

# Dental procedures in children with severe congenital heart disease: a theoretical analysis of prophylaxis and non-prophylaxis procedures

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## Abstract

**Objective**—To estimate the cumulative exposure to bacteraemia from dental procedures currently recommended for antibiotic prophylaxis and compare this with cumulative exposure from dental procedures not recommended for prophylaxis.

**Design**—Retrospective analysis.

**Setting**—University and teaching hospital maxillofacial and dental department.

**Patients**—136 children with severe congenital cardiac disease attending for dental treatment between 1993 and 1998 and for whom full records were available. Each dental procedure was tallied.

**Main outcome measures**—Cumulative exposure per annum to “non-prophylaxis procedures”; cumulative exposure per annum to “prophylaxis procedures”.

**Results**—Cumulative exposure to bacteraemia from prophylaxis procedures was not significantly greater than from non-prophylaxis procedures.

**Conclusions**—The data raise important questions about the appropriateness of current guidelines for antibiotic prophylaxis of bacterial endocarditis.

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Keywords: congenital heart disease; dental treatment; cumulative risk; endocarditis

The reported prevalence of congenital heart disease in western countries is between 4/1000 and 12/1000 live births.<sup>1</sup> Congenital or acquired abnormalities involving the cardiac endothelium predispose to the risk of bacterial endocarditis.<sup>2</sup> This may occur following a bacteraemia caused by soft tissue manipulations such as dental treatment or instrumentation of the urinary tract.<sup>3</sup> The overall reported prevalence of bacterial endocarditis in the general population is between 11 and 50 cases per million annually.<sup>4</sup> At least 40% of these cases have no known risk factors. Despite the advent of antibiotics the overall number of cases has not declined.<sup>5–7</sup>

Dental treatment is responsible for only a small proportion of cases of bacterial endocarditis.<sup>4,6,8–10</sup> It is impossible to predict which individuals will develop bacterial endocarditis.<sup>11,12</sup> Cumulative exposure to dental bacteraemia from dental filling procedures may be a greater risk than bacteraemia from occasional surgical procedures, such as extractions.<sup>10</sup> This is of special concern given the relatively high levels of dental disease present in children with heart disease.<sup>13,14</sup>

There are clear guidelines regarding antibiotic prophylaxis for dental procedures likely to cause bacteraemia. The endocarditis working party of the British Society for Antimicrobial Chemotherapy recommends antibiotic prophylaxis for extractions, scaling, and periodontal surgery.<sup>15</sup> The American Heart Association<sup>12</sup> has extended the list of procedures to include placement of dental implants, reimplantation of avulsed teeth, endodontic instrumentation beyond the root apex, and intraligamental injections. There are also various procedures for which antibiotic prophylaxis is

not recommended, although recent research shows that they cause significant bacteraemia. These include the use of a matrix band and wedge, and the placement of a rubber dam.<sup>16</sup> There is also a small background bacteraemia which occurs in approximately 10% of subjects,<sup>16,17</sup> with *Streptococcus sanguis* being the most common species isolated.<sup>18</sup>

Our purpose in this study was to estimate the theoretical cumulative exposure to bacteraemia caused by dental procedures. These data were divided into “prophylaxis procedures” and “non-prophylaxis procedures” for statistical comparison.

## Methods

### STUDY POPULATION

Ethical approval was obtained from Great Ormond Street Hospital for Children NHS Trust (GOS) and the Eastman Dental Hospital (EDH) research and ethics committee. The children in the study population were receiving all their dental treatment at GOS or EDH because of the severity of their congenital heart disease.

