

APPLICATION OF THE IMD IN MEASUREMENT OF AIRBORNE MICROBIAL PARTICLES

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ABSTRACT

Traditional method for measuring airborne microbes is based on two procedures called sampling and incubation. Sampling normally involves drawing a sampler from an air stream or room by means of instruments based on 3 type's collecting-method, which named impaction, liquid impingement and filtration. Incubation of agar plates typically requires several days. Though the traditional methods can identify the species of microorganisms, they can't obtain any information about suspended viable particles in real time.

Recently, outbreaks of microbial infections and measures of bioterrorism have been the subject of social attention. The technology for real time detection of the presence of suspended viable particles was developed. In order to verify the performance of a new type measurement IMD (Instantaneous Microbial Detection, Bio Vigilant, Inc.), which is used to measure the concentrations of suspended particles with different size distribution based on optical technology and can simultaneously determine whether each particle is inert or biologic in real time, measurements on airborne microbes in six hospital waiting rooms located in Tokyo area were conducted by using parallel an IMD and MG sampler (culture-based, slit type, Mattson-Garvin Inc.).

Significant correlations between suspended bacterial concentration and biological particle concentration were obtained. The measurement results pointed out that the IMD can measure the fluctuation patterns of suspended biological particles in field environments in real time.

KEYWORDS

Indoor air environment, Airborne microbes, Suspended biological particles, Real-time detection

INTRODUCTION

Various technologies for the detection and identification of biological agents are available today, but the number of agents that can be detected are limited [1]. Air sampling normally involves drawing a sampler from an air stream or room by means of equipments based on 3 type's collecting-method, which named impaction, liquid impingement and filtration. Incubation of agar plates typically requires several days. Though the traditional methods can identify the species of microbes, they can't obtain any information about suspended viable particles in real time.

In medical facilities, real-time detection of airborne microbes is especially important to control appropriately environment contaminated by microorganisms indoors. Though the IMD (Instantaneous Microbial Detection) was developed, it is not shown clearly whether application in field environments is possible.

This paper reports the measurement results obtained by using parallel an IMD and MG air sampler (culture-based, slit type, Mattson-Garvin Inc.) in six hospital waiting rooms.

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METHODS

Measurement instruments description

Two type's measurement instruments, IMD and MG air sampler were used in this study. An IMD consists of three components: (1) an optical assembly to measure individual particle size; (2) a concurrent optical assembly to detect a UV laser-induced fluorescence signal from certain metabolites inside microbial cells and spores; and (3) an algorithm for differentiating airborne microbes from inert particles. By use of UV light illumination to concurrently examine each particle for the presence of the metabolites NADH and riboflavin, which are necessary intermediates for metabolism of living organism, and therefore exist in microbes such as bacteria and fungi. A MG air sampler consists of a height adjustment for the three prong sample holder, a 60 minute timer, an SCFH air gauge and a clear dome.

Object waiting rooms description

Table1 shows the outline of object hospitals. **Table2** shows the air conditioning system of surveyed waiting room.

Table 1 Outline of surveyed hospitals

Hospital	Location	Aera [m ²]	Number of beds
A	Minatoku	28,549	535
C	Wakoshi	24,426	350
E	Oumeshi	3,732	120
F	Hitachishi	58,196	563
G	Osakashi	30,288	487
I	Morikuchishi	29,123	359

Table 2 Air conditioning system

Hospital	Air conditioning system ¹⁾	Air filter efficiency ²⁾		Operating time
		Front	Rear	
A	AHU+duct	70%	-	6:30-17:30
C	FCU	-	-	7:00-17:00
E	FCU	-	-	24h
F	AHU+duct+FCU	-	90%	24h
G	AHU	-	-	7:00-19:00
I	AHU+duct+FCU	70%	90%	7:00-16:45

1) AHU: Air-handing unit, OAHU: AHU for outdoor air, FCU: Fan coil unit

2) Front stage: Weight method, Rear stage: Dust spot method

Measurement procedures

In the period of 10:00 to 16:00, continuation measurements of the airborne bacteria by using a MG air sampler and 1-minute interval continuation measurement of the suspended particles, biological particles by using an IMD were conducted. SCDA (Soybean Casein Digest Agar) culture media were used in this study and SCDA were incubated 48 hours at 32 °C.

RESULTS AND DISCUSSIONS

Suspended biological particle concentration vs. elapsed time

Figure 1 shows concentrations of suspended bacteria and biological particles by a MG air sampler and IMD respectively in each hospital. The concentrations of bacteria were obtained from 5-minute intervals' colony forming units on SCDAs. Moreover, in order to compare with suspended bacteria concentrations, the average values for each 5 minute are also shown in Figure 1.

Generally, the fluctuation patterns of concentration vs. elapsed time obtained from both measuring instruments as shown in Figure 1 were similar. In the hospitals except Hospital G, significant correlations between suspended bacteria concentration and biological particle concentration were obtained ($p < 0.01$).

The measurement results mentioned above pointed out that the IMD can measure the fluctuation patterns of suspended biological particles in field environment in real time.

