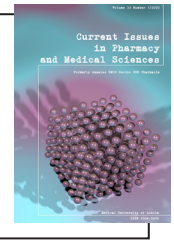
DOI: 10.2478/cipms-2020-0019

Curr. Issues Pharm. Med. Sci., Vol. 33, No. 2, Pages 102-105

Current Issues in Pharmacy and Medical Sciences

Formerly ANNALES UNIVERSITATIS MARIAE CURIE-SKLODOWSKA, SECTIO DDD, PHARMACIA

journal homepage: http://www.curipms.umlub.pl/



Microbiological purity of syringes containing composites in the context of cross-infection prevention in dental practices

Joanna Bialowska[1*], Witold Bojar[2], Tomasz Zareba[3], Stefan Tyski[3], Barbara Tymczyna-Borowicz[1]

[1] Chair and Department of Conservative Dentistry with Endodontics, Medical University of Lublin, Karmelicka 7, 20-081 Lublin, Poland
[2] Department of Oral Surgery, Medical University of Warsaw, Nowogrodzka 59, 02-006 Warsaw, Poland
[3] Department of Antibiotics and Microbiology, National Medicines Institute, Chełmska 30/34, 00-725 Warsaw, Poland

ARTICLE INFO

Received 24 December 2019
Accepted 30 December 2019

Keywords:
cross-infection,
microbiological
contamination,
dental materials.

ABSTRACT

Cross-infection involves the transmission of microorganisms through secretions, bodily fluids and excreta, as well as undisinfected surfaces and medical equipment. In the dental office, diseases are transmitted via various routes, e.g. from patient to dentist or other member of dental team, from doctor or dental team member to patient, from patient to another patient, from dental office to community and from community to patient. The study was conducted to evaluate the effectiveness of infection control in dental practices based on the qualitative and quantitative assessment of microbiological contaminants detected on the surface of filling material packaging used in dental offices. The material for research were 9 packages containing dental materials during their use in 3 dental settings. The packages were placed in sterile flasks and rinsed to wash microorganisms from the surfaces. The washes were filtered through membrane filters and cultured under proper aerobic and anaerobic conditions, and at elevated CO_2 concentration. Microbial growth on TIO and TSB media was observed. The contamination of most samples remained low as indicated by the growth from one to a maximum of five colonies on TSA. The contamination remained at the level of 10-50 CFU/package, i.e. <100 CFU/single package. The tests evaluating the contamination of dental package surfaces with aerobic bacteria confirmed high hygiene standards observed in dental offices from which the packages were brought.

INTRODUCTION

Cross-infection involves the transmission of microorganisms, including viruses, bacteria and fungi, through secretions, bodily fluids and excreta, as well as by way of undisinfected surfaces and medical equipment. In dental offices, diseases are transmitted via various routes, e.g. from the patient to dentist or other member of dental team, from doctor or dental team member to patient, from patient to patient, from dental office to community and from community to patient [1]. Chances of infection transmission can be divided into: high risk – transcutaneous and contact infections, moderate risk – infections due to the inhalation of aerosols or droplets containing pathogens, and low risk – indirect contact with infectious material [2].

* **Corresponding author**
e-mail: joannabialowska@umlub.pl

Pathogenic microorganisms that reside in the oral cavity and airways likely to be transmitted during dental procedures include: cytomegalovirus (CMV), hepatitis C virus (HCV), hepatitis B virus (HBV), herpes simplex virus (HSV1 and HSV2), human immunodeficiency virus (HIV) and many bacteria e.g. *Mycobacterium* spp., *Pseudomonas* spp., *Legionella* spp., *Staphylococcus aureus*, group A streptococci (GAS), *Streptococcus pneumoniae*, *Haemophilus influenzae*, *Neisseria meningitidis*, *Corynebacterium diphtheriae* and *Bordetella pertusis* [3-5]. Viral infection can cause a specific disease, however, not all bacteria can lead to developing infection since some of them are opportunistic microorganisms [4].

