Published in final edited form as:

Plast Reconstr Surg. 2018 May ; 141(5): 1183–1191. doi:10.1097/PRS.0000000000004317.

The effect of impactful papers on clinical practice in the US: Corticosteroid injection for patients with lateral epicondylitis

Yuki Fujihara, M.D., Ph.D.^{1,2}, Helen E. Huetteman, B.S.³, Ting-Ting Chung, M.S.^{4,5}, Melissa J. Shauver, M.P.H.⁶, and Kevin C. Chung, M.D., M.S.⁷

¹Research fellow, Section of Plastic Surgery, Department of Surgery, The University of Michigan Health System; Ann Arbor, MI, USA

²Clinical fellow, Department of Hand Surgery, Nagoya University Graduate School of Medicine, Nagoya, Japan

³Research Assistant, Section of Plastic Surgery, University of Michigan Medical School, Ann Arbor, MI

⁴Data Analyst, Division of Rheumatology, Allergy and Immunology, Chang Gung Memorial Hospital, Taoyuan, Taiwan

⁵Data Analyst, Center for Big Data Analytics and Statistics, Chang Gung Memorial Hospital, Taoyuan, Taiwan

⁶Clinical Research Coordinator, Section of Plastic Surgery, Department of Surgery, University of Michigan Medical School, Ann Arbor, MI

⁷Professor of Surgery, Section of Plastic Surgery, Assistant Dean for Faculty Affairs, The University of Michigan Medical School, Ann Arbor, MI, USA

Abstract

Background—Following the publication of high level evidence demonstrating that corticosteroid inject is not an effective treatment for lateral epicondylitis, a reduction in the rate of corticosteroid injection would be expected. We aimed to clarify the current clinical practice pattern for lateral epicondylitis and to identify which factors hinder or encourage the introduction of evidence into clinical practice.

Methods—In this administrative claims analysis, we used the 2009 to 2015 Truven MarketScan databases. We extracted claims for corticosteroid injection, physiotherapy, platelet-rich-plasma injection, and surgery for lateral epicondylitis. We performed multivariable analysis using generalized estimating equation model to identify the variables that potentially affect the odds of receiving a given treatment.

Results—We included a total of 711,726 claims. The odds of receiving a corticosteroid injection slightly increased after publication of these impactful papers (OR: 1.7 95% CI: 1.04–1.11 in 2015). Patient-related factors such as male sex (OR: 1.21 95% CI: 1.19–1.23), older age (OR: 1.16

95% CI: 1.13–1.19), and managed care insurance (OR: 1.15 95% CI: 1.13–1.18) significantly contributed to increased odds of receiving corticosteroid injections. Patients seen at facilities in the South (OR: 1.33 95% CI: 1.30–1.36 compared with Northeast) and by plastic or orthopaedic surgeons (OR: 2.48 95% CI: 2.43–2.52) also had increased odds of receiving corticosteroid injection.

Conclusions—Corticosteroid injection use did not decrease after publication of impactful papers, regardless of provider specialty or other patient-related factors. This finding implies that there are various barriers for even high level evidence to overcome the inertia of current practice.

Keywords

lateral epicondylitis; evidence-based medicine; corticosteroid injection

Introduction

Lateral epicondylitis is the most common disease of the elbow, impacting approximately one to three percent of the general population.(1, 2) There is no definitive treatment; most patients undergo conservative treatments such as rest, avoidance of aggravating activities, modification of behavior, physical therapy, analgesic medications, or corticosteroid (CS) injection.(3, 4) Platelet-rich plasma (PRP) injections can also control symptoms but are less frequently used.(5, 6) Although numerous physicians are attempting to identify an effective treatment option, it is challenging to conduct even single-blinded randomized controlled trials (RCTs) for this condition.

In 2010 and 2013, two impactful studies with high levels of evidence were reported by Coombes et al.(7, 8) In 2010, they performed a well-designed meta-analysis and concluded that CS injection for lateral epicondylitis achieved favorable short-term results. However, at six months and one year, pain had returned. In fact, patients who received CS injections reported worse pain than patients who received other interventions, such as nonsteroidal anti-inflammatory drugs, physical therapy, PRP injection, or those who received no treatment. Although the studies included in the analysis did not address methodological features such as concealed allocation, intention-to-treat, and treatment masking, the investigators concluded that CS injections actually worsen symptoms of lateral epicondylitis in the long-term. In 2013, the same team reported the results of an elaborate double-blinded RCT comparing CS and placebo injections. They addressed the methodological deficiencies of previous studies and reached the same conclusion: although symptoms initially improved following CS injections, symptoms actually worsened by the 6-month mark. Researchers theorized that CS could aggravate the healing process of the injured tendon.(9) Or, more simply, the immediate pain relief afforded by CS could encourage patients to return to aggravating activities sooner than they may have following other treatments. This may cause further damage to tendons, rather than promote healing.(10, 11) Since the publication of their studies, several other groups have reported on RCTs comparing CS injection to other treatments; none of these conclude that CS injections possess any long term benefit. (12–16)

