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ORIGINAL RESEARCH ARTICLE

Use of Muscle Relaxants After Surgery in Traditional Medicare Part D Enrollees

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Abstract

Background Surgeons have come under increased scrutiny for postoperative pain management, particularly for opioid prescribing. To decrease opioid use but still provide pain control, nonopioid medications such as muscle relaxants are being used, which can be harmful in older adults. However, the prevalence of muscle relaxant prescribing, trends in use over time, and risk of prolonged use are unknown.

Study Design Using a 20% representative Medicare sample, we conducted a retrospective analysis of muscle relaxant prescribing to patients ≥ 65 years of age. We merged patient data from Medicare Carrier, MedPAR, and Outpatient Files with Medicare Part D for the years 2013–2018. A total of 14 surgical procedures were included to represent a wide range of anatomic regions and specialties.

Results The study cohort included 543,929 patients. Of the cohort, 8111 (1.5%) received a new muscle relaxant prescription at discharge. Spine procedures accounted for 12% of all procedures but 56% of postoperative prescribing. Overall, the rate of prescribing increased over the time period (1.4–2.0%, $p < 0.001$), with increases in prescribing primarily in the spine (7–9.6%, $p < 0.0001$) and orthopedic procedure groups (0.9–1.4%, $p < 0.0001$). Of patients discharged with a new muscle relaxant prescription, 10.7% had prolonged use.

Conclusions The use of muscle relaxants in the postoperative period for older adults is low, but increasing over time, especially in ortho and spine procedures. While pain control after surgery is crucial, surgeons should carefully consider the risks of muscle relaxant use, especially for older adults who are at higher risk for medication-related problems.

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Key Points

Use of muscle relaxants for older adults in the postoperative period is low, but increasing over time.

Ortho and spine procedures account for the majority of cases in which older adults receive muscle relaxants after surgery.

While pain control after surgery is crucial, surgeons should carefully consider the risks of muscle relaxant use for older adults, who are at higher risk for medication-related problems.

1 Introduction

Surgeons have come under increased scrutiny for postoperative pain management, particularly for opioid prescribing, in part because it can lead to prolonged use [1], contributing to the opioid epidemic as well as a myriad of safety-related concerns, including the risk of opioid use disorders. However, controlling pain is a critical issue for patient recovery and rehabilitation and enhances the ability to participate in rehabilitation. Physiologic benefits of good analgesia include dampening the stress and inflammatory response that is inherent to surgery [2]. Pain control also contributes to patient perception of their care. To decrease opioid use but still provide adequate pain control, nonopioid medications and other modes of pain relief are more commonly used. Minimization of opioids improves respiratory function and return of gastrointestinal motility [2]. Centrally acting muscle relaxants, originally used for spasms and lower back pain, are increasingly used off-label for neuropathic pain [1], with older adults being more likely to receive these prescriptions. Additionally, muscle relaxants have been used as opioid-sparing medications after a surgical procedure, though the rates of use are unknown.

However, just as for opioids, muscle relaxants have their own set of risk profiles, both in the short and long term, including anticholinergic effects, sedation, and increased risks of falls and associated fractures. These risks are heightened in older adults who are more at risk than their younger counterparts for adverse drug events, an issue worsened further by contributing to polypharmacy. The AGS Beers Criteria [2], a list compiled by an interprofessional expert panel reviewing evidence with regard to medications in older adults, gives a strong recommendation to avoid muscle relaxants because of anticholinergic, adverse effects, sedation, and increased risk of fractures, as well as the lack of effectiveness at dosages tolerated by older adults [2]. Even short-term use is called in to question for older adults, and prolonged use can be dangerous in this population. In fact, recommendations generally limit the use of muscle relaxants outside the surgical setting to a maximum duration of 2–3 weeks [3], and there is no reason to believe they should be continued longer after a procedure if the original aim is to treat acute pain. Like opioids, muscle relaxants are unlikely to be beneficial past the immediate postoperative period and have clear risks. Baclofen and tizanidine, known specifically as antispastics [4] and potentially different from typical skeletal relaxants, have similar adverse effects and risk profiles. In 2016, more than 30 million prescriptions of muscle relaxants were recorded in ambulatory care visits [5], though use after surgery is unknown.