Considering the various possibilities of infection transmission in dental office, it is justified to prevent cross-infections and minimize the risk of their occurrence as early as

during clinical training in educational institutions. Prevention of pathogen transmission is a key issue not only for dental practitioners in clinical practice, but also in the education of dental students. Educational institutions take much effort to ensure that student-dentists are aware of the requirements of cross-infections monitoring in dentistry [6]. Despite the importance of teaching cross-infection protocols in medicine and dentistry, there are some challenges that hinder proper practice. This mainly applies to dental procedures that require tools and materials that cannot be sterilized [7-9], e.g. composite resins commonly used in restorative dentistry as an aesthetic material for dental restorations [10]. While the material is packed in light-impervious syringes, during practical classes, resin syringes are commonly used by many students learning how to perform dental treatment. This may increase the risk of cross-infection due to the contamination of the outside surfaces of syringe-packages [11].

AIM

The study was conducted to evaluate the effectiveness of infection control in dental practices based on the qualitative and quantitative assessment of microbiological contaminants detected on the surface of filling material packaging used in dental offices.

MATERIAL AND METHODS

The material for research were 9 packages containing dental materials during their use in 3 dental settings, i.e. The Chair and Department of Conservative Dentistry with Endodontics, Medical University of Lublin and two 'anonymous' dental offices. The products were brought packed in a sterile paper-foil sleeve (samples 1-3, unit-packaging), in a sterile paper envelope (samples 4-6, bulk packed), or in a sterile foil zipper bag (samples 7-9, bulk packed) (Figure 1).

The packages were placed in sterile flasks, one in each, then rinsed with three portions of wash, each containing 100 ml of buffer with peptone and surface-active Tween 80 to facilitate washing of microorganisms from the surface. The washes were filtered through membrane filters $\phi = 0.45$ µm. 1:10 volume of wash fluid was used to determine the population of mesophilic aerobic microorganisms on the surface of packages. The filters were then placed on casein-soy agar medium and incubated at 30°C for 5 days. The remaining volume of washes was divided into 2 equal portions and filtered separately. Next, the filters were placed in microbiological media for sterility testing of medicinal and medical products. One filter was placed in thioglycolate broth – TIO medium and the other in tryptic soy broth – TSB and were incubated at 35°C for 3 days. After the incubation, 0.1 ml of the media (which yielded microbial growth) was placed on Columbia Agar with 5% sheep blood, and incubated under aerobic and anaerobic conditions and at elevated CO_2 concentration. Microbial growth on TIO and TSB media was observed. Species identification of all the microorganisms was performed using the Vitek 2 Compact (bioMérieux).

Figure 1. Packaging (syringes with composite resin) from 3 dental settings: a) Chair and Department of Conservative Dentistry with Endodontics, Medical University of Lublin, b) dental office No 1, c) dental office No 2

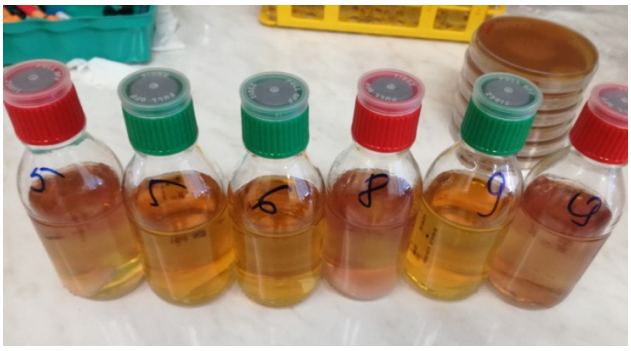
RESULTS

In the washes of samples 5 and 9, no microbes were detected in either the quantitative test on agar or the qualitative test in liquid medium. Absence of microbial growth in the sterility assessment (qualitative test) indicated the lack of germs capable of multiplication on the surface of both packages.

Two samples demonstrated growth in qualitative testing, i.e. sample 6 in TIO medium intended for the growth of aerobic and anaerobic bacteria, and sample 8 in TSB intended for aerobic bacteria and fungi.

Quantitative assessment found low levels of surface contaminants. According to the research methodology, the culture of 1/10 volume of the obtained washes corresponded to 10 CFU (colony forming units). This indicated the level of contaminant detection.

The contamination of most samples remained low, as indicated by the growth from one to a maximum of five colonies on TSA (tryptic soy agar). Considering the filtered volume of washes, it can be stated that the contamination remained at the level of 10-50 CFU/package, i.e. <100 CFU/single package.



