CLINICAL PRACTICE GUIDELINE
ON
THE TREATMENT OF
CARPAL TUNNEL SYNDROME

Adopted by the American Academy of Orthopaedic Surgeons

Board of Directors

September 2008

This clinical guideline was developed by an AAOS physician volunteer Work Group and is provided as an educational tool based on an assessment of the current scientific and clinical information and accepted approaches to treatment. It is not intended to be a fixed protocol as some patients may require more or less treatment. Patient care and treatment should always be based on a clinician's independent medical judgment given the individual clinical circumstances.

Endorsed By:

DISCLAIMER

This Clinical Practice Guideline was developed by an AAOS physician volunteer Work Group based on a systematic review of the current scientific and clinical information and accepted approaches to treatment and/or diagnosis. This Clinical Practice Guideline is not intended to be a fixed protocol, as some patients may require more or less treatment or different means of diagnosis. Clinical patients may not necessarily be the same as those found in a clinical trial. Patient care and treatment should always be based on a clinician's independent medical judgment, given the individual patient's clinical circumstances.

CONFLICT OF INTEREST

All panel members gave full disclosure of conflicts of interest prior to voting on the recommendations contained within these guidelines.

FUNDING SOURCE

These guidelines were funded exclusively by the American Academy of Orthopaedic Surgeons who received no funding from outside commercial sources to support the development of this document.

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Disclosure Requirement

In accordance with AAOS policy, all individuals whose names appear as authors or contributors to Clinical Practice Guideline filed a disclosure statement as part of the submission process. All panel members provided full disclosure of potential conflicts of interest prior to voting on the recommendations contained within this Clinical Practice Guidelines.

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Summary of Recommendations

The following is a summary of the recommendations in the AAOS' clinical practice guideline, The Treatment of Carpal Tunnel Syndrome. This summary does not contain rationales that explain how and why these recommendations were developed nor does it contain the evidence supporting these recommendations. All readers of this summary are strongly urged to consult the full guideline and evidence report for this information. We are confident that those who read the full guideline and evidence report will also see that the recommendations were developed using systematic evidence-based processes designed to combat bias, enhance transparency, and promote reproducibility. This summary of recommendations is not intended to stand alone.

Recommendation 1
A course of non-operative treatment is an option in patients diagnosed with carpal tunnel syndrome. Early surgery is an option when there is clinical evidence of median nerve denervation or the patient elects to proceed directly to surgical treatment.

(Grade C, Level V)

Recommendation 2
We suggest another non-operative treatment or surgery when the current treatment fails to resolve the symptoms within 2 weeks to 7 weeks.

(Grade B, Level I and II)

Recommendation 3
We do not have sufficient evidence to provide specific treatment recommendations for carpal tunnel syndrome when found in association with the following conditions: diabetes mellitus, coexistent cervical radiculopathy, hypothyroidism, polyneuropathy, pregnancy, rheumatoid arthritis, and carpal tunnel syndrome in the workplace.

(Inconclusive, No evidence found)

Recommendation 4a
Local steroid injection or splinting is suggested when treating patients with carpal tunnel syndrome, before considering surgery.

(Grade B, Level I and II)

Recommendation 4b
Oral steroids or ultrasound are options when treating patients with carpal tunnel syndrome.

(Grade C, Level II)

Recommendation 4c
We recommend carpal tunnel release as treatment for carpal tunnel syndrome.

(Grade A, Level I)

Recommendation 4d
Heat therapy is not among the options that should be used to treat patients with carpal tunnel syndrome.

(Grade C, Level II)

Recommendation 4e
The following treatments carry no recommendation for or against their use: activity modifications, acupuncture, cognitive behavioral therapy, cold laser, diuretics, exercise, electric stimulation, fitness, graston instrument, iontophoresis, laser, stretching, massage therapy, magnet therapy, manipulation, medications (including anticonvulsants, antidepressants and NSAIDs), nutritional supplements, phonophoresis, smoking cessation, systemic steroid injection, therapeutic touch, vitamin B6 (pyridoxine), weight reduction, yoga.

(Inconclusive, Level II and V)

Recommendation 5
We recommend surgical treatment of carpal tunnel syndrome by complete division of the flexor retinaculum regardless of the specific surgical technique.

(Grade A, Level I and II)

Recommendation 6
We suggest that surgeons do not routinely use the following procedures when performing carpal tunnel release:

skin nerve preservation (Grade B, Level I)
epineurotomy (Grade C, Level II)

The following procedures carry no recommendation for or against use: flexor retinaculum lengthening, internal neurolysis, tenosynovectomy, ulnar bursa preservation

(Inconclusive, Level II and V).

Recommendation 7
The physician has the option of prescribing pre-operative antibiotics for carpal tunnel surgery.

(Grade C, Level III)

Recommendation 8
We suggest that the wrist not be immobilized postoperatively after routine carpal tunnel surgery

(Grade B, Level II).

We make no recommendation for or against the use of postoperative rehabilitation.

(Inconclusive, Level II).

Recommendation 9
We suggest physicians use one or more of the following instruments when assessing patients' responses to CTS treatment for research:

- Boston Carpal Tunnel Questionnaire (disease-specific)
- DASH – Disabilities of the arm, shoulder, and hand (region-specific; upper limb)
- MHQ – Michigan Hand Outcomes Questionnaire (region-specific; hand/wrist)
- PEM (region-specific; hand)
- SF-12 or SF-36 Short Form Health Survey (generic; physical health component for global health impact)

(Grade B, Level I, II, and III)

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AMERICAN ACADEMY OF ORTHOPAEDIC SURGEONS CLINICAL PRACTICE GUIDELINE ON THE TREATMENT OF CARPAL TUNNEL SYNDROME

I. OVERVIEW

Evidence-based Practice (EBP) standards are in a state of continuous evolution. Current EBP standards demand that physicians use the best available evidence to guide their clinical decision making processes. Increasingly rigorous EBP standards have also resulted in more rigorous clinical studies of ever stronger design, complexity, and statistical analysis. This clinical practice guideline consists of a systematic review of the available literature regarding the treatment of carpal tunnel syndrome. The purpose of this clinical practice guideline is to help improve carpal tunnel syndrome treatment based on the current best evidence. The systematic review detailed herein was conducted between June and October of 2007 and demonstrates where there is good evidence, where evidence is lacking, and what topics future research must target in order to improve carpal tunnel syndrome treatment. The AAOS Carpal Tunnel Syndrome (CTS) Guideline Work Group systematically reviewed the available literature, evaluated the level of evidence found in that literature, and subsequently wrote the following recommendations based on a rigorous, standardized process.

GOALS AND RATIONALE

The AAOS has created this clinical practice guideline to improve patient care by outlining the appropriate information-gathering and decision-making processes involved in managing the treatment of carpal tunnel syndrome. This guideline is also an educational tool to guide qualified physicians (see Intended Users) through a series of treatment decisions in an effort to improve the quality and efficiency of care.

This guideline should not be construed as including all proper methods of care or excluding methods of care reasonably directed to obtaining the same results. The ultimate judgment regarding any specific procedure or treatment must be made in light of all circumstances presented by the patient and the needs and resources particular to the locality or institution. Further, the patient must be an active participant in treatment decisions. All treatment for CTS is based on the assumption that final decisions are predicated on patient and physician mutual communication about available treatment alternatives and procedures applicable to the individual patient. These decisions include an evaluation of the patient's current quality of life with CTS. Patients will present with considerable variability in acceptable choices, needs, and access to non-operative alternatives. It is understood that after the patient has been informed of available alternative non-operative therapies and has discussed these options with their physician, the informed patient choice may be to go directly to surgery.

SCOPE AND ORGANIZATION

INTENDED USERS

This guideline is intended to be used by all appropriately trained surgeons and all qualified physicians considering treatment of CTS. Typically, appropriately trained surgeons will have completed medical training, a qualified residency and some may have additional sub-specialty training. Insurance payers, governmental bodies, and health-policy decision-makers may also find this guideline useful as an evolving standard of evidence regarding treatment of Carpal Tunnel Syndrome.

PATIENT POPULATION

Persons of all genders, races, ages, occupations and health status may be afflicted by Carpal Tunnel Syndrome. The present guideline is aimed towards treatment of carpal tunnel syndrome in adults (defined as patients older than 18 years of age).

These recommendations assume that the patient has reversible mechanical compression of the median nerve based on the diagnostic criteria set forth in the AAOS clinical practice guideline for The Diagnosis of Carpal Tunnel Syndrome. This does not include patients who have nerve damage characterized by irreversible microscopic damage to the nerve ultra-structure. Such cases, understood to exist, without biopsy evidence, have a worse prognosis for recovery with sustained numbness, tingling, paralysis, dyshidrotic changes of the skin, and pain. Diagnostic stratification studies which define preoperative criteria for this division between reversible and irreversible damage were not found. The clinical objective in the more damaged group has lesser expectations and anticipated outcomes by definition.

INCIDENCE AND PREVALENCE

Carpal tunnel syndrome incidence in the United States has been estimated at 1-3 cases per 1000 persons per year.[1] Prevalence is approximately 50 cases per 1000 persons in the general population.[1]

BURDEN OF DISEASE

Many Americans experience symptoms of carpal tunnel syndrome and they also expect relief of the condition, which can be accomplished with proper treatment. Untreated or ill-treated carpal tunnel syndrome may worsen and progress to permanent sensory loss and thenar paralysis in some cases.

As carpal tunnel syndrome in the workplace demands attention and as the number of worker's compensation cases are filed increases, the expense for lost productivity and cost of treatment continues to increase. According to the National Institute of Health (NIH), the average lifetime cost of carpal tunnel syndrome, including medical bills and lost time from work, is estimated to be about $30,000 for each injured worker."[2] Hanrahan et al quote similar estimates by the National Council on Compensation Insurance that estimates the average CTS case costs $29,000 in Worker's Compensation benefits and medical costs.[3] The Bureau of Labor Statistics reports, as of 2005, the major industry division with highest number of events and exposures is manufacturing.[4] There

were more than 3.8 million visits made to physicians in office-based practices in 2003 because of carpal tunnel syndrome.[6] According to the Burden of Musculoskeletal Diseases in the United States (2008, p.136), the National Health Interview Survey "is believed to underreport the incidence of injuries" and the Bureau of Labor Statistics only report work related data.[5]

ETIOLOGY

Carpal Tunnel Syndrome (CTS) is among the most common disorders of the upper extremity. It is related to many factors but is thought to be caused by increased pressure on the median nerve in the carpal tunnel at the wrist.[7]

DIAGNOSIS AND TREATMENT

Diagnosis of carpal tunnel syndrome is made on the basis of signs, symptoms, and electro-diagnostic tests, as put forth by the AAOS clinical practice guideline on Diagnosis of Carpal Tunnel Syndrome. [8] Appropriate diagnosis is a critical factor to providing treatment.

Treatment for CTS is based on the assumption that final decisions are predicated on patient and physician mutual communication, discussion of available treatment alternatives and procedures applicable to the individual patient. Once the patient has been informed of available alternative non-operative therapies and has discussed these options with his/her physician, an informed decision can be made. Clinician input based on experience with both conservative management and surgical skills increases the probability of identifying patients who will benefit from specific treatment options. Patient compliance with prescribed treatments is also a contributing factor for successful treatment.

RISK FACTORS

Several key co-morbidities and/or human factors potentially increase the risk of developing carpal tunnel syndrome. Primary considerations include advancing age, female gender, and the presence of diabetes and/or obesity. Other risk factors include pregnancy, specific occupations, cumulative and repetitive motion injuries, strong family history, specific medical disorders such as hypothyroidism, autoimmune diseases, rheumatologic diseases, arthritis, renal disease, trauma, anatomic predisposition in the wrist and hand due to shape and size, infectious diseases, and substance abuse. These are all common exclusion criteria in CTS treatment studies and hence these potential risks have not been clearly assessed. [9]

Persons involved in manual labor in some occupations have a greater incidence and severity of the symptoms.[7] The relationship between work, co-morbidities and personal factors require good physician judgment, experience with medical evidence and knowledge of the vast occupational literature in assigning and apportioning causation. In many cases, there is no identifiable co-morbidity or causal relationship.

