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# Antibiotic prophylaxis for patients with hydrocephalus shunts: a survey of pediatric dentistry and neurosurgery program directors

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## Abstract

*A survey of antibiotic prophylaxis recommendations for patients with hydrocephalus shunts was sent to directors of advanced programs in pediatric dentistry and neurosurgery. Recommendations were sought for patients with ventriculoperitoneal (VP) or ventriculoatrial (VA) shunts who were to receive dental care. Most respondents believed that shunt infection (SI) was related infrequently to dental procedures. Pediatric dentists believed that 5.2% of infected VA shunts were related to dental procedures, while neurosurgeons believed the rate to be 3.0% ( $P < 0.05$ ). There was no difference in perceived risk for VP shunts. Except for the equal risk associated with extractions, pediatric dentists were significantly more likely than neurosurgeons to recommend chemoprophylaxis for patients with VA shunts undergoing invasive dental procedures ( $P < 0.05$ ). They were more likely to agree with neurosurgeons when VP shunts were involved. Except for the equal risk associated with dental prophylaxis, pediatric dentists and neurosurgeons believed VA shunt patients were at greater risk for SI than VP shunt patients ( $P < 0.05$ ). Pediatric dentists were significantly more likely to ascribe SI to streptococcal organisms, and recommended penicillin for prophylaxis for both VA and VP shunts ( $P < 0.01$  and  $0.025$ , respectively). Although neurosurgeons believed that staphylococcal organisms were most likely to be responsible for SI ( $P < 0.001$ ), 60% still recommended using penicillin for shunt prophylaxis following dental procedures. (Pediatr Dent 14:246-50, 1992)*

## Introduction

Hydrocephalus is an enlargement of the ventricular system, which results from an imbalance between production and absorption of cerebrospinal fluid (CSF) within the brain-fluid pathways.<sup>1</sup> It is a pathologic condition caused either by overproduction of CSF or obstruction in the aqueducts connecting the ventricles. There may be passive ventricular enlargement resulting from loss of surrounding brain tissue due to aging or cerebrovascular accident, abnormal development of the cisterna magna and its connections over the brain surface, or insufficient CSF circulatory absorption caused by failure of either villi function or venous drainage of arachnoidal spaces.<sup>2</sup>

The incidence of hydrocephalus alone has been estimated as 0.48/1000 total births.<sup>3</sup> The total incidence of hydrocephalus in association with other disorders, such as spina bifida, has been reported as 1.33/1000 total births.<sup>1</sup>

Ventriculoatrial (VA) shunts connecting the lateral ventricles with the venous circulation were used widely, until they were supplanted by ventriculoperitoneal (VP) shunts. VP shunts empty CSF directly into the abdominal cavity, thus bypassing the venous circulation. It is now generally believed that patients with VP shunts are less likely to suffer serious morbidities, particularly those associated with shunt infection (SI), than are patients with VA shunts.<sup>4, 5</sup>

Shunt infections are costly in terms of morbidity, human suffering, intellectual and neurologic deficits

and health care funds.<sup>3</sup> The incidence of SI has been reported to range from 5 to 31%, with mortality rates ranging from 34 to 40%. SI is most likely to occur in the first postoperative month.<sup>7</sup>

It has been suggested that oral and nasopharyngeal sources of staphylococci play a potential role in shunt infections,<sup>8</sup> but no shunt infections have been related directly to dental procedures. However, VA shunts have been assigned a "high relative risk rate for bacteremia-induced infections," while VP shunts have been classified as being of "moderate risk." High-risk patients always require antibiotic chemoprophylaxis, but the need for antibiotic chemoprophylaxis for moderate risk patients is controversial, and consultation with a child's physician is required before dental treatment.<sup>9</sup>

The purpose of this study was to investigate the relative risks assigned to VA and VP shunts following specific dental procedures for bacteremia-induced shunt infections, as defined by directors of pediatric dentistry and neurosurgery advanced educational programs. Additionally, the study sought to tabulate antibiotic chemoprophylaxis recommendations for patients with hydrocephalus shunts.

## Materials and Methods

A brief survey was mailed to directors of all accredited advanced educational programs in pediatric dentistry and neurosurgery in the continental United States.

The survey sought to investigate shunt prophylaxis recommendations for VA and VP shunts based on procedures performed. Also, information was sought on the putative organisms of shunt infection, and the perceived risk of shunt infection following dental procedures.

