A Cochrane Systematic Review Finds No Evidence to Support the Use of Antibiotics for Pain Relief in Irreversible Pulpitis

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Abstract

The Cochrane Systematic Review promotes evidence-based outcomes studies. The review summarized here was conducted in an attempt to achieve reliable evidence concerning the effectiveness, or otherwise, of prescribing antibiotics for patients having irreversible pulpitis. A competent search strategy was developed and used across several databases including MEDLINE to identify randomized controlled trials for inclusion. Assessment of methodological quality was based on criteria defined by The Cochrane Collaboration. Clinical outcome, expressed in terms of pain relief, was examined. There was a relative dearth of research providing a high level of evidence. Only one methodologically sound trial was found that compared pain relief with systemic antibiotic/analgesic treatment against a placebo/analgesic combination during the acute preoperative phase of irreversible pulpitis. Although the selected study used a relatively small, low-powered sample, it did provide some evidence that there is no significant difference in pain relief for patients with untreated irreversible pulpitis who received antibiotics versus those who did not. These findings increase the rationale to investigate the teaching of safe and effective antibiotic prescribing in endodontics and to advance the development of appropriate evidence-based clinical guidelines. *(J Endod 2006;32:87–92)*

Key Words

Anti-bacterial agent, antibiotic, irreversible, pulpitis

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0099-2399/$0 - see front matter

doi:10.1016/j.joen.2005.10.029

This paper provides the essence of a Cochrane Review published in The Cochrane Library Issue 2, April 2005 (see http://www3.interscience.wiley.com/aboutus/sharedfiles/cochrane_transition/ for further information). Cochrane Reviews are regularly updated in response to comments and criticism, and as new evidence emerges. Hence, The Cochrane Library should be consulted for the most recent version of this Systematic Review.

Dental emergencies are extremely common. In a survey conducted in the United States 12% of the population had experienced toothache in the preceding 6 months (1). Although there is very little data available, irreversible pulpitis, characterized by acute and intense pain, is considered to be one of the most frequent reasons for patients to seek emergency dental care. Irreversible pulpitis is defined as an inflammatory process in which the dental pulp has been damaged beyond repair and will eventually become necrotic (2). Most commonly the inflammation of irreversible pulpitis in vital teeth occurs beneath a deep carious lesion before bacteria reaching the pulp (3). Therefore, the involved tooth often has an extensive restoration and/or caries, which may give way to necrosis of the pulp (4). The process of irreversible pulpitis may progress even in the absence of the initiating irritant (e.g. dental caries). Irreversible pulpitis is considered to be an immune system–mediated event. It is most often not a result of a bacterial infection of the pulp, but rather of inflammatory mediators (2). A number of studies indicate that antibiotics do not reduce pain, percussion sensitivity, or the amount of analgesics required in untreated teeth diagnosed with irreversible pulpitis (5).

The symptoms of irreversible pulpitis constitute a continuum. A history of spontaneous pain is usual and can include an exaggerated response to hot or cold that lingers after the stimulus is removed (6). Any tooth may be affected by irreversible pulpitis. The condition can affect individuals in any age group. It may occur as a direct result of dental caries, a cracked tooth, or as a sequel to trauma. The affected tooth is usually not sensitive to percussion, and palpation tests do not produce an untoward reaction. The characteristics of irreversible pulpitis are a vital pulp that responds to cold and electric pulp testing, with responses to cold stimuli resulting in prolonged reaction. Not infrequently, cold may actually alleviate the pain of irreversible pulpitis and thus can be used as a diagnostic test (7). Apart from removal of the tooth, the customary way of relieving the pain of irreversible pulpitis is by accessing the pulp chamber, removing the inflamed pulp tissue, and cleaning the root canal as a prelude to endodontic treatment (8). Nevertheless, some dentists continue to prescribe antibiotics to stop the pain of irreversible pulpitis (9).

The prescription of systemic antibiotics as a perceived means for relieving pain in endodontic emergencies has received considerable attention (10). There appears to be limited empirical evidence to support the effectiveness of this approach and there have been questions raised about the safety of indiscriminate antibiotic prescription. A study conducted in the United States on antibiotic use by members of the American Association of Endodontists evaluated the practice of prescribing antibiotics for irreversible pulpitis among endodontists (9). It was found that 16.76% of endodontists responding prescribed antibiotics for irreversible pulpitis. Although very little information exists concerning the prescription of antibiotics by general dental practitioners for this purpose, it is likely that the percentage could well exceed that of endodontists. In a study of the prescribing habits of general dental practitioners in the United Kingdom, it was

found that a significantly higher number of practitioners prescribe antibiotics before root canal treatment (5.4%) than after (2.8%). Unnecessary prescription of antibiotics, aside from the impact on healthcare costs, also bears the risk of promoting the development of antibiotic-resistant strains of bacteria. Other potential side effects to antibiotics include sensitization, skin rashes and on rare occasions anaphylactic shock.