II. **METHODS**

An AAOS Work Group, consisting of eight physician members, was assembled specifically for the development of this guideline. The Work Group consisted of a diverse group of physician specialists with expertise in treating patients with carpal tunnel syndrome.

PROCESS OVERVIEW

The Work Group, with the assistance of the AAOS staff, began by formulating "simulated recommendations". The simulated recommendations were used to define the scope of the guideline and to refine the literature searches that were conducted. The Work Group, with the assistance of the AAOS medical librarian and staff, completed a systematic review of the relevant literature. Details of the systematic review are provided below.

During the process of developing this guideline, the Work Group participated in a series of conference calls and meetings. When published information of sufficient quality was not available, consensus opinion was employed.

The final draft of the guideline was reviewed by an outside advisory panel (peer review), reviewed internally by the AAOS Board of Directors, Council on Research Quality Assessment and Technology, Board of Councilors, and Board of Specialty Societies (public commentary) and approved by the AAOS Evidence Based Practice Committee, Guideline Oversight and Technology Committee, Council on Research Quality Assessment and Technology, and the Board of Directors.

Peer review of the draft guideline is completed by an outside Peer Review Advisory Panel. Outside Advisory Panels are convened for each AAOS guideline and consist of experts in the guideline's topic area. These experts represent professional societies other than AAOS and are nominated by the guideline Work Group prior to beginning work on the guideline. Non-editorial comments received from each reviewer are documented, reviewed by the Work Group and approved by the Work Group Chairperson. AAOS staff sends each reviewer the approved documentation for his/her comments. For this guideline, thirteen outside peer review organizations were invited to review the draft guideline and all supporting documentation. Seven societies participated in the review of the CTS Treatment guideline draft.

Following response to all reviews, the guideline draft was sent to thirty-one individuals, who were members of the AAOS Board of Directors, Council on Research Quality Assessment and Technology, Board of Councilors, and Board of Specialty Societies for public commentary. Following this period of public commentary, the guideline was submitted for approval.

Within AAOS, multiple iterations of written review were conducted by the participating Work Group, AAOS Guidelines and Technology Oversight Committee, AAOS Evidence Based Practice Committee, and the AAOS Council on Research, Quality Assessment and Technology prior to final approval by the AAOS Board of Directors. The total number of

AAOS reviewers within these governing bodies is fifty-eight. The approval process is documented in Appendix VI.

CONSENSUS DEVELOPMENT

Voting on guideline recommendations will be conducted using a modification of the nominal group technique (NGT), a method previously used in guideline development.[10] Briefly, each member of the guideline Work Group ranked his or her agreement with a guideline recommendation on a scale ranging from 1 to 9 (where 1 is "total disagreement" and 9 is "total agreement"). Consensus is obtained if the number of individuals who do not rate a measure as 7, 8, or 9 is statistically non-significant (as determined using the binomial distribution). Because the number of Work Group members who are allowed to dissent with the recommendation depends on statistical significance, the number of permissible dissenters varies with the size of the work group. The number of permissible dissenters for several work group sizes is given in the table below:

Work Group Size	Number of Permissible Dissenters
≤3	Not allowed. Statistical significance cannot be obtained
4-5	0
6-8	1
9	1 or 2

The NGT is conducted by first having members vote on a given recommendation without discussion. If the number of dissenters is "permissible", the recommendation is adopted without further discussion. If the number of dissenters is not permissible, there is further discussion to see whether the disagreement(s) can be resolved. Three rounds of voting are held to attempt to resolve disagreements. If disagreements are not resolved after three voting rounds, no recommendation is adopted.

ARTICLE INCLUSION AND EXCLUSION CRITERIA

Inclusion and exclusion criteria were developed a priori. Articles were retrieved and included only if they met these specific inclusion and exclusion criteria (see Appendix II: Article Inclusions and Exclusions). Supplemental searches were conducted to identify national rates and other information relevant to performance measures.

Work Group members were given the opportunity to supplement the searches of electronic databases with articles not identified by those searches. No additional articles were added by the Work Group for this guideline. Had articles been added, they would have been subjected to the same *a priori* inclusion and exclusion criteria specified in Appendix II.

A total of three hundred thirty-two articles were reviewed for this guideline. Ninety-four articles met all *a priori* inclusion criteria. Two hundred and thirty eight articles were excluded for various reasons. Tracking these numbers in the flowcharts is not possible because a study could be included in more than one flowchart (i.e. some of the surgical studies were included in the infection flowchart). These numbers can be verified using the evidence tables and counting the references in the technical report. The flowcharts in Appendix II: Article Inclusions and Exclusions illustrate the number of articles retrieved for specific recommendations as well as the number of articles used to update systematic reviews.

For all recommendations except recommendation 3, we included only studies that diagnosed patients with a combination of electro-diagnostic tests and signs and symptoms. For recommendation 3, which addresses workplace issues, we required only that patients be diagnosed with signs and symptoms (see Appendix II: Article Inclusions and Exclusions). We relaxed the inclusion criteria for studies addressing CTS in the workplace because these patients are typically symptomatic and rarely receive electro-diagnostic tests to confirm their diagnosis. Even though we relaxed our inclusion criteria we were unable to find relevant literature which, to us, indicates a critical need for future research in this area.

We did not search for, or include, all available evidence. Wherever appropriate, we searched for and included the best available evidence. Hence, if Level II evidence was available, we did not search for or include Level III evidence or lower unless there was very little Level II evidence, and a great deal of Level III evidence.

Our analyses focused on patient-oriented outcome measures. These measures are defined in clinical research as "outcomes that matter to patients including reduced morbidity, reduced mortality, symptom improvement, or improving patients' quality of life".[11] By critically focusing on patient-oriented outcomes, the recommendations in this guideline are expected to improve overall patient care in the treatment of carpal tunnel syndrome.

LITERATURE SEARCHES

We searched four electronic databases, MEDLINE, EMBASE, CINAHL and the Cochrane database of systematic reviews, to identify literature for this guideline. Search strategies were reviewed by the work group prior to conducting the searches. A list of the electronic databases we searched and the search strategies we used are provided in Appendix I: Literature Searches. All literature searches were supplemented with manual screening of bibliographies in publications accepted for inclusion into the evidence base. In addition, the bibliographies of recent review articles were searched for potentially relevant citations. All included articles met the specified a priori inclusion/exclusion criteria.

ASSIGNING A LEVEL OF EVIDENCE

The quality of evidence was rated using the evidence hierarchy shown in Appendix III: Rating Evidence Quality. A complete description of the hierarchy is included in the AAOS Evidence Report for this guideline. This hierarchy is also on the American Academy of Orthopaedic Surgeons (AAOS) website at: http://www.aaos.org/Research/Committee/Evidence/loetable1.pdf

DATA EXTRACTION

Six reviewers independently completed data extraction for all studies. Evidence tables were constructed to summarize the best evidence pertaining to each recommendation and all evidence can be found in the accompanying Evidence Report [9] to this guideline.

GRADING THE RECOMMENDATIONS

Each guideline recommendation was graded using the following system:

A: Good evidence (Level I Studies with consistent findings) for or against recommending intervention.
B: Fair evidence (Level II or III Studies with consistent findings) for or against recommending intervention.
C: Poor quality evidence (Level IV or V) for or against recommending intervention.
I: There is insufficient or conflicting evidence not allowing a recommendation for or against intervention.

The Committee used the following language in constructing the recommendations:

We recommend Treatment X: (for Grade A recommendations)
We suggest Treatment X: (for Grade B recommendations)
Treatment X is an option: (for Grade C recommendations)

These definitions[12, 13] help clarify the intent of the Work Group by reflecting the assessment of the importance of adherence to the recommendation based on the grade of the recommendation.

STATISTICAL METHODS

The statistical analyses performed help compare the treatment options available to patients with carpal tunnel syndrome. In order to assess specific treatments, comparisons were made between similar populations of patients receiving the treatment to patients receiving a control, placebo, or a second treatment. The goal of most treatment comparisons is to demonstrate that a treatment has a significant effect or that there is a significant difference between two treatments.

Small sample sizes in clinical trials present serious concerns because a lack of statistical power means that small but clinically important differences may go undetected. We calculated the minimal detectable difference to determine if a study was sufficiently powered for the given outcome. In our power calculations, we used 80% power, 95% confidence intervals and the number of patients per group. This allowed calculation of the minimal detectable effect size which was compared to the calculated effect size to

determine if the study had enough power to detect the observed effect. If the trial was found to lack sufficient power for a given outcome, its results were taken as inconclusive. Power calculations were performed using G Power 3 (Version 3.0.5).[14] Results are listed in the Evidence Report [9] and Evidence Tables.[15]

For recommendations one through eight in this guideline, several measures of association including the odds ratio (OR) and the natural log of the odds ratio (log OR) were used to compare treatments. In addition, the standardized mean difference (SMD) was used for computing standardized measures of effect size. Effect sizes were calculated when applicable; OR and log OR for dichotomous data and the SMD for continuous data. The larger the OR is, the larger the effect size. The SMD can be evaluated as follows: 0.2 for a small effect, 0.5 for a moderate effect and 0.8 for a large effect.[16]

Studies had to have treatments, outcome measures, and durations of follow up in common to perform meta-analysis of the data. Given the paucity and heterogeneity of the data for specific recommendations, we did not apply formal meta-analytic techniques in all circumstances. Log OR and Cohen's h were computed for dichotomous outcome measures and SMD was computed for continuous outcome measures that were pooled for meta-analyses. When the event rate was zero for dichotomous outcome measures, a continuity correction was added. The Log OR and SMD values were then meta-analyzed using standard DerSimonian and Laird random effects model meta-analysis.[17] When possible, effect sizes were pooled across different studies, and heterogeneity was assessed with the I-squared statistic.[16] Summary statistics were presented when heterogeneity was less than 50%. All meta-analyses and effect size calculations were performed using STATA 10.0 (StataCorp LP, College Station, Texas) and the "metan" command.

Recommendation nine addressed the applicability of various instruments for the evaluation of carpal tunnel syndrome treatment in patients. Instruments are generally evaluated using eight key component areas: appropriateness, reliability, validity, responsiveness, precision, interpretability, acceptability, and feasibility.[18] For this evaluation, we did not assess appropriateness, precision, interpretability, acceptability or feasibility. The physician should consider whether the instrument used was appropriate to measure CTS outcomes, that it contained the appropriate number of distinctions with regard to the dimensions being measured for precision and that the instruments were generally acceptable and feasible for use in the identified patient population. An overall summary of the properties assessed in each instrument (by primary study) is illustrated in the Evidence Tables.[15]

Reliability, validity, and responsiveness were the three primary key components addressed in the studies for this recommendation. Reliable instruments are internally consistent and internal consistency is commonly measured by Cronbach's alpha. This statistic measures how comparable the results of the instrument would be if the instrument were split into two versions or the average level of agreement of all the possible ways of performing split-half tests.[18]

Validity was quantified using Spearman and Pearson correlation coefficients. Instruments with similar concepts should have large correlations and instruments with different

concepts should have small correlations. A correlation coefficient of 0.5 and above is a large correlation, indicating two converging instruments, and a correlation coefficient below 0.5 is a smaller correlation, indicating two diverging instruments.[19] A negative correlation indicates two instruments that score in the opposite direction.

Responsiveness was measured using the standardized response mean (SRM). The SRM is expressed as the change score divided by the standard deviation of the change score. A standardized response mean of 0.2 is indicative of a small change, 0.5 a medium change, and 0.8 a large change. [19, 20]

REVISION PLANS

This guideline represents a cross-sectional view of current intervention methods and will become outdated when more sophisticated tests, more objective assessments and more rigorous differential diagnosis are possible. Linkage to other disorders, genetic diagnosis, and occupational and human factors literature will contribute to our understanding of the early stages of this condition and the means of differential treatment.

Because of the high profile of CTS in the workplace and the high level of interest in this topic, the guideline will be revised in accordance with changing practice, rapidly emerging opinion, new technology, and new evidence. It is anticipated that this guideline will be revised in 2011.

