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The impact of oral disease and nonsurgical treatment on bacteremia in children

Michael T. Brennan, DDS, MHS; M. Louise Kent, RN; Philip C. Fox, DDS; H. James Norton, PhD; Peter B. Lockhart, DDS

Studies have demonstrated a wide range of incidence, nature (species of bacteria) and duration (IND) of bacteremia after dental office procedures that are both minimally invasive (for example, tooth brushing) and more invasive (for example, dental extractions).¹⁻⁶ The impact of bacteremia from dental procedures on the risk of developing infective endocarditis (IE) remains controversial, as the American Heart Association (AHA) guidelines for prevention of IE from dental procedures are not based on prospective clinical trials.⁷

The impact of dental disease on the IND of bacteremia after dental procedures still is unclear; no associations are found in some studies,^{8,9} and a significant effect is found in others.^{1,10-13} Similar to the literature on adults, investigators have reported a wide range of IND of bacteremia in children,^{8,12,14-18} and the role of dental disease in IND is poorly understood. In a study by Lockhart and colleagues,¹⁴ the investigators randomized 100 children to receive an antibiotic or a placebo before dental rehabilitation in an operating room (OR) setting.¹ They reported the role of the AHA-recommended dose of amoxicillin in moderating the IND of bacteremia in children younger than 8 years and demonstrated that the incidence of bacteremia was reduced significantly in the amoxicillin

ABSTRACT



Background. The authors examine the role of dental disease and nonsurgical dental procedures in the incidence and duration of bacteremia in children.

Methods. The authors randomized a group of children to receive amoxicillin or a placebo before dental rehabilitation in an operating room setting. They collected eight blood draws at the following times: two minutes after intubation (draw 1); after dental restorations, pulp therapy and cleaning (draw 2); 10 minutes later (draw 3); and five draws during and after dental extractions (draws 4-8). The authors compared dental disease parameters and the type of dental procedures performed with the incidence and duration of bacteremia.

Results. The authors enrolled 100 children (aged 1-8 years) in the study. The incidence of bacteremia from draw 2 was 20 percent in the placebo group and 6 percent in the amoxicillin group ($P = .07$), and the incidence from draw 3 was 16 percent in the placebo group and zero percent in the amoxicillin group ($P = .03$). Subjects with higher gingival scores were more likely to have a bacteremia for draw 2 ($P = .01$). The authors found that subjects in the group with bacteremia for draw 3 had undergone more pulpotomies than did subjects in the group without bacteremia for draw 3 (3 ± 2.5 standard deviation [SD] versus 1.5 ± 1.6 SD, $P = .04$), while they found almost no differences for draw 2.

Conclusions. This study suggests that gingival disease has an impact on bacteremia after dental restorations and prophylaxis. Although antibiotics have an impact, they do not eliminate bacteremia altogether.

Key Words. Bacteremia; infective endocarditis; pediatric dental care; gingival diseases.

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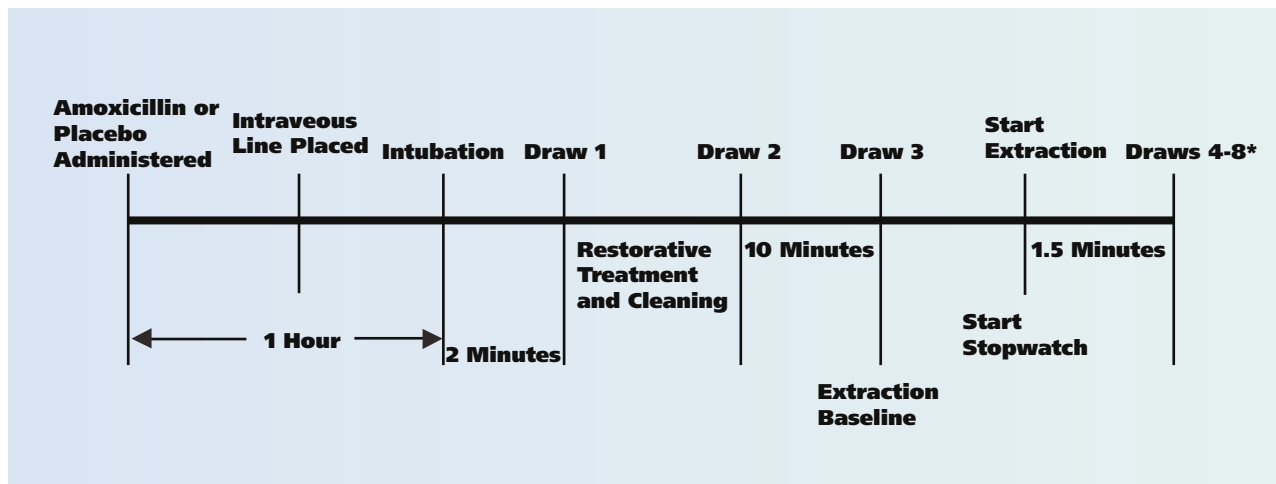


