Table 2. Amount of Oral Morphine Equivalents Dispensed Following Tooth Extraction by Procedure Type Among Medicaid Patients (N = 693 702)[a,b]

	Dispensed Morphine Equivalents, mg Median (IQR) [10th-90th Percentile]
Overall cohort	120 (90-150) [75-225]
By procedure	
Surgical extraction of nonimpacted tooth	113 (90-150) [68-225]
Removal of impacted tooth	
Soft tissue	120 (100-150) [75-225]
Partially bony	140 (100-160) [75-225]
Completely bony	150 (100-188) [80-225]
Completely bony with unusual surgical complications	150 (113-210) [90-250]
Surgical removal of residual tooth roots	125 (98-180) [75-276]

[a] Data were from the Medicaid Analytic eXtract.[1]

[b] Oral morphine equivalents calculated based on the following study: Von Korff M, Saunders K, Thomas Ray G, et al. De facto long-term opioid therapy for noncancer pain. *Clin J Pain*. 2008;24(6):521-527.

oral morphine equivalents prescribed. Although a limited supply of opioids may be required for some patients following tooth extraction, these data suggest that disproportionally large amounts of opioids are frequently prescribed given the expected intensity and duration of postextraction pain, particularly as nonopioid analgesics may be more effective in this setting.[5]

This study has limitations. Findings based on data from Medicaid claims may not generalize to a commercially insured population. Also, the final year of the study was 2010, and it is possible that dental prescribing practices have changed somewhat since that time.

This common dental procedure may represent an important area of excessive opioid prescribing in the United States. As the nation implements programs to reduce excessive prescribing of opioid medications, it will be important to include dental care in these approaches.

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Opioids Prescribed After Low-Risk Surgical Procedures in the United States, 2004-2012

Adverse events related to opioid analgesics are common.[1,2] Although opioids represent a component of pain treatment regimens following low-risk surgery,[3,4] few data exist regarding patterns of postoperative opioid prescribing over time. We assessed trends in the amount of hydrocodone/acetaminophen and oxycodone/acetaminophen prescribed, 2 opioids commonly used for postoperative pain management.

Methods | The University of Pennsylvania determined this research was exempt from review. We identified patients from the Clinformatics Data Mart Database (OptumInsight),[5] including health care encounters of approximately 14 million primarily commercially insured patients. Adults in the database tend to be younger and from the South compared with the US population. The database includes pharmacy and medical claims with data on services and procedures.

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The sample included opioid-naive adults (age, 18-64 y) who underwent 1 or more of 4 low-risk surgical procedures in 2004, 2008, or 2012: carpal tunnel release, laparoscopic cholecystectomy, inguinal hernia repair, or knee arthroscopy. Patients who filled any opioid prescription in the 6 months before surgery were excluded. We assessed the proportion of patients who filled any opioid prescription (and specifically hydrocodone/acetaminophen or oxycodone/

Table 1. Characteristics of Opioid-Naive Patients Who Underwent Carpal Tunnel Release, Laparoscopic Cholecystectomy, Inguinal Hernia Repair, or Knee Arthroscopy Surgical Procedures, 2004-2012

