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A portable sampler (PARTRAP FA 52) for microbiological evaluation of airborne particles: comparison with standard sedimetric and volumetric methods in haemodialysis rooms

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Abstract - Experiments for microbiological evaluation of airborne particles were led in two haemodialysis rooms at the beginning and at the end of activity time (6 h). The efficiency of a new personal and portable aerobiological sampler in comparison with a fixed sampler and a traditional sedimetric method was evaluate. The personal and portable sampler allowed a good evaluation of concentration of bacteria and fungi per cubic metres of sampled air. Since its aspiration flow is equal to Minute Ventilation of an adult; this device provides a quantification of inhaled particles. We propose this device for evaluating the risk for patients and sanitary operators, for monitoring air quality and in implementing adequate environmental prophylaxis and for other applications, e.g. environmental applications.

Key words: microbes, haemodialysis, volumetric sampling, sedimetric sampling, aerobiological evaluation.

INTRODUCTION

The amount of air suspended microbes inside nosocomial closed environments is expression of indoor air quality (Weber and Rutala, 1997) but it seems not related with increasing of nosocomial infections even in high risk zones such as operating rooms (Dharan and Pittet, 2002).

Besides as far as nosocomial infections of the respiratory tract and notably pneumonia are concerned, only for some mycetes such as *Aspergillus* a relation between air suspended mycetes and the incidence of lung mycosis has been observed (Alberti *et al.*, 2001) but a tight relation between the amount of air suspended aspergilli and aspergillar illness was not found (VandenBergh *et al.*, 1999).

As far as healthcare workers procedures are concerned, numerous guidelines have been issued (Garner and Favero, 1985; Larson, 1995; Garner, 1996) and the infection incidence seems often related to the absence or unsound application of the rules. However, despite a lack of evidence-based on the correlation between air quality and pneumonia, it seems to be likely that a high amount of microbes or mycetes inhaled by patients would increase the risk to contract pneumonia.

In the available studies, traditional sedimetric methods or volumetric methods, such as the Andersen apparatus (Andersen, 1958), were usually employed (Haas *et al.*, 2002; Lee *et al.*, 2004): nevertheless such samples are not representative of microbic charge suspended in the proximity of mouth and nose of patient because of the large dimensions of such devices.

In order to define in a realistic way the infectious environmental risk, the volumetric evaluation could be performed using an aspiration rate close to the normal lung ventilation of adult humans at rest (10 L/min).

A new airborne particles personal sampler, PARTRAP FA 52 (Coppa, Biella, Italy) allows indoor and outdoor sampling of airborne particles (as others portable samplers do), but it is also useful in close proximity to the person, at about 10-20 cm from his mouth and nose. This instrument processes 10 litres of air per minute; this airflow aspiration is similar to Minute Ventilation (MV) of a healthy adult subject at rest (Fiorina, 1998; Fiorina *et al.*, 1999, 2000).

We performed an aerobiological evaluation in a hospital unit (haemodialysis rooms) using this personal and portable volumetric sampler. The aim was to compare the results obtained using PARTRAP FA 52 with those obtained with a traditional sedimetric method and a standard fixed volumetric apparatus (Sartorius).

MATERIALS AND METHODS

Setting. Aerobiological samplings were carried out in two haemodialysis rooms (Fig. 1). The dimensions of the rooms were 14 x 7 x 3,30 m and 10 x 6 x 3,30 m respectively. The temperature inside the rooms was maintained constant at 24 °C, and the relative humidity was 65%. Each room contained 10 beds employed for haemodialysis purpose. Sampling was performed before a new haemodialysis cycle after

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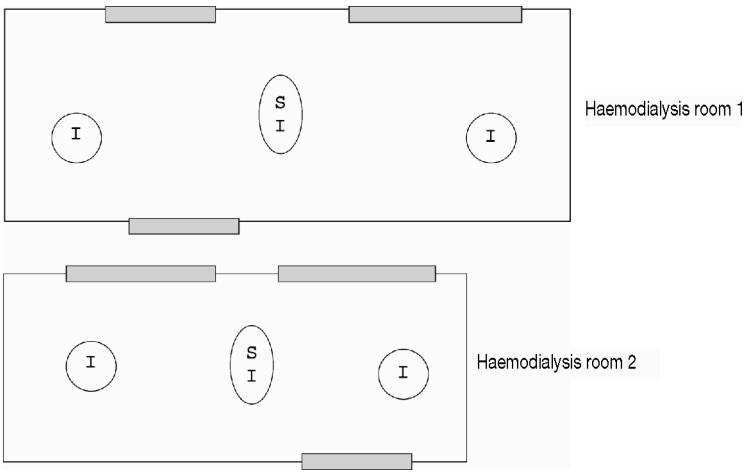