Given the rapidly increasing proportion of older adults in the USA [6], it is critical to understand the short- and long-term use of muscle relaxants in the postoperative pain period in this population, including risk factor use or trends in use over time, especially concerning if use of these medications was increasing. Therefore, we aimed to use Medicare data, a large national dataset of older adults, to better understand prevalence of and associations with muscle relaxant prescribing, as well as the trends in use over time.

2 Methods

2.1 Data Source

Using a 20% representative Medicare sample, we conducted a retrospective analysis of muscle relaxant prescribing to patients ≥ 65 years of age. For the 5% and 20% samples, beneficiaries are selected for inclusion in the database on the basis of the last two digits of their health insurance claim number (which, in the vast majority of cases, is their social security number). Information on all beneficiaries included in the 5 or 20% Standard Analytic Files (SAF) are provided for all years for which they have received Medicare benefits (until death or disenrollment) within the time period included [3]. We merged patient data from Medicare Carrier, MedPAR, and Outpatient Files with Medicare Part D for the years 2013–2018. We used the Master Beneficiary Summary File (MBSF) base file to determine cohort composition regarding age, gender, race, and comorbidity score. We identified both hospitalizations and fee-for-service claims at free-standing ambulatory surgical centers for specifically identified procedures. We tracked both muscle relaxants and postoperative opioid prescribing over time including prescription strength and quantity.

2.2 Study Population

We included patients undergoing one of the 14 most common non-cataract surgeries performed in older adults (eAppendix 2) [8, 9], who were ≥ 66 years at time of the procedure to allow for a prior year for calculating comorbidities using the Charlson comorbidity score [10], calculated using an updated 17-disease version for use in administrative databases [11]. We only included patients who had at least one prescription filled in Medicare Part D 3 months prior to surgery and who had continuous Part D coverage for 3 months before and 6 months after the procedure date to ensure they were using Part D. For patients who had multiple procedures over the time period, we included only their most recent procedure. We excluded patients whose discharge disposition was death or hospice [12], who died within 30 days after discharge, and who had ≥ 3 procedures on the same day (eAppendix 3).

The 14 surgical procedures included represent a wide range of anatomic regions and specialties. We defined inpatient procedures using ICD9-CM or ICD10-PCS codes and outpatient procedures using HCPCS/CPT codes (eAppendix 4). We created specific groupings for procedures commonly performed together. We defined race using the Research Triangle Institute (RTI) race code, which is an algorithm providing an expanded definition of race to the Medicare data [13].

We defined patients who had a new postoperative prescription for a muscle relaxant at the time of surgery, which excluded patients already on muscle relaxants prescribed in the 3 months prior to surgery (excluding the 7 days prior to surgery) [8]. We linked the NDC codes from Part D claims with Medispan crosswalk files to identify generic drug names and prescription information. We considered a postoperative prescription as any fill between 7 days before and 7 days after the surgery (or discharge for inpatients) [14, 15], as some surgical practices prescribe medications preoperatively so that patients can have the medication ready at home. We created a variable to assess chronic preoperative opioid use, including any patient who received a prescription of opioids for either 60 continuous days before surgery or had filled three or more prescriptions of at least 28 days duration for opioids within 180 days before surgery. We excluded patients discharged to SNF as prescribing information in SNFs is unavailable in Medicare data.

2.3 Outcomes and Data Analyses

Our primary outcome was fills of postoperative muscle relaxant prescribing (eAppendix 5). We then evaluated fills of postoperative muscle relaxant prescribing in several ways. First, we identified associations with muscle relaxants by defining which types of patients and which procedures most commonly had fills of muscle relaxants prescribed postoperatively. Then, we analyzed the rate of procedural prescribing of muscle relaxants after surgery over time. Of note, we also evaluated the prevalence of prolonged use of fills of muscle relaxants, which we defined as a prescription refilled at 90–180 days after discharge from surgery, a time period based on definitions of prolonged use of opioid after surgical procedures [8, 16, 17].

We also assessed opioid prescribing as the premise that postoperative muscle relaxant use could decrease the need for opioids [4]. We measured opioid prescribing (eAppendix 6) using the same methods we used for muscle relaxant prescribing. We also evaluated concomitant prescribing of opioids in the postoperative period, as well as oral morphine equivalents (OME) to assess overall trends of the amount of opioid prescribing. OME is used as a tool to compare the amount of different opioids using an equianalgesic dose chart to calculate opioid dosage in a consistent and systematic way [18].

