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Microbiological contamination of spirometers

An exploratory study in general practice

Background

Spirometry is an important tool when diagnosing chronic respiratory conditions in general practice. However, the equipment may harbour pathogenic micro-organisms and cross-transmission of aerolised pathogens could occur if hygiene measures are insufficient.

Methods

We assessed microbiological contamination in 16 spirometers from a convenience sample of South Australian general practices.

Results

We found potentially relevant microbiological contamination in three spirometers: two *Pseudomonas* spp.; one coagulase negative *Staphylococcus* sp. and one *Alcaligenes* sp. Although the three practices concerned all reported to have a written spirometer cleaning protocol in place, the frequency of spirometer disinfection did not match the manufacturers' recommendations.

Discussion

Despite the small size of our study sample, we found potentially relevant microbiological contamination in 3 out of 16 spirometers from metropolitan general practices. The potential hazard of spirometers as reservoirs of micro-organisms stresses the need for stricter attention to hygiene measures for spirometer maintenance in general practices.

Keywords

spirometry; equipment contamination; general practice

Spirometry has become an important tool for general practitioners to diagnose and monitor chronic respiratory conditions.¹ About 65% of Australian practices own a spirometer.² Colonisation of respiratory pathogens in laboratory spirometers has been reported³ but no such data are available for general practice.⁴ Procedures for spirometer cleaning have been shown to be below laboratory standards in some overseas general practices.⁵ Because spirometers may harbour pathogenic micro-organisms, there is the potential risk of cross-transmission of aerolised respiratory pathogens. These pathogens are especially relevant to patients with chronic airways conditions, such as chronic obstructive pulmonary disease (COPD) and asthma, as they may cause aggravation of respiratory symptoms and exacerbations.

The objective of the exploratory study reported in this article was to assess microbiological contamination in a sample of spirometers taken from South Australian general practices.

Methods

In 2009, we swabbed 16 spirometers from a convenience sample of metropolitan general practices in the Adelaide area of South Australia. Details of the spirometers (*Table 1*) and their use were obtained by questionnaire. The spirometers were swabbed in their 'ready to use' state in the practice. The sampling of the spirometers was done aseptically, ie. using sterile swabsticks that touched only the sampling area. Conditions in the laboratory were also aseptic.

Swabs from the turbine, mesh, mouthpiece

tube or flow head were taken, placed into Amies transport medium and shipped to the Institute of Medical and Veterinary Science (Adelaide) within 12 hours after sampling. Swabs were inoculated onto a horse-blood agar plate, a chocolate agar plate (ie. a blood agar plate in which the blood has been 'chocolatised', which releases more nutrients for organisms to utilise) and a cysteine lactose electrolyte deficient (CLED) agar plate (which supports the growth of both Gram positive and Gram negative isolates). The blood and chocolate plates were incubated at 35°C in an atmosphere containing 5% CO₂ while the CLED plate was incubated aerobically, also at 35°C. After 24 and 48 hours incubation, colony types present were identified by appearance on the inoculated medium and by Gram stain of the growing colonies, followed by testing the isolates against a battery of biochemical tests, including sugar utilisation tests.

We consulted the 2007 revised National Statement on Ethical Conduct in Human Research,⁶ and because no human subjects were involved in the study, did not consider that ethics approval was required.

Results

Eight of the practices (50%) reported having a spirometer cleaning protocol in place. Three practices used spirometers that had disposable flow heads. None of the other practices used bacterial filters, with seven using one way valved disposable cardboard mouthpieces. Reported frequency of spirometer cleaning varied between once per week (in one practice) to 4–6 times per year (in two practices).

Three spirometers carried potentially pathogenic micro-organisms (*Table 1*): two *Pseudomonas* spp., one coagulase negative *Staphylococcus* sp. and one *Alcaligenes* sp. All three spirometers had been in use for less than

Table 1. Characteristics of the spirometers and practices, and results for the 16 spirometers assessed in the study

