

IN BRIEF

- Intravenous ampicillin is an effective drug regimen for reducing dental bacteraemia for comprehensive treatment under GA.
- If antibiotic resistant *Staphylococcus aureus* is a concern, alternative antibiotics to those published in the guidelines are required.
- A combination of teicoplanin IV and amikacin IV proved to be as effective an antibiotic regimen as ampicillin IV.

Intravenous antibiotic regimens and prophylaxis of odontogenic bacteraemia

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Objectives This study retrospectively examines the efficacy of prophylactic intravenous antibiotic regimens in the prevention of odontogenic bacteraemia in children with severe congenital heart defects receiving comprehensive dental treatment under general anaesthesia.

Patients and methods Blood cultures were taken from children with congenital cardiac defects 30 seconds after completion of dental treatment under general anaesthesia. Antibiotic prophylaxis had been given intravenously immediately before dental treatment. The choice of antibiotics and the extent of dental treatment were recorded. The percentage prevalence of bacteraemia was compared with published data following multiple dental extractions using the same clinical and microbiological methodology.

Results The overall percentage prevalence of positive cultures in children receiving intravenous prophylactic antibiotics was 16%. The percentage of positive blood cultures in cardiac children who received ampicillin alone was not significantly different from that in children having a combination of amikacin and teicoplanin (16.7% v 22.2%) respectively [Chi Square = 0.385, df = 1, $P = 0.535$]. When compared with multiple extractions, both ampicillin alone and amikacin with teicoplanin were effective in reducing the prevalence of odontogenic bacteraemia.

Conclusions In children with cardiac defects, bacteraemia after dental treatment is reduced by antibiotics but is still detected on 16% of occasions. In comparison with children receiving ampicillin alone, the combination of amikacin and teicoplanin is as effective in reducing bacteraemia in children who are either allergic to penicillins or who have received them within the previous month.

The risk of contracting bacterial endocarditis (BE) is believed to be closely linked to bacteraemia inducing procedures including the extraction of teeth.¹ Prophylactic antibiotics effectively neutralise the pathogenic effects of dental bacteraemia² so it is recommended

that patients having dental procedures associated with bleeding and who are regarded 'at risk' of contracting BE, should have systemic antibiotic prophylaxis.²

The reduction in odontogenic bacteraemia is regarded as an indirect measure of the efficacy of prophylaxis.³ Several studies have tested the efficacy of antibiotics in reducing bacteraemia in healthy volunteer patients having dental extractions.^{4,5} Only one study has examined the efficacy of antibiotic prophylaxis in cardiac patients 'at risk' and was limited to the use of intramuscular penicillin prophylaxis.³

The purpose of this study was to examine the efficacy of prophylactic intravenous antibiotic regimens in the prevention of odontogenic bacteraemia in children with congenital heart defects receiving dental treatment consisting of multiple extractions and fillings under intubation general anaesthesia.

PATIENTS AND METHODS

The project was approved by the ethical committees of both hospitals. Parents and patients were given an information sheet describing the project and written consent was obtained from the parent or from the child when appropriate.

As the numbers of children with congenital cardiac disease are limited, every cardiac child who required extractions and restorations under general anaesthesia was included in the study. No child had extractions or restorations in isolation so it was not possible to compare the two different operative procedures for the prevalence of bacteraemia. All children received intravenous antibiotic drugs immediately upon attainment of anaesthesia but before the start of dental treatment. Ampicillin was used as the first choice of IV drug as it has exactly the same range of antibacterial activity as amoxicillin but is significantly less expensive as an IV preparation and as the children were fasted prior to general anaesthesia an IV preparation was required. The use of teicoplanin and amikacin combined was required as part of the hospital infection control policy as there were concerns about antibiotic resistant *Staphylococcus aureus*. Where appropriate, the dose of antibiotic was adjusted to match the weight of the child eg 6 mg/kg for teicoplanin as per the manufacturer's instructions. Blood was sampled once from each child 30 seconds after treatment was completed.^{6,7} Dental treatment consisted of a mixture of dental extractions and restorations. The antibiotics used were those advised by the child's cardiac physician. Exclu-

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sions were anticoagulant treatment, antibiotic therapy within the last month, and known viral carriage.