FIG. 1 – Haemodialysis room plants and sampling sites: I on the right, II on the centre, III on the left, S with Sartorius on the room centre.

having cleaned, aired the room, and disinfected the floors with sodium hypochlorite solution and at the end of the day. The experiments were led in the presence of 6 patients and 4 health-care workers, therefore 10 persons were involved in each sampling session. The total sampling time exposition for all methods was 60 min for each room, as this time emerged as optimal after many sampling tests conducted before the beginning of the study. The volumetric samplers ventilated 600 litres of air per hour.

Sampling devices. Three different aerobiological sampling methods were simultaneously used in haemodialysis rooms (Fig. 1), as follows:
the PARTRAP FA 52, patented in USA, Canada, Europe, made by Coppa, Biella, Italy (Fig. 2) is a noiseless, compact (external size: 18 x 9 x 4 cm), low weight (about 500 gr.) airborne particle personal sampler equipped with a particular sampling chamber. This instrument is useful in sampling airborne particles of organic or inorganic origin (pollens, bacteria, moulds, dust, etc.) ranging in size between 1 and 150 microns in diameter. It has an airborne particle capture rate of about 90 ± 5%. The sampling chamber (Fig. 3) allows the tra p-ping of atmospheric particles directly on a Petri dish in which a sterilized culture medium was previously inserted for microbiologic research. This instrument possesses constant aspiration airflow of 10 L/min (0.000167 m^3/s). This fixed airflow sampling is equivalent to the amount of air ventilated during quiet respiration by a healthy adult subject (Minute Ventilation, MV) and is equal to the International Standard used in Aerobiological volumetric studies, also employed with Hirst instruments (Fiorina *et al.*, 1997). It is equipped with an electric engine (direct current at 12 Volts) working at fixed velocity (11000 revolutions per min); low energy consumption, due to good efficiency of the engine, it permits continual aspiration for about 14 h.

PARTRAP FA 52 was located on the bedside table of three beds located on the right, on the left and in the centre of each room: the distance from the mouth/nose of the patient was about 50 cm. The device was equipped with an appropriate sampling chamber containing a 7.5 cm Petri dish with Mueller Hinton agar or alternatively Sabouraud agar for mycetes. Mueller Hinton agar is used for susceptibility testing of

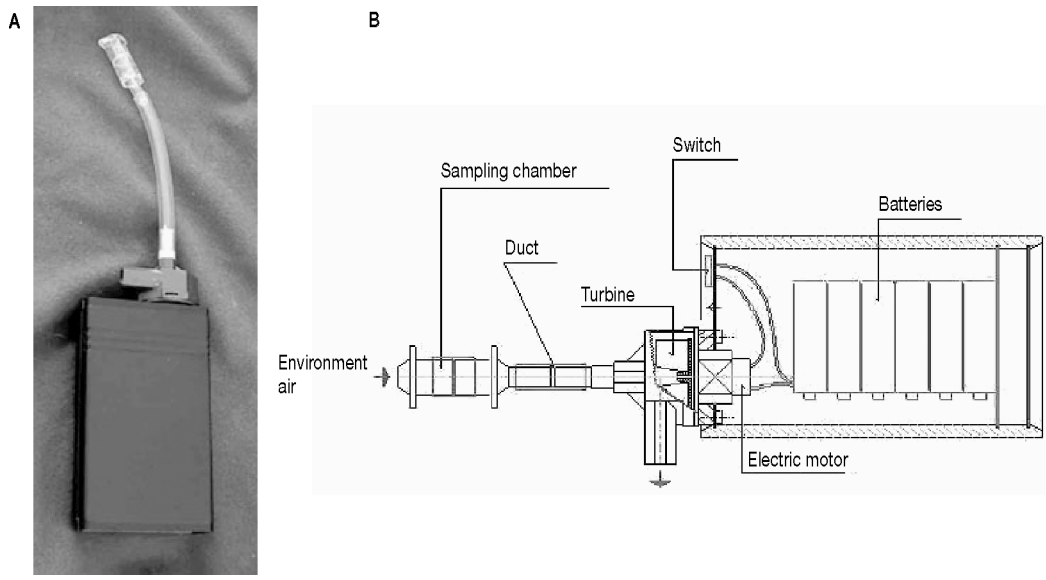

FIG. 2 – A: the "PARTRAP FA 52" Personal Aerobiological Particulate Sampler; B: details.

