

Efficacy of Antibiotic Prophylaxis in The Prevention of Bacterial Endocarditis in Dental Practice

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Abstract

Patients at risk from Bacterial endocarditis (BE) are those with a congenital heart disease (CHD), while the most etiologic factors are oral cavity microorganisms. One of the negative effects from frequent intake of antibiotics is the increase of resistant bacterial strains.

Aim of this study was to determine the antibiotic resistance of oral streptococci after having received the amoxicillin prophylaxis prior to dental procedures in children with CHD.

This study included 60 children with CHD, 6-15 years old, divided into two groups: children with CHD who had not taken (n=30) and who had taken antibiotics (n=30) of the penicillins within the last three months. Ten children from each group were selected as subgroups (subgroup 1, subgroup 2), which were patients at high risk and they were covered with a prophylactic dose (pd) of amoxicillin one hour before dental procedures. The study was carried out in the University Dentistry Clinical Center of Kosova, Department of Pediatric Dentistry in cooperation with the Microbiological Department.

After coverage with the prophylactic dose according to the indication, there had been an increase of bacterial resistance in amoxicillin.

Based on the results of our study we can conclude that with the prophylactic coverage of amoxicillin before the dental procedures, we cannot ensure we have achieved a safe defense from the development of BE.

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Introduction

Bacterial endocarditis is one of the most serious human infections associated with high morbidity and mortality. It has low incidence, from 5 to 7.9 per 100000 person-years, but it is a life-threatening infection.¹ Patients at risk from this infection are those with a congenital heart disease (CHD), while the most etiologic factors are oral cavity microorganisms.² The oral cavity contains various microorganisms and such a diverse composition has been described by Antonie van Leeuwenhoek in 1683.^{3,4} Bacterial deposits on tooth surfaces known as bacterial or dental plaque, represent a colony of bacteria attached tightly to the surface of the tooth, in

which viridans group streptococci (VGS) represent the biggest population.^{5,6} According to Martin H. et al (2015) oral viridans streptococci, are implicated as causal microorganisms of BE in ~35%–45% of cases.⁷

Bacteremia is the initiating factor for BE.^{6,8} Polymicrobial oral infections play a role in the development of dental origin bacteremia.⁹ Bacteria from the oral cavity may be introduced in blood-flow through various mechanisms and portals. It is commonly caused by procedures that can follow up bleeding such as: tooth extraction, scaling, endodontic treatment, surgical *incision, etc.*⁸ Odontogenic bacteriemia is transient in nature, for 10-15 minutes.¹⁰ For patients at risk such short lasting bacteriemia is sufficient for the development of bacterial endocarditis.^{10,11} Bacteremias induced by invasive dental treatments have been reported as a cause of bacterial endocarditis in these patients.¹²

Oral infections can mainly be caused from gram-positive and gram-negative of both anaerobic and aerobic bacteria. Both aerobic and anaerobic

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microorganisms are susceptible to penicillin.¹³ Therefore, antibiotics of the penicillin family are the most widely used antimicrobial agents in dental practice, excluding allergy situations.^{14, 15}

Amoxicillin is still considered the most effective antimicrobial medication against etiologic causes of oral and odontogenic infections.¹⁶

In recent literature, the use of antibiotics is still subject to debate due to the fact that transitional bacteremia and BE can also be caused spontaneously, in the absence of dental procedures.^{6,17- 19} There is evidence that specific episodes of dental treatment in patients at risk is less likely to cause BE than spontaneous bacteraemia.²⁰

The frequent usage of antibiotics could also have negative effects on health such as the increase of antimicrobial resistance.^{2, 21}

According to Richard J (2014), antibiotic resistant bacterial strains have been observed with increasing frequency over the past several decades.²²

In dental practice antibiotics are not only used to treat dental infections but also as prophylaxis especially for patients at risk from BE prior to certain dental procedures. Also, antiseptic mouthwashes, prior to dental procedures, have an impact in reducing of bacteremia.^{20, 23}

In the past, the American Heart Association (AHA) guidelines recommended that most patients with a congenital heart anomalies receive antibiotics prior to almost any dental procedure. However, as more information has become available regarding the risk of dental procedures for patients with heart diseases, these guidelines have changed.¹

Reviews of studies performed between 1950 and 2006, which included thousands of patients, has shown that there was no benefit in using preventive antibiotics before dental procedures, except at higher risk patients, namely those who have:²

- Prosthetic cardiac valve, Previous endocarditis, Congenital heart disease (CHD) only in the following categories:
 - Unrepaired cyanotic congenital heart disease, including those with palliative shunts and conduits
 - Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or catheter intervention, during the first six months after the procedure

- –Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
- Cardiac transplantation recipients with cardiac valvular disease

Preventive antibiotics are recommended for high-risk patients undergoing dental procedures that involve manipulation of the tissue of the gums, the periapical region of the teeth, tooth extractions, dental scaling, or drainage of a dental abscess.^{2, 18}

The recommended prophylactic dose by the AHA guidelines (2007) is as follows: 2gr Amoxicilin for adults and 50 mg/kg for children 30 -60 min before procedures. In cases of penicillin allergy, Cephalexin (2gr for adults, 50mg/kg for children), Clindamycin (600mg for adults and 20mg/kg for children) or Azitromycin (500mg for adults and 15mg/kg for children) are recommended.²

The purpose of this study was to determine the antibiotic resistance of oral streptococci after having received the amoxicillin prophylaxis prior to dental procedures based on the standard prophylaxis of the AHA guidelines in 2007, in children with Congenital heart disease-CHD. Furthermore, the resistance on erythromycin, clindamycin and cephalixin was evaluated.