Based on the standard levels of evidence for therapeutic studies established by the Oxford Centre for Evidence-Based Medicine,(17) the aforementioned meta-analysis and RCT are

classified as a Level 1 or Level 2 study, respectively. Grading recommendations from the American Society of Plastic Surgeons place a strong recommendation on “evidence from two or more ‘High’ quality studies with consistent findings for recommending for or against the intervention”.(18) Thus, the combination of these two studies provides strong evidence against the routine injection of steroid medications to treat lateral epicondylitis, not only because they were published in high impact journals, but also because of their quality research design.

It remains unknown if the publication of these studies has had an appreciable impact on daily clinical practice. Following the basic principles of evidence-based medicine, clinical practice patterns should reflect recommendations from high level research evidence within an appropriate amount of time to remain clinically relevant. Yet, several authors have reported on the difficulty of changing clinical practice, even in the face of overwhelming evidence. For example, following the publication of two landmark studies, both of which demonstrated that percutaneous coronary intervention does *not* improve outcomes for patients with stable coronary artery disease, Siontis et al. reported that more than 15% of papers citing those studies reported that percutaneous coronary intervention was, indeed, efficacious.(19) In previous epidemiologic studies performed by our group, it was discovered that approximately 90% of patients with thumb basilar joint arthritis were treated with trapeziectomy with soft-tissue arthroplasty despite accumulating high level evidence suggesting that this procedures does not lead to superior outcomes and may be less cost-effective than other surgical options.(20, 21) Undoubtedly, evidence-based medicine has contributed to medical advances, but it is still unknown how and from where high level evidence spreads to result in changes in clinical practice. The specific aim of this study is to clarify the spread of evidence, as reflected by changes in clinical activity, and to identify factors that hinder or enhance evidence diffusion.

Materials & Methods

This retrospective claims analysis fully adheres to the guidelines for observational studies listed in The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.(22) This study was exempt from institutional review board oversight.

Data Source

We performed a retrospective analysis using the Truven MarketScan Commercial Claims and Encounters and Medicare Supplement and Coordination of Benefits database from 2009 to 2015. The MarketScan database contains de-identified health insurance claims for inpatient care, outpatient care, and prescription drugs. The data are collected from more than 50 million people covered by healthcare plans administered in the United States by large employers and from managed care organizations, Medicare Part C, and Multi-State Medicaid, creating a large enough sample to be representative of Americans covered by commercial insurance or Medicaid.(23) All data regarding diagnosis, treatment, and cost are reported at the time of service.

Creation of analysis cohort

Inclusion and exclusion criteria are shown in Table 1. This study included claims citing a diagnosis of lateral epicondylitis and at least one of the following treatments: CS injection, PRP injection, physiotherapy, or surgery. We identified diagnoses using *International Classification of Disease, Ninth Revision, Clinical Modifications* (ICD-9-CM, January 1, 2009 through September 30, 2015) and *International Classification of Disease, Tenth Revision, Clinical Modifications* (ICD-10-CM, October 1, 2015 through December 31, 2015) codes. We used Current Procedural Terminology (CPT) codes to determine the type of treatment received. (See table, Supplemental Digital Content 1, which shows Procedure and Diagnosis Codes for Patient Selection and Identification of Study Variables, INSERT [HYPER LINK](#)). To prevent the inclusion of miscoded claims, we required that all eligible patients have both a relevant ICD and CPT code. This excluded patients who may have been diagnosed but did not undergo any type of treatment intervention.

We excluded claims from patients who had any diagnosis of tendinopathy or enthesopathy other than lateral epicondylitis during the study period because the CPT code for CS injection does not specify the body region. Thus, we avoided including patients who were diagnosed with lateral epicondylitis but received CS injection treatment for a different condition, for example Achilles tendinopathy. We used the insurance type variable recorded in MarketScan to categorize insurance plan type as either fee-for-service or capitated managed care. We categorized provider specialty into two groups: plastic or orthopaedic surgeons and all other physicians.

Data Analysis

We used descriptive statistics to summarize the characteristics of the cohort, including sex, age, region, type of insurance, and provider specialty by calendar year. The utilization rate for each treatment was defined as the total number of claims citing that particular procedure for any given year divided by the total number of claims for that same year. To detect any change in the use of CS injection after the publication of high level of evidence papers, we compared the annual rate before and after publication. We calculated odds ratios (OR) to identify factors that may influence which procedures particular patients received. Because patients may receive more than one treatment during the study period, we used multivariable logistic regression with a generalized estimating equation model to calculate estimated OR and 95% confidence intervals to address the potential problem of correlated data. The correlation structure was based on an autoregressive model, which is usually used for time-series data analysis. We adjusted all analyses for sex, age, region, type of insurance, provider specialty, and calendar year. All tests were done using a two-sided significance level of $p=0.05$.

