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Opioid prescribing for surgical dental procedures in dental clinics of military treatment facilities

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ABSTRACT

Background. Variation in opioid prescribing rates among geographic regions is well known and, to the authors' knowledge, there have been no studies of variation from 1 dental clinic to another, and such variation might suggest an excess of opioid prescriptions.

Methods. The authors used a retrospective cohort design study of all dental encounter records for 819,453 soldiers in the dental clinics ($n = 250$) of the US Military Health System during the period from 2008 through 2017.

Results. There were 743,459 dental surgical encounters. Opioid prescriptions were filled for 36.7% of these encounters. Multinomial multilevel regression found statistically significant between-facility variance in opioid prescribing, which was partially explained via facility-level characteristics (region, type, and percentage of surgeries for young patients), and practice variables (mean percentage extractions, percentage periodontic surgery, and percentage specialists).

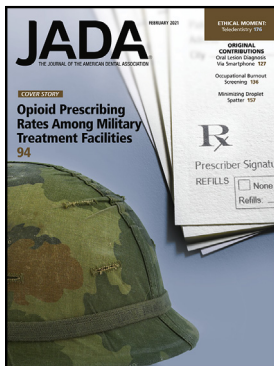
Conclusions. The authors found a substantial variation in opioid prescribing among dental clinics in the US Military Health System. Dentists at 11 of the 30 largest military treatment facilities prescribed at a rate 4 percentage points higher than expected, and dentists at 9 of these military treatment facilities had a rate of 4 percentage points lower than expected. Additional study of the factors allowing the low-prescribing facilities to achieve these rates might lead to an overall decrease in opioid prescribing.

Practical Implications. The authors' findings of dental opioid prescribing in the military can lead to appreciation of the guidelines from the American Dental Association and the American Association of Oral and Maxillofacial Surgeons, which suggest alternatives to opioid prescribing for surgical procedures, particularly for tooth extractions.

Key Words. Dental clinics; opioid prescribing; practice variation, military health system.

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The number of drug overdose deaths is increasing; there were 70,237 US drug overdose deaths in 2017 compared with 63,632 in 2016. The latter is a 21.4% increase from 2015 and two-thirds involved an opioid.¹ Nonfatal overdoses far exceed the number of overdose deaths.² To develop a public health response to opioid-related morbidity, researchers and policy makers are looking to prevent first opioid exposure, long-term opioid use, and diversion. The first exposure to opioids is usually from a prescription or prescription diversion and larger quantities, higher dosages, and longer duration play a significant role in later opioid use.³⁻⁸

Dental clinicians' prescribing of opioids appears to account for from 5% through 10% of all opioid prescriptions.⁹⁻¹³ Many pills from dental opioid prescriptions go unused,¹⁴ and the necessity for opioids rather than other analgesics for dental and other surgical procedures has been questioned.^{15,16} Supporting this contention, the number of prescriptions written by US dentists for opioids is 37 times greater than the proportion written by English dentists.¹⁷ Studies have found substantial variation in opioid prescribing between different geographic regions or states, and this variation has raised concerns about overprescribing; however, there is no literature on variation among dental providers.¹⁸

To our knowledge, ours is the first study to focus on dental clinicians' prescribing of opioids for service members in the US Military Health System (MHS). The MHS possesses unique features for a dental study; there is a centralized computerized pharmacy record, soldiers are universally covered for medical and oral health care, there are regular dental examinations to prevent dental emergencies during deployment, a dental encounter record is part of the medical record system, and centralized policies are promulgated, including following Centers for Disease Control and Prevention guidelines on opioid prescribing. These features permit us to compare military dental practices with published findings on civilian practices and to address the limitations that we identified in prior dental literature related to matching opioid prescriptions to dental encounters, assigning dental opioids to surgical versus nonsurgical encounters, and selected samples that might not be generalizable to the studied population.^{10,19,20}

Our study provides information on this urgent and important public health issue. We updated estimates of prior dental studies conducted in civilian settings, separately examined opioid prescribing for dental extractions versus other surgical or invasive procedures, and examined differences between younger and older soldiers and between 2 periods. We advance knowledge on variation in dental prescribing by means of comparing opioid prescribing rates among parent facilities of dental clinics.

METHODS

Design and setting

This retrospective secondary data analysis examines dental encounter records and filled opioid prescriptions from October 2008 through September 2017 for a sample of US Army soldiers who comprised the Substance Use and Psychological Injury Combat study cohort. The MHS dental program operates 270 dental clinics in the United States, US territories, and military bases in Europe, the Pacific, and Asia for active duty service members only.

Participants

The Substance Use and Psychological Injury Combat study is a longitudinal study of all active duty and activated reserve component Army soldiers ($n = 865,460$) who returned from a deployment as part of Operation Enduring Freedom, Operation Iraqi Freedom, or Operation New Dawn from fiscal years (October-September) 2008 through 2014.²¹ No data on military family members were obtained. Any sample member who had a dental program encounter during the study period, whether before or after their deployment, was eligible for inclusion. We defined the study's participants as sample soldiers with 1 or more surgical or invasive (hereafter, surgical) procedures performed by dentists and therefore might be associated with an opioid prescription. Our methods for selecting procedure codes are described in the [Appendix](#) (available online at the end of this article). All procedures performed by nondentists (providers who do not prescribe opioids) were excluded. We rolled up all included procedure records to the encounter level for matching to prescription claims and for analysis. We examined all of the prescription claims of the sample and selected for inclusion opioid prescriptions using the Centers for Disease Control algorithm modified to remove opioids that are used to treat addiction disorders^{22,23} ([Appendix](#); available online at the end of this article).

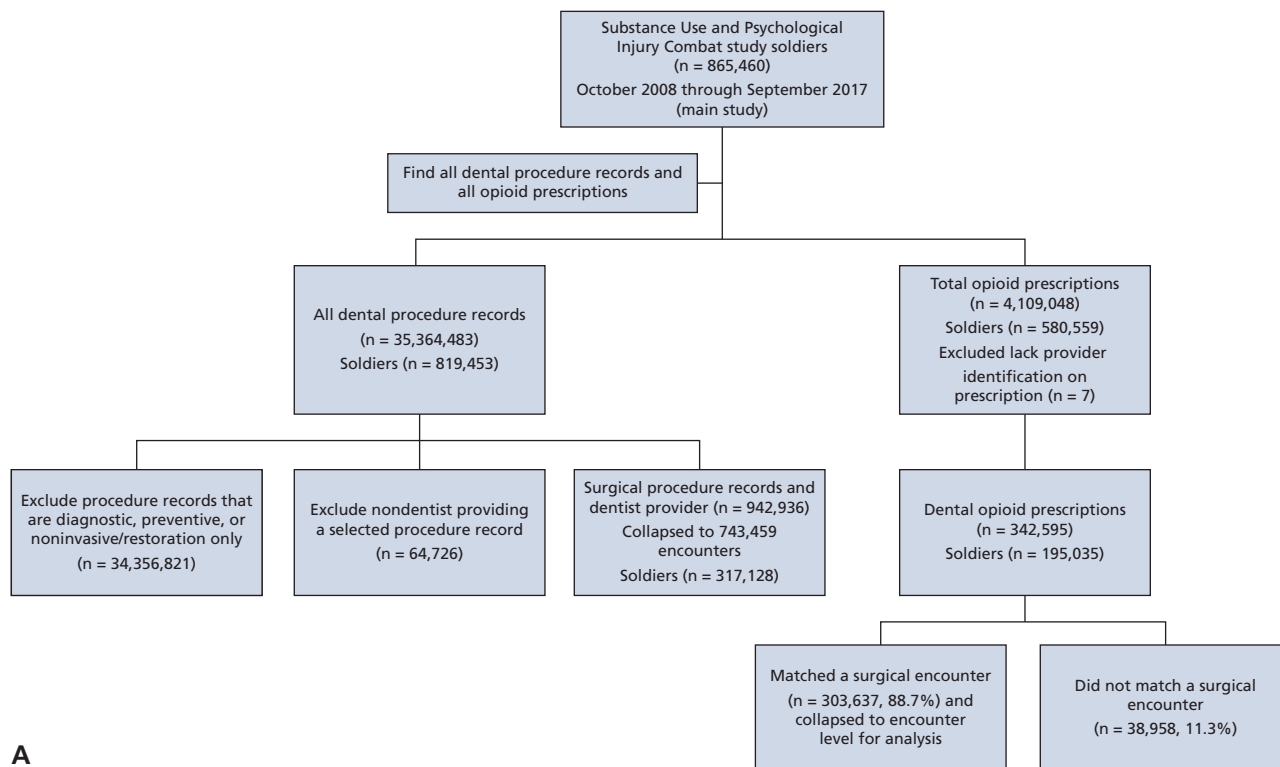
The study protocol was reviewed and approved by the Institutional Review Boards of Brandeis University and the Uniformed Services University and Department of Defense.

Outcomes

Our primary outcome was an encounter with opioid exposure. We specified a 60-day period around each surgical encounter and matched all opioid prescriptions written by a dentist on the date of a surgical encounter, presurgery (within 30 days before surgery), or postsurgery (within 30 days after surgery). A dental encounter with 1 or more pre- or postsurgery opioid prescriptions was classified as an opioid-exposed encounter. A second measure of opioid exposure was based on total morphine milligram equivalents (MMEs) dispensed for the dental encounter during the 60-day period ([Appendix](#); available online at the end of this article),²³ with dental encounters classified as more than 100 MMEs (yes or no), which is equivalent to the typical 5-day supply described in the literature. To characterize opioid exposure, we examined mean MMEs, mean days' supply, and frequency by opioid subclass for young and older patient groups.

ABBREVIATION KEY

- Fac:** Facility.
- MHS:** US Military Health System.
- MME:** Morphine milligram equivalent.



A

Figure 1. Flow diagrams: main study (A) and facility substudy (B).

Covariates

We defined covariates at 2 levels, the encounter level and the facility level. The encounter-level variables were types of surgical procedure (endodontic, periodontic, implant, oral and maxillofacial excluding extraction, dental extraction, emergency palliative care), type of dentist (general dentist, specialist), patient age group at time of encounter (< 26 years, ≥ 26 years), military rank (junior enlisted, senior enlisted, officer, warrant officer), sex, fiscal year of encounter, and patient's opioid status at time of encounter (opioid naïve defined as no filled opioid prescriptions in the past 90 days). We identified the “parent” military treatment facility for each dental clinic and aggregated encounters to the facility level owing to insufficient sample size of most dental clinics. We defined facility-level variables in 2 groups. First were the following facility characteristics: region or if outside the continental United States, facility type (medical center, hospital, clinic, other), and percentage of dental surgeries for young patients (< 26 years). Second, we computed the following dental practice variables at the facility-level: proportion of surgeries for tooth extractions, proportion of surgeries for periodontic procedures, and the proportion of dentists that were specialists.

Statistical methods

Descriptive analysis was conducted on dental surgical encounters for the full study period (that is, the main study). We determined the percentage of surgical encounters that resulted in opioid exposure and more than 100 MMEs for patient subgroups and types of encounters. We separately examined tooth extraction encounters and all other surgical encounters, as some earlier literature has focused on tooth extractions. To address policy maker interest, we compared the proportion of all opioids prescribed for dental surgical procedures for 2 periods—2008 through 2013 and 2014 through 2017. To address our core question about the degree of variation between facilities, we nested dental encounters within specific facilities to examine variation in prescribing rates between facilities. For these analyses, we restricted the data to the period of October 2014 through September 2017 (facility study). Dentists in the military's dental program move among facilities approximately every 3 years and by restricting study years, we attempted to stabilize the pool of dentists at each facility.

