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Original Research Article

Microbiological quality of indoor air of a general hospital and a health center in Rivers State Nigeria

Agbagwa, Obakpororo. E* and Onyemaechi, Sandra. A

Department of Microbiology, Faculty of Biological Sciences, College of Natural and Applied Sciences, University of Port Harcourt, P. M. B. 5323,
East- West Road Choba, Rivers State, Nigeria

**Corresponding author*

A B S T R A C T

The presence of microorganisms in indoor air of hospital environment brings about a challenge to the health of individuals in the hospital which can also lead to hospital acquired infection and prolonged stay in the hospital. This study was geared at the isolation and identification of airborne microorganisms found in the wards of two hospitals within the University of Port Harcourtbetween 8 -11 am and 4–7 pm. Samples were collected from 13 wards in the general hospital and 6 wards in the health center. The study was carried out using plate exposure and count method. Plates containing different sterile culture media were exposed for 15- 20 minutes in the different wards, after which plates were incubated at 37oC for 24 hours for bacteria while fungal plates were incubated at room temperature for 5-7 days. Results obtained from the study showed that bacterial counts from the general hospital for the morning session ranged from 39 – 195 and for the evening 28- 204, while bacterial counts for the health center ranged from 32 – 122 for morning and 48 – 144 for evening. Fungal counts ranged from 5 -180 for the morning sessions and 6 – 160 for the evening session.

Keywords

Bacteria,
fungi,
health
center,
hospital,
indoor air,
microorganisms

Introduction

Indoor air quality is used to describe the quality of air in or around a particular building as it relates to the health of the people around that building and environment. Good air quality is very important especially in health care setting that involves a large number of people. Such settings that are of great concern include hospitals, schools, prisons, prisons, family houses, restaurants, banks etc. (Tambeker*et al*., 2007). Airborne transmission is one of the routes of spreading diseases responsible for a number of nosocomial infections (Claudete *et al*., 2006). Nosocomial infection also known as hospital acquired infection is infection acquired in the hospital environment, which are not present in the patient at the time of admission (Beggs, 2003; Omoigberale *et al.*, 2014). The study of airborne microorganisms in indoor environment is important because this brings about the understanding of the population of

airborne microbes in the hospital environment. The hospital where patients are treated has an influence on the health of the patient recovering or acquiring infection that may complicate or increase the condition of the patient (Ekhaise *et al*., 2009; 2010). Studies have been carried out in Nigeria and other countries on indoor and outdoor air quality of hospital environment, from the studies microorganisms responsible to cause disease have been isolated. Some of the microorganisms contains spores and can withstand different conditions thereby making them resistant (Odinayo *et al*., 2008; Prigane *et al*., 2004). Studies have also shown that air outside the hospital is partly responsible for some indoor air microorganisms. Some other indoor sources of airborne microorganisms in hospital environment include equipment used for cleaning and products, ventilation systems and also personal activities (Douwes *et al.,* 2003; Luksamijarakul 2011, 2012).

Materials and Methods

Study Area

A general hospital and a health center within the University of Port Harcourt were selected for the purpose of this study. The selected general hospital is one of the best public hospitals in Rivers State, Nigeria with` about 23 different wards. Samples were collected from eye ward, accident and emergency, men orthopedics, male medical wards, female medical ward, children ward, anti-natal ward, burns and plastic center, post natal ward, female emergency ward, eye ward, ear, nose and throat ward and gynecology ward. The health center is made up of 6 wards namely: children ward, male ward, female ward, injection room and general ward. The study was carried between the months of October - December 2013.

Sampling and Microbiological Analysis

Plate exposure method which involves the opening of plate with specific culture media was used for this study (Bhatia and Vishwakarma, 2010; Ekhaise and Ogboghodo 2010). This method allows bacteria or fungi carrying particles to settle on the respective culture media. Prepared plates of mannitol salt agar (oxoid), nutrient agar (oxoid) and sabouraud agar (oxoid) were exposed for about 10–15 minutes in the different wards in the mornings (8 am–11 am) and evenings (4 pm–7 pm).

Nutrient agar was used to enumerate total bacteria counts, sabouraud agar was used for the isolation of fungi and MSA was for isolation of *Staphylococcus aureus*. After sampling, the plates were kept in tight sealed case and taken to the laboratory for incubation. Plates were incubated under appropriate temperature, bacteria was incubated for 24-48hours while fungi was incubated at room temperature for 5-7days.