To identify associations with overall prescribing, we constructed logistic regression models adjusted for procedure characteristics (surgery type), patient characteristics (age, sex, race/ethnicity, Charlson comorbidity score), length of stay, disposition location, and care complexity [19–21] (number of physicians seen in prior 6 months). We defined which procedures most commonly had muscle relaxants prescribed postoperatively, and the unadjusted risk of prescribing for each medication category and for type of surgery. Additionally, we assessed concomitant prolonged use of opioids since that can increase the risk of adverse drug events.

We then analyzed prescribing trends over time. We adjusted for age, race, gender, and type of procedure. We analyzed the proportion of postoperative prescribing of new muscle relaxants, opioids and average OME across each year from 2014 to 2018. We used 2013 to calculate comorbidities for people in the first cohort year. To analyze overall prescribing trend over year, we constructed multivariate logistic regression models for muscle relaxant (MR) and opioid prescribing, including procedure year as a categorical variable and adjusting for age, sex, race and ethnicity, and procedure types. Linear trends in the log odds of both MR and opioid prescribing over time were analyzed by comparing a linear contrast of regression coefficients across all levels of procedure year to the null value zero. We also analyzed trends over time by each procedure group by collapsing procedures into similar groups including laparoscopic, open, orthopedic, spine, and vascular (eAppendix 1).

To assess risk factors for prolonged use, we first defined the unadjusted risk of prolonged use for each medication category and for type of surgery. We then constructed logistic regression models, adjusted for age, gender, race, facility type, and procedure type. We managed competing risks

through a descriptive model as the number of deaths within 30 days was too small for a Fine-Gray calculation.

Finally, we performed a subanalysis of each step above after removing the antispastics, as the Beers criterion does not apply to muscle relaxants typically used for the management of spasticity (i.e., baclofen and tizanidine) instead of pain, although these drugs are in fact also used for postoperative pain and can also cause substantial adverse effects [2]. Therefore, we aimed to assess whether there was a difference between muscle relaxant use as a whole with skeletal muscle relaxants specifically.

We conducted analyses using SAS 9.4 and Stata 17, and plots were generated with R. Data were last extracted on 2/26/2024. This manuscript complies with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guideline for cross-sectional studies (e Appendix2) [7]. The study was approved by the University of California San Francisco Institutional Review Board.

3 Results

The total study cohort included 543,929 patients after inclusion/exclusion criteria were applied (eAppendix 3). The mean age was 73.7 years, with 66% being 75 years old or less, 55% female and 86% white (Table 1). Of the total cohort, 8111 (1.5%) received a new prescription for a muscle relaxant at discharge. Of these patients, those discharged with a muscle relaxant were also more likely to have an opioid prescription (unadjusted 1.8 versus 1.0% $p < 0.0001$), have a higher OME (average 576 versus 451, OR 1.08, CI 1.01–1.16, $p < 0.0001$, only among those who received an opioid), had their procedure in an outpatient facility (1.8 versus 1.3%, $p < 0.0001$) with planned surgery (1.5 versus 0.6%, $p < 0.0001$) who were discharged home (1.6% versus all others, $p < 0.0001$). On multivariable analysis, patients who received a new muscle relaxant at discharge were more likely to be younger (OR 0.37, CI 0.31–0.44 for oldest age group versus youngest, $p < 0.0001$ for all), white (1.5% versus 1–1.42% for all other races, OR 0.85, CI 0.76–0.95 for Black, $p < 0.0001$ for all), have chronic opioid use (2.2 versus 1.4%, OR 1.08, CI 1.01–1.16, $p < 0.001$) (Table 2). Though statistically significant, many of these differences were not clinically significant. These patients were also more likely to have higher care complexity as measured by the number of physicians seen in the prior 6 months. The most likely procedure to have an MR at discharge was lumbar laminotomy/laminectomy (7.1%) followed by total hip arthroplasty (1.2%).

Spine procedures accounted for 12% of all procedures included over the time period but accounted for 56% of postoperative muscle relaxant prescribing (Fig. 1). The next most common procedure was knee arthroplasty, which accounted for 20% of postoperative muscle relaxant prescribing. On multivariable regression, the variables that remained statistically significant with postoperative muscle relaxant prescribing included younger age, white race, chronic opioid use, outpatient facility (Table 2), and lumbar laminotomy/laminectomy followed by total hip arthroplasty (Fig. 1). We repeated these analyses removing antispastics (baclofen/tizanidine) and the risk factors were similar (eAppendix 7); 70% (5688) of patients prescribed a muscle relaxant at discharge were also prescribed an opioid.