Chi-square contingency testing was performed on the dependent variable of shunt prophylaxis, based on procedure performed and differences in responses between pediatric dentists and neurosurgeons. Likewise, antibiotic recommendations were evaluated based on specialty. Differences in the perceived risk of shunt infection were evaluated using Student's *t*-test. Relative risk, a measure of individual respondent's different recommendations for chemoprophylaxis based upon the type of shunt, was evaluated using McNemar's test.

## Results

Surveys were returned by 70.6% (*N* = 51) of all pediatric dental program directors. Neurosurgery directors returned 61.9% (*N* = 63). There was no significant difference in study compliance.

### Shunt Prophylaxis Recommendations (Table 1)

#### VA Shunts

Except for "invasive oral surgery procedures," pediatric dental directors were significantly more likely to recommend chemoprophylaxis for routine dental procedures for these patients. Pediatric dentist and neurosurgeon respondents agreed, with near unanimity, that invasive oral surgical procedures warranted antibiotic prophylaxis. Pediatric dental respondents, however, unlike their neurosurgery counterparts, were equally unanimous in recommending antibiotic prophylaxis for routine restorative dental procedures and scaling/root planing.

#### VP Shunts

There were no significant differences in the incidence of antibiotic prophylaxis recommendations for these patients. More than 50% of respondents recommended prophylaxis following invasive oral surgery procedures and extractions.

### Organisms Responsible for Shunt Infection

Most of the neurosurgery directors (92.3%) believed that staphylococcal organisms were most likely responsible for VA shunt failure, compared to 36.1% of pediatric dental directors (*P* < 0.001). When VP shunts were considered, 84.6% of neurosurgeons believed that staphylococcal organisms were responsible for shunt infection, compared to 33.3% of pediatric dentists (*P* < 0.001). Pediatric dentists were significantly more likely to believe that streptococcal organisms were responsible for shunt failure due to infection.

### Recommended Antibiotic (Table 2)

Pediatric dentists were significantly more likely to recommend penicillin as the antibiotic of choice for both VA and VP shunts, recommending it nearly 100% of the time. (*P* < 0.01 and *P* < 0.025, respectively). Although neurosurgery respondents were less likely to recommend penicillin, more than 60% did recommend penicillin.

### Relative Risk (Table 3, next page)

Relative risk is expressed in terms of the per cent of respondents recommending shunt prophylaxis for VA shunts, but not for VP shunts, for a specific procedure.

#### Neurosurgeons

With the exception of noninvasive dental prophylaxis, neurosurgeons are significantly more likely to recommend shunt prophylaxis for VA shunts than for

**Table 1. Antibiotic prophylaxis recommendations**

Procedure	VA Shunts		VP Shunts	
	Pediatric Dentists	Neurosurgeons	Pediatric Dentists	Neurosurgeons
Restorative	35 (97.2)*	19 (48.7)	12 (33.3)	9 (23.1)
Extractions	36 (100.0)	36 (92.3)	19 (52.8)	27 (69.2)
Prophylaxis	17 (47.2)	9 (23.1)	4 (11.1)	6 (15.4)
Scaling	36 (100.0) <sup>†</sup>	17 (47.2) <sup>§</sup>	19 (52.8)	20 (51.3)

\* *P* < 0.001, Chi-square = 17.27, 1 df; <sup>†</sup> *P* < 0.025, Chi-square = 6.25, 1 df.

<sup>§</sup> *P* < 0.05, Chi-square = 4.82, 1 df.

Absolute count (percentage) recommending shunt prophylaxis for VA and VP shunts.

**Table 2. Antibiotic of choice for shunt prophylaxis**

Antibiotic	VA Shunts		VP Shunts	
	Pediatric Dentists	Neurosurgeons	Pediatric Dentists	Neurosurgeons
Penicillin	31 (93.9)*	19 (63.3)	15 (100.0) <sup>†</sup>	19 (63.3)
Other	2 (6.1)	11 (36.7)	0 (0.0)	6 (27.3)

\* *P* < 0.025, Chi-square = 5.20, 1 df.

<sup>†</sup> *P* < 0.01, Chi-square = 7.53, 1 df.

Absolute count (percentage) recommending specific antibiotic, for those recommending prophylaxis.

