Agency for Healthcare Research and Quality

Evidence Report/Technology Assessment

Number 62

Diagnosis and Treatment of Worker-Related Musculoskeletal Disorders of the Upper Extremity

Summary

Overview

This report is a systematic evaluation of the evidence pertaining to a broad range of issues related to the diagnosis and treatment of worker-related upper extremity disorders (WRUEDs). For the purposes of this report, "worker-related" is defined as a disorder that affects workers, not as a disorder necessarily caused by work. Four disorders are the focus of this report; carpal tunnel syndrome, cubital tunnel syndrome, epicondylitis, and de Quervain's disease.

The first two disorders are the result of nerve entrapment. Carpal tunnel syndrome is the result of increased pressure on the median nerve in the carpal tunnel of the wrist, resulting in sensory and motor disturbances in the parts of the hand innervated by this nerve. Cubital tunnel syndrome results from increased pressure on the ulnar nerve in the cubital tunnel of the elbow, resulting in sensory and motor disturbances in the parts of the forearm and hand innervated by this nerve. The second two disorders are the result of stress to the tendons of the elbow and wrist, respectively. All four disorders can lead to pain, loss of function, and long-term disability.

The overall prevalence of carpal tunnel syndrome in the United States may be as high as 1.9 million people, and each year there are 300,000–500,000 operations for the condition. Epicondylitis has been reported to affect 4.23 individuals per 1,000 adults per year in the U.S. The prevalence of cubital tunnel syndrome and de Quervain's disease has not been established.

In this evidence report, the Evidence-based Practice Center (EPC) assessed the published literature describing the effects of these disorders, before and after treatment, on patients, particularly workers. They did this by examining the literature pertaining to 13 key questions.

Reporting the Evidence

This report addresses 13 questions regarding worker-related disorders of the upper extremity. Eleven of these are condition-specific. Therefore, the EPC individually addressed them for each of the four above-mentioned disorders. Two questions are not condition-specific. Therefore, the EPC addressed them only once. The 11 condition-specific Key Questions addressed in this evidence report are:

Question 1: What are the most effective methods and approaches for the early identification and diagnosis of worker-related musculoskeletal disorders of the upper extremity?

Question 2: What are the specific indications for surgery for worker-related musculoskeletal disorders of the upper extremity?

Question 3: What are the relative benefits and harms of various surgical and nonsurgical interventions for persons with worker-related musculoskeletal disorders of the upper extremity?

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Question 4: Is there a relationship between specific clinical findings and specific treatment outcomes among patients with worker-related musculoskeletal disorders of the upper extremity?

Question 5: Is there a relationship between duration of symptoms and specific treatment outcomes among patients with worker-related musculoskeletal disorders of the upper extremity?

Question 6: Is there a relationship between factors such as patients' age, gender, socioeconomic status and/or racial or ethnic grouping and specific treatment outcomes among patients with worker-related musculoskeletal disorders of the upper extremity?

Question 7: What are the surgical and nonsurgical costs or charges for treatment of worker-related musculoskeletal disorders of the upper extremity?

Question 8: For persons who have had surgery for worker-related musculoskeletal disorders of the upper extremity, what are the most effective methods for preventing the recurrence of symptoms, and how does this vary depending on subject characteristics or other underlying health problems?

Question 9: What instruments, if any, can accurately assess functional limitations in an individual with a worker-related disorder of the upper extremity?

Question 10: What are the functional limitations for an individual with a worker-related musculoskeletal disorder of the upper extremity before treatment?

Question 11: What are the functional limitations of an individual with a worker-related musculoskeletal disorder of the upper extremity after treatment?

The two Key Questions that are not condition-specific are:

Question 12: What are the cumulative effects on functional abilities among individuals with more than one worker-related musculoskeletal disorder of the upper extremity in the same limb?

Question 13: What level of function can patients achieve in what period of time when they are required to change hand dominance as a result of injury to their dominant hand?

Methodology

A panel of nine Technical Experts was employed to assist in defining the scope of this evidence report, developing its questions, and developing the criteria for retrieving and including articles.

To identify information for this evidence report, the EPC searched 31 electronic databases, the World Wide Web, and four U.S. Government databases. In addition to these searches, researchers also reviewed the bibliographies and reference lists of all studies included in this evidence report, searched Current Contents®/Clinical Medicine on a weekly basis, and routinely reviewed over 1,600 journals and supplements maintained in ECRI's collections.

To be included in this evidence report, an article had to meet a set of a priori retrieval criteria and a set of a priori question-specific inclusion criteria. The EPC designed broad retrieval criteria to ensure comprehensive retrieval. They retrieved an article whenever there was uncertainty about whether it met the retrieval criteria. They also retrieved articles when an abstract was not present in the search results, but when the title of the article suggested that it was relevant. The criteria for article retrieval are briefly summarized below:

- The patients had to have been diagnosed with a worker-related disorder of the upper extremity.
- All controlled trials, regardless of whether they were described as randomized or prospective, were retrieved, regardless of year of publication.
- Case series and other reports were evaluated only if published in 1980 or later and included 10 or more patients.
- Only English-language articles were retrieved.

Once an article was retrieved, it was examined to determine whether it met the question-specific criteria. The major criteria are briefly summarized below; additional question-specific inclusion criteria, which are not listed here, were also applied:

- The study could not have a serious design flaw that precluded interpretation of the results.
- The study must have addressed one of the key questions and have included patients with one of the WRUEDs of interest.
- For studies addressing Key Question 3, the study must have been a controlled trial.
- The study must have reported on at least one of the seven key outcomes addressed in this assessment. The outcomes are: pain, function, quality of life, ability to return to work, ability to return to activities of daily living, harms, and global outcome.