We first calculated the observed opioid prescribing rates for tooth extractions and other surgical encounters; we present these data for the 30 facilities with the largest volume of dental encounters. We then conducted a multivariate analysis to estimate the variation in opioid prescribing within

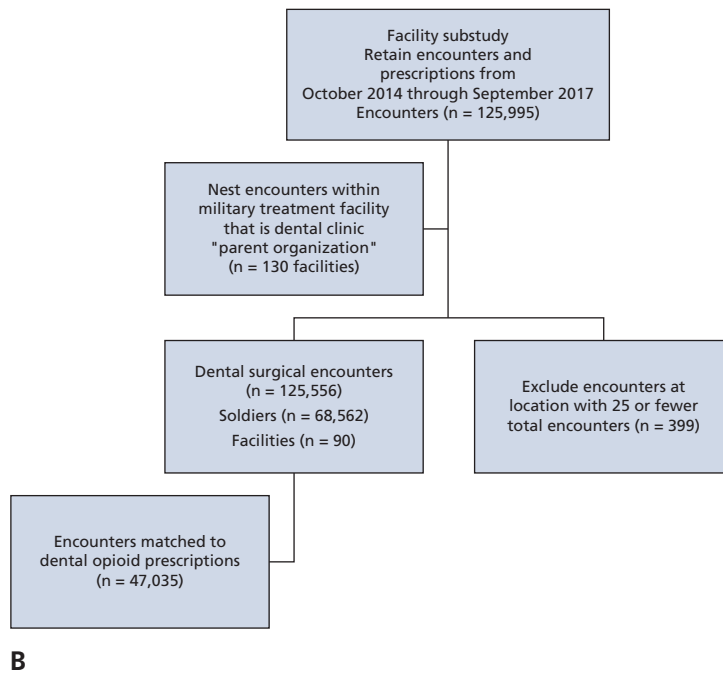


Figure 1. Continued.

Table 1. Percentage of total opioid prescriptions attributable to the dental program in study sample.

SAMPLE AND PERIOD*	OPIOID PRESCRIPTIONS FOR STUDY SAMPLE		
	Total Prescriptions, No.	Dental Program No.	Prescriptions [†] Total Prescriptions, %
< 26 Years, All Years	848,760	138,085	16.3
2009-2014 [‡]	780,188	129,037	16.5
2015-2017	59,524	9,048	15.2
≥ 26 Years, All Years	3,260,288	204,510	6.3
2009-2014 [‡]	2,208,011	153,032	6.9
2015-2017	1,062,277	51,478	4.9
All Ages, All Years	4,109,048	342,595	8.3
2009-2014	2,988,199	282,069	9.4
2015-2017	1,120,849	60,526	5.4

* Years are fiscal years; that is, 2009 started October 1, 2008. † Includes surgical and nonsurgical dental opioid prescriptions. ‡ A multiple logistic regression on proportion of opioid prescriptions found that the indicator variables for age group and period and the interaction term of age group × period were each significant, $P < .001$.

and among facilities owing to encounter-level variables (within facility) or context or facility-level variables (between facilities). We used a 2-level multilevel model, using the STATA command *melogit estat ICC* (StataCorp). In the Appendix (available online at the end of this article), we present a supplementary analysis that compares the observed with the expected opioid prescribing rate for facilities with at least 25 encounters, which takes into account the facility case mix.

Statistical significance was defined at the $P < .01$ level. Analyses were performed using SAS, Version 9.4 (SAS Institute) and STATA, Version 15 (StataCorp).

RESULTS

Dental opioids overview

Among soldiers eligible for the study ($n = 865,460$), nearly all ($n = 819,453$) had at least 1 military dental program encounter and 317,128 dental patients (38.7%) had at least 1 surgical encounter

Table 2. Characteristics of dental encounters by opioid exposure, October 2008 through September 2017.*

ENCOUNTER CHARACTERISTIC	SEs [†] , NO.	SEs, %	WITH OPIOID PRESCRIPTION		WITH TOTAL OPIOID DOSE > 100 MORPHINE MILLIGRAM EQUIVALENTS	
			No.	Row, %	No.	Opioid Prescriptions, %
Total SEs[†]	743,459	100.0	272,718	36.7	138,346	50.7
Age Group, y						
≥ 26	471,739	63.5	161,323	34.2	76,633	47.5
< 26	271,720	36.6	111,395	41.0	61,713	55.4
Sex						
Female	101,651	13.7	35,882	35.3	17,445	48.6
Male	641,808	86.3	236,836	36.9	120,901	51.0
Rank						
Enlisted	653,126	87.8	245,096	37.5	125,473	51.2
Officer	90,333	12.2	27,622	30.6	12,873	46.6
Race and Ethnicity						
Non-Hispanic, Asian, or Pacific Islander	79,388	10.7	29,915	37.7	15,411	51.5
Non-Hispanic, black	166,843	22.4	62,414	37.4	31,642	50.7
Hispanic	80,796	10.9	32,176	39.8	16,796	52.2
Non-Hispanic, white	401,485	54.0	142,986	35.6	71,982	50.3
American Indian, Alaskan Native, or other	14,947	2.0	5,227	35.0	2,515	48.1
Component[§]						
Active duty	565,551	90.5	216,329	37.1	11,308	51.0
National Guard	38,443	6.1	9,749	25.3	4,195	43.0
Reserve	20,559	3.3	5,686	27.6	2,482	43.7
Patient Opioid Status at Time of Encounter[¶]						
Naïve	502,941	80.5	169,157	33.6	86,673	51.2
Not naïve	121,735	19.5	62,630	51.4	30,323	48.4
Type of Surgical Procedure (Not Mutually Exclusive)[#]						
Endodontic	357,189	48.0	38,118	10.7	9,812	25.7
Periodontic	56,057	7.5	41,485	74.0	19,268	46.4
Implant	46,550	6.3	18,976	40.8	10,533	55.5
Oral and maxillofacial (excluding extraction)	46,977	6.3	24,860	52.9	13,626	55.0
Tooth extraction	203,559	27.4	165,757	81.4	96,192	58.0
Palliative emergency	78,019	10.5	14,997	19.2	5,148	34.3

* All χ^2 values for cross-tabulations of each characteristic by opioid prescription and each characteristic by dose > 100 morphine milligram equivalents given an opioid prescription, are significant at $P < .001$. † SE: Surgical encounter. ‡ Number of encounters with opioids is less than total number of dental opioids (Table 1) because each encounter can be associated with more than 1 opioid prescription. § Total includes 123 encounters for which component at time of the encounter was not recorded. ¶ Opioid naïve defined as no filled opioid prescriptions in the past 90 days. # Includes palliative emergency and invasive procedures that are not surgical, but the authors hypothesized would account for some opioid prescriptions. ** TRICARE North: Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin, and portions of Iowa (Rock Island Arsenal area), Missouri (St. Louis area), and Tennessee (Fort Campbell area). TRICARE South: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, Tennessee (excluding Fort Campbell area), and Texas (excluding southwest corner including El Paso area). TRICARE West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Iowa (excluding Rock Island Arsenal area), Kansas, Minnesota, Missouri (except St. Louis area), Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas (the southwestern corner including El Paso), Utah, Washington, and Wyoming. TRICARE OCONUS (outside the United States): Hawaii, Guam, Puerto Rico, Europe, Asia, and Pacific.

Table 2. Continued

ENCOUNTER CHARACTERISTIC	SEs [†] , NO.	SEs, %	WITH TOTAL OPIOID DOSE > 100 MORPHINE MILLIGRAM EQUIVALENTS			
			WITH OPIOID PRESCRIPTION		Opioid Prescriptions, %	
			No.	Row, %	No.	
By Provider Type						
Oral surgeon	50,226	6.8	43,270	86.2	30,362	70.2
Periodontist	17,839	2.4	13,671	76.6	5,362	39.2
Prosthodontist	11,090	1.5	1,033	9.3	393	38.0
Orthodontist	1,066	0.1	143	13.4	65	45.5
Oral pathologist	689	0.1	264	38.3	21	7.9
Endodontist	36,738	4.9	7,905	21.5	1,310	16.6
Dental officer general	624,319	84.0	206,034	33.0	100,688	48.9
Pedodontist	1,492	0.2	398	26.7	145	36.4
By Opioid Subclass						
Codeine	17,625	6.5	17,625	100.0	73	0.04
Hydrocodone	68,352	25.1	68,352	100.0	12,622	18.5
Oxycodone	183,888	67.4	183,888	100.0	123,355	67.1
Tramadol	1,912	1.0	1,912	100.0	880	46.0
Other	941	< 1.0	941	100.0	173	18.4
Facility Service Branch						
Army	633,913	85.3	248,415	39.2	127,014	51.1
Other branch	20,815	2.8	7,403	35.6	3,759	50.8
Facility Type Associated With Dental Clinic						
Medical Center (largest)	185,549	25.0	80,050	43.1	47,453	59.3
Hospital (medium)	368,098	49.5	140,449	38.2	74,473	53.0
Clinic and other (smallest)	189,812	25.5	52,219	27.5	16,420	31.4
Facility Region**						
TRICARE OCONUS	42,544	5.7	17,878	42.0	5,923	33.1
TRICARE North	155,063	20.9	53,137	34.3	21,547	40.5
TRICARE South	255,779	34.4	94,401	36.9	49,903	52.9
TRICARE West	215,343	29.0	95,120	44.2	54,951	57.8
Other or unknown	74,730	10.1	12,182	16.3	6,022	49.4

during the study period from October 2008 through September 2017. There were 743,459 surgical encounters; each dental patient with a surgical encounter had a mean of 2.3 surgical encounters. There were 4,472 dentists who performed these surgical procedures (Figure 1, flow diagram).

There were 4,109,048 opioid prescriptions filled by the sample for any purpose during the study period, of which 342,595 prescriptions were linked to a dental program surgical or nonsurgical encounter (8.3%). Among the 580,599 soldiers who received an opioid prescription, 195,035 (33.6%) received at least 1 dental opioid prescription and 88.7% of dental prescriptions were for surgical procedures (Figure 1).

To compare time trends, we examined changes within 2 age groups (Table 1). We hypothesized a priori that younger patients were more likely to have opioid prescriptions from dental encounters than older patients, but because of the longitudinal cohort design, the sample aged during the study. Of all opioid prescriptions filled by younger patients, 16.5% were written by dentists in the earlier period compared with 6.9% of those filled by older patients. The percentage of opioids written by the dental program declined for both age groups in the later period ($P < .001$).

In [Table 2](#) we describe all surgical encounters for the dental sample and the rate of opioid prescribing. One-third of encounters were made by patients younger than 26 years, the most encounters were among male and enlisted patients, nearly one-half were among racial and ethnic groups other than white, and more than 80% of patients were opioid-naïve (no opioid prescriptions filled in the prior 90 days) at the time of the encounter. The most frequent types of procedures were endodontic and tooth extraction. Eighty-four percent of the encounters were with general dentists rather than specialists, and nearly one-half of the encounters were at dental clinics associated with a medium-sized military treatment facility.