**Table 3. Relative risk of shunt infection**

Procedure	Pediatric Dentists		Neurosurgeons	
Restorative	23	(65.7)*	10	(52.6) <sup>†</sup>
Extractions	17	(48.7)*	9	(25.0) <sup>†</sup>
Prophylaxis	13	(76.5)*	3	(33.3)
Scaling	17	(48.2)*	11	(35.5)*

\*  $P < 0.001$ , McNemar test, 1 df, VA > VP.

<sup>†</sup>  $P < 0.01$ , McNemar test, 1 df, VA > VP.

For those recommending VA shunt prophylaxis, absolute number (percentage) not recommending prophylaxis for patients with VP shunts undergoing corresponding procedures.

VP shunts ( $P < 0.01$ ). Changes in recommendation philosophy for extractions and noninvasive dental prophylaxis suggest a perception of high risk associated with extractions, and low risk associated with dental prophylaxis.

### Pediatric Dentists

Pediatric dental directors consistently believed that shunt prophylaxis was more appropriate for patients with VA shunts ( $P < 0.001$ )

### Perceived Risk

#### VA Shunts

Neurosurgery directors believed that 3.0% (SD 0.026) of infected VA shunts may have resulted from dental procedures. Pediatric dental directors, however, ascribed 5.2% (SD 0.076) of infected VA shunts to dental procedures. ( $P < 0.05$ ,  $t = 1.73$ , 45 df)

#### VP Shunts

Neurosurgery directors believed that 1.8% (SD 0.019) of infected VP shunts may have resulted from dental procedures. Pediatric dental directors believed 2.8% (SD 0.063) of infected VA shunts were ascribed to dental procedures. (NS)

## Discussion

Antibiotic prophylaxis to prevent infective endocarditis in susceptible patients undergoing invasive dental procedures has become an accepted standard of care, despite lack of controlled studies substantiating effectiveness or risk/benefit. Highly specific guidelines have been promulgated and updated periodically.<sup>10</sup>

The need for antibiotic prophylaxis for the hydrocephalic dental patient with a surgically placed shunt is controversial. Few medical and dental studies address either side of the issue; since Croll's call for more definitive knowledge and research in this area,<sup>2</sup> little has been added to the literature. Since Croll's article, VP shunts have superseded VA shunts in the United States. However, the pediatric dentist treating

developmentally disabled patients is still likely to encounter older individuals with VA shunts. This study indicates nearly unanimous agreement that VA shunts require antibiotic prophylaxis.

The current survey indicates dichotomies in managing hydrocephalic shunt patients. In general, pediatric dental respondents were more aggressive in recommending antibiotic prophylaxis of shunts, particularly VA shunts. This aggressive use of antibiotics belies their belief that dental procedures may be responsible for SI, although, overall, pediatric dental program directors believed that less than 5% of all shunt infections resulted from bacteremias caused by dental procedures. This aggressive use of chemoprophylaxis is directed toward streptococcal species and, accordingly, penicillin is recommended nearly universally. However, it is interesting that the neurosurgery respondents, while more likely to ascribe shunt infection to staphylococcal species, still frequently recommended penicillin. Neurosurgery directors did recommend a significantly greater variety of antibiotics, including dicloxacillin, trimethoprim/sulfamethoxazole (Bactrim, Roche Products Inc., Manati, Puerto Rico), vancomycin, tobramycin, oxacillin, amoxicillin, ampicillin/gentamicin, and cephalixin.

The spectrum of microorganisms associated with SI is wide. Although most reports agree that *Staphylococcus aureus* (coagulase positive) and *Staphylococcus epidermidis* (coagulase negative) are the most common infective microorganisms,<sup>5, 8, 11</sup> recovered bacterial pathogens have included diphtheroids, enterococci, klebsiella, and streptococci,<sup>5, 7</sup> in addition to fungal pathogens.<sup>12</sup> Although most SI occurs within the first month of shunt placement and is caused by either *S. aureus* or *S. epidermidis*, introduced at the time of shunt placement, the role of prophylactic antibiotics at the time of shunt placement is equivocal and remains highly controversial.<sup>7</sup> The agents used most widely when shunts are placed have been oxacillin, methicillin, dicloxacillin, and vancomycin, which are all effective against *S. aureus* and *epidermidis*.<sup>2, 6, 13</sup>

