TITLE: Prophylactic Removal of Wisdom Teeth: A Review of the Clinical Benefit and Guidelines

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CONTEXT AND POLICY ISSUES:

Third molars (or wisdom teeth) are the final teeth to erupt, typically between the ages of 18 and 24 years of age, but with variation in this range.[1] In some cases, eruption of these teeth will be uneventful, and they will provide normal function. In other cases, the positioning of another tooth in the mouth may inhibit complete entry of the third molar due to a lack of sufficient space or due to growth in an abnormal position, and function of the tooth will be limited. In some cases, there is a risk of clinically important pathology including pericoronitis (i.e. inflammation of tissue surrounding a third molar due to presence of bacteria), non-restorable carious lesions, infection, tumor and cyst development, risk of mandibular fractures, and overcrowding (leading to tooth and bone damage).[2-4] Due to these risks, the removal of impacted wisdom teeth is a common surgical procedure that is universally agreed upon in cases where current or perceived potential for pathology exists.[5]

Contrary to the extraction of impacted third molars associated with clinically important pathology, there remains debate regarding prophylactic removal of asymptomatic third molars, and practice variation has been documented.[3,5-9] Despite a 1979 meeting on the topic of third molar removal sponsored by the National Institutes of Health, there continues to remain no unanimous agreement regarding prophylactic extraction.[10] Some suggest third molar removal is justified for reasons such as lack of a vital role in the mouth, increased risk of pathological changes and symptoms, and reduction of risk compared to a watchful waiting approach (which may be associated with what some consider to be higher risk surgery due to increased age if symptoms appear).[6] Conversely, others note that normal tooth eruption may occur without complications, and that the pain and risks (such as alveolitis, post-operative infections, nerve dysfunction, and post-operative bleeding[11]) of third molar extraction may not be warranted. Friedman[12] cites data suggesting that only 12% of impacted third molars are associated with outcomes such as cyst development or damage to surrounding teeth, and suggests that other cited reasons for prophylactic removal (such as pain/discomfort or infections) often vanish once eruption is complete, or are easily managed with conservative alternatives including a combination of antibiotics and other minor oral therapies.

Removal of third molars is the most commonly performed oral surgery.[5,6,13] While data regarding Canadian rates were unavailable, published literature citing data from the US suggests that approximately 10 million impacted teeth (i.e. teeth which fail to erupt in normal position and are at least partially covered by the jaw or gums) are extracted from approximately 5 million people annually.[12] Estimated annual third molar removal costs of $2 billion in the US were noted in a 2003 article, excluding the costs of examinations, radiographs, medication, anesthesia, hospital/surgical center charges, and patients' time away from work.[10]

Prophylactic wisdom tooth extraction is currently a covered benefit by some Canadian healthcare plans. This rapid review was undertaken to evaluate the extent of evidence supporting this practice.

RESEARCH QUESTIONS:

1. What is the evidence for the clinical benefit of prophylactic removal of asymptomatic wisdom teeth compared with retention of asymptomatic wisdom teeth?

2. What are the evidence-based guidelines for the prophylactic removal of asymptomatic wisdom teeth?

METHODS:

A limited literature search was conducted on key health technology assessment resources, including PubMed, EBSCOhost: CINAHL, The Cochrane Library (Issue 7, 2010), University of York Centre for Reviews and Dissemination (CRD) databases, ECRI (Health Devices Gold), EuroScan, international health technology agencies, and a focused Internet search. The search was limited to English language articles published between January 1, 2000 and July 9, 2010. No filters were applied to limit retrieval by study type.

To address research question 1, health technology assessments, systematic reviews (with or without meta-analyses), randomized controlled trials (RCTs), and non-randomized studies were eligible for inclusion. Studies were required to compare clinical outcomes between groups of individuals diagnosed as having asymptomatic wisdom teeth where one portion of the group underwent prophylactic surgery for third molar removal, while the other group retained their asymptomatic teeth. No restrictions on clinical outcomes, participant age, or duration of follow- were used. Reviews which did not appear to be conducted using a systematic approach (e.g. narrative reviews, or those failing to report a framework for their literature search) were excluded.

Clinical practice guidelines and recommendations were retained for inclusion to address research question 2.

HTIS reports are organized so that the higher quality evidence is presented first. Therefore, systematic reviews and meta-analyses are presented first. These are followed by non-randomized studies and evidence-based guidelines.