This review sought to provide reliable evidence concerning the effectiveness of prescribing systemic antibiotics for irreversible pulpitis. Clinical outcomes compared were expressed in terms of pain relief. The following null hypothesis was tested: "for irreversible pulpitis, there is no difference in pain relief between patients who took antibiotics/analgesics compared to those who received placebo/analgesics."

Methods

Types of Studies

Only randomized controlled clinical trials (RCTs) were considered for the purpose of this review.

Types of Participants

Only studies that had recruited patients who were over the age of 18 years and who presented with a single tooth with a clinical diagnosis of irreversible pulpitis were included.

Types of Interventions

Active Interventions

Administration of any systemic antibiotic at any dosage and any analgesic at any dosage prescribed in the acute preoperative phase of irreversible pulpitis.

Control

Administration of placebo and any analgesic, at any dosage, prescribed in the acute preoperative phase of irreversible pulpitis.

Types of Outcome Measures

Primary

The primary outcome for this review was patient reported pain (intensity/duration) and pain relief measured on a categorical scale in the preoperative phase of irreversible pulpitis.

Secondary

The secondary outcomes for this review were type, dose, and frequency of medication required for pain relief. No additional secondary outcomes or adverse effects related to any clinically diagnosed hypersensitivity reactions to either antibiotics or analgesics, nor any data on the costs of prescribing antibiotics for irreversible pulpitis were included.

Search Strategy for Identification of Studies

Electronic Search

For the identification of studies to be considered for this review, detailed search strategies were developed for each database to be searched. These were based on the search strategy developed for MEDLINE but revised appropriately for each database. The search strategy combined the subject search with phases 1, 2, and 3 of the Cochrane Optimal Search Strategy for Randomized Controlled Trials revised by the Cochrane Oral Health Group (OHG) taking into account research methods applicable to oral health.

Databases Searched

Cochrane Oral Health Group Trials Register to September 6, 2004.

- Cochrane Pain, Palliative Care and Supportive (PaPaS) Care Group Trials Register to September 6, 2004.
- Cochrane Central Register of Controlled Trials (CENTRAL), *The Cochrane Library,* Issue 3, 2004.
- MEDLINE (1966 to September 6, 2004).
- EMBASE (1980 to week 36 2004).

The detailed search strategy developed for each database is available in Issue 2, April 2005 of The Cochrane Library (www.thecochranelibrary.com).

Handsearching

A list of the journals already hand searched by the Cochrane Oral Health Group was compiled; no additional hand-searching was conducted. Reference lists of relevant articles, clinical trials, and the reviewers' personal databases of trial reports were searched in an attempt to identify applicable studies for inclusion in the review.

Language

Although no language restriction was made on included studies, no relevant trials were identified in languages other than English.

Review Methods

Assessment of Search Results

The abstracts of studies identified by the searches were independently assessed by two reviewers, Zbys Fedorowicz (ZF) and James Keenan (JVK). Papers that did not meet the criteria for inclusion were excluded. Full copies of designated potentially relevant studies in accordance with the inclusion criteria were obtained. The full paper was also obtained where insufficient data was available in the title and abstract to make a clear decision.

Assessment of Methodological Quality

Each reviewer graded the selected studies. Studies reporting a randomized controlled trial were assessed using a simple contingency form following the Cochrane Reviewers' Handbook 4.2.0 criterion grading system (11). Grading scores were compared and any inter-reviewer inconsistencies in the interpretation of the inclusion criteria and their significance to the selected studies were discussed and resolved. Studies deemed not to match the inclusion criteria were eliminated from further review. Reasons for their exclusion were noted in a 'Characteristics of Excluded Studies' Table (Table 1).

The following parameters of methodological quality were assessed:

TABLE 1. Characteristics of excluded studies

Study	Reason for Exclusion
Fouad 1996	This study combined antibiotic or placebo or neither as an adjunct to operative endodontic treatment in resolving the acute apical abscess.
Henry 2001	This study combined antibiotic as an adjunct to endodontic treatment.
Nusstein 2003	This study was a retrospective non-experimental study.

