Postoperative Opioid-Prescribing Practice in Limb Preservation Surgery

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Background: Limb preservation surgery affects more than 100,000 Americans annually. Current postoperative pain management prescribing practices of podiatric physicians in the United States are understudied. We examined prescribing practices for limb preservation surgery to identify prescriber characteristics' that may be associated with postoperative opioid-prescribing practices.

Methods: We administered an anonymous online questionnaire consisting of five patient scenarios with limb preservation surgery commonly performed by podiatric physicians. Respondents provided information about their prescription choice for each surgery. Basic provider demographics were collected. We developed linear regression models to identify the strength and direction of association between prescriber characteristics and quantity of postoperative opioid "pills" (dosage units) prescribed at surgery. Logistic regression models were used to identify the odds of prescribing opioids for each scenario.

Results: One hundred fifteen podiatric physicians completed the survey. Podiatric physicians reported using regional nerve blocks 70% to 88% of the time and prescribing opioids 43% to 67% of the time across all scenarios. Opioids were more commonly prescribed than nonsteroidal anti-inflammatory drugs and anticonvulsants. Practicing in the Northeast United States was a significant variable in linear regression ($P = .009$, a decrease of 9–10 dosage units) and logistic regression (odds ratio, 0.23; 95% confidence interval, 0.07–0.68; $P = .008$) models for the transmetatarsal amputation scenario.

Conclusions: Prescribing practice variation exists in limb preservation surgery by region. Podiatric physicians reported using preoperative regional nerve blocks more than prescribing postoperative opioids for limb preservation surgeries. Through excess opioid prescribing, the diabetes pandemic has likely contributed to the US opioid epidemic. Podiatric physicians stand at the intersection of these two public health crises and are equipped to reduce their impact via preventive foot care and prescribing nonopioid analgesics when warranted. (J Am Podiatr Med Assoc 114(2), 2024; doi:10.7547/21-256)

Limb preservation surgeries affect the lives of more than 100,000 Americans annually; of note, more than 86% of nontraumatic amputations in the United States are attributable to diabetes mellitus.[1] To maintain a functional limb, a wide range of limb preservation procedures are performed, ranging from toe amputations and split-thickness skin grafts to transmetatarsal amputations and partial calcanectomies.[2] Although patients who undergo these procedures may have debilitating health conditions, it remains unclear what constitutes acceptable postoperative pain management practices after limb preservation procedures, especially among patients with altered epicritic and protopathic sensation.[3] As

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a result, the balance between effective pain management and prevention of opioid dependence can be a difficult ethical dilemma in the setting of limb preservation scenarios.[3,4]

The current opioid epidemic in the United States is a severe public health crisis.[3,5-7] More than 1.6 million people had an opioid use disorder in 2020, with opioid-involved overdoses killing more than 50,000 people in the United States in 2019.[8,9] Furthermore, close to 80% of current heroin users first misused prescription opioids.[10]

The declaration of pain as the "fifth vital sign" in 1995 and subsequent initiatives of pain management have contributed to the current opioid epidemic.[11,12] These changes led to the common use of the visual analog scale, a subjective pain measurement tool, to assess patient pain as routinely as other vital signs; therefore, clinicians were expected to move beyond acetaminophen and nonsteroidal anti-inflammatory drugs to address patient pain.[11,12] Opioid prescriptions almost doubled, from 3.2% of Americans in 1988-1994 to 5.7% of Americans in 2005-2008.[11,12] This increase has significantly contributed to the rise in serious consequences of opioid use, such as addiction, overdose, and death. In 2020, Larach et al[13] found that prescription opioids after surgery is one of the common paths for opioid addiction among opioid-naive patients and a leading cause of the opioid epidemic. It is important for physicians to exercise sound clinical judgment when faced with the decision to prescribe opioids after nontraumatic amputations; such decisions can be a contributing factor to the current state of opioid misuse in the country.[14,15]

Benchmarking the postoperative opioid-prescribing habits of podiatric physicians in the United States may be useful in refining prescribing protocols to effectively control postoperative pain and minimize unused opioid distribution after limb preservation surgery.[3,16-19] This study, to our knowledge, was the first to explore the current prescription patterns of opioids after limb preservation surgery; this may aid podiatric physicians with this decision-making dilemma, as very little is currently known in the literature regarding an appropriate regimen for postoperative pain management for limb preservation procedures. Given that few national guidelines exist for opioid prescribing for acute pain, the purpose of this study was to evaluate the postoperative prescribing habits to manage postoperative pain among podiatric physicians. We believe that prescribing practices will be consistent with the previous work of Brooks et al[3] (N = 860) and hypothesize that the median quantity of opioids prescribed at the time of surgery will be 30 opioid dosage units. In addition, we sought to identify whether certain demographic characteristics of podiatric physicians were associated with their postoperative opioid-prescribing practices.