SUMMARY OF FINDINGS:

Overall, seven relevant articles were identified from the electronic search of databases and grey literature. This included four systematic reviews,[1,14-16] one non-randomized study,[17] and two clinical practice guidelines.[18,19] No relevant health technology assessment reports or RCTs were identified. Details from these articles are summarized below, stratified by type of publication, and with accompanying study details provided in tables in Appendix 1 of this review where indicated.

Systematic reviews and meta-analyses

A total of four relevant systematic reviews (Song 2000,[14] Mettes 2008,[15] Norwegian Knowledge Centre for Health Services 2003,[16] Dodson 2009[1]) were identified by the literature search. A summary of their findings is presented here, and an overview of methods used by these reviews is provided in Table 1 of Appendix 1.

Song et al (2000):[14]

In 2000, Song and colleagues[14] reported findings from a systematic review carried out to explore the clinical and cost-effectiveness of prophylactic wisdom tooth removal. The authors located totals of two RCTs, 34 literature reviews, and four decision analysis studies from their search that were included in their review.

The two RCTs identified were published in 1998 and 1999, respectively, with one carried out in the UK and one in Denmark. The UK-based trial primarily explored the impact on incisor crowding with wisdom tooth retention (n=33) relative to prophylactic extraction (n=44). Outcomes collected and analyzed by study investigators included Little's Irregularity Index, intercanine width, and arch length. Five years of follow-up were planned, with analysis of outcomes based on comparison of baseline and final follow-up measures. Based on the collected data and data analysis, the authors concluded that there was insufficient evidence to suggest a benefit of third molar removal.

The second RCT, based in Denmark, was still ongoing at the time the work of Song and colleagues was published, and therefore limited intermediate findings were available (200 of a planned 500 participants had been enrolled). The study was planned to evaluate the clinical and cost-effectiveness of prophylactic third molar extraction, with extraction performed according to associated comorbidities (i.e. watchful waiting) in a collection of participants aged between 18 and 30 years. Questionnaires were to be used for outcome data collected related to clinical effectiveness and quality of life, and an economic evaluation from a societal perspective was to be carried out. Song et al. indicated that only descriptive results from the study were available at that time, and that these results suggested the following findings: (1) prophylactic wisdom tooth extraction may be associated with reduced functional health status, as well as elevated healthcare costs and losses in productivity; (2) amongst participants being monitored according to the principle of watchful waiting, few had shown indication of changes in pathology suggestive of the need for wisdom tooth removal. Unfortunately, no subsequent publications of the clinical or cost-effectiveness findings could be located for this report.

The collection of 34 literature reviews identified by the authors was described as being of low methodologic quality, and the authors noted that none were systematic reviews. The authors also noted that relevant details of individual studies described within these literature reviews were typically limited, thereby preventing readers from developing an appropriate sense of the reliability of study findings. None of the included literature reviews made mention of identified RCTs, and instead primarily consisted of varied forms of observational studies. Quantification of risks and benefits were not discussed by this collection of literature. Relevant and common themes extracted by the authors from these studies were as follows: (1) from a total of nine reviews focused on the aspect of anterior crowding, eight claimed there was little to no benefit of prophylactic third molar extraction; (2) amongst 21 reviews described by the authors as being

more general, 12 of them were associated with conclusions of uncertainty regarding the practice of prophylactic extraction; and (3) three of four reviews mainly oriented to the topic of surgical complications expressed uncertainty regarding best practice.

The collection of four decision analyses (all of which were published prior to 2000) employed different methods to compare clinical outcomes associated with extraction versus retention of asymptomatic third molars, including variations in methods for estimating the risk of complications (both related to surgery or to third molar retention), means of representing patient utilities, and consideration of costs. While these studies varied in certain methodological aspects, their findings were consistent; all suggested that the well-being of participants is greatest if surgical extraction is only performed in the presence of impacted third molars which are associated with pathologic changes, and that such practice was also the most cost-effective approach. Work by the ECRI institute cited, but not formally included by the authors, concluded that there are no reliable predictors of future pathologic changes, and that while prophylactic removal reduced the risk of future pathologic changes and post-surgical complications, dental crowding is not reduced; it was suggested that only one of every six patients would benefit from prophylactic removal. The authors noted that given the lack of long-term, randomized studies addressing this issue, the evidence upon which decision modeling exercises was based is generally from studies associated with a greater potential for bias.

Mettes et al (2008):[15]

In 2008, a Cochrane systematic review by Mettes and colleagues[15] reported findings regarding the effectiveness of interventions for management of asymptomatic impacted wisdom teeth in adolescents and adults. No meta-analyses were performed by the authors due to important variations amongst studies, and thus a narrative review of study findings was provided.