All the data were taken from the records of children with severe congenital heart disease for the five year period June 1993 to June 1998 at Great Ormond Street Hospital and from January to July 1998 at the Eastman Dental Hospital. From the case records, each dento-gingival manipulative procedure was tallied. As some individual patient’s records covered less than a year or up to several years, the number of times a dento-gingival manipulative procedure was carried out was standardised on a year to allow comparison between different procedures or groups of procedures.<sup>19</sup>

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Table 1 UK and US recommendations for antibiotic prophylaxis in cases of congenital heart disease

British Society for Antimicrobial Chemotherapy <sup>15</sup>	American Heart Association <sup>12</sup>
<b>Dental procedures requiring antibiotic prophylaxis</b>	
Dental extractions	Dental extractions
Periodontal surgery or scaling with or without local anaesthesia	Periodontal procedures including surgery, scaling, root planing, probing, and recall
	Maintenance
	Dental implants placement and reimplantation of avulsed teeth
	Endodontic (root canal) instrumentation or surgery only beyond the apex
	Subgingival placement of antibiotic fibres or strips
	Initial placement of orthodontic bands, but not brackets
	Prophylactic cleaning of teeth or implants where bleeding is anticipated
	Intraligamentary local anaesthetic injections
<b>Dental procedures not requiring antibiotic prophylaxis</b>	
	Restorative dentistry with or without retraction cord
	Local anaesthetic injections
	Intracanal endodontic treatment, post-placement and buildup
	Placement of rubber dam
	Postoperative suture removal
	Placement of removable prosthodontic or orthodontic appliances
	Taking of oral impressions
	Shedding of primary teeth

The procedures tallied were then classified as either prophylaxis procedures or non-prophylaxis procedures according to the guidelines of the endocarditis working party of the British Society of Antimicrobial Chemotherapy (1993)<sup>15</sup> and the American Heart Association (1997).<sup>12</sup> These are shown in table 1.

#### OUTCOME VARIABLES

The main outcome variables derived for this study were: the mean number of dento-gingival manipulative procedures per person per year which were “prophylaxis procedures”; the mean number of dento-gingival manipulative procedures per person per year which were “non-prophylaxis procedures”; and cumulative exposure to bacteraemia for prophylaxis and non-prophylaxis procedures.

The estimate for the cumulative exposure was derived from the equation: intensity  $\times$  tally  $\times$  prevalence  $\times$  duration = cumulative exposure in cfu/ml/procedure/year, where

- *Intensity* is the number of colony forming units (cfu)/ml blood and is derived from several sources.<sup>16 20–24</sup>
- *Tally* is the average number of a given dento-gingival manipulative procedure performed annually (these data were derived solely from the present study).
- *Prevalence* is the number of positive cultures expressed as a proportion; these data were derived from several sources.<sup>16 22–26</sup> For purposes of calculation, a percentage prevalence is converted to a proportion, for example: 38% = 0.38.
- *Duration* is the length of bacteraemia, which is 15 minutes.<sup>10</sup>

These data for cumulative exposure were then exported to SPSS for Windows, version 7.0, and the mean and SD for prophylaxis procedures and non-prophylaxis procedures were derived. The cumulative exposure for each procedure was estimated using the above formula. These data (the cumulative exposure) were tested for normality using the Shapiro-Wilk test. The data were not normally distributed. For this reason the two groups of cumulative exposure—prophylaxis procedures and non-prophylaxis procedures—were compared using the Mann-Whitney U test for independent samples.<sup>27</sup>

#### Results

In all, 133 children received treatment at GOS and a further three at EDH, a total of 136 fully documented records. Eighty one children were treated under general anaesthesia, and the remaining 55 were treated using local anaesthesia. There were 79 boys and 57 girls, and the mean (SD) age for the whole group was 10.5 (3.8) years, with a range of 2.3–19 years. The time over which data were collected for individual patients varied from 0.4–5.8 years.

#### AVERAGE NUMBER OF PROCEDURES/YEAR

For each dental procedure the total number of occurrences was divided by the number of years (or part years) to provide an average number/year for each procedure. These were then partitioned into prophylaxis procedures

Table 2 Calculation of the cumulative exposure to odontogenic bacteraemia for prophylaxis and non-prophylaxis procedures

