Published in final edited form as:

J Hand Surg Am. 2019 February ; 44(2): 85–92.e1. doi:10.1016/j.jhsa.2018.11.002.

Variation in Nonsurgical Services for Carpal Tunnel Syndrome Across a Large Integrated Health Care System

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Abstract

Purpose—To evaluate facility-level variation in the use of services for patients with carpal tunnel syndrome (CTS) receiving care in the Veterans Health Administration (VHA).

Methods—A national cohort of VHA patients diagnosed with CTS during fiscal year 2013 was divided into nonsurgical and operative treatment groups for comparison. We assessed the use of 5 types of CTS-related services (electrodiagnostic studies [EDS], imaging, steroid injection, oral steroids, and therapeutic modalities) in the prediagnosis and postdiagnosis periods before any operative intervention at the patient and facility levels.

Results—Among 72,599 patients newly diagnosed with CTS, 5,666 (7.8%) received carpal tunnel release within 12 months. The remaining 66,933 (92.2%) were in the nonsurgical group. Therapeutic modalities and EDS were the most commonly employed services after the index diagnosis and had large facility-level variation in use. At the facility level, the use of therapeutic modalities ranged from 0% to 93% in the operative group (mean, 32%) compared with 1% to 67% (mean, 30%) in the nonsurgical group. The use of EDS in the postdiagnosis period ranged from 0% to 100% (mean, 59%) in the operative treatment group and 0% to 55% (mean, 26%) in the nonsurgical group at the facility level.

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Conclusions—There is wide facility variation in the use of services for CTS among patients receiving operative and nonsurgical treatment. Care delivered by facilities with the highest and lowest rates of service use may suggest overuse and underuse, respectively, of nonsurgical CTS services and a lack of consideration of individual patient factors in making health care decisions regarding use.

Clinical relevance—Surgeons must understand the degree of treatment variability for CTS, comprehend the ramifications of large variation in reimbursement and waste in the health care system, and become involved in devising strategies to optimize hand care across all phases of care.

Keywords

Carpal tunnel release; carpal tunnel syndrome; treatment variation

Approximately 1 in 10 individuals will develop carpal tunnel syndrome (CTS) at some point during their lifetime.¹ Carpal tunnel syndrome is one of the most common musculoskeletal condition leading to work absence,² and 27% to 45% of CTS patients change jobs or are permanently out of work owing to associated disability.^{3–5} Providing timely and high-quality care for CTS has important long-term implications for maintaining optimal hand and occupational function.

Although strong evidence supports that patients with prolonged or recurrent CTS symptoms benefit from surgical treatment, there is currently no practical guidance for the provision of nonsurgical care.^{6,7} Recent clinical practice guidelines for management of CTS from the American Academy of orthopaedic Surgeons (AAoS) acknowledge that on average, surgery should have greater treatment benefit at 6 and 12 months compared with nonsurgical therapies, but they suggest that several nonsurgical treatments (immobilization, steroid injection, and oral steroids) may also improve patient-reported outcomes and that additional occupational therapy modalities (ketoprofen phonophoresis, laser therapy, and therapeutic ultrasound) might be effective compared with placebo.⁶ Given that existing guidelines do not provide specific recommendations about the timing, duration, and type of nonsurgical treatments for CTS, one might expect large variation in treatment practice patterns. However, the nature and extent of variation in treatment patterns have not been described.

Furthermore, prior studies found that patients with prolonged use of nonsurgical treatments and longer-lasting symptoms had inferior outcomes after carpal tunnel release (CTR) compared with patients who had surgery at earlier stages.^{8–12} Beyond the prolonged use of nonsurgical treatments for CTS, routine use of electrodiagnostic studies (EDS) before CTR has been associated with prolonged time to surgery.¹³ Therefore, if providers apply tests and treatments uniformly to all patients with CTS in practice without considering symptom severity, duration, and patient preferences, many services may result in inefficiency and waste without improving patient outcomes. Such variability may have implications for long-term outcomes and might indicate the need to improve the delivery of individualized care and develop systems-level interventions to incorporate best evidence into daily practice for clinicians and surgeons who treat patients with CTS. Although the cause of such inappropriate delays could be multifactorial (eg, access to surgical care, patient preferences, provider knowledge), the presence of substantial variability in employing diagnostic and

