·Clinical Research·

# Bacterial colonization of hydrogel disposable contact lenses

*Bakiah Shaharuddin[1], K Wei Chan[2], Siti Suraiya Mohd Noor[1], Zunaina Embong[1]*

[1]Department of Ophthalmology, School of Medical Sciences, University Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia
[2]Department of Microbiology and Parasitology, School of Medical Sciences, University Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia

**Correspondence to:** Bakiah Shaharuddin. Department of Ophthalology, School of Medical Sciences, University Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia. bakiah@kb.usm.my
Received:2009-02-24 Accepted:2009-05-08

## Abstract

• AIM: To determine the rate of bacterial colonization in hydrogel disposable contact lenses and solutions and to identify the contaminating organisms.

• METHODS: A cross sectional study with purposive sampling was carried out. One hundred hydrogel contact lenses were collected from wearers among undergraduate students of Health Campus, University Sains Malaysia. All lenses and storage solutions were sent for microbiological culture and gram staining.

• RESULTS: The majority of study participants were females (98% ). The mean age was 21.36 ±1.63 years. Forty-one subject participants (82%) showed positive bacterial colonization of the lenses. From storage solutions 32% yielded positive colonization by bacteria. The most common organisms were coagulase negative staphylococcus, Staph aureus and streptococci while Pseudomonas sp. and Serratia sp. were isolated more frequently from contact lenses.

• CONCLUSION: Contact lens wearing is potentially dangerous as a result of high rate of bacterial colonization of the lenses and its storage solutions. Extreme precaution and adherence to strict hygienic practice is recommended during lens handling and wearing.

• KEYWORDS: hydrogel contact lens; bacterial colonization; contact lens wearing in university students

Shaharuddin B, Chan KW, Noor SSM, Embong Z. Bacterial colonization of hydrogel disposable contact lenses. *Int J Ophthalmol* 2009;2(2):158-161

## INTRODUCTION

Contact lenses are worn for correction of refractive errors, tectonic support, prosthetic, cosmetic and therapeutic purposes. In recent years co-polymers have been incorporated into the soft hydrogel lens materials, including silicone polymers for increased oxygen permeability and phosphorylcholine to increase biocompatibility [1].

The problems associated with contact lens wear are potentially sight threatening, which require rapid diagnosis and treatment to prevent vision loss. Contact lens complications include acute red eye, peripheral ulcers, infiltrative keratitis and asymptomatic keratitis [1,2-8].

We conduct a study in a group of young disposable hydrogel contact lens wearers who are also a subpopulation of biomedical students of the Faculty of Medicine in the Health Campus of University Sains Malaysia, at the north-eastern region part of Malaysia. The aim of this study was to determine the prevalence rate of bacterial colonization in hydrogel contact lenses among our study participants.

## METHODS

Demographic data, type of contact lens, duration of lens wearing and wearing schedule were derived from a self-administered questionnaire. Informed consent was obtained from all participants. All lenses which had been worn for a minimum period of 30 days were collected aseptically.

The contact lenses and solutions were cultured using the standard methods. Storage or washing solutions were obtained from the nozzle of the containers. Further gram staining is done if there were growths for the identification of microorganism. Gram positive organisms are identified using catalase and coagulase enzyme activity. If the organism showed positive reaction with catalase test, coagulase test is used to differentiate Staphylococcus aureus (coagulase positive) from coagulase negative staphylococcus. Negative result for catalase test would investigate further test to classify streptococci. Gram negative organisms were identified using biochemical tests such as Triple Sugar Iron agar, Sulfur Indole Motility test medium, Methyl Red test,

Citrate utilization test and urease test.

## RESULTS

One hundred disposable hydrogel contact lenses were cultured. The participants consist of one (2%) male student and 49 (98%) female students with a mean age of (21.36± 1.63) years. Patterns of contact lens wearing which included the total duration of time the study participants had experience wearing contact lens, the duration of the current lens, and the daily average time the lens was being put on were analyzed (Table 1).

The duration of wearing contact lenses has a median of 3 years and the contact lenses being collected for this study had been in use for a median value of 30 days. Most of the participants wore their contact lenses on a daily basis of an average of 9.86 hours.

All retrieved lenses were sent for microbiological cultures. Microorganisms were cultured from 68% of the lenses. Forty-one samples (82%) showed positive bacterial colonization with 27 samples (54%) having bacteria on both eyes and 14 samples (28%) on one eye. As for storage solutions, only 16 (32%) of the samples showed positive bacterial colonization (Table 2).

Figure 1 shows the species of bacteria and its representation (in percentage) that were isolated from contact lenses and storage solutions. The most common bacteria isolated were gram positive bacteria, including coagulase negative staphylococcus, Staphylococcus aureus, Streptococcus sp. and Bacillus sp. Of the gram negative bacteria isolated, Pseudomonas sp. and Serratia sp. were isolated more frequently from contact lenses. Bacteria were also isolated from storage solutions with coagulase negative staphylococcus predominating.