TABLE 2. Characteristics of included studies

Study	Methods	Participants	Interventions	Outcomes	Notes	Allocation Concealment
Nagle (2000)	Prospective, randomized, double blinded trial. Before the experiment, patient groups (penicillin or placebo) were assigned by using 4-digit numbers from a random number table. Only the random numbers were recorded on the data collection and postoperative diary sheets to blind the experiment. The medications were blinded, randomized, and packaged by a pharmacy.	Study population-USA. Forty emergency adult patients with a clinical diagnosis of irreversible pulpitis were divided into two groups of 20. Mean age and standard deviation (SD) in the penicillin group was 30 and SD 9.8. In the placebo group, the mean age was 34 and SD 11.6. The penicillin group was 7 women and 13 men and the placebo 16 women and 4 men.	Oral penicillin or placebo control (lactose) and all patients received analgesics. Patients randomly received a 7-day oral dose of 500 mg capsules to be taken every 6 hours (total, 28 capsules) of either penicillin or a placebo control (lactose) in a double blind manner. Each patient also received a labelled bottle of 600 mg tablets of ibuprofen and also received a labeled bottle of acetaminophen with 30 mg of codeine.	Primary outcomes were the between-group differences in sum pain intensity differences (SPID), sum pain percussion intensity differences (SPPID), and quantity of pain medications taken.	There were no withdrawals or drop outs	None

- Randomization was graded as adequate (A), unclear (B), or inadequate (C). Adequate (A) included any one of the following methods of randomization; computer generated or table of random numbers, drawing of lots, coin-toss, shuffling cards, or the throw of a dice. Inadequate method of randomization (C) utilized any of the following: case record number, date of birth, or alternate designated numbers.
- Concealment of allocation was graded as adequate (A), unclear (B), or inadequate (C). Adequate (A) methods of allocation concealment included either central randomization or sequentially numbered sealed opaque envelopes. This criterion was considered unmet (C) if there was an open allocation sequence and the participants and trialists were able to foresee the upcoming assignment.
- Blinding of outcomes assessment: whether persons assessing the outcomes of care were aware of the treatment the participant received, or there was any other form of detection bias.
- Handling of withdrawals and losses was graded as yes (A), unclear (B), or no (C), if there was a clear description given of the difference between groups lost to follow up (attrition bias).

Data Collection

After the above methods had been followed, only one randomized controlled trial met the full inclusion criteria. Details of this study were entered independently by each reviewer into the 'Characteristics of Included Studies' Table of "The Cochrane Collaboration RevMan 4.2.2" (see Table 2). The independent entries were then crosschecked. The following details were extracted.

1. Study methods: method of allocation, masking of participants, and outcomes.
2. Participants: country of origin, sample size, age, sex, inclusion, and exclusion criteria.
3. Intervention: type of antibiotic.
4. Control: analgesic, placebo, or nil.
5. Outcomes: primary and secondary outcomes described in the outcome measures section of this review.

Outcomes data were extracted from the included study and entered sequentially by each reviewer into the appropriate tables.

Data Synthesis

The included study did not provide sufficient data to perform statistical analysis; hence, the only data presented was that published in the study. Unsuccessful attempts to obtain additional and individual level data from the trialists made it difficult to re-confirm the results presented.

Sensitivity Analysis

It had been anticipated that sensitivity analyses would be conducted to assess the robustness of the review results by repeating the analysis with the following adjustments: exclusion of studies of lower methodological quality and unpublished studies. As only a single trial matched the inclusion criteria, no sensitivity analyses were carried out.

Results

Finding the Trials

The search strategy identified 35 references of which all but four were excluded from further analysis. Full text copies of these four papers were obtained for further assessment. One paper was a systematic review (12), which included a potential trial (13), which was subsequently rejected as it considered the effect of antibiotics on postoperative endodontic pain. One trial (10) was rejected as the study combined the interventions with operative endodontic treatment. A further trial (14) was excluded as it was a retrospective nonexperimental study. Only one study (5) finally met all the inclusion criteria and was included in the review.

