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National patterns of cessation of prescription opioids among Medicare beneficiaries, 2013–2018

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Abstract

Objective: To understand the changes in opioid cessation surrounding the release of CDC guidelines and changes in state Medicaid coverage at the individual patient level.

Methods: This study used a 20% national sample of Medicare beneficiaries between 2013 and 2018 with at least 90 days of consecutive opioid use in the first year of either of 2 study periods (2013–2015 or 2016–2018). Cessation of opioid use was assessed in year 3 of each period by generalized linear mixed models.

Results: Opioid cessation rates were higher in period 2 (11.2%) compared to period 1 (10.1%). Adjusted for beneficiary characteristics, those in period 2 had 1.07 times the odds of cessation (95% CI: 1.05–1.09) compared to those in period 1. Additionally, the increase in opioid cessation over time was larger in states with Medicaid expansion compared to those without.

Conclusion: The increase in opioid cessation after 2016 suggests the potential effects of the CDC guidelines on opioid prescribing and underscores the need for further research on the relationship between opioid cessation and subsequent change in pain control, quality of life, and opioid toxicity.

Abbreviations: CDC = Centers for Disease Control and Prevention,CHF = congestive heart failure,CI = Confidence Interval,CMS = Centers for Medicare & Medicaid Services,HIV = human immunodeficiency virus, HMO = health maintenance organization, MAT = medication assisted therapy, MBSF = Master Beneficiary Summary Files, MME = morphine milligram equivalent, OR = Odds Ratio, PDE = Part D Event Files, SD = standard deviation.

Keywords: CDC guideline for prescribing opioids for chronic pain, Medicaid expansion, opioid cessation

1. Introduction

Prescription opioid use rates rose until they peaked between 2010 and 2012, at which point they have been declining.[1] To combat the high rates of opioid use, state and federal governments have implemented an increasing number of laws, regulations, and guidelines designed to lower rates of overall opioid use and opioid-related deaths. In 2014, hydrocodone was reclassified from schedule III to schedule II, a more restrictive class.[2,3] Beginning in 2014, states began adopting the Medicaid expansion proposed by the Affordable Care Act.[4] In addition to regulations, guidelines have also been released regarding prescribing practices for opioids. In 2016, the Centers for Disease Control and Prevention (CDC) released a guideline for prescribing opioids for chronic pain and offered practices to reduce the risk of opioid dependence such as using the lowest effective dosage, repeated evaluation

of the need for opioids, and the use of drug testing.[5] This was the first guideline to address general chronic pain, while other guidelines had addressed the use of opioids in specific conditions, such as those with mental health conditions or substance use disorders, or for specific opioids, such as methadone or codeine.

Much of the previous research on opioid use rates have come from cross-sectional studies, with few long-term nationwide longitudinal studies on changes over time in prescription opioid cessation and its replacements, given the myriad state and federal laws and regulations enacted over the last decade.[6–10] In addition, much of the longitudinal research has focused on opioid use following surgical intervention and had small samples or were limited in geographic scope.[11–17] From these studies, preoperative opioid use[11–17], age[11,14], type of surgery[11,14], preoperative pain[12], income[14], anxiety[15], arthritis[15], and smoking status[15] have been identified as predictors of opioid cessation.

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In addition to these studies, there has been some research specifically addressing the CDC opioid guideline released in 2016.[18–21] This research has shown that the population rates of opioid use decreased following the release of the CDC guideline. Despite these findings, there is still limited knowledge on the individual factors affecting the decline in opioid use.

Additionally, while the expansion of Medicaid included increased access to treatment for opioid use disorders, such as medication-assisted therapy (MAT), the effect of Medicaid expansion on opioid use rates is not well-studied.[4,22] Exploring how the expansion of Medicaid has affected opioid cessation is vital to understanding the effects this policy can have on opioid use disorders.

Because of the limited number of prior studies done longitudinally assessing individual patterns of opioid use, there is a need for a large, national study of opioid cessation rates. This study aims to fill that gap by assessing if the rate of opioid cessation changed following the release of the CDC guideline in 2016; assessing the variation in opioid cessation rates across the US; assessing which predictors are associated with an increased rate of cessation, and by assessing the effect Medicaid expansion has on the change over time. Understanding trends and drivers of cessation of prescription opioid use has the potential to guide opioid-related policy and inform any quality improvement program aimed at reducing the currently high rates of opioid overprescribing and its attendant risks of an opioid use disorder, opioid overdose, and death.