Practice	Type of practice*	Brand of spirometer	Sensor type	Type of mouthpiece
1	Group	EasyOne	Ultrasound	Plastic spirettes
2	Group	Spirobank G	Turbine	One-way valved cardboard
3	Group	OneFlow (Clement Clarke)	Pneumotachograph	Regular cardboard
4	Large group	Micromedical Microlab 3300	Turbine	One-way valved cardboard
5	Group	Spirobank G	Turbine	One-way valved cardboard
6	Group	Welch Allyn Spiroperfect	Pneumotachograph	Reusable plastic
7	Large group	OneFlow (Clement Clarke)	Pneumotachograph	One-way valved cardboard
8†	Group	Welch Allyn Vitalograph	Pneumotachograph	Regular cardboard
9	Solo	EasyOne	Ultrasound	Plastic spirettes
10	Large group	Spirobank G	Turbine	One-way valved cardboard
11	Group	Spirobank G	Turbine	Regular cardboard
12	Large group	Spirobank G	Turbine	Regular cardboard
13	Group	Cosmed Pony (turbine)	Turbine	One-way valved cardboard
14	Group	OneFlow (Clement Clarke)	Pneumotachograph	One-way valved cardboard
15	Group	OneFlow (Clement Clarke)	Pneumotachograph	Regular cardboard
16	Group	OneFlow (Clement Clarke)	Pneumotachograph	Regular cardboard

* Solo = 1 full time GP; group = 4–7 full time GPs; large group = ≥8 full time GPs

† Year the spirometer was purchased or acquired by the practice

‡ This particular spirometer was contaminated with mixed saprophytic fungi on the mesh, but had not been used for many months due to put back into use again

§ The mixed saprophytes were minimally identified by their appearance on the inoculated media and wet mounts of the colonies

3 years, all three practices had written cleaning protocols in place and all stated that they were using a recommended detergent for cleaning. Two practices used one-way disposable cardboard mouthpieces and one used disposable (non-one-way) cardboard mouthpieces. None of the three practices with contaminated spirometers performed inspiratory manoeuvres.

Discussion

We found potentially relevant microbiological contamination in 3 out of 16 general practice spirometers. This occurred despite the fact that these practices had relatively new spirometers and had written cleaning protocols in place. However, the practices' cleaning protocols did not match the manufacturers' recommendations regarding the frequency of disinfection: according to the manuals disinfection would need to be carried out 'prior to every use' (for

the Spirobank G spirometer)⁷ or 'weekly' (for the OneFlow spirometer when used with disposable one-way cardboard mouthpieces),⁸ respectively. All three practices reported a lower cleaning frequency than recommended. On the other hand, none of the three practices performed inspiratory manoeuvres, which would probably have posed more of a risk.

The potential hazard of spirometers as reservoirs of micro-organisms stresses the need for stricter attention to hygiene measures for spirometers in general practices, since we don't know the likelihood of pathogens being breathed in by subsequent patients. Limitations of this exploratory study were: the small sample size; no negatives controls (eg. swabbing with sterile water) were collected; no viral sampling was performed; there was an (inevitable) delay of a maximum of 12 hours between sampling and incubation; and the microbes found on

the spirometers were not characterised in sufficient detail to determine whether or not they were human pathogens or nonpathogenic environmental species.

Nonetheless, until further research clarifies this risk, we strongly recommend that general practices implement and adhere to a strict protocol for spirometer cleaning following the manufacturers' instructions and use appropriate barrier filters in order to prevent equipment contamination with and cross-transmission of micro-organisms. Alternatively, practices can choose to switch to a spirometer that uses disposable flow heads.

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Year spirometer [†] purchased	Average frequency of use	Forced manoeuvres performed	Presence written cleaning protocol	Organism cultured
2007	5–14 x per week	Expiratory	No	Nil
2005	<5 x per week	Expiratory	Yes	Nil
2008	5–14 x per week	Expiratory + inspiratory	No	Nil
1993	<5 x per week	Expiratory	Yes	Nil
2008	<5 x per week	Expiratory	No	Nil
2007	<5 x per week	Expiratory + inspiratory	No	Nil
2007	1–3 x per month	Expiratory	No	Nil
>10 years ago	<5 x per week	Expiratory + inspiratory	No	Mixed saprophytic fungi [§]
2007	1–3 x per month	Expiratory	Yes	Nil
2007	5–14 x per week	Expiratory	Yes	Coagulase negative <i>Staphylococcus</i> sp. <i>Pseudomonas</i> spp.
1999	1–3 x per month	Expiratory	Yes	Nil
2008	5–14 x per week	Expiratory	Yes	<i>Alcaligenes</i> sp.
Unknown	5–14 x per week	Expiratory	Yes	Nil
2007	<5 x per week	Expiratory	Yes	<i>Pseudomonas</i> spp.
Unknown	1–3 x per month	Expiratory	No	Nil
2002	<5 x per week	Expiratory	No	Nil

a missing part. This disused piece of equipment had been replaced with another spirometer and the practice indicated that it would not be

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