Methods

Research Design

This study was based on a previous study by Brooks et al,[3] which used a scenario-based questionnaire inspired by Hearty et al,[20] to survey podiatric physicians' postoperative opioid-prescribing practices in foot and ankle surgery. We received exempt status from the Committee for the Protection of Human Subjects at Dartmouth College (Hanover, New Hampshire) for an open, voluntary, anonymous, online questionnaire distributed on the Internet via the Qualtrics survey platform (Qualtrics, Seattle, Washington), which uses panel-based sampling to reach specific demographic populations. Respondents received no incentive for survey completion and could use a back button to revisit their answers. No personal or identifiable information was stored. We used the patient scenario surgery concept first used by Hearty et al.[20] The five procedures in this survey were 1) partial toe amputation, 2) incision and drainage with a partial fifth-ray amputation, 3) transmetatarsal amputation with percutaneous tendo Achillis lengthening, 4) partial calcanectomy, and 5) wound debridement and split-thickness skin graft application. Full patient scenarios are found in Appendix 1. Content validity was established through an extensive review of the literature in September 2019 and by the members of the 2019-2020 Clinical Practice Advisory Committee of the American Podiatric Medical Association (APMA), who served as content experts and offered input on each patient scenario and on commonly prescribed postoperative pain medications in limb preservation surgeries. We completed the pilot study in March 2020. This study adhered to the Checklist for Reporting Results of Internet E-Surveys (CHERRIES), found in Appendix 2.

Sample and Population

The target population was practicing podiatric physicians in the United States. We recruited practicing podiatric physicians exclusively through e-mail invitation from the APMA membership list, which

consisted of approximately 8,736 members who fit the eligibility criteria. Retired podiatric physicians, podiatric physicians who no longer perform surgery, current fellows, and residents were excluded. Survey respondents who did not complete the demographics section, which was at the end of the questionnaire, were also excluded from analysis.

Data Collection Process and Questionnaire

Two survey invitations were sent out via e-mail during the data collection period from March 20, 2021, to April 20, 2021. In the consent statement provided at the beginning of the survey, participants were asked to respond to the questionnaire only once (Appendix 3). The survey took an estimated 10 to 15 min to complete. Conditional branching was used. Respondents were presented with five different patient scenarios. For each scenario, respondents were then provided six multiple-choice options regarding which postoperative medication they would prescribe. Respondents were asked to complete a fill-in-the-blank response for the number of "pills" (dosage units) prescribed at the time of surgery. Dichotomous options for supplementing with nonsteroidal anti-inflammatory drugs, regional nerve blocks, and anticonvulsants were provided. We collected the following demographic information: gender identity, year of residency graduation, practice size, self-perception of one's prescribing practice, first-generation American status, practice environment, and the state in which each respondent primarily practiced. States were then reclassified into the US Census regions (Midwest, Northeast, South, and West), with Puerto Rico classified in the South region. Year of residency graduation was reclassified into "before 1996" and "1996 and after" to capture the effect of inclusion of pain as the fifth vital sign. We decided a posteriori to present "self-identified prescribing practice" in a separate study.

Statistical Analysis

Unweighted responses were analyzed. The Student t test was used for continuous variables, and analysis of variance was used for dichotomous and categorical variables. We analyzed the data using R, Version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria). Completed surveys were analyzed at a predefined level of $\alpha \leq .05$ for statistical significance. To adjust for confounding in the analysis stage, we initially planned for a multiple linear regression model among opioid prescribers consisting of variables that achieved $P < .1$ in the univariate analysis; however, given the lower-than-anticipated response rate, we made a decision a posteriori to present the unadjusted results for all of the explanatory variables except "self-identified prescribing practice" in the linear regression model, and we elected to do the same for the logistic regression analysis comparing opioid prescribing with nonopioid prescribing. All of the assumptions were met.

Variables of Interest

Number of pills prescribed (opioid dosage units) at the time of surgery was the dependent variable for the linear regression models. Prescribing opioids was the dependent variable for the logistic regression models. The percentages of podiatric physicians who opted to prescribe opioids, nonsteroidal anti-inflammatory drugs, regional nerve blocks, and anticonvulsants were also obtained, as was the most common opioid prescribed for each scenario.

Results

Descriptive Results

The survey was sent to 8,736 APMA members who met the inclusion criteria. There was a completeness rate of 89.84% (115 of 128 respondents). The final sample included 115 podiatric physicians who completed 100% of the survey, resulting in an overall response rate of 1.32% (115 of 8,736 potential responders). Opioids were prescribed 43% to 67% of the time across all five scenarios. Among opioid prescribers, the most commonly prescribed opioid in patient scenarios 1, 2, 3, and 5 was hydrocodone, and oxycodone was more commonly prescribed in patient scenario 4. Regional nerve blocks were common forms of analgesia, ranging from 70% to 88% across all of the scenarios, whereas nonsteroidal anti-inflammatory drugs and anticonvulsants (ie, gabapentin) were not more commonly prescribed than opioids (Table 1). Among opioid prescribers, the mean dosage units prescribed at the time of surgery ranged from 21.9 to 26.4 across all of the scenarios, and the median dosage units ranged from 20 to 28 across the same scenarios (Table 2).

Univariate Analysis

Compared with podiatric physicians who began practicing before 1996, those who began practicing in 1996 or later prescribed more in most scenarios; this was significant in patient scenario 3 ($P = .048$).