The procedures used to treat lateral epicondylitis are applied at differing frequencies. For instance, a patient may undergo physiotherapy several times a week over a period of months. In contrast, CS or PRP injections are given only once in a two-month period or even less frequently. Therefore, if we simply compared the actual number of claims in our specified time period, the rate of therapy use may be magnified. To protect against this, we performed a sensitivity test that only counted whether a patient received a treatment in a month, rather

than the number of times a treatment was received. In other words, for each patient in the dataset and for each month in the study period, the four treatments (CS or PRP injections, physiotherapy, and surgery) were binary variables, “0/1: Did this patient have therapy this month?, 0/1: Did this patient have a CS injection this month?, 0/1: Did this patient have a PRP injection this month?, and 0/1: Did this patient have surgery this month?” To assess the impact of missing values for any variable, we performed an additional sensitivity test that excluded all encounters with missing values.

Results

Our primary analysis included a total of 711,726 claims from 156,547 patients (Figure 1). The baseline characteristics of the research cohort are presented in Table 2. Our study included about 100,000 encounters per year, and approximately 56% of total encounters were with female patients. Similar to previous epidemiologic studies, the 40–54 year age group showed the highest number of claims.(1, 2, 24) Around 90% of patients used fee-for-service insurance.

After publication of the two impactful papers in November 2010 and February 2013, the CS injection rate did not decrease. In fact, we found that CS injection rate actually increased over time (Figure 2, Table 3). Patients older than 55 years of age were less likely to undergo surgical treatment than younger patients (OR: 0.65 95% CI: 0.60–0.71). Procedure received was significantly related to geographic region (Table 3). For example, patients in the South were significantly more likely to receive CS injection. Patients in the Northeast and West were more likely to receive therapy. Likewise, those same patients were less likely to undergo surgery. As expected, patients who were treated by plastic or orthopaedic surgeons were significantly more likely to undergo surgery (OR: 6.19, 95% CI: 5.77–6.65), CS injection (OR: 2.48, 95% CI: 2.43–2.52), and PRP injection (OR: 3.26, 95% CI: 2.41–4.41), whereas patients treated by other physicians were far more likely to receive therapy. The effect of high level evidence on CS injection rate did not differ based on provider specialty. The rate of CS injection increased among plastic and orthopedic surgeons as well as among physicians from other specialties or primary care physicians (Table 4).

We did find a slight fluctuation of PRP injection rates over the study period. For example, the rate of PRP injection per 1,000 cases jumped from 0.78 to 3.03 among plastic or orthopedic surgeons between 2010 and 2012. However, this rate had decreased to 1.22 by 2014. This fluctuation was more pronounced among plastic/orthopaedic surgeons as opposed to physicians in primary care or another specialty. We suspect this variation is a result of the novelty of this method of treatment being used for lateral epicondylitis.

As demonstrated in the multivariable analysis, the evidence-based publications did not alter the treatment received in a meaningful way within the study period. The odds of a patient receiving a CS injection actually increased slightly over time, whereas there was no significant change in the odds of undergoing therapy or surgery. The results of our sensitivity analyses indicated that the variation in frequency of use between any combinations of possible treatments did not introduce bias or change the conclusions of our study. Likewise,

the large proportion of missing data in physician specialty and region did not affect our conclusions.

Discussion

High level evidence may not be sufficient to influence existing clinical practice patterns. In this study, we found that even after publication of two high quality papers dissuading physicians from using CS injection, the odds of a patient receiving this treatment for lateral epicondylitis did not decrease. The impactful evidence did not alter the treatment received in any way. In contrast, several patient-related factors, such as sex, age, and type of insurance still continue to affect the treatment received. Moreover, there continues to be significant regional differences in treatment.

Previous research indicates that only 14% of all new discoveries ultimately become a persistent part of daily clinical practice.(25) To date, several authors have reported on barriers that prevent evidence diffusion. Cabana et al. performed a systematic review and reported seven adherence barriers: lack of awareness, lack of familiarity, lack of agreement, lack of self-efficacy, lack of outcome expectancy, adherence to previous practice, and external barriers.(26) Hay et al. identified physicians' tendency to rely on clinical experience, the opinions of colleagues, and evidence summarized in electronic clinical resources (such as WebMD, ClinicalKey, or Mayo Clinic) rather than on original articles. (27) Difficulty in searching for evidence or preparing resources for implementation may also discourage providers from adopting evidence-based clinical practice.(28)

In our study, we found numerous patient-level factors to be associated with the type of treatment received. Geographic region was shown to strongly influence the odds of receiving a particular treatment, supporting the existence of regional variations in surgical decision-making. Regional variations occur frequently and may be explained by some of the same adherence barriers preventing the spread of novel evidence, such as lack of familiarity, lack of outcome expectancy, and adherence to previous practice. We further speculate that the regional discrepancies for lateral epicondylitis treatment are an extension of variations that present themselves on the provider level, such as physician background or resources available. These factors may also contribute to the persistence of conventional practice patterns despite contradictory evidence.