TABLE 3. Baseline pain and percussion values for penicillin and placebo groups

Pain and Percussion Rating	Penicillin	Placebo
Initial pain (median & interquartile range)	2.00 ± 0.00	2.00 ± 1.00
Initial percussion pain (median & interquartile range)	2.00 ± 0.50	2.00 ± 1.00
Pain ratings: moderate	65%	80%
Pain ratings: severe	35%	20%
Percussion pain ratings: mild	20%	25%
Percussion pain ratings: moderate	50%	65%
Percussion pain ratings: severe	30%	10%

Summary of Trial Details

The (5) study was a double-blinded randomized clinical trial of 40 adult patients who presented for emergency dental treatment. All of the participants were in good health as determined by a written health history and by oral questioning. They were considered eligible if they were not taking antibiotics and had not taken any within 30 days of taking part in the study. Each participant included in the study had experienced spontaneous moderate to severe pain from a tooth with a clinical diagnosis of irreversible pulpitis (Table 3). All of the selected teeth were vital and gave a positive response to an electric pulp tester and a prolonged painful response to cold stimulus. In addition they displayed percussion sensitivity and had a widened periodontal ligament space visible on radiograph. Teeth that did not provide a positive response to an electric pulp tester and Endo Ice were not included in the study.

A total of 40 participants completed the trial of which 20 were allocated to antibiotic and analgesic and 20 to placebo and analgesic. The participants randomly received a 7-day oral dose (28 capsules each to be taken every 6 h) of either penicillin (500 mg) or a placebo control in which the participants and trialists were double-blinded. They also received a supply of pain medication consisting of ibuprofen 600 mg; acetaminophen with codeine 30 mg; and a 7-day diary to record pain, percussion pain, and number and type of pain medication taken. No operative endodontic treatment was performed during the course of the study.

The primary outcome measures for the included study was pain relief in the preoperative phase of irreversible pulpitis. This was assessed by asking patients to rate the pain they were experiencing on a short ordinal numerical scale graded from 0 to 3: zero (0) indicating no pain; one (1) indicating mild pain, that is, pain that was recognizable but not discomforting; two (2) indicating moderate pain, or pain that was discomforting but bearable; three (3) indicating severe pain, or pain that caused considerable discomfort and was difficult to bear.

Additionally the patients had been asked to use the same scale to rate pain to percussion that was achieved by tapping the affected tooth with a finger. The pain scale used in this trial had been used in studies referenced by the trialists. Furthermore, in a personal communication the trialists indicated that they had more recently used a modified Heft-Parker visual analog scale (15) and that the two measures had shown a high degree of correlation although the results were unpublished.

The secondary outcome for the selected study was the type and dose of pain medication required to achieve pain relief. The participants were instructed to initially take one tablet of the ibuprofen every 4 to 6 hours as needed for pain and to take the acetaminophen with codeine 30 mg (two tablets every 4–6 h) only if the ibuprofen did not relieve their pain. Each participant received a 7-day diary to record their symptoms and the number and type of pain medication taken. No adverse effects to either the antibiotics or analgesics were reported in this trial.

Methodological Quality of Included Study

The intervention (penicillin) and control (placebo) groups were assigned before the experiment by using four-digit numbers from a random number table (5). To ensure adequate blinding, only the random numbers were recorded on the data collection and postoperative diary sheets. The medications were blinded, randomized, and packaged by a pharmacy. Each 500-mg gelatin capsule of either penicillin or placebo was identical in form. The 500-mg tablets of penicillin VK were ground into a powder and placed into the clear, unlabeled gelatin capsules. The white powder of the lactose placebo was indistinguishable from the white powder of the penicillin tablets when viewed through the capsule. The measures taken by the authors to randomize the groups and conceal allocation of the interventions were deemed to be adequate. There were no study dropouts to consider.

The trialists provided only group level data of the primary and secondary outcomes for every one of the seven study days. In a personal communication they indicated that the pain intensity difference scores (PID) were derived by subtracting the pain intensity score at the given time interval from the patient's baseline pain intensity score. Additionally, they confirmed that the sum of the pain intensity differences (SPID) comprised the total area under the time-effect curve over the first 7 days and was arrived at by summing the PID scores. Similarly the sum of percussion pain intensity difference (SPPID) was arrived at by totaling the percussion pain intensity difference scores (PPID) (Table 4). The between group differences in SPID and SPPID were then assessed by the Mann-Whitney-Wilcoxon test.

No individual level PID or PPID data were made available by the trialists and in the absence of more detailed individual level change data it was not possible to confirm the SPID or SPPID data. Moreover, the reasoning for some of the statistical conclusions were not fully explained in the text. Therefore only the published group level outcomes data and a descriptive summary of results were considered.