Three relevant studies were identified and selected for inclusion by the authors. Two were RCTs exploring the impact of prophylactic third molar removal on late incisor crowding in adolescents. The two RCTs were completed in 1982 and 1998. The 1998 study is not discussed in further detail here, as it was the same UK-based study included in the earlier described review by Song et al;[14] the study's data did not provide support for prophylactic removal of impacted wisdom teeth.

The 1982 study was carried out in Sweden amongst adolescents aged 13 to 19 years with unerupted wisdom teeth, and employed a split-mouth design (i.e. each participant experiences both interventions, one on each side of the mouth) to examine the impact of surgical removal of asymptomatic third molars versus third molar retention on arch length over a minimum three year follow-up period. The study was assigned an overall quality grade of C (i.e. a high risk of bias) based on the presence of inadequate allocation concealment, lack of outcome assessor blinding, unclear description of randomization, and a presence of withdrawals. It was found that benefits and harms were not predictable amongst the treatment and control groups, as mean changes in arch length were comparable in both groups.

The third study was an ongoing trial at the time the review was carried out. Mettes et al reported that the investigators of the third trial indicated an intention to publish findings, but no data were available to them for inclusion in their review.

The authors noted that neither of the two trials provided data related to patient oriented outcomes or aspects of cost, and that no studies in adults were located. The difficulty of carrying out a study with sufficient follow-up was also noted. The authors recommended that clinicians place primary focus on considerations such as consistent radiographic examination and monitoring of third molars beginning in adulthood (with careful attention to the occurrence of pathologic sequelae), and that the current uncertainty of the benefits of prophylactic third molar removal be shared with patients. The need for sound research studies with longer follow-up was stated, as well as the need for additional exploration of decision analytic exercises with adequate incorporation of patient preferences.

Norwegian Knowledge Centre for Health Services (2003):[16]

A report authored by the Norwegian Knowledge Centre for Health Services[16] (2003) explored the issue of prophylactic third molar removal, specifically examining the incidence of surgical complications associated with removal, morbidities related to tooth retention, and relevant issues related to either changes to patients' quality of life or items of economic importance. The review was published in Norwegian and, thus, not all details could be included here, but an English summary was available. The report was based on existing reviews from the National Coordinating Centre for Health Technology Assessment (NCCHTA), the National Institute for Health and Clinical Excellence (NICE), and the Scottish Intercollegiate Guidelines Network (SIGN), as well as an updated review of studies published between 1999 and 2003.

A total of 25 studies were included in the report: eleven patient series, five cohort studies, two case-control studies, six cross-sectional studies, and one decision analysis. Studies related to complications from prophylactic third molar extraction were described as generally being associated with low frequencies of inferior alveolar or lingual nerve damage lasting beyond six months, pain, serious infections, or fractures. Complications related to retention of asymptomatic third molars included high frequencies of both caries and pericoronitis, as well as lower frequencies of cysts, tumors, and root resorption (supporting data were not available in the English summary). The authors described a UK-based decision analysis as concluding that retention of asymptomatic third molars was the more cost-effective strategy compared to prophylactic removal. The authors suggested that this conclusion may be different in Norwegian practice for two reasons: (1) the UK-based analysis likely included extraction of both fully retained and partially erupted wisdom teeth, while Norwegian practice would only consist of removal of partially erupted teeth; and (2) all four wisdom teeth are often removed simultaneously in the UK under general anesthesia, which is not standard practice in Norway. The authors concluded by recommending that prophylactic extraction of asymptomatic, partially erupted wisdom teeth only be pursued when future morbidity is anticipated, and the treating practitioner feels that the patient would be at low risk of surgical complications; extraction of asymptomatic and fully retained wisdom teeth was not recommended. The authors cited the fact that most studies were small and of a non-randomized design to be a limiting factor, and that patient preferences also warrant consideration given the uncertainty of the evidence.

Dodson and Susarla (2009):[1]

In 2009, Dodson and Susarla[1] reported findings from a systematic review carried out to address two of research questions, one of which was to determine whether asymptomatic and disease-

free impacted wisdom teeth should be removed prophylactically. Based on the evidence that the authors reviewed, the authors noted several points:

- approximately 30-60% of patients who retain asymptomatic third molars will have at least one of them removed in the four to twelve year period following initial assessment;
- no evidence was currently sufficient to confirm or disprove benefits of prophylactic wisdom tooth removal;
- it remains unclear whether the practice of active surveillance (i.e. watchful waiting) is effective for management of asymptomatic third molars.