	Intensity (cfu/ml)	Tally (this study) (n/year)	Prevalence (from percentage)	Duration (min) <sup>10</sup>	Cumulative exposure
<b>Prophylaxis procedures</b>					
Scaling	2.16 <sup>23</sup>	0.13	0.4 <sup>23</sup>	15	1.685
Single extraction primary tooth	0.23 <sup>20</sup>	0.04	0.43 <sup>20</sup>	15	0.059
Single extraction permanent tooth	1.12 <sup>25</sup>	0.06	0.68 <sup>25</sup>	15	0.685
Multiple extractions—primary and permanent	12.77 <sup>20</sup>	0.53	0.51 <sup>20</sup>	15	51.775
Mucoperiosteal surgery	63.0 <sup>20</sup>	0.05	0.39 <sup>20</sup>	15	18.428
<b>Non-prophylaxis procedures</b>					
Dental examination	0.28 <sup>23</sup>	2.80	0.17 <sup>23</sup>	15	1.999
Polishing teeth	5.47 <sup>23</sup>	0.80	0.25 <sup>23</sup>	15	16.410
Local anaesthetic infiltration	*3.60 <sup>23</sup>	0.57	0.16 <sup>23</sup>	15	4.925
Rubber dam placement with clamps	1962 <sup>21</sup>	0.90	0.31 <sup>21</sup>	15	8210.970
Slow drill	0.31 <sup>21</sup>	1.78	0.12 <sup>21</sup>	15	0.993
Fast drill	1.9 <sup>21</sup>	1.67	0.04 <sup>21</sup>	15	1.904
Matrix band placement	4.8 <sup>21</sup>	0.12	0.32 <sup>21</sup>	15	2.7648

\*No data on published studies available. To preserve the mathematical calculation, the pre-procedure or baseline value from a recent unpublished study on children has been substituted.

Prophylaxis procedures *v* non-prophylaxis procedures: Mann-Whitney U test,  $p = 0.4649$  (NS).

Superscripts are references; cfu, colony forming units.

and non-prophylaxis procedures (table 2). The US guidelines,<sup>12</sup> which incorporate the UK guidelines,<sup>15</sup> were used to partition the data in this way.

#### CUMULATIVE EXPOSURE

The theoretical cumulative exposure, expressed as the number of colony forming units/ml blood/minute in the standardised year, is shown in table 2. This table combines data from a variety of investigations. The greatest cumulative exposure was from the placement of rubber dam (8849.000). The smallest was from a single primary tooth extraction (0.059). Dental examinations had a cumulative exposure of 1.999 and polishing of teeth with a rubber cup and polishing paste, a cumulative exposure of 16.410.

#### Discussion

The purpose of this study was to estimate the cumulative exposure to odontogenic bacteraemia over a period of a standardised year<sup>19</sup> in a group of children with severe congenital heart disease. Several dento-gingival manipulative procedures were investigated and divided into two groups following the guidelines of the American Heart Association (1997).<sup>12</sup> These have been updated more recently than the UK guidelines,<sup>15</sup> which are incorporated within the guidelines from the USA. Of interest was the finding that none of the children in this study received intraligamental analgesic injections. This is reassuring, as the technique is associated with a very high prevalence of bacteraemia.<sup>28</sup>

The two groups compared were procedures that required antibiotic prophylaxis and those that did not. It is clear that the non-prophylaxis procedures present a similar risk of cumulative bacteraemia to the prophylaxis procedures.

A weakness of this study is that these data were derived retrospectively. However, there would be various difficulties in carrying out a prospective study—a very large number of subjects would need to be recruited to obtain sufficient data for statistical analysis, and a large proportion of these children would be dentally fit when examined by their dentist and would not need any active dental treatment.<sup>14</sup> The results presented here, although retrospective, are from dental treatment completed on a large number of children who are known to be at risk of odontogenic bacteraemia. This has significant clinical implications for the management of children with severe congenital heart disease. These data are applicable to any child with congenital heart disease receiving dental treatment, whether in a hospital dental department, a community dental clinic, specialist practice, or general dental practice. In stating this it is recognised that the rubber dam is not used very often in general dental practice, so its contribution to cumulative exposure may not

be as important as the others. Of considerable concern are the high cumulative exposure values obtained from dento-gingival manipulative procedures related to conservative dentistry—procedures not recommended for antibiotic prophylaxis by either UK or US working parties on endocarditis prophylaxis.<sup>12 15</sup>

These data raise questions about the appropriateness of current recommendations for preprocedure antibiotic prophylaxis in children at risk of developing bacterial endocarditis.

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