quite similar in composition. The results suggest the relationship between the stench of the patient expired air and the stench of the ward.

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## 重症心身障害者の口臭と施設臭に関する研究

### 1. 採取法と分析法について

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### 抄 録

重症心身障害者施設の問題の一つに施設特有の臭気があるが、これは口腔内の重症な歯科疾患を改善することによって減少させることが可能と思われる。そこで我々は施設入所者の口臭と施設内臭気の採取法、濃縮法、分析法について検討した。その結果次のことが明らかとなった。

- 1) 非協力的な重症の障害者からの口臭採取には、テフロン製の吸引口が付いた真空採集ビン (Vacuum jar) が最も効果的であった。
- 2) 真空採集ビン (Vacuum jar) やテドラーバックで採取した臭気を  $-183^{\circ}\text{C}$  で濃縮した後、瞬時に気化させることによって、ガスクロマトグラフで分析することが可能であった。
- 3) 口臭および施設臭気のガスクロマトグラフによる分析では、カラム内の物質の保持時間や波形が非常に類似しており、両者間に強い相関性のあることが示唆された。