This systematic review included the same studies summarize above,[14-16] and thus no further details regarding their findings are provided here. However, the interpretations of the authors, along with a summary of their perceived quality of the evidence based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) scale, have been provided. The authors reported the following conclusions and associated qualities of evidence:

- It is currently unclear whether early extraction of asymptomatic wisdom teeth in adolescents of ages 13 to 19 years provides benefit in terms of prevention of late crowding of lower incisor teeth relative to no extraction. (quality of evidence: very low)
- It is currently unclear whether early extraction of asymptomatic wisdom teeth in adolescents of ages 13 to 19 years provides benefit in terms of reductions in pain, infection, or limited mouth opening at three years after extraction relative to no extraction. (quality of evidence: very low).
- No direct information from RCTs or prospective cohort studies were found that addressed any of the following comparisons: active surveillance versus active surveillance plus no extraction, active surveillance versus extraction.

The authors also noted that when caries are present in the adjacent second molar, prophylactic extraction of asymptomatic third molars may be beneficial in order to permit treatment. There may also be benefit when periodontal pockets distal to the second molar are present.

Non-randomized Studies

One non-randomized study with a treatment and a control group was identified by the literature search.

Kunkel and colleagues[17] (2007) reported findings from a cohort study that enrolled hospitalized patients who were admitted for third molar associated complications between 2003 and 2006. Patients were retrospectively categorized according to whether, upon admission, a third molar had been prophylactically removed, therapeutically removed (i.e. non-elective), or was still present.

A total of 100 participants aged from 14-86 years (median 31 years) were enrolled during the study period: 27 undergoing prophylactic extraction, 44 undergoing non-elective extraction, and 29 with molars intact who had experienced complications associated with pericoronitis. Amongst them, reasons for admission primarily consisted of severe infection, as well as small numbers of mandible fracture, luxation (of teeth, fragments or instruments to soft tissues or maxillary sinus), lingual nerve transaction, and post-surgical hemorrhage. Using a conventional statistical

significance level of 5%, the authors concluded that there was no difference in length of hospital stay (prophylactic: mean 6.7 days with range 2 - 16 days versus therapeutic: mean 7.9 days with range 2 - 28 days), direct treatment costs (mean €2,650 with range €1,349 - €7,775 versus mean €2,747 with range €1,259 - €7,775) or days of disability (mean 16.3 days with range 3 - 42 days versus mean 18 days with range 6 - 35 days) based on statistical analyses carried out to compare those that underwent prophylactic versus therapeutic third molar removal, respectively. Levels of white blood cells and C-reactive protein did not show a difference between groups based on formal statistical comparison. The authors concluded by noting that while complications were seen in all age groups in their study (i.e. were not limited to older patients), a considerable amount of the complications seen occurred after 40 or more years of symptom-free living. It was also noted that there is no comprehensive study design that will permit capture of all long-term implications of a watchful waiting approach for third molar removal. This statement was based primarily on the death of a 77 year old individual who experienced a myocardial infarction and died 23 days after third molar removal which was necessary due to the presence of a pericoronal cyst.

Guidelines and recommendations

Two relevant guideline documents were identified by the literature search: one was issued by NICE in 2000,[18] and the other by the Agency for Quality in Dentistry in 2006.[19]

NICE (2000):[18]

A brief guideline document was issued by NICE in 2000[18] regarding prophylactic removal of asymptomatic third molars. The guidance was based upon appraisal of the earlier described review by Song et al[14] by a committee of 24 experts in health economics, epidemiology, public health, and surgery. Professional group submissions from the Faculty of Dental Surgery from the Royal College of Surgeons of Englan, the Birmingham Dental Hospital, the British Dental Association, the British Medical Association, the Royal College of Nursing, and the British Dental Industry Association were also reviewed by the committee, as were submissions from a group of three invited experts. The guideline did not contain discussion of interpretations of the evidence generated by this exercise. The review panel recommended that prophylactic removal of asymptomatic wisdom teeth be discontinued, and noted that only pathologies such as unrestorable caries, abscess and osteomyelitis, cellulitis, tooth fracture, resorption of the tooth or adjacent teeth, follicle disease (including cysts or tumours), and tooth involvement within the field of tumour re-section be considered as sufficient pathology for removal. The budget impact of cessation of this practice was described as unclear given the uncertainty surrounding rates of this procedure for prophylactic purposes.

