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ORIGINAL RESEARCH

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Opioid-limiting legislation and prescribing habits of otolaryngologists among Medicare beneficiaries

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Abstract

Objectives: To identify changes in otolaryngologists' opioid prescribing trends for Medicare beneficiaries associated with the enactment of state laws that limit the duration of prescriptions to 3–7 days in the years 2016 and 2017 in the United States.

Methods: Through the Centers for Medicare and Medicaid Services (CMS) database, we retrieved data on Medicare enrollment and on the total days prescribed and total number of beneficiaries for the drugs codeine/acetaminophen, hydrocodone/acetaminophen, oxycodone HCl, oxycodone/acetaminophen, and tramadol HCl, by each otolaryngologist prescriber in 13 states from January 2013 to December 2019. We modeled trends using linear spline regression models that controlled for Medicare beneficiaries' state-level socio-demographic characteristics' fixed effects.

Results: Across the 13 states, the number of days of all five opioids prescribed per beneficiary declined by 8.35 (SD = 12.61). The most commonly prescribed opioid type by otolaryngologists during the 5-year study period was tramadol HCl (28.72 days/beneficiary) followed by oxycodone HCl (19.99 days/beneficiary). All opioids had declines in prescription days over this time window and higher rates of decline in the years following law passage. Four states experienced statistically significant declines in the prescriptions of all opioids after the year of legislation passage ($p < .05$). Some states that had the greatest inclines in opioid prescriptions in the years prior to law enactment also experienced the greatest reductions in the time after legislation enactment.

Conclusions: Opioid prescribing practices of otolaryngologists may have been affected by opioid prescription duration limiting laws passed in 13 states in 2016 and 2017.

Level of Evidence: Level 4.

KEYWORDS

opioid, opioid legislation, opioid prescription, otolaryngology

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1 | INTRODUCTION

The opioid crisis is a nationwide epidemic that has persisted over the last 20 years. According to the Centers for Disease Control and Prevention (CDC), opioids were involved in over 70% of all drug overdose-related deaths in 2019, equivalent to roughly 50,000 deaths.[1] In addition to being a public health issue associated with misuse, dependence, and overdose-related deaths, the opioid crisis imposes upon the US health care system $78.5 billion annually in increased costs.[2,3]

Otolaryngologists contribute to the opioid crisis in the United States by overprescribing these medications postoperatively.[4–6] In an attempt to regulate the over-prescription of opioids among all medical specialties, 23 states enacted laws between the years 2007 and 2018 that limit the maximum duration of opioid prescriptions to 3–7 days.[7] In addition, the CDC released their Guideline for Prescribing Opioids for Chronic Pain in 2016, with voluntary prescribing recommendations in regards to opioid selection, dosage, and duration, risk assessment for potential opioid misuse, prescription drug monitoring program (PDMP) review and consideration of alternative pain control methods.[8] A recent study by Cramer et al. showed that this policy was generally effective, as total days of opioids prescribed per Medicare beneficiary from 2013 to 2018 was statistically significantly lower in the states adopting these new policies compared with other states.[9]

To date, there are no published studies on the effects of policies limiting the duration of opioid prescriptions on the prescribing habits of otolaryngologists specifically. Therefore, we aim to investigate if there were significant changes in the duration of opioid prescriptions among otolaryngologists practicing in states that enacted laws limiting opioid prescription duration. We hope that this information will help elucidate whether this type of legislation may be effective at curbing opioid prescription duration to help guide future policies aimed at ending the opioid crisis.

2 | MATERIALS AND METHODS

2.1 | Data sources

Through the Centers for Medicare and Medicaid Services (CMS) database, we retrieved yearly data from 2014 to 2019 on Medicare enrollment, as well as the total days of opioids prescribed by otolaryngologists and total number of beneficiaries receiving opioid prescriptions by otolaryngologists for the five most commonly prescribed postoperative opioid medications: acetaminophen with codeine, hydrocodone/acetaminophen, oxycodone HCl, oxycodone/acetaminophen, and tramadol HCl.[9] New prescriptions as well as medication refills were included in the study. Tramadol was included in this study because in addition to inhibiting the reuptake of norepinephrine and serotonin, its mechanism of action includes the binding of opioid receptors, and it is considered an opioid by the Food and Drug Administration as well as the American Academy of Otolaryngology.[10,11] Importantly, although the CMS database is predominantly composed of prescriptions made by physicians, including resident physicians, a small proportion of the included medication prescriptions are made by non-physician practitioners and facilities acting under the supervision of otolaryngologists.[12]