We also found that the utilization rate for CS injection decreased among neither plastic/orthopaedic surgeons nor other physicians based on the introduction of new evidence. Patients treated by orthopaedic or plastic surgeons were significantly more likely to receive CS injection for lateral epicondylitis than were patients treated by other physicians. Orthopaedic or plastic surgeons may be hesitant to abandon CS injections as a treatment option because of the relatively low cost or the dearth of evidence supporting a single superior treatment. It is also possible that surgeons are aware of the evidence, but patients still chose to receive CS injections for the short-term reduction in symptoms. Harmful long term results may not be easily understood by patients who seek immediate relief. Facing an ethical dilemma between addressing patients' immediate needs and providing the best care, we must continue to guide patients to choose an appropriate treatment while balancing the

fine line between respecting the wishes of the patient and ensuring nonmaleficence. Because lateral epicondylitis is a common disease, family doctors and general surgeons may be consulted for treatment. In our cohort, approximately 30% of patients were treated by “other physicians”. Patients who were treated by these physicians predominantly received therapy, yet some received surgery or CS injections. There may be additional barriers such as a lack of awareness or the familiarity of previous practices that hinder these physicians from altering practice based on new evidence. The latest evidence recommends physiotherapy or other conservative treatments such as analgesic or anti-inflammatory medication, rest, and ice in place of CS injection.(7)

Insurance type also affected the treatment received. Most notably patients with managed care insurance were significantly more likely to receive surgery than patients with the other types of insurance. Considering that surgery is typically more expensive, this finding may reflect that patients with a managed care plan show less concern about treatment costs. In contrast, patients with fee-for-service insurance were more likely to undergo physiotherapy, a less costly treatment than surgery.

This study had several limitations. First, this project, like all studies based upon large administrative datasets, is dependent upon the accuracy of coding and diagnosis for the conditions of interest. This factor is especially relevant to this study because there is no definitive test for lateral epicondylitis. To protect against miscoding, we only included insurance claims with both a diagnosis for lateral epicondylitis and an appropriate treatment code. In addition, we excluded any patients who had a diagnosis of tendinopathy or enthesopathy in any other part of the body during the study period. We were unable to distinguish cases of bilateral disease or misdiagnosis because of the lack of clinical details available, which may have artificially inflated treatment rates. However, these factors were less of a concern because our outcome of interest was treatment choice when a patient had been diagnosed with lateral epicondylitis. Our results then were based less on the accurate diagnosis of lateral epicondylitis than on the accurate identification of treatment received for lateral epicondylitis.

Secondly, the two impactful papers were published relatively recently; our analysis included a follow-up period of only five years and two months after the meta-analysis publication and two years and ten months after the publication of the RCT results. Popular wisdom says that it takes about 17 years for novel findings in any field of health research to be introduced into daily clinical practice.(25, 29, 30) However, as Morris and his colleagues describe in their review, the methodologies that previous investigations use to calculate time lags are not consistent. For example, one study defined the time lag as the time frame between publication of a clinical trial and the publication of a clinical guideline,(31) whereas others measured the time between an initial publication and a highly cited publication.(32, 33) Despite the length of our follow-up period, our findings emphasize the need for improvements in the translation of research findings to practice. Finally, we were unable to assess if the physicians who continued to provide corticosteroid injections had actually read the two high quality studies that we reference. It is entirely possible that we did not observe any substantial changes in the rates of injection because providers were oblivious to the

newfound evidence. However, this scenario also underscores the need for more effective methods to distribute and disseminate research findings into practice.