Table 1. Pain Management Prescribing Practices by Patient Scenario

Patient Scenario	Analgesic	Responses (%)	
		Yes	No
1: Partial toe amputation	Regional nerve block	86	14
	Opioid	67	33
	NSAID	45	55
	Anticonvulsant	15	85
2: I&D with partial fifth-ray amputation	Regional nerve block	88	12
	Opioid	57	43
	NSAID	32	68
	Anticonvulsant	16	84
3: Transmetatarsal amputation with percutaneous tendo Achillis lengthening	Regional nerve block	72	28
	Opioid	43	57
	NSAID	32	68
	Anticonvulsant	16	84
4: Partial calcanectomy	Regional nerve block	70	30
	Opioid	43	57
	NSAID	38	62
	Anticonvulsant	17	83
5: Wound debridement and split-thickness skin graft	Regional nerve block	73	27
	Opioid	51	49
	NSAID	33	67
	Anticonvulsant	23	77

Abbreviations: I&D, incision and drainage; NSAID, nonsteroidal anti-inflammatory drug.

Practice region was significant in patient scenario 3 ($P = .001$). There was no statistical significance by other surgeon characteristics (Table 3).

Simple Regression Analysis

Only two variables were significant in both the simple linear and logistic regressions. Practicing in the Northeast United States was a significant variable in linear regression ($P = .009$; a decrease of 9–10 dosage units) and logistic regression (odds ratio, 0.23; 95% confidence interval, 0.07–0.68; $P = .008$) models for the transmetatarsal amputation scenario (patient scenario 3). Practicing after 1996, which we used a proxy for established pain as the fifth vital sign, was significant in the linear regression ($P = .048$; an increase of 5–6 opioid dosage units) and the logistic regression (odds ratio, 2.24; 95% confidence interval, 1.03–4.88; $P = .042$) (Table 4). The a priori–adjusted results are given in the Supplemental Material.

Discussion

Summary of Findings

In this nationwide cross-sectional study of 115 podiatric physicians, regional nerve blocks were the most common form of pain management across all of the scenarios of limb preservation–related surgery. Opioids were the second most common form of postoperative pain management, followed by nonsteroidal anti-inflammatory drugs and anticonvulsants. Although the Northeast region trended toward significance in several other models, patient

Table 2. Dosage Units Prescribed at the Time of Surgery

Patient Scenario	Dosage Units Prescribed (No.)		
	Mean	Median	SD
1: Partial toe amputation	23.6	20	13.01
2: I&D with partial fifth-ray amputation	21.9	20	12.45
3: Transmetatarsal amputation with percutaneous tendo Achillis lengthening	25.7	28	14.14
4: Partial calcanectomy	26.4	28	14.95
5: Wound debridement and split-thickness skin graft	23.8	24	13.7

Abbreviation: I&D, incision and drainage.

Table 3. Univariate Analysis by Podiatric Physician Characteristics for Opioid Dosage Units Prescribed at the Time of Surgery

	Characteristics (*P* Values)							
Patient Scenario	Age	Sex	Practicing Since 1996	Small Practice	Practice Environment	First-Generation American	Practice Region	Board Certified
1: Partial toe amputation	.202	.296	.384	.828	.529	.907	.613	.763
2: I&D with partial fifth-ray amputation	.462	.308	.229	.729	.817	.249	.182	.669
3: Transmetatarsal amputation with percutaneous tendo Achillis lengthening	.159	.461	.048[a]	.796	.303	.284	.001[a]	.695
4: Partial calcanectomy	.873	.537	.336	.877	.665	.811	.52	.559
5: Wound debridement and split-thickness skin graft	.103	.741	.194	.667	.599	.485	.149	.365

Abbreviation: I&D, incision and drainage.
[a]Statistically significant.

scenario 3 (ie, transmetatarsal amputation with percutaneous Achilles tendon lengthening) was the only time it was statistically significant. We consider the reduction of 9 to 10 opioid dosage units prescribed at the time of surgery by podiatric physicians practicing in the Northeastern United States to be clinically meaningful. Among opioid prescribers, the median number of opioid dosage units prescribed by all of the podiatric physicians at the time of surgery never exceeded 28 regardless of the scenario. Nonetheless, there is variation in postoperative pain management among patients who underwent limb preservation–related procedures across the nation, with practice region being statistically significant.

Opioid Prescription in Limb Preservation versus Elective and Traumatic Foot and Ankle Surgery

To our knowledge, this is the first study investigating postoperative opioid-prescribing patterns after limb preservation procedures. This study expanded on the previous work by Hearty et al[20] and Brooks et al.[3] The questionnaire-based cross-sectional study (N = 64) by Hearty et al,[20] which Brooks et al[3] modified (N = 860), examined the association between prescriber characteristics and postoperative pain management prescribing practice among orthopedic foot and ankle surgeons and podiatric foot and ankle surgeons, respectively. Regarding opioid dosage units, Hearty et al[20] and Brooks et al[3] placed the median values at 40 and 30, respectively, yet in the present study the respondents reported an aggregate median that never exceeded 28 opioids at the time of surgery, which is closer to the median reported by Brooks et al[3] than by Hearty et al[20]; despite the scenarios in the present study containing people who typically have poor sensation, the dosage units prescribed were somewhat similar to those of elective foot and ankle surgery on sensate patients. Brooks et al[3] and Hearty et al[20] both investigated elective or traumatic foot and ankle procedures, which often constitute a very different population than patients who undergo limb preservation procedures.