Prior to taking the blood, the skin of the right or left antecubital fossa was prepared using 1% povidine iodine solution. An intravenous cannula of 23 gauge was inserted into a vein in the left or right antecubital fossa using aseptic technique. A total of 8 ml of blood was drawn. Two commercial blood culture systems were used: the Bactec radiometric system at Guy's and St Thomas' and the Bactec 760 at Great Ormond Street Hospital for Children. A 3 ml volume of blood was inoculated into each of the aerobic and the anaerobic bottles.⁸ Bacteria were speciated using standard microbiological methods with oral streptococci speciated using the API Strep 20 system.⁹ Results are expressed as the percentage of children in whom positive cultures were detected using either system. Statistical calculations were made using Stata.¹⁰ Proportions were evaluated using the Chi Squared Test.

The extent of dental disease was graded using simplified indices for dental plaque (pi), gingivitis (gi) and spontaneous gingival bleeding (bi) described previously.¹¹ The presence of a dental abscess was recorded for all groups.

RESULTS

A total of 92 children, mean age 8yrs 2mths (range 1yr 5mths to 19yrs 8mths) were included in the study. The cardiac conditions of the children and adolescents are shown in Table 1. The antibiotic drugs used for prophylaxis are shown in Table 2. The two major antibiotic groups used were ampicillin, and teicoplanin and amikacin. There was no identifiable pattern of antibiotic usage in relation to the underlying cardiac condition. The major outcome variable is the percentage prevalence of positive blood cultures. There was no significant difference between the percentage positive blood cultures in the ampicillin group (16.7%) and the teicoplanin and amikacin group (22.2%). These data were compared with that from a contemporaneous study examining the percentage positive cultures following multiple extractions.¹² The ampicillin group (16.7% positive) was highly statistically significantly less than multiple extractions (54.2% positive) [Chi Square = 14.6, df = 1, P = 0.0001]. The teicoplanin and amikacin group (22.2%) were also statistically significantly less than the multiple extractions (54.2%) [Chi Square = 8,849, df = 1, P < 0.003]. There was no significant relationship between the presence or absence of bacterial dental plaque and/or gingivitis. The organisms isolated are shown in Table 3. All of these exhibited full antibiotic sensitivity during routine testing. All patients made an uneventful recovery from the dental treatment without any signs or symptoms of bacterial endocarditis.

Table 1 Specific cardiac conditions of children and adolescents with severe congenital heart disease

Cardiac condition	Number
Ventricular septal defect (repaired)	20
Ventricular septal defect (unrepaired)	28
Coarctation of the aorta	12
Fallot's tetralogy	8
Pulmonary stenosis	5
Transposition of the great arteries	5
Truncus arteriosus (De George Syndrome)	3
Noonan's Syndrome	1
Substenotic stenosis	2
Pulmonary artesia	2
Ebstein's Anomaly	2
Patent ductus arteriosus	1
Aortic stenosis	1
Aortic dilatation with leak	1
Mitral regurgitation	1

DISCUSSION

This is the first report from a large group of children with severe congenital heart defects undergoing comprehensive dental treatment consisting of restorations and extractions with the protection of intravenous antibiotic prophylaxis. It is clear that intravenous antibiotics significantly reduce the level of detectable bacteraemia. The nature of the organisms are typical of those obtained from odontogenic bacteraemia.^{13,14}

The bacteraemia rate in the cardiac group is similar to that from other studies where antibiotic prophylaxis was administered orally, either in children, or adults.^{14,15} This is surprising considering that IV antibiotics should achieve very high blood levels at the time of dental treatment. This is not too worrying as there is evidence from animal studies that antibiotic prophylaxis not only kill micro-organisms but also prevents adherence to thrombotic vegetation.¹⁶ Perhaps the latter is achieved equally well by oral doses of antibiotics. This may be important in the present study where the multiple procedures of conservation and extractions often took an hour to complete. It is likely that the peak level of the antibiotic may have passed by the time that the extractions were carried out. This may be a justification for administering a booster dose for procedures that last more than 15 minutes.