III. **RECOMMENDATIONS**

RECOMMENDATION 1

A course of non-operative treatment is an option in patients diagnosed with carpal tunnel syndrome. Early surgery is an option when there is clinical evidence of median nerve denervation or the patient elects to proceed directly to surgical treatment.

(Grade C, Level V)

Rationale
Data were extracted from three systematic reviews and twenty-three randomized controlled or controlled trials for evidence to support this recommendation. The literature found supported the effectiveness of non-operative treatment over placebo.[9] Data were not found that clearly identified when non-operative treatment should be considered the only option, nor were studies found in which non-operative treatment was clearly shown to be completely ineffective and therefore contraindicated.

Studies of carpal tunnel syndrome often included denervation as an indication for surgery, and a relative contraindication for non-surgical treatment, so such cases were not studied systematically. Consequently, it was not possible to make a Grade A or B recommendation.[9] Therefore, this guideline recommendation is, of necessity, based upon expert opinion.

See Evidence Tables 1-21 and Evidence Report page 12.[9,15]

RECOMMENDATION 2

We suggest another non-operative treatment or surgery when the current treatment fails to resolve the symptoms within 2 weeks to 7 weeks.

(Grade B, Level I and II)

Rationale

Considerable evidence exists that suggests patients benefit from a variety of non-operative treatment and surgical options for carpal tunnel syndrome.[9] Although the data did not report the minimum time for effectiveness, an analysis of the level I and II data reviewed for Recommendations 4a-c suggested that all effective or potentially effective non-operative treatments (local steroid injections, splinting, oral steroids and ultrasound) for carpal tunnel syndrome have a measurable effect on symptoms within two to seven weeks of the initiation of treatment. If a treatment is not effective in reducing symptoms within that time frame, then consideration should be given to trying a different one, assuming, of course, that the diagnosis of carpal tunnel syndrome is not in doubt.[8]

Because this recommendation considers a variety of non-operative treatments, the levels of evidence varied. More level II evidence exists than level I evidence; hence the grade of recommendation is based on consistent level II evidence.

See Evidence Tables 1-21 and Evidence Report page 13.[9,15]

RECOMMENDATION 3

We do not have sufficient evidence to provide specific treatment recommendations for carpal tunnel syndrome when found in association with the following conditions: diabetes mellitus, coexistent cervical radiculopathy, hypothyroidism, polyneuropathy, pregnancy, rheumatoid arthritis, and carpal tunnel syndrome in the workplace.

(Inconclusive, No evidence found)

Rationale

Despite an exhaustive review of the literature, there was insufficient evidence to make conclusions about these conditions and carpal tunnel syndrome in the workplace. These potentially treatable medical conditions are common exclusion criteria from controlled trials.[9] This makes it difficult to make specific recommendations for how to treat such patients.

See Evidence Tables 1-21 and Evidence Report pages 12-15.[9,15]

RECOMMENDATION 4A

Local steroid injection or splinting is suggested when treating patients with carpal tunnel syndrome, before considering surgery.

(Grade B, Level I and II)

Rationale

Local steroid injection and splinting are effective in treating carpal tunnel syndrome. Splinting was effective at 2, 4, and 12 weeks in reducing symptoms and improving functional status.[84, 93] No conclusion could be drawn at the 6 month time point because the studies were underpowered.

Steroid injections are also effective for treating carpal tunnel syndrome. Patient satisfaction (2 weeks [23]), clinical improvement (4 weeks[44, 77] 8 weeks,[116] 12 weeks [116]), symptoms (2 weeks,[58] 4 months,[27] 6 months [108]), function (3 months [108]), and pain (8 weeks [58]) were shown to improve after cortisone injections.

Patients with more severe or prolonged CTS, however defined, may not benefit from prolonged, non-operative treatment. Trials of non-operative treatment are suggested for the treating physician and should show remission as described in the recommendations above at the intervals indicated.

See Evidence Tables 1- 21 and Evidence Report pages 16-61, figures 1-6, & 37-41.[9,15]

RECOMMENDATION 4B

Oral steroids or ultrasound are options when treating patients with carpal tunnel syndrome.

(Grade C, Level II).

Rationale

Oral steroid treatment was effective in the treatment of carpal tunnel syndrome.[63, 84] However, the evidence suggested that local steroid injection is more effective than oral steroids.[77] Since the evidence supports other more effective treatments, the Work Group downgraded the recommendation about oral steroids to Grade C, "optional".

Ultrasound was also shown to be effective in the treatment of carpal tunnel syndrome in two studies.[28,84] One of the studies [28] however, compared ultrasound to laser treatment, an unproven modality, rather than to a control. Hence, there was only one level II study supporting ultrasound. Based on this methodological flaw, the Work Group chose to downgrade this recommendation on ultrasound to Grade C, "optional".

See Evidence Tables 1- 21 and Evidence Report pages 16-61, figures 12-15, 23, & 24.[9,15]

RECOMMENDATION 4C

We recommend carpal tunnel release as treatment for carpal tunnel syndrome.

(Grade A, Level I)

Rationale

Level I evidence demonstrates that surgical release of the flexor retinaculum is an extremely effective treatment for patients with carpal tunnel syndrome.[47,64,108,110] The evaluation of operative versus non-operative treatment of carpal tunnel syndrome demonstrated the effectiveness of the surgical treatment.

These recommendations assume that the patient has reversible mechanical compression of the median nerve based on the diagnostic criteria set forth in the AAOS clinical practice guideline for The Diagnosis of Carpal Tunnel Syndrome. This does not include patients who have nerve damage characterized by irreversible microscopic damage to the nerve ultra-structure. Such cases, understood to exist, without biopsy evidence, have a worse prognosis for recovery with sustained numbness, tingling, paralysis, dyshidrotic changes of the skin, and pain. Diagnostic stratification studies which define preoperative criteria for this division between reversible and irreversible damage were not found. The clinical objective in the more damaged group has lesser expectations and anticipated outcomes by definition.

See Evidence Tables 1-21 and Evidence Report pages 62-66, figures 53-58.[9,15]

RECOMMENDATION 4D

Heat therapy is not among the options that should be used to treat patients with carpal tunnel syndrome.

(Grade C, Level II)

Rationale
Heat therapy was less effective than placebo control in treating carpal tunnel syndrome.[81] The grade of recommendation is based on a single study therefore, it was downgraded to Grade C, "optional".

See Evidence Tables 1- 21 and Evidence Report page 43, figure 30.[9,15]

RECOMMENDATION 4E

The following treatments carry no recommendation for or against their use: activity modifications, acupuncture, cognitive behavioral therapy, cold laser, diuretics, exercise, electric stimulation, fitness, graston instrument, iontophoresis, laser, stretching, massage therapy, magnet therapy, manipulation, medications (including anticonvulsants, antidepressants and NSAIDs), nutritional supplements, phonophoresis, smoking cessation, systemic steroid injection, therapeutic touch, vitamin B6 (pyridoxine), weight reduction, yoga.

(Inconclusive, Level II and V).

Rationale
Despite an extensive review of the literature, there was insufficient evidence to make conclusions about these modalities. For some treatments, there were simply no studies that met the inclusion criteria. For others, the studies had too little statistical power to allow for meaningful conclusions. Still other studies were downgraded from a higher grade of recommendation because their applicability was questioned. Consequently, we are unable to make recommendations for or against the use of these treatments.

One study compared the Graston Instrument to manual therapy.[37] The applicability of this study was questioned because the Graston instrument was compared to an unproven alternative treatment. This was the only study looking at the Graston instrument that met the inclusion criteria. The grade of recommendation was downgraded because the evidence was inconclusive.

One systematic review[84] examined the comparison of Vitamin B (pyridoxine) to placebo. The applicability of the outcome measure was questioned because it was not considered to be critical to determining whether Vitamin B was beneficial in the treatment of CTS. The grade of recommendation was downgraded because the evidence was inconclusive.

All of these modalities require further investigation in appropriately designed studies to determine their efficacy in the treatment of carpal tunnel syndrome.

See Evidence Tables 1- 21 and Evidence Report pages 16-61.[9,15]

Table A. Recommendation 4e Summary of Treatment Evidence

Reasoning for Insufficient Evidence		
No evidence	*Insufficient Power*	*Applicability*
activity modifications	acupuncture	graston instrument
anticonvulsants	diuretics	systemic steroid injection
antidepressants	exercise	vitamin B6 (pyridoxine)
cognitive behavioral therapy	iontophoresis	yoga
cold laser	laser	
electric stimulation	NSAIDs	
fitness	phonophoresis	
magnet therapy	therapeutic touch	
manipulation		
massage therapy		
nutritional supplements		
smoking cessation		
stretching		
weight reduction		

RECOMMENDATION 5

We recommend surgical treatment of carpal tunnel syndrome by complete division of the flexor retinaculum regardless of the specific surgical technique.

(Grade A, Level I and II).

Rationale

Complete division of the flexor retinaculum is an effective method for treating CTS. Two systematic reviews [97,107] and six randomized controlled trials [26,32,39,95,96,115] examined comparisons between open carpal tunnel release, endoscopic carpal tunnel release, or minimal incision carpal tunnel release. Several patient-oriented outcome measures, including symptom severity and functional status at 52 weeks post-operatively, residual pain at 12 weeks post-operatively, reversible nerve damage, return to work and wound-related complications, were evaluated using meta-analytic techniques to compare open release and endoscopic release. Endoscopic release was favored in residual pain at 12 weeks post-operatively, return to work time, and wound related complications. Open release was favored when reversible nerve damage was the outcome compared. No difference in the techniques was found in symptom severity or functional status at 52 weeks, complications, and infections.

In addition, minimal incision release was compared to open or endoscopic release in Level I studies. When compared to open release, minimal incision was favored in symptom severity, functional status, and scar tenderness. When compared to endoscopic release, minimal incision was favored when pain at two or four weeks was the outcome measure.

The Work Group discussed the studies and agreed that not all relevant outcomes were available, addressed, and/or analyzed by the evidence comparing the various surgical techniques. Nevertheless, Level I and Level II evidence clearly indicates the effectiveness of complete division of the flexor retinaculum, regardless of surgical technique, as a treatment for CTS.

See Evidence Tables 23-37 and Evidence Report pages 68-87, figures 59-81.[9,15]

RECOMMENDATION 6

We suggest that surgeons not routinely use the following procedures when performing carpal tunnel release:

skin nerve preservation (Grade B, Level I)

epineurotomy (Grade C, Level II)

The following procedures carry no recommendation for or against their use: flexor retinaculum lengthening, internal neurolysis, tenosynovectomy, ulnar bursa preservation.

(Inconclusive, Level II and V)

Rationale

A single Level I study [101] evaluated the effect of preserving cutaneous nerves in the path of a skin incision made in the customary location for a carpal tunnel release. Preservation was compared to a standard approach to making a skin incision, which did not seek to preserve any nerve branches encountered as the wound was deepened down to the palmar fascia. The Patient Evaluation Measure (PEM) indicated a slight advantage in favor of the standard approach at the three-month assessment. The PEM is a broader evaluation of outcome than the VAS suggesting that the advantages for a standard carpal tunnel release incision refer to a domain other than pain.

Epineurotomy was studied in a systematic review and in a single Level II study. In the systematic review [97] the outcome was described as "overall improvement" at 12 months and, in the single Level II study, [34] the outcomes were "nocturnal pain" and "paraesthesia" at three months following surgery. Both studies indicated a mild effect favoring no epineurotomy.

Tenosynovectomy and internal neurolysis were compared in a systematic review [97] and the data were inconclusive. Lengthening of the flexor retinaculum was studied in a Level I study [49] that used the Boston Carpal Tunnel Questionnaire as the outcome measure. The results were inconclusive because the study had too little power to allow for statistically meaningful comparison. A single Level I study [53] examining ulnar bursa preservation, with VAS and PEM as the outcome measures at 8 weeks, also had too little power to allow for meaningful statistical comparisons. The study was therefore inconclusive.

See Evidence Tables 23-37 and Evidence Report pages 88-95, figures 82-88.[9,15]

RECOMMENDATION 7

The physician has the option of prescribing pre-operative antibiotics for carpal tunnel surgery.