We aimed to collect data for equal time periods before and after the passage of opioid limiting legislation. Because the CMS database had data available through 2019 at the time of our inquiry and the states included in our study passed their laws in 2016 and 2017, we began data collection in 2014, resulting in a 5-year analysis window per state, containing 2 years before the legislation, the year of the passage, and 2 years after legislation passage. We also desired to collect data within at least 2 years after law enactment to properly evaluate the significance of changes in prescription trends. If the law is effective in its goal, awareness among clinicians would peak at the 2-year point and significant changes would already be seen. After this point, the effects could be masked by stabilization.[13] We included data beginning 2 years prior to the law passing to determine if prescription reduction after law enactment is more pronounced in states that had significant increases in opioid prescription rates prior to the law. Within this 5-year window, state-level data on beneficiary demographics such as race, ethnicity, gender, and age compositions were collected using the CMS database.[14] Median income and poverty rate data were obtained from US Census database.[15] Individuals were defined as "in poverty" if their income was less than twice their poverty threshold.[16]

State-level average prescription days per beneficiary for each of the five drugs were computed using data from 13 states that passed the law between 2016 and 2017: Connecticut (CT), Delaware (DE), Indiana (IN), Kentucky (KY), Louisiana (LA), Massachusetts (MA), Maine (ME), New Jersey (NJ), New York (NY), Ohio (OH), Rhode Island (RI), Utah (UT), and Virginia (VA). Six states were excluded because their opioid duration limiting laws passed in 2018 and thus, the database did not have enough data available for trend analysis. Two states were excluded because they passed their laws much earlier than 2016 and therefore, were considered contextually inappropriate for our study. Two states were excluded due to unavailability of data for one or more opioid drugs in the 5-year analysis window. Prescription data for tramadol HCl was unavailable for Utah and was omitted when calculating the combined effect of the legislation on all drugs for this state. Because records contained no identifiable patient information, the study was determined to be exempt from review by the University of Southern California's Institutional Review Board.

2.2 | Analysis

Our primary outcome was change in the mean number of days of opioids prescribed per Medicare Part D beneficiary per year before and after passage of opioid legislation. Owing to multiple time points, regression spline models were constructed for each drug to estimate continuous changes in the mean prescription days at 2 years before passing the law (T1), at time of passing the law (T2), and at 2 years

TABLE 1 Unadjusted frequencies and distributions in sociodemographic data within a 5-year analysis window per state.