A global outcome is any score that attempts to encompass the overall success or failure of the treatment. It may be a numerical rating of overall symptom relief or patient satisfaction, a categorical rating such as excellent, good, fair or poor, or a dichotomous rating such as the answer to the question "Would you undergo this procedure again?"

Data from all articles that met our inclusion criteria were abstracted using electronic data abstraction forms. Separate data abstraction forms were designed for entering data about basic trial design information; patient signs, symptoms, comorbidities, characteristics, and treatments; reporting of treatment outcomes; surgical complications; and nerve conduction measurements.

The EPC employed a variety of statistical methods in this evidence report. Meta-analyses of studies of treatments were conducted using Hedges' d as a measure of each study's effect size, and then computing the precision-weighted summary d

from the combined results of all studies. Hedges' d is the difference between the means of any study's two groups expressed in standard deviation units. Researchers employed two tests for heterogeneity, the Q statistic and each study's standardized residual. The EPC researchers regarded the data as heterogeneous if the results of either test were statistically significant.

Diagnostic test meta-analyses were performed according to the method of Littenberg and Moses. The researchers took the mean threshold as the best estimate of a single threshold, and the values of sensitivity and specificity at the mean threshold as the single best global estimate of test effectiveness. Before using the results of a meta-analysis of diagnostics, they verified that there was no statistically significant heterogeneity among the results of the included articles using the Q statistic. If heterogeneity was detected, they removed any subgroups that caused the heterogeneity from the analysis. If there were no subgroups in the analysis, or those subgroups did not cause the heterogeneity, they looked for data points that were outliers, and reported the meta-analytic results with and without exclusion of these outliers.

The EPC performed numerous other statistical computations in addition to those involved in performing meta-analyses. Briefly, these were:

- Corrections for patient attrition.
- Statistical power analyses.
- Multiple regression for certain questions when such results were of interest.
- Computations of effect sizes for all studies, when possible, even when no meta-analysis was performed.
- Determinations of whether there were statistically significant differences between the characteristics of patients in any given study.
- Computation of pretreatment effect sizes.
- Verification of diagnostic test characteristics.

Findings

Carpal Tunnel Syndrome

Question 1: What are the most effective methods and approaches for the early identification and diagnosis of carpal tunnel syndrome?

- The evidence base on most individual diagnostic tests for carpal tunnel syndrome is small, even though the total number of articles on CTS diagnosis is large. This is because many different tests have been described. Nerve conduction tests are most frequently reported in the literature, but there is great diversity in their methods.
- The results of our analyses may overestimate the specificity of nerve conduction measurements in typical practice. This is because the trials we examined used healthy, asymptomatic persons as controls. In clinical practice, the test would be used on workers believed to be at risk for CTS or persons suspected of having CTS. Under these conditions, the false positive rate would be higher, and the specificity correspondingly lower.
- The most frequently reported nerve conduction tests were distal motor latency and palmar sensory latency. For both tests, clinicians chose thresholds that yielded high specificity (a low incidence of false-positive results). The EPC's meta-analyses of distal motor latency studies found the sensitivity of the test to be 57% to 66% and the specificity to be 98%. Meta-analysis of palmar sensory latency studies found a sensitivity of 76% and a specificity of 98%.
- Clinical signs and symptoms are also used in the diagnosis of CTS. They attempted to use their meta-analysis techniques to obtain summary values for the sensitivity and specificity of two such signs: Tinel's sign and Phalen's maneuver. In both cases, there was heterogeneity in the published results that could not be explained by differences in patient selection or by single outlier studies. Therefore, they did not calculate summary measurements for sensitivity or specificity. The sensitivity of Phalen's maneuver was lower than its specificity, and two trials reported sensitivity of 80% to 90%. All of the studies of Tinel's sign found that its sensitivity was lower than its specificity, and none found a sensitivity of 75 percent or greater. There was too much heterogeneity in the results for them to conclude that one test was superior to the other, or to compare these tests to nerve conduction testing.
- Regarding sensory tests, composite nerve conduction tests, and imaging tests, there was insufficient evidence for the EPC to perform meta-analyses of clinical trial results.
- Their well-designed study suggests that nerve conduction measurement may be able to identify some workers at risk of developing CTS in the future. By itself, this evidence is not sufficient for the EPC to conclude that nerve conduction screening for CTS is effective.

Question 2: What are the specific indications for surgery for carpal tunnel syndrome?

- Patients who have undergone surgery for carpal tunnel syndrome are predominantly middle aged and female.
- Because of underreporting, no firm evidence-based conclusions can be drawn regarding the signs, symptoms, neuroelectrical characteristics, and comorbidities of these patients.

Question 3: What are the relative benefits and harms of various surgical and nonsurgical interventions for persons with carpal tunnel syndrome?

- Meta-analysis of studies comparing open and endoscopic carpal tunnel release show a small but statistically significant advantage to endoscopic release in global

treatment outcome. In addition, the data show a trend toward faster return to work and to activities of daily living among patients receiving endoscopic release. However, these findings must be viewed only as trends in currently available data. This is because they are based on a meta-analysis that contained a number of non-randomized, non-blinded studies. Data from these studies also suggests that endoscopic release has a higher complication rate and a higher rate of reoperation compared to open release. The higher reoperation rates likely arise because of incomplete transection of the transverse carpal ligament. Exact complication rates cannot be determined from presently available data. Presently available data also do not allow one to reach firm evidence-based conclusions about the relative effects of open and endoscopic surgery on the ability of patients to perform daily functions.