treatment modalities would suggest the need for targeted interventions to improve the efficiency and appropriateness of CTS management. The aim of this descriptive study was to evaluate health system variation in the use of diagnostic and treatment services among patients with CTS receiving care in the veterans Health Administration (VHA). The VHA is the largest integrated health care system in the United States and includes 130 major health care centers; it possesses an integrated health record that allows tracking of service use across centers. As such, the VHA is an ideal setting to measure facility-level variation in the use of health care services by identifying areas in need of quality improvement that can be widely applicable across various health care settings. As a secondary aim, we sought to compare differences in the use of nonsurgical services among patients who ultimately receive surgical care and those who receive only nonsurgical treatment. We hypothesized that considerable variability would exist among facilities in the use of nonsurgical services for CTS and that patients who received surgical treatment would also be high users of nonsurgical services.

MATERIALS AND METHODS

Data source and study cohort

The institutional review board approved this study. We used outpatient and surgical administrative data from the VHA Corporate Data Warehouse to identify a national sample of patients newly diagnosed with CTS. Patients were included in the study cohort if they had an encounter associated with a diagnosis of CTS (international Classification of Diseases, Ninth Revision diagnosis code 354.0) during fiscal year (FY) 2013, in which the earliest encounter was noted as the index diagnosis. Patients were excluded if they had an encounter with a CTS diagnosis within the 12 months before the index diagnosis.

Study variables

The study cohort was observed for 12 months both before and after the index diagnosis to assess the use of services for evaluating and treating CTS. The 12 months before the index CTS encounter was defined as the prediagnosis period, which we included to capture the use of relevant services such as diagnostic tests that were employed before a diagnosis of CTS was documented or confirmed. The 12 months after the index CTS encounter was defined as the postdiagnosis period. Services provided on the day of the index CTS encounter were included in the postdiagnosis period.

We recorded the use of nonsurgical and surgical services related to the evaluation and treatment of CTS. We selected services that could potentially be used in the diagnosis, evaluation, and management of patients with CTS or CTS-related symptoms. This included services that could be deemed both appropriate and inappropriate to understand the full spectrum of the use of potential services for application by primary care physicians, specialists, and surgeons. All encounters with codes for nonsurgical services were associated with a CTS diagnosis starting with the index diagnosis and during the postdiagnosis and pre-CTR periods. During the prediagnosis period (before CTS was coded), because CTS was not documented, the services were not associated with a CTS diagnosis code. However, by nature of their code description (eg, steroid injection of the carpal tunnel, upper-extremity

imaging studies) many codes were specific to the upper extremity or extremity in general (Appendix A, available on the *Journal's* Web site at <http://www.jhandsurg.org>).

Surgical services included receipt of a CTR. Appendix A lists Current Procedural Terminology and Healthcare Common Procedure Coding System codes used to identify each service. Nonsurgical services included EDS, imaging (upper-extremity x-ray, magnetic resonance imaging, computed tomography, or ultrasound), steroid injection, oral steroids, and therapeutic modalities (physical therapy, occupational therapy, or placement of an orthosis). Therapeutic modalities, placement of an orthosis, and therapy evaluation and treatment codes were grouped as a single entity (referred to collectively as therapeutic modalities), because the method varies in which orthoses are provided and documented or coded across facilities. For example, occupational therapists may provide patients with CTS orthoses but code an occupational therapy evaluation and treatment service with or without the use of additional therapeutic modalities. For this reason, occupational/physical therapy evaluation and treatment, or placement of an orthosis were combined into a single therapeutic modality group.

Patient characteristics were recorded at the time of the index diagnosis, including age, sex, race, and whether medical care was paid for in part or as a whole by VHA for etiologies related to military service (ie, service connection, akin to insurance coverage in that it is related to copays and out-of-pocket expenses). Each patient was assigned to a home facility, which was defined as the single facility out of 130 VHA major health care systems that the patient visited most often in the observation period.