State	Number of Beneficiaries[a]	Female[b]	White[b]	Black[b]	API[b]	Multiple races[b]	Hispanic[b]	Total state population[a]	Median household income[a]	Poverty rate[b]
Connecticut	641,554 (16,944)	366,308 (57.1)	531,101 (82.8)	46,169 (7.2)	12,831 (2)	3785 (0.6)	46,236 (7.2)	3,584,973 (10,079)	67,754 (13,045)	631,672 (17.6)
Delaware	193,879 (9526)	108,506 (56.0)	151,951 (78.4)	30,633 (15.8)	4290 (2.2)	365 (0.2)	5844 (3)	960,175 (11,239)	60,872 (9565)	151,900 (15.8)
Indiana	1,197,816 (43,354)	666,779 (55.7)	1,061,215 (88.6)	86,184 (7.2)	9527 (0.8)	9527 (0.8)	26,245 (2.2)	6,668,730 (45,412)	52,925 (4953)	1,488,734 (22.3)
Kentucky	893,420 (23,194)	488,268 (54.7)	814,773 (91.2)	55,334 (6.2)	5359 (0.6)	7119 (0.8)	8934 (1.0)	4,450,466 (19,089)	48,472 (2944)	1,127,748 (25.3)
Louisiana	825,570 (31,490)	457,100 (55.4)	551,440 (66.8)	232,852 (28.2)	6563 (0.8)	6563 (0.8)	19,771 (2.4)	4,669,099 (14,901)	47,010 (2573)	1,238,245 (26.5)
Maine	320,958 (13,385)	173,117 (53.9)	310,720 (96.8)	675 (0.2)	675 (0.2)	3159 (1.0)	1281 (0.4)	1,335,866 (5876)	53,733 (5418)	322,478 (24.1)
Massachusetts	1,241,085 (42,456)	709,252 (57.1)	1,054,756 (85)	59,572 (4.8)	47,218 (3.8)	12,411 (1.0)	67,180 (5.4)	6,822,715 (60,380)	69,293 (14,259)	1,379,553 (20.2)
New Jersey	1,544,510 (44,572)	888,072 (57.5)	1,093,232 (70.8)	172,932 (11.2)	89,694 (5.8)	12,304 (0.8)	173,210 (11.2)	69,293 (14,259)	73,700 (16,523)	1,543,004 (17.3)
New York	3,390,269 (106,584)	1,942,616 (57.3)	2,311,482 (68.2)	406,832 (12.0)	203,416 (6.0)	33,903 (1.0)	413,889 (12.2)	73,700 (16,523)	59,864 (9031)	4,183,892 (21.2)
Ohio	2,233,094 (73,572)	1,243,385 (55.7)	1,929,298 (86.4)	223,309 (10.0)	22,331 (1.0)	11,777 (0.8)	40,192 (1.8)	11,652,989 (37,819)	53,182 (5246)	2,582,302 (22.2)
Rhode Island	211,549 (6744)	120,360 (56.9)	182,697 (86.4)	7631 (3.6)	3806 (1.8)	3825 (1.8)	13,497 (6.4)	1,057,808 (1597)	60,956 (9814)	221,717 (21.0)
Utah	367,101 (22,295)	198,066 (54.0)	332,571 (90.6)	731 (0.2)	8073 (2.2)	2180 (0.6)	20,640 (5.6)	3,103,206 (83,853)	65,268 (12,009)	518,856 (16.7)
Virginia	1,410,393 (65,924)	790,171 (56.0)	1,057,557 (75.0)	239,767 (17.0)	56,416 (4.0)	14,101 (1.0)	42,312 (3.0)	8463,605 (65,800)	66,699 (12,592)	1,533,363 (18.1)

[a]Mean (SD).
[b]*N* (%).
Abbreviation: API: Asian/Pacific Islander.

after passing the law (T3), and the associated 95% confidence intervals, using the package "*lspline*" in R 4.0.3.[17] All models were adjusted for state-level differences in race, ethnicity, gender and age compositions, median income, and poverty rate. Akaike information criteria were used to assess the fit of the models to the data, and to assist in identifying the appropriate number of degrees of freedom for the spline models. Validity and robustness were verified for all linear regression models using analysis of residuals, normal probability plots, and leverage versus residual-squared plots, residual quintile ranges, and variance inflation factors. Statistical significances were determined at $\alpha = .05$.

3 | RESULTS

3.1 | State-level demographic characteristics

Unadjusted frequencies and distributions in sociodemographic data within the 5-year analysis window per state are shown on Table 1. The 13 states included in our study had, on average, 1,113,169 (SD = 909,807) Medicare beneficiaries. In all states, a greater proportion of beneficiaries were female (>50%) than male. ME was the least racially diverse state with 96.8% of patients who identified as white. LA had the greatest percentage of Black patients (26.2%) and the least White patients (66.8%). NY had the greatest number of Hispanic and Asian and Pacific Islander beneficiaries (12.2% and 6.0%, respectively). LA had the greatest poverty rate (26.5%), whereas DE had the least (15.8%). No states had significant changes in these sociodemographic characteristics within the analysis window.

