Opioid Prescribing after Carpal Tunnel Release: Analysis from the Michigan Collaborative Hand Initiative for Quality in Surgery

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Background: Little is known regarding the national practice patterns for postoperative opioid prescribing after carpal tunnel release, which is one of the most common surgical procedures performed. The authors sought to assess the rate of opioid prescribing after carpal tunnel release and patient-, surgeon-, and practice-level predictors of opioid prescriptions after surgery.
Methods: The authors conducted a cohort study from the Michigan Collaborative Hand Initiative for Quality in Surgery, a national consortium of nine practices with 33 surgeons who prospectively collect data for the purpose of quality improvement. Patients were included who underwent carpal tunnel release between July 1, 2019, and December 31, 2019. Multilevel logistic regression was used to determine practice and surgeon variation in postoperative opioid prescribing related to patient characteristics.
Results: Of the 648 patients with 792 operative hands, 52.9 percent were prescribed a postoperative opioid. After controlling for patient, surgeon, and practice characteristics, endoscopic carpal tunnel releases were associated with a decreased odds of receiving a postoperative opioid prescription compared to open carpal tunnel releases (OR, 0.19; 95 percent CI, 0.07 to 0.52). However, 57.4 percent of the variation in opioid prescribing was explained at the practice level, and 4.1 percent of the variation was explained at the surgeon level.
Conclusions: Practice-level prescribing patterns play a substantial role in opioid prescribing. National efforts should consider development of evidence-based opioid prescribing recommendations for carpal tunnel release that target all prescribers, including trainees and advanced practice providers. In addition, endoscopic carpal tunnel release may offer an opportunity to minimize opioid prescribing. The authors recommend that providers encourage the use of nonopioid analgesia and limit opioid prescriptions after carpal tunnel release. (*Plast. Reconstr. Surg.* 148: 1064, 2021.)
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There is a well-known opioid epidemic in the United States. In 2018, approximately 10.3 million people aged 12 years or older misused opioids. The vast majority (92 percent) of individuals who misused opioids obtained them from prescriptions, most commonly hydrocodone

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products.[1] Previous studies demonstrated the large overprescribing of opioids after surgery, resulting in excess pills that can subsequently lead to diversion into the community.[2–7] For example, it was estimated that in 1 year at one institution, there was an excess of 43,000 opioid pills after the five most common elective orthopedic operations.[4] In addition, the initiation of opioids for even minor, elective hand surgery procedures has been shown to present a risk of persistent opioid use in opioid-naive patients.[8,9] These studies highlight the concern that opioid prescribing after surgery may be one of the drivers of the opioid epidemic.

Studies have shown a large variation in the number of opioids prescribed for the same procedures, even at the same institution.[4,10–15] For instance, at one academic medical center, a mean of 33 opioid pills were prescribed for open inguinal hernia repair, with a range of 15 to 120 pills.[11] The variation in prescribing may be because of multiple factors including a lack of evidence-based guidelines to aid in prescribing. In response, the Michigan Opioid Prescribing Engagement Network developed guidelines for more than 20 procedures.[16] However, there are still many procedures that are absent from this list, specifically, any type of hand surgery procedure. In addition, providers may be reluctant to adopt new guidelines.[13] One study showed that the prescribing behaviors of attending surgeons and hand surgery fellows are most influenced by their personal experience, and resident surgeons are most likely to prescribe pain medications according to the preferences of their supervising attending surgeons. Peer-reviewed literature was the second-least influential factor in their decision-making for opioid prescribing.[10] Given the concern for opioid overprescribing, little is known regarding the current prescribing patterns of hand surgeons after a common, low-complexity procedure such as carpal tunnel release.

In this study, we used data from a national hand surgery collaborative to assess the rate of opioid prescribing after carpal tunnel release. Carpal tunnel release was chosen because it is a commonly performed procedure; over 575,000 are performed annually in the United States.[17,18] Our a priori hypothesis was that there was substantial practice-level variation in prescribing and that patient-level factors were not significant predictors.