Data analysis

The study cohort was divided into nonsurgical and operative treatment groups for comparison. The operative treatment group received an open or endoscopic CTR operation within the 12-month postdiagnosis period. The remaining patients were included in the nonsurgical treatment group. The use of nonsurgical services was evaluated during the 12-month prediagnosis period and the postdiagnosis period. For the nonsurgical group, the postdiagnosis observation period was 12 months. For the operative group, the postdiagnosis observation period included the time from the index diagnosis to CTR and included no services after CTR. We calculated descriptive statistics to assess the use of 5 types of CTS-related services (EDS, imaging, steroid injection, oral steroids, and therapeutic modalities) in the prediagnosis and postdiagnosis observation periods for the operative and nonsurgical treatment groups. Descriptive statistics were calculated nationally at the patient and facility levels.

RESULTS

Among the 72,599 patients with an index diagnosis of CTS in VHA during FY 2013, 5,666 (7.8%) received a CTR within 12 months and constituted the operative treatment group. The remaining 66,933 (92.2%) were in the nonsurgical treatment group. Table 1 provides the patient characteristics for the study cohort. Among the whole CTS cohort, 12.5% also had cubital tunnel syndrome documented during the study period (11.7% in the nonsurgical treatment group and 21.7% in the operative treatment group). Mean duration from index

CTS diagnosis to receiving CTR in the operative treatment group was 152 days (SD, 96 days). On average, 558 patients/facility had an index CTS diagnosis (range, 13–1,738 patients/facility) and 8.0% of CTS patients received operative treatment at the facility level (range, 0% to 24% of patients) during FY 2013.

The 5 types of services evaluated in the study during the prediagnosis and postdiagnosis periods are listed in Tables 2 and 3. Therapeutic modalities and EDS were the most commonly employed services after the index diagnosis in both treatment groups. These 2 services also had the greatest variation in use at the facility level in both treatment groups (Figs. 1 and 2). For each of the 5 services examined, there was greater facility-level variation in the use of all services in the operative group compared with the nonsurgical group (Tables 4 and 5).

At the patient level, a similar proportion of patients received therapeutic modalities after the index diagnosis in the operative and nonsurgical groups (29.6 vs 30.9%, respectively). The use of therapeutic modalities varied widely at the facility level for both treatment groups, ranging from 0% to 93% in the operative group (mean, 32%), compared with 1% to 67% (mean, 30%) in the nonsurgical group. A higher proportion of patients in the operative group received EDS after the index diagnosis compared with the nonsurgical group (61.1% vs 28.3%, respectively) at the patient level. Among patients who had CTR, 30.8% did not undergo EDS before surgery. At the facility level, the proportion of patients receiving EDS in the postdiagnosis period ranged from 0% to 55% (mean, 26%) in the nonsurgical group and from 0% to 100% (mean, 59%) in the operative treatment group. Imaging, oral steroids, and steroid injections were less commonly used in both the prediagnosis and postdiagnosis periods (Tables 2 and 3). However, these less commonly used services also had greater facility-level variation in the operative group compared with the nonsurgical group (Tables 4 and 5).

DISCUSSION

There was wide facility-level variation in the use of diagnostic and treatment services for CTS. The degree of variation in all types of services evaluated in this study was greatest among patients who received operative treatment. Therapeutic modalities and EDS were used most often after CTS diagnosis, but their use also had the widest facility-level variability between both treatment groups. The impact of facility variation on treatment efficiency and patient outcomes is unknown. However, the variability of application observed across health care facilities in this study indicates that quality improvement efforts focused on increasing the appropriateness of EDS and therapeutic modalities, based on patient symptoms, severity, patient preferences, and potential impact on treatment and long-term outcomes rather than local system practices, may improve the delivery of efficient, high-value, and patient-centered care for patients with CTS. In the case of CTS there is a great body of literature regarding aspects of diagnosis and treatment, but wide variation in the use of nonsurgical services exists and may contribute to overall waste in the health care system. There is potential benefit to incorporating diagnosis and treatment best practices into the daily care of patients with CTS to reduce the use of health care services that have little benefit for patients.