Several studies have indicated bacteremia in children following routine dental procedures. The incidence of bacteremia following dental prophylaxis has been reported to be 28%, while bacteremias were reported in 63% of children undergoing extractions.<sup>14</sup> The incidence of bacteremia following extractions performed after penicillin prophylaxis has been reported to range from 21 to 35%.<sup>15, 16</sup> The microorganisms isolated following extractions or dental prophylaxis have included those capable of causing SI.<sup>14-16</sup> Although coagulase-positive and negative microorganisms have been reported in such isolates only infrequently, the number of other penicillin-resistant strains

isolated may be of concern.<sup>16</sup> Moenning et al.<sup>17</sup> have suggested the use of amoxicillin and potassium clavulanic acid combinations (Augmentin, Beecham Labs, Bristol, TN) available for oral use or ampicillin and sulbactam (Unasyn, Pfizer, Inc., New York, NY) for parenteral use to overcome the action of penicillinase, thus allowing beta-lactam antibiotics to be effective. These preparations are effective against many staphylococci, klebsiella, virtually all anaerobes, and oral streptococci.

Little evidence supports antibiotic prophylaxis for patients with hydrocephalus shunts following dental procedures. Respondents believed that dental procedures were related only infrequently to subsequent shunt infection, but they clearly perceived a hierarchy of risk, based both upon shunt type and procedure performed. VA shunts are considered to be at higher risk for SI, based upon the greater frequency of antibiotic prophylaxis recommendations. However, antibiotic prophylaxis also is recommended frequently for patients with VP shunts, particularly when extractions or scaling/root planing are performed. The low risk of SI related to dental procedures is perhaps reflected in the lack of coherent approach to chemoprophylaxis. The philosophical approach to shunt prophylaxis is complex. Penicillin resistant organisms are associated predominantly with SI, but it is not known whether they exist in sufficient number and virulence in the mouth to colonize shunts. The bacteremias that follow dental procedures typically are responsive to penicillin. In general, for those infections or procedures producing bacteremia that ordinarily are responsive to penicillin, the selection of a penicillinase resistant antibiotic is deferred until the primary antibiotic is shown to be ineffective, or until sensitivity testing confirms penicillin resistant organisms.

An inherent quandary exists. When faced with SI, the neurosurgeon aggressively administers a penicillinase-resistant antibiotic, and often must replace the infected shunt.<sup>7</sup> Should we risk development of organisms resistant to penicillinase-resistant antibiotics because of their prophylactic use, particularly when the presence of these microorganisms in the oral cavity is so low, and unlikely to colonize and infect shunts? This may explain why neurosurgeons are still very likely to recommend penicillin for shunt chemoprophylaxis. Reserving the use of penicillinase resistant antibiotics for actual shunt infections, rather than for postshunt placement prophylaxis, appears to be a strategy used by neurosurgery program directors.

Croll et al.<sup>2</sup> recommended using dicloxacillin for procedures that may cause gingival hemorrhage. Only 13.3% of neurosurgery directors recommending prophylaxis advised using dicloxacillin for patients with

VA shunts undergoing extractions. For patients with VP shunts or undergoing other procedures, dicloxacillin was recommended less often.

Definitive knowledge concerning shunt prophylaxis is lacking. An understanding of the organisms involved, drug sensitivities, and a risk/benefit assessment for antibiotic prophylaxis is necessary to formulate a coherent approach to manage hydrocephalus shunt patients undergoing dental procedures. This coherent approach must be based on an investigation of the incidence of SI following dental procedures, and a dialogue between pediatric dentists and neurosurgeons in their mutual advocacy for patient health.

## Conclusions

1. Shunt infection is considered an infrequent consequence of dental treatment, although pediatric dentists are significantly more likely to believe that VA shunt infections may be due to antecedent dental procedures.
2. Antibiotic prophylaxis is recommended more frequently for VA shunts, particularly by pediatric dental program directors.
3. Extractions and scaling/root planing are perceived to be higher risk procedures, by both pediatric dentists and neurosurgeons, regardless of shunt type.
4. Pediatric dentists are significantly more likely to believe that streptococcal species are responsible for SI following dental procedures, while neurosurgeons ascribe SI to staphylococcal organisms.
5. Penicillin is the antibiotic most commonly recommended for shunt prophylaxis by both pediatric dentists and neurosurgeons, although neurosurgeons are significantly more likely to recommend an antibiotic other than penicillin.

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