PATIENTS AND METHODS

Data Source

The Michigan Collaborative Hand Initiative for Quality in Surgery is a collaborative quality initiative consisting of nine hand surgery practices across the United States. The sites are as follows: University of Michigan, Indiana University, and Mayo Clinic (Midwest region); University of Pittsburgh and University of Rochester (Northeast region); and Curtis National Hand Center, OrthoCarolina Hand Center, Emory Orthopaedics, Sports & Spine, and Wake Forest Baptist Health (Southern region). Participating sites were recruited by the coordinating site to increase the generalizability in terms of geographic location, type of practice (private versus academic), and patients served. Collaborative quality initiatives represent a new movement in improving care quality through a collaborative and team-based approach.[19] The first initiative focuses on carpal tunnel surgery. The general aim of the collaborative is to understand variations in the quality of care of hand surgery and to develop and implement measures to improve quality. The process is achieved through a continuous feedback mechanism that has been used by other quality collaboratives.[19] Data are collected prospectively as part of standard clinical care and extracted from the electronic medical records at each site 6 to 8 weeks postoperatively. Study data were collected and managed using the Research Electronic Data Capture tool hosted at the reporting center.[20,21] Each site obtained institutional review board approval to collect and analyze a limited data set. The coordinating site performed regular data audits to ensure validity.

Study Cohort

We included patients who underwent elective primary carpal tunnel release at nine practices between July 1, 2019, and December 31, 2019, performed by 33 surgeons. The practices included eight academic centers and one private practice. Patients were included if they were 18 years or older and underwent open carpal tunnel release or endoscopic carpal tunnel release. Patients were excluded if they had undergone a previous carpal tunnel release of the affected hand or if the carpal tunnel release was not elective (i.e., performed for trauma-related procedures). In addition, we excluded patients undergoing concomitant surgical procedures where the patient would be more likely to receive a postoperative opioid prescription. (**See Figure, Supplemental Digital Content 1**, which shows the patient exclusion criteria, ***http://links.lww.com/PRS/E662***.) The final cohort included patients who underwent carpal tunnel release alone or with concomitant trigger finger release, trigger finger corticosteroid injection, de

Quervain corticosteroid injection, carpometacarpal joint corticosteroid injection, or excision of small hand masses.

Primary Outcome

The primary outcome of this study was receipt of a postoperative opioid prescription. This was determined for each surgical operation. For example, if a patient underwent a right carpal tunnel release and then a left carpal tunnel release 1 month afterward, the presence of a postoperative opioid prescription was collected separately for each operation. For concurrent bilateral carpal tunnel releases, we recorded the presence of a postoperative opioid prescription once. We also gathered information regarding prescription size, type of opioid prescribed, and dosage. We calculated the average oral morphine equivalents using previously described conversions by the U.S. Centers for Disease Control and Prevention.[22]

Explanatory Variables

Sociodemographic and clinical factors were obtained for each patient. Variables of interest included age, sex, race, and insurance type. Race was categorized as white, black, and other. Insurance type included private/employer-sponsored health insurance, Medicare, Medicaid, workers' compensation, and other. We determined the type of carpal tunnel release: open versus endoscopic. Lastly, we collected information regarding comorbidities potentially associated with opioid use including whether the patient was a current smoker or had chronic pain (defined as pain that typically lasts >3 months or past the time of normal tissue healing and/or the current use of a gabapentinoid or opioid).

Statistical Analyses

We used descriptive analyses to examine the differences between patients receiving and not receiving postoperative opioid prescriptions. We calculated unadjusted associations using two-tailed *t* test for continuous variables and chi-square test for categorical variables.

Multilevel logistic regression was used to examine the association among patient-level, surgeon-level, and practice-level characteristics and receipt of a postoperative opioid prescription. Practice-level variation was defined as differences between the sites, representing the culture of the institutions. Surgeon-level variation was defined as differences between the surgeons, representing differences in individual practice patterns. Given the nonrandom clustering of patients within surgeons and surgeons within practices, we used random intercepts at the surgeon level and the practice level. Covariates in the model included age as a quadratic, sex, race, insurance type, current smoker, history of chronic pain, and surgery type (open versus endoscopic). To assess variation at the cluster level, we calculated the intraclass correlation coefficient and the median odds ratio for the surgeon level (i.e., between the different surgeons) and the practice level (i.e., between practices).[23] Postestimation marginal effects was used to determine the predicted probability of receipt of a postoperative opioid prescription. Finally, to support the findings of our original analysis, we performed a sensitivity analysis excluding all patients with any concomitant surgical procedure (i.e., trigger finger release, trigger finger corticosteroid injection, de Quervain corticosteroid injection, carpometacarpal joint corticosteroid injection, and excision of small hand masses) and patients undergoing concurrent bilateral carpal tunnel release. A significance level of $p < 0.05$ was used for all analyses. Analyses were performed using Stata 15.0 (StataCorp, College Station, Texas).