Because CTS is a clinical diagnosis, the routine use of EDS is debated for patients evaluated for CTS.¹⁴ Studies are consistent in finding that EDS is not the reference standard test to diagnose CTS and that physical examination findings alone are sufficient to diagnose CTS in patients with classic symptoms.^{15–20} Furthermore, previous studies demonstrated that for patients with a high probability of CTS based on examination criteria alone, EDS does little to change the probability of diagnosis.^{18,21} Wang et al²⁰ recently demonstrated the relatively poor specificity of nerve conduction studies in the prospective diagnosis of CTS, which means that the routine use of EDS as a confirmatory test to diagnose CTS before a surgical consultation could be considered wasteful. Although EDS may be helpful in scenarios in which the diagnosis is unclear, using EDS routinely as a confirmatory test has little value in directing treatment recommendations for patients with classic symptoms. Patients receiving preoperative EDS were shown to have prolonged time to surgery and greater costs compared with patients not receiving preoperative EDS.¹³

The most recent AAOS clinical practice guidelines cite moderate evidence that diagnostic questionnaires and/or EDS could be used to aid the diagnosis of CTS, without offering guidance to identify patients who are unlikely to benefit from testing. In the effort to reduce low-value testing, future clinical practice guidelines should suggest more explicitly when EDS is unlikely to affect diagnosis and/or treatment. Carpal tunnel syndrome clinical practice guidelines before 2016 recommended using EDS for all patients who were considered for surgery.⁷ Although the literature over the past 2 decades has been consistent in demonstrating that EDS is not a reference standard for diagnosing CTS, prior guidelines may have affected the high rates of EDS use in some VHA facilities, given the time in which patients in the study cohort were diagnosed. Currently, it is possible that many providers are still in the habit of routinely ordering EDS to confirm a CTS diagnosis in all patients before CTR, as was previously reported.^{22–27} In the current study, we found that for the top quartile of facilities employing EDS, 77% to 100% of patients received it before surgery, whereas in the lowest quartile, 0% to 50% of patients received it before surgery. These findings suggest that some facilities were requiring most if not all patients to receive EDS before CTR and some facilities were using EDS more selectively or rarely. Future studies are warranted to determine the impact of receiving care at facilities with the highest and lowest rates of presurgical diagnostic testing on the value, efficiency of care, and patient outcomes, and whether similar trends are seen in health systems outside the VHA.

Clinicians could use additional resources to provide practical guidance in choosing high value and efficient services for CTS, which may contribute to the variability among facilities observed in this study. For example, the manner in which treatments should be used relative to one another is not specified in the AAOS clinical practice guidelines other than to acknowledge that on average, surgery should have greater treatment benefit at 6 and 12 months compared with nonsurgical therapies.⁶ Furthermore, the most widely used guidelines do not differentiate among treatment recommendations based on severity of symptoms. A variety of nonsurgical treatments may be considered appropriate in the general sense, but may be of low value if they lead to treatment delay in patients who would benefit from early surgery, or patients may incur worse hand functioning than might have been achieved with more prompt surgical intervention. Clinicians who interpret and apply the recommendations as written may apply nonsurgical therapies for a patient with severe CTS who would have

little long-term benefit.^{28–31} Given the wide facility-level variability in the care of patients with CTS, it appears that clinicians could benefit from more concrete guidance, such as clinical integration of a care pathway that is used in daily practice, to inform the use of services based on severity, duration of symptoms, patient preferences, and the likelihood of being a high-value service.

This study had limitations inherent in the use of administrative data. Facility-level characteristics such as proximity to individual patients, surgical volume, staffing levels of specialty providers and surgeons, and teaching status were not recorded and may account for some of the facility variation noted. The VHA administrative data do not capture patient-level details related to symptoms, severity, individual preferences, the method in which CTS was diagnosed (history and examination, EDS results, or both), and the characteristics of the clinician who diagnosed CTS. Use of services in the prediagnosis period may indicate some variability in confirming the diagnosis of CTS through coding. Although the services evaluated in the postdiagnosis period were associated with a CTS diagnosis for each encounter that was recorded, it is possible that services such as therapy services or EMG were used for multiple diagnoses (in addition to CTS) for the minority of patients who also had cubital tunnel syndrome. Electrodiagnostic studies for confirmed CTS (by EDS criteria) are most likely to be attributed to the postdiagnosis period because encounter diagnoses are documented at the time of clinical documentation after the test is performed. Differences in the severity of CTS symptoms may also lead to some variability in the use of CTS-related services. However, case-mix severity of CTS is unlikely to differ considerably at the regional facility level among the 130 VHA health systems included. In addition, we were unable to assess the impact of referral protocols on the use of CTS-related services. Staffing and protocols vary at the local level and among different specialty services caring for patients with CTS. Based on the facility-level variability demonstrated in this study, future assessment is warranted of facilitators and barriers that lead to differences in care, to inform quality improvement initiatives and reduce health care waste. Finally, the impact of the use of services outside the VHA system is unknown and the observed patterns of care may differ in other health care systems. However, in prior work, we noted variability in the use of diagnostic testing and treatment for CTS outside the VHA.^{13,32,33}