The mean bacterial count (in CFU/lens) of contact lenses and storage solutions is 31.4 (median: 14, IQR: 35) and 1.7 (median: 0, IQR: 2) respectively. The bacteria that were isolated from the storage solutions were of the same types of organisms of contact lenses.

Figure 2 represents the different number of bacteria present on contact lenses and storage solutions. Contact lenses were colonized predominantly by only one type of microorganism (60% contact lens and 68% storage solutions).

## DISCUSSION

Estimation suggests that there are approximately 125 million contact lens wearers worldwide where the United States alone may have as many as 38 million contact lens wearers [9,10].

**Table 1 Pattern of contact lens wear among study participants**

| Pattern of contact lens wear | Mean (SD) | Median (IQR) |
|---|---|---|
| Duration of wear of contact lenses (years) | | 3.0 (3.0) |
| Duration of wear of current pair (days) | | 30.0 (2.5) |
| Duration of wear per day (hours) | 9.86 (2.718) | |

**Table 2 Frequency of bacterial colonization on contact lenses and storage solutions**

| Bacterial colonization | Frequency (%) |
|---|---|
| Contact lenses | 9 (18) |
| No | 41 (82) |
| Yes | |
| - Bacterial colonization on both eyes | 27 (54) |
| - Bacterial colonization on one eye | 14 (28) |
| Storage solutions | |
| No | 34 (68) |
| Yes | 16 (32) |

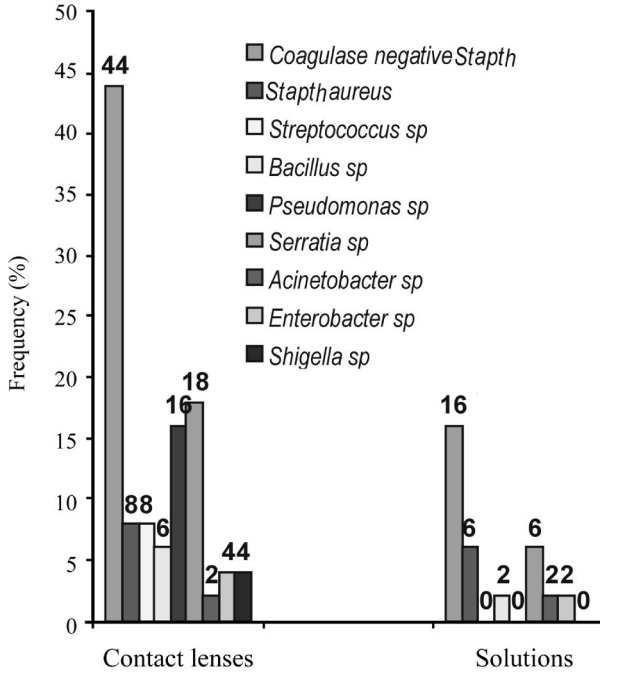


**Figure 1 Species of bacteria isolated from contact lenses and storage solutions**

With millions of individuals wearing contact lenses, even a small percentage of complications create a major public health problem [2-4].

Our study population forms a majority of female students which are gender-comparable to other studies in this age group [9,11,12]. The median duration of contact lens wear among our participants was 3 years. For the current pair of lens, the mean duration was 30 days and the daily use was almost up to 10 hours.

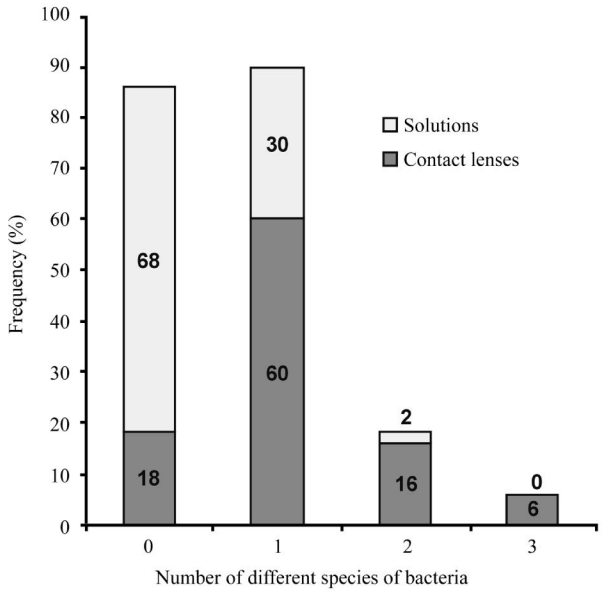


**Figure 2 Number of different species of bacteria (in percentage) isolated from contact lenses and solutions**

Pritchard *et al* [13] found that frequent replacement of soft lenses for daily wear as compared to non-replacement daily wearing is reported less likely to cause contact lens-induced complications and improves satisfaction with lens wearing. Besides the association of length of wear with bacterial colonization, the duration of lens wearing is also associated with other physiological alterations. Simon *et al* [14] reported that the severity of cytological changes increased with duration of lens wearing.