Figure. Study timeline. * In cases of single tooth extractions, the fifth blood draw took place three minutes after the initiation of the first extraction. Adapted and modified with permission by Lippincott Williams and Wilkins from Lockhart and colleagues.¹⁴

group compared with the placebo group (33 percent versus 84 percent, $P < .0001$). The species of bacteria and duration of bacteremia also were affected. The severity of dental disease did not affect the incidence of bacteremia shortly after extractions, but increases in age and number of teeth extracted were associated with higher incidence levels of bacteremia.

The goal of our study was to examine the role of dental disease and nonsurgical dental procedures on the incidence and duration of bacteremia in children.

SUBJECTS, MATERIALS AND METHODS

We enrolled 100 children who required dental treatment in an OR setting owing to uncooperative behavior, young age or the extent of treatment needs. We obtained consent from each child's parent or legal guardian as approved by the institutional review board at Carolinas Medical Center, Charlotte, N.C. We randomized the subjects using a computer-generated random number scheme, and used identical-appearing syringes to administer the placebo or the amoxicillin. All of the investigators were blinded to the assigned treatment.

The subjects received the AHA-recommended dose of an amoxicillin elixir (50 milligrams/kilogram) or a placebo one hour before dental rehabilitation in an OR setting (Figure). We then sedated the subjects with midazolam and brought them to the OR, where we performed a mask induction and placed an intravenous line for anesthetic administration purposes. For blood culture draws, we placed a large-bore (18-22 grams)

angiocath needle with a line in the antecubital fossa or dorsum of the hand, after we prepared the skin in the usual manner with alcohol, followed by povidone-iodine (10 percent).

We drew 6 milliliters of blood (draw 1) two minutes after we initiated intubation. After placing throat packs, we took dental radiographs and conducted a thorough oral examination. After we completed dental restorations, pulp therapy and prophylaxis, we drew a second 6-mL blood sample (draw 2). Ten minutes later, we drew a third 6-mL blood sample (draw 3) to determine the duration of bacteremia after the procedures were performed and as a baseline culture before dental extractions were performed. We have reported data from draw 1 and draws 4 to 8 after dental extractions.¹⁴

We flushed the angiocath needle and line with 3 cubic centimeters of saline after each blood draw, and we drew and discarded 2 cm³ of blood before each draw. The order of dental procedures was completion of the dental restoration followed by dental prophylaxis. Therefore, we performed draw 2 immediately after the dental cleaning; however, the incidence and duration of bacteremia likely also were influenced by the restorative treatment.

In addition to recording demographic variables (age, sex, ethnic group), we recorded the following for each subject:

ABBREVIATION KEY. **AHA:** American Hospital Association. **IE:** Infective endocarditis. **IND:** Incidence, nature (species of bacteria) and duration. **OR:** Operating room.

- periodontal status (gingival score [0 = normal, 1 = mild inflammation, 2 = moderate inflammation, 3 = severe inflammation],¹⁹ gingival size [0 = normal, 1 = slight enlargement, 2 = moderate enlargement, 3 = gross enlargement] and periodontal disease present with any probing depths > 3 millimeters [yes/no]);
- mixed dentition versus primary dentition;
- caries present (yes/no);
- depth of caries (0 = none, 1 = to dentin, 2 = to pulp, 3 = gross);
- periapical radiolucency present (yes/no);
- the size of the radiolucency (in mm);
- swelling present (yes/no);
- suppuration present (yes/no);
- type of dental procedure performed:
- prophylaxis completed (yes/no);
- number of amalgam restorations, resin-based composites, sealants and stainless steel crowns placed;
- number of pulpectomies (removal of pulpal tissue from pulp chamber and roots) and pulpotomies (removal of pulpal tissue from pulp chamber only) performed;
- time required to complete dental restorations.