3.2 | Unadjusted prevalent opioid use

The mean number of days of all five opioids prescribed per beneficiary each year between T1 and T3 for each of the 13 states are shown in Table 2. Ten (DE, IN, KY, LA, ME, NJ, OH, RI, UT, VA) and three states (CT, MA, NY) enacted their opioid prescription duration limiting laws in 2017 and 2016, respectively. The unadjusted mean prescription days across the 13 states were 13.95, 15.84, and 7.49 per beneficiary at T1, T2, and T3, respectively. The average decline across all 13 states from T2 to T3 was by −8.35 days/beneficiary. However, this decrease was highly variable between states (SD = 12.61), with decreases ranging from −3.17 to −47.12 days/beneficiary. The state with the greatest mean number of days per beneficiary was DE in 2017 at T2 (50.39 days/beneficiary). However, DE had the greatest decrease from T2 to T3 (−47.12 days/beneficiary). NY had the second greatest mean number of days prescribed per beneficiary at T2 (25.70 days/beneficiary) and the second greatest decrease from T2 to T3 (−14.09 days/beneficiary). LA had the third highest value at T2 (19.97 days/beneficiary) and third greatest decrease from T2 to T3 (−10.01 days/beneficiary). Conversely, CT had an "increase," rather than a "decrease," from T2 to T3 (3.17 days/beneficiary) and was the only state that had an increase in opioid prescription days after passing the law. Before law enactment, states, on average, increased the number of prescription days per beneficiary by 1.88 from T1 to T2 with a SD of 8.28. States where there were already decreases from T1 to T2, had average decreases by 1.23 days/beneficiary (SD = 3.45) from T2 to T3, which compared to the states where there were increases from T1 to T2, is a relatively lesser decline. The latter states had an average decrease of 12.80 days/beneficiary (SD = 14.38) from T2 to T3.

TABLE 2 Unadjusted mean prescription days per beneficiary for five opioid drugs combined.

State (T2)	T1	T2	T3
Connecticut (2016)	16.53	10.52	13.69
Delaware (2017)	25.24	50.39	3.27
Indiana (2017)	21.13	13.20	6.77
Kentucky (2017)	19.69	19.97	10.34
Louisiana (2017)	15.44	16.29	6.28
Maine (2017)	6.68	5.77	4.33
Massachusetts (2016)	5.93	5.05	3.72
New Jersey (2017)	4.46	9.36	5.39
New York (2016)	19.67	25.70	11.61
Ohio (2017)	16.51	17.90	7.99
Rhode Island (2017)	5.51	11.69	6.55
Utah (2017)	4.84	5.93	3.40
Virginia (2017)	19.77	14.09	13.97

Note: T1: 2 years prior to the enactment of opioid prescription duration limiting legislation; T2: the year the law passed; T3: 2 years following the law passing. Five opioid drugs include oxycodone/acetaminophen, hydrocodone/acetaminophen, oxycodone HCl, tramadol HCl, and codeine/acetaminophen.

The opioid types with the greatest mean number of prescription days per beneficiary during the cumulative 5-year study period were tramadol HCl (28.72 days/beneficiary), followed by oxycodone HCl (19.99 days/beneficiary). All opioid analgesics had decreases in days prescribed per beneficiary in all 13 states combined between T3 and T1, with oxycodone HCl having the greatest reduction (−17.83 days/beneficiary).

3.3 | States with significant changes in prescribing trends

In 10 states (IN, KY, LA, ME, NJ, NY, OH, RI, UT, VA), the mean days of all five opioids prescribed per Medicare beneficiary per year decreased over the 2 years that followed passing of opioid prescription duration limiting laws. In four states, KY (7.88–6.55 [−17%], $p = .0259$), LA (12.88 – 11.83 [−8%], $p = .0071$), NJ (4.84 – 4.37 [−10%], $p = .0165$), and UT (5.17 – 4.48 [−13%], $p = .0202$), the declines were statistically significant. Conversely, three states (CT, DE, MA) had increases in mean days per beneficiary of all opioids after law enactment. MA had a statistically significant increase (5.51–6.09