Legend: sample 5 – no growth in TSB and TIO, sample 6 – no growth in TSB, sample 8 – no growth in TIO, sample 9 – no growth in TSB and TIO
TSB – tryptic soy broth
TIO – thioglycolate broth

Figure 2. Packages of microbiological media after completed incubation in which no growth was observed.

Table 1. Microbiological contamination of package surfaces with dental filling materials

No of sample	CFU/package	Microorganism
1	10	*Sphingomonas paucimobilis* *Bacillus pumilus*
2	10	*Sphingomonas paucimobilis* *Rhizobium radiobacter*
3	20	*Sphingomonas paucimobilis* *Bacillus licheniformis*
4	10	*Staphylococcus warneri* *Pseudomonas koreensis*
5	-	-
6	<10	*Sphingomonas paucimobilis* *Staphylococcus warneri* *Micrococcus spp.*
7	50	*Bacillus subtlis* *Bacillus pumilus* *Corynebacterium spp.* *Paenibacillus glucanolyticus*
8	<10	*Bacillus megaterium* *Bacillus pumilus* *Kocuria palustris*
9	-	-

Both Gram-positive and Gram-negative bacteria were isolated from the package surfaces of the sampled medical products. Identified Gram-positive bacteria included microorganisms commonly found in the air (*Micrococcus* spp.), soil and water (*Kocuria* spp., *Bacillus* spp., *Paenibacillus* spp.), and the microbiota of human skin (*Staphylococcus warneri*) and upper respiratory tract (*Corynebacter* spp.). Gram-negative bacteria included those found in soil and not forming spores: *Pseudomonas koreensis*, *Sphingomonas paucimobilis* and *Rhizobium radiobacter*.

DISCUSSION

The study analyzed microbiological contamination of syringes with composite filling materials brought from three different settings of dental practice. Comparison of the results found that in two dental offices, no bacteria were found on the surface of one composite package, however, a relatively small growth of microorganisms was detected on the surfaces of all other samples tested.

Although dental facilities follow the highest hygienic standards, some authors indicate a high risk of cross-infection when using syringes containing composites. Considering dental surroundings, the highest concentration of microorganisms in dental office is in the patient's mouth [12]. Oliveira *et al*. [11] and Batista *et al*. [9] indicated a high risk of contamination of composite resins through direct contact, where the operator could transfer the infectious agent from the patient through gloves or dental tools. The hands of dentists, often contaminated with patient's saliva or blood, are the main carriers of etiological agents to various surfaces, including syringes with composite resins.

Ferreira *et al*. [13] carried out research in dental clinics at the University of Manaus and observed the growth of Gram-positive and Gram-negative bacteria, yeasts and molds on the surfaces of 12 (92.3%) syringes with composites used by students during dental procedures. Also Almeida *et al.* [8] assessed the contamination of 55 composite resin samples used in various dental offices, of which 44 (80%) samples were contaminated by coagulase-negative *Staphylococcus* spp. (47.2%), coagulase-negative *Staphylococcus* spp. and *Bacillus* spp. (16.3%), and *Bacillus* spp. (12.7%) and *Aspergillus* spp. (3.6%). In addition, the study by Aleixo *et al*. [14] showed enhanced contamination of the external surfaces of 52 (86.6%) syringes with composites. Moreover, Batista *et al*. [9] observed contamination of 46.15% of syringes with composites, while, Cardoso *et al.* [15] found 100% contamination of resin samples detected as early as the first use of the filling. Only studies by Oliveira *et al*. [11] showed no statistically significant contamination of composite materials.

The results of conducted analyses confirm the possibility of cross-infection spread in dental offices and draw attention to the need of using protocols to deal with potentially infectious materials. Compliance with the disinfection and sanitization rules allows the spread of microorganisms to be limited. Indeed, Silva and Jorge [16] confirmed that disinfection can help reduce microbial contamination of the materials that cannot be sterilized. Still, it is extremely important to be aware of the risk of cross-infection in dental offices and dental educational facilities, as well as their prevention.

CONCLUSIONS

The tests evaluating the contamination of dental package surfaces with aerobic bacteria confirmed high hygiene standards observed in the dental offices from which the packages were brought. No microbiological contamination was found in 2 out of 9 packages tested. On the surfaces of other packages, several to several dozen microbes were found, but at less than 100 CFU/unit package. This value is a conventional value considered as an acceptable level of contamination for packaging containing non-sterile pharmaceutical products.