2. Methods

2.1. Data source

This retrospective cohort study used a 20% national sample of Medicare beneficiaries between 2013 and 2018. The Medicare files used included the Master Beneficiary Summary Files (MBSF) and claims files including Medicare Provider and Analysis Review (MedPAR) Files, Carrier Claims, Outpatient Standard Analytic Files (OutSAFs), and Part D Event Files (PDE) for all years. The MBSF file contains the demographic and enrollment information and PDE contains the prescription information that was used to create the cohort. Medicare data were obtained from the Centers for Medicare & Medicaid Services (CMS). This study was approved by the institutional review board at the University of Texas Medical Branch.

2.2. Study cohort

Included in the study were beneficiaries who had 3 years of continuous Medicare parts A, B, and D eligibility with no health maintenance organization (HMO) in 1 of 2 periods: 2013–2015 or 2016–2018. From this group, beneficiaries who were younger than 18 years old at the beginning of either period and those with missing demographic data were excluded. Beneficiaries who had opioid use greater than 90 consecutive days in the first year of each period were selected for the cohort. Beneficiaries could contribute to only 1 period, with a random selection used when a beneficiary qualified in both periods.

2.3. Measures

There were 2 outcomes of interest in this study. The first was stopping opioid use (yes/no), defined as having no opioid use in the third year of the period. The second outcome was reducing opioid use to less than 90 total days during the third year of the period. The main variable of interest was the study period, 2013–2015 or 2016–2018. Other variables of interest included the use of medication-assisted therapy (MAT), depression, anxiety, opioid use disorder, cancer, arthritis, the number of comorbidities, state Medicaid expansion status, and morphine

milligram equivalent (MME) per day in year 1. The number of comorbidities included asthma, atrial fibrillation, Alzheimer's disease and related disorders, congestive heart failure (CHF), chronic obstructive pulmonary disease, chronic kidney disease, diabetes, human immunodeficiency virus (HIV), ischemic heart disease, hyperlipidemia, hypertension, liver disease, osteoporosis, and stroke. These conditions were obtained from the CMS chronic conditions. Medicaid expansion status (yes/no) was defined as yes if the state had introduced Medicaid expansion before the third year of the period.[4] Other covariates include age at the beginning of the period (18–39, 40–54, 55–64, 65–74, 75–84, 85+), sex, race (White, Black, Asian, Hispanic, Other), original Medicare entitlement (disabled/old age), Medicaid dual eligibility status (yes/no), and state.

2.4. Statistical analysis

Descriptive characteristics were calculated by period, with N (%) for categorical variables and mean (standard deviation (SD)) and median (Q1–Q3) for continuous variables. The unadjusted rate of stopping opioid use was calculated for each state, divided into quintiles based on the first period, and then mapped. The difference in opioid cessation rates between the 2 periods was assessed using a generalized linear mixed model with logit link binary distribution and state added as a random effect with an unstructured covariance structure. This model was used to account for the clustering of beneficiaries within states. Another model included interaction effects between period and original Medicare entitlement, MAT, Medicaid expansion, and MME/day. Interactions were tested by adding the product term of period and each interaction variable to the model and assessing the significance of the product term. For significant interactions, the odds ratio for the period was reported stratified by the levels of each predictor. A similar model was used to assess the secondary outcome of opioid use reduction between the 2 periods. In addition, the Sobel method was used to assess the potential mediation by MAT of the relationship between Medicaid expansion and opioid cessation. All models were adjusted for age, sex, race, original Medicare entitlement, Medicaid dual eligibility, state, MAT use, MME/day, depression, anxiety, opioid use disorder, arthritis, number of comorbidities, and state Medicaid expansion status. Odds ratios and 95% confidence intervals were reported. All analyses were done using SAS Enterprise Guide 7.1 (SAS Inc., Cary, NC, USA) and ArcGIS (ESRI Inc.).

3. Results

The final cohort consisted of 591,468 Medicare beneficiaries, 314,318 in period 1 and 277,150 in period 2 (Table 1, Supplementary Digital Content, http://links.lww.com/MD/G987). On average, those in period 1 had fewer days of opioid use (mean: 251.0, SD: 93.5) compared to those in period 2 (mean: 254.6, SD: 94.9). Additionally, the average MME/day was lower in period 2 compared to period 1 (mean: 208.6, SD: 311.3 vs. mean: 242.9, SD: 377.1).