3.1 Trends over Time

We also looked at the trends over time for postoperative muscle relaxant prescribing. Overall, the rate of prescribing increased only slightly from 2014 to 2018 (1.4–2.0%, OR 1.49, 1.36–1.61, $p < 0.001$) (Fig. 2, eAppendix 8), with increases in prescribing primarily in the spine (7–9.6%, $p < 0.0001$) and orthopedic procedure groups (0.9–1.4%, $p < 0.0001$). Of note, opioid prescribing did increase in a statistically significant manner overall (Fig. 3, eAppendix 9) and in each procedural group, however, the relative increase was small in most cases (ortho: 61.5–65.1%, spine: 53.2–53.8%, laparoscopic procedures: 49–53%, open abdominal cases 50.8–52.3%, vascular: 34.6–30.9%). These trends were similar when antispastics were removed.

3.2 Prolonged Use

We also identified patients with prolonged use (a prescription fill > 90 days after the procedure). Of patients who were discharged with a new muscle relaxant prescription, 887 (10.7%) had prolonged use. Patients with prolonged use were more likely to be younger (71.3 versus 72.5 years, $p < 0.0001$), female (12.7% versus 8.7%, $p < 0.001$), had a higher median days supply of muscle relaxants on the initial fill (29.3 versus 18.4 days, $p < 0.0001$), with an opioid prescription (63 versus 37%, $p < 0.0001$), have a higher length of stay if an inpatient (4.1 versus 3.1 days, $p < 0.0001$), and with a higher care complexity (eAppendix 10). These results were all similar when antispastics were removed, except that length of stay was no longer significantly different.

4 Discussion

In this study of postoperative prescribing of muscle relaxants to older adults across a broad range of common surgical procedures, we found that in most procedures, prescribing was low and there has been only a small increase in prescribing over time, specifically in spine procedures. Furthermore, our study found that antispastics (baclofen/tizanidine) had similar use and trends as skeletal muscle relaxants as a whole.

Table 1 Characteristics of cohort

	Total (N = 543,929, col%)
Age, mean (sd)	73.7 (5.9)
66–70	197049 (36.2%)
71–75	162296 (29.8%)
76–80	106088 (19.5%)
81–85	54191 (10.0%)
86+	24305 (4.5%)
Gender	
Male	246,500 (45.3%)
Female	297,429 (54.7%)
Race	
White	466873 (85.8%)
Black	27012 (5.0%)
Hispanic	28489 (5.2%)
All other/unknown	21555 (4.0%)
Chronic opioid use	
No	504326 (92.7%)
Yes	39603 (7.3%)
Concurrent opioid prescription (7 days before admission to 7 days after discharge)	309404 (56.9%)
Opioid OME	
Opioid prescribing at discharge (− 7 days before admission and + 7 days after discharge) median (q1, q3)	300 (200, 600)
Facility type	
Inpatient	328871 (60.5%)
Outpatient	215058 (39.5%)
Disposition location	
Home	382785 (70.4%)
Home under care of organized home health service organization	157936 (29.0%)
Transfer to acute care	1993 (0.4%)
Other/missing	1215 (0.2%)
Planned surgery (vs emergent)	
Yes	512034 (94.1%)
No	31895 (5.9%)
Care complexity (number of physicians seen in prior 6 months)	
q1 (1–4)	136849 (25.2%)
q2 (5–12)	158358 (29.1%)
q3 (13–17)	127004 (23.4%)
q4 (18–171)	121718 (22.4%)

Our findings show that muscle relaxant prescribing has been and remains low.

Though there has been a rise in the use and prescribing of postoperative gabapentinoids [22], unlike gabapentinoids, muscle relaxants are less likely to be standardized in postoperative pain protocols, therefore, these results are not surprising. However, there are older studies showed the opposite trend, with one study from 2003 to 2006 showing a decrease in muscle relaxant prescribing to older adults [23]. As prescribing increases and the population of older adults grows, the overall number of patients on muscle relaxants may come to represent a larger number of the population and has the potential to grow over time. Given the risks of muscle relaxants [24] and the doubt about efficacy at doses tolerated by older adults, it is unclear whether these medications should be used at all.

