

Impact of State Nurse Practitioner Regulations on Potentially Inappropriate Medication Prescribing Between Physicians and Nurse Practitioners

OPEN

A National Study in the United States

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ABSTRACT

Background: The American Geriatrics Society regularly updates the Beers Criteria for Potentially Inappropriate Medication (PIM) to improve prescribing safety.

Purpose: This study assessed the impact of nurse practitioner (NP) practices on PIM prescribing across states in the United States and compared the change in PIM prescribing rates between 2016 and 2018.

Methods: We used data from a random selection of 20% of Medicare beneficiaries (66 years or older) from 2015 to 2018 to perform multilevel logistic regression. A PIM prescription was classified as initial or refill on the basis of medication history 1 year before a visit. PIM use after an outpatient visit was the primary study outcome.

Results: We included 9 000 224 visits in 2016 and 9 310 261 in 2018. The PIM prescription rate was lower in states with full NP practice and lower among NPs than among physicians; these rates for both physicians and NPs decreased from 2016 to 2018.

Conclusions: Changes could be due to individual state practices.

Keywords: advanced practice nurse, Beers Criteria, inappropriate prescribing, nurse practitioner, primary care physician, scope of practice

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Nurse practitioners (NPs) are a growing component of the primary care workforce, caring for patients of all ages across the United States.^{1,2} The number of NPs in the United States increased from 82 000 in 2001 to more than 290 000 in 2020.³ NPs hold prescriptive privileges in the United States; 69% provide primary care and the malpractice rate is low (1.1%).³ Among patients with diabetes, chronic obstructive pulmonary disease, and heart failure, the quality of care from NPs in primary care settings (such as for preventive care, which helps patients avoid emergency department visits and hospitalizations) is comparable with care from physicians.⁴⁻⁸ In recent years, several national agencies have emphasized safe prescribing of medication with a focus on preventing potentially inappropriate medications (PIMs).⁹⁻¹² Since 1991, the American Geriatrics Society (AGS) has maintained the Beers Criteria, which include a list of PIMs for older adults.^{13,14} Regulations on NP prescriptive authority vary widely across

states, from full to reduced or restricted authority (as documented in the American Association of Nurse Practitioners' webpage, "State Practice Environment").¹⁵ NPs have independent prescribing authority in some states, but other states limit the classes of medications that NPs can prescribe or require a physician's signature. Whether the differences in PIM prescription patterns between physicians and NPs are due to the state's scope of practice regulations for NPs remains to be determined. No studies have investigated the differences in safe prescribing practices between NPs and physicians across state NP practice regulations.

Prescription Drug Monitoring Programs (PDMPs), interactive databases for sharing controlled substance prescriptions and requirements, vary by state.¹⁰ Increasing numbers of NPs are participating in PDMPs to provide safe and effective care for patients with chronic pain.¹⁶ However, the differences in PIM prescribing patterns for NPs across state NP regulations have not yet been examined.

NEW CONTRIBUTION

This article addresses the differences in PIM prescribing patterns between primary care physicians and NPs across state NP regulations. As for the purpose of this study, we assessed the impact of a state's scope of practice for NPs on PIMs by comparing the differences in PIM prescribing patterns between primary care physicians and NPs according to the level of NP regulation. We also compared the change in PIM prescribing rates between 2016 and 2018 among NPs by level of NP regulation, limiting these comparisons to states that changed their NP regulations in 2017 and 2018—namely, South Dakota, Indiana, and Virginia, in which the state regulations changed from restricted authority to conditional authority.

The differences in PIM prescribing patterns between primary care physicians and NPs across state NP regulations are of importance and interest to health services researchers, policy makers, managers, and clinicians because PIM prescription has been found to be associated with adverse health outcomes (eg, falls).^{13,14} Understanding the impact of state NP regulations—as in the current study—on safe prescribing can inform future policy and clinical practice. We hypothesized that the difference in PIM prescribing behaviors between physicians and NPs is smaller

in states with restricted practice than in full-practice states. We also hypothesized that PIM changes among NPs are larger in full-practice states than in restricted-practice states, especially in states where regulations changed in 2017–2018.

We used Donabedian's^{17,18} structural-process-outcome model as our conceptual framework to develop our research hypotheses. The structural factors of this study are state regulations and provider credentials (physicians compared with NPs). The prescription of PIMs resulting from an outpatient visit was the primary outcome. The other study outcome was a comparison of PIMs as the result of outpatient visits over time, including a period where there were regulation changes. We explored several process factors that could influence PIM prescriptions, including Medicare beneficiary characteristics. This study is unique because it analyzes the providers' PIM prescribing behavioral changes that resulted from the state-level NP practice regulation changes in 2017–2018 as a process and timing-related factor.