(Grade C, Level III)

Rationale

Our searches indicated that the current literature rarely reports whether pre-operative antibiotic treatment was used in carpal tunnel release. Of forty-five studies analyzed for this recommendation, forty-four did not report whether pre-operative antibiotics were used. The study that did report antibiotic use reported that 6.03% of patients developed a post-operative infection, even though all patients received antibiotics.[96a]

An examination of the various trials addressing carpal tunnel syndrome treatment did not provide insight on whether there are conditions or comorbidities that predispose patients to post-surgical infection. Patients with diabetes mellitus, for example, were excluded from the trials.[9] A single Level IV study [83] looked at rates of post-operative infections in persons with and without diabetes and found that the rate was similar in the two groups.

See Evidence Tables 38-41 and Evidence Report pages 96-100.[9,15]

RECOMMENDATION 8

We suggest that the wrist not be immobilized postoperatively after routine carpal tunnel surgery.

(Grade B, Level II)

We make no recommendation for or against the use of postoperative rehabilitation.

(Inconclusive, Level II).

Rationale

The wrist should not be immobilized postoperatively after routine carpal tunnel release. Post-operative splinting for longer than two weeks did not offer any specific benefit in terms of grip or lateral pinch strength, bowstringing, complication rates, subjective outcome and patient satisfaction.[38,43,52,78]

Clinicians may wish to provide protection for the wrist in a working environment or for temporary protection. However, the evidence does not provide objective criteria for these situations. Clinicians should be aware of the detrimental affects including adhesion formation, stiffness and prevention of nerve and tendon movement which may compromise the carpal tunnel release results in achieving another objective such as early release to work.

For postoperative rehabilitation, one study examined supervised hand therapy [94]. The applicability of the outcome measure (return to work) was questioned because it was not considered to be critical to determining whether supervised hand therapy was beneficial to postoperative rehabilitation. The grade of recommendation was downgraded because the evidence was inconclusive.

There were no included studies that looked at work hardening and the role of various modalities for post-operative carpal tunnel management. The role of supervised therapy after carpal tunnel release in the work-related population will need further evaluation to determine if there is any advantage to work hardening, work simulation, or routine strengthening.

See Evidence Tables 42-51 and Evidence Report pages 101-110, figures 92-101.[9,15]

RECOMMENDATION 9

We suggest physicians use one or more of the following instruments when assessing patients' responses to CTS treatment for research:

Boston Carpal Tunnel Questionnaire (disease-specific)

DASH – Disabilities of the arm, shoulder, and hand (region-specific; upper limb)

MHQ – Michigan Hand Outcomes Questionnaire (region-specific; hand/wrist)

PEM (region-specific; hand)

SF-12 or SF-36 Short Form Health Survey (generic; physical health component for global health impact)

(Grade B, Level I, II, and III)

Rationale

All measurement instruments, whether they are aimed at diagnosis, evaluation of disease activity or outcome, must be judged on their key psychometric characteristics: reliability, validity, interpretability and responsiveness. Reliability was generally measured in these studies by assessing the internal consistency and reproducibility of the study.

Per Jenkinson [67], "validity is assessed in relation to a specific purpose and setting." Validity is established statistically for an instrument by measuring construct validity, convergent and divergent validity, and/or criterion validity. Instruments having construct validity are summarized in the table below.

Convergent and divergent validity measures can be found in the Evidence Tables (Tables 69-85). More information concerning interpretation of these measures can be found in the Evidence Report but an inclusive discussion is beyond the scope of the guideline. These values were not graphed and were provided to illustrate the direction and magnitude of relationships. Criterion validity was not summarized.

While adequate reliability and validity are concepts that are, for the most part, clear to clinicians, the capacity for interpretability and responsiveness may be less familiar. Interpretability refers to the fundamental meaning of the measure. Instruments that encompass items that are meaningful to patients and/or clinicians will have good interpretability and users can easily understand the meaning of these measures. Few studies measured interpretability therefore they are not summarized in the table below.

Responsive measures reflect small changes in a given condition. This may be important where subtle differences could be clinically important. Responsive measures are helpful in the planning of trials where the objective may be to demonstrate a small difference between, for example, treatments.

Generally speaking, generic measures, like the Short Form 36 (SF-36), look at a broadly based assessment of health and, as a result may not be very responsive to changes in status related to a relatively minor condition such as CTS.[9]

Disease-specific instruments such as the Boston Carpal Tunnel Questionnaire (BCTQ) are most responsive .[9] The BCTQ shows excellent responsiveness for the measurement of disease activity in CTS. Wherever possible the full instrument should be used because this gives the most comprehensive evaluation of both function and symptoms in CTS without any loss of responsiveness. The subscales of this instrument also have satisfactory responsiveness [9] but give a more narrow view of disease activity. The BCTQ is fully validated in the treatment of carpal tunnel syndrome.

The region-specific instrument, The Disabilities of the Arm, Shoulder and Hand (DASH) was moderate to highly responsive [9] and the Michigan Hand Outcomes Questionnaire (MHQ) was highly responsive in three of five subscales .[9]

The Patient Evaluation Measure (PEM), (MHQ) and DASH are more broadly based region-specific instruments that can be considered to be responsive for the evaluation of CTS. The responsiveness of the DASH is slightly below the acceptable threshold (standardized response mean (SRM) = 0.80) but should be considered if the goal of the evaluation is a focus on disability because it has been evaluated in three key domains: internal consistency, reproducibility and responsiveness.

See Evidence Tables 52-101 and Evidence Report pages 111-125, figures 102-120.[9,15]

Table B. Psychometric Properties of Instruments

Instrument	Internal Consistency (Reliability)	Reproducibility (Reliability)	Construct Validity (Validity)	Responsiveness (SRM)
BCTQ-Total				>0.8
BCTQ-SSS	X	X	X	>0.8
BCTQ-FSS	X	X	X	>0.8
AIMS2 subscales*				0.06 – 1.72
DASH	X	X	X	0.76
MHQ subscales*				0.5 – 1.1
PEM		X	X	>0.8
VAS			X	0.51
SF-36 subscales*				0 – 0.86
SF-12 subscales*				0.08 – 0.58

* See the Evidence Report for CTS Treatment for responsiveness of individual subscales.[9]

FUTURE RESEARCH

Although we make every effort to find studies of the highest quality, such evidence is not readily available for carpal tunnel syndrome treatment at this time. This guideline has been hindered by a relative lack of power in the studies even though these studies were of Level I and II evidence. The recommendations of this guideline therefore depend to some degree on lesser evidence, including expert opinion.

To achieve a high-quality literature base, academic authors and scientists should invest their time and effort in studies designed to avoid bias (e.g., blinded and properly randomized controlled trials of sufficient power to address the outcome of interest). Future studies should, from the onset, be based on improved study design that includes *a priori* power calculations. Risk stratification studies are also needed to detect when antibiotics might be justified on the basis of co-morbidities and co-interventions.

We recognize that the issue of carpal tunnel syndrome in the workplace is important. Studies identified by the literature search commonly analyze risk, prevalence, and predictability of carpal tunnel syndrome in specific job categories but good evidence to address the effectiveness of workplace modifications was not available. Working patients, payors, and physicians clearly lack the evidence base to determine “best options”. Physicians and patients must first decide the desired outcome. Should the goal be permanent modification of activities for the worker or proceed to surgery and return to normal activities? Future research must rigorously address this subpopulation to determine if activity modification will result in positive outcomes such as ultimately avoiding surgery.

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IV.**APPENDIXES**

APPENDIX I: LITERATURE SEARCHES

DATABASES SEARCHED

The search for eligible literature began with a search for applicable systematic reviews. The search for systematic reviews was performed using the following databases. The full search strategies are displayed below.

- MEDLINE (from 1966 through April 6, 2007)
- EMBASE (from 1966 through April 6, 2007)
- The Cochrane Database of Systematic Reviews (through April 6, 2007)

This initial search yielded 109 systematic reviews, of which 51 were retrieved and evaluated. Fifty-eight systematic reviews were not retrieved because their titles indicated they reviewed topics that were irrelevant to the recommendations in this guideline. Of the fifty-one retrieved, five systematic reviews met all inclusion criteria. These systematic reviews were updated with controlled trials identified through MEDLINE and EMBASE searches.

The literature searches for recommendations that were not addressed by existing systematic reviews were performed using one or more of the same databases identified previously except through June 12, 2007. A search of the CINAHL database from 1982 through June 12, 2007 was also conducted for Recommendation 9.

All literature searches were supplemented with manual screening of bibliographies in publications accepted for inclusion into the evidence base. In addition, the bibliographies of recent review articles were searched for potentially relevant citations.

SEARCH STRATEGIES

ORIGINAL SEARCH FOR SYSTEMATIC REVIEWS

Our search for systematic reviews using PubMed included the following search strategy, with limits of publication dates 1966 to present, English language, and humans:

(("carpal tunnel syndrome"[TIAB] NOT Medline[SB]) OR "carpal tunnel syndrome"[MeSH Terms] OR carpal tunnel[Text Word]) AND systematic[sb]

Our search for systematic reviews using EMBASE included the following search strategy with limits of publication dates 1966 to present, English language, and humans:

carpal AND tunnel AND ([cochrane review]/lim OR [systematic review]/lim) AND [humans]/lim AND [embase]/lim)

SEARCHES FOR PRIMARY STUDIES FROM SYSTEMATIC REVIEWS

The following search strategies are the searches we used to update the identified systematic review. In all cases, we replicated as closely as possible the strategies identified by the original authors of the applicable systematic review. These strategies however may not be precisely duplicated due to lack of complete information in the original systematic review.

MARSHALL ET AL

1. clinical trial.pt.
2. randomized controlled trial.pt.
3. tu.fs.
4. dt.fs.
5. random$.tw.
6. (double and blind$).tw.
7. placebo$.tw.
8. exp Comparative Study/
9. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10. exp Carpal tunnel syndrome/
11. exp Steroids/
12. exp injections/ or exp injections, intra-articular/
13. 11 or 12
14. 10 and 13
15. 9 and 14

O'CONNOR ET AL

1. randomized controlled trial.pt.
2. randomized controlled trials/
3. controlled clinical trial.pt.
4. controlled clinical trials/
5. random allocation/
6. double-blind method/
7. single-blind method/

8. clinical trial.pt.
9. exp clinical trials/
10. (clin$ adj25 trial$).tw.
11. ((singl$ or doubl$ or tripl$ or trebl$) adj25 (blind$ or mask$ or dummy)).tw.
12. placebos/
13. placebo$.tw.
14. random$.tw.
15. research design/
16. (clinical trial phase i or clinical trial phase ii or clinical trial phase iii or clinical trial phase iv).pt.
17. multicenter study.pt.
18. meta analysis.pt.
19. prospective studies/
20. intervention studies/
21. cross-over studies/
22. meta-analysis/
23. (meta?analys$ or systematic review$).tw.
24. control$.tw.
25. or/1-24
26. human/
27. 25 and 26
28. Carpal tunnel syndrome/dt,rh,th [Drug Therapy, Rehabilitation, Therapy]
29. 27 and 28

SCHOLTEN ET AL

Specific search for CTS: ’carpal tunnel syndrome [mesh]’ OR ’carpal tunnel syndrome [tw]’ OR ’carpal tunnel [tw]’ OR ’carp* syndr* [tw]’ OR ’carp* tunn* [tw]’ OR ’tunn* syndr* [tw]’ OR ’median nerve entrapment [mesh]’ OR ’median nerve entrapment [tw]’.
Specific search for surgical interventions: ’surgical [mesh]’ OR ’surgical [tw]’ OR ’surgery [mesh]’ OR ’surgery [tw]’ OR ’release [tw]’ OR ’reconstruct* [tw]’ OR ’epineurotomy [tw]’.