While rates are low overall, the majority of this prescribing is for patients after spinal surgery (laminectomy/laminotomy). It is in this patient population that careful attention should be given to ensure appropriate use, discontinuation, and avoidance of concomitant opioid use to avoid adverse drug events. Prior studies evaluating the use of muscle relaxants have focused on outpatient prescribing. One study found a threefold increase in office visits

Table 2 Characteristics of cohort comparing patients who did and did not receive a muscle relaxant (MR) at discharge

	With MR at discharge ($N = 8111$, row%)	No MR at discharge ($N = 535{,}487$, row%)	p value	p value (adjusted) OR (95% CI) (adjusted)	p value (adjusted)
Age			< 0.0001	.	< 0.0001
65–70	3584 (1.8%)	193465 (98.2%)		Ref	
70–75	2519 (1.6%)	159777 (98.5%)		0.79 (0.75, 0.83)	
75–80	1344 (1.3%)	104744 (98.7%)		0.64 (0.60, 0.68)	
80–85	523 (1.0%)	53668 (99.0%)		0.53 (0.48, 0.57)	
85+	141 (0.6%)	24164 (99.4%)		0.37 (0.31, 0.44)	
Gender			0.6895		0.9835
Male	3658 (1.5%)	242842 (98.5%)		Ref	
Female	4453 (1.5%)	292976 (98.5%)		1.00 (0.96, 1.05)	0.9951
Race			< 0.0001		< 0.0001
White	7215 (1.5%)	459658 (98.5%)		Ref	
Black	327 (1.2%)	26685 (98.8%)		0.85 (0.76, 0.95)	
Hispanic	278 (1%)	28211 (99%)		0.79 (0.70, 0.89)	
All other/unknown	291 (1.4%)	21264 (98.6%)		0.87 (0.77, 0.98)	
Chronic opioid use (no)			< 0.0001		
No	7239 (1.4%)	497087 (98.6%)		Ref	0.0330
Yes	872 (2.2%)	38731 (97.8%)		1.08 (1.01, 1.16)	
Facility type			< 0.0001		< 0.0001
Inpatient	4138 (1.3%)	324733 (98.7%)		Ref	
Outpatient	3973 (1.8%)	211085 (98.2%)		0.89 (0.84, 0.94)	

In the multivariable analysis, we adjusted for age, gender, race and ethnicity, facility type and chronic opioid use. We only included variables that were clinically significant in the multivariable analysis

Ref reference group

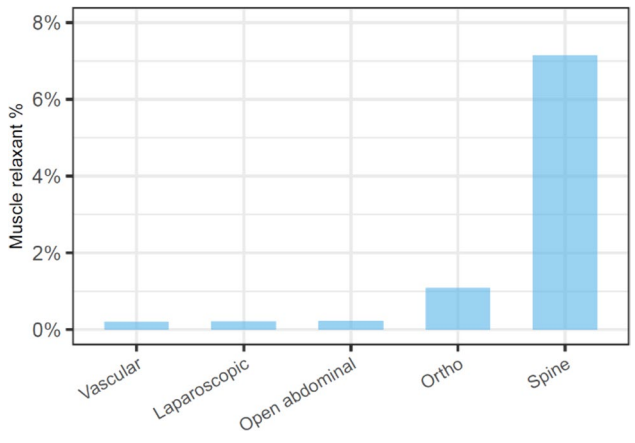

Fig. 1 Surgical procedures receiving muscle relaxants at discharge by procedure group ($p < 0.001$)

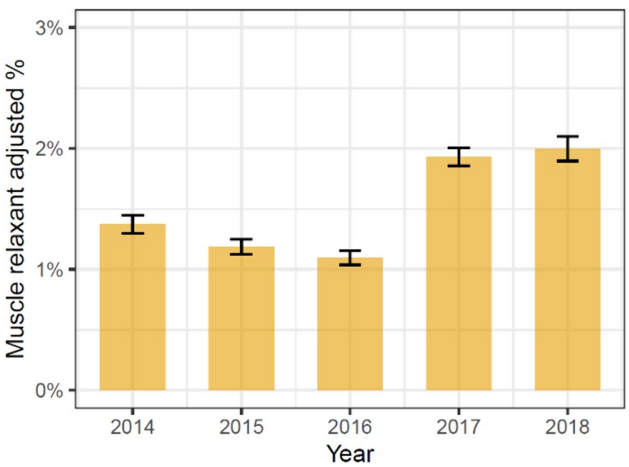

Fig. 2 Postoperative muscle relaxant prescribing: trends over time. Model adjusted for age, gender, race and ethnicity, procedure type and chronic opioid use