- Meta-analysis of global outcomes demonstrates a potential benefit from not performing neurolysis. Available return to work data also shows a trend toward an advantage to not performing neurolysis. There is insufficient data to determine the effect of neurolysis on pain and function. The available evidence suggests there is little or no benefit from performing neurolysis along with surgical release of the carpal tunnel. The possibility remains that neurolysis may be helpful in special cases, such as in the presence of marked scarring or neural adhesion, but no available evidence specifically documents the benefits and harms of neurolysis among such patients.
- Results of four studies suggest that injection of steroid into the carpal tunnel yields superior global outcomes compared to no treatment, placebo, or oral steroids. However, relief from steroid treatments is not complete. Carpal tunnel injection was significantly better than intramuscular injection at a 1 month followup time. Because no further time points were reported, researchers are unable to determine whether this difference persists beyond this time. There are no data available that indicate whether any type of steroid may be superior to any other, or whether any particular dose is optimum. Although the effects of steroid injection may wear off over time, there is no information indicating the expected duration of relief for the average patient, or whether any patients can expect to experience permanent relief.
- Two double-blinded randomized controlled trials suggest that oral steroids may lead to a reduction in symptoms of CTS. However, the effects of oral steroids are short-lived and may not be sufficient for patient satisfaction. The effects of higher steroid doses or longer treatment regimens have not been examined in published controlled trials.
- A single published randomized controlled trial indicates that oral tenoxicam (a NSAID) and trichlormethiazide (a diuretic) do not reduce the symptoms of CTS under the dosing regimens described. Further trials are needed to confirm this observation, and to test the effects of additional drugs and dosing regimens.
- Results of a single study suggest that manual therapy may have some use in the treatment of carpal tunnel syndrome. This study suggests that carpal bone mobilization provides pain relief, improves function, and delays or eliminates the need for surgery among patients with carpal tunnel syndrome. However, this small study was unblinded. Results from neurodynamic mobilization show a similar trend, but because of a lack of statistical power one cannot conclude that this trend is real. For the same reason, differences in effectiveness between these two treatment groups cannot be determined. A large, blinded, randomized controlled trial is necessary to confirm these results.
- A larger, more statistically powerful study found no difference between the effects of a physical therapy program and home exercise instructions on pain or function. However, patients receiving physical therapy returned to work faster than those instructed to exercise at home.
- Although these studies indicate a trend toward some forms of physical therapy having an effect on carpal tunnel syndrome, their small size and design difficulties make it difficult to arrive at a firm evidence-based conclusion.
- Only one study meeting inclusion criteria addresses the use of ultrasound for carpal tunnel syndrome. Because of this, and because of its associated design and analysis difficulties, one cannot reach a firm evidence-based conclusion.
- Splint use was addressed only by a single trial that had design difficulties. Because of this, one cannot reach a firm evidence-based conclusion about splint use. There may be conditions under which splints offer an advantage and conditions under which they do not, but this is not addressed by available evidence.
- The results of one study suggest that suboptimal outcomes are obtained when patients receive ligament reconstruction. However, this trial was neither randomized nor blinded, so one cannot draw firm evidence-based conclusions from it.
- Although the low statistical power of the one relevant study prevents any solid conclusion from being drawn, this study does not support the therapeutic effectiveness of Vitamin B6. This is because it showed a trend toward a greater percentage of improved patients in the placebo group.

Question 4: Is there a relationship between specific clinical findings and specific treatment outcomes among patients with carpal tunnel syndrome?

- The only clinical finding variable shown by more than one study to significantly predict treatment outcomes was electrodiagnostic testing. Patients with mildly impaired or normal results of electrodiagnostic tests had longer sick leaves and were less likely to be satisfied with the results of treatment. This finding was statistically significant in three of the four studies examining this relationship.
- This apparent lack of consistency of results could indicate that, although the relationship between electrodiagnostic tests and treatment outcomes is statistically significant, it may not be substantial. The possibility that this relationship is small is supported by the results of stratified studies that examined the relationship between electrodiagnostic test results and global outcomes. Six of seven studies did not find a statistically significant relationship.

Question 5: Is there a relationship between duration of symptoms and specific treatment outcomes among patients with carpal tunnel syndrome?

- The majority of available evidence is less than optimal because it consists primarily of retrospective studies. The highest quality study (prospective with multiple regression analysis) suggested that there was no statistically significant correlation between duration of symptoms and global outcome after surgery. One prospective and two retrospective stratified studies found similar results. Two retrospective studies (one performing multiple regressions, one stratified) found a statistically significant relationship between shorter duration of symptoms and symptom resolution or patient satisfaction after surgery. The retrospective nature of these trials could have created bias that influenced these findings. An additional high quality prospective study is needed before firm conclusions can be reached.

Question 6: Is there a relationship between factors such as patients' age, gender, socioeconomic status and/or racial or ethnic grouping and specific treatment outcomes among patients with carpal tunnel syndrome?

- The available evidence suggests that patients who are not receiving workers' compensation tend to return to work faster than those receiving such compensation. This is suggested by one of two "multiple regression" studies of this relationship and by a combination of 10 prospective and retrospective stratified studies. Evidence of a relationship does not constitute evidence of causality.
- Some evidence also suggests that patients who are not receiving workers' compensation have better global outcomes, but this evidence is derived exclusively from retrospective studies. Therefore, these latter findings require confirmation.
- Available evidence suggests that there is no strong relationship between gender, employment status, or hand dominance and return to work or global outcomes.
- There is insufficient evidence to arrive at a firm evidence-based conclusion on the relationship between type of work, presence of diabetes, or age and patient outcomes.