[11%], $p = .0255$). Models assessing oxycodone/acetaminophen prescription trends identified significantly greater declines in mean prescription duration in three states after passage of legislation: CT (5.46 – 4.78 [−12%], $p = .0059$), LA (9.99 – 8.53 [−15%], $p = .0404$), and NY (8.01 – 5.96 [−16%], $p = .0270$). Among these three states, CT had a significant increase by 11% during the 2 years prior to law enactment ($p = .0095$). For hydrocodone/acetaminophen, the decline between T2 and T3 was significant for NY only (11.92–7.93 [−33%], $p = .0323$). This state's prescription trends were rising by 13% prior to the law. On average, the 13 states already saw a 4% decline (SD = 9%) in the prescription of hydrocodone/acetaminophen during the 2 years leading up to law enactment with a range of −1% to −16%. For oxycodone HCL, prescription duration significantly decreased in three states after legislation: NY (21.03 – 8.44 [−60%], $p = .0045$), UT (8.52 – 4.47 [−48%], $p = .0385$), and MA (6.84 – 5.66 [−17%], $p = .0196$). For tramadol HCl, prescription duration significantly decreased after legislation in DE (8.25 – 6.33 [−23%], $p = .0000$), ME (8.46 – 5.89 [−30%], $p = .0187$), NY (65.01 – 45.53 [−30%], $p = .0408$), and RI (26.16 – 15.89 [−39%], $p = .0046$). Notably, ME and NY had increases by 2% and 4%, respectively, in tramadol HCl prescription days leading up to the year of law enactment. In addition, this analgesic had the highest average adjusted mean prescription days at T2 of 32.08 days/beneficiary (SD = 25.53). There was a significant increase in prescription duration of tramadol HCL in MA after legislation (5.37 – 5.92 [10%], $p = .0394$). Interestingly, the prescription of this drug in MA significantly decreased from T1 to T2 (6.59–5.37 [−19%], $p = .0085$). For acetaminophen with codeine, none of the states showed significant decrease between T2 and T3. However, UT (2.09 – 2.18 [4%], $p = .0491$) demonstrated a significant increase post-legislation. State-level sociodemographic characteristics had no significant impact on prescribing trends, and therefore the models were not further stratified. Table 3 summarizes the adjusted estimates with *p*-values from the spline regression models. Figure 1 illustrates percent changes in prescription days per beneficiary before and after legislation passage across all 13 states for all five drugs combined and each drug individually. For all five drugs combined, there was no visible increase or decrease in prescription days per beneficiary before law enactment. Post-legislation, however, there was an approximately 10% decrease. For the drugs oxycodone/acetaminophen and hydrocodone/acetaminophen, the state-to-state variations lessened after law enactment, but the decreases in prescription days were relatively small. Oxycodone HCl and tramadol HCl experienced the largest drops in prescriptions, but the variations between states increased. For codeine/acetaminophen, the plots before and after law passage are visibly similar.

4 | DISCUSSION

In this study, we utilized the CMS database to investigate the opioid prescribing habits of otolaryngologists before and after the time of implementation of legislation limiting opioid prescription duration in 2016 and 2017. We found that the unadjusted combined mean prescription durations for the five most commonly prescribed postoperative opioids in the Medicare population decreased from T1 to T3 in 11 (CT, DE, IN, KY, LA, MA, ME, NY, OH, UT, VA) of the 13 states studied. In four (NJ, KY, LA, and UT) of the 13 states studied, the combined mean prescription duration for the five opioids had a significantly greater decrease in the years following the passage of legislation, independent of differences in demographic variables between states.

NY demonstrated a greater decline in prescription duration for four drugs individually after the passage of legislation, the most of any state. It was noted that in states where there were increases in prescriptions from T1 to T2, the average decreases from T2 to T3 were relatively greater than those of states where there were already decreases from T1 to T2. For example, CT and NY's prescribing trends of oxycodone/acetaminophen and hydrocodone/acetaminophen were increasing by 11% and 13% over the 2 years prior to law enactment, but experienced large and statistically significant declines of −12% and −33%, respectively, after the law passed. A similar trend was observed among the five opioid drugs. When combining the percent changes in prescribing habits of all 13 states, we observed that there was a decline in all five opioids post-legislation. We also saw that for two drugs that decreased the least after law enactment, in comparison to before law enactment, state-to-state variation decreased. In addition, the prescriptions of these drugs were already declining at a greater rate than the other drugs. In other words, the law may have had a more consistent but less pronounced effect on the states for these drugs. On the other hand, tramadol HCl and oxycodone HCl, which were the most heavily prescribed drugs during the study period, had the greatest declines in prescriptions and the most states with significant declines after legislation passage. However, these two drugs had the most inconsistent responses between states to the legislation. Therefore, the law may have had a large but inconsistent effect on the states for these drugs. Overall, these findings demonstrate that the passage of legislation aimed at reducing opioid prescription duration may have been associated with changes in the opioid prescribing practices of otolaryngologists for the Medicare population. Our results are also consistent with a previously published study by Cramer et al., which found that the mean days of opioids prescribed per beneficiary by surgeons, dentists, and other specialists in states exposed to opioid duration limiting legislation was reduced to a significantly greater degree when compared with states that did not pass this legislation.[9]