An increasing span of contact lens wearing has been associated with the morphological changes in the corneal endothelium. Contact lens wearing also caused increased corneal thinning proportional to the duration of contact lens wearing [15]. These findings indicated that with the increase of duration of lens wear and the morphological and cytological changes, wearers are susceptible to infections, especially true with the presence of pathogenic bacteria such as Pseudomonas sp.S. aureus and other gram negative bacteria. Manifestations related to contact lens wearing like dry eye, red eye, foreign body sensation or grittiness, itchiness, blurred vision and watery eyes are among common associated problems with contact lens wearing [1-3,16].

We isolated 82% bacteria from the lenses and 32% from storage solutions. In majority of contact lens contamination by one type of bacteria was predominant (Figure 2). Isolation of bacterial colonies in our samples shows close similarity with previous findings [1,5-8,16-20].

The most common gram positive bacteria isolated from the contact lenses is coagulase negative staphylococcus which is also a normal constituent of ocular microbiota [1-4,17-22]. Pseudomonas sp. and Serratia sp. are the two most common gram negative bacteria being isolated [1,5,6,19]. However, these bacteria were isolated infrequently and showed a low isolation frequency.

The colonization of contact lenses with the normal ocular microbiota may indicate that the most likely source of bacteria is the lid margin which was introduced during the handling of lens or during normal daily wearing, as previously suggested [18,21,22]. Other practices, such as rubbing or touching the area around the eyes during contact lens wearing, may also cause the colonization of bacteria on the surface of contact lenses.

Whereas the colonization by gram negative bacteria is proposed to be originated from domestic water supply [18]. These microorganisms are water-borne bacteria and occur naturally in water droplets. Another potential source of bacteria is the lens cases. Devonshire *et al* [23-25]. Shows that cases used with conventional wearing and disposable systems were both contaminated which may lead to colonization.

Our study also showed contaminated storage solutions with coagulase negative staphylococcus predominating. There are also other bacteria isolated from storage solutions but are in a lower frequency (Figure 1). The presence of microorganisms in storage solutions raised the questions of the efficacy of these agents in disinfection properties [26,27]. Donzis *et al* [26] found that 13% of commercial contact lens care solutions were contaminated. They also reported that contaminated commercial solutions were opened and used for a longer period of time than uncontaminated solutions. The contaminating bacteria are thought to have been introduced to the lens storage as a result of lens handling and subsequent failure to disinfect lenses [6,24-27].

The fact that lenses were colonized by normal ocular microbiota during uncomplicated wear supports that these bacteria could be non-pathogenic. Colonization of the lens surface with bacteria that are commensal to the eye may inhibit the adhesion of pathogenic species to the lens [1,18,20].

However, essential knowledge regarding contact lens and its accessories and hygienic practice when handling them are imperative to prevent undesirable adverse effects from contact lens wearing. Strict adherence to the manufacturer's guidelines may reduce the rate of highly morbid complications.

Acknowledgements: The authors would like to acknowledge laboratory staff of the Medical Microbiology Department, School of Medical Sciences, University Sains Malaysia, for their assistance during the period of the study and all the undergraduate students of the Health Campus, School of Medical Sciences, University Sains Malaysia, who have participated in this study.

**REFERENCES**

1 Willcox MD, Harmis N, Cowell , Williams T, Holden. Bacterial interactions with contact lenses; effects of lens material, lens wear and microbial physiology. *Biomaterials* 2001;22(24):3225-3247

2 E-medicine [homepage on the Internet]. Contact Lens Complications [cited on January 26, 2007]. Available from: http://www.emedicine.com/OPH/topic651.htm

3 Nortje B. Disadvantages and Eye Problems from Contact Lens [article on the Internet ]. 2003 [cited on 2006 February 12]. Available from : http://www.billnortje.co.za/contact_lenses.htm

4 Giese MJ, Weissman BA. Contact lens associated corneal infections. Where do we go from here? *Clin Exp Optom* 2002;85(3):141-148

5 Borazjani RN, Levy B, Ahearn DG. Relative primary adhesion of Pseudomonas aeruginosa, Serratia marcescens and Staphylococcus aureus to HEMA-type contact lenses and an extended wear silicone hydrogel contact lens of high oxygen permeability. *Cont Lens Anterior Eye* 2004;(1):3-8