Question 7: What are the surgical and nonsurgical costs or charges for treatment of carpal tunnel syndrome?

- According to the Medicare Provider Analysis and Review (MEDPAR) database, which covers hospital inpatient services, average total charges per patient for the DRG (diagnosis-related group) of carpal tunnel release are $8,185.24 (calculated by dividing total charges by number of discharges). This DRG includes open and endoscopic release.
- The Median Costs for Hospital Outpatient Services Dataset contains median costs for services that are reimbursed under Medicare for the hospital outpatient prospective payment system. The reported median cost for endoscopic release of the transverse carpal ligament is $849.84 (cost of open release was not reported by this database). The reported median cost for application of a short arm static splint is $72.69.

Question 8: For persons who have had surgery for carpal tunnel syndrome, what are the most effective methods for preventing the recurrence of symptoms, and how does this vary depending on subject characteristics or other underlying health problems?

- No controlled trials have been published that report on the efficacy or effectiveness of any technique for the prevention of recurrence of carpal tunnel syndrome. In the absence of controlled trials, no analysis may be performed and no evidence-based conclusions may be drawn.

Question 9: What instruments, if any, can accurately assess functional limitations in an individual with carpal tunnel syndrome?

- Three prospective cohort trials have indicated that the SF-36 is not a useful instrument for assessing functional limitations in individuals with carpal tunnel syndrome. The SF-36 was reported to be unresponsive to treatment and unable to predict ability to work.
- Four prospective cohort trials have indicated that the Levine CTS-I may be a useful instrument for assessing functional limitations in individuals with carpal tunnel syndrome. This instrument was reported to be responsive to treatment, and to have concurrent validity as measured by grip and pinch strength. However, the studies that addressed the Levine CTS-I did not examine

its internal reliability, content validity, or its ability to predict how well patients could perform activities of daily living. In addition, the Levine CTS-I has been reported by one study to be unable to predict ability to work.

- No other instrument has been evaluated by more than one study. It is difficult to reach an evidence-based conclusion as to the usefulness of the other instruments evaluated in this report due to the limited evidence base.

Question 10: What are the functional limitations for an individual with carpal tunnel syndrome before treatment?

- There is some evidence to suggest that most untreated patients with carpal tunnel syndrome have mild to moderate functional difficulties before treatment. However, this evidence is derived from only two studies comprised of a total of 51 patients. This is too few patients and too few studies to allow one to reach a firm evidence-based conclusion.

Question 11: What are the functional limitations of an individual with carpal tunnel syndrome after treatment?

- Although studies of non-surgical therapies suggested that most patients experience only mild difficulty with functional activities after treatment, it is unclear whether the results of these two studies are generalizable to the larger patient population.
- Studies with surgical outcomes suggested that most patients report no-to-moderate difficulty with functional activities (mean 1.4-2.6 on the Levine CTS-I) after surgery.
- Although there were no statistically significant differences between specific patient groups, there was a trend toward more difficulty with functional activities among workers' compensation patients in surgical studies. This trend was based on the results of two studies.
- The available data are insufficient to determine a cutoff point on measuring scales above which patients are unable to work.

Cubital Tunnel Syndrome

Question 1: What are the most effective methods and approaches for the early identification and diagnosis of cubital tunnel syndrome?

- One test for cubital tunnel syndrome, ulnar motor nerve conduction velocity at the elbow, was commonly mentioned by reviewers. Three studies reported high specificity and low sensitivity for this test. Due to the small number of studies, however, one cannot draw quantitative conclusions about the effectiveness of the test. There are insufficient data to permit firm evidence-based conclusions about the effectiveness of this or any other tests for cubital tunnel syndrome.

Question 2: What are the specific indications for surgery for cubital tunnel syndrome?

- Thirty-two studies of patients who received surgery for cubital tunnel syndrome were identified. The mean age of patients who received surgery for cubital tunnel syndrome was 46 years.
- The patients were slightly more likely to be male (62% male).
- On average, patients had symptoms 10 to 24 months before receiving surgical treatment.

Question 3: What are the relative benefits and harms of various surgical and nonsurgical interventions for persons with cubital tunnel syndrome?

- One randomized controlled trial of 52 patients found that medial epicondylectomy was superior to anterior transposition in relieving pain and in improving global outcome scores. The results of this study are suggestive, but one cannot arrive at a strong conclusion from the results of only one trial. There is insufficient evidence to determine the relative effectiveness of other surgical treatments.
- There are insufficient data available to determine the rates of surgical complications for any of the described surgical procedures.

Question 4: Is there a relationship between specific clinical findings and specific treatment outcomes among patients with cubital tunnel syndrome?

- The only clinical finding variable shown by more than one study to significantly predict treatment outcomes was severity of symptoms. This correlation was statistically significant in four out of seven studies that examined it. The studies that did not find a statistically significant correlation may have been underpowered. Therefore, currently available evidence tentatively suggests that there is a correlation between having less severe symptoms and having a higher global outcome score after surgical treatment for cubital tunnel syndrome.
- There are insufficient data to reach evidence-based conclusions about the relationships between other clinical findings and treatment outcomes.