One goal of limiting opioid prescription duration is to prevent medication overuse and misuse, which can lead to opioid use disorder, progression to stronger narcotics, and overdose. In the years following the passage of opioid duration-limiting legislation in 2016, otolaryngologists in NY wrote significantly shorter prescriptions for oxycodone/acetaminophen, hydrocodone/acetaminophen, oxycodone HCl, and tramadol HCl. Correspondingly, the state saw a steady decline in opioid overdose-related deaths from 2017 to 2019, when the rate finally dropped below the national average. In NJ, the opioid overdose-related death rate climbed from 2013 to 2018. Concurrently, the rate surpassed the national average in 2016, peaked at 29.7 deaths per 100,000 population, and NJ subsequently became

TABLE 3 Adjusted estimates of state-level multivariate linear spline models for oxycodone/acetaminophen, hydrocodone/acetaminophen, oxycodone HCl, tramadol HCl, codeine/acetaminophen, and all five opioid drugs combined.

		All drugs		Oxycodone/acetaminophen		Hydrocodone/acetaminophen		Oxycodone HCl		Tramadol HCl		Codeine/acetaminophen	
State	Time	Estimate	PC	Estimate	PC	Estimate	PC	Estimate	PC	Estimate	PC	Estimate	PC
Connecticut	T1	7.70		4.93		4.21		49.62		12.07		5.22	
	T2	7.97	0.03	5.46	0.11**	4.46	0.06	35.44	−0.29	10.41	−0.14	4.65	−0.11
	T3	8.04	0.01	4.78	−0.12**	3.99	−0.11	36.43	0.03	21.98	1.11	4.46	−0.04
Delaware	T1	36.66		6.02		4.09		97.80		8.25		6.25	
	T2	47.48	0.30	5.56	−0.08	3.44	−0.16*	125.86	0.29	8.25	0.00	5.56	−0.11
	T3	52.99	0.12	4.68	−0.16	3.13	−0.09	135.19	0.07	6.33	−0.23**	4.70	−0.15
Indiana	T1	8.76		13.62		8.78		55.73		13.79		6.55	
	T2	8.99	0.03	9.71	−0.29	8.19	−0.07	37.46	−0.33	17.24	0.25	5.84	−0.11
	T3	8.05	−0.10	8.75	−0.10	7.31	−0.11	28.34	−0.24	13.66	−0.21	5.64	−0.03
Kentucky	T1	7.97		7.01		7.87		3.66		58.44		7.02	
	T2	7.88	−0.01	6.15	−0.12*	7.28	−0.07	22.29	5.09	38.08	−0.35	7.02	0.00
	T3	6.55	−0.17*	6.20	0.01	6.41	−0.12	6.81	−0.69	39.75	0.04	4.81	−0.31
Louisiana	T1	13.31		10.50		13.14		6.92		62.02		3.99	
	T2	12.88	−0.03*	9.99	−0.05	12.98	−0.01	6.61	−0.04	59.95	−0.03	4.75	0.19
	T3	11.83	−0.08**	8.53	−0.15*	12.17	−0.06	5.67	−0.14	28.09	−0.53	5.12	0.08
Massachusetts	T1	5.68		5.63		5.50		6.97		6.59		4.96	
	T2	5.51	−0.03	5.01	−0.11	5.17	−0.06	6.84	−0.02	5.37	−0.19**	5.21	0.05
	T3	6.09	0.11*	4.82	−0.04	4.65	−0.10	5.66	−0.17*	5.92	0.10*	3.97	−0.24
Maine	T1	6.90		5.53		7.12		8.37		8.31		5.85	
	T2	6.43	−0.07	4.44	−0.20*	6.31	−0.11*	8.04	−0.04	8.46	0.02	4.32	−0.26
	T3	5.74	−0.11	4.50	0.01	6.04	−0.04	6.67	−0.17	5.89	−0.30**	4.38	0.01
New Jersey	T1	4.41		5.11		3.82		4.32		2.50		4.08	
	T2	4.84	0.10*	5.33	0.04	4.05	0.06	4.31	0.00	13.84	4.54	4.10	0.00
	T3	4.37	−0.10*	5.07	−0.05	3.50	−0.14	3.24	−0.25	7.21	−0.48	3.91	−0.05
New York	T1	10.05		7.79		10.57		11.08		62.47		6.51	
	T2	11.40	0.13	8.01	0.03	11.92	0.13	21.03	0.90**	65.01	0.04	−0.25	−1.04
	T3	8.57	−0.25	5.96	−0.26*	7.93	−0.33*	8.44	−0.60**	45.53	−0.30*	−0.23	−0.08
Ohio	T1	6.98		6.82		6.05		7.59		62.56		4.39	
	T2	6.58	−0.06	6.04	−0.11*	5.67	−0.06	7.91	0.04	60.42	−0.03	4.39	0.00
	T3	6.40	−0.03	6.04	0.00	5.70	0.01	6.54	−0.17	34.44	−0.43	4.51	0.03