More than one-third of surgical encounters (36.7%) resulted in an opioid prescription being filled, and the total opioid dose was more than 100 MMEs for one-sixth of encounters (18.6%) ([Table 2](#)). The percentage of encounters with an opioid and the percentage with higher total dose were larger among young, enlisted, Hispanic soldiers, and for periodontic and tooth extraction procedures (all comparisons, $P < .01$). Among these dental prescriptions, 83.1% were written on the same day as a surgical procedure, 13.8% were written within 30 days before the surgery, and 3.1% were written within 30 days after the surgery date (data not shown in [Table 2](#)).

Hydrocodone (25.1%) and oxycodone (67.4%) were the most frequent opioid prescriptions. The median opioid dose was 120 MMEs for tooth extraction encounters and 90 MMEs for nonextraction surgical encounters, and the median days' supply was 3 ([Table 3](#)). Only 4.7% of prescriptions were for a 1-day supply; 24.0% were for 2 days, and 6.3% were for 21 or more days' supply of opioids. Younger soldiers received higher mean MMEs than older soldiers for tooth extractions, and mean MMEs for all tooth extraction encounters were higher than other dental surgery procedures ([Table 3](#)).

Facility-specific analysis: October 2014 through September 2017

Facility-specific observed prescribing percentages varied by a factor of 30.1 (87.5% versus 2.9%) for facilities with at least 25 observations in the study. [Figure 2](#) shows the difference in prescribing rates among the 30 facilities with the largest volume of surgical procedures, stratified by encounters for extractions versus other surgical procedure. The range of prescribing rates for tooth extraction was 60% through 94% and for other surgical encounters was 10% through 29%. In the supplemental analysis provided in the [Appendix](#) (available online at the end of this article), we describe the expected prescribing percentage for each facility with at least 25 observations. Among these facilities, the range remained large (64.7%-19.0%) after we adjusted for case mix.

In the multilevel multinomial models, the facility-level (level 2) variables were important predictors of opioid prescribing after controlling for encounter (level 1) factors ([Appendix](#); available online at the end of this article). The multilevel results also showed that facility-level regional variables and facility-level variables that captured the clinical practice behavior explained 80% of the between-facility variation.

DISCUSSION

Clinicians' decisions regarding the prescription of opioids require a balance between the pain-reducing benefits and the possible adverse short-term (for example, constipation) and long-term (for example, habituation) risks. The recommendations of respected organizations urge caution in prescribing opioids. In this context, our finding that some military dental clinics prescribe opioids at a significantly lower rate than other clinics suggests a path to follow. In this retrospective study, we found facility-specific opioid prescribing percentages varied by a factor of 30. In our supplemental analysis we found that dentists at 11 of the 30 largest facilities prescribed at a rate 4 percentage points higher than expected given their case mix, and dentists at 9 of these facilities had a rate 4 percentage points lower than expected. Based on this variation among dental clinics, it would be reasonable for dental leadership to compare clinical practices among facilities and attempt to identify the basis for lower reliance on opioid analgesics.

In our study, we provided comparisons with studies in civilian populations. Opioid prescriptions were filled for 36.7% of dental encounters; 50.1% of opioid encounters received more than 100 MMEs. Oral health care accounted for a substantial proportion of all opioid prescriptions in the population, particularly among young patients, for which it was 16.5% of all opioids in the period from October 2008 through September 2014 and 13.2% in the period from October 2014 through September 2017. A unique aspect of military dentistry is that service members receive a dental readiness classification based on annual examinations, giving them much higher access to oral

Table 3. Percentage distribution of opioid days' supply and mean opioid dose per surgical encounter with opioid,* October 2008 through September 2017.

DENTAL OPIOID DESCRIPTION	NONEXTRACTION ENCOUNTERS			ENCOUNTERS WITH EXTRACTIONS			ALL SURGICAL ENCOUNTERS, ALL AGES
	≥ 26 Years	< 26 Years	All Ages	≥ 26 Years	< 26 Years	All Ages	
Sample No.	81,224	25,737	106,961	80,099	85,658	165,757	272,718
Percentage Distribution							
Total days' supply							
1	5.6	7.2	6.0	3.8	3.2	3.7	4.7
2	26.5	28.2	26.9	22.6	21.7	22.1	24.0
3	29.3	26.3	28.6	32.1	30.5	31.3	30.2
4	11.1	10.4	10.7	11.9	13.5	12.7	12.0
5	10.0	8.6	9.9	11.6	11.5	11.6	10.7
6-10	5.1	4.8	5.0	5.0	5.0	4.5	4.9
11-20	3.2	3.0	3.1	2.7	2.6	2.6	2.8
≥ 21	8.3	9.6	8.6	7.5	8.2	7.9	8.2
Mean MMEs							
Mean (standard deviation) [†]	109 (76)	104 (74)	108 (76)	126 (69)	134 (59)	131 (64)	121 (70)
Median	90	90	90	113	150	120	105
Interquartile range [‡] (low-high)	75-150	60-120	67-150	80-150	90-150	90-150	75-150
Total MME ≥ 100, yes, %	40.5	36.0	36.2	54.6	61.2	58.0	50.7

* Analysis based on opioid prescriptions that were written on date of surgical encounter or either presurgery (within 30 days before surgery) or postsurgery (within 30 days after surgery). If multiple prescriptions were on the same date or within this 60-day period, days' supply and total morphine milligram equivalents (MME) were summed for all prescriptions. † A *t* test of difference in means 26 years and older relative to younger than 26 years for nonextraction procedures, unequal variances = 9.3 ($P < .0001$); *t* test for extraction procedures, unequal variances = -26.3 ($P < .001$). ‡ Values are for the 25th percentile and 75th percentile.

health care than the civilian population. Furthermore, the military pays for all oral health care for active duty service members to avoid emergency care and morbidity. In our sample, 4.3% of records had oral conditions classified as expected to result in dental emergencies within 12 months if not treated, 56.8% had oral conditions that, if not treated, had the potential but were not expected to result in dental emergencies within 12 months. This percentage would be higher among service members just starting a military career, reflecting the restricted access to oral health care in the United States.

The higher rate of opioid prescribing to the younger than 26 years sample than the 26 years or older sample (42% versus 34%) is noteworthy, given oral health care is often the source of first prescribing in this age group and has been found to increase risk of developing subsequent opioid use and misuse.¹⁹ Eighty percent of our sample had not filled opioid prescriptions in the past 90 days. The decrease in percentage of dental to overall opioid prescribing within age group during the study parallels a decrease seen in the civilian world,²⁴ as the overall dental community learned to manage dental pain through nonopioid medications. Dental opioid prescriptions in 1 Canadian province during the 2014 through 2017 period were only 3.8% of total opioid prescriptions,²⁵ lower than what we report.

Tooth extractions, which were 27.4% of surgical encounters, accounted for a disproportionate share of opioid exposure. The rate of opioid exposure for extraction procedures in military clinics (81%) matches the rate in a civilian study (80%).²⁶ For patients 26 years and older and younger than 26 years, tooth extractions accounted for 43.3% and 73.6%, respectively, of dental opioids. The American Association of Oral and Maxillofacial Surgeons recommends nonsteroidal anti-inflammatory drugs as the first-line analgesic for extractions.²⁷

The median days' supply in our study, estimated at 3, matched civilian studies.¹⁰ Military dentists were more likely than their civilian counterparts to prescribe oxycodone (67% military, 11% civilian) and less likely to prescribe hydrocodone (25% of military and 65% of civilian dental opioid prescriptions), codeine (7% military, 14% civilian), and tramadol (1% military, 5% civilian).¹⁰ Expert guidelines do not recommend 1 short-acting opioid over another,²⁸ and a study found little difference in pain relief between oxycodone and acetaminophen and hydrocodone and acetaminophen.²⁹

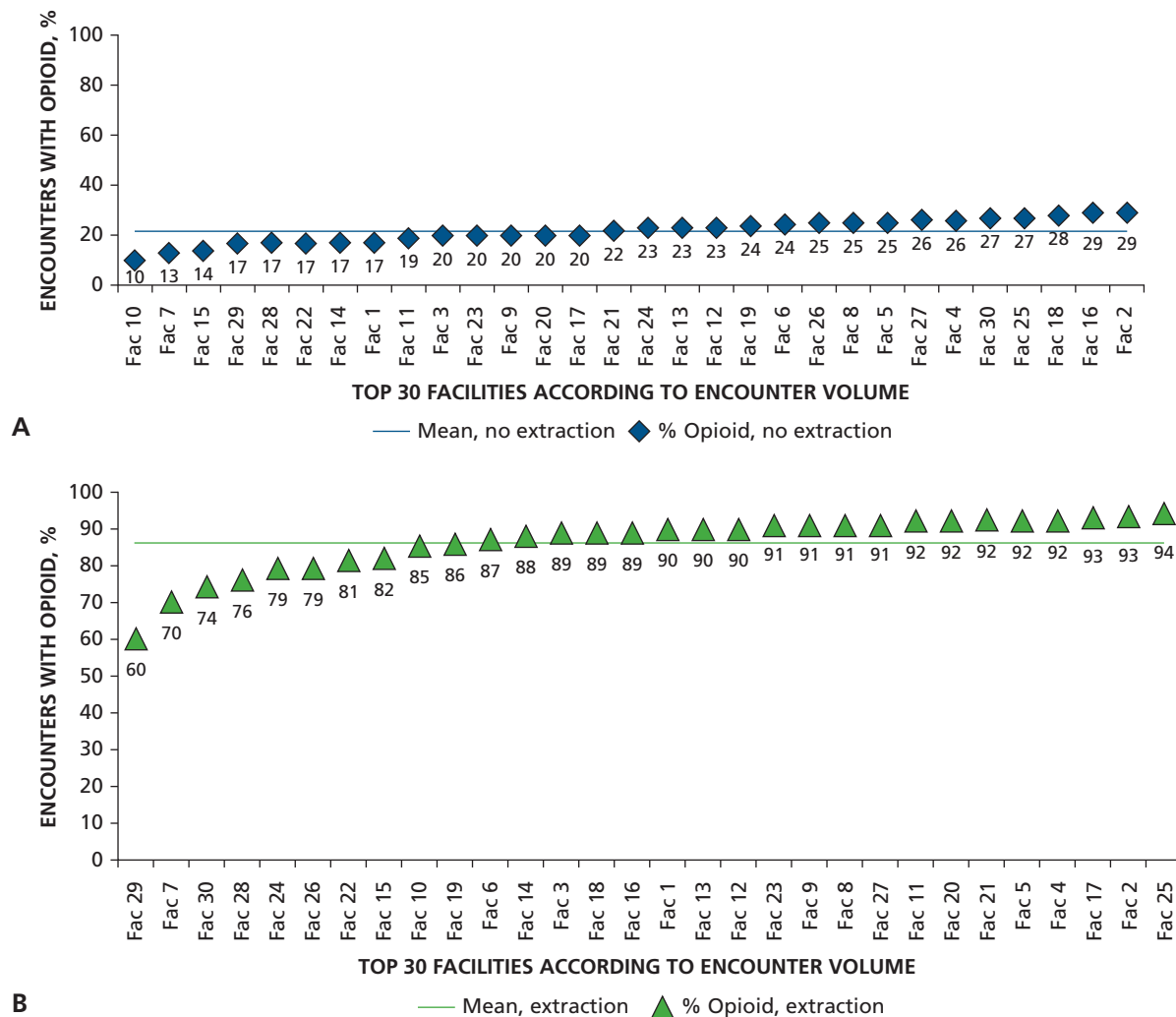


Figure 2. Percentage of dental surgical encounters with opioid prescriptions according to facility: top 30 of 130 facilities according to encounter volume, October 2014 through September 2017. **A.** Nonextraction. **B.** Extraction. Observed percentage of encounters associated with dental opioid prescription on date of encounter, within 30 days before surgery or within 30 days after surgery. Facilities numbered by total number of surgical encounters (1 = highest). Restricted to top 30 facilities by encounter volume; minimum volume of encounters = 1,968. Fac: Facility.