METHODS

Data sources

We used Medicare data from a random selection of 20% of Medicare beneficiaries from 2015 to 2018. Medicare enrollment status and demographic factors were determined from Master Beneficiary Summary Files.¹⁹ The provider types and outpatient visits were defined from Outpatient Statistical Analysis Files (OutSAFs) and Carrier files. The Prescription Drug Event (PDE) files were used to define medication use. The history of hospitalization and comorbidity were determined from Medicare Provider Analysis and Review files, OutSAFs, and Carrier files. The institutional review board of the University of Texas Medical Branch approved this study.

Cohort selection

To observe outcomes in 2016 and 2018, we selected 2 sets of cohorts with the same selection criteria. First, we selected beneficiaries that were continuously enrolled in Medicare Parts A, B, and D—without Medicare Advantage Plan coverage—in the observational year and the previous year. Second, we restricted the study population to those 66 years or older who were alive at the end of the observation period and had at least 1 outpatient visit

to a primary care provider (PCP). The outpatient visit was identified by the use of *Current Procedural Terminology* codes (99201-99205, 99211-99215). PCPs were identified by Centers for Medicare & Medicaid Services (CMS) specialty codes and classified into 2 types: physician and NP. Physicians included those with CMS specialty codes 01, 08, 11, and 38, and NPs included those with specialty code 50 and taxonomy codes 363L00000X, 363LA2200X, 363LF0000X, 363LG0600X, 363LP2300X, and 363LW0102X. To retain providers with enough clinical practice in the analyses, only those with at least 40 outpatient visits per year were included. Finally, 9 000 224 visits from 2 184 737 patients were included in the 2016 cohort and 9 310 261 visits from 2 321 005 patients were included in the 2018 cohort (see Supplemental Digital Content, Table 1, available at: <http://links.lww.com/JNCQ/A896>).

Measurements

Measuring the prescription of PIMs resulting from an outpatient visit was the primary outcome. To estimate the PIM prescription rate, we only included medications prescribed by the same provider and filled within 7 days after a face-to-face outpatient visit. This approach eliminated prescriptions received from other providers or for another medical need.

Because older adults are often prescribed high-risk medications listed in the Healthcare Effectiveness Data and Information Set (HEDIS),²⁰ a list of 8695 National Drug Codes from HEDIS 2017²¹ was linked with PDE files to determine PIM use. This list included 76 medications from 20 therapeutic categories (see Supplemental Digital Content, Table 2, available at: <http://links.lww.com/JNCQ/A897>) according to the 2015 AGS Beers Criteria.¹³ A PIM prescription was classified as either an initial or refill prescription on the basis of the beneficiary's medication history 1 year before a visit. All prescriptions from any provider during the look-back period were used to determine PIM history. An initial PIM prescription was defined as a PIM prescribed for a beneficiary who had not taken the same medication during the past 12 months. A refill PIM prescription was defined as a PIM prescribed for a beneficiary who had taken the same medication during the past 12 months.

The state's NP practice environment was the main independent variable (as documented in the

American Association of Nurse Practitioners' webpage, "State Practice Environment")^{15,22,23} and included 3 practice authority categories: (1) full practice (herein referred to as full authority), whereby NPs have full, autonomous practice and prescriptive authority without requiring attestation from the supervising physician, delegation, consultation, or collaboration; (2) full or reduced practice with a transition (herein referred to as conditional authority), whereby NPs have full autonomous practice and prescriptive authority but require a postlicense or postcertification period of supervision, collaboration, or mentorship; and (3) reduced or restricted practice (herein referred to as restricted authority), whereby NPs require attestation by the supervising physician supervision, delegation, consultation, or collaboration for practice and (or) prescription. In 2017-2018, the state regulations changed from giving NPs restricted authority to conditional authority in South Dakota, Indiana, and Virginia.