Table 1 shows the descriptive statistics by period for each of the covariates included in the analysis. Overall, beneficiaries in the 2 time periods were similar in age, race, original entitlement, use of MAT, and the number of chronic conditions. Beneficiaries in period 2 were more likely to be male, live in the West, have diagnoses of arthritis, anxiety, depression, or OUD, live in a Medicaid expansion state and less likely to have Medicaid dual eligibility, and had lower average MME/day compared to those in period 1. The overall cessation rate in period 2 (11.2%) was higher than the cessation rate in period 1 (10.1%). Additionally, cessation rates (Table 2) were higher among older adults, males, Asians, those who were not disabled, and those without Medicaid dual eligibility. Cessation rates were also lower for

Table 1

Opioid cessation rate by period and beneficiary characteristics.

	2013		2016	
	N	%	N	%
All	314,318	100%	277,150	100%
Age				
Mean, SD	66.4	14.4	66.0	13.1
Median, Q1–Q3	67.8	56.1–77.0	67.2	57.5–74.6
18–39	14,233	4.5%	10,659	3.8%
40–54	51,622	16.4%	39,529	14.3%
55–64	56,606	18.0%	54,517	19.7%
65–74	91,224	29.0%	98,804	35.7%
75–84	66,055	21.0%	52,161	18.8%
85+	34,578	11.0%	21,480	7.8%
Sex				
Male	103,099	32.8%	98,838	35.7%
Female	211,219	67.2%	178,312	64.3%
Race				
White	251,679	80.1%	220,137	79.4%
Black	38,297	12.2%	32,303	11.7%
Asian	2772	0.9%	2972	1.1%
Hispanic	16,386	5.2%	15,809	5.7%
Other	5184	1.6%	5929	2.1%
Original entitlement*				
Disabled/ESRD	170,561	54.3%	148,851	53.7%
Old age	143,757	45.7%	128,299	46.3%
Medicaid dual eligibility				
No	167,637	53.3%	160,190	57.8%
Yes	146,681	46.7%	116,960	42.2%
Region				
MW	78,742	25.1%	67,025	24.2%
NE	43,319	13.8%	37,551	13.5%
SO	143,480	45.6%	121,724	43.9%
WE	48,777	15.5%	50,850	18.3%
Arthritis				
No	149,724	47.6%	110,021	39.7%
Yes	164,594	52.4%	167,129	60.3%
Anxiety				
No	232,980	74.1%	188,238	67.9%
Yes	81,338	25.9%	88,912	32.1%
Depression				
No	210,639	67.0%	176,487	63.7%
Yes	103,679	33.0%	100,663	36.3%
Opioid use disorder				
No	298,779	95.1%	250,176	90.3%
Yes	15,539	4.9%	26,974	9.7%
Chronic condition count				
Mean, SD	2.7	2.1	2.9	2.1
Median, Q1–Q3	2.0	1–4	3.0	1–4
Medication-assisted therapy				
No	311,262	99.0%	273,792	98.8%
Yes	3056	1.0%	3358	1.2%
Medicaid expansion				
No	162,724	51.8%	111,759	40.3%
Yes	151,594	48.2%	165,391	59.7%
MME/day				
Mean, SD	242.9	377.1	208.6	311.3
Median, Q1–Q3	135.0	79.3–233.6	115.5	68.3–209.5
<50	27,990	8.9%	36,057	13.0%
50–89	67,772	21.6%	67,793	24.5%
90+	218,556	69.5%	173,300	62.5%

*Disabled includes those eligible for Medicare through disability or end-stage renal disease. Old age includes those eligible for Medicare due to age (65 and older).

SD = standard deviation, Q1 = Quartile 1, Q3 = Quartile 3, ESRD = end stage renal disease, MME = morphine milligram equivalent.

those with chronic conditions and higher for those in Medicaid expansion states, those with MAT use, and those with the lowest MME/day.