In spite of these limitations, this project has demonstrated that inducing evidence-based change to clinical practice requires more than simply publishing evidence. To promote change, researchers should build a strategy to disseminate and implement findings as part of their project plans.⁽³⁴⁾ As it currently stands, dissemination and implementation are afterthoughts, only considered once the project has been completed. Researchers must understand the role of their findings in modern clinical practice before initiating a study. In addition, major associations and high-level education institutions, which typically hold more power and influence than the individual researcher, should also be responsible for promoting the dissemination and implementation of the latest evidence. The Clinical and Translational Science Award program from the National Institutes of Health, for instance, is one example of a program implemented to not only facilitate a network between basic and clinical research, but also from clinical research into practice. Similar efforts that promote methods for new findings to reach their intended populations should be mirrored across organizations. The findings of our analysis highlight the need for further efforts focusing on the direct translation of evidence into practice.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Funding Sources: Though our study was supported by a Midcareer Investigator Award in Patient-Oriented Research (2K24AR053120-06) to Kevin C. Chung, Principal Investigator, the National Institutes of Health did not have any role in preparation of the manuscript or in the decision to submit it for publication. This work was also funded by the Chang Gung Memorial Hospital (project CORPG3G0111 and CORPG3G0161) to Ting-Ting Chung.

References

1. Verhaar JA. Tennis elbow. Anatomical, epidemiological and therapeutic aspects. *Int Orthop*. 1994; 18:263–267. [PubMed: 7852001]
2. Shiri R, Viikari-Juntura E, Varonen H, Heliovaara M. Prevalence and determinants of lateral and medial epicondylitis: a population study. *American journal of epidemiology*. 2006; 164:1065–1074. [PubMed: 16968862]
3. Amar E, Chechik O, Khashan M, Lador R, Rath E. Lateral epicondylitis treatment: international survey of surgeons' preferences and literature review. *Int J Clin Pract*. 2014; 68:1383–1387. [PubMed: 25040243]
4. Orchard J, Kountouris A. The management of tennis elbow. *BMJ (Clinical research ed)*. 2011; 342:d2687.
5. Mishra A, Pavelko T. Treatment of chronic elbow tendinosis with buffered platelet-rich plasma. *The American journal of sports medicine*. 2006; 34:1774–1778. [PubMed: 16735582]
6. Peerbooms JC, Sluimer J, Bruijn DJ, Gosens T. Positive effect of an autologous platelet concentrate in lateral epicondylitis in a double-blind randomized controlled trial: platelet-rich plasma versus corticosteroid injection with a 1-year follow-up. *The American journal of sports medicine*. 2010; 38:255–262. [PubMed: 20448192]
7. Coombes BK, Bisset L, Brooks P, Khan A, Vicenzino B. Effect of corticosteroid injection, physiotherapy, or both on clinical outcomes in patients with unilateral lateral epicondylalgia: a randomized controlled trial. *Jama*. 2013; 309:461–469. [PubMed: 23385272]

8. Coombes BK, Bisset L, Vicenzino B. Efficacy and safety of corticosteroid injections and other injections for management of tendinopathy: a systematic review of randomised controlled trials. *Lancet* (London, England). 2010; 376:1751–1767.
9. Paavola M, Kannus P, Jarvinen TA, Jarvinen TL, Jozsa L, Jarvinen M. Treatment of tendon disorders. Is there a role for corticosteroid injection? *Foot and ankle clinics*. 2002; 7:501–513. [PubMed: 12512406]
10. Bisset L, Beller E, Jull G, Brooks P, Darnell R, Vicenzino B. Mobilisation with movement and exercise, corticosteroid injection, or wait and see for tennis elbow: randomised trial. *BMJ* (Clinical research ed). 2006; 333:939.
11. Fredberg U, Stengaard-Pedersen K. Chronic tendinopathy tissue pathology, pain mechanisms, and etiology with a special focus on inflammation. *Scandinavian journal of medicine & science in sports*. 2008; 18:3–15. [PubMed: 18294189]
12. Tahririan MA, Moayednia A, Momeni A, Yousefi A, Vahdatpour B. A randomized clinical trial on comparison of corticosteroid injection with or without splinting versus saline injection with or without splinting in patients with lateral epicondylitis. *Journal of research in medical sciences : the official journal of Isfahan University of Medical Sciences*. 2014; 19:813–818. [PubMed: 25535493]
13. Branson R, Naidu K, du Toit C, et al. Comparison of corticosteroid, autologous blood or sclerosant injections for chronic tennis elbow. *Journal of science and medicine in sport/Sports Medicine Australia*. 2017; 20:528–533.
14. Lebedzinski R, Synder M, Buchcic P, Polguy M, Grzegorzewski A, Sibinski M. A randomized study of autologous conditioned plasma and steroid injections in the treatment of lateral epicondylitis. *Int Orthop*. 2015; 39:2199–2203. [PubMed: 26224613]
15. Mardani-Kivi M, Karimi-Mobarakeh M, Karimi A, et al. The effects of corticosteroid injection versus local anesthetic injection in the treatment of lateral epicondylitis: a randomized single-blinded clinical trial. *Archives of orthopaedic and trauma surgery*. 2013; 133:757–763. [PubMed: 23494116]
16. Krogh TP, Fredberg U, Stengaard-Pedersen K, Christensen R, Jensen P, Ellingsen T. Treatment of lateral epicondylitis with platelet-rich plasma, glucocorticoid, or saline: a randomized, double-blind, placebo-controlled trial. *The American journal of sports medicine*. 2013; 41:625–635. [PubMed: 23328738]
17. OCEBM Levels of Evidence Working Group. O. C. f. E.-B. Medicine. *The Oxford 2011 Levels of Evidence*. 2011.
18. American Society of Plastic Surgeons. *ASPS Evidence-Based Clinical Practice Guideline Methodology*. 2016.
19. Siontis GC, Tatsioni A, Katritsis DG, Ioannidis JP. Persistent reservations against contradicted percutaneous coronary intervention indications: citation content analysis. *Am Heart J*. 2009; 157:695–701. [PubMed: 19332198]
20. Aliu O, Davis MM, DeMonner S, Chung KC. The influence of evidence in the surgical treatment of thumb basilar joint arthritis. *Plast Reconstr Surg*. 2013; 131:816–828. [PubMed: 23542253]
21. Yuan F, Aliu O, Chung KC, Mahmoudi E. Evidence-Based Practice in the Surgical Treatment of Thumb Carpometacarpal Joint Arthritis. *J Hand Surg Am*. 2017; 42:104–112. e101. [PubMed: 28160900]
22. von Elm E, Altman DG, Egger M, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *Lancet* (London, England). 2007; 370:1453–1457.
23. Adamson, DM., Chang, S., Hansen, LG. *Health research data for the real world: the MarketScan databases*. New York: Thompson Healthcare; 2008. p. b28
24. Hamilton PG. The prevalence of humeral epicondylitis: a survey in general practice. *The Journal of the Royal College of General Practitioners*. 1986; 36:464–465. [PubMed: 3440991]
25. Balas EA, Boren SA. *Managing Clinical Knowledge for Health Care Improvement*. Yearbook of medical informatics. 2000:65–70. [PubMed: 27699347]
26. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *Jama*. 1999; 282:1458–1465. [PubMed: 10535437]