Results and Discussion

A total of 13 wards were sampled for the general hospital and 6 wards/ units from the health center. Results obtained showed that bacterial counts during the morning sessions ranged from 38–196 while bacteria counts for the evening session ranged from 25–209. The highest bacterial population were found in MMW(Male Medical Ward), while the lowest counts was observed in GW (Gynecology Ward) as presented in Figure 1 below. Bacterial counts for the morning and evening were significantly different for the general hospital.

The microbial population of airborne bacteria was also determined for the health center. Results obtained for the morning and evening are shown in Figure 2 below.

Microbial population of air borne bacteria in a health center in University of Port Harcourt showed that the highest bacteria count was noted in injection room of 144 followed by female ward having bacterial counts of 122. Counts obtained in the general hospital were higher compared

to those obtained from the health center. Bacterial populations were found to be higher in the evenings, the least bacterial populations in the health center was found in children ward with bacterial population of 32. The differences observed in the bacterial population in the health center were significant.

Results obtained from fungal counts for the two hospitals are presented in Figure 3 below, counts ranged from 5–180 for both hospitals. Significant variation in the fungal counts during the morning and evening was observed. Fungal counts were observed to be higher in the evenings than mornings. The highest fungal counts were observed in the general hospital. The wards with the highest fungal count were ANW followed by GW and CW.

Fungal counts in the PNW were high in the evening and very low in the morning. The differences in the PNW was significant, the variation in fungal counts between the morning and evening was striking. The lowest fungal count for the general hospital was in the EW and FOW, while in the health center the lowest count was observed in CW.

Figure 4 shows the average bacterial and *Staphylococcus* sp population for both mornings and evenings in the general hospital. The result obtained from the study showed that the percentage of *Staphylococcus* sp present in the total bacteria population is not comparable in all the wards. Ninety percent of the wards sampled had significant difference between the bacteria population and *Staphylococcus* population except ENT where no significant difference was observed between the average bacteria population and *Staphylococcus* sp population.

Results obtained for fungal and *Staphylococcus* population from health center in the morning and evening is shown in Figure 4 below. From the figure below *Staphylococcus* was highest for both mornings and evenings in MW, this was followed by the FW, which had high population of *Staphylococcus* in the evening and lower counts in the morning. The least *Staphylococcus* population was observed in IR. Comparing both fungal and *Staphylococcus* airborne population, results showed that fungal counts were lower compared to *Staphylococcus* population.

Bacterial isolates identified from both hospitals include the following, *Staphylococcus* sp, *E. coli, Bacillus* spp, *Streptococcus* sp and *Proteus* sp. Fungal isolates identified include *Penicillium*, *Aspergillus* sp, *Mucor* sp. Results obtained after the identification showed that *Aspergillus* sp was the highest in occurrence for the fungal specie as shown in Figure 5.

Studies have shown that the quality of indoor depends on several factors such as the number of people present in the hospital, the level of hygiene maintained in the hospital, the mechanical movement of people within a place in the hospital, the population of the ward and the number of patients put together in a small place. All these and many other factors can lead to the increase of indoor airborne that can be released by human bodies.

Hospital acquired infections can also be

linked to many factors among which is microbial quality of indoor air in different wards and units in the hospital (El–Sharkawy *et al*., 2014; Brimekree and Forsberg 2005). The ventilation system in a ward goes a long way to determine the microbial load per ward of a given hospital. Studying the airborne microorganisms in the hospital is important to understanding the distribution of microorganisms and the level of cleanliness in that particular area. Thus the environment where patients are treated has an influence on the recovery of the patients. Results obtained in this study showed that the number of patients in each particular ward affected the number airborne microorganisms in that particular ward and hospital.

Airborne bacterial counts carried in the various wards of the two hospitals showed that MMW recorded the highest microbial count and was followed by AE and MOT. These wards were at their maximum capacity because these areas attracted more patients' relatives in and out the wards thereby increasing the shedding of bacteria in air. However, a similar study by Ekhaise *et al*., 2010 reported that A&E (accident and emergency) recorded the highest airborne bacteria and fungi. Bacterial counts were higher during the evening hours for 90% of the sampled wards except for ANW and GW which had high counts in the morning.

