Postoperative Opioid-Prescribing Practice in Foot and Ankle Surgery

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Background: Approximately 3,900 Americans die every month of opioid overdose. The total economic burden of the opioid epidemic is estimated to be more than $78 billion annually. We sought to determine whether postoperative opioid-prescribing practice variation exists in foot and ankle surgery.

Methods: We administered a voluntary, anonymous, online questionnaire consisting of six foot and ankle surgery scenarios followed by a demographics section. The purpose of the demographics section was to gather characteristics of podiatric foot and ankle surgeons. We invited podiatric foot and ankle surgeons practicing in the United States to complete the questionnaire via e-mail from the American Podiatric Medical Association's membership list. For each scenario, respondents selected the postoperative opioid(s) that they would prescribe at the time of surgery, as well as the dose, frequency, and number of "pills" (dosage units). We developed multiple linear regression models to identify associations between prescriber characteristics and two measures of opioid quantity: dosage units and morphine milligram equivalents.

Results: Eight hundred sixty podiatric foot and ankle surgeons completed the survey. The median number of dosage units never exceeded 30 regardless of the foot and ankle surgery. Years in practice correlated with reduction in dosage units at the time of surgery. Compared with the orthopedic community, podiatric foot and ankle surgeons prescribe approximately 25% less dosage units than orthopedic foot and ankle surgeons.

Conclusions: Postoperative opioid-prescribing practice variation exists in foot and ankle surgery. Further research is warranted to determine whether additional education is needed for young surgeons. (J Am Podiatr Med Assoc 113(5), 2023)

Approximately 3,900 Americans—the equivalent of a small town—die every month after overdosing on opioids.[1,2] Deaths from heroin, synthetic opioids (eg, fentanyl, tramadol), and natural and semisynthetic opioids (eg, oxycodone, hydrocodone) continue to rise in many states.[2,3] Opioid overdose is the leading cause of accidental deaths in young adults.[4] Postoperatively, opioid misuse is associated with increased risk of complications.[4] Prescription and illicit opioid use has resulted in an opioid epidemic in the United States.[5,6] The total economic burden of the opioid epidemic is estimated to be more than $78 billion dollars annually.[7]

Opioid prescribing has dramatically increased since the early 1990s.[6,8,9] Governmental agencies, patients, pharmaceutical companies, and physicians have all contributed to this public health crisis.[10] Opioid prescribing can be quantified by the number of opioid "pills" (dosage units) and morphine milligram equivalents (MMEs). Whereas national prescribing guidelines exist for MMEs for patients with

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chronic pain, national guidelines for acute pain have not yet been established.[10] An MME is defined as the amount of morphine in milligrams that is equivalent to the strength of the opioid dose prescribed.[11] Using MME allows for comparison between the strengths of different types of opioids.[11] It can be a tool for clinicians to make safe, appropriate decisions concerning opioid regimens.[12]

Foot and ankle surgery can cause severe postoperative pain, which often necessitates opioid prescriptions.[10,13] Podiatric foot and ankle surgeons are among the leading providers in the United States who manage postoperative pain in foot and ankle surgery.[13-15] Understanding the prescribing habits of the more than 18,000 podiatric physicians in the United States is paramount for establishing appropriate prescribing protocols that effectively control postoperative pain and minimize unused opioid distribution after foot and ankle surgery.[10,16,17] Previous research via the Dartmouth Atlas has demonstrated substantial variation in the distribution and use of a variety of medical resources in the United States based largely on geography.[18] The authors hypothesize that postoperative opioid-prescribing variation also exists after foot and ankle surgery. We believe that variation in prescribing habits will be consistent with previous work, where the southwestern region of the United States may prescribe higher MME and/or higher dosage units than other regions. In addition, we aimed to identify whether other demographic characteristics of podiatric foot and ankle surgeons were associated with their postoperative opioid-prescribing practices.

Methods

Research Design

We obtained institutional review board exempt status from the Committee for the Protection of Human Subjects at Dartmouth College (Hanover, New Hampshire) and the institutional review board at Rosalind Franklin University of Medicine and Science (North Chicago, Illinois) for a voluntary, anonymous, online questionnaire via Qualtrics (Provo, Utah). This survey was based on a currently published survey by Hearty et al,[19] which consisted of four foot and ankle scenarios resulting in 31 total questions to describe the prescribing habits of orthopedic foot and ankle surgeons. We modified and improved on this previous survey by including 93 additional questions and two additional patient scenarios—a digital surgery typically performed in-office and a commonly performed forefoot surgery—for a total of 124 possible questions and six patient scenarios. These additional questions included data regarding opioid choice and number of "pills" (dosage units) dispensed for the purpose of reporting prescribing habits in the form of MME and dosage units. The MME provides a valuable means of quantifying postoperative opioid-prescribing practice variation and informing prescribing practice, and it is a common standard unit used.[20-23]

We used conditional branching based on the medication(s) selected for each scenario. If a respondent prescribed only one opioid per scenario, then no more than 52 of 124 questions would appear. We established content validity through an extensive review of the literature in September 2018 and content experts. We consulted with the members of the 2019–2020 Clinical Practice Advisory Committee of the American Podiatric Medical Association (APMA) for input on each patient scenario and commonly prescribed postoperative pain medications after foot and ankle surgery. We completed a pilot study after initial institutional review board exempt status was granted in October 2019. After the pilot study, we moved the demographics section to the end of the survey.

Sample

The target population was practicing podiatric foot and ankle surgeons in the United States. Retired podiatric foot and ankle surgeons, podiatric physicians who no longer perform surgery, fellows, and residents were excluded. We recruited practicing podiatric foot and ankle surgeons exclusively through e-mail invitation from the APMA membership list, which consists of approximately 8,736 members who fit the eligibility criteria. Survey respondents who did not complete the demographics section were excluded from the analysis. The purpose of the demographics section was to gather characteristics of prescribing podiatric foot and ankle surgeons.

Survey and Measures

Data collection occurred from December 10, 2019, to April 10, 2020. Eight e-mail invitations were sent out during the 4-month period. Participants were asked to respond only once. A consent statement was given at the beginning of the survey (Supplemental Appendix 1). The survey took an estimated 10 to 15 min to complete.