Despite these limitations, the current study demonstrated the presence of wide facility variation in the use of services for CTS among patients receiving both operative and nonsurgical care. Individual patient factors such as disease severity, comorbidities, and patient preferences should influence treatment rendered on an individual level. However, care delivered by facilities with the highest and lowest rates of service use may suggest overuse and underuse, respectively, of nonsurgical CTS services and a lack of consideration of these individual patient factors in making health care decisions regarding application. There is a need to understand better the impact of tests and treatments for CTS that seem appropriate when considered in isolation but may be of low value, prolong care in certain settings, and lead to higher resource use in the longitudinal care of patients. Research to inform the development of more prescriptive clinical practice guidelines that can be incorporated into everyday practice and quality improvement initiatives focused on shared decision making for presurgical care may improve the value and efficiency of surgical care as a whole. Hand surgeon involvement in developing systems-level interventions to inform

the care of these patients at the time of diagnosis could improve the selection of appropriate nonsurgical services based on individual patient presentation and preferences and may reduce overall waste in the current health care system.

ACKNOWLEDGMENTS

Support for this study was provided in part by a Career Development Award (IK2 HX002592) to Dr. Sears, a Research Career Scientist Award to Dr. Harris (RCS-14-232) from the Department of Veterans Affairs Health Services Research and Development Service, and a Midcareer Investigator Award in Patient-Oriented Research from the National Institute of Arthritis and Musculoskeletal and Skin Diseases of the National Institutes of Health (2 K24-AR053120-06) to Dr. Chung. The funding organizations had no role in the design and conduct of the study, including collection, management, analysis, and interpretation of the data. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Department of Veterans Affairs or the National Institutes of Health.

APPENDIX A. CPT and HCPCS Procedure Codes for CTS-Related Services

CTS-Related Services	CPT/HCPCS* Procedure Codes
Carpal tunnel release	64721, 29848
EDS	95860, 95861, 95863, 95870, 95872, 95864, 95885, 95886, E0746, 95900, 95903, 95904, 95905, 95907, 95908, 95909, 95910, 95911, 95912, 95913, G0255
Imaging	
X-ray	73090, 73100, 73110, 73130
Magnetic resonance imaging	73221, 73223
Computed tomography	73200, 73201, 73202, 73206
Ultrasound	76881, 76882
Steroid injection	20550, 20526, 96732, J1020, J1030, J1040, J2920, J2930, J3300, J3301, J3302, J3303, J1094, J1100, J0702, J2650
Oral steroids	J8540, J7509, J7510, J7512
Therapeutic modalities (physical therapy/ occupational therapy/ placement of orthosis/prosthetics/ orthotics)	97001, 97002, 97003, 97004, S9445, S9446, 97035, 97010, 97012, 97014, 97018, 97022, 97026, 97032, 97033, 97110, 97112, 97124, 97140, 97530, 90901, 97039, 97760, 98960, 4018F, A4265, E0235, E0730, G8990, G8991, G8992, G8994, G8995, 29125, A4570, L3807, L3908, 29126, A4590, L3806, L3809, L3900, L3908, L3913, L3915, L3919, L3923, L3967, L3999, L4210, Q4051, S8450, S8451, 97762

CPT, Current Procedural Terminology; HCPCD, Healthcare Common Procedure Coding System.

* Codes beginning with J indicate that HCPCS codes are used; all other codes represent that CPT codes are used.