After adjusting for demographic factors and comorbid conditions, the odds of stopping opioid use in period 2 were 1.07 (95% Confidence Interval (CI): 1.05–1.09) times the odds of cessation in period 1. Odds of stopping opioid use were increased for the oldest (85+: 1.32, 95% CI: 1.29–1.36) and youngest (18–39: 1.32, 95% CI: 1.26–1.38) compared to those who were 65–74. Asians and Hispanics were more likely to stop using opioids compared to Whites (1.53, 95% CI: 1.42–1.64; 1.18, 95% CI: 1.13–1.22). Those with <50 MME/day and 50–89 MME/day were more likely to stop opioid use compared to those with 90+ MME/day (2.41, 95% CI: 2.36–2.42; 1.85, 95% CI: 1.82–1.89). Additionally, those originally enrolled in Medicare due to old age, those with Medicaid dual eligibility, who had a depression diagnosis, or who used MAT had higher odds of stopping opioid use. Additionally, those with arthritis and opioid use disorders were less likely to stop opioid use. Opioid cessation odds ratios are shown for all factors in Table 3.

Figure 1 shows the variation in cessation rates by state. There is a large variation in cessation rates in period 1, with Utah having the lowest cessation percentage (7.2 %) and Rhode Island having the highest (14.1%). Period 2 saw an increase in cessation rate for 44 states, with Oklahoma having the lowest cessation rate (8.1%) and Vermont the highest (15.6%). State cessation percentages are shown in Table 2, Supplementary Digital Content, http://links.lww.com/MD/G987. Between the 2 periods Minnesota (5.7%), Delaware (4.3%), Vermont (3.9%), Virginia (3.8%), and Maine (3.7%) had the largest increases, while Kentucky (–1.3%), Florida (–0.9%), the Nebraska (–0.9%), Texas (–0.7%), and Hawaii (–0.5%) had the largest decreases. Of the largest increases, Minnesota, Delaware, Vermont, and Virginia had expanded Medicaid before 2017, while Maine had not. Of the smallest increases, Hawaii and Kentucky had expanded Medicaid before 2017, while Florida, Nebraska, and Texas had not.

We also examined the reduction of opioid use to less than 90 days in year 3 between 2 periods (Table 3). After adjusting for demographic factors and pain diagnoses, the odds of reducing opioid use in period 2 were 0.92 (95% CI: 0.90–0.93) times the odds of reducing in period 1. The odds of reducing opioid use were highest for those who were 18–39 (1.59, 95% CI: 1.53–1.64) compared to those who were 65–74. Asians were more likely to reduce opioid use compared to Whites (1.51, 95% CI: 1.43–1.606). Those with <50 MME/day and 50–89 MME/day were more likely to reduce opioid use compared to those with 90+ MME/day (2.44, 95% CI: 2.39–2.48; 1.96, 95% CI: 1.93–1.98). Additionally, those originally enrolled in Medicare due to old age, those using MAT, and those with depression had higher odds of reducing opioid use. Those with arthritis or opioid use disorders were less likely to reduce their opioid use compared to those without the conditions.

The interactions between period and original entitlement status (cessation $P < .0001$; reduction $P < .0001$), state Medicaid expansion (cessation $P = .0015$; reduction $P = .0396$), and MME/day (cessation $P < .0001$; reduction $P = .0002$) were significant in both models, while the interaction between period and MAT (cessation $P = .6103$; reduction $P = .9238$) were not significant. Odds ratios for period were stratified by original entitlement status, state Medicaid expansion status, and MME/day categories. Period OR was higher for those who were enrolled in Medicare for disability (OR: 1.12, 95% CI: 1.09–1.15) compared to those enrolled for old age (OR: 0.99, 95% CI: 0.97–1.02). Those in states with Medicaid expansion also showed an increased effect of period compared to those without Medicaid expansion (OR: 1.08, 95% CI: 1.06–1.11 vs. OR: 1.02, 95% CI: 0.99–1.05). There was an increased period effect for those with 50–89 MME/day (OR: 1.12, 95% CI: 1.09–1.15) while those with <50 MME/day and those with 90+ MME/day had no saw no period effect (OR: 1.02, 95% CI: 0.99–1.06; OR: 1.02, 0.98–1.06). For a reduction in opioid use the differences were less drastic, with disabled Medicare beneficiaries (disabled OR: 0.94, 95% CI: 0.92–0.96; old age OR: 0.87, 95% CI: 0.85–0.88), those in Medicaid expansion states (expansion OR: 0.91, 95% CI: 0.90–0.93; no expansion OR: 0.89, 95% CI: 0.87–0.91), and those with 50–89 MME/day (50–89 OR: 0.93,

Year 3 opioid outcomes by beneficiary characteristic.