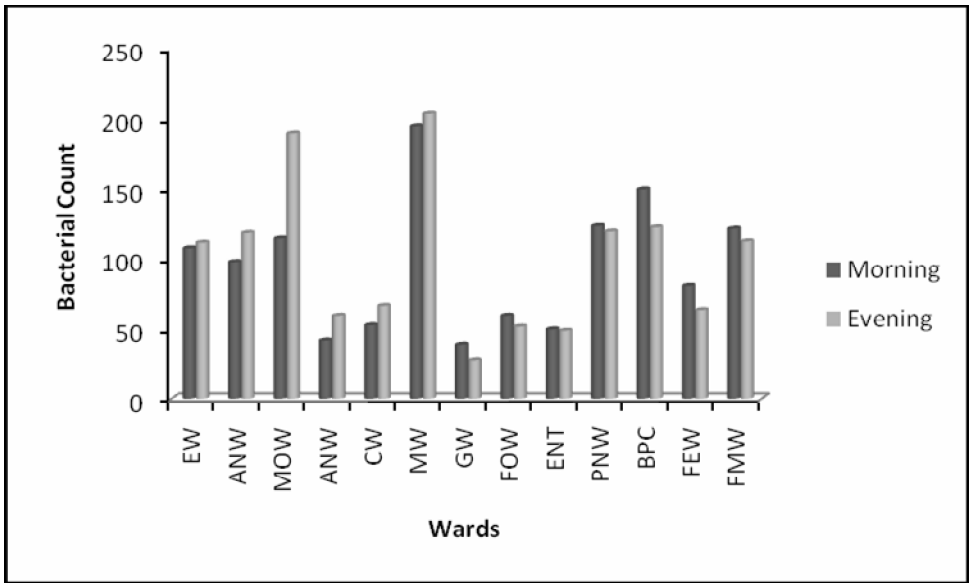
These high microbial populations in the morning hours in both wards could be attributed to the number of women that usually come for antenatal during the morning hours even before the nurses arrive and leave later in the day, this was also applicable to the gynecology ward. The differences observed in microbial population observed in the different wards is in conformity with results obtained from previous studies (Awosike *et al*., 2012; Augustowska and Dutkiewicz, 2006).

The least bacterial population observed in the health center was in the CW while the highest was observed in the IR. The low bacterial population recorded in the children ward is understandable because the number of children coming to the health center is low, and most times they are not admitted and referred to the general hospital. The IR has high bacterial population because patients are always coming in for their injections at all times of the day and above all the nurses spend most of their time there, either sleeping or entertaining their friends.

Fungal population of the different wards was higher in the evening compared to the mornings. For the general hospital fungal counts were highest in ANW followed by GW and CW. Bacterial Population was higher than fungal population from the different hospitals for all the wards studied. *Staphylococcus* population was higher generally than the fungal counts for all the wards. *Staphylococcus* count was highest in MMW followed by MOW and the least was in GW.

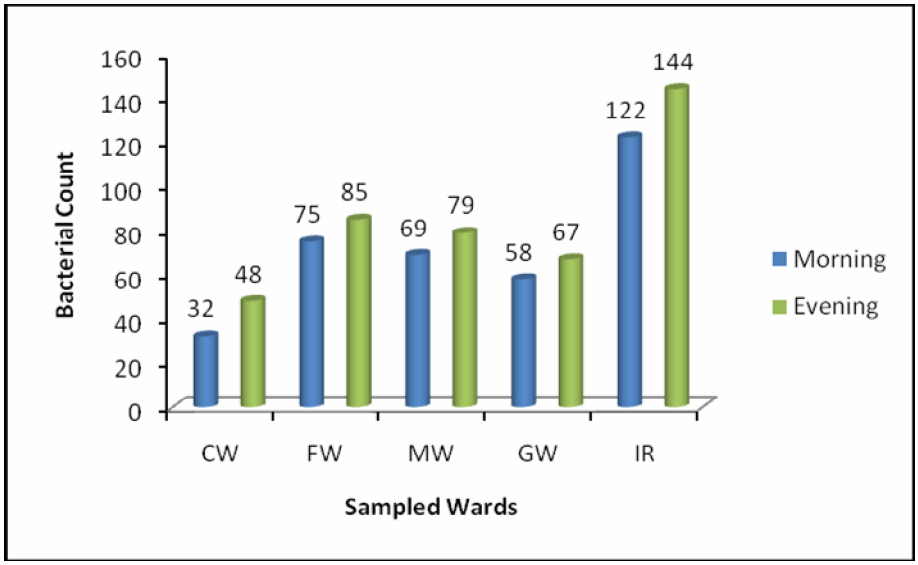
Different species of bacteria fungi were isolated from the different wards studied from the two hospitals. Bacteria isolated include: *Staphylococcus* spp, *Bacillus* spp, *Enterococcus* sp, *Proteus* spp and *Micrococcus* spp. *Staphylococcus aureus* was the most frequently isolated bacteria, *Staphylococcus aureus* can be found everywhere and transmitted from person- to-person, from fomites-to-people and also from air-to- people in the hospital.