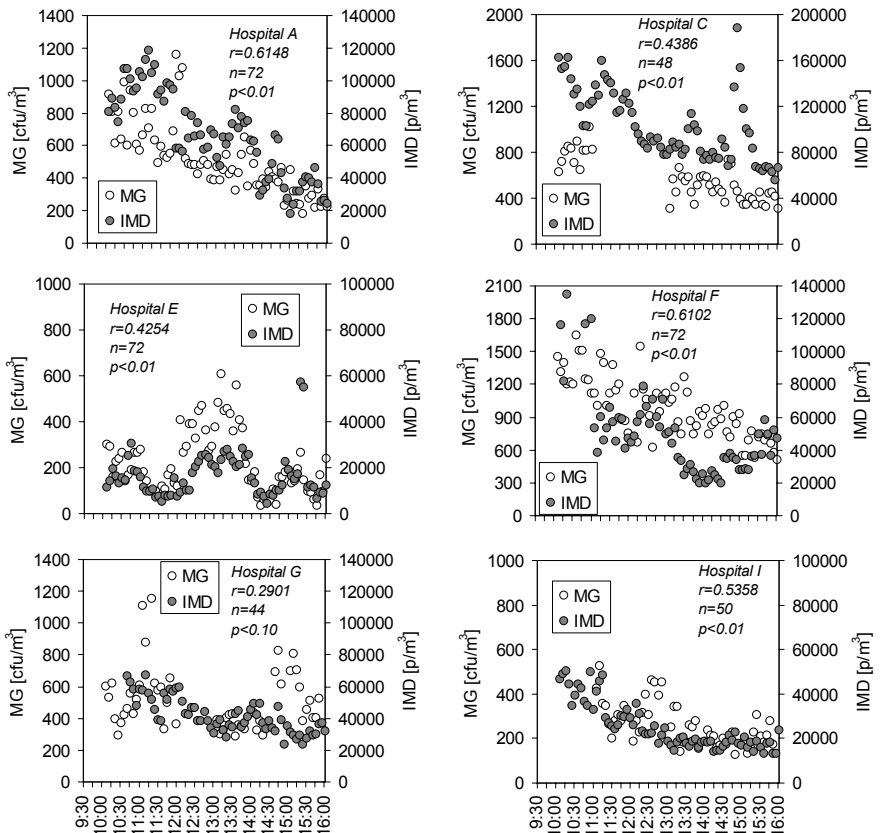


Figure 1 Suspended bacteria concentration and biological particle concentration vs. elapsed time

Size distribution of suspended particle and biological particles

As an example, the size distributions of suspended particles and biological particles at 11:00 and 15:00 in Hospital A are shown in **Figure 2**. Many large particles were detected in 11:00 with comparatively high suspended bacteria concentration. On the other hand, at 15:00 with comparatively low suspended bacteria concentration, there were few large particles. Moreover, Figure 2 also shows that most particles larger than 10 μm are biological particles.

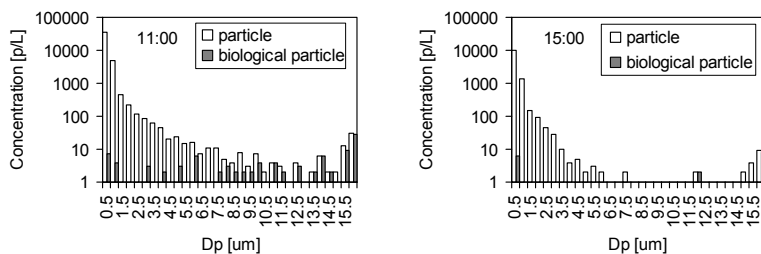


Figure 2 Size distributions of suspended particle and biological particles

Relationship between suspended particles and biological particles

Table 3 shows the correlation coefficients between suspended particle and biological particle with size of $\geq 1 \mu\text{m}$, $\geq 2\mu\text{m}$, $\geq 5 \mu\text{m}$, and $\geq 10 \mu\text{m}$. Except Hospital E with $\geq 1 \mu\text{m}$ and $\geq 2\mu\text{m}$, significant correlations were obtained ($p < 0.01$). Moreover, the larger the particle size, the more the biological particles.

Table 3 Correlation coefficients between particle and biological particle

Hospital	$D_p \geq 1\mu\text{m}$	$D_p \geq 2\mu\text{m}$	$D_p \geq 5\mu\text{m}$	$D_p \geq 10\mu\text{m}$
A	0.7184	0.7863	0.9407	0.9575
C	0.6314	0.7748	0.9232	0.9593
E	-0.0066	0.2084	0.8010	0.9393
F	0.8063	0.9339	0.9433	0.9287
G	0.4325	0.7854	0.8768	0.9312
I	0.6209	0.8125	0.8802	0.9475

CONCLUSIONS

From the results of field measurements on suspended particle, biological particle, and bacteria in six hospital waiting, the following matters were clarified.

Significant correlations between suspended bacterial and biological particle were obtained. The measurement results pointed out that the IMD can measure the fluctuation patterns of suspended biological particles in field environments in real time.

REFERENCES

1. Wladyslaw Ian Kowalski. (2002) "Immune Building System Technology", McGraw-Hill