RESULTS

A total of 648 patients and 792 hands received a carpal tunnel release between July 1, 2019, and December 31, 2019. Of these patients, 15 (2.3 percent) underwent concurrent bilateral carpal tunnel release, resulting in 777 separate operative procedures. Within this cohort, 69 of the carpal tunnel release procedures (8.9 percent) were performed with another procedure (i.e., 51 trigger finger releases, six trigger finger injections, one de Quervain injection, seven carpometacarpal joint injections, and four excisions of small hand masses).

Of the 777 separate carpal tunnel release procedures, 53 percent were prescribed a postoperative opioid. The average oral morphine equivalents was 53.1 (SD, 39.2) with an average of 10.7 pills prescribed (SD, 8). Table 1 illustrates patient characteristics stratified by postoperative opioid use. There were no differences in age or sex and whether the patient received a postoperative opioid prescription. Of the patients who received a postoperative opioid prescription, 285 (69 percent) were white, 93 (23 percent) were black, and 33 (8 percent) were other compared to patients who did not receive a postoperative opioid prescription (84 percent white, 11 percent black, and 6

Table 1. Patient Sociodemographic and Clinical Characteristics Stratified by Receipt of a Postoperative Opioid Prescription

	Total Cohort (%)	No Prescription (%)	Yes Prescription (%)	*p**
No.	777	366	411	
Mean age ± SD	58.0 ± 13.9	58.4 ± 13.9	57.6 ± 13.9	0.42
Sex				0.09
Male	267 (34.4)	137 (37.4)	130 (31.6)	
Female	510 (65.6)	229 (62.6)	281 (68.4)	
Race				<0.001
White	591 (76.1)	306 (83.6)	285 (69.3)	
Black	133 (17.1)	40 (10.9)	93 (22.6)	
Other	53 (6.8)	20 (5.5)	33 (8.0)	
Insurance type				0.001
Private	377 (48.5)	192 (52.5)	185 (45.0)	
Medicare	234 (30.1)	109 (29.8)	125 (30.4)	
Medicaid	96 (12.4)	27 (7.4)	69 (16.8)	
Self-pay	9 (1.2)	4 (1.1)	5 (1.2)	
Workers' compensation	52 (6.7)	31 (8.5)	21 (5.1)	
Unknown	9 (1.2)	3 (2.2)	6 (1.5)	
Average BMI ± SD, kg/m^2	32.7 ± 7.6	32.3 ± 7.6	33.0 ± 7.7	0.17
Comorbidities				
Smoker	66 (8.5)	21 (5.7)	45 (11.0)	0.009
Diabetes	159 (20.5)	73 (20.0)	86 (20.9)	0.74
Rheumatoid arthritis	35 (4.5)	9 (2.5)	26 (6.3)	0.009
History of chronic pain	121 (15.6)	48 (13.1)	73 (17.8)	0.08
History of wrist fracture	19 (2.5)	7 (1.9)	12 (2.9)	0.36
Surgery type				0.54
Open carpal tunnel release	516 (66.4)	239 (46.3)	277 (53.7)	
Endoscopic carpal tunnel release	261 (33.6)	127 (48.7)	134 (51.3)	

BMI, body mass index.
*Two-tailed *t* test for continuous variables and χ^2 test for categorical variables.

percent other; $p < 0.001$). Approximately 54 percent of open carpal tunnel release procedures received a postoperative opioid and 51 percent of endoscopic carpal tunnel release procedures received a postoperative opioid.

Figure 1 depicts the proportion of patients receiving a postoperative opioid prescription stratified by practice. There was substantial variation in opioid prescribing between the sites, ranging from 6 percent of the operations receiving a postoperative opioid prescription to 92 percent of the operations receiving a postoperative opioid prescription. In addition, there was substantial variation in the average number of pills prescribed per practice, ranging from five to 22 pills (Fig. 2).