Primary Outcomes

Baseline data indicated that all of the participants entering the study had moderate to severe pain (Table 3). After the first day of the study the average pain rating decreased and remained quite stable over the following 6 days. This initial decrease in pain may be considered to be a result of the effect of the analgesics. However, at the end of the study period and at the commencement of operative endodontic treatment it

TABLE 4. Sum pain and percussion pain intensity differences

Pain/Percussion	Penicillin	Placebo	p-value
Sum pain intensity difference (median and interquartile range)	6.0 ± 10.5	6.0 ± 9.5	.776
Sum percussion pain intensity difference (median and interquartile range)	3.5 ± 7.5	2.0 ± 7.0	.290

TABLE 5. Use of pain medication for penicillin and placebo groups (n and quantity)

Day	n ibuprofen	n acetaminophen with 30 mg codeine	No pain medication
DAY 1			
Penicillin	17 (85%)	10 (50%)	1 (5%)
No of tablets	33	21	0
Placebo	16 (80%)	8 (40%)	0
No of tablets	28	11	
DAY 2			
Penicillin	17 (85%)	10 (50%)	0
No of tablets	30	28	
Placebo	16 (80%)	9 (45%)	1 (5%)
No of tablets	31	18	
DAY 3			
Penicillin	13 (65%)	9 (45%)	4 (20%)
No of tablets	27	20	
Placebo	15 (75%)	8 (40%)	3 (15%)
No of tablets	28	14	
DAY 4			
Penicillin	12 (60%)	9 (45%)	6 (30%)
No of tablets	24	23	
Placebo	17 (85%)	5 (25%)	2 (10%)
No of tablets	28	8	
DAY 5			
Penicillin	12 (60%)	8 (40%)	7 (35%)
No of tablets	21	15	
Placebo	16 (80%)	7 (35%)	3 (15%)
No of tablets	32	11	
DAY 6			
Penicillin	13 (65%)	8 (40%)	5 (25%)
No of tablets	24	15	
Placebo	13 (65%)	6 (30%)	6 (30%)
No of tablets	24	13	
DAY 7			
Penicillin	14 (70%)	10 (50%)	4 (20%)
No of tablets	25	16	
Placebo	11 (55%)	7 (35%)	7 (35%)
No of tablets	20	14	

was found that 75% of the teeth in the penicillin group and 80% in the placebo were still vital.

There was a close parallel distribution of the pain ratings in both the intervention and placebo groups over the 7 days. The in between-group differences in sum pain intensity differences (SPID) for the penicillin group were (6.0 ± 10.5), and for placebo (6.0 ± 9.5) $p = 0.776$. The sum pain percussion intensity differences (SPPID) for the penicillin group were (3.5 ± 7.5) and placebo (2.0 ± 7.0) $p = 0.290$ with differences as assessed by the Mann-Whitney-Wilcoxon test considered to be statistically significant at $p < 0.05$ (Table 4).

Secondary Outcomes

The number, percentage, and average use and nonuse of ibuprofen and acetaminophen with codeine are summarized in (Table 5). On both day 1 and day 2 only 1(5%) of the participants took neither medication. The number not taking any medication increased to 3 to 4 (15–20%) on day 3, and 2 to 6 (10–30%) on day 4. On the 5th to 7th days, only 4 to 7(20-35%) did not take any additional pain medication. At day 7, 20% of the penicillin group and 35% of the placebo group took no additional analgesics.

The trialists indicated that there was no significant difference in the mean total number of ibuprofen tablets ($p = 0.839$) and acetaminophen with codeine tablets ($p = 0.325$) taken by either group over the study period (Table 6). The administration of penicillin over placebo did not appear to significantly reduce the quantity of analgesic medication consumed ($p > 0.05$) for irreversible pulpitis.

Discussion

The results of this well constructed but underpowered trial of 20 participants in each study arm indicate that the administration of penicillin did not appear to significantly ($p > 0.05$) reduce either the pain perception, the percussion perception or the quantity of analgesic medication required by patients with irreversible pulpitis. The significance of the relatively common occurrence of toothache, the prevalence of inappropriate prescribing of antibiotics with the potential for producing antibiotic resistance and patient sensitization cannot be underestimated.