REFERENCES

1. Practice parameter for carpal tunnel syndrome (summary statement): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 1993;43(11):2406–2409. [PubMed: 8232968]
2. US Department of Labor, Bureau of Labor Statistics. Nonfatal occupational injuries and illnesses requiring days away from work, 2015 Available at: https://www.bls.gov/news.release/archives/osh2_11102016.pdf. Accessed November 21, 2018.
3. Katz JN, Lew RA, Bessette L, et al. Prevalence and predictors of long-term work disability due to carpal tunnel syndrome. *Am J Ind Med* 1998;33(6):543–550. [PubMed: 9582945]
4. Katz JN, Amick BC, III, Keller R, et al. Determinants of work absence following surgery for carpal tunnel syndrome. *Am J Ind Med*. 2005;47(2):120–130. [PubMed: 15662641]
5. Faucett J, Blanc PD, Yelin E. The impact of carpal tunnel syndrome on work status: implications of job characteristics for staying on the job. *J Occup Rehabil*. 2000;10(1):55–69.

6. American Academy of Orthopaedic Surgeons. Management of Carpal Tunnel Syndrome Evidence-Based Clinical Practice Guideline. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2016.
7. American Academy of Orthopaedic Surgeons. Clinical Practice Guideline on the Diagnosis of Carpal Tunnel Syndrome. Rosemont, IL: American Academy of Orthopaedic Surgeons; 2007.
8. Vahi PS, Kals M, Koiv L, Braschinsky M. Preoperative corticosteroid injections are associated with worse long-term outcome of surgical carpal tunnel release. *Acta Orthop*. 2014;85(1):102–106. [PubMed: 24286569]
9. Chandra PS, Singh PK, Goyal V, Chauhan AK, Thakkur N, Tripathi M. Early versus delayed endoscopic surgery for carpal tunnel syndrome: prospective randomized study. *World Neurosurg*. 2013;79(5-6):767–772. [PubMed: 23022645]
10. Eisenhardt SU, Mathonia C, Stark GB, Horch RE, Bannasch H. Retrospective analysis of 242 patients whose carpal tunnels were released using a one-port endoscopic procedure: superior results of early intervention. *J Plast Surg Hand Surg*. 2010;44(6):311–317. [PubMed: 21446811]
11. DeStefano F, Nordstrom DL, Vierkant RA. Long-term symptom outcomes of carpal tunnel syndrome and its treatment. *J Hand Surg Am*. 1997;22(2):200–210. [PubMed: 9195415]
12. Fowler JR, Munsch M, Huang Y, Hagberg WC, Imbriglia JE. Preoperative electrodiagnostic testing predicts time to resolution of symptoms after carpal tunnel release. *J Hand Surg Eur Vol*. 2016;41(2):137–142. [PubMed: 25770901]
13. Sears ED, Swiatek PR, Hou H, Chung KC. Utilization of preoperative electrodiagnostic studies for carpal tunnel syndrome: an analysis of national practice patterns. *J Hand Surg Am*. 2016;41(6):665–672.e1. [PubMed: 27068003]
14. Ring DC. Clinical faceoff: routine electrodiagnostic testing is not helpful in the management of carpal tunnel syndrome. *Clin Orthop Relat Res*. 2016;474(8):1770–1774. [PubMed: 25690166]
15. Zyluk A, Szlosser Z. The results of carpal tunnel release for carpal tunnel syndrome diagnosed on clinical grounds, with or without electrophysiological investigations: a randomized study. *J Hand Surg Eur Vol*. 2013;38(1):44–49. [PubMed: 22618564]
16. Concannon MJ, Gainor B, Petroski GF, Puckett CL. The predictive value of electrodiagnostic studies in carpal tunnel syndrome. *Plast Reconstr Surg*. 1997;100(6):1452–1458. [PubMed: 9385956]
17. Finsen V, Russwurm H. Neurophysiology not required before surgery for typical carpal tunnel syndrome. *J Hand Surg Br*. 2001 ;26(1):61–64. [PubMed: 11162020]
18. Graham B The value added by electrodiagnostic testing in the diagnosis of carpal tunnel syndrome. *J Bone Joint Surg Am*. 2008;90(12):2587–2593. [PubMed: 19047703]
19. Fowler JR, Cipolli W, Hanson T. A comparison of three diagnostic tests for carpal tunnel syndrome using latent class analysis. *J Bone Joint Surg Am*. 2015;97(23):1958–1961. [PubMed: 26631997]
20. Wang WL, Buterbaugh K, Kadow TR, Goitz RJ, Fowler JR. A prospective comparison of diagnostic tools for the diagnosis of carpal tunnel syndrome. *J Hand Surg Am*. 2018;43(9):833–836. e832. [PubMed: 29935774]
21. Szabo RM, Slater RR, II, Farver TB, Stanton DB, Sharman WK. The value of diagnostic testing in carpal tunnel syndrome. *J Hand Surg Am*. 1999;24(4):704–714. [PubMed: 10447161]
22. Lane LB, Starecki M, Olson A, Kohn N. Carpal tunnel syndrome diagnosis and treatment: a survey of members of the American Society for Surgery of the Hand. *J Hand Surg Am*. 2014;39(11):2181–2187.e4. [PubMed: 25227597]
23. Storm S, Beaver SK, Giardino N, et al. Compliance with electrodiagnostic guidelines for patients undergoing carpal tunnel release. *Arch Phys Med Rehabil*. 2005;86(1):8–11. [PubMed: 15640981]
24. Shin EK, Bachoura A, Jacoby SM, Chen NC, Osterman AL. Treatment of carpal tunnel syndrome by members of the American Association for Hand Surgery. *Hand (N Y)*. 2012;7(4):351–356. [PubMed: 24294152]
25. Leinberry CF, Rivlin M, Maltenfort M, et al. Treatment of carpal tunnel syndrome by members of the American Society for Surgery of the Hand: a 25-year perspective. *J Hand Surg Am*. 2012;37(10):1997–2003.e3. [PubMed: 23021173]