Table 2 Intravenous antibiotics used for prophylaxis in children with severe congenital heart disease

Antibiotic	Mean dose in mg (sd)	n / N Number positive/ number in group	% positive blood culture
Ampicillin	627 (259)	7/42	16.7%
Clindamycin	280 (128)	0/6	nil
Teicoplanin	257 (220)	0/2	nil
Amikacin	200*	0/1	nil
Vancomycin	1,000 [infused over 60 minutes]	0/2	nil
Ampicillin + Clindamycin	250* 600*	0/1	nil
Ampicillin + Vancomycin	250 600 mg infused over 100 minutes	0/1	nil
Teicoplanin + Amikacin	6 mg/kg and 15 mg/kg	8/35	22.2%
Ampicillin + Amikacin	50 mg/kg and 15 mg/kg	0/4	nil

*Insufficient to compute sd

Table 3 Organisms isolated from blood of children with severe congenital heart disease receiving intravenous prophylactic antibiotics

AEROBIC BOTTLE		ANAEROBIC BOTTLE	
Ampicillin group		Ampicillin group	
Organisms	Number	Organisms	Number
<i>S. sanguis</i>	2	<i>S. sanguis</i>	2
<i>S. mitis</i>	2	<i>S. mitis</i>	1
<i>Eikenella corrodens</i>	1	Viridans 'streptococci	1
<i>Staphylococcus epidermidis</i>	1	<i>Staphylococcus epidermidis</i>	1
<i>Haemophilus parainfluenzae</i>	1	<i>Gemella morbillorum</i>	1
<i>Neisseria pharyngis</i>	1	<i>Neisseria pharyngis</i>	1
Teicoplanin and amikacin		Teicoplanin and amikacin	
<i>S. sanguis</i>	3	<i>S. sanguis</i>	1
<i>S. mitis</i>	1	<i>S. mitis</i>	1
Viridans streptococci	1		
<i>Staphylococcus epidermidis</i>	1		
<i>Fusobacterium nucleatum</i>	1		
<i>Gemella morbillorum</i>	1		
<i>Corynebacterium</i> spp.	1		
		<i>Veillonella</i> spp.	1

The levels of bacterial dental plaque, gingivitis and spontaneous gingival bleeding do not appear to have a significant bearing on the risk of a bacteraemia. This is probably because the numbers in the groups are too small to show significant statistical associations.

An important feature of children with congenital cardiac disease is the increased carriage of penicillin resistant organisms^{17,18} and there is concern that the reservoir of antibiotic resistant organisms will result in failure of antibiotic prophylaxis.

The diversity of antibiotic prophylaxis regimens used in our study is direct evidence of the failure of physicians to comply closely with the recommendations of the Endocarditis Working Party.³ A combination of amikacin and teicoplanin was used extensively as these drugs were employed if there was a history of penicillin use within the preceding month of treatment. Bacteraemia after their use was similar to that after ampicillin alone. This supports the continued use of ampicillin IV for antibiotic prophylaxis in children receiving treatment under general anaesthesia provided there is no penicillin allergy or related antibiotic usage within the previous month.

This study shows that antibiotic prophylaxis, even given IV, does not completely eliminate a post dental treatment bacteraemia. Does this leave the children with an important risk of contracting bacterial endocarditis? There are reasons for believing that the risk is very small. Bacteraemia detected by the blood culture is partly due to the rapid dilution of the antibiotic in the patients' blood by the relatively large volume of broth in the Bactec culture bottles and therefore any positive cultures could be 'false' positives. Also, antibiotics may reduce the adhesion of micro-organisms.¹⁶

The pattern of organisms isolated is similar to that of other studies in children^{4,5,7,19} and there does not appear to be any trend

for a shift of in the nature of the organisms appearing in the bacteraemia following dental treatment in children. Antibiotic resistant organisms were not detected.

Finally, this study provides further indirect evidence of the woeful dental state of children with congenital cardiac disease.²⁰ It is at least a strong theoretical possibility that BE due to viridians streptococci could be reduced by prevention of dental disease rather than by prevention of the bacteraemia resulting from the treatment of such dental disease.

CONCLUSIONS

Bacteraemia in children with cardiac defects after dental treatment is reduced by antibiotics but is still detected in 16%. The combination of amikacin and teicoplanin is effective in reducing bacteraemia in children who are either allergic to penicillins or who have received them in the last month.

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