Peripheral Neuropathy and Opioid Prescription

Although the previously discussed investigations[3,20] shed some light on current opioid-prescribing patterns among orthopedic and podiatric physicians, patients who undergo limb preservation procedures often have severe comorbidities, such as peripheral neuropathy or peripheral artery disease (PAD).[1] The perception of pain among patients with peripheral neuropathy is often diminished.[2,21] Intuitively, the consumption and requirement of opioid prescription for postoperative management may be less. Furthermore, in a 22-patient case series, Arts et al[22] noted that patients with an insensate foot rarely even required any form of anesthesia, including local anesthesia, while undergoing surgery. For patients with PAD, a recent retrospective study further suggested that patients with PAD were at higher risk for high-dose opioid use after PAD-related procedures, including lower-extremity amputations.[23] Therefore, the opioid-prescribing pattern for elective foot and ankle surgery may not be suitable or appropriate for this population; this should be a topic for future research. Yet, the present investigation suggested that the amount of opioid received by patients who undergo limb preservation procedures seems to be somewhat similar to that reported previously by Hearty et al[20] and Brooks et al.[3] This brings into question the appropriate quantity of opioid prescription in a population that has underlying peripheral neuropathy, PAD, or both, especially

Table 4. Unadjusted Logistic Regression Models for Prescribing Any Opioids and Linear Regression Models for Opioid Dosage Units Prescribed the Day of Surgery

	Scenario 1			Scenario 2			Scenario 3			Scenario 4			Scenario 5		
Linear Regression: Quantity of Opioids Prescribed at Time of Surgery															
Predictor	Estimates	95% CI	*P* Value	Estimates	95% CI	*P* Value	Estimates	95% CI	*P* Value	Estimates	95% CI	*P* Value	Estimates	95% CI	*P* Value
Age	0.13	−0.07 to 0.34	0.202	−0.08	−0.28 to 0.13	.462	−0.16	−0.39 to 0.06	.159	−0.02	−0.26 to 0.22	.873	0.18	−0.04 to 0.40	.103
Sex [male]	2.98	−2.64 to 8.59	0.296	2.78	−2.60 to 8.15	.308	−2.29	−8.42 to 3.85	.461	−2.03	−8.52 to 4.46	.537	0.99	−4.94 to 6.93	.741
Began practicing after 1996	−2.13	−6.97 to 2.70	0.384	2.82	−1.79 to 7.43	.229	5.24	0.06 to 10.42	.048[a]	2.71	−2.84 to 8.26	.336	−3.35	−8.42 to 1.72	.194
Small practice [yes]	−0.54	−5.41 to 4.33	0.828	0.82	−3.84 to 5.47	.729	−0.69	−5.98 to 4.60	.796	0.44	−5.16 to 6.03	.877	1.12	−4.01 to 6.24	.667
First-generation American [yes]	−0.33	−6.01 to 5.34	0.907	3.21	−2.29 to 8.71	.249	−3.39	−9.63 to 2.85	.284	0.8	−5.83 to 7.44	.811	−2.14	−8.20 to 3.91	.485
Practice location	−3.27	−9.93 to 3.40	0.333	−1.95	−8.35 to 4.45	.547	−5.63	−12.83 to 1.57	.124	−3.41	−11.12 to 4.29	.382	−1.21	−8.24 to 5.82	.733
Practice location [urban]	−4.1	−11.60 to 3.40	0.281	−2.02	−9.21 to 5.18	.58	−4.68	−12.78 to 3.42	.254	−3.3	−11.97 to 5.37	.452	−3.73	−11.64 to 4.17	.351
Board certified [yes]	1.07	−5.91 to 8.04	0.763	−1.44	−8.11 to 5.23	.669	1.5	−6.07 to 9.08	.695	2.37	−5.64 to 10.37	.559	3.36	−3.96 to 10.68	.365
Regions [Northeast]	−1.41	−8.24 to 5.42	0.683	−5.87	−12.32 to 0.57	.074	−9.37	−16.33 to −2.42	.009[a]	−1.85	−9.49 to 5.79	.633	−2.51	−9.59 to 4.57	.484
Regions [South]	2.94	−3.56 to 9.43	0.372	0.41	−5.71 to 6.54	.894	0.17	−6.44 to 6.78	.959	1.89	−5.37 to 9.16	.606	−3.9	−10.62 to 2.83	.254
Regions [West]	1.89	−4.86 to 8.65	0.58	0.61	−5.76 to 6.98	.85	6.05	−0.82 to 12.93	.084	8.79	1.24 to 16.35	.023[a]	4.09	−2.91 to 11.08	.25
Logistic Regression: Yes or No to Prescribing Any Postoperative Opioids															
Predictor	Odds Ratio	95% CI	*P* Value	Odds Ratios	95% CI	*P* Value	Odds Ratios	95% CI	*P* Value	Odds Ratios	95% CI	*P* Value	Odds Ratios	95% CI	*P* Value
(Intercept)	0.15	0.02 to 0.99	.049[a]	0.27	0.11 to 0.67	.005[a]	0.66	0.40 to 1.09	.104	0.61	0.35 to 1.08	.093	0.49	0.32 to 0.75	.001[a]
Age	1.02	0.99 to 1.06	.163	0.99	0.96 to 1.02	.539	0.97	0.93 to 1.00	.054	1.00	0.97 to 1.03	.871	1.02	0.99 to 1.05	.209
Sex [male]	2.4	0.88 to 6.52	.087	1.8	0.75 to 4.34	.191	0.81	0.33 to 1.96	.64	1.04	0.43 to 2.49	.931	1.15	0.49 to 2.70	.748
Began practicing after 1996	0.68	0.31 to 1.47	.322	1.44	0.69 to 3.01	.333	2.24	1.03 to 4.88	.042[a]	1.14	0.54 to 2.44	.73	0.64	0.31 to 1.35	.241
Small practice [yes]	0.83	0.39 to 1.80	.645	1.07	0.51 to 2.24	.857	0.79	0.37 to 1.69	.547	0.98	0.46 to 2.09	.96	1.34	0.64 to 2.82	.432
First-generation American [yes]	1.12	0.45 to 2.75	.812	1.37	0.57 to 3.26	.48	0.63	0.26 to 1.51	.301	1.1	0.45 to 2.69	.835	0.93	0.39 to 2.22	.876
Practice location	0.5	0.18 to 1.39	.183	0.74	0.27 to 2.04	.566	0.33	0.10 to 1.11	.074	0.61	0.21 to 1.80	.369	0.78	0.28 to 2.17	.637
Practice location [urban]	0.43	0.13 to 1.39	.157	0.55	0.17 to 1.71	.299	0.33	0.09 to 1.21	.095	0.64	0.19 to 2.14	.472	0.51	0.16 to 1.61	.251
Board certified [yes]	1.26	0.40 to – 3.91	.692	0.87	0.30 to 2.50	.793	1.25	0.43 to 3.63	.684	1.3	0.45 to 3.79	.627	1.48	0.51 to 4.29	.469
Regions [Northeast]	0.81	0.26 to 2.52	.72	0.47	0.16 to 1.38	.17	0.23	0.07 to 0.68	.008[a]	0.96	0.34 to 2.71	.943	0.73	0.26 to 2.05	.55
Regions [South]	1.6	0.58 to 4.43	.367	1.31	0.49 to 3.51	.594	0.83	0.29 to 2.32	.717	1.78	0.64 to 4.90	.266	0.53	0.19 to 1.42	.207
Regions [West]	1.31	0.45 to 3.80	.623	0.86	0.31 to 2.38	.768	1.59	0.50 to 5.09	.431	2.96	0.95 to 9.21	.06	1.49	0.52 to 4.28	.457