We found that younger, enlisted, Hispanic, and male patients were more likely than other soldiers to receive an opioid prescription. Contrariwise, researchers from 1 study in the civilian literature reported Hispanic patients were less likely than white patients and black patients were more likely than white patients to receive opioid prescriptions,³⁰ and a separate study found no difference between racial and ethnic groups.²

Geographic variation in overall prescribing of opioids is well known; the mean per capita MMEs in the top quartile of US counties was approximately 6 times the amount prescribed in the lowest quartile.¹⁸ To our knowledge there are no published studies of variation in opioid prescribing among dental group practices. One might expect local leadership, shared norms, and instruction of junior dentists by experienced dentists to affect the decisions of each group's practices.

As with all retrospective cohort studies, our study has several limitations. First, we did not account for variation among prescribers, which was beyond the scope of this article. Second, there were unmeasured patient characteristics, for example, opioid use disorder. Third, a small number of dental procedures for this sample might have occurred outside of the dental program in emergency departments, which were not studied here.

The combination of nonsteroidal anti-inflammatory drugs and acetaminophen is better than opioids for controlling postdental procedure pain in some studies.³¹ Based on the literature, the American Dental Association's guidelines recommend screening patients for opioid "red flags" or risk signs and recommend that dentists consult a state's prescription drug monitoring program before

prescribing.³² Civilian dental practices have had low rates of requesting medical records and rare use of prescription drug monitoring programs.³³ The MHS has advantages here because it integrates oral health care into the medical record and a unified prescription record system provides military dental clinicians with readily available information and other flags for possible opioid overuse.

It is difficult to change the behavior of clinicians whose training has been to provide opioids to ameliorate substantial pain. The MHS has undertaken many initiatives to address possible over-prescribing, for example, the creation of an Opioid Registry in 2017 intended to help clinicians and clinic directors monitor care delivery. There are some signs that their efforts have been successful; the military's rate of deadly overdoses is one-quarter of the national average.³⁴ However, our study suggests additional strategies might be warranted. Researchers have reported that "academic detailing," or direct outreach education to clinicians, is an effective communication strategy that actually leads to change in practice,³⁵ and it has been successfully tailored to encourage safer opioid prescribing.^{36,37} Additional strategies might be needed to address patient expectations for narcotic pain medication, which can translate into pressure on clinicians.

CONCLUSIONS

Our findings imply that more attention should be paid to strategies used at dental clinics of military facilities achieving lower prescribing rates, given that 9 of the 30 largest facilities reported rates significantly lower than the average. We hope that our evidence showing that some dental groups can achieve lower levels of opioid prescribing can increase confidence in dental leadership discussions leading to lower rates of opioid prescribing. ■

SUPPLEMENTAL DATA

Supplemental data related to this article can be found at: <https://doi.org/10.1016/j.adaj.2020.09.020>.

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STUDY METHODS

Data sources

The Dental Encounter data file contained 1 record for each discrete dental procedure performed in a military dental clinic, resulting in multiple procedure records for each dental encounter. Each record contained a detailed description of the procedure (coded using the Current Dental Terminology code^{e1}), date of service, dental clinic name, ZIP code, and parent facility), the provider's National Provider Identification, the dental provider type (11 categories), and demographic characteristics of the patient. The Pharmacy Data Transaction Service file contained each prescription filled by the patient in any setting paid by the MHS health program (that is, TRICARE) and included the date written, date dispensed, the source of the prescription (for example, direct care, retail, and mail order), American Hospital Formulary Service therapeutic class, National Drug Code, days' supply, quantity dispensed, the Drug Enforcement Agency (DEA)—controlled substance class, and the prescriber identification.

Dental procedure codes

We defined the study's participants as sample soldiers with 1 or more procedures performed by dentists that were surgical or invasive (hereafter, surgical) and therefore might be associated with an opioid prescription. We selected procedures that were described as surgical in the study by Gupta and colleagues,¹⁰ and added certain procedures that were invasive or palliative on the basis of advice from dentists with whom we consulted. All procedures performed by nondentists, providers who do not prescribe opioids, were excluded. See eTable 1 for the dental procedure codes selected as surgical or invasive. We rolled up all included procedure records to the encounter level for matching to prescription claims and for analysis.

Opioid medications included in dental encounter analysis

We examined all of the prescription claims of the sample and selected for inclusion opioid prescriptions using the Centers for Disease Control and Prevention algorithm modified to remove opioids that are used to treat addiction disorders.²³

A team of investigators and consultants reviewed all medications on the CDC list and made selected exclusions for medication forms perceived to have uses other than pain treatment, such as in addiction treatment, for example, certain forms of buprenorphine, methadone, and medications typically dispensed in inpatient settings only (eTable 2).

MMEs were based on the values assigned in the Centers for Disease Control and Prevention algorithm.²³

Dental opioids matching and overview

The number of encounters in the 2015 to 2017 (fiscal years) period is substantially smaller than the other period, in part because of the Substance Use and Psychological Injury Combat study design (see Table 1 in main text). The total observable months for sample members were 41,441,050 for 2009 to 2014 and 16,967,233 for 2015 to 2017. The number of dental encounters per 1,000 observable months in the sample was 14.8 in the 2009 to 2014 period and 7.7 in the 2015 to 2017 period. This likely reflects the longitudinal study design; soldiers receive annual dental examinations and must meet dental readiness standards to be deployable. As soldiers age in the sample they become less likely to require tooth extractions and other dental surgery because of the oral health care they received in the earlier period. We accrued soldiers who had deployments between fiscal years 2009 to 2014 (only). Because of sample attrition, the number of observable months per year declined from 8,288,210 to 5,655,744 in the 2 periods.

We identified all prescriptions written by a provider who was a dentist (by examining provider National Provider Identification on the dental encounter and prescriber DEA on the Pharmacy Data Transaction Service; note, although labeled a DEA number, the number was not typically stored as a DEA number but rather an Electronic Data Interchange Personal Identifier or National Provider Identification). These prescriptions were labeled dental prescriptions ($n = 4.1$ million, see eFigure). Our primary outcome was a surgical encounter with opioid exposure. We specified a 60-day window around each surgical encounter and matched all opioid prescriptions written by a dentist on the date of a surgical encounter, pre surgery (within 30 days before surgery), or post

surgery (within 30 days after surgery). A dental encounter with 1 or more pre- or post-surgery opioid prescriptions was classified as an opioid-exposed encounter. Of all opioid prescriptions, we matched 342,595 to a dentist prescriber number (8.4%). We then matched the dental opioid prescription to a specific dental encounter based on encounter visit date and prescription written date. Of dental opioids, 303,637 matched a surgical encounter because of an exact date match, or because it was within 30 days before the encounter or 30 days after the encounter; 38,958 dental opioid prescriptions were excluded from analysis as nonsurgical (11.4%).

Description of characteristics for facility substudy: October 2015 to September 2017

[eTable 3](#) provides the characteristics of the restricted sample used for the facility-level and multi-level analysis.

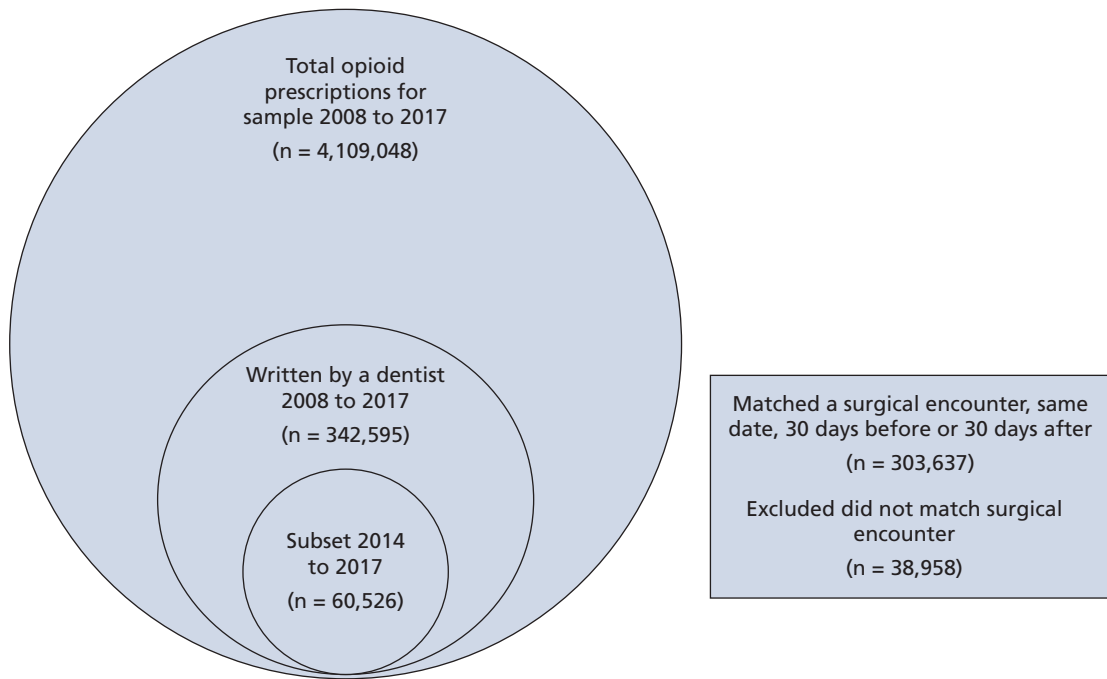
Expected versus observed prescribing rates

We calculated the expected opioid prescribing rate at each facility, computing the expected rate using a general estimating equation presented in [eTable 4](#).

Facility-specific observed prescribing percentages varied by a factor of 30.1 (87.5% versus 2.9%) for facilities with at least 25 observations in the study. After adjustment for type of procedure, type of provider, region, and case mix (that is, gender, rank, and age), the expected prescribing percentages in the 30 facilities with the largest volume of procedures fell into a narrower but still large range (64.7% to 19.0%). In [eTable 5](#) we present the ratio of observed prescribing to expected opioid prescribing for each facility and the adjusted prescribing rate estimate with 95% confidence intervals. We note that 16 facilities had higher than expected prescribing percentages, including 11 with higher than expected percentages by 4 or more points; 14 facilities had lower than expected prescribing percentages, including 9 with a difference of 4 or more points.

Multinomial model findings

We performed multilevel mixed-effects logistic regression (STATA `melogit`) to reflect estimates of the effect of encounter and facility variables on the outcome of opioid prescribing. In the multilevel multinomial models, the facility-level (level 2) variables were important predictors of opioid prescribing after controlling for level 1 (encounter) factors. The multilevel results also showed that by adding facility-level regional variables and variables that captured the clinical practice behavior, 80% of the between-facility variation in opioid prescribing was attributed to the facility-level; this model had the lowest intraclass correlation coefficient, suggesting that this was the best model to explain variation at the facility level ([eTables 6 and 7](#)).



eFigure. Number of total opioid prescriptions for the sample written by a dentist, matched a surgical encounter (main sample), and selected for facility substudy.

eTable 1. Dental procedure codes included in the analysis as surgical or invasive.