Question 5: Is there a relationship between duration of symptoms and specific treatment outcomes among patients with cubital tunnel syndrome?

- Currently available evidence does not suggest a clear-cut relationship between the duration of symptoms before treatment and the success of surgery.
- There are insufficient data available to reach evidence-based conclusions about the relationship between symptom duration and other treatment outcomes.

Question 6: Is there a relationship between factors such as patients' age, gender, socioeconomic status and/or racial or ethnic grouping and specific treatment outcomes among patients with cubital tunnel syndrome?

- The available data do not suggest a substantial correlation between the age, sex, or workers' compensation status of the patient and the success of surgery.
- Two studies that used multiple regression to examine relationships between patient characteristics and treatment outcomes found that patients whose cubital tunnel syndrome is caused by an acute trauma have better outcomes after surgical treatment than patients with cubital tunnel syndrome from other causes. However, three studies that stratified by etiology found no statistically significant relationship between cause and patient outcomes. The studies that used multiple regression techniques are of better quality than the stratified studies. Thus, current data suggest that there may be a correlation between etiology and patient outcomes, but this cannot be regarded as definitive.

Question 7: What are the surgical and nonsurgical costs or charges for treatment of cubital tunnel syndrome?

- According to Medicare Provider Analysis and Review (MEDPAR), average total charges per patient for the DRG (diagnosis-related group) of major shoulder/elbow procedures with comorbidities or complications are $9,008.94 (calculated by dividing total charges by number of discharges).
- For the DRG shoulder, elbow or forearm procedures, except major joint procedures, without comorbidities or complications, average total charges per patient are $7729.16.
- For the DRG peripheral and cranial nerve and other nerve procedures without complications or comorbidities, the average total per patient charges are $14,357.65 (with complications or comorbidities the charges are $24,288.00).
- The Median Costs for Hospital Outpatient Services Dataset contains median costs for services that are reimbursed under Medicare for the hospital outpatient prospective payment system. The reported median cost for a decompression fasciotomy of the forearm and/or wrist is $603.85. The reported median cost for application of a long-arm splint is $80.48.

Question 8: For persons who have had surgery for cubital tunnel syndrome, what are the most effective methods for preventing the recurrence of symptoms, and how does this vary depending on subject characteristics or other underlying health problems?

- None of the included studies addressed this question.

Question 9: What instruments, if any, can accurately assess functional limitations in an individual with cubital tunnel syndrome?

- None of the included studies addressed this question.

Question 10: What are the functional limitations for an individual with cubital tunnel syndrome before treatment?

- None of the included studies addressed this question.

Question 11: What are the functional limitations of an individual with cubital tunnel syndrome after treatment?

- None of the included studies addressed this question.

Epicondylitis

Question 1: What are the most effective methods and approaches for the early identification and diagnosis of epicondylitis?

- There are insufficient data to permit evidence-based conclusions about the effectiveness of any tests for epicondylitis. This is because the evidence base is small and heterogeneous.

Question 2: What are the specific indications for surgery for epicondylitis?

- Nineteen studies of patients who received surgery for epicondylitis were identified. Due to a lack of reported data, few trends or characteristics of patients who received surgery could be identified. A typical patient who received surgery for epicondylitis was middle-aged and equally likely to be male or female.

Question 3: What are the relative benefits and harms of various surgical and nonsurgical interventions for persons with epicondylitis?

- Seven double-blinded randomized controlled trials compared laser therapy to sham laser therapy as treatment for epicondylitis. A meta-analysis of the results of the four studies that reported "success of treatment" did not reveal a statistically significant difference in outcome between laser and sham-treated patients.
- The four studies that reported the effect of laser treatment on pain also did not find a statistically significant difference in outcome between laser and sham treated patients. However, EPC researchers were unable to perform a meta-analysis of the outcome pain and, because all of these studies were small, their individual results cannot be taken as definitive proof that laser therapy has no effect on the pain of epicondylitis.
- Only one study examined work status of patients after laser treatment. This study was also small, and it failed to find a statistically significant effect of laser treatment on work status. The results of all seven small randomized double-blinded controlled trials are consistent with the

results of our meta-analysis, and suggest that if there is an effect of laser therapy on epicondylitis, it is not large.