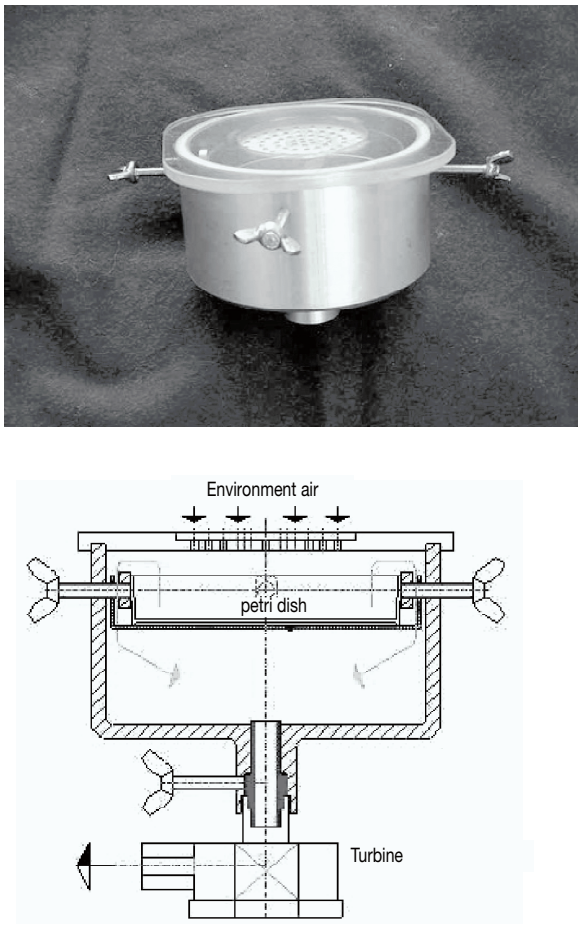

FIG. 3 – A: Sampling chamber used to capture bacteria and fungi in direct culture medium in a Petri dish; B: details.

pathogen Bacteria as standardized by the National Committee for Clinical Laboratory Standards (NCCLS, 2000). The sampling chamber was sterilised by immersion in Cidex (glutaraldehyde 1%, Sigma-Aldrich, Italy) for 20 min, before inserting the Petri dish (Martin and Recheldorfer, 1994; Russel, 1994). Sampling was carried out for one hour with no air movements (doors and windows closed).

The sedimetric aerobiological method consisted in exposing 7.5 cm diameter Petri dishes with Mueller Hinton agar and Sabouraud agar to the room air in three different predetermined sites in the two haemodialysis rooms. Sedimetric exposure was carried out in the identical experimental conditions employed for the PARTRAP FA 52 and at the same time.

The control for the volumetric sampling Sartorius apparatus was set at an aspiration rate of 10 L/min. This fixed device was located in the centre of the two rooms used for haemodialysis. Aspiration was carried out for one hour in still air (with closed doors and windows). The Sartorius membrane was then removed in sterility conditions and layed on Petri dish with Mueller Hinton agar or alternatively Sabouraud agar. Sampling was carried out in the identical experimental conditions employed for the PARTRAP FA 52 and at the same time.

Petri dishes with Mueller Hinton agar and Sabouraud agar were incubated at 37 °C for 24 h (bacteria) and 48 h (mycetes).

Bacteria and mycetes identification. Mueller Hinton agar allows the growth of a wide number of species which will be afterwards identified by isolation in selective mediums and by biochemical tests following NCCLS guidelines (2000). The selective media used to cultivate bacteria were: Mueller-Hinton, Columbia blood and Mac Conkey agar.

Staphylococcus spp. and *Streptococcus* spp. were identified by using automatic tools such as Vitek (Biomerieux, Italia); *Sarcina* sp. and *Bacteroides* spp. by using API galleries (Biomerieux, Italia); *Corinebacteria, Cladosporium* sp., *Aerobasidium* sp., *Mucor* sp. and *Penicillium* sp. by using optical microscopy.

RESULTS

Counts of airborne bacteria and mycetes collected after 60 min, in the two rooms respectively at the beginning and at the end of haemodialysis are reported in Table 1.