VERDUGO ET AL

1. ('median nerve entrapment' or 'carpal tunnel syndrome' or 'entrapment neuropathy')
2. limit 1 to english language
3. limit 2 to yr="2003 - 2007"
4. and randomized.mp.
5. remove duplicates from 4
6. from 5 keep 98-127

SEARCH STRATEGIES FOR RECOMMENDATIONS WITHOUT RELEVANT SYSTEMATIC REVIEWS

RECOMMENDATION 3

In addition to the associated conditions found in the systematic reviews and relevant RCT's the Work Group examined coexisting cervical radiculopathy and CTS in the workplace. Searches for applicable studies concerning coexisting cervical radiculopathy and carpal tunnel syndrome were limited to what has been termed "double crush syndrome" (in conducting this search we acknowledge that there is controversy surrounding the existence of "double crush syndrome"). The searches for coexisting cervical radiculopathy and CTS in the workplace were conducted as follows:

PubMed and Embase databases were searched for the phrase "double crush" [All Fields].

The PubMed database was searched using the following strategy:
(carpal tunnel or carpal tunnel syndrome or median neuropathy) AND work AND (intervention OR activity OR activities OR moderation OR behavior OR modification OR modify OR restriction*) AND English[lang]

RECOMMENDATION 7

After examining the included studies from controlled trials examining surgical or post-surgical treatments, another literature search was conducted. All study designs focusing on surgical and post-surgical treatments were examined for reports of infection.

PubMed:
"Carpal Tunnel Syndrome/surgery"[Majr] OR "Median Neuropathy/surgery"[Majr] NOT Comment[Publication Type] NOT Letter[Publication Type] NOT Biography[Publication Type] NOT Historical Article[Publication Type] NOT Practice Guideline[Publication Type] NOT Guideline[Publication Type] NOT Case Reports[Publication Type] NOT Editorial[Publication Type] NOT Clinical Trial[Publication Type] NOT Meta-Analysis[Publication Type] NOT Review[Publication Type] NOT Validation Studies[Publication Type] AND (hasabstract[text] AND (Humans[Mesh]) AND (English[lang]))

RECOMMENDATION 8

The PubMed database was searched for carpal tunnel syndrome and postoperative or rehabilitation studies. The search was limited to clinical trials only using the following strategy:

((("carpal tunnel syndrome"[TIAB] NOT Medline[SB]) OR "carpal tunnel syndrome"[MeSH Terms] OR carpal tunnel[Text Word]) OR ("carpal tunnel syndrome"[MeSH Terms] OR carpal tunnel syndrome[Text Word]) OR ("median neuropathy"[MeSH Terms] OR median neuropathy[Text Word])) AND ((("postoperative period"[TIAB] NOT Medline[SB]) OR "postoperative period"[MeSH Terms] OR postoperative[Text Word] OR "postoperative care"[MeSH Terms] OR postoperative care[Text Word]) OR ("rehabilitation"[Subheading] OR "rehabilitation"[MeSH Terms]

OR rehabilitation[Text Word])) AND (English[lang] AND (Clinical Trial[ptyp] OR Clinical Trial, Phase I[ptyp] OR Clinical Trial, Phase II[ptyp] OR Clinical Trial, Phase III[ptyp] OR Clinical Trial, Phase IV[ptyp]))

RECOMMENDATION 9

The PubMed database was searched using the following strategy:
(("michigan hand outcome" OR "michigan hand outcomes" OR "Boston Carpal Tunnel Questionnaire" OR "Boston Questionnaire" OR "global symptom score" OR "Multidimensional Health Assessment Questionnaire" OR "visual analogue scale" OR "visual analog scale" OR Disability of the Arm, Shoulder, and Hand OR "Carpal Tunnel Syndrome Instrument" OR "symptom severity score" OR "functional status score" OR "short form 36" OR "SF36" OR "SF-12" OR "SF12" OR "Levine functional score" OR "Brigham and Women's carpal tunnel questionnaire" OR "brief pain inventory" OR postoperative pain OR return to work OR work absence) AND (median neuropathy OR carpal tunnel OR carpal tunnel syndrome)) AND English[lang]

The EMBASE database was searched using the following strategy:
('michigan hand outcome' OR 'michigan hand outcomes' OR 'boston carpal tunnel questionnaire' OR 'boston questionnaire' OR 'global symptom score' OR 'multidimensional health assessment questionnaire' OR 'visual analogue scale' OR 'visual analog scale' OR 'disability of the arm, shoulder, and hand' OR 'carpal tunnel syndrome instrument' OR 'symptom severity score' OR 'functional status score' OR 'short form 36' OR 'sf36' OR 'sf-12' OR 'sf12' OR 'levine functional score' OR 'brigham and womens carpal tunnel questionnaire' OR 'brief pain inventory' OR postoperative AND pain OR return AND to AND work OR work AND absence) AND ('carpal tunnel syndrome'/exp OR 'median neuropathy'/exp) AND [embase]/lim

The CINAHL database was searched using the following strategy:
(michigan hand outcome OR michigan hand outcomes OR boston carpal tunnel questionnaire OR boston questionnaire OR global symptom score OR multidimensional health assessment questionnaire OR visual analogue scale OR visual analog scale OR disability of the arm, shoulder, and hand OR carpal tunnel syndrome instrument OR symptom severity score OR functional status score OR short form 36 OR sf36 OR sf-12 OR sf12 OR levine functional score OR brigham and womens carpal tunnel questionnaire OR brief pain inventory OR postoperative pain OR return to work OR work absence) AND (carpal tunnel syndrome or median neuropathy)

APPENDIX II: ARTICLE INCLUSIONS AND EXCLUSIONS

Flow charts illustrating study attrition are depicted in Figure 1 - Figure 10 below. All abstracts were downloaded, reviewed, and evaluated for the following criteria:

EXCLUSION CRITERIA

- Abstracts and unpublished study reports.
- Cadaveric, animal or in vitro studies.
- Letters, case reports, historical articles, editorials, and commentaries.
- Non prospective studies.
- Studies where gender is restricted.
- Studies where results for CTS population cannot be separated from results from other populations.
- Studies with < 10 patients.
- Studies with patients under 18 years of age.
- Studies written in languages other than English.

INCLUSION CRITERIA

- Studies evaluating a treatment or intervention for CTS.
- Studies that measured the validity, reliability, or responsiveness of any assessment instrument.
- The following study designs: randomized controlled trials or prospective controlled trials. Where appropriate, observational study designs were also considered (i.e. prospective cohorts, case series, etc.).
- Studies where data can be extracted for statistical analysis.
- Studies reporting patient-oriented outcome measures using previously validated instruments.
- Studies that diagnose CTS with electro-diagnostic tests, signs and/or symptoms of the syndrome.

Full articles were retrieved for all abstracts meeting these criteria. Once retrieved the complete articles were reviewed and evaluated for inclusion. See Figure 1 - Figure 10 below.