Using multilevel modeling controlling for patient, surgeon, and practice characteristics (Table 2), endoscopic carpal tunnel releases were significantly associated with decreased odds of receiving a postoperative opioid prescription compared to open carpal tunnel releases (OR, 0.19; 95 percent CI, 0.07 to 0.52). The predicted probability of receiving a postoperative opioid prescription for patients undergoing open carpal tunnel release was 64.7 percent (95 percent CI, 44.9 to 84.6), compared to a predicted probability of 42.3 percent for patients undergoing endoscopic carpal tunnel release (95 percent CI, 19.7 to 65.0). Other patient characteristics including sex, race, and history of chronic pain were not associated with the receipt of a postoperative opioid prescription. However, 57 percent of the variation was explained at the practice level, with a median odds ratio of 8.26, and 4 percent of the variation was explained at the surgeon level, with a median odds ratio of 1.75.

Sensitivity analyses after removing all patients with concomitant procedures or undergoing concurrent bilateral carpal tunnel releases demonstrated similar results. Approximately 51 percent of carpal tunnel release patients received a postoperative opioid prescription. [**See Table, Supplemental Digital Content 2**, which shows sensitivity analysis (patient sociodemographic and clinical characteristics stratified by receipt of a postoperative opioid prescription after removing bilateral carpal tunnel releases and carpal tunnel releases performed with other concomitant procedures), ***http://links.lww.com/PRS/E663***.] In the multilevel model, endoscopic carpal tunnel releases were associated with decreased odds of receipt of a postoperative opioid prescription (OR, 0.22; 95 percent CI, 0.08 to 0.62). [**See Table, Supplemental Digital Content 3**, which shows sensitivity analysis (multilevel modeling for predictors for receipt of a postoperative opioid prescription with removal of bilateral carpal tunnel releases and carpal tunnel releases performed

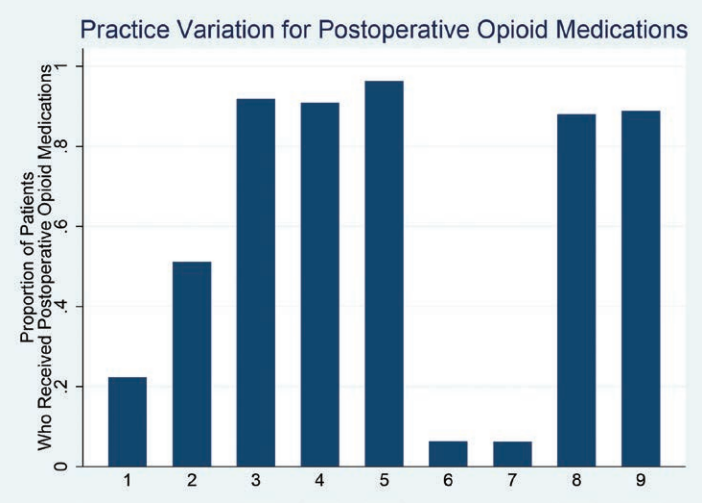

Fig. 1. Substantial variation in opioid prescribing is seen at the practice level.

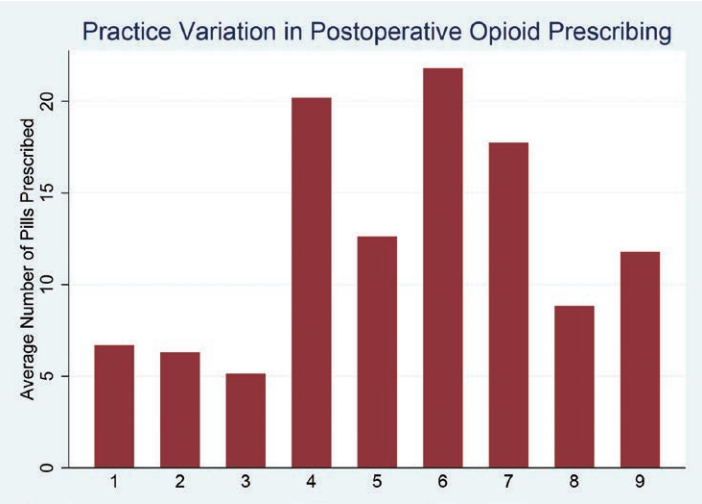

Fig. 2. Variation in the average number of opioid pills prescribed after carpal tunnel release.

with other concomitant procedures), ***http://links.lww.com/PRS/E664***.] The variation explained at the practice level was 54 percent, with a median odds ratio of 7.6; the variation explained at the surgeon level was 6 percent, with a median odds ratio of 2.0.