For each of the six patient scenarios (Supplemental Appendix 2), respondents had six multiple-choice options regarding which postoperative medication they would prescribe. Respondents were given multiple-choice responses for the common schedules and doses of the prescribed medication and completed a free-response text box to submit any numerical value for the number of "pills" (dosage units) prescribed at the time of surgery. After the six patient scenarios, we collected the following respondent demographic information: gender identity (female, male, nonbinary/third gender, other/prefer to self-describe, and prefer not to say); years in practice (<5, 6–15, and >15 years), which served as a proxy for age; podiatric medical school; years of residency (up to 4 years); completion of a fellowship; practice setting (academic, federal services, hospital/health-care system, private practice); and the state that each respondent primarily practiced in. We made an a priori decision to reclassify states into the US Census regions (Midwest, Northeast, South, and West). The demographic information served as explanatory variables for statistical analysis.

Outcomes

Each patient scenario had two continuous outcomes: dosage units prescribed at the time of surgery (Supplemental Figure 1) and MMEs (Supplemental Figure 2). Podiatric foot and ankle surgeons who opted to prescribe nonopioids were excluded from the analysis of the dosage units prescribed at the time of surgery. The MMEs were calculated by multiplying the conversion factor of each drug by the dose of the drug and by the frequency prescribed in the 24 hours after surgery. The purpose of this was to capture the amount of postoperative MME prescribed for the first 24 hours after foot and ankle surgery, also known as postoperative day 0. We chose postoperative day 0 to generate comparable data; podiatric foot and ankle surgeons may have different postoperative follow-up preferences within the first week.

Statistical Analysis

We completed the analytic plan a priori. We used a χ^2 test to check for nonresponse bias between the characteristics of respondents and eligible members from the APMA's membership list; these characteristics included gender identity, podiatric medical school, and practice region. We excluded patient scenario 1, a digital surgery typically performed in-office, from statistical analysis due to an expected small sample size of opioid prescribers for this procedure. For both of the dependent variables (postoperative day 0 MMEs and the opioid dosage units prescribed at the time of surgery), we performed a univariate analysis consisting of analysis of variance for categorical explanatory variables and the t test for dichotomous explanatory variables to determine differences in podiatric foot and ankle surgeon characteristics for patient scenarios 2 through 6. To identify significant associations between physician characteristics and prescribing practices for both continuous outcomes, we developed multiple linear regression models. Only variables with a $P < .1$ in the univariate analysis were considered for inclusion in the multivariable models. A model was developed for each of scenarios 2 through 6.

A sensitivity analysis was additionally performed to test for volatility within the results. Dosage units were obtained from the survey via a free-response text box allowing participants to submit any numerical value. There were 35 unique dosage units reported. However, to eliminate the concern for clustering of responses surrounding common dispensing habits (eg, ten tablets, 30 tablets, 45 tablets), a sensitivity analysis was undertaken using a logistic regression model. To our knowledge, there is no widely accepted threshold that is clinically meaningful for acute pain management regarding MMEs and dosage units. A value of 50 MME was used as a threshold (ie, >50 MME or ≤50 MME), and 30 tablets (ie, >30 tablets dispensed or ≤30 tablets dispensed) was used as a cutoff for the dosage units variable. A value of 50 MME was used because it has been identified as a meaningful threshold in chronic pain management and was consistently close to the mean/median in our scenarios. A dosage unit of 30 was used because this was a consistent mean/median in the data.

The assumptions for linear regression were tested, and no variables were found to grossly violate the linear regression assumptions. Normality was tested with a normal Q-Q plot and histogram. Multicollinearity was tested using the variance inflation factor. The Breusch-Pagan test was used to test for heteroscedasticity. Because all of the variables were ascertained at the same time point, the authors were not concerned for autocorrelation. We analyzed the data using a statistical software program (Stata Statistical Software: Release 15.1; StataCorp LLC, College Station, Texas). We assessed statistical significance at $P < .05$ for the final multivariable models. All of the P values were two-sided.

Results

Eight hundred sixty podiatric foot and ankle surgeons completed the questionnaire, resulting in a response rate of 9.8% (Fig. 1). When assessing for nonresponse bias, we found that respondents practicing in the northeasternregion of the United States were underrepresented in the survey (Table 1), with most respondents practicing in the southern and midwestern regions. Approximately 11% of respondents completed a 1- to 2-year fellowship program after residency.

The median number of dosage units prescribed by all podiatric foot and ankle surgeons at the time of surgery never exceeded 30 tablets regardless of the foot and ankle surgery performed. The mean and median MMEs prescribed (Tables 2 and 3) was higher for rearfoot procedures compared with forefoot procedures. Total ankle arthroplasty had the highest mean and median MMEs prescribed among the scenarios (mean ± SD, 50.2 ± 35.4 MME; median, 45 MME), followed by open reduction and internal fixation (ORIF) of a bimalleolar ankle fracture (mean ± SD, 46.0 ± 28.2 MME; median, 45 MME). For forefoot and digital procedures, 91.3% and 6.5% of respondents reported that they would not prescribe an opioid after a chemical matrixectomy and after a first metatarsal osteotomy (bunionectomy), respectively. The number of tablets (dosage units) prescribers dispensed was similar across rearfoot scenarios (Tables 4 and 5), with a median of 30 dosage units for an ankle fracture ORIF, tibiotalocalcaneal arthrodesis, and total ankle arthroplasty. For bunionectomy, the median was 25 dosage units. For chemical matrixectomy, 8.7% of prescribers reported that they would prescribe an opioid, with a median of 18 dosage units.

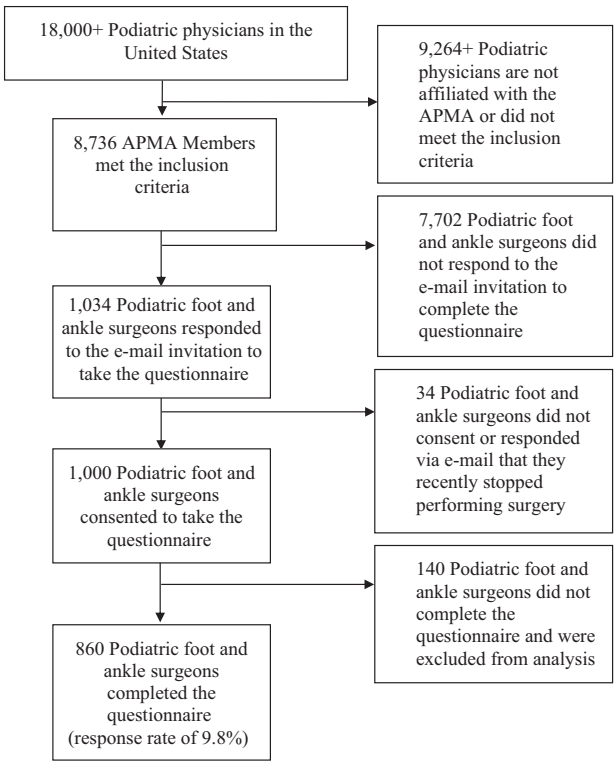

Figure 1. Representation of response rate. APMA, American Podiatric Medical Association.