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
ENDO†	D3110	Pulp cap—direct (excluding final restoration)
ENDO	D3120	Pulp cap—indirect (excluding final restoration)
ENDO	D3220	Therapeutic pulpotomy (excluding final restoration)—removal of pulp coronal to the dentinocemental junction and application of medicament
ENDO	D3221	Pulpal debridement, primary and permanent teeth
ENDO	D3222	Partial pulpotomy for apexogenesis—permanent tooth with incomplete root development
ENDO	D3230	Pulpal therapy (resorbable filling)—anterior, primary tooth (excluding final restoration)
ENDO	D3240	Pulpal therapy (resorbable filling)—posterior, primary tooth (excluding final restoration)
ENDO	D3310	Endodontic therapy, anterior tooth (excluding final restoration)
ENDO	D3320	Endodontic therapy, bicuspid tooth (excluding final restoration)
ENDO	D3330	Endodontic therapy, molar (excluding final restoration)
ENDO	D3331	Treatment of root canal obstruction; non-surgical access
ENDO	D3332	Incomplete endodontic therapy; inoperable, unrestorable or fractured tooth
ENDO	D3333	Internal root repair of perforation defects
ENDO	D3346	Retreatment of previous root canal therapy—anterior
ENDO	D3347	Retreatment of previous root canal therapy—bicuspid
ENDO	D3348	Retreatment of previous root canal therapy—molar
ENDO	D3351	Apexification/recalcification—initial visit (apical closure/calific repair of perforations, root resorption, etc.)
ENDO	D3352	Apexification/recalcification—interim medication replacement
ENDO	D3353	Apexification/recalcification—final visit (includes completed root canal therapy—apical closure/calific repair of perforations, root resorption, etc.)
ENDO	D3354	Pulpal regeneration—(completion of regenerative treatment in an immature permanent tooth with a necrotic pulp); does not include final restoration
ENDO	D3355	Pulpal regeneration—initial visit
ENDO	D3356	Pulpal regeneration—interim medication replacement
ENDO	D3357	Pulpal regeneration—completion of treatment
ENDO	D3410	Apicoectomy—anterior
ENDO	D3421	Apicoectomy—bicuspid (first root)
ENDO	D3425	Apicoectomy—molar (first root)
ENDO	D3426	Apicoectomy (each additional root)
ENDO	D3427	Periradicular surgery without apicoectomy
ENDO	D3428	Bone graft in conjunction with periradicular surgery—per tooth, single site
ENDO	D3429	Bone graft in conjunction with periradicular surgery—each additional contiguous tooth in the same surgical site
ENDO	D3430	Retrograde filling—per root
ENDO	D3431	Biologic materials to aid in soft and osseous tissue regeneration in conjunction with periradicular surgery
ENDO	D3432	Guided tissue regeneration, resorbable barrier, per site, in conjunction with periradicular surgery
ENDO	D3450	Root amputation—per root

Source: American Dental Association.^{e1}

* ADA: American Dental Association. † ENDO: All endodontic therapies and procedures in the ADA classification. ‡ PERIO: ADA classification periodontic surgical services (including usual postoperative care). § IMPLANT: All ADA Classification implant surgical and other services. ¶ NA: Not applicable. # FPD: Fixed partial denture. ** OMS: ADA classification all oral and maxillofacial extraction and other procedures. †† TMD: Temporomandibular joint dysfunction.

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
ENDO	D3460	Endodontic endosseous implant
ENDO	D3470	Intentional re-implantation (including necessary splinting)
ENDO	D3910	Surgical procedure for isolation of tooth with rubber dam
ENDO	D3920	Hemisection (including any root removal), not including root canal therapy
ENDO	D3950	Canal preparation and fitting of preformed dowel or post
ENDO	D3999	Unspecified endodontic procedure, by report
PERIO*	D4210	Gingivectomy or gingivoplasty—4 or more contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4211	Gingivectomy or gingivoplasty—1 to 3 contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4212	Gingivectomy or gingivoplasty to allow access for restorative procedure, per tooth
PERIO	D4230	Anatomical crown exposure—4 or more contiguous teeth per quadrant
PERIO	D4231	Anatomical crown exposure—1 to 3 teeth per quadrant
PERIO	D4240	Gingival flap procedure, including root planing—4 or more contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4241	Gingival flap procedure, including root planing—1 to 3 contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4245	Apically positioned flap
PERIO	D4249	Clinical crown lengthening—hard tissue
PERIO	D4260	Osseous surgery (including elevation of a full thickness flap and closure)—4 or more contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4261	Osseous surgery (including elevation of a full thickness flap and closure)—1 to 3 contiguous teeth or tooth bounded spaces per quadrant
PERIO	D4263	Bone replacement graft—retained natural tooth—first site in quadrant
PERIO	D4264	Bone replacement graft—retained natural tooth—each additional site in quadrant
PERIO	D4265	Biologic materials to aid in soft and osseous tissue regeneration
PERIO	D4266	Guided tissue regeneration—resorbable barrier, per site
PERIO	D4267	Guided tissue regeneration—nonresorbable barrier, per site (includes membrane removal)
PERIO	D4268	Surgical revision procedure, per tooth
PERIO	D4270	Pedicle soft tissue graft procedure
PERIO	D4271	Free soft tissue graft procedure (including donor site surgery)
PERIO	D4273	Autogenous connective tissue graft procedure (including donor and recipient surgical sites) first tooth, implant or edentulous tooth position in graft
PERIO	D4274	Mesial/distal wedge procedure, single tooth (when not performed in conjunction with surgical procedures in the same anatomical area)
PERIO	D4275	Non-autogenous connective tissue graft (including recipient site and donor material) first tooth, implant, or edentulous tooth position in graft
PERIO	D4276	Combined connective tissue and double pedicle graft, per tooth
PERIO	D4277	Free soft tissue graft procedure (including recipient and donor surgical sites) first tooth, implant or edentulous tooth position in graft
PERIO	D4278	Free soft tissue graft procedure (including recipient and donor surgical sites) each additional contiguous tooth, implant or edentulous tooth position in same graft site
PERIO	D4283	Autogenous connective tissue graft procedure (including donor and recipient surgical sites)—each additional contiguous tooth, implant or edentulous tooth position in same graft site
PERIO	D4285	Non-autogenous connective tissue graft (including recipient surgical site and donor material)—each additional contiguous tooth, implant, or edentulous tooth position in same graft site
IMPLANT ⁵	D6010	Surgical placement of implant body: endosteal implant

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
IMPLANT	D6011	Second stage implant surgery
IMPLANT	D6012	Surgical placement of interim implant body for transitional prosthesis: endosteal implant
IMPLANT	D6013	Surgical placement of mini implant
IMPLANT	D6040	Surgical placement: eosteal implant
IMPLANT	D6047	NA ^f
IMPLANT	D6050	Surgical placement: transosteal implant
IMPLANT	D6051	Interim abutment
IMPLANT	D6052	Semi-precision attachment abutment
IMPLANT	D6053	Implant/abutment supported removable denture for completely edentulous arch
IMPLANT	D6054	Implant/abutment supported removable denture for partially edentulous arch
IMPLANT	D6055	Connecting bar—implant supported or abutment supported
IMPLANT	D6056	Prefabricated abutment—includes modification and placement
IMPLANT	D6057	Custom fabricated abutment—includes placement
IMPLANT	D6058	Abutment supported porcelain/ceramic crown
IMPLANT	D6059	Abutment supported porcelain fused to metal crown (high noble metal)
IMPLANT	D6060	Abutment supported porcelain fused to metal crown (predominantly base metal)
IMPLANT	D6061	Abutment supported porcelain fused to metal crown (noble metal)
IMPLANT	D6062	Abutment supported cast metal crown (high noble metal)
IMPLANT	D6063	Abutment supported cast metal crown (predominantly base metal)
IMPLANT	D6064	Abutment supported cast metal crown (noble metal)
IMPLANT	D6065	Implant supported porcelain/ceramic crown
IMPLANT	D6066	Implant supported porcelain fused to metal crown (titanium, titanium alloy, high noble metal)
IMPLANT	D6067	Implant supported metal crown (titanium, titanium alloy, high noble metal)
IMPLANT	D6068	Abutment supported retainer for porcelain/ceramic FPD ^g
IMPLANT	D6069	Abutment supported retainer for porcelain fused to metal FPD (high noble metal)
IMPLANT	D6070	Abutment supported retainer for porcelain fused to metal FPD (predominantly base metal)
IMPLANT	D6071	Abutment supported retainer for porcelain fused to metal FPD (noble metal)
IMPLANT	D6072	Abutment supported retainer for cast metal FPD (high noble metal)
IMPLANT	D6073	Abutment supported retainer for cast metal FPD (predominantly base metal)
IMPLANT	D6074	Abutment supported retainer for cast metal FPD (noble metal)
IMPLANT	D6075	Implant supported retainer for ceramic FPD
IMPLANT	D6076	Implant supported retainer for porcelain fused to metal FPD (titanium, titanium alloy, or high noble metal)
IMPLANT	D6077	Implant supported retainer for cast metal FPD (titanium, titanium alloy, or high noble metal)
IMPLANT	D6078	Implant/abutment supported fixed denture for completely edentulous arch
IMPLANT	D6079	Implant/abutment supported fixed denture for partially edentulous arch
IMPLANT	D6080	Implant maintenance procedures when prostheses are removed and reinserted, including cleansing of prostheses and abutments
IMPLANT	D6081	Scaling and debridement in the presence of inflammation or mucositis of a single implant, including cleaning of the implant surfaces, without flap entry and closure
IMPLANT	D6085	Provisional implant crown
IMPLANT	D6090	Repair implant supported prosthesis, by report

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
IMPLANT	D6091	Replacement of semi-precision or precision attachment (male or female component) of implant/abutment supported prosthesis, per attachment
IMPLANT	D6092	Re-cement or re-bond implant/abutment supported crown
IMPLANT	D6093	Re-cement or re-bond implant/abutment supported fixed partial denture
IMPLANT	D6094	Abutment supported crown (titanium)
IMPLANT	D6095	Repair implant abutment, by report
IMPLANT	D6100	Implant removal, by report
IMPLANT	D6101	Debridement of a peri-implant defect or defects surrounding a single implant, and surface cleaning of the exposed implant surfaces, including flap entry and closure
IMPLANT	D6102	Debridement and osseous contouring of a peri-implant defect or defects surrounding a single implant and includes surface cleaning of the exposed implant surfaces, including flap entry and closure
IMPLANT	D6103	Bone graft for repair of peri-implant defect—does not include flap entry and closure
IMPLANT	D6104	Bone graft at time of implant placement
IMPLANT	D6110	Implant/abutment supported removable denture for edentulous arch—maxillary
IMPLANT	D6111	Implant/abutment supported removable denture for edentulous arch—mandibular
IMPLANT	D6112	Implant/abutment supported removable denture for partially edentulous arch—maxillary
IMPLANT	D6113	Implant/abutment supported removable denture for partially edentulous arch—mandibular
IMPLANT	D6114	Implant/abutment supported fixed denture for edentulous arch—maxillary
IMPLANT	D6115	Implant/abutment supported fixed denture for edentulous arch—mandibular
IMPLANT	D6116	Implant/abutment supported fixed denture for partially edentulous arch—maxillary
IMPLANT	D6117	Implant/abutment supported fixed denture for partially edentulous arch—mandibular
OMS**	D7110	Extraction, single tooth
OMS	D7111	Extraction, coronal remnants—deciduous tooth
OMS, Extraction	D7140	Extraction, erupted tooth or exposed root (elevation and/or forceps removal)
OMS, Extraction	D7210	Extraction, erupted tooth requiring removal of bone and/or sectioning of tooth, and including elevation of mucoperiosteal flap if indicated
OMS, Extraction	D7220	Removal of impacted tooth—soft tissue
OMS, Extraction	D7230	Removal of impacted tooth—partially bony
OMS, Extraction	D7240	Removal of impacted tooth—completely bony
OMS, Extraction	D7241	Removal of impacted tooth—completely bony, with unusual surgical complications
OMS	D7250	Removal of residual tooth roots (cutting procedure)
OMS	D7251	Coronectomy—intentional partial tooth removal
OMS	D7260	Oroantral fistula closure
OMS	D7261	Primary closure of a sinus perforation
OMS	D7270	Tooth reimplantation and/or stabilization of accidentally evulsed or displaced tooth
OMS	D7272	Tooth transplantation (includes re-implantation from one site to another and splinting and/or stabilization)
OMS	D7280	Exposure of an unerupted tooth
OMS	D7282	Mobilization of erupted or malpositioned tooth to aid eruption
OMS	D7283	Placement of device to facilitate eruption of impacted tooth
OMS	D7285	Incisional biopsy of oral tissue—hard (bone, tooth)
OMS	D7286	Incisional biopsy of oral tissue—soft
OMS	D7287	Exfoliative cytological sample collection