DISCUSSION

In this national quality improvement study, we found that the majority of patients undergoing carpal tunnel release receive a postoperative opioid prescription. Patients undergoing endoscopic carpal tunnel releases were less likely to receive a postoperative opioid. However, the variation in opioid prescribing was explained primarily at the practice level, rather than by patient-level or surgeon-level factors.

Opioid prescribing after carpal tunnel release is pervasive. In a national study from 2009 to 2013 by Waljee et al., approximately 62 percent of patients undergoing a carpal tunnel release filled a postoperative opioid prescription, with 9 percent refilling their prescription.[24] In our study of patients undergoing carpal tunnel release in 2019, we found that 53 percent of patients received a postoperative opioid prescription. This smaller percentage in opioid prescribing compared to the study by Waljee et al. may be because of the media attention surrounding the opioid epidemic, the national efforts to minimize opioid use, and our specific sample of patients. Although

Table 2. Multilevel Modeling for Predictors of Receipt of a Postoperative Opioid Prescription*

Covariate	OR (95% CI)	*p*
Sex		
Male	1 (Ref)	0.38
Female	1.22 (0.78–1.91)	
Race		
White	1 (Ref)	0.22
Black	1.51 (0.78–2.93)	
Other	1.08 (0.44–2.63)	0.87
Current smoker		
No	1 (Ref)	0.55
Yes	0.79 (0.37–1.70)	
History of chronic pain		
No	1 (Ref)	0.10
Yes	0.61 (0.34–1.10)	
Surgery type		
Open carpal tunnel release	1 (Ref)	0.001
Endoscopic carpal tunnel release	0.19 (0.07–0.52)	
Practice level		
ICC	57.4	
Median OR	8.26	
Surgeon level		
ICC	4.1	
Median OR	1.75	

Ref, reference; ICC, intraclass correlation coefficient.
*Covariates in the model include age as a quadratic, sex, race, insurance type, current smoker, history of chronic pain, and surgery type with intercepts at the practice and surgeon levels.

studies have shown that nonopioid analgesia after carpal tunnel release demonstrates similar pain control, patient satisfaction, and functional outcomes compared to opioid analgesia,[25] the majority of patients undergoing carpal tunnel release still receive opioids postoperatively, highlighting an area for quality improvement. Moreover, we found substantial variation in the number of opioid pills prescribed, ranging from five to 22 pills, underscoring the need for additional efforts to minimize opioid prescribing. Recent data have shown that providers overprescribe opioids after carpal tunnel release, leading to a substantial number of unused pills.[2,26] Excess opioid prescribing after surgery has been implicated in the nonmedical use of opioids and subsequent addiction.[27] More specifically, for elective hand surgery, 13 percent of previously opioid-naive patients continue to use opioids between 90 and 180 days after surgery, highlighting the risk of continued opioid use after hand surgery.[9] Therefore, efforts to minimize prescribing to achieve desired analgesia without overprescribing are essential.

Multiple institutions and hospital consortiums have initiated evidence-based opioid prescribing guidelines to reduce postoperative opioid prescriptions. Recently, development and implementation of statewide opioid prescribing guidelines after surgery resulted in a reduction of opioid prescription sizes without affecting patient satisfaction or pain scores.[28] In a study by Howard et al., a statewide hospital consortium initiated a quality-based reimbursement incentive to use an opioid-sparing pathway after surgery. This monetary incentive resulted in 70.4 percent of target operations adopting an opioid-sparing pathway.[29] Within the field of hand surgery, a single academic center initiated mandatory narcotic-prescribing education and postoperative opioid prescribing guidelines, resulting in a 12-pill reduction in postoperative opioid prescribing after carpal tunnel release from an average of 23.8 pills before intervention to 11.4 pills after intervention.[30] However, not all prescribers are targeted in these initiatives. In another study by Gaspar et al.,[10] trainees reported higher postoperative opioid prescription sizes for commonly performed hand procedures compared to attending surgeons, revealing the importance of education of all prescribers, including trainees. In our study, 57 percent of the variation in opioid prescribing was explained at the practice level (i.e., between practices) and 4 percent at the surgeon level (i.e., between surgeons), revealing that surgeons at the same practice generally prescribe in a similar manner. Discussions with Michigan Collaborative Hand Initiative for Quality in Surgery providers indicate that the participating sites did not have formal guidelines regarding opioid prescriptions following carpal tunnel release at the time of data collection. Therefore, the institutional milieu may be a more important factor than individual preferences in prescribing practices. These findings underscore the importance of minimizing between-practice variation through national efforts for opioid prescribing standardization and incorporating all prescribers from an institution, including trainees and advanced practice providers, in opioid reduction efforts. However, there are no established recommendations regarding the number of opioid pills to prescribe after carpal tunnel release and which patients benefit from avoiding postoperative opioid analgesia altogether. Given that many patients undergo carpal tunnel release without any need for opioid analgesia, we agree with previous studies that recommend that providers encourage the use of nonopioid analgesia and limit opioid prescriptions to zero to five pills and possibly up to 10 pills.[6,31] However, there are specific instances where a one-size-fits-all model does not work. In this study, certain practices that rarely prescribe opioids after carpal tunnel release had specific patients that required larger opioid prescriptions after surgery, highlighting the importance of a more nuanced patient-centered approach to prescribing. Moreover, patients on opioids before their carpal tunnel release may consist of a unique