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TABLE 3 (Continued)

State	Time	All drugs Estimate	All drugs PC	Oxycodone/acetaminophen Estimate	Oxycodone/acetaminophen PC	Hydrocodone/acetaminophen Estimate	Hydrocodone/acetaminophen PC	Oxycodone HCl Estimate	Oxycodone HCl PC	Tramadol HCl Estimate	Tramadol HCl PC	Codeine/acetaminophen Estimate	Codeine/acetaminophen PC
Rhode Island	T1	6.47		7.37		6.20		1.81		26.46		4.11	
	T2	6.29	−0.03	6.29	−0.15	5.18	−0.16*	7.27	3.02	26.16	−0.01	3.82	−0.07*
	T3	5.78	−0.08	5.75	−0.09	5.21	0.01	6.34	−0.13	15.89	−0.39**	3.99	0.04
Utah	T1	5.15		4.43		5.25		6.54				1.75	
	T2	5.17	0.00	4.91	0.11	5.08	−0.03	8.52	0.30			2.09	0.19**
	T3	4.48	−0.13*	4.45	−0.09	4.52	−0.11	4.47	−0.48*			2.18	0.04*
Virginia	T1	6.87		5.58		6.07		7.23		88.27		5.32	
	T2	7.83	0.14	5.83	0.04	5.74	−0.05	51.09	6.07	71.71	−0.19	5.08	−0.05
	T3	7.48	−0.04	5.53	−0.05	5.18	−0.10	57.62	0.13	65.30	−0.09	5.96	0.17

Note: PC: percent change. T1: 2 years prior to the enactment of opioid prescription duration limiting legislation; T2: the year the law passed; T3: 2 years following the law passing.
$^{*}p < 0.05$; $^{**}p < 0.01$.

one of the top five states in the United States in opioid overdose-related deaths. However, since 2018, a year after their legislation was passed, the overdose-related death rate has steeply decreased. Similarly, KY was one of the 10 states with the largest number of opioid overdose-related deaths from 2013 to 2017. After the time of law enactment, the state dropped to the 12th position in overdose-related deaths in the United States in 2018. UT similarly witnessed a decline in overdose-related death rate in the years following the passage of their legislation in 2016 and dropped below the national average in 2018. In addition, in the population of patients aged 65 years and older in UT, the rate of opioid-overdose related deaths declined from 8 to 6.3 deaths per 100,000 from 2018 to 2019.[18] One exception to this pattern is LA, where opioid prescription duration among all medical specialties, including otolaryngology, has decreased since the year of legislation passage in 2017, but the overdose-related death rate has been steadily climbing since 2014. Nonetheless, LA remains below the national average for opioid overdose-related deaths.[9,19]

Three (IN, OH, VA) states did not demonstrate a greater decrease in average prescription duration after legislation for any of the five opioids investigated in our study. In addition, at T3, six (CT, DE, IN, LA, NY, VA) states still had a mean number of prescription days per beneficiary greater than 7 days, the maximum number of days allowed per the legislation. This may be due to a misunderstanding of the laws among prescribers and pharmacists, as Rogala et al observed in their study of RI, which only experienced a decrease in tramadol HCl. The study identified prescribers' misclassifications of patients, and misunderstandings of exclusions and the required frequency of PDMP monitoring as disparities in the understanding of updated regulations.[20] Differences in the laws between states can further contribute to misunderstanding and confusion. In some states, the law only applies to initial prescriptions, imposes a dosage limit, or provides exemptions based on professional judgment or surgical pain. In addition, education surrounding the new policies and IT infrastructure for PDMP utilization may have been lacking and violations may be under-penalized by law enforcement.