26. Duncan KH, Lewis RC, II, Foreman KA, Nordyke MD. Treatment of carpal tunnel syndrome by members of the American Society for Surgery of the Hand: results of a questionnaire. *J Hand Surg Am.* 1987;12(3):384–391. [PubMed: 3584886]
27. Munns JJ, Awan HM. Trends in carpal tunnel surgery: an online survey of members of the American Society for Surgery of the Hand. *J Hand Surg Am.* 2015;40(4):767–771.e2. [PubMed: 25747738]
28. Baker NA, Livengood HM. Symptom severity and conservative treatment for carpal tunnel syndrome in association with eventual carpal tunnel release. *J Hand Surg Am.* 2014;39(9):1792–1798. [PubMed: 24909563]
29. Visser LH, Ngo Q, Groeneweg SJ, Brekelmans G. Long term effect of local corticosteroid injection for carpal tunnel syndrome: a relation with electrodiagnostic severity. *Clin Neurophysiol.* 2012;123(4):838–841. [PubMed: 21962473]
30. Shi Q, MacDermid JC. Is surgical intervention more effective than non-surgical treatment for carpal tunnel syndrome? A systematic review. *J Orthop Surg Res.* 2011;6:17. [PubMed: 21477381]
31. Boyd KU, Gan BS, Ross DC, Richards RS, Roth JH, MacDermid JC. Outcomes in carpal tunnel syndrome: symptom severity, conservative management and progression to surgery. *Clin Invest Med.* 2005;28(5):254–260. [PubMed: 16265997]
32. Sears ED, Lu YT, Wood SM, et al. Diagnostic testing requested before surgical evaluation for carpal tunnel syndrome. *J Hand Surg Am.* 2017;42(8):623–629.e1. [PubMed: 28666673]
33. Sears ED, Swiatek PR, Chung KC. National utilization patterns of steroid injection and operative intervention for treatment of common hand conditions. *J Hand Surg Am.* 2016;41(3):367–373.e2. [PubMed: 26774548]

FIGURE 1:
Variation in facility-level rates of post-CTS diagnosis services among nonsurgical patients (n = 130).

FIGURE 2:
Variation in facility-level rates of pre-CTR services among operative patients (n = 126). Pre-CTR period includes services received from index CTS diagnosis to CTR.