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
OMS	D7288	Brush biopsy—transepithelial sample collection
OMS	D7290	Surgical repositioning of teeth
OMS	D7291	Transseptal fiberotomy/supra crestal fiberotomy, by report
OMS	D7292	Placement of temporary anchorage device [screw retained plate] requiring flap; includes device removal
OMS	D7293	Placement of temporary anchorage device requiring flap; includes device removal
OMS	D7294	Placement of temporary anchorage device without flap; includes device removal
OMS	D7295	Harvest of bone for use in autogenous grafting procedure
OMS	D7310	Alveoplasty in conjunction with extractions—4 or more teeth or tooth spaces, per quadrant
OMS	D7311	Alveoplasty in conjunction with extractions—1 to 3 teeth or tooth spaces, per quadrant
OMS	D7320	Alveoplasty not in conjunction with extractions—4 or more teeth or tooth spaces, per quadrant
OMS	D7321	Alveoplasty not in conjunction with extractions—1 to 3 teeth or tooth spaces, per quadrant
OMS	D7340	Vestibuloplasty—ridge extension (secondary epithelialization)
OMS	D7350	Vestibuloplasty—ridge extension (including soft tissue grafts, muscle reattachment, revision of soft tissue attachment and management of hypertrophied and hyperplastic tissue)
OMS	D7410	Excision of benign lesion up to 1.25 cm
OMS	D7411	Excision of benign lesion greater than 1.25 cm
OMS	D7412	Excision of benign lesion, complicated
OMS	D7413	Excision of malignant lesion up to 1.25 cm
OMS	D7414	Excision of malignant lesion greater than 1.25 cm
OMS	D7415	Excision of malignant lesion, complicated
OMS	D7440	Excision of malignant tumor—lesion diameter up to 1.25 cm
OMS	D7441	Excision of malignant tumor—lesion diameter greater than 1.25 cm
OMS	D7450	Removal of benign odontogenic cyst or tumor—lesion diameter up to 1.25 cm
OMS	D7451	Removal of benign odontogenic cyst or tumor—lesion diameter greater than 1.25 cm
OMS	D7460	Removal of benign nonodontogenic cyst or tumor—lesion diameter up to 1.25 cm
OMS	D7461	Removal of benign nonodontogenic cyst or tumor—lesion diameter greater than 1.25 cm
OMS	D7465	Destruction of lesion(s) by physical or chemical method, by report
OMS	D7471	Removal of lateral exostosis (maxilla or mandible)
OMS	D7472	Removal of torus palatinus
OMS	D7473	Removal of torus mandibularis
OMS	D7485	Reduction of osseous tuberosity
OMS	D7490	Radical resection of maxilla or mandible
OMS	D7510	Incision and drainage of abscess—intraoral soft tissue
OMS	D7511	Incision and drainage of abscess—intraoral soft tissue—complicated (includes drainage of multiple fascial spaces)
OMS	D7520	Incision and drainage of abscess—extraoral soft tissue
OMS	D7521	Incision and drainage of abscess—extraoral soft tissue—complicated (includes drainage of multiple fascial spaces)
OMS	D7530	Removal of foreign body from mucosa, skin, or subcutaneous alveolar tissue
OMS	D7540	Removal of reaction producing foreign bodies, musculoskeletal system
OMS	D7550	Partial ostectomy/sequestrectomy for removal of non-vital bone
OMS	D7560	Maxillary sinusotomy for removal of tooth fragment or foreign body
OMS	D7593	NA

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
OMS	D7610	Maxilla—open reduction (teeth immobilized, if present)
OMS	D7620	Maxilla—closed reduction (teeth immobilized, if present)
OMS	D7630	Mandible—open reduction (teeth immobilized, if present)
OMS	D7640	Mandible—closed reduction (teeth immobilized, if present)
OMS	D7650	Malar and/or zygomatic arch—open reduction
OMS	D7660	Malar and/or zygomatic arch—closed reduction
OMS	D7670	Alveolus—closed reduction, may include stabilization of teeth
OMS	D7671	Alveolus—open reduction, may include stabilization of teeth
OMS	D7680	Facial bones—complicated reduction with fixation and multiple surgical approaches
OMS	D7710	Maxilla—open reduction
OMS	D7720	Maxilla—closed reduction
OMS	D7730	Mandible—open reduction
OMS	D7740	Mandible—closed reduction
OMS	D7750	Malar and/or zygomatic arch—open reduction
OMS	D7760	Malar and/or zygomatic arch—closed reduction
OMS	D7770	Alveolus—open reduction stabilization of teeth
OMS	D7771	Alveolus—closed reduction stabilization of teeth
OMS	D7780	Facial bones—complicated reduction with fixation and multiple approaches
OMS	D7810	Open reduction of dislocation
OMS	D7820	Closed reduction of dislocation
OMS	D7830	Manipulation under anesthesia
OMS	D7840	Condylectomy
OMS	D7850	Surgical discectomy, with/without implant
OMS	D7852	Disc repair
OMS	D7854	Synovectomy
OMS	D7856	Myotomy
OMS	D7858	Joint reconstruction
OMS	D7860	Arthrotomy
OMS	D7865	Arthroplasty
OMS	D7870	Arthrocentesis
OMS	D7871	Non-arthroscopic lysis and lavage
OMS	D7872	Arthroscopy—diagnosis, with or without biopsy
OMS	D7873	Arthroscopy: lavage and lysis of adhesions
OMS	D7874	Arthroscopy: disc repositioning and stabilization
OMS	D7875	Arthroscopy: synovectomy
OMS	D7876	Arthroscopy: discectomy
OMS	D7877	Arthroscopy: debridement
OMS	D7880	Occlusal orthotic device, by report
OMS	D7881	Occlusal orthotic device adjustment
OMS	D7899	Unspecified TMD ^{††} therapy, by report
OMS	D7903	NA
OMS	D7910	Suture of recent small wounds up to 5 cm
OMS	D7911	Complicated suture—up to 5 cm

eTable 1. Continued

ADA* CATEGORY	ADA PROCEDURE CODE	ADA PROCEDURE DESCRIPTION
OMS	D7912	Complicated suture—greater than 5 cm
OMS	D7920	Skin graft (identify defect covered, location and type of graft)
OMS	D7921	Collection and application of autologous blood concentrate product
OMS	D7940	Osteoplasty—for orthognathic deformities
OMS	D7941	Osteotomy—mandibular rami
OMS	D7943	Osteotomy—mandibular rami with bone graft; includes obtaining the graft
OMS	D7944	Osteotomy—segmented or subapical
OMS	D7945	Osteotomy—body of mandible
OMS	D7946	LeFort I (maxilla—total)
OMS	D7947	LeFort I (maxilla—segmented)
OMS	D7948	LeFort II or LeFort III (osteoplasty of facial bones for midface hypoplasia or retrusion) —without bone graft
OMS	D7949	LeFort II or LeFort III—with bone graft
OMS	D7950	Osseous, osteoperiosteal, or cartilage graft of the mandible or maxilla—autogenous or nonautogenous, by report
OMS	D7951	Sinus augmentation with bone or bone substitutes via a lateral open approach
OMS	D7952	Sinus augmentation via a vertical approach
OMS	D7953	Bone replacement graft for ridge preservation—per site
OMS	D7955	Repair of maxillofacial soft and/or hard tissue defect
OMS	D7960	Frenulectomy—also known as frenectomy or frenotomy—separate procedure not incidental to another procedure
OMS	D7963	Frenuloplasty
OMS	D7970	Excision of hyperplastic tissue—per arch
OMS	D7971	Excision of pericoronal gingiva
OMS	D7972	Surgical reduction of fibrous tuberosity
OMS	D7980	Sialolithotomy
OMS	D7981	Excision of salivary gland, by report
OMS	D7982	Sialodochoplasty
OMS	D7983	Closure of salivary fistula
OMS	D7990	Emergency tracheotomy
OMS	D7991	Coronoidectomy
OMS	D7995	Synthetic graft—mandible or facial bones, by report
OMS	D7996	Implant-mandible for augmentation purposes (excluding alveolar ridge), by report
OMS	D7997	Appliance removal (not by dentist who placed appliance), includes removal of archbar
OMS	D7998	Intraoral placement of a fixation device not in conjunction with a fracture
OMS	D7999	Unspecified oral surgery procedure, by report
PALLIATIVE EMERG ENCY	D9110	Palliative (emergency) treatment of dental pain—minor procedure

eTable 2. Opioid subclasses included in study and specific exclusions.

OPIOID SUBCLASSES INCLUDED	COMMENT ON DRUG EXCLUSIONS
Buprenorphine	Buprenorphine-naloxone, suboxone, and zubsolv excluded; powder buprenorphine excluded (PRODFORM: POWDER [GM])
Butorphanol	NA*
Codeine	Powder codeine excluded (PRODFORM: POWDER [GM])
Dihydrocodeine	NA
Fentanyl	NA
Hydrocodone	NA
Hydromorphone	NA
Meperidine	NA
Methadone	Oral methadone/methadose excluded (PRODFORM: CONCENTRATE, ORAL, SOLUTION, ORAL)
Morphine	NA
Oxycodone	NA
Oxymorphone	NA
Pentazocine	NA
Tapentadol	NA
Additional Opioid Exclusions	
All injectables	PRODFORM: AMPUL (ML), PATIENT CONTROLLED ANALGESIC SYRINGE, DISPOSABLE SYRINGE (ML), VIAL (SDV, MDV, OR ADDITIVE) (ML), PLASTIC BAG, INJECTION (ML), PATIENT CONTROLLED ANALGESIC VIAL
Belladonna-opium	NA
B & O Suppettes	NA
Propoxyphene	Includes Darvon, Darvocet, and Balacet

* NA: Not applicable.

eTable 3. Distribution on characteristics for multilevel regression models, October 2014 to September 2017.

