J. King Saud Univ., Vol. 17, *Science* (1), pp. 9-15, Riyadh (1425H/2004)

SHORT COMMUNICATION

Bacterial Distribution Analysis in the Atmosphere of Two Hospitals at Ibb City, Yemen

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(Received 27/8/1423H.; accepted for publication 21/10/1423H.)

Abstract. Bacteriological distribution analysis at the atmospheric air of hospitals applying AI-Thawra and AI-Nasir, General Hospitals, at Ibb City, Yemen, was performed during a period between February and June, 2002. The results indicated that at both hospitals, and among different places studied, to detect bacteriological concentration, only three sites, i.e. reception hall, hospital passages, and out-patient clinic, were given an impressive meaning for the distribution of bacteria in the atmospheric air of the hospital. In these places, the average concentration of TPC (total plate count), lactose fermenting, haemolytic, and non-lactose fermenting bacteria were 478.6, 24.9, 6.5, and 4.8 cfu (colony forming unit)/m^3 respectively. The reception hall revealed the highest bacterial count, followed by hospital passages, and finally out-patient clinic. With respect to day-time, these sites demonstrated a morning values of highest bacterial count, followed by noon, and finally, evening time.

Introduction

Hospitals have a notorious reputation for infection. Septic infection have been well documented (Ayliffe *et al.*,1990). Despite the dramatic development in surgical and medical techniques, infection acquired in hospitals remain a major cause of morbidity and mortality, leading directly or indirectly to an enormous increase in the cost of hospital care and to emergence of new health hazards for the community (Simpson, 1997). Infection may be spread by air-born transmission from the respiratory tract, from the skin by natural shedding of skin scales, during wound dressing or bed making and by aerosols from equipment such as respiratory apparatus and air-conditioning plant. Infectious agents may be dispersed as small particles or droplets over long distance (Ayliffe *et al*.,1992).

Quantitative and qualitative microbiological measurements are acquired in premises where safe working depends on the air's content of microorganisms being kept

at a very low level e.g. surgical theaters and premises where certain food and pharmaceutical materials are prepared. In hospital wards in which there is outbreak of cross-infection, it may be required to examine the air for its content of a particular pathogen. The type and number of the microorganisms in the air at any time depended on a variety of factors, the most important of which are number of persons present, the amount of their body movement and the amount of disturbance of their clothing (1967).

Since most of the data available in this field concerned with fungi (Krikland & Fierer, 1996), while little or no data available concerning bacterial concentration of the hospital atmospheric air, therefore the aim of the present work is an attempt to study the bacterial distribution analysis of hospital ambient air.

Materials and Methods

Sample collection

Air samples were collected during a period between February and June, 2002, from AI-Thawra and AI-Nasir, General Hospital, at Ibb City, Yemen. These two hospital have an average out-patient visitors of 233 and 75 patient/day respectively. Microbiological air sampler (Merck, model MAS-100) was used for the collection of air samples. The air sampler was loaded with the petridishes , that were previously prepared under sterile condition with the following media: Plate count agar (for total plate count of bacteria); blood agar (for haemolytic bacteria); MacConkey agar (for lactose and non-lactose fermenting bacteria). The altitude of the air sampler was 1.5m above the ground level, with an horizontal position. The sampler was set to allow the passage of 1000 liters (one cubic meter) of air sample over the microbiological media.

Sampling sites

From both hospitals, the examined air samples were collected from the following hospital appendices: Operation theater, male surgical ward, female internal ward, refreshment room, clinical laboratory, out patient clinic, hospital passages, and reception hall. From each site, three daytimes, for sample collection, were chosen, i.e. morning (at 8.00 am), noon (at 2.00 pm) and evening (at 6.00 pm). From each site, three replicates of the samples were collected. The time between sample collection and sample analysis never exceeded one hour.

Sample analysis

Microbiological analysis for total plate count, lactose and non-lactose fermenting and haemolytic bacteria was performed according to the method described by Collee, *et al.* (1996).

Preparation of the figure and table

To consolidate comprehension, the original data, from both hospitals, were processed and expressed either as an average or as a percentage. Microsoft Word and Excel computer programs were used for the demonstration of the tables and figures.

Results and Discussion

For bacteriological distribution analysis, the following hospital appendices, at AI-Thawra and Al-Nasir, General Hospitals, were examined: Operation theater, male surgical ward, female internal ward, out-patient clinic, refreshment room, hospital passages, clinical laboratory, and reception hall. The results of the present study indicated that, at both hospitals, only three sites, i.e. reception hall, hospital passages, and outpatient clinic gave a significant meaning for the distribution of the bacteria in the atmospheric air of the hospital that consequently allowed a reasonable analysis for the distribution of the bacteria at these sites, therefore they will be discussed in details. Other places, that showed an equivocal results, may be explained to the oscillation of the variables that affect bacterial concentration.

Figure 1. demonstrates the average concentration of TPC, lactose fermenting, haemolytic, and non-lactose fermenting bacteria, at different hospital sites, were 478.6, 24.9, 6.5 and 4.8 cfu/m^3 respectively. The highest, which is TPC, is expected since nutrient agar is known to allow the growth of a wide range of saprophytic and other bacteria. Lactose fermenting bacteria shows a higher count than non-lactose fermenting bacteria. This result is also expected since many reports stated that strains of bacteria that ferment lactose is more widely distributed than non-lactose fermenting bacteria (Tarr, 1995, & Lewis, 1997). Haemolytic bacteria also formed a considerable count, i.e. 6.5 cfu/m^3. However, Collee, *et al* (1996) have reported that studies concerned with airborne infection in man, the particles encountered are those that carry bacteria capable of growth on blood agar during aerobic incubation for 24 or 48 hours at 37 C. Such incubation time and temperature were also applied in our study, according to the method described previously (Collee, *et al.*,1996).