[a]Statistically significant.

given the harmful and addictive effects of this class of drugs.[24]

Opioid Prescribing Engagement Network Recommendations and Patient Education

Due to the prolongation of the opioid epidemic in the United States, the topic of excessive opioid prescription is gaining much of the attention.[25,26] As a result, methods to mitigate excessive opioid prescription have recently been explored.[25,27] Managing both patient and physician expectations has been shown to effectively reduce opioid prescription and use.[25] The importance of patient counseling is the cornerstone of an opioid prescription guide developed by the University of Michigan in 2017, which contains carefully studied recommendations for appropriate quantities of opioid prescription after a variety of surgeries.[27-29] These recommendations were made through the use of patient-reported data after elective laparoscopic cholecystectomy procedures; patients were surveyed regarding the quantity of opioid tablets (dosage units) actually consumed compared with the amount prescribed, and their corresponding pain levels.[25] The data showed that most patients used 6 opioid dosage units postoperatively but were prescribed 50 dosage units, on average.[25] The researchers noted that these leftover prescriptions were major contributors to opioid addiction, as 6% of opioid-naive patients went on to develop chronic opioid dependence.[25] Through the use of such patient-reported data, published studies, and expert opinion from surgeons, anesthesiologists, psychologists, and nurses, the Opioid Prescribing Engagement Network (OPEN) opioid-prescribing recommendations were made.[25,28,29]

Although the OPEN guidelines lack recommendations for foot and ankle surgery, an important takeaway is the emphasis on a patient- and procedure-dependent method of determining the correct amount of opioid prescription, as opposed to a one-size-fits-all anatomical-dependent method.[28,29] The latter method can lead to a large surplus of opioid dosage units, which may lead to opioid addiction. Furthermore, their research serves as evidence that patient education before surgery regarding the risks, benefits, and overall need for postoperative opioid prescription leads to its decreased use.[28,29] Their studies found that, contrary to popular belief, fewer quantities of opioid prescription did not lead to increased requests and phone calls for refills and inadequate pain control.[28,29] This was a result of appropriate patient counseling through setting proper expectations regarding postoperative pain, recommending nonopioid medication use, and discussing adverse effects.[29,30] As a result, it is evident that evidence-based recommendations for opioid prescription, coupled with patient education regarding opioid use, will allow the patient to manage their own expectations postoperatively and help reduce opioid use after surgery.[27-29]

