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Comparing the rates of low-value back images ordered by physicians and nurse practitioners for Medicare beneficiaries in primary care

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ABSTRACT

Background: Little is known about the extent of ordering low-value services by.
Purpose: To compare the rates of low-value back images ordered by primary care physicians (PCMDs) and primary care nurse practitioners (PCNPs).
Method: We used 2012 and 2013 Medicare Part B claims for all beneficiaries in 18 hospital referral regions (HRRs) and a measure of low-value back imaging from Choosing Wisely. Models included random clinician effect and fixed effects for beneficiary age, disability, Elixhauser comorbidities, clinician sex, the emergency department setting, back pain visit volume, organization, and region (HRR).
Findings: PCNPs ($N = 231$) and PCMDs ($N = 4{,}779$) order low-value back images at similar rates (NP: all images: 26.5%; MRI/CT: 8.4%; MD: all images: 24.5%; MRI/CT: 7.7%), with no detectable significant difference when controlling for covariates.
Discussion: PCNPs and PCMDs order low-value back images at an effectively similar rate.

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Introduction

As much as 30% of health care spending in the United States is attributed to the provision of unnecessary services and systematic inefficiencies (Berwick & Hackbarth, 2012; Institute of Medicine, 2012). A substantial portion of this spending, which some label as wasteful, is on low-value care (Colla, Morden, Sequist, Schpero, & Rosenthal, 2015; Schwartz, Landon, Elshaug, Chernew, & McWilliams, 2014; Segal et al., 2014), defined as health care services that are minimally beneficial or involve a risk that outweighs any potential benefit (Institute of Medicine, 2001). The Medicare Payment Advisory Commission estimates that 37% of Medicare beneficiaries received at least one low-value service in 2012, costing Medicare $5.8 billion (Medicare Payment Advisory Commission, 2016). In recent years, the call to study and reduce low-value care has been increasing. For example, the

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Choosing Wisely campaign is a partnership of the American Board of Internal Medicine and 80 specialty societies that aim to eliminate low-value care by encouraging clinicians and patients to engage in shared decision-making about the use of unnecessary tests and treatments. To date, this ongoing effort has published over 500 recommendations identifying avoidable low-value services (American Board of Internal Medicine, 2018).

The most commonly ordered low-value service is lumbar imaging in the evaluation of low back pain (Colla et al., 2015; Schwartz et al., 2014; Segal et al., 2014). While it has been demonstrated that imaging is not associated with improved clinical outcomes, clinicians continue to order radiography and more resource intensive imaging such as MRIs and CTs (Chou, Fu, Carrino, & Deyo, 2009). Such modalities are expensive. Depending on geography and facility, the price of a lumbar MRI varies between $300 and $2,500 with a national average of $894 (Claxton, Rae, Levitt, & Cox, 2018). Beyond needlessly increasing spending, low-value x-rays and CTs expose patients to unnecessary high-dose radiation (Smith-Bindman et al., 2012). Back pain is the second most common reason for a primary care visit in the United States (Hart, Deyo, & Cherkin, 1995). Therefore, understanding low-value back imaging patterns has become increasingly important to improve patient safety and reduce wasteful spending. Our analysis examined low-value radiography, MRIs, and CTs ordered by nurse practitioners (NPs) and physicians in the evaluation of low back pain in primary care.

Evidence on NP image ordering patterns is inconclusive, even though some researchers assert that NPs order more imaging than physicians to compensate for fewer years of required training relative to physicians (Hughes, Jiang, & Duszak, 2015). Prior studies comparing back imaging by NPs and physicians are limited by specific practice environments (e.g., VA hospitals, Military Health Systems) (Dietrich et al., 2018; Gidwani et al., 2016), or younger populations studied (Dietrich et al., 2018; Mafi, Wee, Davis, & Landon, 2016). Furthermore, some study designs include potentially appropriate imaging (Dietrich et al., 2018; Hughes et al., 2015), or do not account for the influence of organizational factors on image ordering (Mafi et al., 2016).

An additional problem common to many studies is the combination of NPs and physician assistants (PAs) into the same category of nonphysician clinicians (Hughes et al., 2015; Mafi et al., 2016), thereby masking important differences between these distinct types of health care providers. NPs and PAs are generally employed in different clinical settings and while some areas of their practice overlap, other aspects are substantially different (Fraher, Morgan, & Johnson, 2016). Last, prior research assesses the impact of geographic influence on low-value care utilization with region (Northeast, Southeast, etc.) (Dietrich et al., 2018; Mafi et al., 2016) or states (Hughes et al., 2015), which may not adequately account for the influence of discrete health care markets.

To address these gaps, in our study, we (a) directly compared back low-value radiography, MRIs, and CTs ordered by primary care nurse practitioners (PCNPs) and primary care physicians (PCMDs), (b) used a large, nationally representative sample of 2012 to 2013 Medicare administrative claims from primarily older adults, (c) employed Choosing Wisely recommendations, (d) controlled for organizational influence, and (e) used the Dartmouth hospital referral regions (HRR) as the geographic unit for analysis.

Methods

The purpose of this retrospective cohort study was to compare the frequency of low-value images ordered by PCMDs and PCNPs after primary care visits for first-time low back pain. To estimate differences in low-value imaging, we used a random effects model that included a random clinician effect (to adjust for correlation at the individual clinician level) and fixed effects for beneficiary age, disability, Elixhauser comorbidities, clinician sex, clinician-specific organization, emergency department (ED) setting, back pain visit volume, and region.