TABLE 1 – Bacterial charge at the beginning and at the end of hemodialysis

Sampling method	Bacteria				Mycetes			
	At the beginning		After 60 min		At the beginning		After 60 min	
	1st Room	2nd Room	1st Room	2nd Room	1st Room	2nd Room	1st Room	2nd Room
PARTRAP FA 52 (CFU/MC)								
Right position	16	13	18	44	12	19	31	18
Centre position	15	15	28	53	19	2	25	10
Left position	10	25	29	31	19	9	14	22
Total	41	53	75	128	50	30	70	40
Sartorius method (CFU/MC)								
Centre position	14	13	30	54	21	3	23	9
Sedimetric method (CFU/h)								
Right position	2	2	10	3	0	4	5	1
Centre position	3	3	14	5	1	0	3	2
Left position	2	1	6	4	0	4	2	2
Total	7	6	30	12	1	8	10	5

At the beginning of haemodialysis the registered values were in the range considered "very low" from the European Concerted Action (Commission of European Communities, 1993), while after 60 min it can be noted a tendency to increase of the values even remaining in the range considered "very low".

The aerobiological sampling in the two haemodialysis rooms, showed the following bacteria and moulds: *Staphylococcus* spp., *Streptococcus* spp., *Sarcina* sp., *Bacteroides* spp., *Corinebacteria, Cladosporium* sp., *Aerobasidium* sp., *Mucor* sp., *Penicillium* sp.

Values of bacterial and mycetes charge registered with PARTRAP FA 52 method resulted higher than those recorded with sedimetric method.

Apparently, there was not a relation between samples obtained at the same times with PARTRAP FA 52 method and sedimetric method. On the other hand, samples obtained in the centre of each room with both PARTRAP FA 52 and Sartorius method resulted very similar.

DISCUSSION

The control of microbiological airborne contamination in high risk hospital departments would be useful to prevent respiratory nosocomial infections. Unfortunately a correlation between air suspended microorganisms and respiratory infections has not been established (Eickhoff, 1994).

Therefore, in the study described in this paper, we decided to survey the microbiological contamination of the air using an easy-to-use, cheap and efficient aerobiological sampler (PARTRAP FA 52) in two room of haemodialysis (Fiorina *et al.*, 1997). The PARTRAP FA52 is a light (about 500 g), small, and battery powered volumetric air sampler; it generates airflow of about 10 L/min, equivalent to the normal ventilation values. It can be easily transported, moved and placed everywhere. Therefore it seems an optimal instrument for multiple, repeated and easy aerobiological sampling at low cost (Fiorina *et al.*, 1999, 2000).

The haemodialysis rooms, where patients usually more susceptible to infections have to stay for several hours a day, may be considered a site at high risk of respiratory infections (Berman *et al.*, 2004). However, in those areas it seems not necessary to observe a high level of environmental requirements such as in ICU (Intensive Care Unit) so we thought that haemodialysis wards were good places to start with this analysis.

Results of samples obtained with PARTRAP FA 52 method have been compared with those obtained with sedimetric method: in both cases values registered at the beginning of haemodialysis showed a tendency to increase with respect of those registered at the end of haemodialysis. This event could be caused by the progressive rise of the health-care workers activities that increase the amount of the environmental air particles.

Besides, the comparison of the PARTRAP FA 52 method with the sedimetric method outlined that the amount of microbes captured with the first method is greater than the second demonstrating that there is not correlation between the two methods. The cause is probably due to the characteristics of the tools: while the PARTRAP FA 52 sampled air for 1 h in the strict proximity of the patient with an aspiration capacity of 10 L/min corresponding to the volume of air ventilated by an adult at rest, the samples registered with the sedimetric tool depend above all on the environmental currents of air and on crowding in the haemodialysis rooms.

Volumetric samples lead with PARTRAP FA 52 were checked by including a Sartorius apparatus set at an aspiration rate of 10 L/min located in the centre of the two rooms used for haemodialysis: the comparison outlined that data obtained with the two method were very similar but the Sartorius apparatus is a heavy, large and expensive device in comparison with PARTRAP FA 52. Besides, such volumetric device can not be used for an air analysis in the strict proximity of the patient, while a light and manageable device such as PARTRAP FA 52 indicates significantly the air quality inhaled by single patient.

In conclusion, the PARTRAP FA52 personal and portable sampler seems to be an optimal choice for air monitoring in sanitary environments in order to evaluate the real exposure risk to microorganisms. Besides, in future developments, a similar study could be lead in an ICU ward to evaluate the correlation with the respiratory infections.

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