Opioid Use Outside the United States

Although complications of type 2 diabetes mellitus and opioid overprescription are not solely American problems, their intersection very well may be an American challenge. Several studies have found that prescription opioid use in the United States occurs 2.5 to 4 times more frequently than in Western Europe[31,32]; this is worsened by the finding that the United States also uses more potent opioids.[31,32] For example, in an observational study performed by Zaslansky et al,[33] patient-reported data demonstrated that US patients received a much higher load of opioids after orthopedic surgeries compared with patients internationally. Furthermore, international patients received nonopioids more frequently than US patients postoperatively.[31-33] Despite increased opioid use, US patients still reported higher pain levels postoperatively.[31-33] Many experts claim that increased marketing by pharmaceutical companies, the use of pain as the fifth vital sign, cultural perception of pain eradication, and few national guidelines and little oversight for opioid prescribing have led to the significantly increased opioid use in the United States, resulting in the devastating consequences of opioid misuse.[12,31,32]

Moving Forward

National recommendations for opioid prescribing in foot and ankle surgery are scarce; however, the lack of guidelines is especially evident in the realm of limb preservation procedures, where no formal investigation is available, to our knowledge. It is imperative to standardize the time frame and quantity of opioid prescriptions after limb preservation procedures to prevent further worsening of the opioid epidemic in the United States. An important consideration in creating specific guidelines for opioid prescription after limb preservation procedures is the high prevalence of peripheral neuropathy and other comorbidities in patients who undergo such procedures, as discussed previously herein. Furthermore, the evidence-based approach of the University of

Michigan OPEN recommendations can serve as a guiding principle in creating similar guidelines for the field of limb preservation surgery.[29] Finally, a multimodal approach to pain management, with emphasis on patient education and nonopioid analgesic use, should be used in such guidelines.[34-36] An established benchmark may aid in improving patient outcomes after limb preservation surgery.

Limitations

There are several limitations of the present study. The study had a 1.3% response rate ($n = 115$). This low response rate makes interpretation of the results difficult to generalize findings to all of the podiatric physicians practicing in the United States. Furthermore, the data were collected only during a brief period. In addition, we were not able to adjust for confounding based on state laws regarding prescription opioids, which may have influenced results; however, we believe that there is still value in benchmarking a median among this national sample. Furthermore, this study used hypothetical patient scenarios rather than gathering actual prescribing practice data. Individual patient characteristics in the clinical setting are often complex and various. The hypothetical scenarios may not reflect clinical scenarios entirely, but the scenarios are developed and vetted by podiatric physicians who are experienced in limb preservation procedures. Furthermore, there may have been some misinterpretation as to what constitutes a regional nerve block because it was not defined in the questionnaire. Last, although we attempt to capture the represented population via the APMA, its membership may not accurately serve as a proxy for the entire podiatric physician population in the United States. Nonetheless, the results of this study highlight an area of deficiency of national recommendations.

Conclusions

The diabetes pandemic has likely contributed to the US opioid epidemic. Podiatric physicians tend to use regional nerve blocks more frequently than prescribing opioids for limb preservation surgeries of the foot, whereas opioids were more commonly prescribed than nonsteroidal anti-inflammatory drugs and anticonvulsants. In four of the five patient scenarios, hydrocodone was the most common opioid prescribed among opioid prescribers. The median quantity of opioid dosage units prescribed at the time of surgery never exceeded 28 regardless of the limb preservation surgery. Prescribing practice variation does exist in limb preservation surgery; however, it remains unknown how much of this variation is unwarranted. Given that the patient population that requires limb preservation surgery tends to have multiple comorbidities, the management of postoperative pain needs to be tailored to the patient to further mitigate unnecessary opioid-related complications. Podiatric physicians can continue to reduce the impact of the opioid epidemic via preventive foot care and prescribing nonopioid analgesics when warranted.

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Appendix 1. Patient Scenarios

Patient Scenario 1

A 56-year-old woman with a history of poorly controlled DM2 (HbA_{1c} level, 10.5%), hypertension, and a body mass index of 35 presents for a neuropathic ulceration of the left second toe due to clawing of digit. The patient is unsure of when it began but noticed stains on her carpet when she went barefoot. The left second digit is rigidly contracted. The ulceration is purulent and probes deep to bone. Radiographic findings are consistent with osteomyelitis. The patient denies pain and use of opioids.

Operation: Partial left second toe amputation

Patient Scenario 2

A 67-year-old man with a history of poorly controlled DM2 (HbA_{1c} level, 9.5%), hypertension, hyperlipidemia, and CKD stage 2 presents for chronic sub–fifth metatarsophalangeal joint plantar neuropathic ulceration. The ulceration began almost 1 year ago and has been worsening during the past few weeks. Previously, the patient had been following up at a wound care center for serial debridement, but he stopped going because his ulceration never hurt him. He now reports 2/10 pain. You note fluctuance on examination, and plain film radiographs are concerning for soft-tissue emphysema and osteomyelitis of the fifth metatarsal head as well as the base of the fifth proximal phalanx. His 1-month-old noninvasive vascular studies were unremarkable. The patient has palpable DP/PT pedal pulses. He denies previous opioid use and has been taking over-the-counter ibuprofen for pain.