Microbial analysis. We divided each blood sample into 2-mL pediatric BACTEC aerobic (PEDS PLUS) (Becton Dickinson, Sparks, Md.) and 4-mL adult BACTEC anaerobic bottles, per the manufacturer's recommendation. After we collected the last draw, we transported all 16 aerobic and anaerobic bottles to the microbiology laboratory for incubation and processing according to standard methods.²⁰ We gram-stained cultures with evidence of bacterial growth and subcultured them onto appropriate media. We continuously monitored blood cultures for growth using an automated microbiology analyzer system (Microscan, Baxter, West Sacramento, Calif.) and manually completed standard biochemical tests for species identification. We incubated blood cultures for up to 14 days to ensure identification of more slow-growing species.

Data analysis. We examined the role of demographics, dental disease and types of dental procedures on the incidence of bacteremia for blood draws 2 and 3. We calculated descriptive statistics, including means and standard deviations, counts and percentages. For continuous data, we used a Student *t* test or a Wilcoxon rank sum test. We used a χ^2 or Fisher exact test for nominal data. We used computer software (SAS, Version 8.2, SAS Institute, Cary, N.C.) for all analyses.

We considered a *P* value of less than .05 to be statistically significant.

RESULTS

We enrolled 100 children (age range, 1-8 years) in the study. We randomized the subjects to receive a placebo (51) or amoxicillin (49). We did not collect draw 2 from one subject, and we did not collect draw 3 from six subjects. We dropped these subjects from the data analyses.

The incidence of bacteremia from draw 2 was 20 percent in the placebo group and 6 percent in the amoxicillin group (*P* = .07). The incidence of bacteremia from draw 3 was 16 percent in the placebo group and zero percent in the amoxicillin group (*P* = .03), as we reported previously.¹⁴

We noted no statistically significant differences in baseline characteristics between subjects in the placebo and amoxicillin groups (Table 1). We compared demographic, dental disease and type of restorative treatment data for bacteremia incidence groups for draws 2 and 3. For draw 2, we found that the mean age of the subjects in the group with bacteremia was 4.1 ± 1.3 standard deviation (SD) years and the mean age of the subjects in the group without bacteremia was 3.4 ± 1.2 SD years (*P* = .06). We also found that two (15 percent) of 13 subjects in the group with bacteremia had a mixed dentition compared with two (2 percent) of the 86 subjects in the group without bacteremia (*P* = .08) (Table 2, page 84).

When we compared dental disease and incidence of bacteremia, we found that subjects with higher gingival scores were significantly more likely to have a bacteremia for draw 2 (*P* = .01). No other dental disease parameters had a statistically significant association with a bacteremia.

We found that subjects in the group with bacteremia for draw 3 had undergone more pulpotomies than did subjects in the group with no bacteremia for draw 3 (3 ± 2.5 SD versus 1.5 ± 1.6 SD, *P* = .04), while we found almost no differences for draw 2. We did not perform pulpectomies in the subjects who had a bacteremia in draws 2 and 3; we performed 0.3 ± 1.0 SD pulpectomies in subjects in the no bacteremia group (*P* = .01).

DISCUSSION

A variety of dental procedures have been associated with bacteremia in children, but few studies have assessed bacteremia after nonsurgical procedures. Incidence rates after oral prophylaxis in children range from 0 to 40 per-

cent,^{15,17,18} while studies in adults have shown incidence rates of 15 to 61 percent.^{21,22} Minimal information is available for incidence rates associated with other types of dental procedures in children. One study reported a higher incidence of bacteremia with rubber dam placement (31 percent) and a matrix band with a wedge (32 percent) compared with baseline (9 percent) and removal of tooth structure with a dental drill (4-12 percent).²³ Although the incidence and nature figures for bacteremia are varied, largely owing to different study methodologies, there have been no large studies concerning the duration of bacteremia in children.