- Two randomized controlled trials of a total of 62 patients compared oral naproxen to oral diflunisal. One study reported no statistically significant difference in outcomes when comparing patients treated with the two different drugs, and did not find a consistent trend in favor of one drug. The other study reported that diflunisal treatment consistently resulted in better outcomes. For two outcomes, pain and function, the difference reached statistical significance. Further studies are necessary to resolve discrepancies between these studies.
- Two randomized controlled trials of 82 patients in total compared ultrasound treatment to phonophoresis of hydrocortisone as a therapy for epicondylitis. Neither study found a statistically significant difference between treatment groups for any of the outcomes. When interpreting these results, it is important to keep in mind that both studies may have been too small to be able to detect clinically relevant differences between treatment groups.
- Three randomized controlled trials of 220 patients in total compared ultrasound treatment to sham ultrasound treatment or no treatment as a therapy for epicondylitis. All three of the studies reported a trend towards better outcomes in the groups treated with ultrasound. However, this difference reached statistical significance in only one of the studies. Although low statistical power may explain the negative results of the two "nonsignificant" studies, further research is required to demonstrate this.
- Simply wearing an elbow brace is reported by two crossover studies to have no effect on pain. Because these two studies were of less than optimal design, further studies are necessary before a conclusion may be reached.
- Two randomized controlled trials of a total of 134 patients evaluated the effect of acupuncture on epicondylitis. Both studies reported patients treated with acupuncture had better global outcomes and greater pain relief than patients treated with sham acupuncture at relatively short (2 weeks) followup times. Although only two studies evaluated this treatment, both were well-designed. It is possible to tentatively conclude that acupuncture is an effective palliative treatment for epicondylitis.
- Two randomized controlled trials of a total of 203 patients compared oral NSAIDs to injections of corticosteroids. One study did not find a statistically significant difference between the groups. The other study reported that patients treated with injections of corticosteroids had better outcomes than the patients treated with oral NSAIDs. Design differences may explain the discrepancy between these studies' results, and further study is required to resolve this issue.
- One double-blinded randomized controlled trial reported that patients treated with placebo had a trend towards better outcomes than patients treated with topical DMSO; however, this trend did not reach statistical significance. This study also reported that topical DMSO application caused clinically significant skin irritation. However, this trial was based on only 51 patients, so further studies are necessary before a definitive evidence-based conclusion can be reached.
- One randomized controlled trial of 128 patients compared oral diclofenac to placebo. The group treated with diclofenac had statistically significantly less pain than the placebo group, but the NSAID treatment had no statistically significant effect on hand/arm function, number of days of missed work, or global outcome. Oral NSAIDs were reported to occasionally cause gastrointestinal side effects. In the absence of a very large effect, it is difficult to reach a firm evidence-based conclusion from the results of a single trial of moderate size.
- One double-blinded randomized controlled trial and one double blinded randomized crossover trial, of a total of 47 patients, compared topical diclofenac to placebo. One of the studies reported no statistically significant differences between the two groups for any of the outcomes. The other study reported that the group treated with the NSAID may have had some statistically significant benefit from the treatment. Researchers were unable to determine whether the differences in results between studies were due to differences in statistical power. Further studies are necessary to resolve discrepancies between these studies.
- One randomized controlled trial of 40 patients compared topical diclofenac to topical salicylate, and reported that diclofenac was more effective for treating epicondylitis. Topical NSAIDs were reported to occasionally cause mild skin rashes. Further studies are necessary before a definitive evidence-based conclusion can be reached.
- One randomized double-blinded study reported that injections of glucosamines are effective in treating the symptoms of epicondylitis in the short term (less than 6 months) as measured by global outcome and patient-reported pain. However, injections of glucosamines were found to have a high rate of side effects—40% of patients experienced pain at the site of injection, and 6% developed hematomas at the site of injection. Further studies are necessary before a definitive evidence-based conclusion about the clinical utility of this treatment can be reached.
- One randomized double-blinded study reported that injections of methylprednisolone plus lidocaine were

statistically significantly more effective at treating pain than injections of lidocaine. Further studies are necessary before a definitive evidence-based conclusion can be reached.

- One randomized double-blinded study reported that injections of lignocaine plus triamcinolone were statistically significantly more effective at treating pain than injections of lignocaine or injections of lignocaine plus hydrocortisone. Further studies are necessary before a definitive evidence-based conclusion can be reached.
- One randomized double-blinded study reported that injections of triamcinolone plus bupivacaine were more successful at treating epicondylitis than injections of triamcinolone plus lidocaine. Further studies are necessary before a definitive evidence-based conclusion can be reached.
- One study reported a trend towards more successful treatment of epicondylitis after injections of methylprednisolone than after injections of hydrocortisone. However, this study was of less than optimal design, which makes it problematic to come to a definitive evidence-based conclusion on the basis of its results.
- One study reported no difference in rates of successful treatment or number of work-days missed after treatment with injections of methylprednisolone as compared to injections of betamethasone plus lidocaine. This study had sufficient statistical power to have detected relatively small differences between treatment groups. However, design flaws in this study make it problematic to come to a definitive evidence-based conclusion on the basis of its results.
- One study reported that wearing a brace regularly over the course of several months is not as effective in treating epicondylitis as is physiotherapy, but a different study reported that wearing a brace regularly in addition to physiotherapy may be more effective than physiotherapy alone. Further studies of these therapies are necessary before one can reach definitive evidence-based conclusions.
- One retrospective case-controlled study compared fasciectomy, wide fasciectomy plus anconeus transfer, and re-operation of failed fasciectomy to include an anconeus transfer. However, because this was a single study of suboptimal design, one cannot reach a firm evidence-based conclusion about the relative efficacy of these procedures.
- One non-parallel historically controlled trial reported that simple denervation led to statistically significantly better global outcome and greater pain relief than denervation plus decompression. However, because this was a single study of suboptimal design, one cannot reach a firm evidence-based conclusion about the relative efficacy of these procedures.
- A single double-blinded randomized controlled trial of 30 patients reported that there were no statistically significant differences in the signs and symptoms of epicondylitis between patients treated with pulsed electromagnetic field therapy and patients receiving sham treatment. When interpreting the results of this trial, it must be kept in mind that the small size of the trial may have prevented the results from reaching statistical significance.
- One randomized controlled trial reported that patients treated with extracorporeal shock wave therapy had statistically significantly greater improvements in pain and arm function than patients given sham treatment. However, it is difficult to reach firm evidence-based conclusions from the results of this trial because the lack of blinding and lack of intent-to-treat analysis of this trial may have affected its results.
- One randomized controlled trial reported that patients treated with injections of corticosteroids had better outcomes than patients treated with manipulations and deep friction massage. Incomplete data and methods reporting from this trial make it problematic to reach any definitive evidence-based conclusions from its results.
- One randomized controlled trial of 76 patients reported that patients treated with injections of corticosteroids had better outcomes than patients treated with braces or immobilization. Partly because of the small size of this trial, further studies are necessary before a definitive evidence-based conclusion can be reached.
- One randomized controlled trial of 63 patients reported that patients treated with acupuncture had better outcomes than patients treated with corticosteroid injections. However, the results of this study may have been affected by patient selection bias because it enrolled only patients previously found to be unresponsive to injections of corticosteroids.