More experienced foot and ankle surgeons (ie, those in practice for >15 years) tended to prescribe less-potent opioids and dispense fewer dosage units than younger surgeons (eg, lower MMEs and lower dosage units) (Tables 2 and 4). Variation in prescribing habits were notable by practice region, where western and southern states prescribed higher MMEs across all of the scenarios, and the northeast prescribed the lowest MME volumes. The northeast continued to demonstrate the lowest prescribing habits in the multivariable model, but this relationship showed statistical significance only for the rearfoot scenarios of tibiotalocalcaneal arthrodesis and total ankle arthroplasty. In the univariate (ie, unadjusted) model assessing MME prescribed on postoperative day 0, completion of a fellowship was associated with lower levels of MME prescribed (ie, correlating to less-potent opioids prescribed) compared with people who did not complete a fellowship. This relationship was found in all scenarios and remained statistically significant in the multivariable, fully adjusted model. Despite prescribing less potent opioids overall, fellowship-trained physicians dispensed more dosage units than non–fellowship-trained physicians (ie, 4.8 dosage units more after ankle ORIF and 3.7 dosage units more after bunionectomy). The R^2 for scenario 3's (ie, open Brostrom-Gould repair) dosage units model was 0.1210, representing the strongest R^2 of all of the scenario models. The results did not change with sensitivity analysis and remained stable after logistic regression models.

Discussion

In this study of 860 podiatric foot and ankle surgeons, the median number of dosage units prescribed by all of the podiatric foot and ankle surgeons at the time of surgery never exceeded 30 regardless of the foot and ankle surgery. Fellowship-trained podiatric foot and ankle surgeons tended to prescribe less-potent opioids but more dosage units

Table 1. Checking for Survey Nonresponse Bias (9.8% Response Rate) by Comparing the Target Population and Respondent Characteristics

Characteristic	Respondents (No. [%]) (n = 860)	Eligible APMA Membership (No. [%]) (n = 8,736)	*P* Value by X^2 Test
Gender identity			
Female	204 (23.7)	2,186 (25.0)	.513
Male	635 (73.8)	6,550 (75.0)	.781
Unknown	21 (2.4)	0	
Years in practice			
≤5	118 (13.7)	1,196 (13.7)	.982
6-15	158 (18.4)	1,864 (21.3)	.097
>15	552 (64.2)	5,676 (65.0)	.833
Unknown	32 (3.7)	0	
Primary practice region			
Northeast	179 (20.8)	2,258 (25.8)	.011[a]
Midwest	210 (24.4)	1,968 (22.5)	.318
South	264 (30.7)	2,698 (30.9)	.936
West	166 (19.3)	1,454 (16.6)	.097
Unknown	41 (4.8)	358 (4.1)	
Podiatric medical school			
Arizona College of Podiatric Medicine at Midwestern University	19 (2.2)	98 (1.1)	.006[a]
Barry University School of Podiatric Medicine	53 (6.2)	540 (6.2)	.984
California School of Podiatric Medicine at Samuel Merritt University	109 (12.7)	1,077 (12.3)	.794
Des Moines University - College of Podiatric Medicine and Surgery	80 (9.3)	678 (7.8)	.142
Kent State University School of Podiatric Medicine	140 (16.3)	1,551 (17.8)	.363
New York College of Podiatric Medicine	87 (10.1)	1,219 (14.0)	.006[a]
Dr. William M. Scholl College of Podiatric Medicine	222 (25.8)	1,841 (21.1)	.011[a]
Temple University School of Podiatric Medicine	137 (15.9)	1,691 (19.4)	.047[a]
Western University of Health Sciences College of Podiatric Medicine	9 (1.0)	41 (0.5)	.026[a]
Unknown	4 (0.5)	0	

Abbreviation: APMA, American Podiatric Medical Association.
[a]$P < .05$.

overall compared with their non–fellowship-trained counterparts. This difference equates to approximately 5 to 10 MME less (or one or two fewer tablets of hydrocodone 5 mg) and 3 to 5 dosage units more. Although quantity of dosage units prescribed at the time of surgery has been shown to be an area needing improvement in several studies among several specialties,[19] one could argue that 3 to 5 dosage units more does not represent a clinically important difference in prescribing habits between these two groups (fellowship-trained versus non–fellowship-trained surgeons). More-experienced surgeons (ie, those in practice >15 years) tended to prescribe less-potent opioids and fewer dosage units overall compared with younger surgeons. Practice region was trending toward significance in several scenarios but did not show consistent statistical significance.

This study expanded on previous work by Hearty et al.[19] Their questionnaire-based cross-sectional study (n = 64) examined the association between prescriber characteristics and postoperative opioid-prescribing practice among orthopedic foot and ankle surgeons. Most orthopedists prescribed 40 dosage units (tablets) or more of either hydrocodone or oxycodone for each scenario; in the present study, podiatric physicians dispensed a median of 30 dosage units or less for the same scenarios.[19] This equates to podiatric physicians dispensing approximately 25% fewer dosage units compared with their orthopedic counterparts. This difference was also evidenced by Saini et al,[20] where the authors conducted a prospective cohort study to assess opioid consumption patterns after outpatient orthopedic foot and ankle procedures. The authors found that the patients (n = 988) consumed a median of 20 tablets, whereas the median number of tablets prescribed was 40.[20] In addition, Hearty et al[19] demonstrated a significant difference in prescribing multiple opioids—tramadol plus another opioid—concurrently among orthopedists by years in practice; orthopedic foot and ankle surgeons in practice less than 5 years supplemented with

Table 2. Univariate Analysis for Postoperative Day 0 Morphine Milligram Equivalents (MME)