Agency for Quality in Dentistry (2006):[19]

A 2006 guideline developed and reported by the Agency for Quality in Dentistry, a unit of the Institute of German Dentists, focused on the topic of surgical removal of third molars. [19] Based upon a review of relevant literature whose methods were not described in detail (only a partial list of reviewed literature was provided), relevant evidence was compiled. Level of evidence was assigned a grade of A if a meta-analysis of RCTs, a grade of B1 if based on at least one well designed controlled study without randomization or a well designed quasi-experimental study, a grade of B2 if based on well-designed non-experimental descriptive studies, or a grade of C if

based on reports or opinions of experts, consensus conferences and/or clinical experience or case studies. Recommendation levels of either '*Strongly Recommend*', '*Recommend*', or '*Recommendation Open'* were determined by all parties involved in the process. Regarding extraction of asymptomatic third molars, recommendations from the guideline document regarding situations where this practice was considered indicated or non-indicated are summarized in Table 1 of the main text (shown below). Limitations of this guideline are that the document only partially cited literature which was used in the development, and that the process regarding how the evidence was used to develop recommendations was not described in detail.

Table 1: Summary of Relevant Recommendations, Agency for Quality in Dentistry Guidelines

Prophylactic Extraction Indicated	Prophylactic Extraction Not Indicated
• "Higher-level reasons associated with the patient's life situation" (Recommend); pg. 11[19] • "If other measures are being conducted under anesthetic and further anesthesia would be necessary for removal of a third molar" (Recommend); pg. 11[19] • "Where prosthetic treatment is planned and secondary eruption due to further atrophy of the alveolar ridge or to pressure of the removable prosthesis is likely" (Recommend); pg. 11[19] • "To facilitate orthodontic treatment such as tooth movement and/or retention" (Recommend); pg. 11[19]	• "Where spontaneous regular positioning of the third molars in the dental arch is likely" (Strongly Recommend); pg. 11[19] • "If the extraction of other teeth and/or orthodontic treatment with correct positioning of the tooth is appropriate" (Strongly Recommend); pg. 11[19] • "Deeply impacted and malposed teeth without associated pathology, where a high risk of surgical complications exists" (Recommend); pg. 11[19]

LIMITATIONS:

There are several limitations to this rapid review that affect the ability to address the research questions of interest. These include the following:

Extent of Available Literature:

- Four systematic reviews[1,14-16] relevant to the question of benefits and risks of prophylactic third molar extraction were identified. One was a rapid review published in 2000 which consisted of information from a limited amount of RCT data and a collection of methodologically limited literature reviews, and thus its reliability is unclear.[14] A second was a Cochrane review consisting of two trials, and a third which was not completed or published.[15] A third review was published in Norwegian and, thus, only an English summary abstract was available, but the majority of evidence included consisted of observational studies.[16] The most recent review was based upon the earlier reviews, which had methodological limitations.[1] Two literature reviews, one guideline and one observational study providing further discussion of past evidence have been provided as potential references of interest in Appendix 2; these were excluded from this review, as they failed to meet one or more inclusion criteria, but have been provided as supplemental sources of information.

- Within the past ten years, limited comparative research exploring the benefits of prophylactic wisdom tooth extraction has been published. More studies providing evidence from direct comparisons of prophylactic removal versus watchful waiting are warranted in order for this practice to be justified, as current evidence is insufficient to promote this practice.

Literature Search:

- Due to findings from a preliminary literature search suggesting that there existed limited information published between 2005-2010, the literature search for this review was expanded upon to include publications from the years 2000-2004. However, it is worth noting that any relevant evidence published prior to 2000 was excluded from this rapid review. Inspection of literature included in this review suggests that there is likely to be additional evidence of potential relevance which was published in the 1980s and 1990s.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING:

This rapid review identified four systematic reviews, two clinical guidelines, and one non-randomized study addressing the question of benefits and risks associated with the prophylactic extraction of asymptomatic third molars. Findings from the reviews and recommendations summarized in this report suggested that there is insufficient evidence in terms of additional benefit or reduced future risk to warrant prophylactic wisdom tooth extraction, and additional research using sound study methodology and ensuring adequate durations of follow-up may be beneficial to better address the research questions. Further decision analyses with increased focus on incorporation of patient preferences have been suggested.[15]

As was expressed by a number of the original authors of the included research, review of the identified evidence demonstrated that there remains a lack of high quality evidence addressing this issue, as the majority of primary research thus far has employed non-randomized study designs, had shorter durations of follow-up, and has lacked certain patient focused outcomes. The majority of evidence and guidance included in this review is older, and little published research from the past 5 years was found.