Patient Characteristics	Total Cohort	Carpal Tunnel Release			Laparoscopic Cholecystectomy			Inguinal Hernia Repair			Knee Arthroscopy		
		2004	2008	2012	2004	2008	2012	2004	2008	2012	2004	2008	2012
Total patients, No.	155 297	7459	7123	6567	14 615	17 165	15 409	8719	8311	6266	20 867	22 945	19 851
Filling a prescription within 7 d, No. (%)													
Any opioid	124 207 (80.0)	5402 (72.4)	5369 (75.4)	5000 (76.1)	10 995 (75.2)	13 621 (79.4)	12 464 (80.9)	7223 (82.8)	7098 (85.4)	5375 (85.8)	16 504 (79.1)	18 882 (82.3)	16 274 (82.0)
Hydrocodone/acetaminophen or oxycodone/acetaminophen	107 348 (69.1)	4030 (54.0)	4249 (59.7)	4340 (66.1)	8586 (58.8)	11 538 (67.2)	11 469 (74.4)	6197 (71.1)	6378 (76.7)	5019 (80.1)	14 172 (67.9)	16 620 (72.4)	14 750 (74.3)
Age, mean (SD), y	45.3 (11.9)	48.4 (9.7)	49.7 (9.3)	50.2 (9.7)	42.6 (11.5)	43.0 (11.8)	43.2 (11.9)	45.1 (12.0)	46.4 (11.9)	47.5 (12.0)	44.3 (11.9)	45.7 (12.1)	46.4 (12.3)
Men, No. (%)	76 912 (49.5)	2210 (29.6)	2254 (31.6)	2333 (35.5)	3342 (22.9)	4201 (24.5)	4075 (26.5)	7919 (90.8)	7593 (91.4)	5755 (91.8)	12 309 (59.0)	13 437 (58.6)	11 484 (57.9)
Inpatient procedure, No. (%)	6367 (4.1)	53 (0.7)	56 (0.8)	35 (0.5)	2014 (13.8)	1910 (11.1)	1439 (9.3)	203 (2.3)	164 (2.0)	116 (1.9)	168 (0.8)	130 (0.6)	79 (0.4)
Region, No, (%)													
Northeast	14 454 (9.3)	669 (9.0)	640 (9.0)	542 (8.3)	1120 (7.7)	1228 (7.2)	1100 (7.1)	999 (11.5)	864 (10.4)	666 (10.6)	2130 (10.2)	2336 (10.2)	2160 (10.9)
South	68 060 (43.8)	2888 (38.7)	3152 (44.3)	2848 (43.4)	6827 (46.7)	9030 (52.6)	7943 (51.6)	3504 (40.2)	3777 (45.5)	2728 (43.5)	7728 (37.0)	9817 (42.8)	7818 (39.4)
Midwest	51 859 (33.4)	3252 (43.6)	2529 (35.5)	2352 (35.8)	5047 (34.5)	4737 (27.6)	4311 (28.0)	3131 (35.9)	2551 (30.7)	1886 (30.1)	7981 (38.3)	7323 (31.9)	6759 (34.1)
West	20 853 (13.4)	647 (8.7)	799 (11.2)	823 (12.5)	1611 (11.0)	2168 (12.6)	2047 (13.3)	1078 (12.4)	1114 (13.4)	982 (15.7)	3011 (14.4)	3467 (15.1)	3106 (15.7)
Unknown	71 (0.1)	<10	<10	<10	10 (0.1)	<10	<10	<10	<10	<10	17 (0.1)	<10	<10

acetaminophen) in the 7 days after hospital discharge (inpatients) or after the procedure date (outpatients).

For patients who filled a prescription for hydrocodone/acetaminophen or oxycodone/acetaminophen, we calculated morphine equivalents dispensed using a standard conversion table.[6] We calculated the mean duration of prescriptions, daily morphine equivalent dose, and total morphine equivalents across the procedures and over time. We assessed trends using linear regression, adjusting for age, sex, inpatient/outpatient procedure, and region. Two-sided *P* values less than .05 were considered statistically significant; SAS (SAS Institute), version 9.3, was used.

Results | Characteristics of opioid-naive patients who underwent a low-risk surgical procedure (N = 155 297) changed over time, becoming more likely to be older and male and less likely to have inpatient surgery. Within 7 days, 80.0% filled a prescription for any opioid, and 86.4% of these prescriptions were for hydrocodone/acetaminophen or oxycodone/acetaminophen (**Table 1**). The proportion filling a prescription for hydrocodone/acetaminophen or oxycodone/acetaminophen varied across surgical procedures from 59.7% (carpal tunnel release) to 75.5% (inguinal hernia repair). The proportions of patients filling prescriptions for any opioid and for hydrocodone/acetaminophen and oxycodone/acetaminophen increased over time for all surgical procedures (Table 1).

Among patients filling a prescription for hydrocodone/acetaminophen or oxycodone/acetaminophen, the mean morphine equivalents dispensed ranged from 203.0 (95% CI, 202.1-204.0) for laparoscopic cholecystectomy to 268.8 (95% CI, 267.6-270.0) for knee arthroscopy (**Table 2**). The mean morphine equivalents dispensed increased over time for all procedures: adjusted increase from 2004 through 2012, 29.71 (95% CI, 28.08-31.35; *P* < .001). The adjusted increase was highest for knee arthroscopy: 45.16 morphine equivalents (95% CI, 42.26-48.07; *P* < .001). This increase was driven by an increase in the mean daily dose prescribed, with little change in the duration of prescriptions (Table 2).