The microbiological media used for testing, among others, thioglycolate broth for sterility testing of medicinal and medical products on which most microorganisms can grow, found no microorganisms representing oral or nasopharyngeal microbiota. The transmission of etiological infectious agents in dental offices was effectively reduced due to following the rules of disinfection and sanitization.

Cross-infection control is based on continuous analysis and monitoring of potential sources of infection. The systematic development and implementation of detailed protocols for dealing with potentially infectious materials prevents the spread of infectious diseases and ensures health safety for medical personnel and patients.

ORCID iDs

Joanna Białowska https://orcid.org/0000-0002-2393-3538
Witold Bojar https://orcid.org/0000-0003-1645-5272
Tomasz Zaręba https://orcid.org/0000-0003-2000-8248
Stefan Tyski https://orcid.org/0000-0003-3352-038X
Barbara Tymczyna-Borowicz https://orcid.org/0000-0002-5981-7205

REFERENCES

1. Miller CH, Palenik CJ, Jkan B, Altay MA. Infection control and management of hazardous materials for the dental team, 3rd ed 10 infectious disease and personal protection techniques for infection control in dentistry. *J Dent Med Sci*. 2017;16(04):126-41.
2. Kohli A, Puttaiah R. *Dental infection control and occupational safety for oral health care professionals Australian Dental Association*. Guidelines for Infection Control, Second Edition, 2012.
3. Baseer MA, Rahman G, Yassin MA. Infection control practices in dental school: a patient perspective from Saudi Arabia. *DRJ* (Isfahan). 2013;10:25-30.
4. Laheij AMGA, Kistler JO, Belibasakis GN, Välimaa H, de Soet JJ. Healthcare-associated viral and bacterial infections in dentistry. European Oral Microbiology Workshop (EOMW) 2011 *J Oral Microbiology*. 2012;4:17659.
5. John M. Risk of bacterial transmission in dental practice. *J C an Dent Assoc*. 2000;66:550-2.
6. Westall JO, Dickinson C. Compliance with occupational exposure risk management procedures in a dental school setting. *British Dental Journal*. 2017;222(11):859-63.
7. Samaranayake LP. Rules of infection control. *IDJ*. 1993;43(6):578-84.
8. Almeida JCF, Prado AKS, Silva WC, Wértina C, Pedrosa SF, Moura MAO, Lopes LG. Contamination of composite resins in dental offices. *ROBRAC*. 2010;19:211-5.
9. Batista ME, Gomes PS, Freitas MRLS, Alvaez-Leite ME. Evaluation of microbiological contamination of tubes of composite resin, syringes of acid and fur brushes used in different dental restorations. *Revista de Odontologia da Universidade Cidade de São Paulo*. 2013;25;115-25.
10. Pauletti NA, Girotto LPS, Leite FHS, Mario DN. Effect of photoactivation on the reduction of composite resin contamination. *EJOS*. 2017;125(3):223-6.
11. Oliveira M, Barreto RM, Salgado IO, Chaves Filho HDM, Diniz CG. Evaluation of bacterial contamination in composite resins used at graduation clinics of FO-UFJF. *Odontol ClínCient*. 2010;9(1):73-6.
12. Ranali J, Ramacciato JC, Motta RHL. Biossegurança na sedação inalatória com óxido nitroso e oxigênio. *APCD*. 2004;58(5):374-8.
13. Ferreira RO, Caires NCM. Avaliação da contaminação dos tubos de resina composta nas clínicas do Curso de Odontologia de uma universidade partículas em Manaus - AM. *J Health Sci Inst*. 2012;30(3):206-10.
14. Aleixo RQ, Queiroz RC, Custódio VC, Moura JA. Contaminação dos tubos de resina composta utilizados na clínica odontológica. *Clínica e Pesquisa em Odontologia - UNITAU*. 2010;2(1):39-45.
15. Cardoso CT, Pinto JR. Junior, Pereira EA, Barros LM, Freitas ABDA. Contaminação de tubos de resina composta manipulados sem barreira de proteção. *ROBRAC*. 2010;19(48).
16. Silva CRG, Jorge AOC. Evaluation of surface disinfectants utilized in dentistry. *Pesquisa Odontológica Brasileira*. 2002;16(2):107-14.