Figure.1 Microbial population of airborne bacteria from general hospital



Abbreviations: AEW: Accident and Emergency Ward, MOW: Male Orthopedics Ward, ANW: Antenatal Ward, CW: Children Ward, MMW: Male Medical Ward, GW: Gynea Ward, FOW: Female Orthopedics Ward, ENT: Ear, Nose and Throat, PNW: Post Natal Ward,LW: Labor Ward, FEW: Female Emergency Ward, FMW: Female Medical Ward, BPC: Burns and Plastic Center, EW: Eye ward

Figure.2 Microbial population of airborne bacteria from health center



Abbreviations: CW: Children Ward, FW: Female Ward, MW: Male Ward, GW: General Ward, IR: Injection Room.

Figure.3 Fungal counts of general hospital and health center

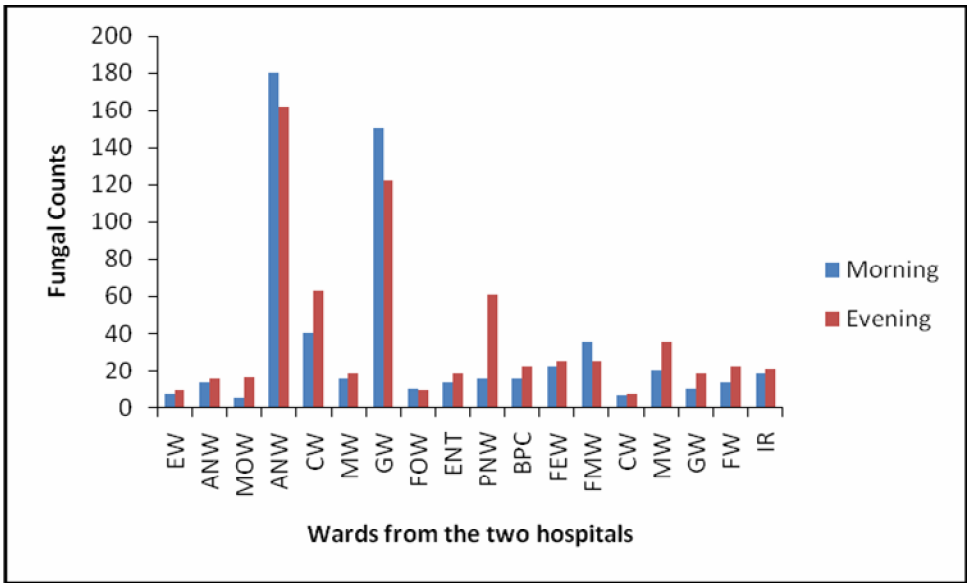


Figure.4 Bacteria and *Staphylococcus* sp population of indoor air in general hospital