Podiatric Foot and Ankle Surgeon Characteristic	Scenario No.: Surgery				
	2: Austin Bunionectomy	3: Open Brostrom-Gould Repair	4: Ankle ORIF	5: TTCA with TAL	6: TAA with TAL
Gender identity	$P = .722$	$P = .958$	$P = .190$	$P = .079$	$P = .148$
Female	30.9 ± 18.0	35.7 ± 22.0	44.0 ± 22.9	39.5 ± 25.7	47.6 ± 32.9
Male	30.3 ± 19.7	35.6 ± 23.1	46.9 ± 29.4	43.8 ± 31.0	51.7 ± 36.1
Years in practice	$P = .100$	$P = .149$	$P = .321$	$P = .005$[a]	$P = .021$[a]
≤5	27.7 ± 17.3	34.7 ± 24.2	45.1 ± 26.7	43.4 ± 29.5	52.9 ± 32.9
6-15	32.8 ± 23.0	38.8 ± 24.4	49.5 ± 27.0	49.7 ± 29.1	56.5 ± 35.1
>15	30.5 ± 18.9	34.9 ± 22.1	45.8 ± 29.1	40.8 ± 30.0	48.0 ± 36.2
Podiatric medical school	$P = .720$	$P = .519$	$P = .571$	$P = .005$[a]	$P = .008$[a]
A	27.8 ± 20.0	38.8 ± 20.0	46.2 ± 18.1	47.4 ± 25.6	56.6 ± 27.8
B	32.0 ± 27.8	36.1 ± 30.0	50.4 ± 39.0	47.6 ± 40.4	64.6 ± 43.8
C	33.2 ± 20.2	38.7 ± 22.2	47.0 ± 25.1	48.5 ± 30.2	53.5 ± 37.5
D	30.8 ± 13.8	36.6 ± 19.6	48.0 ± 22.7	49.7 ± 27.4	53.8 ± 32.9
E	30.8 ± 15.8	35.1 ± 22.5	45.7 ± 27.6	45.5 ± 31.3	53.0 ± 37.8
F	29.6 ± 23.0	32.5 ± 23.3	43.5 ± 27.3	38.1 ± 28.6	41.3 ± 32.1
G	29.4 ± 15.7	35.2 ± 19.7	45.1 ± 28.7	39.3 ± 27.4	45.9 ± 36.3
H	22.0 ± 20.5	23.6 ± 31.4	64.0 ± 74.1	30.7 ± 31.3	54.9 ± 27.2
I	30.0 ± 20.8	34.7 ± 23.6	44.9 ± 26.2	38.4 ± 27.2	48.0 ± 31.8
Completion of a fellowship	$P = .036$[a]	$P = .001$[a]	$P = .001$[a]	$P = .031$[a]	$P = .047$[a]
Yes	25.5 ± 19.3	28.6 ± 23.7	38.0 ± 27.1	37.0 ± 28.2	43.9 ± 32.2
No	31.6 ± 19.2	36.7 ± 22.6	47.6 ± 27.3	44.0 ± 30.0	51.7 ± 36.0
Practice setting	$P = .076$	$P = .495$	$P = .167$	$P = .780$	$P = .286$
Academic	30.9 ± 12.1	36.6 ± 19.0	43.0 ± 21.4	42.8 ± 19.3	49.2 ± 24.6
Federal services (VA, DOD, HHS)	21.9 ± 21.3	35.9 ± 38.2	37.2 ± 31.1	47.1 ± 49.1	58.3 ± 52.23
Hospital/health system	31.1 ± 16.9	31.9 ± 19.0	43.6 ± 23.6	44.1 ± 25.4	55.1 ± 27.9
Private practice	30.8 ± 19.8	35.8 ± 22.5	46.7 ± 27.9	42.3 ± 29.5	49.5 ± 35.7
Practice region	$P = .007$[a]	$P = .002$[a]	$P = .017$[a]	$P = .0006$[a]	$P = .0009$[a]
Northeast	28.1 ± 19.0	30.7 ± 21.1	41.0 ± 26.3	35.6 ± 27.0	41.6 ± 33.1
South	33.5 ± 23.1	37.0 ± 25.2	48.1 ± 31.8	42.8 ± 31.3	51.4 ± 38.3
West	31.0 ± 15.4	39.0 ± 20.2	49.8 ± 22.6	48.5 ± 27.9	56.0 ± 30.9
Midwest	28.2 ± 17.0	34.2 ± 20.5	45.5 ± 28.8	43.2 ± 27.1	52.2 ± 33.9

Note: Data are given as mean ± SD MME.

Abbreviations: DOD, Department of Defense; HHS, Department of Health and Human Services; ORIF, open reduction and internal fixation; TAA, total ankle arthroplasty; TAL, tendo Achilles lengthening; TTCA, tibiotalocalcaneal arthrodesis; VA, Department of Veterans Affairs.

[a] $P < .05$.

tramadol more. Similarly, in the present study, podiatric foot and ankle surgeons in practice for less than 5 years prescribed significantly more dosage units in scenarios 2, 3, and 5, and those in practice for 6 to 15 years prescribed significantly more dosage units in scenarios 2 through 5 compared with those in practice greater than 15 years. This similarity between young orthopedic surgeons and young podiatric surgeons of prescribing more opioids than more-experienced surgeons may highlight an area of needed improvement for surgeons in their early years of practice.

An opportunity for growth and improvement in foot and ankle surgery seems to be in digital surgery (ie, chemical matrixectomies). Thousands of chemical matrixectomies are performed annually in the United States.[24] In this study, 8.7% of prescribers reported that they would prescribe an opioid for postoperative pain after a chemical matrixectomy; among these prescribers, the median dosage units prescribed was 18. Given that 91.3% of podiatric foot and ankle surgeons would not prescribe an opioid for this procedure, we believe that dispensing 18 tablets after matrixectomy seems unnecessary. Although national opioid guidelines for acute pain have yet to be established, the management of postoperative pain after chemical matrixectomies likely represents an area of needed improvement.