Our study is subject to several limitations. Although the CMS database utilized in this study is extensive and includes nearly 98% of US individuals aged ≥65, as well as those of any age with a disability, End-Stage Renal Disease, or ALS, we were not able to collect information on otolaryngologists' prescribing habits for the remainder of the US population, including patients with private insurance and those under the age of 65 years without significant comorbidities. Although the population of patients aged 65 years and older comprised between 4.2% and 5.1% of the total opioid overdose-related deaths in the 13 states included in our study, the rate of opioid overdose-related deaths in this age group has increased by approximately 360% between 2000 and 2020, making this a relevant population to study.[21,22] An additional limitation is that the database does not include data for physicians writing 10 or fewer prescriptions per year, so these providers were not captured in our study. Finally, the results of our study do not directly show that opioid-limiting legislation was the reason for the decrease in opioid prescription duration in some states after 2016–2017, since causation cannot be determined from a

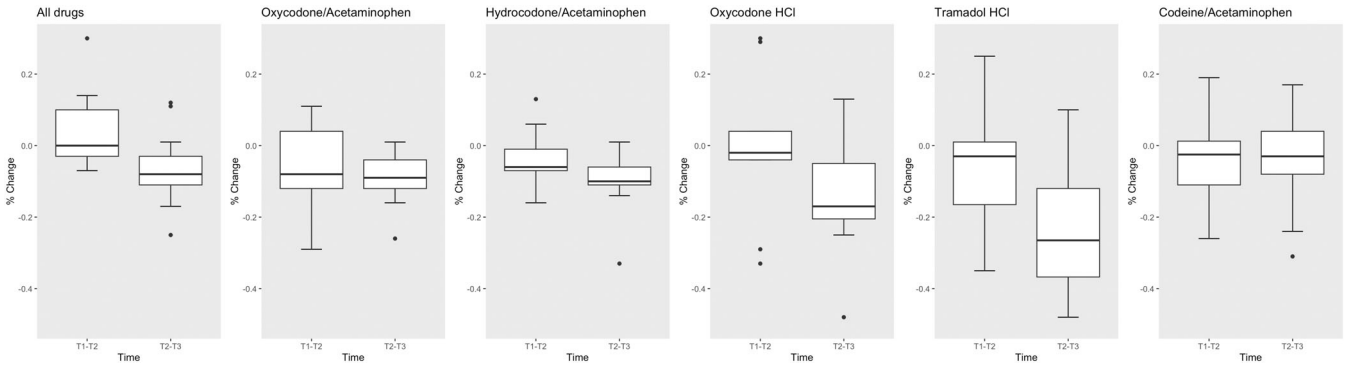

FIGURE 1 Percent changes in prescription days per beneficiary before and after the legislation across all 13 states for each opioid drug individually and for all five drugs combined. T1–T2: from 2 years prior to law enactment to the year of law enactment. T2–T3: from the time of law enactment to 2 years post-legislation.

national database study. Other factors may have contributed to the decline in opioids prescribed by otolaryngologists during this time period, including increased provider awareness, and scientific evidence of the hazards of opioid misuse as well the efficacy of alternative pain management strategies.[23–26]

5 | CONCLUSION

In conclusion, the results of our study suggest that opioid duration-limiting laws enacted between 2016 and 2017 may have been associated with a reduction in the length of opioid prescriptions written by otolaryngologists in the states in which these laws were passed. In many states, these decreases in opioid prescription durations were also accompanied by decreased rates of opioid overdose-related deaths, suggesting that these laws may have been associated with reductions in opioid misuse, overuse, and overdose-related deaths. However, a causative relationship between the passage of legislation and the reduction in opioid prescription duration cannot be definitively established from this study. Future research endeavors may aim to investigate other strategies for limiting the over-prescription of opioids by otolaryngologists, as well as investigating the reasons why some states experienced greater reductions in the duration of opioids prescribed than others.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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