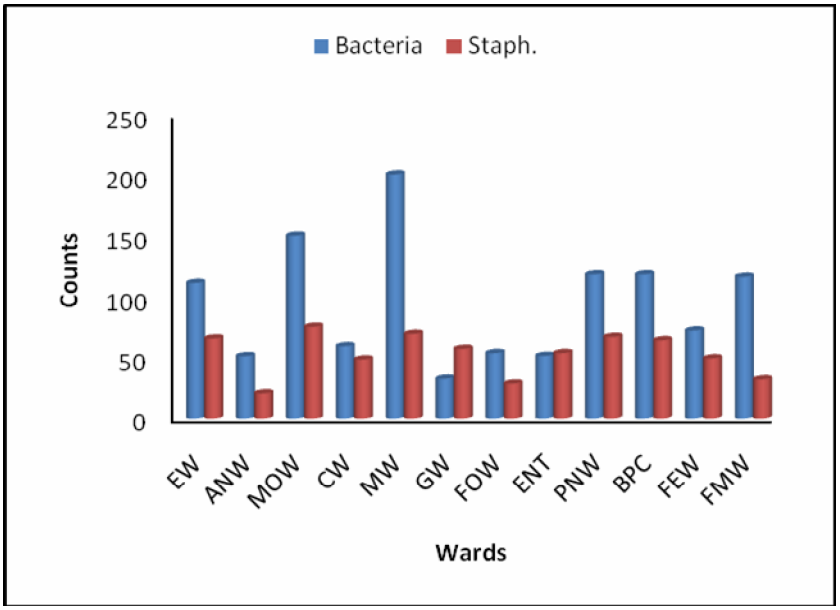
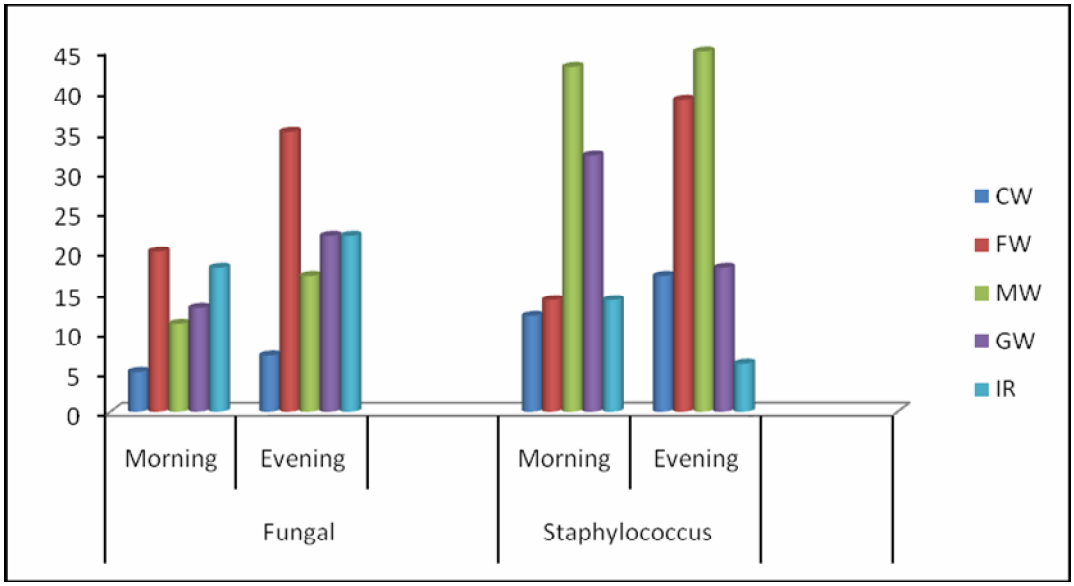


Figure.5 *Staphylococcus* and fungal population of health center indoor environment



Staphylococcus is usually associated in various diseases such as skin infections, urinary tract infections and food poisoning; all thesemay be responsible for its high occurrence (Huang *et al*., 2006; Zuckerman *et al*., 2009; Ekhaise and Ogbaghdo 2009, 2010; Tang *et al* ., 2009).

Bacillus spp were also isolated from the two hospitals, *Bacillus* are organisms that can be found in almost every environment. They contain spores that enables them survive for a long period of time in the environment. The bacterial species isolated in this study are in conformity with those isolated by the study carried out by Omoigberale *et al*. (2014).

Fungi isolated from the indoor hospital environment include *Aspergillus* spp, *Mucor* spp, and *Candida* spp. Fungal species isolated are in conformity with those isolated from previous studies carried out on indoor and outdoor hospital environment (Ekhaise and Ogbaghdo 2010; Sudharsan *et al*., 2008). *Aspergillus* spp was the most predominant fungi isolated from the two hospitals, previous studies on indoor and outdoor environment of hospitals has shown that *Aspergillus* spp are associated with nosocomial infection in immune compromised patients in hospitals.

References

Augustowska, M., Dutkiewicz, J. 2006. Variability of airborne microflora in a hospital ward within a period of one year. *Ann. Agric. Environ. Med*., 13: 99–106.