	No use		1–89 days of use		≥90 days of total use		≥90 days consecutive use	
	N	Row %	N	Row %	N	Row %	N	Row %
All	62,758	10.6%	96,586	16.3%	210,802	35.6%	221,322	37.4%
Year								
2013	31,641	10.1%	53,627	17.1%	111,378	35.4%	117,672	37.4%
2016	31,117	11.2%	42,959	15.5%	99,424	35.9%	103,650	37.4%
Age								
18–39	2977	12.0%	4865	19.5%	6026	24.2%	11,024	44.3%
40–54	8512	9.3%	12,955	14.2%	23,931	26.3%	45,753	50.2%
55–64	9667	8.7%	14,568	13.1%	34,399	31.0%	52,489	47.2%
65–74	19,276	10.1%	32,097	16.9%	73,205	38.5%	65,450	34.4%
75–84	14,089	11.9%	22,031	18.6%	49,818	42.1%	32,278	27.3%
85+	8237	14.7%	10,070	18.0%	23,423	41.8%	14,328	25.6%
Sex								
Male	23,122	11.5%	31,288	15.5%	65,366	32.4%	82,161	40.7%
Female	39,636	10.2%	65,298	16.8%	145,436	37.3%	139,161	35.7%
Race								
White	49,408	10.5%	75,286	16.0%	167,391	35.5%	179,731	38.1%
Black	6976	9.9%	12,210	17.3%	25,802	36.5%	25,612	36.3%
Asian	1046	18.2%	1220	21.2%	2007	34.9%	1471	25.6%
Hispanic	4096	12.7%	6050	18.8%	11,850	36.8%	10,199	31.7%
Other	1232	11.1%	1820	16.4%	3752	33.8%	4309	38.8%
Original entitlement*								
Disabled/ESRD	29,254	9.2%	46,097	14.4%	100,432	31.4%	143,629	45.0%
Old Age	33,504	12.3%	50,489	18.6%	110,370	40.6%	77,693	28.6%
Medicaid Dual Eligibility								
No	35,471	10.8%	55,669	17.0%	126,570	38.6%	110,117	33.6%
Yes	27,287	10.4%	40,917	15.5%	84,232	31.9%	111,205	42.2%
Region								
MW	15,344	10.5%	23,857	16.4%	53,278	36.6%	53,288	36.6%
NE	10,259	12.7%	13,163	16.3%	27,748	34.3%	29,700	36.7%
SO	26,438	10.0%	43,292	16.3%	93,850	35.4%	101,624	38.3%
WE	10,717	10.8%	16,274	16.3%	35,926	36.1%	36,710	36.8%
Joint pain								
No	28,942	11.1%	41,806	16.1%	91,790	35.3%	97,207	37.4%
Yes	33,816	10.2%	54,780	16.5%	119,012	35.9%	124,115	37.4%
Anxiety								
No	45,867	10.9%	69,577	16.5%	155,970	37.0%	149,804	35.6%
Yes	16,891	9.9%	27,009	15.9%	54,832	32.2%	71,518	42.0%
Depression								
No	41,460	10.7%	62,701	16.2%	142,912	36.9%	140,053	36.2%
Yes	21,298	10.4%	33,885	16.6%	67,890	33.2%	81,269	39.8%
Opioid use disorder								
No	58,607	10.7%	90,914	16.6%	200,650	36.6%	198,784	36.2%
Yes	4151	9.8%	5672	13.3%	10,152	23.9%	22,538	53.0%
Medicaid expansion								
No	26,838	9.8%	45,006	16.4%	98,336	35.8%	104,303	38.0%
Yes	35,920	11.3%	51,580	16.3%	112,466	35.5%	117,019	36.9%
Medication-Assisted Therapy								
No	60,851	10.4%	94,887	16.2%	209,756	35.9%	219,560	37.5%
Yes	1907	29.7%	1699	26.5%	1046	16.3%	1762	27.5%
MME/day								
<50	11,643	18.2%	14,556	22.7%	21,840	34.1%	16,008	25.0%
50–89	19,342	14.3%	28,930	21.3%	53,650	39.6%	33,643	24.8%
90+	31,773	8.1%	53,100	13.6%	135,312	34.5%	171,671	43.8%

*Disabled includes those eligible for Medicare through disability or end-stage renal disease. Old age includes those eligible for Medicare due to age (65 and older).