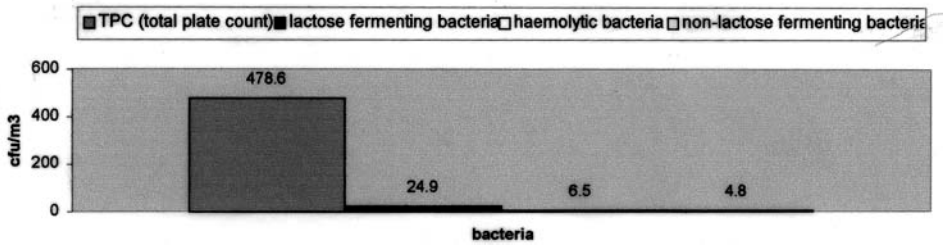

Fig. 1. The average concentraiton of TPC (total plate count), lactose fermenting, haemolytic, and non-lactose fermenting bacteral at receptio hall, hospital passages, and out-patient clinic, cfu/m^3 colony forming unit per cubic meter.

The concentration of TPC, lactose, and non-lactose fermenting bacteria at the reception hall, hospital passages, and out-patient clinic are illustrated in Table 1 (a,b, and c). This table shows that reception hall contained the highest count of bacteria, followed at hospital passages, and finally at out-patient clinic. These variations could be explained to the differences in the degree of the crowds, becuse reception hall is usually more crowded than hospital passages and out-patient clinic. Moreover, the movement, inside these appendices, results in increasing of both humidity and temperature. These two variables are known to be an important growth parameters (Moat & Foster, 1995). Table 1 also shows of appendices demonstrated a highest morning, followed by n oon, and finally evening bacterial count. This observation seems to be related with the rush hours, that is usually occupied the highest level at 8.00am, then drops gradually at noon and then at evening.

Table 1 (a-d). The concentrations of different bacterial types at some places of the hospitals during different day-times {i.e. morning (M), noon (N), and evening (E)}

Bacterial type	Time	Colony forming unit per cubic meter			Reference
		Reception hall	Hospital passages	Out-patient clinic	
Total plate count	M	1190	640	350	a
	N	650	480	240	
	E	370	240	148	
Tactose fermentor	M	50	34	12	b
	N	35	15	5	
	E	29	13	12	
Ton-lactose fefmentor	M	22	0	•	c
	N	13	0	0	
	E	9	0	0	
Haemolytic	M	5	11	1	d
	N	9	4	0	
	E	14	5	10	

Table 1 . d , reveals the distribution of haemolytic bacteria at different hospital appendices and during different day times. Ulike other examined bacteria, it shows an equivocal relationship. Since many virulent strains belong to this bacterial group, excessive studies are required in the field of the distribution of such a bacteria in the ambient air of hospitals.

It has been reported that most of the contaminants are harmless saprophytes and commensals, and even when carriers or infected students are present, usually less than 1% and commonly only 0.01-0.1%, of the airborne bacteria are pathogens(Senior, 1996). In rooms occupied by patient with tonsillitis or infected wounds, *Streptococcus pyogenes* may be present between 0.1-50/m^3 (Collee, *et al*, 1996). Such level of contamination may seem small, but it must be remembered that normal adult person inhales about 15m^3 of air/24hr. The probability of a person becoming infected will be greatest if he is exposed to high concentration of airborne pathogens, but no level of contamination, however low, can be regarded as certainly safe. Infection may usually be initiated by the deposition of a single infected particle at a favorable site in the respiratory tract, although the probability of any one such particle initiating infection is likely to be low for common pathogen, e.g. 10^{-2} to 10^{-5} for acquisition of S. *aureus* in the nose (Lidwell, 1981). It may be high for some, e.g. for acquisition of *M. tuberculosis* in the lung (Riley, 1957).

Finally, the removal of air contaminants and the control of room temperature and humidity is necessary. Recommendation for air treatment in hospital ambient air include:

1. The use of filtration, electronic cleaners, chemical treatment with activated charcoal or other sorbents.
2. Temperature control in the range of 68-76°F (20-24.5°C).
3. Humidity control in the range of 20-60%.

Acknowledgement. I would like to thank Mr. Abdulla Al-Wajeeh and Mr. Mohammad A. Al-Tayeb from Department of Medical Microbiology, Faculty of Science, Ibb University, for their technical assistance.

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تحليل التوزيع البكتيري للهواء المحيط بمستشفتين في مدينة إب باليمن

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ملخص البحث. تم تحليل التوزيع البكتيري الهوائي في كل من مستشفى الثورة العام والناصر العام بمدينة إب في اليمن للفترة ما بين فبراير (شباط) إلى يوليو (تموز) لسنة٢٠٠٢م.

أشارات النتائج إلى أنه، وفي كلتا المستشفتين، ومن بين العديد من الأماكن التي تم اختبارها، فإن ثلاثة مواقع، وهي: العيادة الخارجية، وصالة الانتظار وممرات المستشفى أعطت نتائج قابلة للتفسير. كان معدل تركيز البكتيريا الكلي والبكتيريا المخمرة للاكتوز والبكتيريا غير المخمرة للاكتوز والبكتيريا المحللة لكريات الدم في هذه المواقع هو: ٤٧٨,٦، ٢٤,٩، ٦,٥ و٤,٨ووم (وحدة مكونة للمستعمرة)/م٣على التوالي. أظهرت صالة الانتظار أعلى معدلات للبكتيريا، وتبعها ممرات المستشفى ثم العيادة الخارجية. احتوت العينات التي جمعت في الفترة الصباحية على أعلى التراكيز البكتيرية وتبع ذلك عينات الفترة الظهرية وأخيرا الفترة المسائية.