Bhatia, L., Vishwakarma, R. 2010. Hospital indoor airborne microflora in private and government owned hospitals in Sagar City, India. *World J. Med. Sci*., 53: 65–70

Beggs, C. B. 2003. The airborne transmission of infection in hospital buildings: fact or fiction? *Indoor Built Environ*., 12: 8–9.

Brunekreef, B., Forsberg,B. 2005. Epidemiological evidence of effects of coarse airborne particles on health. *Eur. Respir. J*., 26: 309–18.

Claudete, R.P., Krebs, V.L.J., Auler, M.E., Ruiz, L.S., Matsumoto, F.E.,

Elza, H.S., et al. 2006. Nosocomial infection in Newborns by Pichiaanomala in Brazilian *Intensive Care Unit. Med Mycol*., 44: 479–484

Douwes, J., Thome, P., Pearee, N., Heedrik, D. 2003. Bioaerosolhealth effects and exposure assessment: progress and prospects. *Ann. Occup. Hyg.*, 47: 187–20

Ekhaise, F.O., Ighosewe, O.U., Ajakpovi, O.D. 2008. Hospital indoor airborne microflora in private and government owned hospitals in benin city, Nigeria. *Wld. J. Med. Sci*. 31: 19–23.

Ekhaise, F. O.,Ogboghodo, B.F. 2010. Microbiological indoor and outdoor air quality of two major hospitals in Benin city, Nigeria. *Sierra Leone J. Biomed. Res.*, pp. 169–174.

El–Sharkawy, M.F., Noweir, M.E. 2014. Indoor air quality levels in a University Hospital in the Eastern Province of Saudi-Arabia. *J. Fass Commun. Med.*, 21: 39–47.

Huang, R., Mehta, S., Weed, D., Price, C.S. 2006. Methicillin-resistant *Staphylococcus aureus* survival on hospital fomites. *Infect. Contr. Hosp. Epidemiol.*, 27: 1267–1269.

Luksamijarulkul, P., Kongtip, P. 2010. Microbial counts and particulate matter levels in roadside air samples under sky-train stations, Bangkok, Thailand. *Southeast. Asian J. Trop. Med. Public Health*, 41: 678–84.

Luksamijarulkul, P., Khumsri, J., Vatthanasomboon, P., Aiumlaor, P. 2009. Improving tuberculosis infection control practice and microbial air quality in a general hospital after intervention. *Asian J. Trop*, 2: 39–46.

Odimayo, M.S., Nwabuisi, S., Agegbora, B. 2008. Hospital acquired infections in Illorin, Nigeria. *Trop. J. Hlt. Sci.*, 15: 49–51.

Omoigberale, M.N.O., Amengialue, O. O., Iyamu, M.I. 2014. Microbiological assessment of hospital indoor air quality in Ekpoma Edo state, Nigeria. *Global Res. J. Microbiol.*, 4: 1–5.

Ponce–Caballero. C., Ceron –Palma,I. M., Lopez–Pacheco, M., Gamboa- M., Quintal- Franco, C. 2010. Indoor air–outdoor fungal aerosols rates of domestic homes in Merida. *Mexico Ingenieri*, 14: 169–175.

Prigane, V., Lingua, G., Marchisco, V. F. 2004. Development and use of flow cytometry detection of airborne fungi. *App. Env. Microb.*, 70: 1360 –1365.

Sudharsan, S., Sirkath, P., Sheela, M., Stienbery, R. 2008. Study of indoor air quality in hospitals in South Chennai India. *Ind. Blt. Env.*,17: 435–441.

Tambeker, D.H., Gulhane, P.B., Bhakare, D.D. 2007. Studies on environmental monitoring of microbial air flora in hospitals. *J. Med. Sci.*, 71: 67–72.

Tang, C.S., Chung, F. F., Lin, M. C., Wan, G. H. 2009. Impact of patient visiting activities on indoor climate in a medical intensive care unit: A 1-year longitudinal study. *Am. J. Infect. Control*, 37: 183–8.

Zuckenman, J.B., Zuaro, D.E., Prato, B. S., Ruoff, K.L., Sawicki, R.W., Quinton, H.B., *et al*. 2009. Bacterial contamination of cystic fibrosis clinics. *J. Cystic Fibros*, 8: 186–192.