INCLUDED AND EXCLUDED ARTICLES FLOWCHART

RECOMMENDATIONS 1,2,3,4

Figure 1

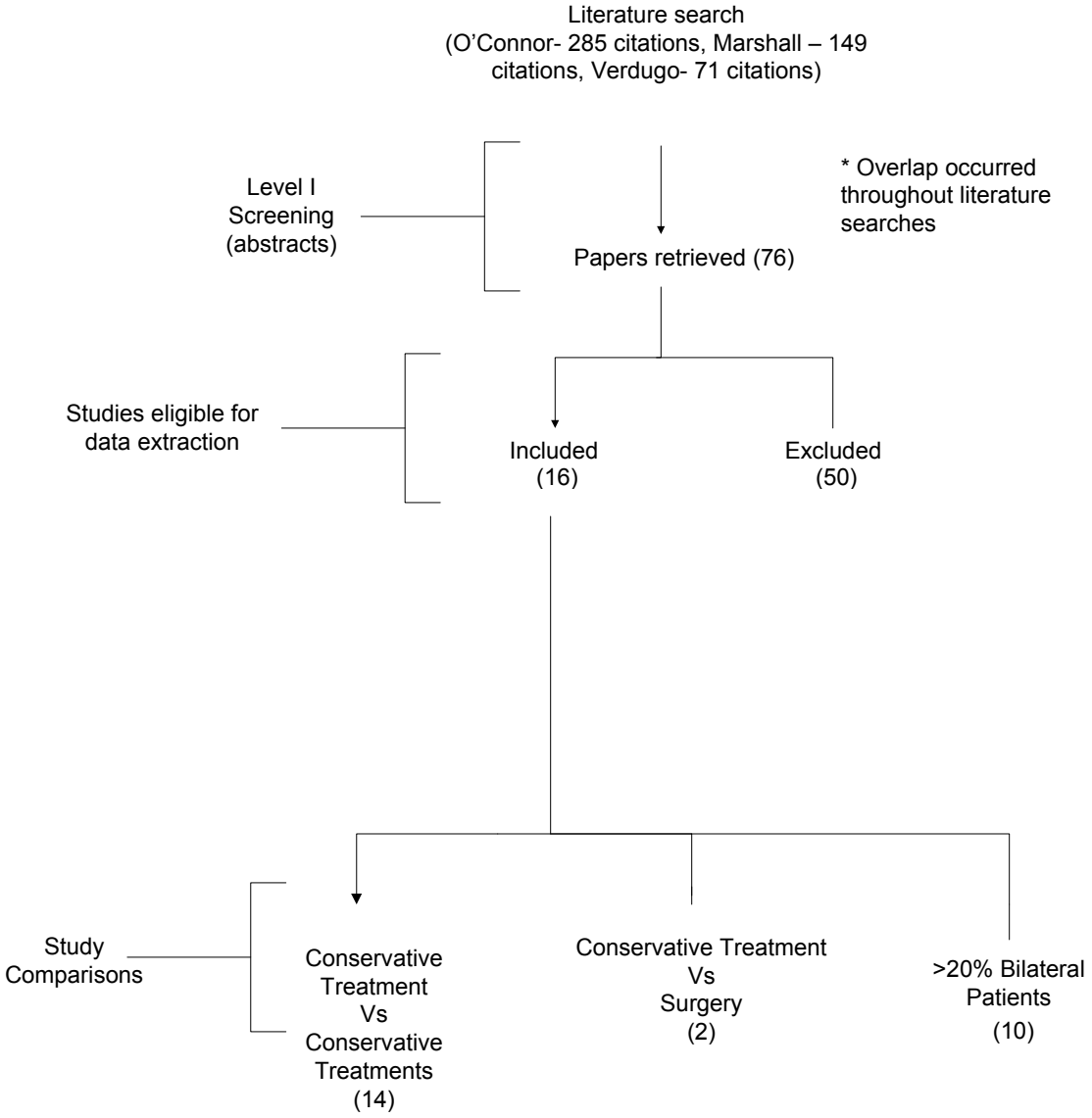


Figure 2

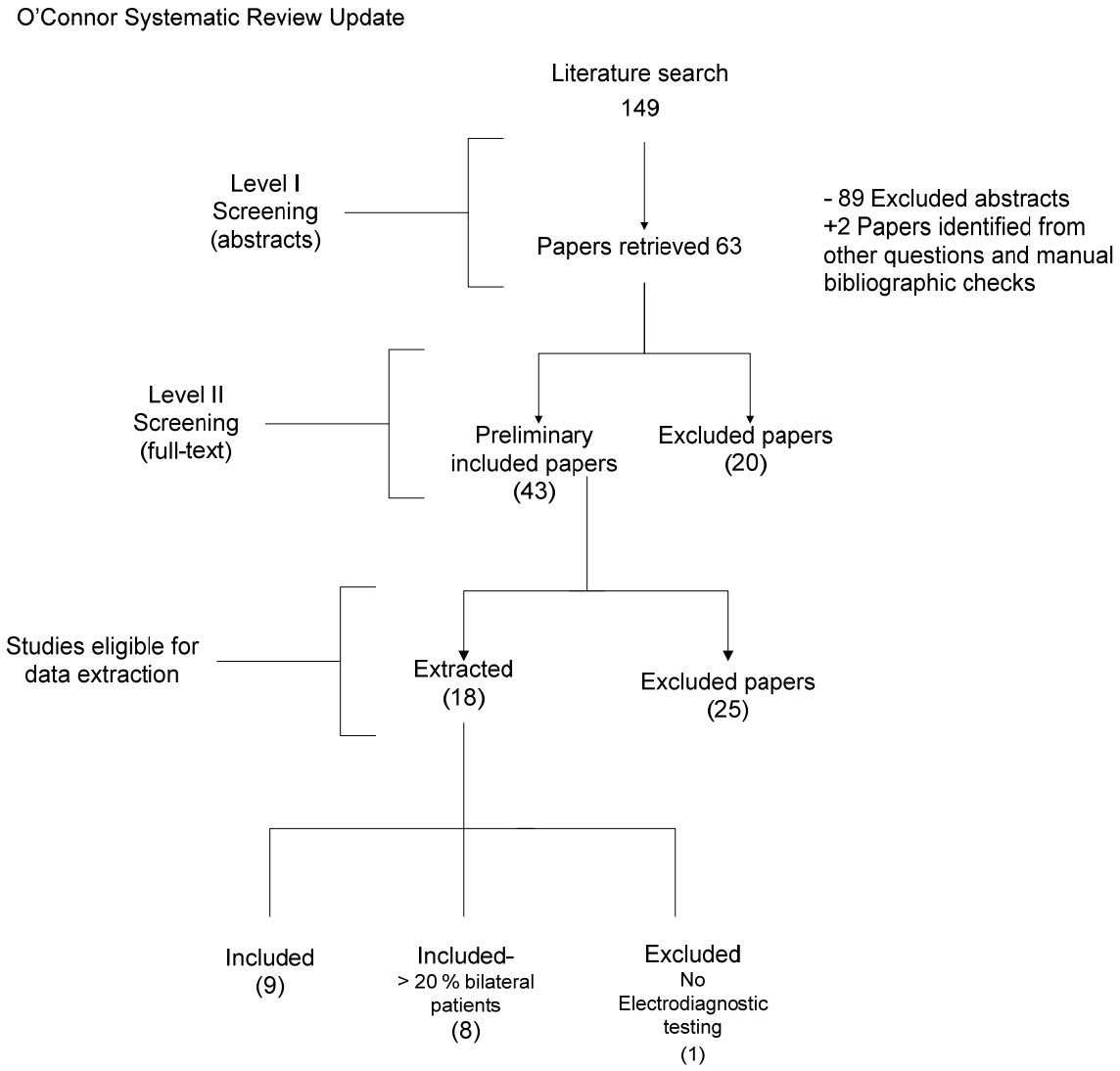

O'Connor Systematic Review Update
Literature search
149
Level I
Screening
(abstracts)
Papers retrieved 63
- 89 Excluded abstracts
+2 Papers identified from other questions and manual bibliographic checks
Level II
Screening
(full-text)
Preliminary included papers (43)
Excluded papers (20)
Studies eligible for data extraction
Extracted (18)
Excluded papers (25)
Included (9)
Included- > 20 % bilateral patients (8)
Excluded No Electrodiagnostic testing (1)

Figure 3

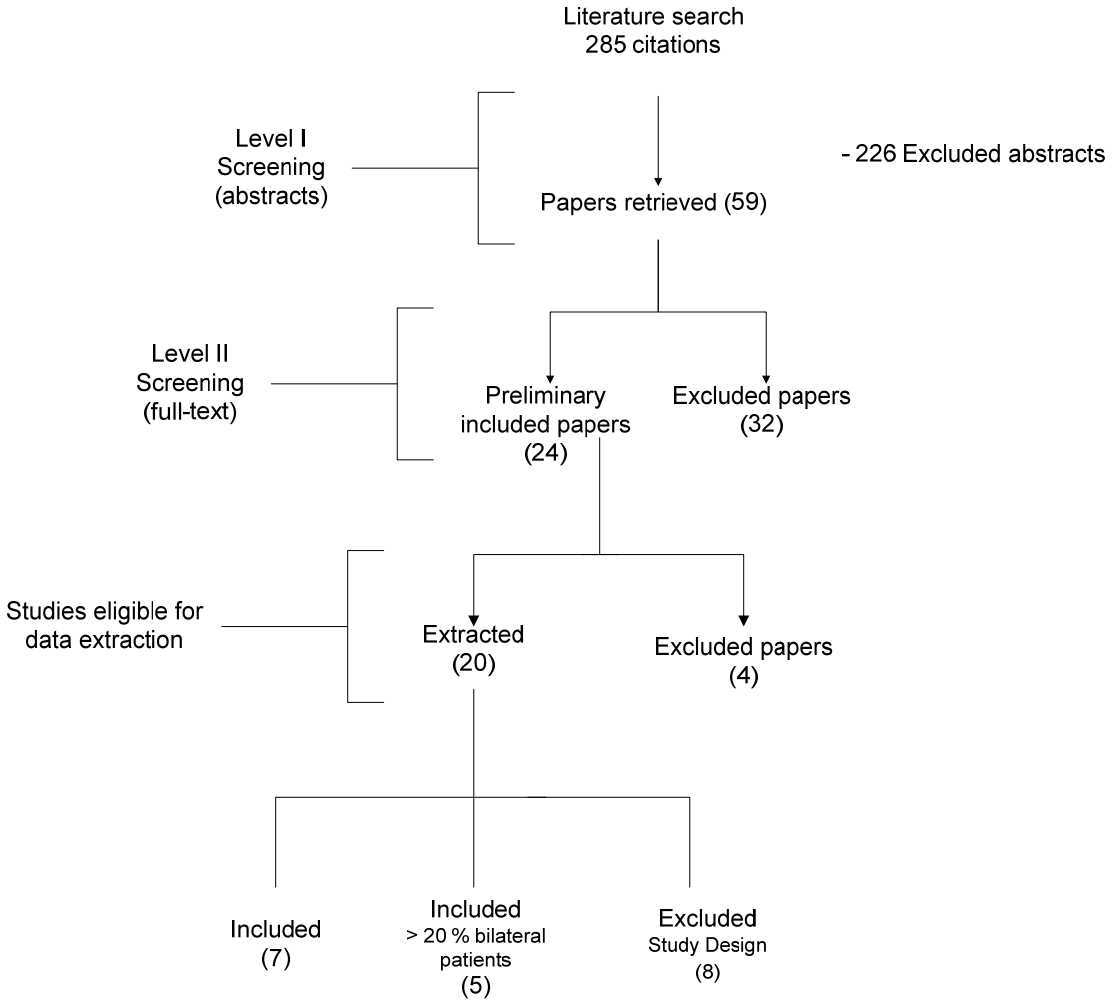
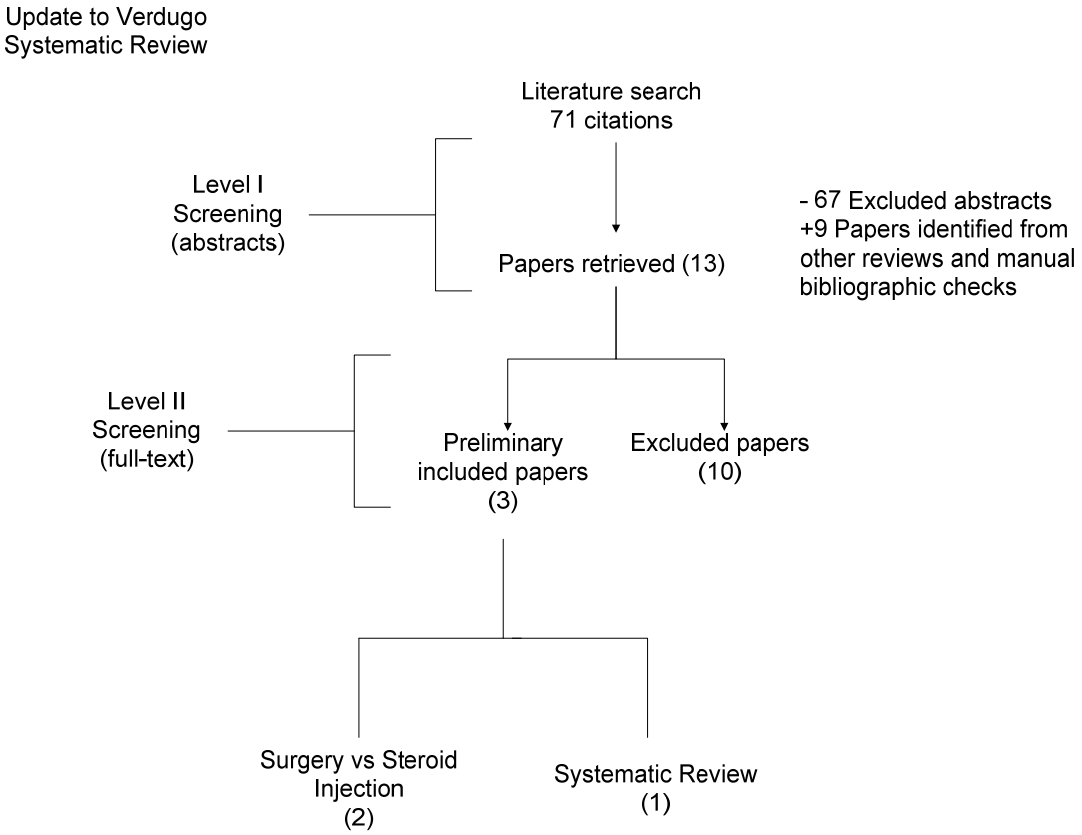

Marshall Systematic Review Update
Literature search
285 citations
Level I
Screening
(abstracts)
- 226 Excluded abstracts
Papers retrieved (59)
Level II
Screening
(full-text)
Preliminary
included papers
(24)
Excluded papers
(32)
Studies eligible for
data extraction
Extracted
(20)
Excluded papers
(4)
Included
(7)
Included
> 20 % bilateral
patients
(5)
Excluded
Study Design
(8)

Figure 4


Update to Verdugo
Systematic Review
Literature search
71 citations
Level I
Screening
(abstracts)
- 67 Excluded abstracts
+9 Papers identified from
other reviews and manual
bibliographic checks
Papers retrieved (13)
Level II
Screening
(full-text)
Preliminary
included papers
(3)
Excluded papers
(10)
Surgery vs Steroid
Injection
(2)
Systematic Review
(1)