booked specifically to prescribe/continue the use of muscle relaxants, particularly concerning as the prescriptions specifically for older adults doubled during this time [1]. Of particular worry is the increase of concomitant prescribing, such as for a muscle relaxant and an opioid, which can lead to drug–drug interactions including respiratory depression and increased risk of overdose [25].

Our study has several limitations. We excluded patients with Medicare Advantage as diagnosis data from outpatient visits can be harder to obtain, which may limit our

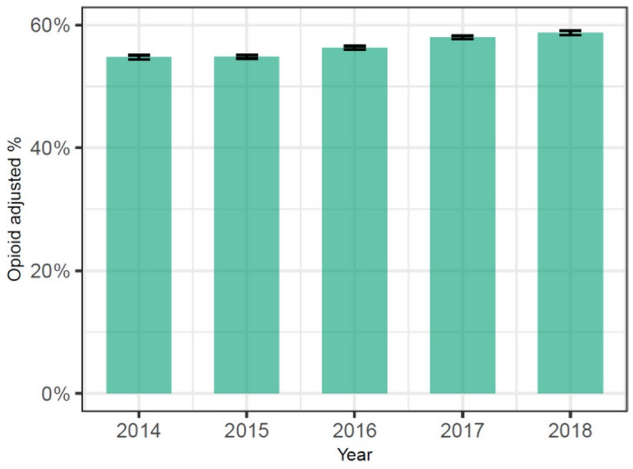

Fig. 3 Trends in postoperative opioid prescribing. Model adjusted for age, gender, race and ethnicity, procedure type and chronic opioid use

generalizability to fee-for-service beneficiaries. These patients may have more restrictions on covered medications and procedures, though muscle relaxants specifically are mostly inexpensive and generic. Additionally, our sample size remains large despite this exclusion to allow robust assessments of the non-Medicare Advantage population. If patients received a supply of medication from the hospital pharmacy, that would not be captured in Part D data and we would be missing those. We exclude patients with a death in 30 days and therefore could be underestimating muscle relaxant use. This would mean a higher number of patients receive muscle relaxants than we report. Due to local availability of Medicare data to our research group, our analysis ends in 2018, so we are unable to assess whether there have been further changes in more recent years. However, to our knowledge this is the most recent study of muscle relaxant use to date [1, 26]. Finally, by only including patients who had a prescription fill in the prior 3 months, we have introduced selection bias into our cohort, effectively excluding people who are "too healthy" to be on any medications.

5 Conclusions

The use of muscle relaxants as multimodal pain control in the postoperative period for older adults is low though slowly increasing over time. Use is higher after spinal or orthopedic surgery. While pain control and the ability to function and participate in rehabilitation after surgery is crucial, surgeons should carefully consider the risks of muscle relaxant use, especially for older adults who are at higher risk for medication-related problems.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40266-024-01124-x.

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Declarations

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Ethics approval This study was approved by UCSF's Institutional Review Board.

Consent to participate Not applicable.

Consent for publication Not applicable.

Data availability The data supporting this study's findings can be requested from the Centers for Medicare and Medicaid Services.

Code availability The analytic code used to support the findings in this study are available from the corresponding author upon reasonable request.

Author contributions Tasce Bongiovanni, MD, MPP: study concept and design, acquisition of data, analysis and interpretation of data, and preparation of manuscript; Siqi Gan, MPH: analysis and interpretation of data, and preparation of manuscript; Emily Finlayson, MD: study concept and design, interpretation of data, and preparation of manuscript; Joseph Ross, MD: interpretation of data, and preparation of manuscript; James Harrison, PhD: interpretation of data, and preparation of manuscript; John Boscardin, PhD: study concept and design, acquisition of data, analysis and interpretation of data, and preparation of manuscript; and Michael Steinman, MD: study concept and design,

acquisition of data, analysis and interpretation of data, and preparation of manuscript

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