ESRD = end stage renal disease, MME = morphine milligram equivalent.

95% CI: 0.92–0.95; <50 OR: 0.89, 95% CI: 0.87–0.91; 90+ OR: 0.88, 95% CI: 0.86–0.91) showing a larger period effect. In the test for potential mediation by MAT of the relationship between Medicaid expansion and opioid cessation, MAT was found to not be a mediator (data not shown).

4. Discussion

In this study of a National Medicare sample from 2013 to 2018, we examined the relationship between time and opioid cessation, as well as the moderating effect of beneficiary characteristics on that relationship. Overall, we found that there was an increase in opioid cessation between 2015 and 2018. This increase in cessation occurred across many beneficiary characteristics, such as age, gender, race, and comorbidities with small but significant differences in magnitude. In addition, this increase varied widely by state.

Conversely, the rate of those who reduced overall opioid use decreased between the 2 periods. While there was an increase in the average number of days used between the periods (251.0–254.6), the average MME/day decreased over time (242.9–208.6). This may suggest that physicians are choosing to

Table 3

Odds ratios for opioid cessation outcomes.

		Outcome 1: No use vs. any use	Outcome 2: <90 days vs. 90+ days
		Adjusted* OR (95% CI)	Adjusted* OR (95% CI)
Year	2013	REF	REF
	2016	1.07 (1.05–1.09)	0.92 (0.91–0.92)
Age	65–74	REF	REF
	18–39	1.32 (1.26–1.38)	1.59 (1.53–1.64)
	40–54	1.08 (1.04–1.12)	1.08 (1.06–1.11)
	55–64	1.02 (0.99–1.05)	0.96 (0.94–0.98)
	75–84	1.12 (1.09–1.14)	1.05 (1.03–1.07)
	85+	1.32 (1.29–1.36)	1.06 (1.03–1.08)
Sex	Male	REF	REF
	Female	0.78 (0.76–0.79)	0.90 (0.88–0.91)
Race	White	REF	REF
	Black	1.04 (1.01–1.07)	1.13 (1.11–1.15)
	Asian	1.53 (1.42–1.64)	1.52 (1.43–1.60)
	Hispanic	1.18 (1.13–1.22)	1.24 (1.21–1.27)
	Other	1.06 (1.00–1.13)	1.08 (1.03–1.12)
Original entitlement status	Disabled/ESRD	REF	REF
	Old age	1.28 (1.24–1.31)	1.32 (1.29–1.34)
Medicaid dual eligibility	No	REF	REF
	Yes	1.06 (1.04–1.08)	0.97 (0.96–0.99)
Joint pain	No	REF	REF
	Yes	0.93 (0.91–0.95)	0.98 (0.97–0.99)
Anxiety	No	REF	REF
	Yes	0.99 (0.97–1.01)	0.99 (0.98–1.01)
Depression	No	REF	REF
	Yes	1.10 (1.08–1.12)	1.13 (1.11–1.14)
Opioid use disorder	No	REF	REF
	Yes	0.97 (0.94–1.01)	0.88 (0.86–0.90)
Medication-assisted therapy	No	REF	REF
	Yes	4.54 (4.28–4.81)	4.74 (4.50–4.99)
Comorbidity count†		0.98 (0.98–0.99)	1.02 (1.01–1.02)
State medicaid expansion	No	REF	REF
	Yes	1.04 (0.99–1.09)	1.01 (0.97–1.04)
MME/d	<50	REF	REF
	50–89	2.41 (2.36–2.47)	2.44 (2.39–2.48)
	90+	1.85 (1.82–1.89)	1.96 (1.93–1.98)

*Adjusted model included all variables listed in this table, plus state.

†Comorbidities included Alzheimer's/dementia, asthma, atrial fibrillation, chronic kidney disease, COPD, diabetes, ischemic heart disease, coronary heart failure, stroke/transient ischemic attack, hyperlipidemia, hypertension, liver disease, HIV/AIDS, and viral hepatitis.