Despite what has been described by several of the authors of the research included in this review as minimal supporting evidence, earlier documented variation in the prevalence of asymptomatic third molar removal indicates that the practice of prophylactic wisdom tooth removal remains prominent in dental and oral surgery practices in various nations. Some literature suggests that variations in practice may be a consequence of incomplete knowledge uptake and awareness amongst practitioners of the limited evidence supporting this practice, and that planned exposure of practitioners to key literature may be able to assist with change of practice.[9,20] Regarding the aspect of cost-effectiveness, Liedholm[11] notes that past researchers have suggested that the consideration of patient flow may be vital, including aspects such as number of visits, and specific services provided at those visits (including radiographs and other aspects of related care or examination). The practice of day surgery has been suggested by others as having low complication rates and high patient satisfaction, and is lower cost than inpatient procedures. Several of the studies included in this review noted that, given a lack of evidence supporting (or refuting) the practice of prophylactic third molar removal, patient preference must also be considered. Liedholm[11] suggests that patients generally appear to opt for a non-interventionist approach more so than clinicians, and thus some may prefer the approach of watchful waiting.

Based on evidence and guidelines from the past ten years of evidence identified for inclusion in this review, there is currently insufficient evidence supporting or refuting the practice of

prophylactic removal of asymptomatic third molars. Regarding clinical practice, the decision to remove asymptomatic wisdom teeth appears to be best based on careful consideration by practitioners of the potential risks and benefits for individual patients, as well as their attitude toward a potentially unnecessary surgical procedure.

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REFERENCES

1. Dodson TB, Susaria SM. Impacted wisdom teeth. Clin Evid (Online) [Internet]. 2010 [cited 2010 Jul 9];4:1302. Available from: http://clinicalevidence.bmj.com/ceweb/conditions/orh/1302/1302-get.pdf Subscription required.

2. Clauser B, Barone R, Briccoli L, Baleani A. Complications in surgical removal of mandibular third molars. Minerva Stomatol. 2009 Jul;58(7-8):359-66.

3. Adeyemo WL. Do pathologies associated with impacted lower third molars justify prophylactic removal? A critical review of the literature. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2006 Oct;102(4):448-52.

4. Bouloux GF, Steed MB, Perciaccante VJ. Complications of third molar surgery. Oral Maxillofac Surg Clin North Am. 2007 Feb;19(1):117-28, vii.

5. NHS Centre for Reviews and Dissemination. Prophylactic removal of impacted third molars: is it justified? Effectiveness Matters [Internet]. 1998 Oct [cited 2010 Jul 9];3(2):1-4. Available from: http://www.york.ac.uk/inst/crd/EM/em32.pdf

6. Jasinevicius TR, Pyle MA, Kohrs KJ, Majors JD, Wanosky LA. Prophylactic third molar extractions: US dental school departments' recommendations from 1998/99 to 2004/05. Quintessence Int. 2008 Feb;39(2):165-76.

7. Dunne CM, Goodall CA, Leitch JA, Russell DI. Removal of third molars in Scottish oral and maxillofacial surgery units: a review of practice in 1995 and 2002. Br J Oral Maxillofac Surg. 2006 Aug;44(4):313-6.

8. Knutsson K, Lysell L, Rohlin M, Brickley M, Shepherd JP. Comparison of decisions regarding prophylactic removal of mandibular third molars in Sweden and Wales. Br Dent J [Internet]. 2001 Feb 24 [cited 2010 Jul 9];190(4):198-202. Available from: http://www.nature.com/bdj/journal/v190/n4/pdf/4800924a.pdf

9. Knutsson K, Lysell L, Rohlin M. Dentists' decisions on prophylactic removal of mandibular third molars: a 10-year follow-up study. Community Dent Oral Epidemiol. 2001 Aug;29(4):308-14.

10. Silvestri AR, Jr., Singh I. The unresolved problem of the third molar: would people be better off without it? J Am Dent Assoc. 2003 Apr;134(4):450-5.

11. Liedholm R. Mandibular third molar removal: patient preferences, assessments of oral surgeons and patient flows. Swed Dent J Suppl. 2005;(175):1-61.