population where national prescribing guidelines are not appropriate. Nevertheless, national organizations should adopt evidence-based opioid prescribing recommendations for carpal tunnel release that target all prescribers.

In our study, the use of endoscopic carpal tunnel release was associated with fewer postoperative opioid prescriptions. Studies have shown no differences in long-term efficacy of endoscopic versus open carpal tunnel release for symptom resolution and long-term pain scores.[32] For the immediate postoperative period, endoscopic carpal tunnel release is associated with less pain,[33,34] perhaps obviating the need for postoperative opioid analgesia. In addition, endoscopic carpal tunnel release is associated with faster return to work and a faster recovery of daily life function.[35,36] However, little is known regarding opioid prescribing and opioid use between patients undergoing open carpal tunnel release and endoscopic carpal tunnel release. In this study, we found a significant decreased odds of receiving an opioid prescription for patients undergoing endoscopic carpal tunnel release, which may suggest an opportunity to minimize opioid prescribing. However, not all surgeons are comfortable with performing endoscopic carpal tunnel releases, and endoscopic carpal tunnel releases may be more costly than open carpal tunnel releases.[37] Nonetheless, for providers who perform both open carpal tunnel release and endoscopic carpal tunnel release, the use of endoscopic carpal tunnel release may obviate the need for a postoperative opioid prescription.

Our study has several limitations. First, this is an observational cohort study, which cannot determine any causation regarding the relationship between the patient, practice, or surgeon characteristics and opioid prescribing. This study also includes surgeons from eight academic centers and one large private practice that all participate in the education of residents and/or fellows, thus possibly limiting the generalizability to other surgeons. However, we are unable to disclose how the private practice performed compared to the other academic practices because of the data-use agreement. In addition, not all surgeons in this consortium perform endoscopic carpal tunnel releases, which may introduce bias into the sample. The fact that a prescription was more likely to be given following open carpal tunnel release does not mean the procedure is more painful or patients will need opioid medications for pain control following surgery. We did control for the practice and the surgeon to account for potential confounding, but each practice did not contain the same number of surgeons, which may also account for variability. Because we did not initially include opioid type and dosage in our data collection process, we had nonrandom missingness of these data and therefore were unable to use oral morphine equivalents in our model. In addition, we did not collect the anesthesia type for each carpal tunnel release, so we cannot assess the association between wide awake local anesthesia no tourniquet technique and opioid use postoperatively. Lastly, opioid prescribing is multifactorial and may be patient, practice, and/or surgeon driven. Although we did collect patient information regarding current opioid use at the time of carpal tunnel release, we did not collect information regarding patient history of chronic pain, opioid use, or opioid abuse. This information could have affected the prescribing practice. We are unable to understand the specific reasons behind opioid prescribing because we lack information on the physician-patient relationship.

In this study, we found that the majority of patients receive an opioid prescription after carpal tunnel release, and endoscopic carpal tunnel release patients were less likely to receive postoperative opioids. Practice-level prescribing patterns play a substantial role in the variation of postoperative opioid prescriptions. Therefore, to reduce opioid prescribing after carpal tunnel release, national evidence-based prescribing recommendations must be developed and should target all prescribers, including trainees and advanced practice providers to minimize the variation in postoperative opioid prescribing.