95% CI = 95% confidence interval, ESRD = end stage renal disease, MME = morphine milligram equivalent, OR = odds ratio.

lower the dosage on opioid prescriptions rather than decrease the number of days prescribed.

There were also many associations between the other variables and opioid cessation, regardless of the period. For instance, there is a U-shaped "dose–response" relationship between the age categories with the odds of cessation increasing the further one is from the 65–74 age group. This finding that older age is associated with higher rates of opioid cessation is consistent with other studies.[11,14]

The overall increase in opioid cessation rates occurred following the release of opioid prescribing guidelines by the CDC in 2016. These results are consistent with other cross-sectional studies that have shown a decreasing rate of overall opioid use.[5–8,16–19] This also points to an association between the CDC guidelines and lower rates of opioid use, suggesting that providers have altered their prescribing practices to reduce both long-term opioid prescribing and initiation of opioid prescription for non-cancer pain.

While the overall effect of Medicaid expansion was not significantly associated with increased opioid cessation, we found a significant interaction between period and state Medicaid expansion. Although the rate of opioid cessation increased for most states, the effect was stronger in states where the Medicaid expansion had been enacted before the third year of the period. These findings suggest that expanding Medicaid insurance might facilitate and increase access to nondrug approaches

(e.g. physical therapy/occupational therapy/cognitive behavior therapy/joint injections and nerve stimulation interventions by pain specialists) for chronic pain treatment. Those on Medicaid might also have easier access to medications to treat opioid use disorder, such as MAT. However, we didn't find MAT being a mediator for the association between Medicaid expansion and period because Medicare stated to cover Methadone under part B in January 2020. Further research is urgently needed to comprehensively examine whether patients in states with Medicaid expansion have an increase in access to non-drug treatments for chronic pain as well as access to MAT.

The larger effect of the period found in disabled Medicare beneficiaries compared to old age beneficiaries is also important. Disabled Medicare beneficiaries account for 80% of opioid overdose deaths among all Medicare beneficiaries and the rate of opioid overdose deaths in this population rose between 2012 and 2016.[23] The increase in opioid cessation between periods among disabled Medicare beneficiaries could help to decrease the opioid overdose death rate.

While there has been a decrease in opioid use rates, other studies have shown that there may be some unintended consequences of the prescriber-initiated cessation of opioid prescriptions. For instance, patients with opioid use disorder may suffer withdrawal symptoms which can lead to further problems, such as overdose, as they may seek non-prescribed opioids from unsafe and unregulated sources (e.g. friends, family,