12. Friedman JW. The prophylactic extraction of third molars: a public health hazard. Am J Public Health [Internet]. 2007 Sep [cited 2010 Jul 9];97(9):1554-9. Available from: http://ajph.aphapublications.org/cgi/reprint/97/9/1554

13. Cabbar F, Guler N, Comunoglu N, Sencift K, Cologlu S. Determination of potential cellular proliferation in the odontogenic epithelia of the dental follicle of the asymptomatic impacted third molars. J Oral Maxillofac Surg. 2008 Oct;66(10):2004-11.

14. Song F, O'Meara S, Wilson P, Golder S, Kleijnen J. The effectiveness and cost-effectiveness of prophylactic removal of wisdom teeth. Health Technol Assess [Internet]. 2000 [cited 2010 Jul 9];4(15):1-55. Available from: http://www.hta.ac.uk/fullmono/mon415.pdf

15. Mettes TG, Nienhuijs ME, van der Sanden WJ, Verdonschot EH, Plasschaert AJ. Interventions for treating asymptomatic impacted wisdom teeth in adolescents and adults. Cochrane Database Syst Rev [Internet]. 2005 [cited 2010 Jul 9];(2):CD003879. Available from: http://mrw.interscience.wiley.com/cochrane/clsysrev/articles/CD003879/pdf_fs.html

16. Norwegian Knowledge Centre for the Health Services. Prophylactic removal of wisdom teeth [Internet]. Oslo: Norwegian Knowledge Centre for the Health Services (NOKC); 2003. 104 p. [cited 2010 Jul 9]. Available from: ftp://ftp.nokc.no/SMM/SMM-Rapport_03-10_Profylaktisk_fjerning_av_visdomstenner.pdf In Norwegian.

17. Kunkel M, Kleis W, Morbach T, Wagner W. Severe third molar complications including death-lessons from 100 cases requiring hospitalization. J Oral Maxillofac Surg. 2007 Sep;65(9):1700-6.

18. Guidance on the extraction of wisdom teeth [Internet]. London: National Institute for Clinical Excellence (NICE); 2000. 12 p. (Technology appraisal guidance no.1). [cited 2010 Jul 9]. Available from: http://www.nice.org.uk/nicemedia/live/11385/31993/31993.pdf

19. ZZQ Agency for Quality in Dentistry. Guideline: surgical removal of third molars: short version [Internet]. Cologne: Institute of German Dentists; 2010 Apr. 16 p. [cited 2010 Jul 9]. Available from: http://www3.zzq-koeln.de/zzqpubl3.nsf/7305289f7d3f7b77c12573370038e5b9/382ea4cdbc1280a0c12573f500482e9d/$FILE/Leitlinie_Weish_EN.pdf

20. van der Sanden WJ, Mettes DG, Plasschaert AJ, Grol RP, van't Hof MA, Knutsson K, et al. Effect of selected literature on dentists' decisions to remove asymptomatic, impacted lower third molars. Eur J Oral Sci. 2002 Feb;110(1):2-7.

APPENDIX 1: Summary of Methodologies of Included Systematic Reviews

Table 1: Summary of Methodologies of Included Systematic Reviews

Author (Year)	Methods	Inclusion Criteria
Song[14] (2000)	**Literature Search**: Systematic review based on evidence gathered from a search of Medline (1984-99), EMBASE (1984-99), Science Citation Index, Cochrane Controlled Trials Register, National Research Register; DARE; paper sources and web-based resources. Relevant agencies were also contacted. No restrictions on language were used. Study selection and data extraction was performed by two reviewers. **Quality Assessment of Studies**: RCTs assessed based on reporting of selection criteria, sample size, a priori power calculation, mode of randomization, group comparability, blinded outcome evaluation, withdrawals, appropriateness of analysis, intention to treat analysis. Literature reviews assessed based on clarity of review goals, literature search, selection criteria, presentation of primary study findings, methods of summarizing data. **Synthesis**: Descriptive summary of study findings	**Design**: RCTs, literature reviews, decision analyses **Population**: individuals with unerupted or impacted wisdom teeth, or patients undergoing wisdom tooth removal for prophylactic or symptomatic reasons **Outcomes**: pathologic changes associated with tooth retention or complications following tooth extraction
Mettes[15] (2008)	**Literature Search**: Cochrane Oral Health Trials Register (4 August 2004), Cochrane Register of Controlled Trials, Medline (1966-2004), Pubmed (1966-2004) **Quality Assessment of Studies**: Grading of allocation concealment, blinding of outcome assessors, completeness of patient follow-up; studies categorized according to perceived risk of bias (low, moderate, high) **Synthesis**: Descriptive summary of findings	**Design**: randomized or controlled clinical trials **Population**: adolescents or adults with asymptomatic impacted wisdom teeth, and participants in the same category undergoing prophylactic removal of asymptomatic wisdom teeth. **Outcomes**: pathologic changes, post-operative complications, costs
Norwegian Knowledge Center for Health Services[16] (2003)	**Literature Search:** the Cochrane Library, Database of Abstracts of Reviews of Effectiveness, International Network of Agencies of Health Technology Assessment database, National Guidelines Clearinghouse, Medline, EMBASE, NHS Economic Evaluation Database, OHE Economic Evaluations Database. **Quality Assessment of Studies**: Not described (English language summary only)	**Details not available (only English abstract available)**