One coordinated mechanism that aims to reduce the misuse of opioids and promote the appropriate use of opioids is opioid stewardship programs.[25-29] To help podiatric foot and ankle surgeons appreciate opioid stewardship programs,[25-29] the acronym *MORPHINE* was created. *M* stands for multimodal

Table 3. Fully Adjusted Model for Postoperative Day 0 Morphine Milligram Equivalents

	Scenario No.: Surgery (Opioid History)				
Podiatric Foot and Ankle Surgeon Characteristic	2: Austin Bunionectomy (Opioid-Naive)	3: Open Brostrom-Gould Repair (Opioid-Naive)	4: Ankle ORIF (Relatively Opioid-Naive)	5: TTCA with TAL (History of Occasional Opioid Use)	6: TAA with TAL (Opioid-Tolerant from Everyday Use)
Gender identity					
Female				–5.1[a]	
Years in practice					
≤5				1.1	2.2
6-15				7.2[a]	6.8[a]
>15				0 (referent)	0 (referent)
Podiatric medical school					
A				6.8	7.3
B				11.1[a]	18.9[a]
C				8.8[a]	4.1
D				13.6[a]	7.4
E				6.0	3.8
F				5.8	0.1
G				5.9	3.0
H				2.1	9.9
I				0 (referent)	0 (referent)
Completion of a fellowship					
Yes	–6.5[a]	–8.7[a]	–9.8[a]	–8.3[a]	–11.3[a]
Practice setting					
Academic	0.2				
Federal services (VA, DOD, HHS)	–7.0				
Hospital/health system	0.9				
Private practice	0 (referent)				
Practice region					
Northeast	–0.1	–4.4	–4.1	–10.9[a]	–11.4[a]
South	5.0[a]	2.5	2.4	–3.8	–4.7
West	3.1	5.5[a]	4.8	1.6	1.3
Midwest	0 (Referent)	0 (Referent)	0 (Referent)	0 (Referent)	0 (Referent)
R^2	0.0304	0.0372	0.0253	0.0663	0.0524
Adjusted R^2	0.0213	0.0321	0.0201	0.0467	0.0342

Note: Variables that failed to achieve $P < .1$ in the univariate analysis were excluded from the model.

Abbreviations: DOD, Department of Defense; HHS, Department of Health and Human Services; ORIF, open reduction and internal fixation; TAA, total ankle arthroplasty; TAL, tendo Achilles lengthening; TTCA, tibiotalocalcaneal arthrodesis; VA, Department of Veterans Affairs.

[a]$P < .05$

analgesic strategies; a multimodal analgesic approach produces superior analgesia over an opioid-only approach because multimodal analgesic agents target a variety of pain pathways.[25-29] *O* stands for the development of an opioid formulary. *R* stands for risk reduction from opioid harm; therapeutic success does depend on proper candidate selection, assessment before administration of opioid therapy, and close patient monitoring.[25] *P* stands for understanding the pharmacokinetics and pharmacodynamics of opioids to avoid dangerous drug combinations.[25-28] *H* stands for help; pain management specialists can empower a patient's ability to function and improve their quality of life.[25-28] *I* stands for use of information technology; the influence of electronic records can provide oversight and adherence to regulatory changes and shifting state laws that can influence opioid prescribing.[25-27] *N* stands for the number of MMEs. Ideally, opioid stewardship programs can assist providers to prescribe lower MMEs to their patients by using data collected and stored by information technology.[25-28] Finally, *E* stands for educating medical professionals, patients, and caregivers. It is paramount that an open dialog can be fostered so that expectations of opioid therapy can be appreciated by all parties.[25-29] Opioid stewardship principles should become a priority for all opioid prescribers.

This study has several limitations. It presented hypothetical situations and asked surgeons what they would expect to prescribe in each scenario. As such, we did not obtain data regarding actual

Table 4. Univariate Analysis for Dosage Units Prescribed at the Time of Surgery

Podiatric Foot and Ankle Surgeon Characteristic	Scenario No.: Surgery				
	2: Austin Bunionectomy	3: Open Brostrom-Gould Repair	4: Ankle ORIF	5: TTCA with TAL	6: TAA with TAL
Gender identity	$P = .018$[a]	$P = .006$[a]	$P = .289$	$P = .521$	$P = .176$
Female	25.6 ± 8.8	27.7 ± 8.6	28.4 ± 9.0	28.1 ± 9.3	28.8 ± 11.1
Male	23.8 ± 8.5	25.5 ± 8.7	27.5 ± 9.1	27.5 ± 10.0	27.5 ± 10.6
Years in practice	$P < .0001$[a]	$P < .0001$[a]	$P = .003$[a]	$P = .034$[a]	$P = .221$
≤5	26.7 ± 8.7	28.2 ± 8.0	28.5 ± 9.3	29.0 ± 9.5	28.3 ± 11.7
6-15	27.4 ± 8.5	28.8 ± 9.2	29.8 ± 9.0	28.9 ± 10.0	28.9 ± 10.8
>15	22.7 ± 8.3	24.6 ± 8.3	26.9 ± 9.0	26.7 ± 9.9	27.1 ± 10.5
Podiatric medical school	$P = .005$[a]	$P = .030$[a]	$P = .202$	$P = .487$	$P = .216$
A	27.0 ± 6.4	28.0 ± 5.4	30.1 ± 6.7	29.9 ± 6.4	28.3 ± 9.7
B	26.1 ± 8.5	27.1 ± 8.4	27.9 ± 9.5	26.9 ± 8.6	26.7 ± 9.2
C	25.5 ± 8.8	27.4 ± 9.6	28.9 ± 8.9	27.3 ± 8.9	29.8 ± 10.6
D	26.0 ± 8.2	28.3 ± 8.7	29.0 ± 8.4	28.6 ± 10.0	29.1 ± 10.1
E	24.1 ± 8.6	25.3 ± 9.0	27.3 ± 9.2	26.9 ± 9.9	26.9 ± 12.2
F	20.7 ± 9.6	23.0 ± 10.3	24.9 ± 11.8	25.2 ± 12.9	24.9 ± 12.4
G	22.9 ± 8.1	25.4 ± 7.3	27.5 ± 8.9	27.9 ± 9.7	27.4 ± 10.5
H	21.4 ± 8.4	23.8 ± 7.5	30.0 ± 11.0	25.4 ± 5.5	28.9 ± 7.5
I	24.7 ± 8.5	26.4 ± 8.2	28.0 ± 8.1	28.5 ± 9.7	28.8 ± 10.0
Completion of a fellowship	$P = .0001$[a]	$P < .0001$[a]	$P < .0001$[a]	$P = .018$[a]	$P = .007$[a]
No	23.9 ± 8.6	25.6 ± 8.5	27.2 ± 8.6	27.2 ± 9.6	27.2 ± 10.5
Yes	28.3 ± 8.9	30.6 ± 9.2	31.8 ± 10.6	30.2 ± 10.4	30.9 ± 11.5
Practice setting	$P = .370$	$P = .063$	$P = .323$	$P = .965$	$P = .766$
Academic	26.2 ± 8.8	28.8 ± 8.4	29.0 ± 10.0	28.5 ± 10.3	29.3 ± 11.0
Federal services (VA, DOD, HHS)	24.6 ± 9.5	29.6 ± 12.1	30.8 ± 12.1	27.7 ± 12.3	26.3 ± 11.2
Hospital/health system	25.3 ± 8.0	26.2 ± 7.5	27.9 ± 7.1	27.6 ± 8.1	27.6 ± 10.2
Private practice	24.0 ± 8.6	25.8 ± 8.6	27.5 ± 9.0	27.6 ± 10.0	27.9 ± 10.9
Practice region	$P = .002$[a]	$P = .070$	$P = .048$[a]	$P = .654$	$P = .412$
Northeast	21.9 ± 8.6	24.8 ± 8.7	26.0 ± 9.9	26.7 ± 11.3	27.2 ± 11.8
South	24.5 ± 8.1	25.8 ± 8.0	27.7 ± 8.4	27.7 ± 9.1	27.2 ± 10.0
West	25.9 ± 8.7	27.6 ± 9.0	28.9 ± 8.4	27.6 ± 9.2	28.8 ± 10.2
Midwest	24.5 ± 8.9	26.0 ± 8.8	28.4 ± 9.7	28.3 ± 10.2	28.5 ± 11.5