2013-2015

2016-2018

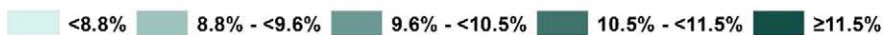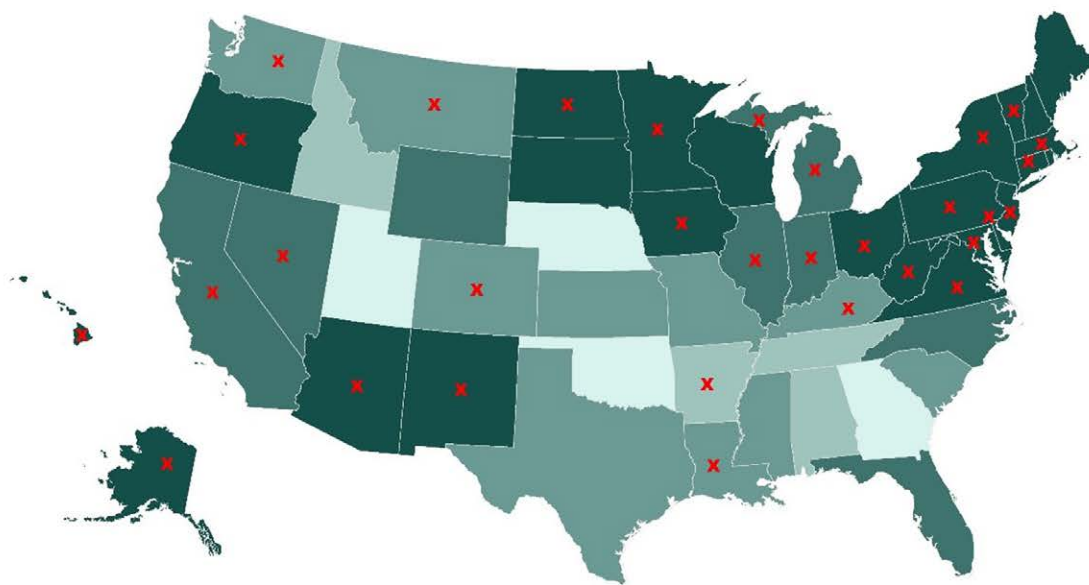| <8.8% | 8.8% - <9.6% | 9.6% - <10.5% | 10.5% - <11.5% | ≥11.5% |
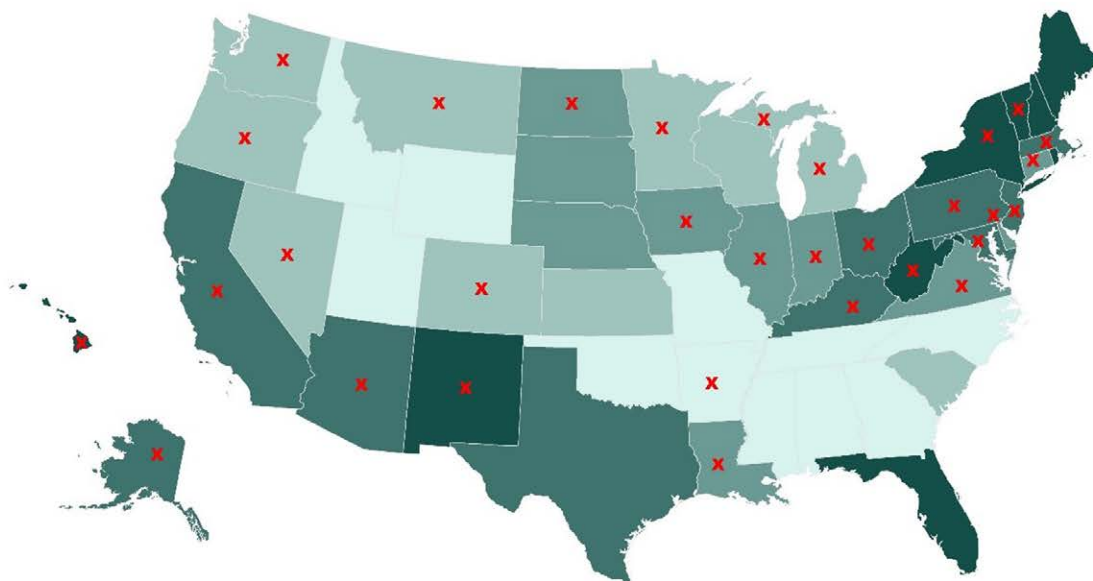
Figure 1. Opioid cessation rates by state and period. Categorization of opioid cessation rates was based on the quintiles from period 1. A red X indicates states that had expanded Medicaid coverage by 2017.

or streets).[24] In addition, opioid-related deaths continue to rise, with the rise being linked to non-prescribed opioids, heroin, and synthetic opioids.[25,26]

This study is not without limitations. First, the application of these results from a sample of Medicare beneficiaries is not generalizable to the entire population. Even though our sample

included those who were under 65, they are not representative of the general population because of their selection into Medicare due to a disability or end-stage renal disease. Second, the opioid prescription data are based on filled prescriptions only, thus we are unable to determine if beneficiaries took the prescribed opioids. Third, this study did not address prescriber characteristics that may play a role in the increased rates of opioid cessation, an important area for future study. Finally, the study did not include some individual factors that may be important confounders, such as socioeconomic status, educational attainment, or smoking status, due to lack of availability within the Medicare claims database.

In summary, we found that the rates of complete opioid cessation increased while reduced opioid use decreased over time. The time frame surrounding these changes coincides with the release of opioid prescribing guidelines from the CDC and suggests that providers have changed prescribing practices to align with these guidelines. We also understand that CDC opioid prescribing guidelines are co-occurring about the same time frame as other opioid-related policy changes at state, health payer, and hospital systems levels, which likely also contribute to some of the changes in opioid cessation trends in our findings.[10] Our findings from longitudinal follow-up add to the body of work that shows opioid use rates are declining. Further research into how these patterns of cessation and initiation relate to the quality of pain control, changes in quality of life, and occurrence of adverse opioid-related outcomes is needed.

Author contributions

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