It was somewhat disappointing to see the limited number of trials that matched our inclusion criteria. One of the excluded studies included operative endodontic treatment supplementary to the prescription of antibiotics and analgesics (10). Another one investigated the potential benefits of antibiotics for pain and swelling in postoperative endodontic treatment (13). There is an acceptance that changes in the dental pulp associated with irreversible pulpitis are a continuum and therefore, it may not be possible to clearly differentiate either clinically

TABLE 6. Number of analgesic tablets prescribed

Analgesic	Penicillin	Placebo	p-value
Total number ibuprofen (mean ± SD)	9.2 ± 6.02	9.6 ± 6.34	.839
Total number acetaminophen with 30 mg codeine (mean ± SD)	6.9 ± 6.87	4.45 ± 4.82	.325

or radiologically between the stages of pulp degeneration and necrosis to acute apical abscess formation. Our electronic searches did identify a systematic review (12), which offered strong confirmatory evidence that in the absence of systemic complications e.g. fever, lymphadenopathy, cellulitis, or in immunocompromised patients, antibiotics alone have no place in the management of localized acute apical abscess. Furthermore, they stated that although the pain from acute apical abscess is as a result of an infective process, the infection is localized and that even in this terminal stage of irreversible pulpitis the use of antibiotics as a sole or concomitant therapy remains questionable.

The indiscriminate prescribing of antibiotics was investigated in a study commissioned by the British National Health Service (NHS). This confirmed that there was evidence of overuse and inappropriate prescribing of antibiotics in NHS general dental practice and antibiotics were frequently prescribed in clinical situations where there was limited evidence of benefit. It was noted that patient expectation (8%), pressure of time and workload (30%), and patient's social history (8%) accounted for a large number of nonclinical factors responsible for antibiotic prescribing. This appeared to be supported by the American Association of Endodontists' study (9), which indicated that some endodontists felt compelled to prescribe antibiotics for medico-legal reasons, to satisfy patient demand and expectation and to decrease the risk of losing referrals.

There is a general awareness among dentists that antibiotics do not have a role to play in alleviating pain in irreversible pulpitis but it is apparent that the practice of prescribing antibiotics continues notwithstanding a lack of evidence of effectiveness and irrespective of potential risk. The use of antibiotics in conjunction with cleaning and disinfection of the root canal or dental extraction should be considered when the spread of infection is systemic and the patient is febrile. Therefore, careful evaluation of a patient's history, a thorough clinical examination and evaluation of each test is vital to establish the status of the pulp. Not infrequently symptomatic pulpitis may become symptomless as the degeneration of the pulp leading to pulpal necrosis may proceed gradually without the development of further symptoms, pulp tests may prove to be indecisive and the first indication may be radiolucency visible at the periapex on a radiograph.

The results of this systematic review confirm the necessity for further larger sample and methodologically sound trials that can assist in providing additional supportive evidence as to whether the prescription of antibiotics either therapeutically or prophylactically can adversely affect treatment outcomes for irreversible pulpitis. There is now a compelling urgency to investigate the teaching of the rationale for safe and effective antibiotic prescribing in endodontics and to advance the development of appropriate evidence-based clinical guidelines.

Acknowledgments

We would like to express our gratitude to the following: the Cochrane Oral Health Group and Sylvia Bickley, the Trials Search Co-ordinator, who developed and executed the electronic searches for our review. To Emma Tavender who has provided exceptional guidance and help with copy editing throughout this review. To Scott McLanahan, Professor of Endodontics at the Naval Postgraduate Dental School, Bethesda MD, the author of an article on this topic that provided the starting point for this review and who kindly agreed to continue providing advice. Our thanks are also going out to Mohammed Ghali Rashid, the reference and serials librarian and ILL service co-ordinator at the Arabian Gulf University Kingdom of Bahrain, who obtained some of the initial background references for this review.

There are no financial conflicts of interest and the reviewers declare that they do not have any associations with any parties who may have vested interests in the results of this review. A version of this review has been published in The Cochrane Library. Cochrane systematic reviews are regularly updated to include new research, and in response to comments and criticisms from readers. Comment on this Cochrane review may be sent to: Emma Tavender, Review Group Co-ordinator, Cochrane Oral Health Group, School of Dentistry, The University of Manchester, Higher Cambridge Street, Manchester M15 6FH, UK. Tel: +44-161-275-7818; fax: +44-161-275-7815; Cochrane Oral Health Group web site: http://www.cochrane-oral.manchester.ac.ukwww.cochrane-oral.manchester.ac.uk or E-mail: Emma.Tavender@man.ac.uk

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