Materials and methods

Ethical considerations

This research was approved by the University Dentistry Clinical Center's Ethics Committee.

The study was carried out in the University Dentistry Clinical Center of Kosova, the Department of Pediatric Dentistry in cooperation with the Microbiological Department, for a period of two years (2014-2016).

The study sample included 60 children with different type of CHD, 6-15 years of age. The children were divided into two groups: group 1 including 30 children with CHD who had not taken antibiotics within the previous three months and group 2 including 30 children with CHD who had taken antibiotics of the penicillins within the previous three months, meanwhile patients who had received antibiotics from other groups had been excluded.

Ten children from each group were selected as subgroups (subgroup1, subgroup 2). Based on AHA guideline of 2007 (2), patients of these two subgroups were at high risk and they were covered with a prophylactic dose (pd) of amoxicillin one hour before dental procedures. (Table 1)

CHD group without antibiotic within three months			CHD group with antibiotic within three months		
non pd	Pd- (Subgroup1)	Total	non pd	Pd- (subgroup2)	total
20	10	30	20	10	30

CHD: congenital heart disease
 non pd: no prophylactic dose received prior to dental treatment
 Pd: prophylactic dose of amoxicillin prior to dental treatment

Table 1. Sample descripton based on the usage of antibiotics.

Initially, general data was taken from parents of the children. Moreover medical documentation from pediatric cardiologist was required from which, data on the type of anomaly were determined. Data on the type of antibiotics taken within the previous three months had also been obtained.

From the total number involved in the research, non-invasive treatments had been carried out in 40 of them (20 who had not and 20 who had used antibiotics). Twenty of the participants involved (10 that had not and 10 that had used antibiotics) were at high risk. These patients were in need of invasive dental treatment (permanent tooth ekstraction and dental scalling) and they were covered with an amoxicilin prophylactic dose one hour before the procedure.

After clinical examination, diagnostics and treatment planning, the samples were obtained from the dental plaque using the sterile swab sticks and were sent for microbiological analysis. The Samples were cultivated on Columbia nutrient agar and placed in the microbiological incubator. Then, the dental plaque gram positive streptococci which is thought to be a potential cause of BE, were identified using the automated system, VITEK 2 (BioMerux). To investigate the possible increase of antibiotic resistance the samples were taken from all participans before dental treatment, meanwhile from each subgroup that was at high risk it was taken twice, before given a prophylactic dose of amoxicilin prior to dental treatment and a week afterwards.

For determining the resistance in

amoxicillin, erythromycin, clindamycin and cephalixin the disc diffusion method was used. Using millimeter measurements, the inhibition zones for four antibiotics were evaluated.

Results

From all isolated strains of bacteria, the following results were found: mitis group (37.2%), non viridans group of streptococci (8.2%), sanguinis group (7.8%), salivarius group (6.7%), anginosus group (3.3%), strains of mutants group (2.8%). (Figure1)

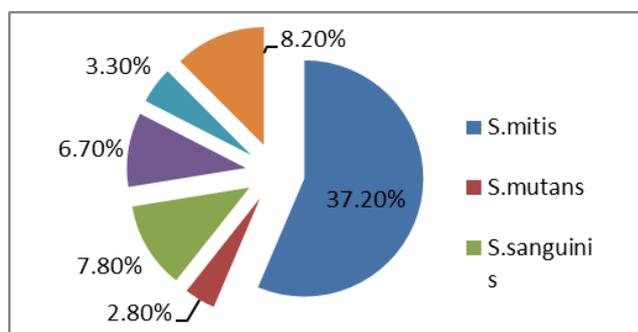


Figure 1. Prevalence of streptococci Group Isolated from Dental Plaque.

The higher resistance of amoxicillin were found on a group of children with CHD who had taken antibiotics within the previous three months (23.3%), while the resistance in the other group was 3.3%, ($P < 0.05$). Ttable 2)

	CHD group without antibiotic within three months		CHD group with antibiotic within three months		TOTAL	
	N	%	N	%	N	%
Amoxicillin						
I	2	6.7	-	-	2	3.3
R	1	3.3	7	23.3	8	10.0
S	27	90.0	23	76.7	50	86.7
Total	30	100.0	30	100.0	60	100.0

Antimicrobial sensitivity: I-intermediate, R-resistance, S-sensitiv

Table 2. Incidence Rate of amoxicillin Resistant Oral streptococci in Children’s Groups.