The provider type was identified by the CMS provider specialty codes. The covariates included demographic factors of the beneficiary (age, gender, race or ethnicity, residential area), original Medicare entitlement, and dual eligibility. The beneficiary's hospitalization information and the Charlson comorbidity score²⁴ in the prior year were also included in the models. The beneficiary's residential area was classified as metropolitan, urban, or rural according to the 2013 rural-urban continuum codes from the US Department of Agriculture Economic Research Service.²⁵ The beneficiary's state of residence was assigned to 1 of 4 census regions: Northeast, Midwest, South, and West.²⁶

Statistical analyses

The initial and refill PIM rates were estimated separately in 2016 and 2018 per 1000 visits for each provider type and for different categories of NP regulations and other characteristics. The impacts of NP regulation and provider type on the PIM prescription rate were estimated as the odds ratio (OR) with adjustment for beneficiary characteristics (ie, age, gender, race or ethnicity, original Medicare entitlement, dual eligibility, comorbidity, hospitalization, area of residence) in multilevel logistic regression models. These models were estimated using generalized linear mixed models (GLMMs) with a logit link binomial distribution, and model parameters were

estimated with maximizing residual pseudo-likelihood. The GLMMs included a random intercept with a variance component structure for a state to account for each state's within-cluster dependence. A full model with a 3-way interaction term (year, provider type, and NP regulation) was utilized to test the interaction effect. For significant interaction effects, stratification analyses were further applied to estimate the main effect in each category of NP regulation. All analyses were performed with SAS version 9.4 (SAS Inc, Cary, North Carolina). A heat map of the United States (see Supplemental Digital Content, Figure 1, available at: <http://links.lww.com/JNCQ/A898>) was used to present the percentage of visits in which at least 1 PIM was prescribed, according to quartiles of the national percentage of initial or refill PIM use in 2016.

RESULTS

Characteristics of Medicare fee-for-service beneficiaries

As shown in Supplemental Digital Content, Table 3 (available at: <http://links.lww.com/JNCQ/A899>), about 61% of the visits involved female patients. Less than 9% of the total visits in 2016 were billed to NPs, which increased to 12.51% in 2018. Also, 82.06% of the total visits in 2016 were billed to states with restricted practice. Around 1 in 100 visits (0.94%) in 2016 resulted in at least 1 initial PIM prescription, with a slight reduction in 2018 (0.85%). We observed a slight downward trend in refill PIM prescriptions (1.56% in 2016, 1.40% in 2018).

Initial versus refill PIM rates per 1000 visits by year

Supplemental Digital Content, Table 4 (available at: <http://links.lww.com/JNCQ/A900>) shows slight decreases from 2016 to 2018 in initial and refill PIM prescription rates per 1000 visits for both physicians and NPs across states with different NP practice authorities and across beneficiary characteristics (eg, demographic, comorbidity, residential characteristics). In both years, initial and refill PIM prescription rates were lower in full-authority states than in those with restricted or conditional authority.

Physicians prescribed more PIMs than NPs regardless of the NP practice authority regulation (Table). The differences were more significant for refill than for initial PIM prescription rates; that is, the rate of refill PIM prescriptions was much

lower among NPs than among physicians. The rates of initial and refill PIM prescriptions for both NPs and physicians also decreased from 2016 to 2018, and the magnitude of these decreases was lower in full-authority states. In 2018, the differences between initial and refill PIM prescription rates between NPs and physicians were greater in restricted-authority states than in full-authority states. We observed a decrease in the rate of initial and refill PIM prescriptions from 2016 to 2018 among NPs in restricted- and conditional-authority states. The direction of the percent change (increase or decrease) from NP visits in full-authority states was inconsistent for initial and refill PIM prescriptions. Three states (Illinois, South Dakota, and Virginia) with NP regulatory changes reported a decrease in the initial and refill PIM rates resulting from NP visits but an increase in refill PIM rates in South Dakota (Table).

As shown in Supplemental Digital Content, Figure 1 (available at: <http://links.lww.com/JNCQ/A898>), the changes (decreases) in initial and refill PIM rates among physicians and NPs were generally consistent. The initial PIM rates among NPs decreased from 2016 to 2018. However, the initial PIM rates among NPs in Colorado and Texas increased from the lowest quartile in 2016 to the second lowest quartile in 2018. In contrast, we observed a decrease from 2016 to 2018 in the initial PIM rates among physicians for Colorado (second lowest quartile in 2016 and lowest quartile in 2018) and Texas (highest quartile in 2016 and second highest quartile in 2018). Among the 3 states with NP practice regulation changes, initial PIM rates among NPs decreased in South Dakota (second lowest quartile in 2016 and lowest quartile in 2018), but there were no changes in the quartiles for Illinois (lowest quartile in 2016 and 2018) and Virginia (highest quartile in 2016 and 2018).