Operation: Right lateral forefoot I&D with a partial fifth-ray amputation

Patient Scenario 3

A 57-year-old man with a history of poorly controlled DM2 (HbA_{1c} level, 12.7%), CKD stage 1, and a previous left partial first-ray amputation presents with a chronic left second sub–metatarsophalangeal joint wound that probes to bone. The ulceration is red, hot, swollen, and warm with purulence. The patient reports no pain. Protective sensation is absent plantarly and diminished elsewhere to the level of the ankle joint. Radiographs reveal underlying osteomyelitis of the second metatarsal head and proximal shaft. Palpable DP/PT pulses bilaterally. Vascular laboratory studies suggest good healing potential. The patient reports never taking opioids.

Operation: Left transmetatarsal amputation with percutaneous tendo Achillis lengthening

Patient Scenario 4

A 55-year-old nondiabetic man with a history of cauda equina complicated by paraplegia presents with a chronic right heel pressure ulcer that probes to bone. The ulceration began more than 1 year ago. There is radiographic evidence of osteomyelitis of the right calcaneus on radiography and MRI. The patient had previously undergone 6 weeks of intravenous antibiotic drug therapy. The wound has continued to worsen despite multiple attempts at off-loading. Palpable pedal pulses bilaterally. The patient has chronic pain due to his spinal cord injury and regularly takes hydrocodone 10 mg.

Operation: Right partial calcanectomy

Patient Scenario 5

A 62-year-old man with a history of poorly controlled DM2 (HbA_{1c} level, 9.5%), low-back pain, hypertension, hyperlipidemia, peripheral artery disease, and Charcot's neuroarthropathy is referred to you for foot pain. The patient has bounding pedal pulses and reports 4/10 pain. His MRI reveals a deep abscess secondary to his Charcot. You perform an I&D of the deep abscess. After completing the I&D, the resulting wound is too large for primary closure; even after the use of negative pressure wound vacuum-assisted closure therapy, which improved the wound depth, the wound remains open. The patient reports daily use of hydrocodone 5 mg for his low-back pain.

Operation: Debridement and application of a split-thickness skin graft to the right plantar midfoot

Abbreviations: CKD, chronic kidney disease; DM2, type 2 diabetes mellitus; DP/PT, dorsalis pedis/posterior tibial; HbA_{1c}, hemoglobin A_{1c}; I&D, incision and drainage; MRI, magnetic resonance imaging.

Appendix 2. Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Checklist Item	Explanation	Page No.
Describe survey design	Describe target population, sample frame. Is the sample a convenience sample? (In "open" surveys this is most likely.)	2-4
IRB approval	Mention whether the study has been approved by an IRB.	2-4
Informed consent	Describe the informed consent process. Where were the participants told the length of time of the survey, which data were stored and where and for how long, who the investigator was, and the purpose of the study?	2-4, Appendix 3
Data protection	If any personal information was collected or stored, describe what mechanisms were used to protect unauthorized access.	2-4
Development and testing	State how the survey was developed, including whether the usability and technical functionality of the electronic questionnaire had been tested before fielding the questionnaire.	2-4
Open survey versus closed survey	An "open survey" is a survey open for each visitor of a site, and a closed survey is open to only a sample that the investigator knows (password-protected survey).	2-4
Contact mode	Indicate whether the initial contact with the potential participants was made on the Internet. (Investigators may also mail questionnaires and allow for Web-based data entry.)	2-4

Advertising the survey	How/where was the survey announced or advertised? Some examples are offline media (newspapers), or online (mailing lists – If yes, which ones?) or banner ads (Where were these banner ads posted and what did they look like?). It is important to know the wording of the announcement as it will heavily influence who chooses to participate. Ideally the survey announcement should be published as an appendix.	2-4
Web/e-mail	State the type of e-survey (eg, one posted on a Web site, or one sent out through e-mail). If it is an e-mail survey, were the responses entered manually into a database, or was there an automatic method for capturing responses?	NA (Qualtrics)
Context	Describe the Web site (for mailing list/newsgroup) in which the survey was posted. What is the Web site about, who is visiting it, what are visitors normally looking for? Discuss to what degree the content of the Web site could preselect the sample or influence the results. For example, a survey about vaccination on an anti-immunization Web site will have different results from a survey conducted on a government Web site.	2-4
Mandatory/voluntary	Was it a mandatory survey to be filled in by every visitor who wanted to enter the Web site, or was it a voluntary survey?	2-4
Incentives	Were any incentives offered (eg, monetary, prizes, or nonmonetary incentives such as an offer to provide the survey results)?	2-4