CHARACTERISTIC	DATA
Total Surgical Encounters, No. (%)	125,556 (100.0)
Age Group, No. (%)	
26 years or older	109,978 (87.6)
Younger than 26 years	15,578 (12.4)
Sex, No. (%)	
Female	18,513 (14.7)
Male	107,043 (85.2)
Rank, No. (%)	
Enlisted	102,880 (81.9)
Officer	22,676 (18.1)
Race and Ethnicity, No. (%)	
Non-Hispanic, Asian, or Pacific Islander	12,629 (10.1)
Non-Hispanic, Black	33,000 (26.3)
Hispanic	14,869 (11.8)
Non-Hispanic, White	62,365 (49.7)
American Indian, Alaskan Native, or other	2,693 (2.1)
Component, No. (%)	
Active duty	114,858 (91.5)
National Guard	6,225 (5.0)
Reserve	4,441 (3.5)
Year of Encounter, No. (%)	
2015	52,524 (41.8)
2016	43,037 (34.3)
2017	29,995 (23.9)
Type of Procedure (not mutually exclusive), No. %	
Endodontic	48,097 (38.3)
Periodontic	17,460 (13.9)
Implant	18,049 (14.4)
Oral and maxillofacial (excluding tooth extraction)	11,959 (9.5)
Tooth extraction	26,810 (21.3)
Palliative emergency	14,902 (11.9)
By Provider Type, No. (%)	
Specialist	15,611 (12.4)
Dental officer general	109,945 (87.6)
Patient Opioid Status at Time of Encounter,* No. (%)	
Not naïve	23,289 (18.5)
Naïve	102,267 (81.5)

* Opioid-naïve defined as no opioid prescription fills within 90 days before the encounter. † TRICARE North: Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin, and portions of Iowa (Rock Island Arsenal area), Missouri (St. Louis area), and Tennessee (Fort Campbell area). TRICARE South: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, Tennessee (excluding the Fort Campbell area), and Texas (excluding the El Paso area). TRICARE West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Iowa (excluding Rock Island Arsenal area), Kansas, Minnesota, Missouri (except the St. Louis area), Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas (the southwestern corner, including El Paso), Utah, Washington, and Wyoming. TRICARE OCONUS: Hawaii, Guam, Puerto Rico, Europe, Asia, and Pacific. ‡ OCONUS: Outside the continental United States. § SD: Standard deviation.

eTable 3. Continued

CHARACTERISTIC	DATA
Facility Service Branch, No. (%)	
Army	107,669 (85.7)
Other branch	17,887 (14.2)
Type of Facility, No. (%)	
Medical center (largest)	35,634 (28.4)
Hospital (medium)	64,025 (51.0)
Clinic and other (smallest)	25,897 (20.6)
Facility Region,[†] No. (%)	
TRICARE OCONUS [‡]	11,495 (9.2)
TRICARE North	26,640 (21.2)
TRICARE South	44,341 (35.3)
TRICARE West	38,304 (30.5)
Other or unknown	4,776 (3.8)
Proportion of Encounters, Younger Than 26 Years, Mean (SD[§]) (n = 90)	0.069 (0.063)
Proportion of Encounters, Extractions (n = 90), Mean (SD)	0.198 (0.070)
Proportion of Encounters, Periodontic (n = 90), Mean (SD)	0.145 (0.087)
Proportion of Encounters, Specialist (SD) (n = 90), Mean (SD)	0.144 (0.151)

eTable 4. Coefficients used to calculate opioid exposure at each facility (modeled with the outcome = no exposure) (n = 131).

VARIABLE	ESTIMATE	STANDARD ERROR	95% CONFIDENCE LIMITS	Z SCORE	P VALUE
Intercept	-29.2005	7.28	-43.47 and -14.93	-4.01	< .0001
Fiscal Year	0.0145	0.004	0.007 and 0.0216	4.03	< .0001
Age Group, 26 Years and Older (Reference: Younger Than 26 Years)	0.0181	0.006	0.006 and 0.030	3.00	< .01
Sex, Male (Reference: Female)	0.0120	0.005	0.003 and 0.021	2.63	< .01
Rank (Reference: Junior Enlisted)	0.0082	0.005	-0.001 and 0.017	1.82	NS
Senior enlisted					
Junior officer	0.0118	0.010	-0.008 and 0.032	1.15	NS
Senior officer	0.0113	0.009	-0.005 and 0.028	1.32	NS
Warrant officer	0.0053	0.009	-0.010 and 0.021	0.68	NS
Dentist Specialist (Reference: Generalist)	-0.0634	0.026	-0.114 and -0.013	-2.45	< .01
Service Branch Other (Reference: Army)	0.0061	0.013	-0.020 and 0.033	0.45	NS
Region* (Reference: TRICARE North)					
TRICARE South	-0.0250	0.017	-0.058 and 0.008	-1.48	NS
TRICARE West	-0.0173	0.011	-0.040 and 0.005	-1.51	NS
OCONUS [†]	-0.0457	0.015	-0.075 and -0.016	-3.05	< .01
Other or unknown	0.0279	0.014	0.001 and 0.05	2.04	NS
Facility Type (Reference: Clinic/Other)					
Hospital	-0.0131	0.014	-0.041 and 0.015	-0.92	NS
Medical center	-0.0406	0.015	-0.070 and -0.011	-2.71	< .01
Prescription Timing Pre Encounter, Yes (Reference: No)	-0.0261	0.005	-0.035 and -0.017	-5.86	< .0001
Type of Surgical Procedure (Reference: No; Not Mutually Exclusive)					
Periodontic	-1.1232	0.067	-1.253 and -0.993	-16.88	< .0001
Endodontic	-0.2100	0.037	-0.283 and -0.137	-5.68	< .0001
Implant	-0.3819	0.040	-0.461 and -0.303	-9.46	< .0001
Emergency palliative	-0.2229	0.037	-0.296 and -0.150	-6.00	< .0001
Extraction	-1.8648	0.141	-2.140 and -1.589	-13.27	< .0001
Oral maxillofacial not extraction	-0.5933	0.040	-0.672 and -0.515	-14.82	< .0001

* TRICARE North: Connecticut, Delaware, District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin, and portions of Iowa (Rock Island Arsenal area), Missouri (St. Louis area), and Tennessee (Fort Campbell area). TRICARE South: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, Tennessee (excluding the Fort Campbell area) and Texas (excluding the El Paso area). TRICARE West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Iowa (excluding Rock Island Arsenal area), Kansas, Minnesota, Missouri (except the St. Louis area), Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas (the southwestern corner, including El Paso), Utah, Washington, and Wyoming. † OCONUS: Outside continental United States (Hawaii, Guam, Puerto Rico, Europe, Asia, Pacific).

eTable 5. Opioid exposure and observed to expected ratio at each facility with 25 or more observations, October 1, 2008 to September 2017.

FACILITY RANK	NO. OF OBSERVED	OBSERVED AND EXPECTED OPIOID ENCOUNTER PROPORTION		OBSERVED TO EXPECTED RATIO	ADJUSTED PRESCRIBING RATE*	95% CONFIDENCE INTERVAL
		OBSERVED	EXPECTED			
1	10,807	0.345	0.352	0.98	0.365	0.358 to 0.373
2	10,041	0.359	0.352	1.02	0.380	0.373 to 0.388
3	7,867	0.438	0.394	1.11	0.415 [†]	0.407 to 0.423 [†]
4	6,621	0.472	0.398	1.19	0.443 [†]	0.434 to 0.451 [†]
5	6,428	0.427	0.419	1.02	0.380	0.372 to 0.389
6	6,322	0.372	0.381	0.98	0.364	0.355 to 0.373
7	5,847	0.360	0.300	1.20	0.446 [†]	0.435 to 0.458 [†]
8	5,328	0.458	0.420	1.09	0.407 [†]	0.398 to 0.416 [†]
9	4,943	0.166	0.266	0.62	0.233 [†]	0.221 to 0.245 [†]
10	4,720	0.448	0.418	1.07	0.399 [†]	0.390 to 0.409 [†]
11	4,121	0.306	0.371	0.82	0.308 [†]	0.297 to 0.320 [†]
12	3,932	0.447	0.436	1.03	0.383	0.372 to 0.393
13	3,621	0.372	0.392	0.95	0.354	0.342 to 0.366
14	3,576	0.437	0.435	1.00	0.375	0.364 to 0.386
15	3,412	0.298	0.358	0.83	0.310	0.299 to 0.322
16	3,219	0.368	0.352	1.05	0.390 [†]	0.377 to 0.403 [†]
17	3,157	0.352	0.359	0.98	0.366	0.352 to 0.380
18	2,594	0.393	0.382	1.03	0.384	0.370 to 0.398
19	2,557	0.401	0.413	0.97	0.362	0.349 to 0.375
20	2,450	0.470	0.436	1.08	0.402 [†]	0.388 to 0.415 [†]
21	2,406	0.414	0.394	1.05	0.391 [†]	0.377 to 0.405 [†]
22	2,388	0.275	0.320	0.86	0.321 [†]	0.304 to 0.338 [†]
23	1,990	0.398	0.426	0.93	0.349	0.334 to 0.364
24	1,906	0.297	0.365	0.81	0.303 [†]	0.287 to 0.320 [†]
25	1,657	0.387	0.395	0.98	0.366	0.349 to 0.383
26	1,645	0.312	0.344	0.91	0.338 [†]	0.319 to 0.358 [†]
27	1,487	0.316	0.345	0.92	0.342	0.322 to 0.362
28	1,405	0.390	0.369	1.06	0.394 [†]	0.374 to 0.414 [†]
29	1,280	0.452	0.400	1.13	0.422 [†]	0.402 to 0.442 [†]
30	1,248	0.317	0.243	1.30	0.485 [†]	0.459 to 0.512 [†]
31	1,002	0.322	0.375	0.86	0.320 [†]	0.298 to 0.343 [†]
32	885	0.199	0.258	0.77	0.287 [†]	0.254 to 0.321 [†]
33	858	0.352	0.419	0.84	0.313 [†]	0.290 to 0.337 [†]
34	757	0.180	0.198	0.91	0.338	0.294 to 0.382
35	744	0.323	0.382	0.85	0.315 [†]	0.289 to 0.341 [†]
36	672	0.210	0.296	0.71	0.264 [†]	0.232 to 0.296 [†]
37	471	0.342	0.374	0.91	0.341	0.308 to 0.374
38	452	0.312	0.369	0.85	0.316 [†]	0.284 to 0.347 [†]
39	361	0.316	0.376	0.84	0.313 [†]	0.276 to 0.351 [†]

* Observed/expected ratio × 0.373 weighted mean † Bold indicates that estimate does not overlap the mean.