COEXISTENT CERVICAL RADICULOPATHY

Figure 5

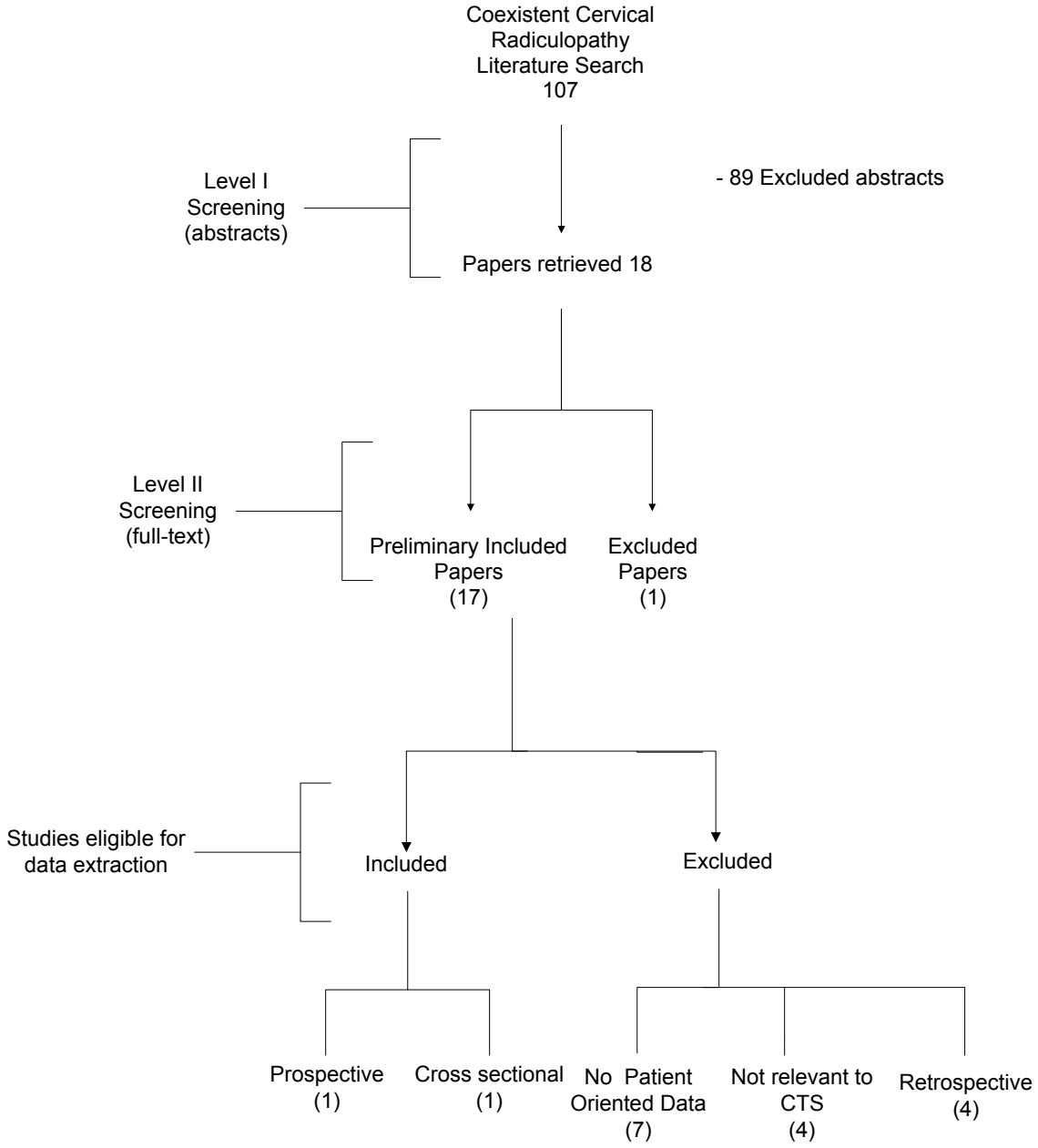
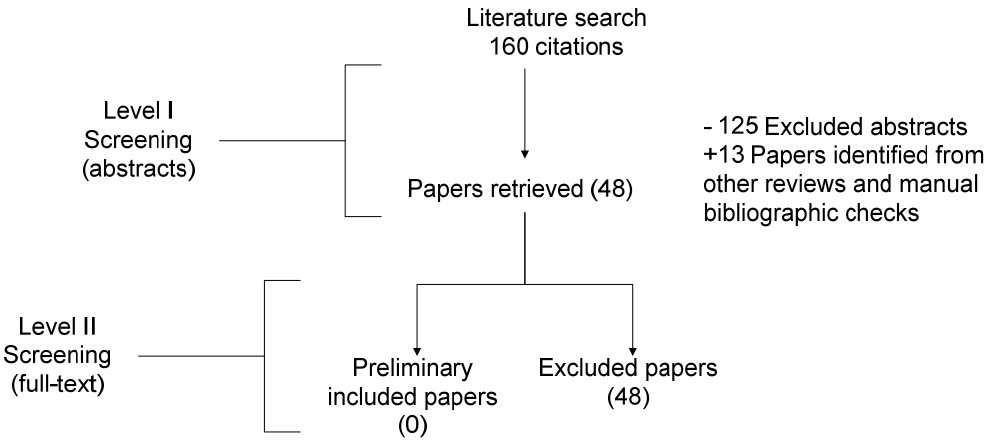
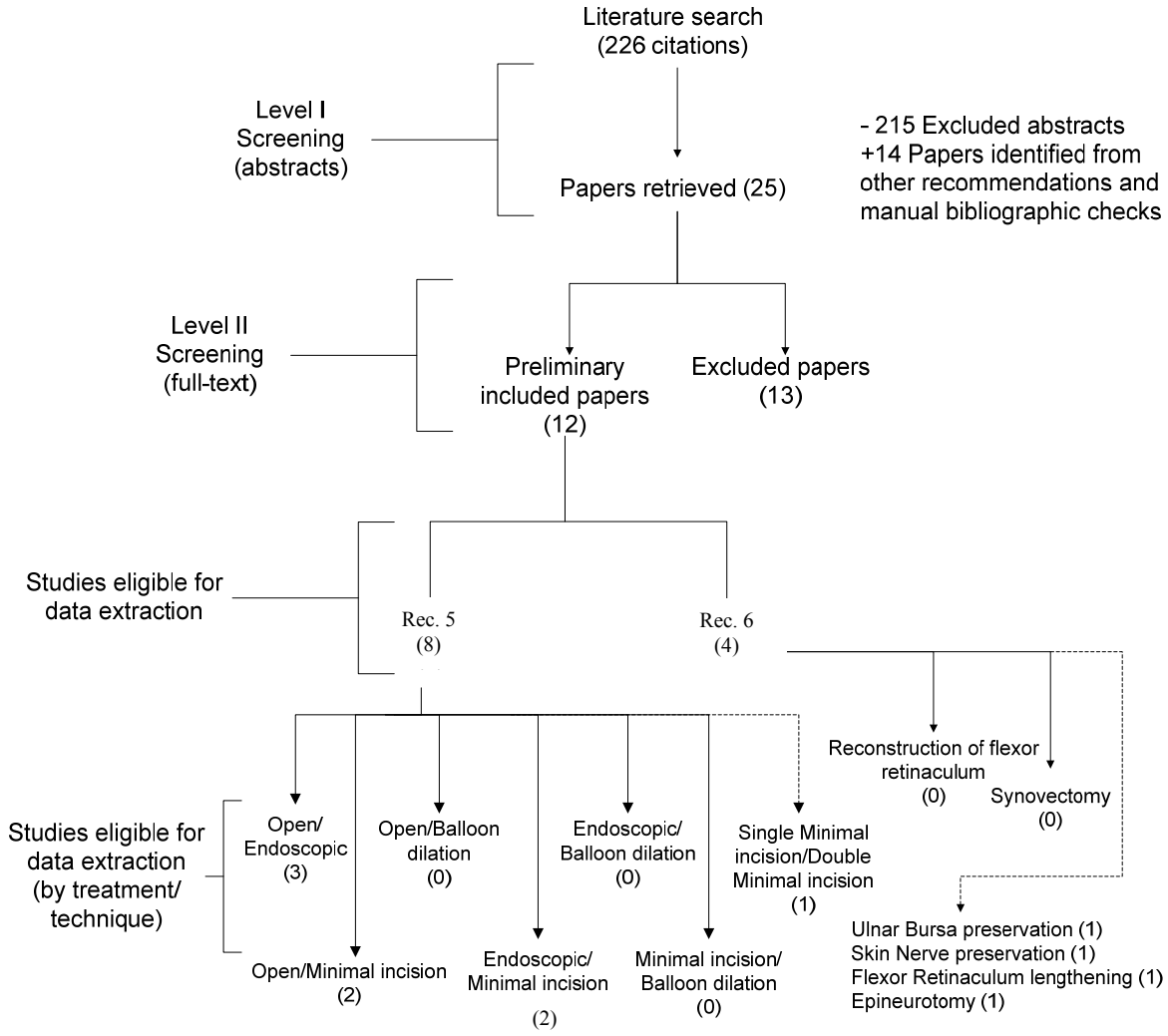


Figure 6


Literature search
160 citations
Level I
Screening
(abstracts)
- 125 Excluded abstracts
+13 Papers identified from other reviews and manual bibliographic checks
Papers retrieved (48)
Level II
Screening
(full-text)
Preliminary included papers (0)
Excluded papers (48)