The refill PIM rates among NPs stayed consistent from 2016 to 2018. The refill PIM rates among NPs for Oklahoma decreased between 2016 and 2018. In contrast, we observed an increase in refill PIM rates among NPs for Nevada (second lowest quartile in 2016 and highest quartile in 2018) and Alaska (lowest quartile in 2016 and highest quartile in 2018). Also, we saw an increase in refill PIM rates among physicians in Alaska (lowest quartile in 2016 and second lowest quartile in 2018). Among the 3 states with NP practice regulation changes, the refill PIM rates

Table. Potentially Inappropriate Medication Prescription Rates per 1000 Visits by Provider Type

Characteristic	Physician Visit		NP Visit		Percent Change ^a
	2016	2018	2016	2018	
Initial PIM, total	9.56	8.66	8.00	7.50	-6.3%
NP regulation					
Restricted authority	9.8	8.94	8.36	7.87	-5.9%
Conditional authority	8.92	8.20	7.86	6.93	-11.8%
Full authority	8.00	7.16	5.91	6.20	4.9%
State with regulation change ^b					
Illinois	8.13	6.86	5.10	4.37	-14.3%
South Dakota	7.64	6.63	8.10	4.65	-42.6%
Virginia	10.28	10.1	11.07	10.21	-7.8%
Refill PIM, total	16.31	14.75	8.87	8.33	-6.1%
NP regulation					
Restricted authority	16.86	15.53	9.21	8.69	-5.6%
Conditional authority	13.89	12.59	7.68	7.54	-1.8%
Full authority	13.51	12.3	7.56	7.39	-2.2%
State with regulation change ^b					
Illinois	13.42	10.75	4.62	4.35	-5.8%
South Dakota	14.95	14.27	5.40	7.20	33.3%
Virginia	14.45	13.5	11.53	10.05	-12.8%

Abbreviations: NP, nurse practitioner; PIM, potentially inappropriate medication.

^aPercent change was calculated as (2018 rate - 2016 rate)/2016 rate.

^bChange from restricted authority to conditional authority.

among NPs remained in the same (lowest) quartile. Thus, we could not conclude that the rates of initial and refill PIM prescriptions were associated with NP state regulations.

Provider type and beneficiary characteristics associated with initial and refill PIM rates

Supplemental Digital Content, Table 5 (available at: <http://links.lww.com/JNCQ/A901>) shows the multilevel logistic regression model results for the impact of NP practice authority regulation and provider type on PIM prescription rates. The OR was estimated with an adjustment for beneficiary characteristics. States characterized by the year of prescription as 2018, the provider type as NP, and the NP regulation as full authority were associated with an OR of 0.91 (95% CI, 0.90-0.92), 0.80 (95% CI, 0.78-0.81), and 0.86 (95% CI, 0.76-0.97), respectively, had a lower odds of an initial PIM prescription visit than states characterized by the year of prescription as 2016, the

provider type as physician, and the NP regulation as restricted authority. States characterized by the year of prescription as 2018, the provider type as NP, and the NP regulation as conditional and full authority were associated with an OR of 0.92 (95% CI, 0.92-0.93), 0.49 (95% CI, 0.49-0.50), 0.94 (95% CI, 0.91-0.97), and 0.80 (95% CI, 0.71-0.90), respectively, had a lower odds of a refill PIM prescription visit, compared with states characterized by the year of prescription as 2016, provider type as physician, and the NP regulation as restricted authority.

The rate of PIM prescription was lower among NPs than among physicians; however, the rate did not differ by NP regulation (see Supplemental Digital Content, Table 6, available at: <http://links.lww.com/JNCQ/A902>). There was little difference between full-authority states and states with the other 2 NP regulation types; that is, PIM prescription patterns were independent of the NP authority regulation. There was a significant 3-way interaction (provider type, year

of prescription, and NP authority regulation) for the initial PIM rates ($P = .015$) and refill PIM rates ($P < .001$). Also, the rates of initial and refill PIM prescriptions among NPs in states with full-practice authority in both 2016 and 2018 were lower than those with restricted authority; this difference was also observed for physician prescribers. These results confirm that PIM prescription patterns were independent of NP authority regulation.

DISCUSSION

We conclude that the rate of PIM prescriptions was lower among NPs than among primary care physicians and was lower in states that allow full-authority NP practice. The rates of PIM prescriptions for both NPs and physician prescribers decreased from 2016 to 2018. However, we cannot conclude that the rate of PIMs was associated with state NP regulations, as other variables beyond NP regulations (eg, socioeconomic, cultural, legal, or environmental factors) may have driven the overall decrease in PIM rates as observed among both NPs and physicians. The difference in PIM prescriptions between NPs and physicians were similar regardless of the state NP regulations. State NP regulations had similar effects on PIM prescriptions among both NPs and physicians. In addition, the decrease of PIM prescription among NPs was not associated with state NP regulations.