Table 1: Summary of Methodologies of Included Systematic Reviews		
Author (Year)	**Methods**	**Inclusion Criteria**
	Synthesis: Descriptive summary of findings	
Dodson[1] (2009)	**Literature Search:** Medline (1966-2009), EMBASE (1980-2009), Cochrane Database of Systematic Reviews and Cochrane Central Register of Controlled Clinical Trials (2009, Issue 1). **Quality**: A GRADE evaluation of evidence quality was performed, resulting in quality rankings of high, moderate, low, or very low.	**Design:** systematic reviews of RCTs; RCTs; prospective cohort studies with a control group; no language restrictions; 20 or more subjects. **Population**: Patients with asymptomatic wisdom teeth **Outcomes**: dental disease, incisor crowding, disruption to regular daily activities, damage to adjacent teeth, lesions, facial cellulitis, need for future extraction, harms data (pain, swelling, trismus, excessive bleeds, infections, nerve injuries, other)

APPENDIX 2: Other Articles of Potential Interest

- The following studies did not meet inclusion criteria for this review due to style of review or due to date of publication, but have been mentioned here as supplemental articles which may be of interest.

    - Marciani R. Third molar removal: an overview of indications, imaging, evaluation, and assessment of risk. Oral Maxillofac Surg Clin North Am. 2007 Feb;19(1):1-13.

    - Bagheri SC, Ali Khan H. Extraction versus nonextraction management of third molars. Oral Maxillofac Surg Clin North Am. 2007 Feb;19(1):15-21.

    - Management of unerupted and impacted third molar teeth [Internet]. Edinburgh: Scottish Intercollegiate Guidelines Network; 1999 Sep [cited 2010 Jul 9]. 36 p. (SIGN publication number 43) Available from: http://www.sign.ac.uk/pdf/sign43.pdf.

- The following observational study identified from the literature search, while not meeting inclusion criteria for this review due to lack of defined treatment and control groups, was considered to be of potential interest and is summarized in brief below.

    - Hill CM, Walker RV. Conservative, non-surgical management of patients presenting with impacted lower third molars: a 5-year study. Br J Oral Maxillofac Surg. 2006 Oct;44(5):347-50.

    - Hill and Walker (2006) reported findings from a study of patients aged between 16 and 30 years who had at least one impacted lower third molar without reason for its immediate removal, and analyzed data after 5 years of follow-up (n=228 of 250 enrolled participants were available; a total of 427 third molars, of which 19 were erupted, and the rest equally split between unerupted and partially erupted). Patients were contacted by telephone or mail at six month intervals and provided with contact information in case difficulties with their teeth were encountered; annual check-ups with further clinical examination and radiographs were also carried out. A total of 66 patients were enrolled with (or had a history of) pericoronitis (i.e. tissue inflammation in proximity of the third molar due to bacteria presence), and two patients had swelling at the time of the initial encounter. Over the five year follow-up period, a total of 71/228 (approximately 31%) participants available for follow-up underwent third molar removal (including 23/66 with a history of or current pericoronitis), with the following rationale provided: pericoronitis after start of study (n=30), cosmetic/orthodontic (n=6), food impacted/difficult to clean (n=4), early caries in second molar (n=4), pain when eating (n=2), earache/TMJ pain (n=2). The authors noted that 150 of the 228 participants enrolled did not develop symptoms or lesions, and no associations of a need for wisdom tooth removal were found to exist with smoking status, extent of visible plaque, depth of pocket distal to second molar, size of follicular space, or bleeding following probing based on chi-square analyses (neither supporting data nor statistical criteria used to determine associations were defined). The authors concluded that while the study did not support the notion of prophylactic wisdom tooth removal, further research was warranted.