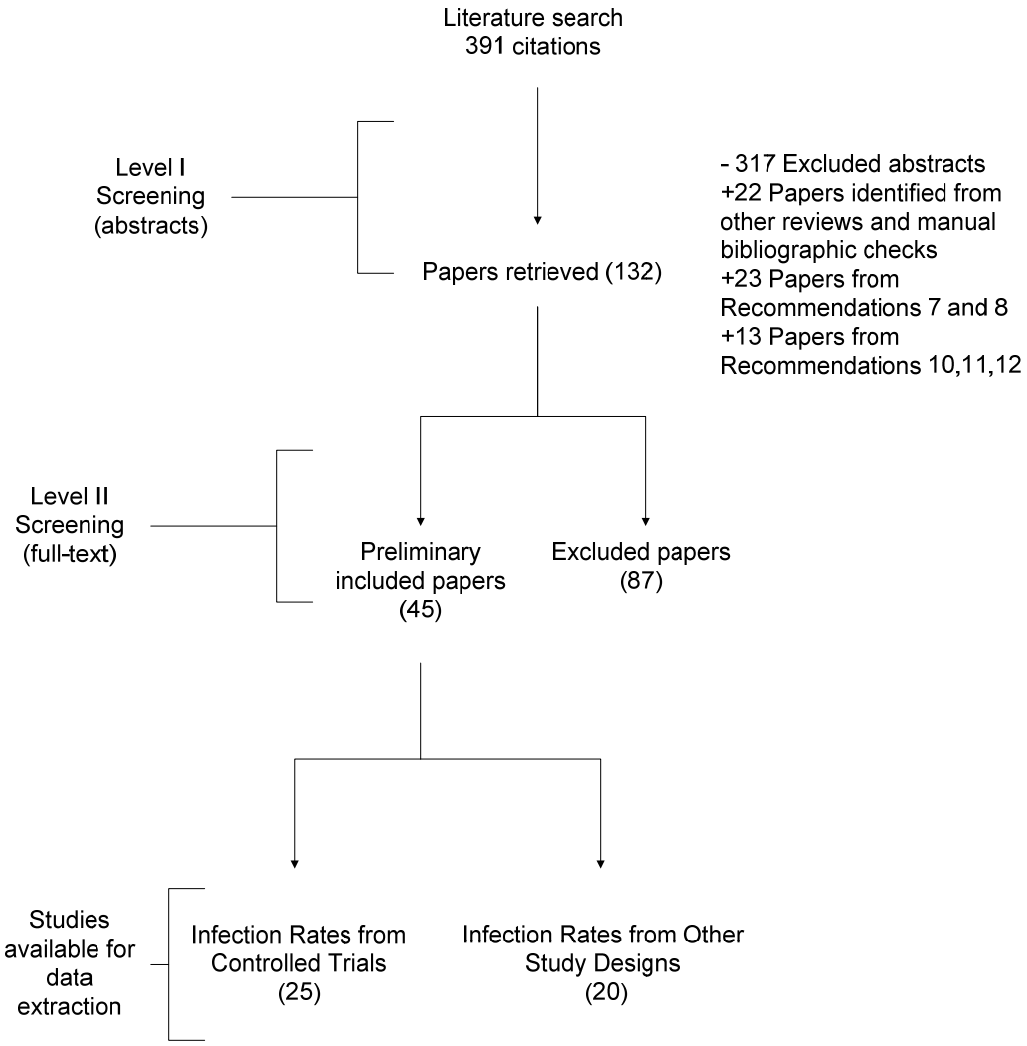
RECOMMENDATION 5 AND 6

Figure 7



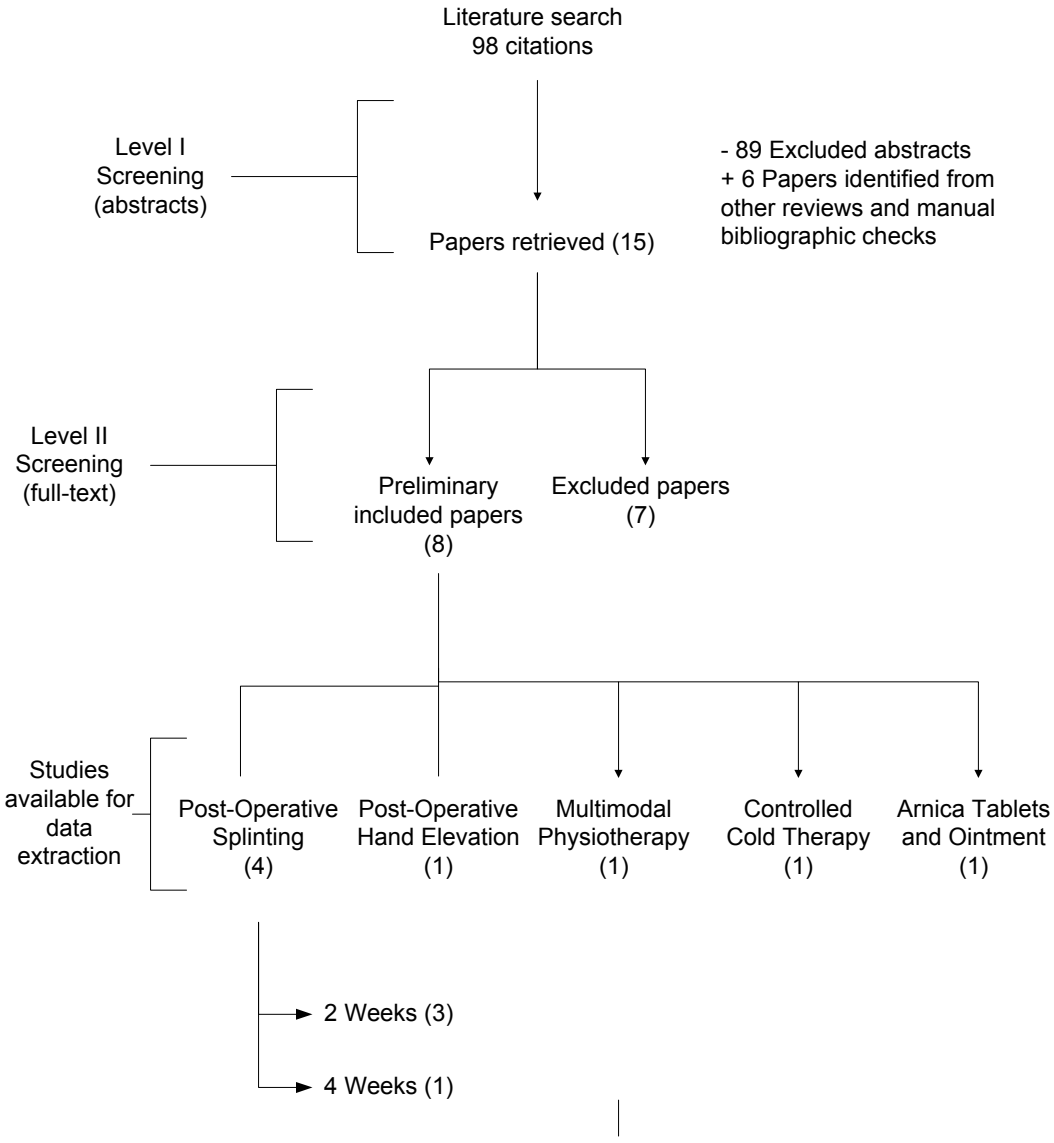
RECOMMENDATION 7

Figure 8



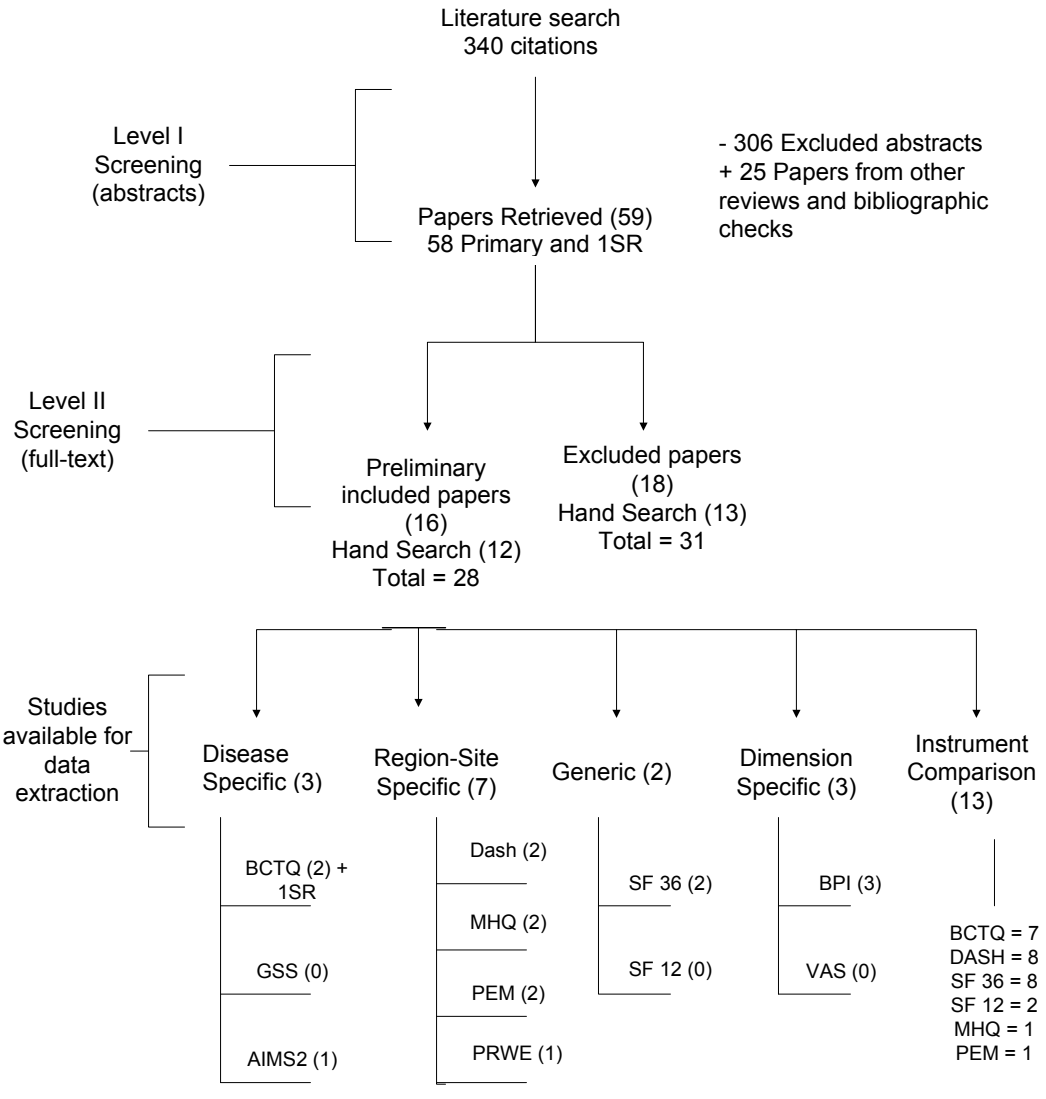
RECOMMENDATION 8

Figure 9



RECOMMENDATION 9

Figure 10



APPENDIX III: RATING EVIDENCE QUALITY

We considered the quality of the available evidence when grading the strength of guideline recommendations. Quality was determined using a "Levels of Evidence" approach in which five levels of evidence were designed for each of four study designs; therapeutic, prognostic, diagnostic and economic or decision modeling. The higher the level of evidence, the greater the ability to draw causal inferences from the results of a study and, hence, the greater the quality of that study.

September 28, 2004

Levels of Evidence For Primary Research Question[1]

	Types of Studies			
	Therapeutic Studies – Investigating the results of treatment	**Prognostic Studies – Investigating the effect of a patient characteristic on the outcome of disease**	**Diagnostic Studies – Investigating a diagnostic test**	**Economic and Decision Analyses – Developing an economic or decision model**
Level I	• High quality randomized trial with statistically significant difference or no statistically significant difference but narrow confidence intervals • Systematic Review[2] of Level I RCTs (and study results were homogenous[3])	• High quality prospective study[4] (all patients were enrolled at the same point in their disease with ≥ 80% follow-up of enrolled patients) • Systematic review[2] of Level I studies	• Testing of previously developed diagnostic criteria on consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level I studies	• Sensible costs and alternatives; values obtained from many studies; with multiway sensitivity analyses • Systematic review[2] of Level I studies
Level II	• Lesser quality RCT (e.g. < 80% follow-up, no blinding, or improper randomization) • Prospective[4] comparative study[5] • Systematic review[2] of Level II studies or Level 1 studies with inconsistent results	• Retrospective[6] study • Untreated controls from an RCT • Lesser quality prospective study (e.g. patients enrolled at different points in their disease or <80% follow-up.) • Systematic review[2] of Level II studies	• Development of diagnostic criteria on consecutive patients (with universally applied reference "gold" standard) • Systematic review[2] of Level II studies	• Sensible costs and alternatives; values obtained from limited studies; with multiway sensitivity analyses • Systematic review[2] of Level II studies
Level III	• Case control study[7] • Retrospective[6] comparative study[5] • Systematic review[2] of Level III studies	• Case control study[7]	• Study of non-consecutive patients; without consistently applied reference "gold" standard • Systematic review[2] of Level III studies	• Analyses based on limited alternatives and costs; and poor estimates • Systematic review[2] of Level III studies
Level IV	Case Series[8]	Case series	• Case-control study • Poor reference standard	• Analyses with no sensitivity analyses
Level V	Expert Opinion	Expert Opinion	Expert Opinion	Expert Opinion

1. **A complete assessment of quality of individual studies requires critical appraisal of all aspects of the study design.**
2. **A combination of results from two or more prior studies.**
3. **Studies provided consistent results.**
4. **Study was started before the first patient enrolled.**
5. **Patients treated one way (e.g. cemented hip arthroplasty) compared with a group of patients treated in another way (e.g. uncemented hip arthroplasty) at the same institution.**
6. **The study was started after the first patient enrolled.**
7. **Patients identified for the study based on their outcome, called "cases"; e.g. failed total arthroplasty, are compared to those who did not have outcome, called "controls"; e.g. successful total hip arthroplasty.**
8. **Patients treated one way with no comparison group of patients treated in another way.**

APPENDIX IV: EVIDENCE TABLES

SEE EVIDENCE TABLES DOCUMENT (EVIDENCE TABLES.PDF)

Please refer to the accompanying PDF Document …

LIST OF TABLES

APPENDIX V: CONFLICTS OF INTEREST

All members of the physician Work Group disclosed any conflicts of interest prior to the development of the recommendations for this guideline. Conflicts of interest are disclosed in writing with the American Academy of Orthopaedic Surgeons via a private on-line reporting database and also verbally at the recommendation approval meeting. No member of the CTS Work Group disclosed a conflict of interest for this guideline.

APPENDIX VI: DOCUMENTATION OF APPROVAL

AAOS Work Group Draft Completed	December 2007
Outside Specialty Review Panel Comments Completed	April 25, 2008
Public Commentary Completed	May 2008
AAOS Guidelines and Technology Oversight Committee	June 11, 2008
AAOS Evidence Based Practice Committee	June 19, 2008
AAOS Council on Research Quality Assessment and Technology	July 9, 2008
AAOS Board of Directors	September 12, 2008

A total of 198 professionals were provided the opportunity to comment on the contents of this document during the peer review, public commentary and approval process.

Suggested Citation for referencing this document:

American Academy of Orthopaedic Surgeons Clinical Practice Guideline on Treatment of Carpal Tunnel Syndrome. Rosemont (IL): American Academy of Orthopaedic Surgeons (AAOS); 2008

APPENDIX VII: ADVISORY REVIEW PANEL

Participation in the AAOS peer review process does not constitute an endorsement of this guideline by the participating organization.

Peer review of the draft guideline is completed by an outside Peer Review Advisory Panel. Outside Advisory Panels are convened for each AAOS guideline and consist of experts in the guideline's topic area. These experts represent professional societies other than AAOS and are nominated by the guideline Work Group prior to beginning work on the guideline. For this guideline, thirteen outside peer review organizations were invited to review the draft guideline and all supporting documentation. Eight societies participated in the review of the CTS Treatment guideline draft and seven consented to be listed as a peer review organization in this appendix. One organization requested that the organization name be withheld from publication. The organizations that reviewed the document and consented to publication are listed below:

The American Academy of Neurology (AAN)
The American Academy of Physical Medicine and Rehabilitation (AAPMR)
The American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS)
The American Association of Neuromuscular and Electrodiagnostic Medicine (AANEM)
The American College of Occupational and Environmental Medicine (ACOEM)
The American Medical Association (AMA)
The American Society of Plastic Surgeons (ASPS)

Again, participation in the AAOS guideline peer review process does not constitute an endorsement of the guideline by the participating organizations listed above.