Discussion | In this cohort, 70% of opioid-naive patients who underwent low-risk surgical procedures filled a prescription for hydrocodone/acetaminophen or oxycodone/acetaminophen within 7 days after discharge or the procedure date. The mean morphine equivalent dose increased over time for all procedures examined, with an increase of 18% (potency equivalent to an additional 45 mg of morphine) for patients undergoing knee arthroscopy, driven by a change in the mean daily dose. Because the cohort was restricted to opioid-naive individuals, these changes are unlikely to represent an appropriate response by prescribing physicians to increasing rates of opioid tolerance over time within the population. Possible explanations include an increased focus on pain treatment or an increasing reliance on opioids for postoperative pain relief vs alternative therapies.

Limitations include restriction to 4 surgical procedures; lack of data after 2012, as further changes in prescribing practices could have occurred; use of data that may not be generalizable; and an inability to determine which patients received a prescription that they did not fill. Details regarding source data for the database were provided to us by the vendor in working documents; there may be uncertainty

Table 2. Total Opioids Prescribed, Mean Daily Dose, and Duration of Prescription for Opioid-Naive Patients Who Filled an Opioid Prescription for Hydrocodone/Acetaminophen or Oxycodone/Acetaminophen Within 7 Days After Surgery (Outpatients) or Hospital Discharge (Inpatients), 2004-2012

	Total Morphine Equivalents Prescribed			Mean Daily Dose Prescribed, mg			Duration of Prescription, d		
Surgery Type	Mean (95% CI)	Absolute Change (95% CI)	*P* Value[a]	Mean (95% CI)	Absolute Change (95% CI)	*P* Value[a]	Mean (95% CI)	Absolute Change (95% CI)	*P* Value[a]
All 4 surgical procedures[b]									
All years	235.1 (234.4 to 235.8)			51.6 (51.4 to 51.7)			5.0 (5.0 to 5.1)		
2004	219.2 (218.1 to 220.2)	Reference		48.7 (48.5 to 49.0)	Reference		5.1 (5.0 to 5.1)	Reference	
2008	237.4 (236.3 to 238.5)	17.83 (16.23 to 19.44)	<.001	51.0 (50.7 to 51.2)	2.19 (1.84 to 2.54)	<.001	5.1 (5.1 to 5.1)	0.03 (−0.01 to 0.07)	.10
2012	247.4 (246.1 to 248.8)	29.71 (28.08 to 31.35)	<.001	54.8 (54.6 to 55.1)	6.29 (5.93 to 6.65)	<.001	4.9 (4.9 to 5.0)	−0.12 (-0.17 to 0.08)	<.001
Carpal tunnel release[c]									
All years	213.1 (211.1 to 215.1)			47.0 (46.7 to 47.4)			5.0 (4.9 to 5.0)		
2004	201.6 (198.7 to 204.5)	Reference		44.4 (43.8 to 45.1)	Reference		5.1 (5.0 to 5.2)	Reference	
2008	216.4 (213.1 to 219.8)	13.21 (8.34 to 18.08)	<.001	46.6 (45.9 to 47.2)	2.03 (1.06 to 2.99)	<.001	5.1 (5.0 to 5.1)	−0.05 (−0.17 to 0.07)	.39
2012	220.5 (216.6 to 224.4)	17.58 (12.74 to 22.43)	<.001	50.0 (49.3 to 50.7)	5.38 (4.42 to 6.34)	<.001	4.8 (4.7 to 4.9)	−0.30 (−0.41 to −0.18)	<.001
Laparoscopic cholecystectomy[c]									
All years	203.0 (202.1 to 204.0)			49.2 (49.0 to 49.5)			4.6 (4.5 to 4.6)		
2004	190.1 (188.4 to 191.8)	Reference		47.0 (46.6 to 47.5)	Reference		4.6 (4.5 to 4.6)	Reference	
2008	203.8 (202.2 to 205.4)	12.47 (10.07 to 14.86)	<.001	48.9 (48.5 to 49.3)	1.75 (1.12 to 2.37)	<.001	4.6 (4.5 to 4.6)	−0.02 (−0.08 to 0.05)	.58
2012	211.9 (210.2 to 213.5)	20.39 (17.99 to 22.79)	<.001	51.3 (50.9 to 51.7)	4.15 (3.52 to 4.78)	<.001	4.6 (4.5 to 4.6)	−0.05 (−0.12 to 0.01)	.13
Inguinal hernia repair[b]									
All years	221.5 (220.1 to 222.9)			51.9 (51.6 to 52.3)			4.7 (4.7 to 4.7)		
2004	212.1 (209.9 to 214.3)	Reference		50.4 (49.8 to 50.9)	Reference		4.7 (4.7 to 4.8)	Reference	
2008	224.6 (222.2 to 226.9)	11.84 (8.57 to 15.10)	<.001	51.7 (51.1 to 52.2)	1.29 (0.47 to 2.11)	.002	4.8 (4.7 to 4.8)	0.03 (−0.05 to 0.11)	.51
2012	229.3 (226.7 to 232.0)	16.57 (13.09 to 20.05)	<.001	54.2 (53.6 to 54.9)	3.82 (2.95 to 4.69)	<.001	4.6 (4.6 to 4.7)	−0.10 (−0.18 to −0.01)	.03
Knee arthroscopy[b]									
All years	268.8 (267.6 to 270.0)			54.3 (54.0 to 54.5)			5.5 (5.5 to 5.5)		
2004	244.8 (243.1 to 246.6)	Reference		50.3 (49.9 to 50.7)	Reference		5.5 (5.5 to 5.6)	Reference	
2008	271.1 (269.1 to 273.0)	25.30 (22.47 to 28.12)	<.001	53.3 (52.9 to 53.6)	2.90 (2.33 to 3.47)	<.001	5.6 (5.6 to 5.7)	0.10 (0.03 to 0.16)	.005
2012	289.2 (286.8 to 291.6)	45.16 (42.26 to 48.07)	<.001	59.2 (58.7 to 59.6)	9.11 (8.53 to 9.70)	<.001	5.4 (5.3 to 5.4)	−0.14 (−0.21 to −0.08)	<.001