27. Hay MC, Weisner TS, Subramanian S, Duan N, Niedzinski EJ, Kravitz RL. Harnessing experience: exploring the gap between evidence-based medicine and clinical practice. *J Eval Clin Pract.* 2008; 14:707–713. [PubMed: 19018899]
28. Taba P, Rosenthal M, Habicht J, et al. Barriers and facilitators to the implementation of clinical practice guidelines: A cross-sectional survey among physicians in Estonia. *BMC Health Serv Res.* 2012;12. [PubMed: 22236336]
29. Morris ZS, Wooding S, Grant J. The answer is 17 years, what is the question: understanding time lags in translational research. *J R Soc Med.* 2011; 104:510–520. [PubMed: 22179294]
30. Stephenson J. AHRQ Director Sets Course for Agency's Health Services Research. *Jama.* 2016
31. Antman EM, Lau J, Kupelnick B, Mosteller F, Chalmers TC. A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts. Treatments for myocardial infarction. *Jama.* 1992; 268:240–248. [PubMed: 1535110]
32. Altman DG, Goodman SN. Transfer of technology from statistical journals to the biomedical literature. Past trends and future predictions. *Jama.* 1994; 272:129–132. [PubMed: 8015123]
33. Contopoulos-Ioannidis D, Alexiou G, Gouvias T, Ioannidis J. Life cycle of translational research for medical interventions. *Science.* 2008; 321:1298–1299. [PubMed: 18772421]
34. Van Riet Paap J, Vissers K, Iliffe S, et al. Strategies to implement evidence into practice to improve palliative care: Recommendations of a nominal group approach with expert opinion leaders Ethics, organization and policy. *BMC Palliative Care.* 2015;14. [PubMed: 25904016]

Figure 1.

CS; corticosteroid, PRP; Platelet-Rich-Plasma

*Codes are listed in Appendix

Claims may include multiple treatments per encounter

Figure 2.

The results of the meta-analysis of randomized controlled trials paper were published on November 20, 2010, whereas the well-designed randomized controlled trial was published on February 6, 2013.