Our study demonstrated an incidence of bacteremia after dental restorations and cleaning of 20 percent in the placebo group (draw 2), which falls within the range of previous studies of dental cleaning in children.^{17,18,24,25} Sixteen percent of the subjects in the placebo group still had bacteremia 10 minutes later (draw 3). As expected, this bacteremia incidence was lower than that from dental extractions (76 percent).^{6,14}

A comparison of the amoxicillin and placebo groups did not show statistically significant differences at draw 2 ($P = .07$), but it did at draw 3 ($P = .03$). For draw 2, three subjects in the amoxicillin group had a bacteremia. This demonstrates that amoxicillin does not completely eliminate bacteremia after dental restorations and prophylaxis in children. However, no subjects in the amoxicillin group had a bacteremia 10 minutes later (draw 3). Therefore, the duration of bacteremia did not linger beyond 10 minutes with antibiotic prophylaxis.¹⁴

We found that only one parameter of dental disease—higher gingival scores—was associated with a higher incidence of bacteremia at draw 2. One pediatric study reported that gingival disease is related to the bacteremia incidence after dental extraction,¹² while other pediatric studies found no relationship between dental disease factors and extractions, oral prophylaxis or noninvasive dental procedures.^{8,17,23} In a previous study, we found that older age was associated with bacteremia after dental extractions,¹⁴ but this finding was not statistically significant for draws 2 or 3. Older children have more teeth and different oral bacterial flora than do younger children, which likely results in a different IND of bacteremia.

We found that subjects in the group with bacteremia for draw 3 had undergone more pulpomies than did subjects in the group without

TABLE 1

Baseline characteristics of 100 subjects randomized to receive amoxicillin or a placebo.*

CHARACTERISTIC	AMOXICILLIN (n = 49)	PLACEBO (n = 51)
Mean Age (Years [SD†])	3.4 (1.3)	3.5 (1.5)
Mean Weight (Kilograms [SD])	16.5 (2.9)	16.5 (2.9)
Male (No. [%])	30 (61)	26 (51)
Ethnic Group (No. [%])		
Asian	1 (2)	4 (8)
African-American	29 (59)	30 (59)
White	16 (33)	14 (27)
Hispanic	3 (6)	3 (6)
Dental Disease		
Radiographic abscess [‡] (No. [%])	25 (51)	36 (73)
Swelling (No. [%])	10 (20)	15 (29)
Suppuration (No. [%])	19 (39)	23 (45)
Clinical caries (No. [%])	49 (100)	51 (100)
Gingivitis (0-3) (No. [SD])	1.0 (0.8)	1.0 (0.7)
% of Drug Ingested	97.7	97.8
Time From Administration of Study Drug to Intubation (Minutes [SD])	47.6 (21.1)	44.4 (20.7)
Restorative Treatment		
Prophylaxis (No. [%])	43 (88)	43 (84)
Amalgam restoration (No. [SD])	0.5 (0.9)	0.8 (1.5)
Resin-based composite (No. [SD])	3.3 (2.6)	3.4 (2.3)
Sealant (No. [SD])	1.5 (1.9)	1.6 (2.0)
Pulpotomy [‡] (No. [SD])	1.9 (1.7)	1.3 (1.6)
Pulpectomy (No. [SD])	0.2 (0.6)	0.3 (1.1)
Stainless steel crown (No. [SD])	3.7 (2.3)	3.1 (2.1)

* Adapted with permission by Lippincott Williams and Wilkins from Lockhart and colleagues.¹⁴
 † SD: Standard deviation.
 ‡ $P = .07$.

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bacteremia for draw 3, while we found almost no differences for draw 2. We also found that pulpec-

TABLE 2

Relationship between baseline demographic and odontogenic findings and bacteremia incidence for draws 2 and 3.