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APPENDIX. MICHIGAN COLLABORATIVE HAND INITIATIVE FOR QUALITY IN SURGERY COLLABORATORS

The members of the Michigan Collaborative Hand Initiative for Quality in Surgery Collaborators are as follows: Joshua Adkinson, M.D.; John Fowler, M.D.; R. Glenn Gaston, M.D.; Aviram Giladi, M.D., M.S.; Michael Gottschalk, M.D.; Warren Hammert, D.D.S., M.D.; Ryan Katz, M.D.; Zhongyu John Li, M.D., Ph.D.; Marco Rizzo, M.D.; and Eric Wagner, M.D., M.S.

REFERENCES

1. Substance Abuse and Mental Health Services Administration. Key substance use and mental health indicators in the United States: Results from the 2018 National Survey on Drug Use and Health (HHS publication no. PEP19-5068, NSDUH Series H-54). Rockville, Md: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration; 2019. Available at: https://www.samhsa.gov/data/sites/default/files/cbhsq-reports/NSDUHNationalFindingsReport2018/NSDUHNationalFindingsReport2018.pdf. Accessed May 21, 2020.
2. Peters B, Izadpanah A, Islur A. Analgesic consumption following outpatient carpal tunnel release. *J Hand Surg Am.* 2018;43:189.e1–189.e5.
3. Rodgers J, Cunningham K, Fitzgerald K, Finnerty E. Opioid consumption following outpatient upper extremity surgery. *J Hand Surg Am.* 2012;37:645–650.
4. Sabatino MJ, Kunkel ST, Ramkumar DB, Keeney BJ, Jevsevar DS. Excess opioid medication and variation in prescribing patterns following common orthopaedic procedures. *J Bone Joint Surg Am.* 2018;100:180–188.
5. Hozack BA, Abboudi J, Gallant G, et al. Prospective evaluation of opioid consumption following cubital tunnel decompression surgery. *Hand (N Y)* 2019;14:42–47.
6. Kim N, Matzon JL, Abboudi J, et al. A prospective evaluation of opioid utilization after upper-extremity surgical procedures: Identifying consumption patterns and determining prescribing guidelines. *J Bone Joint Surg Am.* 2016;98:e89.
7. Miller A, Kim N, Zmistowski B, Ilyas AM, Matzon JL. Postoperative pain management following carpal tunnel release: A prospective cohort evaluation. *Hand (N Y)* 2017;12:541–545.
8. Brummett CM, Waljee JF, Goesling J, et al. New persistent opioid use after minor and major surgical procedures in US adults. *JAMA Surg.* 2017;152:e170504.
9. Johnson SP, Chung KC, Zhong L, et al. Risk of prolonged opioid use among opioid-naïve patients following common hand surgery procedures. *J Hand Surg Am.* 2016;41:947–957.e3.
10. Gaspar MP, Pflug EM, Adams AJ, et al. Self-reported postoperative opioid-prescribing practices following commonly performed orthopaedic hand and wrist surgical procedures: A nationwide survey comparing attending surgeons and trainees. *J Bone Joint Surg Am.* 2018;100:e127.
11. Hill MV, McMahon ML, Stucke RS, Barth RJ Jr. Wide variation and excessive dosage of opioid prescriptions for common general surgical procedures. *Ann Surg.* 2017;265:709–714.
12. Lancaster E, Inglis-Arkell C, Hirose K, et al. Variability in opioid-prescribing patterns in endocrine surgery and discordance with patient use. *JAMA Surg.* 2019;154:1069–1070.
13. Stanek JJ, Renslow MA, Kalliainen LK. The effect of an educational program on opioid prescription patterns in hand surgery: A quality improvement program. *J Hand Surg Am.* 2015;40:341–346.
14. Ziegelmann MJ, Joseph JP, Glasgow AE, et al. Wide variation in opioid prescribing after urological surgery in tertiary care centers. *Mayo Clin Proc.* 2019;94:262–274.
15. Eid AI, DePesa C, Nordestgaard AT, et al. Variation of opioid prescribing patterns among patients undergoing similar surgery on the same acute care surgery service of the same institution: Time for standardization? *Surgery* 2018;164:926–930.
16. Michigan Opioid Prescribing Engagement Network. Michigan OPEN. Available at: https://michigan-open.org/. Accessed May 13, 2020.
17. Fajardo M, Kim SH, Szabo RM. Incidence of carpal tunnel release: Trends and implications within the United States ambulatory care setting. *J Hand Surg Am.* 2012;37:1599–1605.
18. Jain NB, Higgins LD, Losina E, Collins J, Blazar PE, Katz JN. Epidemiology of musculoskeletal upper extremity ambulatory surgery in the United States. *BMC Musculoskelet Disord.* 2014;15:4.
19. Billig JI, Kotsis SV, Chung KC; Michigan Collaborative Hand Initiative for Quality in Surgery. The next frontier of outcomes research: Collaborative quality initiatives. *Plast Reconstr Surg.* 2020;145:1315–1322.
20. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap): A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform.* 2009;42:377–381.
21. Harris PA, Taylor R, Minor BL, et al.; REDCap Consortium. The REDCap consortium: Building an international community of software platform partners. *J Biomed Inform.* 2019;95:103208.
22. Centers for Disease Control and Prevention. Calculating total daily dose of opioids for safer dosage. Available at: https://www.cdc.gov/drugoverdose/pdf/calculating_total_daily_dose-a.pdf. Accessed June 2, 2020.
23. Merlo J, Chaix B, Ohlsson H, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: Using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health* 2006;60:290–297.
24. Waljee JF, Zhong L, Hou H, Sears E, Brummett C, Chung KC. The use of opioid analgesics following common upper extremity surgical procedures: A national, population-based study. *Plast Reconstr Surg.* 2016;137:355e–364e.
25. Grandizio LC, Zhang H, Dwyer CL, Goldberg SH, Klena JC. Opioid versus nonopioid analgesia after carpal tunnel release: A randomized, prospective study. *Hand (N Y)* 2021;16:38–44.
26. Chapman T, Kim N, Maltenfort M, Ilyas AM. Prospective evaluation of opioid consumption following carpal tunnel release surgery. *Hand (N Y)* 2017;12:39–42.