Note: Data are given as mean ± SD dosage units.

Abbreviations: DOD, Department of Defense; HHS, Department of Health and Human Services; ORIF, open reduction and internal fixation; TAA, total ankle arthroplasty; TAL, tendo Achilles lengthening; TTCA, tibiotalocalcaneal arthrodesis; VA, Department of Veterans Affairs.

[a] $P < .05$.

prescribing habits, and there may be variation between what prescribers say they will prescribe and what they actually prescribe. Nonetheless, this study is a direct comparison with the orthopedic community, using similar methods and identical scenarios. We, therefore, feel that the comparison of the two specialties is reasonable. Less commonly prescribed opioids were not included in the questionnaire. The lack of inclusion of all opioids may have impacted the postoperative MME results. Although the APMA is the largest organization within podiatric medicine and foot and ankle surgery, its membership may not accurately serve as a proxy for the entire podiatric foot and ankle surgeon population in the United States; thousands of podiatric foot and ankle surgeons are not members of the APMA. Furthermore, this study had a 9.8% response rate (n = 860), which is an improvement on previous research with much lower sample sizes; however, low overall response rates can make it difficult to generalize findings to all of the podiatric foot and ankle surgeons practicing in the United States. The R^2, which quantified the variance explained by the multiple linear regression model for each scenario, remained relatively low, suggesting that the models do not fully represent the dependent variables. However, the R^2 is typically expected to be lower in studies examining human behavior, which is more difficult to quantify statistically. Although we believe that the variables in the final model are important, note that prescribing habits via MMEs and dosage units is multifactorial and is not fully

Table 5. Fully Adjusted Model for Dosage Units Prescribed at the Time of Surgery

Podiatric Foot and Ankle Surgeon Characteristic	Scenario No.: Surgery (Opioid History)				
	2: Austin Bunionectomy (Opioid-Naive)	3: Open Brostrom-Gould Repair (Opioid-Naive)	4: Ankle ORIF (Relatively Opioid-Naive)	5: TTCA with TAL (Chronic Pain; History of Occasional Opioid Use)	6: TAA with TAL (Chronic Pain; Opioid-Tolerant from Everyday Use)
Gender identity					
Female	0.6	1.4			
Years in practice					
≤5	3.2[a]	3.0[a]	1.1	2.2[a]	
6-15	3.9[a]	3.8[a]	2.8[a]	2.2[a]	
>15	0 (Referent)	0 (Referent)	0 (Referent)	0 (Referent)	
Podiatric medical school					
A	–1.0	–1.3			
B	0.7	0.1			
C	1.0	0.6			
D	1.0	2.1			
E	−0.1	–1.0			
F	–3.2[a]	–3.8[a]			
G	–0.4	–0.3			
H	–5.8	–3.1			
I	0 (Referent)	0 (Referent)			
Completion of a fellowship					
Yes	3.7[a]	4.7[a]	4.8[a]	2.7[a]	3.7[a]
Practice setting					
Academic		1.8			
Federal services (VA, DOD, HHS)		1.8			
Hospital/health system		–1.5			
Private practice		0 (Referent)			
Practice region					
Northeast	–1.3	0.6	–2.5[a]		
South	–0.1	0.0	–0.7		
West	0.4	0.9	0		
Midwest	0 (Referent)	0 (Referent)	0 (Referent)		
R^2	0.1018	0.1210	0.0591	0.0213	
Adjusted R^2	0.0778	0.0911	0.0492	0.0161	

Note: Variables that failed to achieve $P < .1$ in the univariate analysis were excluded from the model. The results for scenario 6 are reported from the univariate analysis only.

Abbreviations: DOD, Department of Defense; HHS, Department of Health and Human Services; ORIF, open reduction and internal fixation; TAA, total ankle arthroplasty; TAL, tendo Achilles lengthening; TTCA, tibiotalocalcaneal arthrodesis; VA, Department of Veterans Affairs.

[a] $P < .05$.

explained by demographic characteristics of providers. Additional research, including large prospective and retrospective cohort studies, would be beneficial to further understand the impact of variation in postoperative MMEs, dosage units, and multimodal analgesics after foot and ankle surgery. Further studies are also warranted to determine the appropriate range of procedure-specific postoperative MMEs.

Conclusions

Postoperative opioid-prescribing practice variation exists in foot and ankle surgery. Compared with the orthopedic community, podiatric foot and ankle surgeons prescribe approximately 25% fewer opioids than orthopedic foot and ankle surgeons. The median number of dosage units prescribed by all podiatric foot and ankle surgeons at the time of surgery never exceeded 30 regardless of the foot and ankle surgery. Young surgeons in practice for less than 15 years may benefit from additional education on opioid prescribing; further research can be conducted to determine whether more opioid education for young surgeons is warranted.