Table 1**Inclusion and exclusion criteria**

Inclusion criteria	Exclusion criteria
<ul style="list-style-type: none"> • Patients with a diagnosis of lateral epicondylitis* • Patients undergoing one of the following treatments for lateral epicondylitis* <ul style="list-style-type: none"> - Corticosteroid injection - Platelet-rich-plasma injection - Physiotherapy - Surgery 	<ul style="list-style-type: none"> • Patients with below diagnoses during study period* <ul style="list-style-type: none"> - Medial epicondylitis of the elbow - Enthesopathy of elbow, unspecified - Tendinopathy Hand & Wrist tendinitis or enthesopathy - Trigger finger; Shoulder & elbow tendinitis, bursitis or enthesopathy - Tendinopathy or enthesopathy for lower extremity - Peripheral enthesopathies and allied syndromes

* Codes are listed in Appendix A

Table 2

Baseline characteristic at each encounter

Patients Characteristics n(%)		2009	2010	2011	2012	2013	2014	2015
No. of encounter		122,722	103,244	114,171	120,481	89,720	93,076	68,312
Demographics								
Sex								
Male		53,292 (43)	45,118 (44)	50,899 (45)	54,476 (45)	39,769 (44)	40,974 (44)	29,560 (43)
Female		69,430 (57)	58,126 (56)	63,272 (55)	66,005 (55)	49,951 (56)	52,282 (56)	38,752 (57)
Age								
<40		19,340 (16)	15,765 (15)	17,946 (16)	19,611 (16)	13,179 (15)	13,892 (15)	10,245 (15)
40-55		73,440 (60)	61,586 (60)	68,151 (60)	71,195 (59)	53,429 (60)	54,043 (58)	39,640 (58)
55		29,942 (24)	25,893 (25)	28,074 (25)	29,675 (25)	23,112 (26)	25,141 (27)	18,427 (27)
Region								
Northeast		31,257 (25)	29,699 (29)	32,562 (29)	31,224 (26)	22,764 (25)	23,930 (26)	16,370 (24)
North Central		29,679 (24)	24,222 (23)	28,088 (25)	29,483 (24)	18,094 (20)	19,970 (21)	14,436 (21)
South		39,131 (32)	30,015 (29)	31,184 (27)	33,113 (27)	23,174 (26)	25,523 (27)	23,522 (34)
West		18,444 (15)	17,973 (17)	19,778 (17)	24,768 (21)	23,633 (26)	21,479 (23)	13,844 (20)
Missing		4,211 (3)	1,335 (1)	2,559 (2)	1,893 (2)	2,055 (2)	2,174 (2)	140 (0)
Type of Insurance								
Fee-for-service		110,170 (90)	94,282 (91)	105,027 (92)	111,521 (93)	80,034 (89)	85,425 (92)	62,774 (92)
Managed care		12,552 (10)	8,962 (9)	9,144 (8)	8,960 (7)	9,686 (11)	7,651 (8)	5,538 (8)
Specialty								
Plastic or orthopaedic surgeons		15,365 (13)	12,891 (12)	13,424 (12)	13,860 (12)	10,971 (12)	11,517 (12)	8,659 (13)
Other specialist or primary care		35,160 (29)	31,556 (31)	34,799 (30)	36,747 (31)	23,475 (26)	23,737 (26)	15,846 (23)
Missing		72,197 (59)	58,797 (57)	65,948 (58)	69,874 (58)	55,274 (62)	57,822 (62)	43,807 (64)

The Meta-analyses of randomized controlled studies were published on November 20, 2010, whereas the well-designed randomized controlled trials were published on February 6, 2013.

Table 3

Adjusted odds ratio for estimating the treatment

	CS injection		PRP injection		Physiotherapy		Surgery	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Sex								
Female	1	Reference	1	Reference	1	Reference	1	Reference
Male	1.21	(1.19–1.23)*	1.23	(0.95–1.60)	0.93	(0.92–0.95)*	1.15	(1.09–1.21)*
Age								
<40	1	Reference	1	Reference	1	Reference	1	Reference
40–55	1.16	(1.13–1.19)*	1.15	(0.79–1.66)	0.95	(0.94–0.97)*	1.03	(0.97–1.10)
55	1.16	(1.13–1.19)*	0.60	(0.38–0.96)*	0.94	(0.92–0.96)*	0.65	(0.60–0.71)*
Region								
Northeast	1	Reference	1	Reference	1	Reference	1	Reference
North Central	1.08	(1.05–1.11)*	1.03	(0.69–1.54)	0.94	(0.92–0.96)*	1.49	(1.38–1.61)*
South	1.33	(1.30–1.36)*	0.84	(0.58–1.20)	0.84	(0.82–0.86)*	1.40	(1.30–1.50)*
West	1.04	(1.01–1.07)*	1.09	(0.72–1.65)	1.01	(0.99–1.02)	1.01	(0.93–1.11)
Missing	1.32	(1.26–1.38)*	1.38	(0.60–3.17)	0.92	(0.89–0.96)*	1.46	(1.24–1.71)*
Type of Insurance								
Fee-for-service	1	Reference	1	Reference	1	Reference	1	Reference
Managed care	1.15	(1.13–1.18)*	1.03	(0.64–1.64)	0.94	(0.91–0.96)*	1.33	(1.24–1.44)*
Provider Specialty								
Other specialist or primary care	1	Reference	1	Reference	1	Reference	1	Reference
Plastic or orthopaedic surgeons	2.48	(2.43–2.52)*	3.26	(2.41–4.41)*	0.32	(0.30–0.33)*	6.19	(5.77–6.65)*
Missing	0.12	(0.12–0.13)*	0.20	(0.13–0.29)*	1.82	(1.78–1.85)*	0.89	(0.83–0.96)*
Calendar Year								
2009	1	Reference	1	Reference	1	Reference	1	Reference
2010	1.04	(1.02–1.07)*	34.3	(4.48–263)*	1.03	(1.01–1.05)*	1.01	(0.93–1.10)
2011	1.07	(1.04–1.10)*	68.4	(9.08–516)*	1.02	(1.00–1.04)*	0.99	(0.92–1.08)
2012	1.05	(1.02–1.08)*	86.2	(11.5–643)*	1.03	(1.01–1.05)*	0.95	(0.88–1.04)