[a] Linear regression adjusting for patient characteristics assessing trends over time.

[b] Adjusted for age, sex, inpatient/outpatient procedure, region, and surgical procedure.

[c] Adjusted for age, sex, inpatient/outpatient procedure, and region.

regarding the validity, completeness, and accuracy of the data. Further research should assess the contribution of postoperative opioid prescribing practices to the epidemic of prescription opioid-related abuse.

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COMMENT & RESPONSE

Financial Incentives and Cholesterol Levels

To the Editor Dr Asch and colleagues[1] reported a randomized clinical trial using economic incentives to promote cardiovascular risk factor reduction. However, one of the tenets of behavioral economics is to design systems that are simple. By selecting low-density lipoprotein cholesterol (LDL-C) reduction as a part of the intervention, the authors created a more difficult system with unrealistic goals.

Focusing primarily on LDL-C levels for the incentives is problematic for 2 reasons. First, checking an individual's cholesterol every 3 months does not find actual LDL-C changes. In fact, checking it more than every 3 years in these patients is more likely to find random noise than actual changes.[2] Although the initial reduction in cholesterol with a statin is approximately 30% to 40%, doubling or quadrupling the dose only leads to another 5% to 10% absolute reduction in LDL-C level. Given the within-person coefficient of variation of approximately 7% for single measurements,[2] a clinician cannot detect clinically relevant changes in LDL-C due to dose changes.

With the study only allowing patients to win the lottery if they had a change in LDL-C level, the investigators may have inadvertently decreased the effectiveness of the intervention. Continual "failures" in attaining LDL-C goals may have led to a reduction in behaviors, thus reducing the effectiveness of the intervention.

Second, the incentive payment to physicians was for something they largely had no control over: short-term changes in LDL-C level. Because many of the changes in LDL-C values were probably random and due to testing variability, there was little a physician could do to achieve a reward. Physicians could only gain rewards by offering statins to new patients.

Typically patients who regularly take a statin will achieve approximately a 1% to 2% absolute reduction in cardiovascular events (5%-7% for secondary prevention) over 5 years regardless of change in surrogate measures such as LDL-C level. Although there is ongoing debate, the most recent guidelines point to the evidence for simply taking a statin, without focusing on LDL-C level.[3]

For the aforementioned reasons, we believe the incentive and outcome of this study should solely have been adherence. The trial was successful in getting patients to start a statin if they were in the combined intervention. It was also successful in improving adherence in the patient-only and combined-incentive groups.

We realize that LDL-C level theoretically provides a more robust measure of incentive effectiveness. But the problems with LDL-C measurement and its tangential relationship to cardiovascular risk make adherence to statins a more reasonable target.

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