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References

1. CDC Injury Center: Drug overdose deaths: drug overdose. Available at: https://www.cdc.gov/drugoverdose/deaths/opioid-overdose.html. Accessed November 10, 2019.
2. National Institute on Drug Abuse: Opioid overdose crisis. Available at: https://www.drugabuse.gov/drugs-abuse/opioids/opioid-overdose-crisis. Accessed November 8, 2019.
3. Mahan KT: The opioid crisis. J Foot Ankle Surg **56:** 1, 2017.
4. Brott NR, Cascella M: Opioid, risk tool. In: *StatPearls [Internet]*. Treasure Island, FL: StatPearls Publishing; 2020. Available at: https://www.ncbi.nlm.nih.gov/books/NBK553147/.
5. Compton WM, Jones CM, Baldwin GT: Relationship between nonmedical prescription-opioid use and heroin use. N Engl J Med **374:** 154, 2016.
6. Cicero TJ, Ellis MS: The prescription opioid epidemic: a review of qualitative studies on the progression from initial use to abuse. Dialogues Clin Neurosci **19:** 259, 2017.
7. Florence CS, Zhou C, Luo F, et al: The economic burden of prescription opioid overdose, abuse, and dependence in the United States, 2013. Med Care **54:** 901, 2016.
8. National Institute on Drug Abuse: Increased drug availability is associated with increased use and overdose. Available at: https://nida.nih.gov/publications/research-reports/prescription-opioids-heroin/increased-drug-availability-associated-increased-use-overdose. Accessed November 10, 2019.
9. Seth P, Scholl L, Rudd RA, et al: Overdose deaths involving opioids, cocaine, and psychostimulants—United States, 2015–2016. MMWR Morb Mortal Wkly Rep **67:** 349, 2018.
10. Bowlby MA, Crawford ME: Opioid crisis and acute pain management after foot and ankle surgery. Clin Podiatr Med Surg **36:** 695, 2019.
11. US Department of Health and Human Services, Centers for Disease Control and Prevention: Calculating total daily dose of opioids for safer dosage: why is it important to calculate the total daily dosage of opioids? how much is 50 or 90 MME/day for commonly prescribed opioids? Available at: http://www.cdc.gov/drugoverdose/prescribing/guideline.html. Accessed April 23, 2020.
12. Volkow ND, McLellan AT: Opioid abuse in chronic pain: misconceptions and mitigation strategies. N Engl J Med **374:** 1253, 2016.
13. Brooks BM, Shih CD, Brooks BM, et al: The diabetic foot-pain-depression cycle. JAPMA **113:** 1, 2023; doi: http://doi.org/10.7547/22-126.
14. Brooks BM, Li Q, Fleischer AE, et al: Postprocedural opioid-prescribing practice in nail surgery. JAPMA **113:** 1, 2023; doi: http://doi.org/10.7547/21-139.
15. Brooks BM, Shih CD, Bratches RWR, et al: Cognitive bias in postoperative opioid-prescribing practice. JAPMA **113:** 1, 2023; doi: http://doi.org/10.7547/21-215.
16. Sabatino MJ, Kunkel ST, Ramkumar DB, et al: Excess opioid medication and variation in prescribing patterns following common orthopaedic procedures. J Bone Joint Surg Am **100:** 180, 2018.
17. Jena AB, Goldman D, Weaver L, et al: Opioid prescribing by multiple providers in Medicare: retrospective observational study of insurance claims. BMJ **348:** g1393, 2014.
18. Dartmouth Atlas Project: About. Available at: https://www.dartmouthatlas.org/about/. Accessed January 15, 2020.
19. Hearty TM, Butler P, Anderson J, et al: Postoperative narcotic prescription practice in orthopedic foot and ankle surgery. Foot Ankle Orthop **3:** 247301141877594, 2018.
20. Saini S, McDonald EL, Shakked R, et al: Prospective evaluation of utilization patterns and prescribing guidelines of opioid consumption following orthopedic foot and ankle surgery. Foot Ankle Int **39:** 1257, 2018.
21. Gupta A, Kumar K, Roberts MM, et al: Pain management after outpatient foot and ankle surgery. Foot Ankle Int **39:** 149, 2018.
22. Merrill HM, Dean DM, Mottla JL, et al: Opioid consumption following foot and ankle surgery. Foot Ankle Int **39:** 649, 2018.
23. Madsen AM, Stark LM, Has P, et al: Opioid knowledge and prescribing practices among obstetrician-gynecologists. Obstet Gynecol **131:** 150, 2018.
24. Espensen EH, Nixon BP, Armstrong DG: Chemical matrixectomy for ingrown toenails: is there an evidence basis to guide therapy? JAPMA **92:** 287, 2002.
25. Smith RG: Mitigating the shadow of the worldwide opioid crisis: a review for the foot and ankle specialist. Foot Ankle Spec **13:** 242, 2020.
26. Weiner SG, Price CN, Atalay AJ, et al: A health system–wide initiative to decrease opioid-related morbidity and mortality. Jt Comm J Qual Patient Saf **45:** 3, 2019.
27. Perrone J, Weiner SG, Nelson LS: Stewarding recovery from the opioid crisis through health system initiatives. West J Emerg Med **20:** 198, 2019.
28. Sandbrink F, Uppal R: The time for opioid stewardship is now. Jt Comm J Qual Patient Saf **45:** 1, 2019.
29. Ardeljan LD, Waldfogel JM, Bicket MC, et al: Current state of opioid stewardship. Am J Health Syst Pharm **77:** 636, 2020.

Supplemental Appendix 1

Start of Block: Consent

Q1.1 **Postoperative Opioid Prescribing Practice in Foot and Ankle Surgery**

You are invited to be in a survey research study to help us better understand the prescribing habits of podiatric foot and ankle surgeons following foot and ankle surgery. You were selected as a possible participant because you are a practicing podiatric foot and ankle surgeon in the United States. This survey contains six patient scenarios that are hypothetical and not based on any one patient but from an aggregate of patients seen by a podiatric foot and ankle surgeon. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by:

Brandon Brooks, DPM; Dartmouth College, Geisel School of Medicine

Adam Fleischer, DPM, MPH; Rosalind Franklin University of Medicine & Science

Procedures: If you agree to be in this study, we would ask that you 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" if the situation was presented to you. Please only take the survey once. This survey will take approximately 10-15 minutes of your time.

Confidentiality: This survey is completely anonymous and the data cannot be traced back to you. No personal information will be asked in this survey. The records of this study will be kept private. In any sort of report that we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not aect your current or future relations with Rosalind Franklin University or Dartmouth College. If you decide to participate, you are free to not answer any question or to withdraw at any time.