	CS injection			PRP injection			Physiotherapy			Surgery		
	OR	95% CI		OR	95% CI		OR	95% CI		OR	95% CI	
2013	1.08	(1.05–1.11) *		71.4	(9.43–547) *		0.99	(0.97–1.01)		1.03	(0.94–1.12)	
2014	1.09	(1.06–1.12) *		34.2	(4.45–262) *		0.99	(0.97–1.01)		1.04	(0.95–1.13)	
2015	1.07	(1.04–1.11) *		74.9	(9.94–565) *		1.01	(0.98–1.03)		1.02	(0.92–1.12)	

CS; corticosteroid, PRP; platelet-rich-plasma, OR; odds ratio, CI; confidence interval

* P<0.05

The Meta-analyses of randomized controlled studies were published on November 20, 2010, whereas the well-designed randomized controlled trials were published on February 6, 2013

Table 4

Utilization rate of each treatment and specialties

Rates per 1,000 encounter (95% CI)	2009	2010	2011	2012	2013	2014	2015
CS injection							
Plastic or orthopaedic surgeons	550 (538–561)	620 (606–633)	634 (621–647)	628 (615–642)	660 (645–676)	671 (656–686)	663 (646–680)
Other specialist or primary care	174 (170–179)	188 (183–193)	185 (181–190)	175 (171–179)	206 (201–212)	203 (197–209)	205 (198–212)
Missing	26 (25–27)	20 (19–21)	24 (23–25)	25 (24–26)	16 (15–18)	15 (14–16)	17 (16–18)
PRP injection							
Plastic or orthopaedic surgeons	N/A	0.78 (0.29–1.26)	2.31 (1.50–3.12)	3.03 (2.11–3.95)	2.37 (1.46–3.28)	1.22 (0.58–1.85)	2.19 (1.21–3.18)
Other specialist or primary care	0.03 (0.00–0.16)	0.57 (0.31–0.83)	0.60 (0.35–0.86)	0.76 (0.48–1.04)	0.89 (0.51–1.28)	0.21 (0.07–0.49)	0.57 (0.26–1.08)
Missing	N/A	0.02 (0.00–0.09)	0.17 (0.07–0.27)	0.16 (0.06–0.25)	0.05 (0.01–0.16)	0.10 (0.04–0.23)	0.23 (0.09–0.37)
Physiotherapy							
Plastic or orthopaedic surgeons	406 (396–416)	334 (324–344)	324 (314–333)	330 (321–340)	296 (286–306)	288 (278–298)	300 (289–312)
Other specialist or primary care	821 (811–830)	809 (799–819)	810 (800–819)	820 (810–829)	787 (775–798)	791 (780–803)	789 (775–803)
Missing	969 (962–976)	976 (968–984)	971 (963–978)	971 (963–978)	979 (971–987)	980 (972–988)	977 (968–987)
Surgery							
Plastic or orthopaedic surgeons	46.3 (42.9–49.7)	48.1 (44.3–51.9)	43.1 (39.6–46.6)	41.3 (38.0–44.7)	45.1 (41.1–49.1)	42.6 (38.9–46.4)	37.4 (33.3–41.5)
Other specialist or primary care	5.94 (5.14–6.75)	5.48 (4.67–6.30)	5.95 (5.14–6.76)	6.18 (5.37–6.98)	7.45 (6.35–8.56)	7.79 (6.67–8.92)	7.83 (6.45–9.20)
Missing	5.48 (4.94–6.03)	5.17 (4.59–5.75)	5.87 (5.28–6.45)	5.21 (4.67–5.74)	5.19 (4.59–5.79)	5.57 (4.96–6.18)	6.32 (5.58–7.07)

CS; corticosteroid, PRP; platelet-rich-plasma, CI; confidence interval

The Meta-analyses of randomized controlled studies was published on November 20, 2010, whereas the well-designed randomized controlled trials were published on February 6, 2013.