BASELINE ODONTOGENIC VARIABLES	DRAW 2		P VALUE	DRAW 3		P VALUE
	Bacteremia (n = 13)	No Bacteremia (n = 86)		Bacteremia (n = 6)	No Bacteremia (n = 88)	
Age (Years) (Mean No. [%])	4.1 (1.3)	3.4 (1.2)	.06	4.2 (0.8)	3.4 (1.2)	.16
Sex (Mean No. [%])			NS*			NS
Male	7 (54)	49 (57)		1 (17)	51 (58)	
Female	6 (46)	37 (43)		5 (83)	37 (42)	
Race (Mean No. [%])			NS			NS
African-American	9 (69)	49 (57)		4 (67)	52 (59)	
White	1 (8)	29 (34)		0	27 (31)	
Hispanic	2 (15)	4 (5)		0	6 (7)	
Other	1 (8)	4 (5)		2 [†] (33)	3 (3)	
Periodontal Status (Mean No. ± SD[‡])						
Gingival score (0-3)	1.5 (0.7)	0.9 (0.7)	.01	1.2 (0.4)	1.0 (0.8)	NS
Gingival size (0-3)	0.8 (0.8)	0.7 (0.7)	NS	0.8 (0.4)	0.8 (0.7)	NS
Periodontal disease with any probing > 3 millimeters (yes/no)	0 (0)	0 (0)	NS	0 (0)	0 (0)	NS
Dental Status						
Mixed dentition [§] (no. [%])	2 (15)	2 (2)	.08	0	4 (4)	NS
Caries present (yes/no) (no. [%])	13 (100)	86 (100)	NS	6 (100)	88 (100)	NS
Depth of caries (0-3) (no. [SD])	2.5 (0.7)	2.5 (0.6)	NS	2.8 (0.4)	2.5 (0.6)	NS
Periapical radiolucency (no. [%])	9 (69)	52 (60)	NS	5 (83)	54 (61)	NS
Size radiolucency (mm) (no. [SD])	2.3 (1.8)	1.9 (1.5)	NS	2.3 (1.4)	1.9 (1.5)	NS
Swelling (no. [%])	5 (38)	20 (23)	NS	3 (50)	22 (25)	NS
Suppuration (no. [%])	7 (54)	39 (46)	NS	3 (50)	43 (49)	NS
Restorative Treatment						
Prophylaxis (no. [%])	10 (77)	76 (88)	NS	5 (83)	76 (86)	NS
Amalgam restoration (no. [SD])	1.3 (2.0)	0.6 (1.1)	NS	0.5 (0.8)	0.7 (1.3)	NS
Resin-based composite (no. [SD])	2.6 (3.1)	3.5 (3.0)	NS	3.7 (2.5)	3.2 (2.5)	NS
Sealant (no. [SD])	1.7 (1.7)	1.5 (2.0)	NS	0.8 (1.6)	1.5 (2.0)	NS
Pulpotomy (no. [SD])	1.5 (1.9)	1.7 (1.6)	NS	3 (2.5)	1.5 (1.6)	.04
Pulpectomy (no. [SD])	0 (0)	0.3 (1.0)	.01	0 (0)	0.3 (1.0)	.01
Stainless steel crown (no. [SD])	2.8 (1.5)	3.5 (2.3)	NS	4.5 (2.1)	3.4 (2.3)	NS
Time to Complete Restorations (Minutes [SD])	94.7 (32.2)	92.8 (39.0)	NS	80 (59)	93 (36)	NS

* NS: Nonsignificant ($P > .05$).
[†] Both patients were of Asian descent.
[‡] SD: Standard deviation.
[§] Mixed dentition includes children with primary and adult dentition.

tomies were more common in the no bacteremia group for both draws 2 and 3. No subjects in the group with bacteremia underwent pulpectomies. As these findings are contradictory, it is unclear if these types of procedures have any role in the incidence or duration of bacteremia in children, or if these findings resulted from the small number of pulpectomies performed overall.

A limitation of our study is the small number of subjects in the group with bacteremia for draws 2 and 3, which allowed for only univariate analyses. Multivariate regression analysis, controlling for the impact of amoxicillin, would have been more appropriate. In addition, multiple comparisons can produce type I errors, which might account for the finding of a lower incidence of bacteremia after pulpectomies. Similarly, because of the low incidence of bacteremia, a type II error may have occurred with differences between the amoxicillin and the placebo at draw 2.

CONCLUSIONS

Few studies have addressed the role of dental disease and dental procedures in children. Our study suggests that gingival disease has an effect on bacteremia after dental restorations and prophylaxis. Although antibiotics have an impact, they do not eliminate bacteremia. ■

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