Since 1998—the year Medicare started reimbursing NPs for their services—states with the least restrictive NP authority regulations have experienced the largest increase in patients seen by NPs.²⁷ A systematic review of randomized controlled trials was inconclusive about whether team-based care that includes physicians and NPs or physician assistants improves patient satisfaction compared with a traditional care model.²⁸ A recent study showed that highly collaborative primary care practices are associated with fewer hospitalizations and emergency department admissions, as well as less total spending.²⁹ As the physician-NP team-based care is more prevalent in primary care services, it is possible that physicians may take care of more severe patients with multiple chronic conditions in states with restricted authority regulations for NPs, possibly resulting in higher PIM prescription rates among physicians than among NPs.

PIM prescription patterns are likely independent of NP authority regulations. The observed

differences in PIM prescription patterns could be due to state-level effects such as the socioeconomic characteristics of Medicare beneficiaries and local state policies (eg, PDMP requirement, political polarization, state and local taxes, local health policies, resources for retirees).^{6,10,30} Our observed difference in PIM prescription across states may be related to other cultural, economic, and environment factors, similar to the discussion in a previous study focused on long-term use of prescription opioid drugs across counties.⁶

State-level efforts in promoting the Choosing Wisely campaign by clinical societies could also influence PIM prescribing.⁹ The Choosing Wisely clinician lists, which are compiled according to AGS recommendations, focus on factors such as not prescribing benzodiazepines or other sedatives or hypnotics in older adults as the first choice for insomnia, agitation, or delirium.⁹ State-level clinician societies may adopt different approaches to promote the Centers for Disease Control and Prevention guidelines for prescribing opioids for chronic pain,^{11,12} depression, and anxiety.³¹ The adoption and requirements of PDMPs also vary by state.¹⁰ National- and state-level efforts in promoting the aforementioned safe prescribing recommendations may have played a key role in reducing PIM prescriptions by physicians and NPs from 2016 to 2018. Further research on state-level effects is warranted.

A national study of older adults with diabetes found that NPs were less likely than physicians to fully adopt disease evaluation and management recommendations.⁸ NPs were more likely to prescribe PIMs, more likely to seek specialist consultations, and less likely to prescribe eye examinations and HbA_{1c} testing. NPs sought specialist consultations more often but had similar overall costs of care compared with physicians.⁸ NPs are a fast-growing workforce in providing primary care^{2,32}; therefore, the number of active practicing NPs per 1000 population and the NP's education level (clinical doctorate or master's degree) could contribute to a change in PIM prescribing rates at the state level.

Study limitations

First, the analyses were limited to Medicare fee-for-service patients. Second, the data for our analyses were limited to Medicare billing data, which did not capture how physicians and NPs performed medication reconciliation and

avoided or substituted PIMs. As a result, we could not determine whether medication reconciliation was performed or whether there was appropriate discussion with the patients (eg, about their priorities and health goals). Third, we focused on prescriptions filled after an outpatient visit to physicians and NPs. Medications prescribed as the result of a telehealth consultation or by other providers were not counted. These choices may have affected our comparisons with regard to state NP authority regulations, if these factors varied by states. Finally, some outpatient visits classified as a physician visit may have included NP involvement under incident to billing rule. Thus, physician- and NP-ordered prescriptions across states might differ because of a misclassification of provider type.

Future research directions

Future research is needed to examine the differences in PIM prescriptions between NPs with a doctor of nursing practice degree³² compared with NPs with a master's degree and their practice experiences. Additional research should examine the impact of the practice environment of physicians and NPs on PIM prescriptions, such as team-based primary care, the density of accountable care organizations in the states,³³⁻³⁶ and meaningful use of electronic health record systems for medication reconciliation.³⁷ Future studies should examine the variance in prescribing safety and patient outcomes between NPs as sole PCPs and NPs in a team-based primary care model. A comparison of NPs and physician assistants working in ambulatory care is needed.³⁸

CONCLUSION

The rate of PIM prescriptions is lower among NPs than among physicians. The rates of PIM prescriptions for both physicians and NP decreased from 2016 to 2018, and they were lower in states whose regulations allowed for full-authority NP practice. However, we cannot conclude that the rate of PIMs is associated with state NP regulation because PIM rates decreased for both physicians and NPs over time. State-level licensure and regulatory agencies may play significant roles in ensuring prescription safety. Annual monitoring of PIM prescription patterns by physicians and NPs is warranted as a quality indicator. Our findings underscore a need to expand the knowledge about PIMs and to teach evidence-informed, safe prescribing prac-

tices in nursing and medical schools. Targeted campaigns to address knowledge deficits in safe prescribing practices are needed to monitor quality improvement efforts and evaluate patient outcomes.

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