After coverage of the prophylactic dose according to the indication, there had been an increase in resistance. In the first group bacterial resistance was found in two patients, a significant change from what had previously been 0. In the second group it was found in three patients, from what had previously been two. (Table 3).

	CHD group without antibiotic within three months		CHD group with antibiotic within three months	
	Before pd	After pd	Before pd	After pd
I	-	-	-	-
R	0	2	2	3
S	10	8	8	7
Total	10	10	10	10

Table 3. Amoxicillin Sensitivity - Resistance by Group Before and After Amoxicillin Prophylaxis.

For all antibiotics tested in our research, antimicrobial resistance was higher in both subgroups after prophylactic coverage with amoxicillin. The increase in resistance was as follows: regarding amoxicillin the 2 cases increased to 5; for erythromycin it increased from 3 to 4; for cephalexin from 5 to 7 and for clindamycin from 3 to 4 (Table 4.)

Antibiotic	CHD group without antibiotic within three months (n=10)			CHD group with antibiotic within three months (n=10)		
	Before pd	After pd	total	Before pd	After pd	total
amoxicillin	0	2	2	2	3	5
erythromycin	1	1	2	1	2	3
cephalexin	2	3	5	3	4	7
clindamycin	1	2	3	2	2	4

Table 4. Frequency of Resistance in All Tested Antibiotics by Group, Before and After Amoxicillin Prophylactic Dose.

Discussion

This study researched antimicrobial resistance of streptococci isolated from dental plaque in children with CHD. Isolated streptococci may be a possible cause of bacterial endocarditis during dental procedures in these patients

The antibiotics involved in this research are amoxicillin, which has a broad spectrum and is recommended by the AHA, then erythromycin, cephalexin and clindamycin, recommended in cases of penicillin allergy.

Various research has been carried out in different countries that provide data regarding oral health status, oral hygiene, types of isolated streptococci in a dental plaque and antimicrobial resistance in children with CHD. Different studies, have determined streptococci and their level in blood, after bacteremia caused by dental treatments.^{11, 20, 24-26}

Most of the studies have reported a weaker oral health status for children with CHD, including the prevalence of caries compared to healthy children. Despite these differences, authors conclude that such a condition is not a consequence of the direct impact of the congenital anomaly but instead of the neglect of their oral health.^{19, 24, 25, 27}

Regarding isolated streptococci from DP for the two study groups (n = 60), the viridans group had dominated with a higher percentage of Streptococcus mitis group (37.2%)

The data from our research correspond to those of Rozkevicz D et al. who in their own research on prevalence of DP streptococci, give data on the dominance of VGS in 72% of patients, also with a higher percentage of S.mitis (27.3%).²⁶

Our research regarding antimicrobial resistance of isolated streptococci in DP, provides data for a higher amoxicillin resistance of streptococci in children who had taken antibiotics within the previous three months (23.3%). In the other group, amoxicillin resistance was found in the lower percentage (3.3%). The difference was significant between the groups (P <0.05).

According to our research, viridans streptococci have been sensitive in amoxicillin at all patients (subgroup 1, n=10) with CHD that haven't taken antibiotics within the previous three months. After taking the prophylactic dose (50mg/kg) 60 minutes before dental procedures, resistance had been found in two patients in this group. As for the patients that had taken antibiotics in these three months (subgroup 2, n=10), resistance was encountered in two of them before taking the prophylactic dose and three after.

Logman LP et. al., (1991) reported an increased resistance on amoxicillin after given the prophylactic dose. They had included 65 patients and examined the antimicrobial resistance of DP bacteria, before and after given the prophylactic dose of amoxicillin (54 patients) and erythromycin (11 patients). Amoxicillin resistance was found in 9% of the patients that had taken it, whereas erythromycin resistance was found in 22% of patients that had taken amoxicillin. Erythromycin resistance was found in 9% of patients that had taken erythromycin.²⁸ Our research report on erythromycin resistance in 15% of the 20 patients (both subgroups) that had

taken prophylactic dose of amoxicillin before treatment.

Harrison G.A et. al. (1985) has analysed the increase of amoxicillin resistance in 10 subjects that have taken a profilactic dose of 3 gram amoxicillin for four weeks straight. There were resistant streptococci found in one of them before the first dose. After receiving the first dose the resistance was found in two volunteers. After receiving two doses resistant streptococci were found in four and after four weeks it was present in six volunteers.²⁹

Conclusions

Based on the results of our study we can conclude that with the prophylactic coverage of amoxicillin before the dental procedures, we cannot ensure we have achieved a safe defense from the development of BE. For this reason, the preliminary verification in antibiotic sensitivity of oral bacteria would be is necessary. Otherwise, it is very important for these patients to have regular dental check-ups in order to prevent dental and oral pathologies, for which, dental treatment should be done with antibiotic coverage. The preventive dental measures are more crucial in reducing the risk of BE than the administration of antibiotic-prophylaxis prior to dental procedures.

Declaration of Interest

The authors report no conflict of interest.

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