eTable 5. Continued

FACILITY RANK	NO. OF OBSERVED	OBSERVED AND EXPECTED OPIOID ENCOUNTER PROPORTION		OBSERVED TO EXPECTED RATIO	ADJUSTED PRESCRIBING RATE*	95% CONFIDENCE INTERVAL
		OBSERVED	EXPECTED			
40	342	0.512	0.430	1.19	0.443 [†]	0.406 to 0.480 [†]
41	251	0.653	0.517	1.26	0.471 [†]	0.438 to 0.505 [†]
42	245	0.392	0.407	0.96	0.359	0.316 to 0.402
43	240	0.450	0.455	0.99	0.369	0.327 to 0.410
44	239	0.351	0.337	1.04	0.389	0.337 to 0.441
45	181	0.276	0.334	0.83	0.308 [†]	0.249 to 0.367 [†]
46	178	0.399	0.418	0.95	0.356	0.305 to 0.406
47	176	0.335	0.374	0.90	0.334	0.283 to 0.385
48	174	0.316	0.315	1.00	0.374	0.311 to 0.437
49	170	0.429	0.402	1.07	0.398	0.344 to 0.452
50	169	0.314	0.370	0.85	0.317	0.260 to 0.373
51	167	0.186	0.299	0.62	0.231 [†]	0.164 to 0.299 [†]
52	167	0.371	0.378	0.98	0.367	0.307 to 0.427
53	148	0.581	0.545	1.07	0.397	0.352 to 0.443
54	146	0.308	0.366	0.84	0.314 [†]	0.256 to 0.372 [†]
55	144	0.326	0.353	0.92	0.345	0.282 to 0.408
56	138	0.355	0.399	0.89	0.332	0.275 to 0.389
57	137	0.314	0.406	0.77	0.288 [†]	0.230 to 0.346 [†]
58	125	0.224	0.315	0.71	0.265 [†]	0.189 to 0.341 [†]
59	122	0.402	0.384	1.05	0.391	0.332 to 0.450
60	113	0.239	0.302	0.79	0.295 [†]	0.221 to 0.370 [†]
61	112	0.402	0.450	0.89	0.333	0.278 to 0.387
62	106	0.113	0.285	0.40	0.148 [†]	0.068 to 0.228 [†]
63	89	0.438	0.398	1.10	0.410	0.335 to 0.486
64	80	0.250	0.266	0.94	0.351	0.246 to 0.456
65	77	0.377	0.399	0.94	0.352	0.272 to 0.433
66	71	0.211	0.401	0.53	0.197 [†]	0.114 to 0.279 [†]
67	65	0.415	0.433	0.96	0.357	0.275 to 0.439
68	62	0.177	0.338	0.52	0.196	0.101 to 0.291
69	61	0.262	0.352	0.74	0.278	0.179 to 0.377
70	60	0.200	0.304	0.66	0.245 [†]	0.137 to 0.353 [†]
71	60	0.150	0.260	0.58	0.215 [†]	0.095 to 0.334 [†]
72	58	0.293	0.348	0.84	0.315	0.213 to 0.416
73	56	0.357	0.404	0.88	0.329	0.233 to 0.426
74	48	0.333	0.313	1.06	0.397	0.281 to 0.514
75	43	0.209	0.268	0.78	0.291	0.138 to 0.444
76	43	0.233	0.371	0.63	0.234	0.124 to 0.344
77	41	0.415	0.400	1.04	0.387	0.278 to 0.495
78	39	0.179	0.343	0.52	0.195 [†]	0.068 to 0.322 [†]

eTable 5. Continued

FACILITY RANK	NO. OF OBSERVED	OBSERVED AND EXPECTED OPIOID ENCOUNTER PROPORTION		OBSERVED TO EXPECTED RATIO	ADJUSTED PRESCRIBING RATE*	95% CONFIDENCE INTERVAL
		OBSERVED	EXPECTED			
79	37	0.405	0.336	1.21	0.450	0.324 to 0.576
80	37	0.108	0.190	0.57	0.212 [†]	0.035 to 0.389 [†]
81	36	0.194	0.250	0.78	0.290	0.129 to 0.451
82	35	0.286	0.324	0.88	0.329	0.198 to 0.461
83	34	0.029	0.269	0.11	0.041 [†]	0.000 to 0.194 [†]
84	33	0.212	0.483	0.44	0.164 [†]	0.063 to 0.265 [†]
85	31	0.323	0.332	0.97	0.362	0.206 to 0.518
86	30	0.100	0.382	0.26	0.098 [†]	0.000 to 0.235 [†]
87	29	0.172	0.307	0.56	0.209 [†]	0.047 to 0.372 [†]
88	29	0.483	0.453	1.07	0.397	0.293 to 0.502
89	29	0.276	0.309	0.89	0.333	0.177 to 0.490
90	28	0.393	0.229	1.72	0.641 [†]	0.440 to 0.842 [†]
91	28	0.500	0.538	0.93	0.346	0.248 to 0.445
92	26	0.346	0.418	0.83	0.309	0.179 to 0.438

eTable 6. Summary of multinomial findings.

MODELING OPIOID PRESCRIPTION RATE						
MODEL NO. AND CONTENT*	BETWEEN FACILITY VARIANCE	P VALUE	% OF BETWEEN FACILITY VARIANCE EXPLAINED BY THE MODEL	ICC, [†] %	CHANGE IN ICC FROM NULL MODEL, %	
1. Null	0.194	< .0001	NA [‡]	5.6	NA	
2. Null + Encounter Level Variables	0.231	< .0001	-19	6.5	-16	
3. Null + Facility Characteristics Variables + Facility Dental Practice Variables	0.039	< .0001	80	1.2	79	
4. Null + Facility Dental Practice Variables	0.074	< .0001	62	2.2	61	
5. Null + Procedure + Facility Characteristics + Facility Dental Practice Variables	0.038	< .0001	2.5	3.8	32	

* Level 1 (procedure) variables included type of surgery, type of dentist, age group, military rank, gender, fiscal year; facility characteristic variables included region, facility type, and percentage of dental surgeries for young patients; facility dental practice variables included average percentage of surgeries for extractions, the mean percentage of surgeries that was periodontic, and the mean percentage of dentists that was specialists. † ICC: Residual intraclass correlation coefficient. ‡ NA: Not applicable.

eTable 7. Mixed-effects logistic regression of opioid prescribed for dental surgical encounter, October 2014 to September 2017 (n = 125,556).

VARIABLES	COEFF [¶] AND OR [#] FOR EACH MULTINOMIAL MODEL ITERATION**											
	MODEL 2*			MODEL 3 [†]			MODEL 4 [‡]			MODEL 5 [§]		
	COEFF	OR	P > Z	COEFF	OR	P > Z	COEFF	OR	P > Z	COEFF	OR	P > Z
Intercept (Grand Mean Across MTFs^{††})	-2.01	0.13	< .0001	-2.23	0.11	< .0001	-2.13	NA ^{‡‡}	< .0001	-2.71	0.07	< .0001
Level 1 Encounter Characteristics												
Year 2016 (reference: 2015)	-0.13	0.88	< .0001	NA	NA	NA	NA	NA	NA	-0.13	0.88	< .0001
Year 2017 (reference: 2015)	-0.27	0.76	< .0001	NA	NA	NA	NA	NA	NA	-0.27	0.76	< .0001
Age group 26 years or older (reference: younger than 26 years)	-0.22	0.81	< .0001	NA	NA	NA	NA	NA	NA	-0.22	0.81	< .0001
Sex, female (reference: male)	0.02	1.02	.32	NA	NA	NA	NA	NA	NA	0.02	1.02	.03
Rank group (reference: junior enlisted)												
Senior enlisted	-0.09	0.91	< .0001	NA	NA	NA	NA	NA	NA	-0.09	0.91	< .0001
Junior officer	-0.09	0.91	< .01	NA	NA	NA	NA	NA	NA	-0.09	0.91	< .01
Senior officer	-0.19	0.83	< .0001	NA	NA	NA	NA	NA	NA	-0.19	0.83	< .0001
Warrant officer	-0.06	0.94	.17	NA	NA	NA	NA	NA	NA	-0.06	0.94	.19
Dental specialist (reference: generalist)	0.11	1.51	< .0001	NA	NA	NA	NA	NA	NA	0.41	1.51	< .0001
Patient opioid-naïve (reference: recent opioid)	0.91	2.48	< .0001	NA	NA	NA	NA	NA	NA	0.91	2.48	< .0001
Tooth extraction surgery (reference: no)	3.56	35.10	< .0001	NA	NA	NA	NA	NA	NA	3.56	35.07	< .0001
Other oral maxillofacial surgery (reference: no)	1.47	4.35	< .0001	NA	NA	NA	NA	NA	NA	1.47	4.34	< .0001
Periodontic surgery (reference: no)	2.37	10.69	< .0001	NA	NA	NA	NA	NA	NA	2.37	10.68	< .0001
Endodontic surgery (reference: no)	-0.30	0.74	< .0001	NA	NA	NA	NA	NA	NA	-0.30	0.74	< .0001
Implant surgery (reference: no)	0.76	2.13	< .0001	NA	NA	NA	NA	NA	NA	0.76	2.13	< .0001
Palliative emergency (reference: no)	-0.13	0.88	< .01	NA	NA	NA	NA	NA	NA	-0.12	0.88	< .01
Level 2 Facility Characteristics												
Medical center, largest hospital facilities (reference: hospital)	NA	NA	NA	0.24	1.26	0.01	NA	NA	NA	0.36	1.43	0.02
Clinic (reference: hospital)	NA	NA	NA	-0.07	0.93	0.23	NA	NA	NA	-0.08	0.93	0.45
TRICARE South ^{§§} (reference: TRICARE North ^{¶¶})	NA	NA	NA	0.25	1.28	< .01	NA	NA	NA	0.35	1.41	< .01
TRICARE West ^{###} (reference: North)	NA	NA	NA	0.13	1.14	0.09	NA	NA	NA	0.11	1.12	0.87
Outside continental United States (reference: North)	NA	NA	NA	0.12	1.12	0.21	NA	NA	NA	0.18	1.19	0.23
Location other or unknown (reference: North)	NA	NA	NA	-0.51	0.60	0.02	NA	NA	NA	-0.95	0.38	0.01
Mean proportion younger than 26 years	NA	NA	NA	0.79	2.20	0.12	0.97	2.64	0.10	1.21	3.34	0.15
Mean proportion that had tooth extraction surgery	NA	NA	NA	4.16	64.03	< .0001	4.32	75.4	< .0001	1.65	5.21	0.04
Mean proportion that had periodontic surgery	NA	NA	NA	3.30	27.00	< .0001	3.28	26.6	< .0001	1.41	4.11	0.02
Mean proportion that had specialist encounter	NA	NA	NA	0.35	1.42	0.07	0.13	1.2	0.42	-0.14	0.87	0.67
μ_{0j} (variation in intercepts level 2)		0.23			0.04			0.07			0.12	
Residual intraclass correlation coefficient		0.065			0.012			0.021			0.036	

* Null + patient/procedure-level variables. † Null + Military treatment facility (MTF)-level organizational variables and MTF-level oral health care practice variables. ‡ Null + MTF-level oral health care practice variables. § Null + patient/procedure-level and all MTF-level variables. ¶ COEFF: Coefficient. # OR: Odds ratio. ** The formula for the model is: $Y_{ij} = \beta_0 + \beta_1 x_{1ij} + \alpha_1 MTF_{1j} + (\mu_{0j} + \mu_1 x_{1ij} + e_{1ij})$, where x_1 is the vector of individual-level factors and MTF_1 is the vector of MTF-level factors. Model 1: Not shown. Model 2: Null + encounter-level variables. Model 3: Null + facility-level organizational variables and facility-level oral health care practice variables. Model 4: Null + facility-level oral health care practice variables. Model 5: Null + encounter-level and all facility-level variables. †† MTF: Military treatment facility. ‡‡ NA: Not applicable. §§ TRICARE South: Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, South Carolina, Tennessee (excluding the Fort Campbell area) and Texas (excluding the El Paso area). ¶¶ TRICARE North: Connecticut, Delaware, the District of Columbia, Illinois, Indiana, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia, Wisconsin and portions of Iowa (Rock Island Arsenal area), Missouri (St. Louis area) and Tennessee (Fort Campbell area). ### TRICARE West: Alaska, Arizona, California, Colorado, Hawaii, Idaho, Iowa (excluding Rock Island Arsenal area), Kansas, Minnesota, Missouri (except the St. Louis area), Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas (the southwestern corner, including El Paso), Utah, Washington, and Wyoming.