Two randomized controlled trials, one comparing transcutaneous electrical nerve stimulation, ultrasound, phonophoresis, and injections of steroids, the other comparing physical therapy to ultrasound, reported no statistically significant differences between treatment groups. However, both trials may have been too small to be able to have detected clinically meaningful differences between treatment groups.

- Five randomized controlled trials evaluated various combinations of therapies for the treatment of epicondylitis. One trial of 18 patients found that patients treated with manipulation plus a home exercise program had fewer difficulties in performing activities of daily living than patients treated with a combination of ultrasound, physiotherapy, and home exercise. The other

four trials did not find statistically significant differences between treatment groups. However, these studies were small, which may have prevented them from detecting clinically important differences between the treatment groups.

Question 4: Is there a relationship between specific clinical findings and specific treatment outcomes among patients with epicondylitis?

- One study reported that the site of pain could be used to predict response to treatment, one reported that the severity of pain could be used to predict response to treatment, and one reported that the timing of onset of symptoms (acute vs. gradual) did not correlate with the response to treatment. Because only one study addressed each outcome, it is difficult to reach firm evidence-based conclusions from the available data.

Question 5: Is there a relationship between duration of symptoms and specific treatment outcomes among patients with epicondylitis?

- Seven studies examined whether duration of symptoms correlated with treatment outcomes. Only one of the four studies that employed multiple regression found a statistically significant relationship between symptom duration and outcomes, and this study was retrospective. One of three studies that stratified patients according to their duration of symptoms found a statistically significant correlation with treatment outcomes. As this study was also retrospective, evidence suggesting a relationship is contradictory and weak. Two prospective studies that employed multiple regression did not find such a relationship. Both were of patients who had received ultrasound. However, currently available evidence about use of ultrasound in patients with epicondylitis or de Quervain's disease does not allow firm evidence-based conclusions. A lack of treatment effectiveness could obscure potential relationships between symptom duration and treatment-related outcomes. Therefore, one cannot draw firm evidence-based conclusions from currently available data.

Question 6: Is there a relationship between factors such as patients' age, gender, socioeconomic status and/or racial or ethnic grouping and specific treatment outcomes among patients with epicondylitis?

- Three studies that used multiple regression found no statistically significant correlation between gender or age and response to treatment, suggesting that there is no strong relationship between these variables and patient outcomes.
- One study found no statistically significant correlation between certain hobbies and response to treatment. However, it is difficult to reach evidence-based conclusions from the results of a single study.
- The only study that examined co-morbidities reported that patients with co-existent ulnar neuropathy had significantly poorer outcomes than patients without ulnar neuropathy. However, it is difficult to reach evidence-based conclusions from the results of a single study.

Question 7: What are the surgical and nonsurgical costs or charges for treatment of epicondylitis?

- According to Medicare Provider Analysis and Review (MEDPAR), average total charges per patient for the DRG (diagnosis-related group) of major shoulder/elbow procedures with comorbidities or complications are $9,008.94 (calculated by dividing total charges by number of discharges).
- For the DRG shoulder, elbow or forearm procedures, excepting major joint procedures, without comorbidities or complications, average total charges per patient are $7729.16.
- The Median Costs for Hospital Outpatient Services Dataset contains median costs for services that are reimbursed under Medicare for the hospital outpatient prospective payment system. The reported median cost for strapping of the elbow or wrist is $62.61 (cost of open release was not reported by this database).

Question 8: For persons who have had surgery for epicondylitis, what are the most effective methods for preventing the recurrence of symptoms, and how does this vary depending on subject characteristics or other underlying health problems?

- No controlled trials addressed this question. Therefore, it was not possible to perform a reliable analysis, and one cannot draw firm evidence-based conclusions from the available data.

Question 9: What instruments, if any, can accurately assess functional limitations in an individual with epicondylitis?

- Three studies evaluated two different instruments (PRFEQ and F-VAS) as ways to measure functional limitations of patients with epicondylitis. Neither assessment instrument has been shown to be a useful instrument for evaluating functional limitations in persons with epicondylitis. However, it is difficult to reach firm evidence-based conclusions about the instruments evaluated in this report due to the limited evidence base.

Question 10: What are the functional limitations for an individual with epicondylitis before treatment?

- This question is addressed by only two studies comprised of a total of 82 patients. Although these studies suggest that epicondylitis patients have an average level of functional difficulty between 30% - 40% (mild to moderate) on functional status scales, the low number of studies and patients makes it difficult to arrive at an evidence-based answer to this question.

Question 11: What are the functional limitations of an individual with epicondylitis after treatment?

- There were no studies that met the inclusion criteria for this question. Therefore, it cannot be answered in an evidence-based fashion.

De Quervain's Disease

Question 1: What are the most effective methods and approaches for the early identification and diagnosis of de Quervain's disease?

- None of the included studies addressed this question.

Question 2: What are the specific indications for surgery for de Quervain's disease?

- Two of the three studies that addressed this question reported that surgery was performed only on patients who did not benefit from conservative (non-operative) treatment. However, with so few studies and so many unreported patient characteristics, one cannot assume that the present data are representative of the larger patient population with de Quervain's disease.