6 Holden BA, La Hood D, Grant T, Newton-Howes J, Baleriola-Lucas C, Willcox MD, Sweeney DF. Gram-negative bacteria can induce contact lens related acute red eye (CLARE) responses. *CLAO J* 1996;22(1):47-52

7 Sankaridurg PR, Willcox MD, Sharma S , Gopinathan U, Janakiraman D, Hickson S, Vuppala N, Sweeney DF, Rao GN, Holden BA. Haemophilus influenzae adherent to contact lenses associated with production of acute ocular inflammation. *Journal of Clinical Microbiology* 1996;34(10):2426-2431

8 Sankaridurg PR, Sharma S, Willcox M, Sweeney DF, Naduvilath TJ, Holden BA, Rao GN. Colonization of hydrogel lenses with Streptococcus pneumoniae: risk of development of corneal infiltrates. *Cornea* 1999;8(3):289-295

9 Barr JT. Contact Lens Spectrum's annual report of major corporate and product developments and events in the contact lens industry in 2004, as well as predictions for 2005 [article on the Internet cited on 2006 March 3].Available from http://www.clspectrum.com/article.aspx?article=12733

10 Contact Lens Statistics [article on the Internet] 2004 [cited on 2006 April 1]. Available from: http://www.eyetopics.com/Articles/8/1/Contact-Lens-Statistics.aspx

11 de Oliveira PR, Temporini-Nastari ER, Ruiz Alves M, Kara-José N. Self-evaluation of contact lens wearing and care by college students and health care workers. *Eye Contact Lens* 2003;29(3):164-167

12 Yung MS, Boost M, Cho P, Yap M. Microbial contamination of contact lens and lens care accessories o soft lens wearers (university students) in Hong Kong. *Ophthalmic Physiol Opt* 2007;27(1):11-21

13 Pritchard N, Fonn D, Weed K. Ocular and subjective responses to frequent replacement of daily wear soft contact lenses. *CLAO J* 1996;22(1):53-59

14 Simon P, Jaison SG, Chopra SK, Jacob S. Conjunctival impression cytology in contact lens wearers. *Indian J Ophthalmol* 2002;50(4):301-306

15 Chang SW, Hu FR, Lin LL. Effects of contact lenses on corneal endothelium-a morphological and functional study. *Ophthalmologica* 2001;215(3):197-203

16 Dumbleton K. Adverse events with silicone hydrogel continuous wear. *Cont Lens Anterior Eye* 2002;25(3):137-146

17 Leitch EC, Harmis NY, Corrigan KM, Willcox MD. Identification and enumeration of staphylococci from the eye during soft contact lens wear. *Optom Vis Sci* 1998;75(4):258-65

18 Fleiszig SMJ, Efron N. Microbial flora in eyes of current and former contact lens wearers. *J Clin Microbiol* 1992;30(5):1156-1161

19 Dang YN, Rao A, Kastl PR, Blake RC Jr, Schurr MJ, Blake DA . Quantifying Pseudomonas aeruginosa adhesion to contact lenses. *Eye Contact Lens* 2003;29(2):65-68

20 Willcox MD, Power KN, Stapleton F, Leitch C, Harmis N, Sweeney DF. Potential sources of bacteria that are isolated from contact lenses during wear. *Optom Vis Sci* 1997;74(12):1030-1038

21 Mowrey-McKee MF, Monnat K, Sampson HJ, Smith CM, Davies GA, Mandt L, Proskin HM. Microbial contamination of hydrophilic contact lenses. Part I: Quantitation of microbes on patient worn-and-handled lenses. *CLAO J* 1992;18(2):87-91

22 Willcox MD, Harmis NY, Holden BA. Bacterial populations on high-Dk silicone hydrogel contact lenses: effect of length of wear in asymptomatic patients. *Clin Exp Optom* 2002;85(3):172-175

23 Stapleton F, Willcox MD, Fleming CM, Hickson S, Sweeney DF, Holden BA. Changes to the ocular biota with time in extended- and daily-wear disposable contact lens use. *Infect Immun* 1995;63(11):4501-4505

24 Mowrey-McKee MF, Sampson HJ, Proskin HM. Microbial contamination of hydrophilic contact lenses. Part II: Quantitation of microbes after patient handling and after aseptic removal from the eye. *CLAO J* 1992;18(4):240-244

25 Devonshire P, Munro FA, Abernethy C, Clark BJ. Microbial contamination of contact lens cases in the west of Scotland. *Br J Ophthalmol* 1993;77(1):41-45

26 Donzis PB, Mondino BJ, Weissman BA, Bruckner DA. Microbial contamination of contact lens care systems. *Am J Ophthalmol* 1987;104(4):325-333

27 Clark BJ, Harkins LS, Munro FA, Devonshire P. Microbial contamination of cases used for storing contact lenses. *J Infect* 1994;28(3):293-304