Contacts and Questions: Please ask any questions you have now. If you have questions later, you may contact Brandon Brooks, DPM at brandon.m.brooks.med@dartmouth.edu. If you have any questions or concerns regarding your rights as a subject in this study you may call the IRB oce (phone: 847-578-8713 or email: IRB@rosalindfranklin.edu).

Statement of Consent: I have read the above information and agree to take part in the study.

☐ Yes

☐ No

Supplemental Appendix 2

Scenario 1

Procedure: Chemical matrixetomy

Full scenario: "A 55-year-old man has recurrent ingrowing medial and lateral borders of his right hallux; otherwise healthy. He previously underwent a total nail avulsion with another podiatrist and now requests a permanent nail-removal procedure. He has been taking ibuprofen for the pain and has never taken opioid pain medication."

Scenario 2

Procedure: First metatarsal osteotomy (Austin bunionectomy)

Full scenario: "45-year-old woman has worsening bunion pain and can no longer tolerate her usual shoes; otherwise healthy. Conservative care has not been successful. She takes ibuprofen as needed for the pain and has never taken opioid pain medication. Radiographs reveal an intermetatarsal angle of 13 degrees."

Scenario 3

Procedure: Open Brostrom-Gould repair

Full scenario: "20-year-old man has lateral ankle instability after sustaining multiple ankle sprains; otherwise healthy. He is a manual laborer. He takes ibuprofen as needed for the pain and has never taken opioid pain medication."

Scenario 4

Procedure: Open reduction and internal fixation of a closed bimalleolar ankle fracture

Full scenario: "45-year-old woman; BMI 35; otherwise healthy; bimalleolar closed ankle fracture from slip and fall. She has no previous history of ankle/foot problems. The patient is a stay-at-home mother. She has been taking 2-3 tablets per day of 5 mg hydrocodone since her injury."

Scenario 5

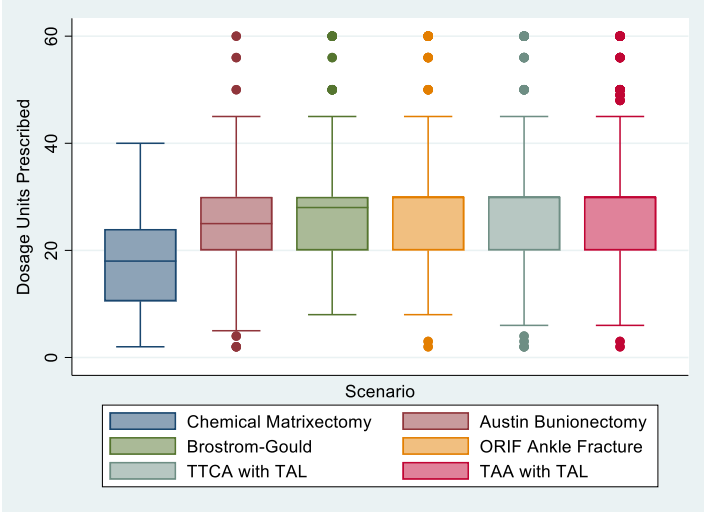
Procedure: Tibiotalocalcaneal arthrodesis with tendo Achilles lengthening

Full scenario: "65-year-old man, insulin-dependent diabetic, BMI 40, has Charcot arthropathy of the foot and ankle and significant deformity. He has altered but intact sensation. He has a history of low back pain and takes daily acetaminophen and occasional hydrocodone."

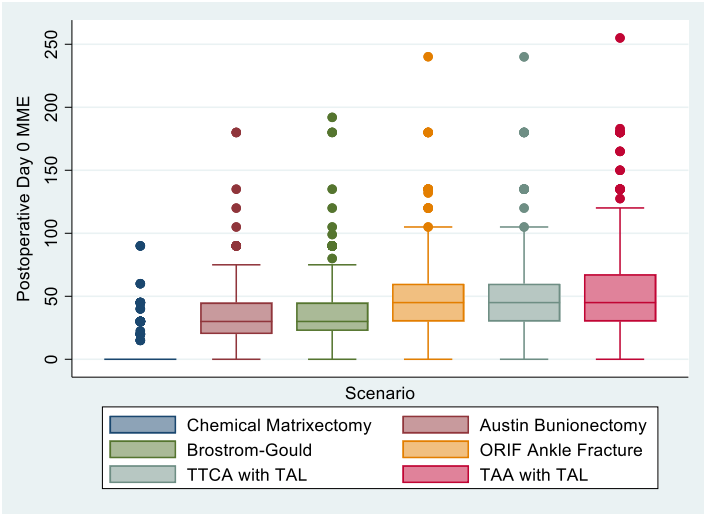
Scenario 6

Procedure: Total ankle arthroplasty with tendo Achilles lengthening

Full scenario: "59-year-old woman with post-traumatic ankle arthritis. She has a history of fibromyalgia and chronic pain. She has been on hydrocodone 5 mg, 2-3 tablets per day for over 2 years as well as an antidepressant medication. She is under the care of a chronic pain physician who refuses to make recommendations on postoperative pain medication plan. She is otherwise healthy."



Supplemental Figure 1. Box plots of dosage units prescribed at the time of surgery in scenarios 1 through 6: 1) chemical matrixectomy, 2) Austin bunionectomy, 3) open Brostrom-Gould repair, 4) open reduction and internal fixation (ORIF) of a closed bimalleolar ankle fracture, 5) tibotalocalcaneal arthrodesis (TTCA) with a tendo Achilles lengthening (TAL), and 6) total ankle arthroplasty (TAA) with a TAL. The horizontal line within each box represents the median. The box represents the interquartile range; below the box is the lower quartile and above the above is the upper quartile. Dots beyond the upper quartile represent outliers and suggests unwarranted variation/excess.



Supplemental Figure 2. Box plots of postoperative day 0 morphine milligram equivalents (MME) after foot and ankle surgery in scenarios 1 thrugh 6: 1) chemical matrixectomy, 2) Austin bunionectomy, 3) open Brostrom-Gould repair, 4) open reduction and internal fixation (ORIF) of a closed bimalleolar ankle fracture, 5) tibotalocalcaneal arthrodesis (TTCA) with a tendo Achilles lengthening (TAL), and 6) total ankle arthroplasty (TAA) with a TAL.