TABLE 1.
Demographics and Veterans Administration Characteristics of Patients With an Index CTS Diagnosis in FY 2013

Patient Characteristics	Nonsurgical Treatment Group (N = 66,933) (92.2%)	Operative Treatment Group (N = 5,666) (7.8%)	All Patients (N = 72,599)
Mean age, y (SD)	59 (14)	61 (13)	59 (14)
Sex			
Female	9,451 (14)	560 (10)	10,011 (14)
Male	57,482 (86)	5,106 (90)	62,588 (86)
Race			
American Indian or Alaska Native	745 (1.1)	65 (1.1)	810 (1.1)
Asian	790 (1.2)	24 (0.4)	814 (1.1)
Hispanic white	3,705 (5.5)	255 (4.5)	3,960 (5.5)
Black or African American	14,016 (20.9)	609 (10.7)	14,625 (20.1)
Non-Hispanic white	42,896 (64.1)	4,374 (77.2)	47,270 (65.1)
Native Hawaiian/other Pacific Islander	792 (1.2)	51 (0.9)	843 (1.2)
Unspecified	3,989 (6.0)	288 (5.1)	4,277 (5.9)
Condition Service Connected (%)			
50–100	23,515 (35.1)	1,863 (32.9)	25,378 (35.0)
<50	14,328 (21.4)	1,241 (21.9)	15,569 (21.4)
Not service connected	29,077 (43.4)	2,562 (45.2)	31,639 (43.6)
Concurrent cubital tunnel diagnosis (%)	7,849 (11.7)	1,231 (21.7)	9,079 (12.5)

TABLE 2.

Prediagnosis and Postdiagnosis Services Received Within Nonsurgical Treatment Group (n [%]) (N = 66,933)

Nonsurgical Services	Before CTS Diagnosis[*]	After CTS Diagnosis[†]
EDS	3,508 (5.2)	18,914 (28.3)
Steroid injection	5,619 (8.4)	1,619 (2.4)
Oral steroids	3,817 (5.7)	4,365 (6.5)
Therapeutic modalities [‡]	24,062 (35.9)	20,714 (30.9)
Imaging [§]	8,869 (13.3)	297 (0.4)

^{*} Services received within 12 months before index CTS diagnosis.

[†] Services received within 12 months after index CTS diagnosis.

[‡] Therapeutic modalities included physical therapy, occupational therapy, and/or placement of an orthotic.

[§] Imaging included x-ray, magnetic resonance imaging, computed tomography, and/or ultrasound.

TABLE 3.

Prediagnosis and Presurgical Services Received Within Operative Treatment Group (n [%]) (N = 5,666)

Nonsurgical Services	Before CTS Diagnosis[*]	Before CTR[†]
EDS	538 (9.5)	3,463 (61.1)
Steroid injection	639 (11.3)	355 (6.3)
Oral steroids	388 (6.8)	290 (5.1)
Therapeutic modalities [‡]	2,400 (42.6)	1,677 (29.6)
Imaging [§]	1,309 (23.3)	114 (2.0)

^{*} Services received within 12 months before index CTS diagnosis.

[†] Services received from index CTS diagnosis to CTR.

[‡] Therapeutic modalities included physical therapy, occupational therapy, and/or placement of an orthosis.

[§] Imaging included x-ray, magnetic resonance imaging, computed tomography, and/or ultrasound.

TABLE 4.
Facility-Level Nonsurgical Patients (%) Receiving After CTS Diagnosis Services (n = 130)

Nonsurgical Services	Mean %	Range %	Median %	Interquartile Range
EDS	26.1	0.0–54.9	27.2	19.9–32.6
Steroid injection	2.3	0.0–10.0	1.8	1.0–2.9
Oral steroids	6.6	1.5–17.4	6.1	5.2–7.8
Therapeutic modalities	30.3	1.4–66.7	31.8	19.7–40.7
Imaging	0.4	0.0–2.9	0.3	0–0.7

TABLE 5.

Facility-Level Operative Patients (%) Receiving Services Before CTR* (n = 126)[†]

Nonsurgical Services	Mean	Range %	Median	Interquartile Range
EDS	59.2	0.0–100	64.1	50.0–76.9
Steroid injection	6.8	0.0–46.7	4.2	1.6–8.3
Oral steroids	5.1	0.0–28.6	4.0	1.4–6.8
Therapeutic modalities	32.4	0.0–93.3	31.3	20.9–43.3
Imaging	2.0	0.0–14.3	0.0	0–3.2

* Services received from index CTS diagnosis to CTR.

[†] Four stations did not perform CTR surgery.