Time/date	In what time frame were the data collected?	2-4
Randomization of items or questionnaires	To prevent biases, items can be randomized or alternated.	NA
Adaptive questioning	Use adaptive questioning (certain items, or only conditionally displayed based on responses to other items) to reduce number and complexity of the questions.	2-4
Number of items	What was the number of questionnaire items per page? The number of items is an important factor for the completion rate.	2-4
Number of screens (pages)	Over how many pages was the questionnaire distributed? The number of items is an important factor for the completion rate.	NA
Completeness check	It is technically possible to do consistency or completeness checks before the questionnaire is submitted. Was this done, and if "yes," how (usually JavaScript)? An alternative is to check for completeness after the questionnaire has been submitted (and highlight mandatory items). If this has been done, it should be reported. All items should provide a nonresponse option such as "not applicable" or "rather not say," and selection of one response option should be enforced.	NA (Qualtrics)
Review step	State whether respondents were able to review and change their answers (eg, through a Back button or a Review step that displays a	2-4

	summary of the responses and asks the respondents if they are correct).	
Unique site visitor	If you provide view rates or participation rates, you need to define how you determined a unique visitor. There are different techniques available, based on IP addresses or cookies or both.	NA (Qualtrics)
View rate (ratio of unique survey visitors/unique site visitors)	Requires counting unique visitors to the first page of the survey, divided by the number of unique site visitors (not page views!). It is not unusual to have view rates of less than 0.1% if the survey is voluntary.	NA (Qualtrics)
Participation rate (ratio of unique visitors who agreed to participate/unique first survey page visitors)	Count the unique number of people who filled in the first survey page (or agreed to participate, eg, by checking a checkbox), divided by visitors who visit the first page of the survey (or the informed consents page, if present). This can also be called “recruitment” rate.	NA (Qualtrics)
Completion rate (ratio of users who finished the survey/users who agreed to participate)	The number of people submitting the last questionnaire page, divided by the number of people who agreed to participate (or submitted the first survey page). This is relevant only if there is a separate “informed consent” page or if the survey goes over several pages. This is a measure for attrition. Note that “completion” can involve leaving questionnaire items blank. This is not a measure for	3-4

	how completely questionnaires were filled in. (If you need a measure for this, use the word “completeness rate.”)	
Cookies used	Indicate whether cookies were used to assign a unique user identifier to each client computer. If so, mention the page on which the cookie was set and read, and how long the cookie was valid. Were duplicate entries avoided by preventing users access to the survey twice; or were duplicate database entries having the same user ID eliminated before analysis? In the latter case, which entries were kept for analysis (eg, the first entry or the most recent)?	NA
IP check	Indicate whether the IP address of the client computer was used to identify potential duplicate entries from the same user. If so, mention the period for which no two entries from the same IP address were allowed (eg, 24 hours). Were duplicate entries avoided by preventing users with the same IP address access to the survey twice; or were duplicate database entries having the same IP address within a given period eliminated before analysis? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	NA
Log file analysis	Indicate whether other techniques to analyze the log file for identification of multiple entries were used. If so, please describe.	NA
Registration	In “closed” (non-open) surveys, users need to log in first and it is easier to prevent duplicate entries from the same user. Describe	NA (Open survey)

	how this was done. For example, was the survey never displayed a second time once the user had filled it in, or was the username stored together with the survey results and later eliminated? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	
Handling of incomplete questionnaires	Were only completed questionnaires analyzed? Were questionnaires that terminated early (where, eg, users did not go through all questionnaire pages) also analyzed?	3-4
Questionnaires submitted with an atypical timestamp	Some investigators may measure the time people needed to fill in a questionnaire and exclude questionnaires that were submitted too soon. Specify the time frame that was used as a cutoff point, and describe how this point was determined.	NA
Statistical correction	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for the nonrepresentative sample; if so, please describe the methods.	3-4

Abbreviations: IRB, institutional review board; NA, not applicable.

Modified from Eysenbach G: Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) [erratum in J Med Internet Res **14:** e8, 2012]. J Med Internet Res **6:** e34, 2004. Copyright © Gunther Eysenbach.

Appendix 3. Informed Consent Statement

Postoperative Narcotic Prescribing Practices in Podiatric Limb Salvage Surgery

Hello! We are interested in understanding the postoperative prescribing practices of podiatric physicians following limb salvage surgeries. We are inviting you to participate in this questionnaire-based research study because of your expertise and experience as a podiatric physician practicing in the United States. This questionnaire contains five hypothetical patient scenarios based on an aggregate of patients seen by podiatric physicians. Participation is voluntary and we appreciate your input. Please review the entire form before agreeing to participate if you choose to do so.

This study is being conducted by:

Brandon Brooks, DPM; Co-Primary Investigator, Dartmouth College, Geisel School of Medicine.

Kristina Wolff, PhD MPH; Co-Primary Investigator, Dartmouth College, Geisel School of Medicine

Please ask any questions you have now. If you have questions later, you may contact Brandon Brooks, DPM, at brandon.m.brooks.gr@dartmouth.edu or Kristina Wolff, PhD at Kristina.b.wolff@dartmouth.edu

Procedures:

If you agree to be in this study, please answer questions to the best of your ability. If a question

is not completely applicable to you, you may either skip the question or answer "what you would have done" in that situation. Please only take the survey once. This questionnaire should take approximately 10-15 minutes of your time.

Confidentiality and Anonymity:

Your responses and information collected via the questionnaire will be maintained confidentially. The results of this study will be kept private and only reported in aggregate. Identifying information will not be used in any presentation or paper written about this project. Research records will be stored securely and only the co–primary investigators will have access to the raw data.

Voluntary Nature of the Study:

Participation in this study is voluntary. If you decide to participate, you are free to not answer any question or to withdraw at any time. If you decide not to participate, we appreciate your time and consideration.

Statement of Consent:

I have read the above information and agree to take part in the study.