Question 3: What are the relative benefits and harms of various surgical and nonsurgical interventions for persons with de Quervain's disease?

- Although one study found that corticosteroid plus lidocaine injection produced more treatment success than immobilization splints among de Quervain's patients, there were design problems with this study. Because of these problems, and because only one study addressed this question, it is difficult to reach firm evidence-based conclusions concerning the effectiveness of any treatment for de Quervain's disease.

Question 4: Is there a relationship between specific clinical findings and specific treatment outcomes among patients with de Quervain's disease?

- This question was addressed by only one relatively small retrospective study. This study found no relation between presence of a septated first dorsal compartment and treatment outcome. However, it is difficult to reach evidence-based conclusions from the results of a single study of suboptimal design.

Question 5: Is there a relationship between duration of symptoms and specific treatment outcomes among patients with de Quervain's disease?

- This question was addressed by only one relatively small retrospective study. This study found no relation between duration of symptoms and treatment outcome. However, it is difficult to reach evidence-based conclusions from the results of a single study of suboptimal design.

Question 6: Is there a relationship between factors such as patients' age, gender, socioeconomic status and/or racial or ethnic grouping and specific treatment outcomes among patients with de Quervain's disease?

- This question was addressed by only one relatively small retrospective study. This study found no relation between age, gender, or occupational status and treatment outcome. However, it is difficult to reach evidence-based conclusions from the results of a single study of suboptimal design.

Question 7: What are the surgical and nonsurgical costs or charges for treatment of de Quervain's disease?

- According to the Medicare Provider Analysis and Review (MEDPAR) database, which covers hospital inpatient services, average total charges per patient for the DRG (diagnosis-related group) of hand or wrist procedures (excepting major joint procedures) without complications or comorbidities are $7,408.14 (calculated by dividing total charges by number of discharges).
- The Median Costs for Hospital Outpatient Services Dataset contains median costs for services that are reimbursed under Medicare for the hospital outpatient prospective payment system. The reported median cost for application of a short arm static splint is $72.69.

Question 8: For persons who have had surgery for de Quervain's disease, what are the most effective methods for preventing the recurrence of symptoms, and how does this vary depending on subject characteristics or other underlying health problems?

- None of the included studies addressed this question.

Question 9: What instruments, if any, can accurately assess functional limitations in an individual with de Quervain's disease?

- None of the included studies addressed this question.

Question 10: What are the functional limitations for an individual with de Quervain's disease before treatment?

- None of the included studies addressed this question.

Question 11: What are the functional limitations of an individual with de Quervain's disease after treatment?

- None of the included studies addressed this question.

Non-Treatment-Specific Questions

Question 12: What are the cumulative effects on functional abilities among individuals with more than one worker-related musculoskeletal disorder of the upper extremity in the same limb?

- There were no studies that met the inclusion criteria for this question. Therefore, it cannot be answered in an evidence-based fashion.

Question 13: What level of function can patients achieve in what period of time when they are required to change hand dominance as a result of injury to their dominant hand?

- The studies of the ability of training to improve use of the non-dominant hand do not allow one to determine the degree to which this training provides the patient with employment opportunities or allows resumption of normal activities. These studies also lack long-term followup data. Evidence from two studies suggests that some learning and training in the use of the non-dominant hand is possible, and statistically significant improvement can be accomplished in 2 to 6 months of training. For some activities, statistically significant improvement can be accomplished within 1 week.

Future Research

In general, the literature addressing WRUEDs is of uneven quality. Well-designed studies on many aspects of WRUEDs are needed. Prospective, randomized double-blinded controlled trials are widely considered to provide the highest quality of evidence for treatment effectiveness. Results of non-randomized trials can be affected by differences in the characteristics of the patient groups, rather than the treatment applied. Uncontrolled trials do not allow one to ascertain whether patients improve in the absence of treatment, and they do not allow one to accurately gauge the magnitude of any change that occurs after treatment. Blinding of patients and evaluators to treatments avoids the potential for placebo effects and previously held beliefs about the effectiveness of treatments to impact on the results of trials.

Studies of diagnostic tests do not necessarily need not be randomized or contain control groups. In the absence of a "gold standard" test, longitudinal studies are the most desirable for assessing diagnostic tests for WRUEDs. In these studies, patients are first given the diagnostic test, and then they are followed for a period of time to determine whether they develop symptoms of a WRUED. Repeating the tests at regular intervals during the trial could yield insights into the etiology of the conditions as well as measure test-retest variability. If a "gold standard" test were developed, then single-arm cross-sectional studies that compared the results of the "gold standard" test to the results of the test under investigation would be appropriate. In such studies, in order to obtain the most useful information, it is important to select a patient population that closely resembles the general population on whom the diagnostic test would ultimately be used.

Availability of Full Report

The full evidence report from which this summary was derived was prepared for AHRQ by ECRI's Health Technology Assessment Group under contract number 290-97-0020. It is expected to be available in the Winter of 2002. At that time, printed copies may be obtained free of charge from the AHRQ Publications Clearinghouse by calling 800-358-9295. Requestors should ask for Evidence Report/Technology Assessment No. 62, *Diagnosis and Treatment of Worker-Related Musculoskeletal Disorders of the Upper Extremity.*

Internet users will be able to access the report online through AHRQ's Web site at: www.ahrq.gov.

AHRQ Pub. No. 02-E037
October 2002
ISSN 1530-440X