27. Bicket MC, Long JJ, Pronovost PJ, Alexander GC, Wu CL. Prescription opioid analgesics commonly unused after surgery: A systematic review. *JAMA Surg.* 2017;152:1066–1071.
28. Vu JV, Howard RA, Gunaseelan V, Brummett CM, Waljee JF, Englesbe MJ. Statewide implementation of postoperative opioid prescribing guidelines. *N Engl J Med.* 2019;381:680–682.
29. Howard R, Hallway A, Santos-Parker J, et al. Optimizing postoperative opioid prescribing through quality-based reimbursement. *JAMA Netw Open* 2019;2:e1911619.
30. Stepan JG, Lovecchio FC, Premkumar A, et al. Development of an institutional opioid prescriber education program and opioid-prescribing guidelines: Impact on prescribing practices. *J Bone Joint Surg Am.* 2019;101:5–13.
31. Dwyer CL, Soong M, Hunter A, Dashe J, Tolo E, Kasparyan NG. Prospective evaluation of an opioid reduction protocol in hand surgery. *J Hand Surg Am.* 2018;43:516–522.e1.
32. Atroshi I, Hofer M, Larsson GU, Ranstam J. Extended follow-up of a randomized clinical trial of open vs endoscopic release surgery for carpal tunnel syndrome. *JAMA* 2015;314:1399–1401.
33. Atroshi I, Larsson GU, Ornstein E, Hofer M, Johnsson R, Ranstam J. Outcomes of endoscopic surgery compared with open surgery for carpal tunnel syndrome among employed patients: Randomised controlled trial. *BMJ* 2006;332:1473.
34. Wong KC, Hung LK, Ho PC, Wong JM. Carpal tunnel release: A prospective, randomised study of endoscopic versus limited-open methods. *J Bone Joint Surg Br.* 2003;85:863–868.
35. Li Y, Luo W, Wu G, Cui S, Zhang Z, Gu X. Open versus endoscopic carpal tunnel release: A systematic review and meta-analysis of randomized controlled trials. *BMC Musculoskelet Disord.* 2020;21:272.
36. Vasiliadis HS, Georgoulas P, Shrier I, Salanti G, Scholten RJPM. Endoscopic release for carpal tunnel syndrome. *Cochrane Database Syst Rev.* 2014;1:CD008265.
37. Zhang S, Vora M, Harris AH, Baker L, Curtin C, Kamal RN. Cost-minimization analysis of open and endoscopic carpal tunnel release. *J Bone Joint Surg Am.* 2016;98:1970–1977.