Data

We used a sample of 2012 to 2013 Medicare claims from 18 Dartmouth Atlas of Health Care hospital referral regions (HRRs), which included all inpatient facility, outpatient facility, and Part B provider bills (Dartmouth Institute for Health Policy and Clinical Practice, 1996). The HRRs were created as catchment areas around major hospitals and generally overlap a metropolitan area. The HRRs are often used as proxies for U. S. health care markets to assess regional variation of health care utilization (Colla et al., 2015; Newhouse & Gardner, 2013; Segal et al., 2014). This was a 100% sample of all claims paid by Medicare for all beneficiaries living in 18 HRRs during 2012 and 2013. The 2012 claims data were used to establish a period in which beneficiaries did not experience high-risk comorbidities or chronic back pain. The 2013 claims data were then used to conduct the analysis of NP ordering of low-value images. Variables used in this study are listed in Table 1 with the respective source file.

Sampling

The full sample contained 3.5 million beneficiaries and included those who qualified for Medicare as a result of a disability, or were dual eligible for both Medicare and Medicaid. To study low-value back imaging, we identified the population of beneficiaries with uncomplicated low back pain, based on the Choosing Wisely recommendations (Choosing Wisely, 2018) and supported by the specifications provided by the National Committee for Quality Assurance (NCQA) to measure appropriate imaging for acute back pain (National

Table 1 – Variables Used for Analysis and Data Sources

Variables	Source
Beneficiary age, sex, race, Elixhauser comorbidities (Elixhauser et al., 1998), disability status, dual eligible, zip code	Beneficiary summary file
Dates of services, International Statistical Classification of Diseases-9 (ICD-9) codes, Current Procedural Technology (CPT) codes, National Provider Identification (NPI) number, provider specialty code, Tax Identification Number (TIN), dual eligible, hospital referral region (HRR),	Medicare Part B administrative claims
Dates of services, ICD-9 diagnosis codes, CPT procedure codes, NPI numbers, specialty code, TINs	Medicare Part A inpatient claims
Clinician sex	The National Plan and Provider Enumeration System

Committee for Quality Assurance, 2014). The sampling approach is summarized below and supplemented in Appendix A, which lists the ICD-9 and CPT codes used to detect eligible beneficiaries and low-value images. Appendix B, describes the sample decomposition in greater detail.

Using the ICD-9 codes listed in Appendix A, we extracted beneficiaries with a back pain diagnosis in 2013 ($n = 836{,}820$). We then restricted the sample to continuously enrolled beneficiaries during 2013 who were without recent history of back pain or back pain-related hospitalizations ($n = 325{,}546$). Next, we excluded beneficiaries with high-risk comorbidities present 12 months before or 28 days after the incident visit. Imaging is more likely to be warranted in this high-risk subgroup and is, therefore, usually omitted from low-value imaging studies (Colla et al., 2015; Mafi et al., 2016; Schwartz et al., 2014). A beneficiary was flagged as high risk if at least one high-risk diagnostic code (shown in Appendix C), such as trauma, neurologic impairment, or cancer, was present during the period around the incident back pain visit (NCQA, 2014). To illustrate, consider the beneficiary with an incident case of low back pain. If this beneficiary also experienced neurologic impairment 12 months before or 28 days after the incident back pain visit, the beneficiary was considered high risk and excluded from the study. Excluding these cases homogenized the sample by only considering beneficiaries with uncomplicated acute back pain (NCQA, 2014) ($n = 133{,}411$).

We further refined the sample by identifying and linking primary care back pain visits with an imaging event and ordering provider. This was done using the National Provider Identification number (NPI) to match the performing clinician of the back pain visit with the referring clinician of the imaging event. The referring NPI was missing in 34% of the imaging events. In these cases, we attributed the image to the performing clinician, unless an alternative clinician billed for services during the time period between the back pain visit and the imaging event. If the image could not be confidently attributed to the performing clinician, the case was excluded. Clinicians with five or fewer cases were also excluded to allow for sufficient samples of beneficiaries (nested within clinicians) to achieve statistical expedience. These exclusions resulted in a beneficiary sample of $N = 64{,}118$.

Last, we excluded all specialist physicians, PAs, and specialty NPs to confine our analytic sample to PCMDs and PCNPs. Unlike physicians, NP specialty is not designated in claims data. For example, neurologists are identified by provider specialty code 13, while NPs are identified by a generic code ("50"), regardless of practice type. Consequently, we identified specialist NPs by examining the concentration of an NP's care across 16 major diagnostic areas.

Based on the distribution of concentration of care provided by specialists and NPs, and our sensitivity analysis of a range of thresholds (Appendix D), we selected a 75% threshold. According to this procedure, NPs providing over 75% of their care in a single diagnostic area are considered specialty NPs and are dropped from the sample. These steps identified 33 specialty NPs (12.3% of the total NP sample). As a point of reference, a 2012 survey found that 19% of NPs provided specialized care (American Academy of Nurse Practitioners, 2014), suggesting that some specialty NPs may be included in the PCNP sample. The analytic sample represents back pain visits attributed to PCMDs and PCNPs ($n = 45{,}295$). Follow-up visits after the incident visit were not studied in this analysis. Consequently, every beneficiary in the sample presented for one incident back pain visit and possibly a subsequent low-value image.

Variables

For the descriptive analysis, a per-clinician rate of low-value imaging was constructed where the denominator was a count of all incident evaluation and management (E&M) visits for back pain and the numerator was a count of low-value back images (operationalized by the CPT codes listed in Appendix A, occurring within 30 days of the incident visit). There were two imaging outcomes. The first detected any low-value image (x-ray, MRI, or CT scan) and the second detected only MRIs and CTs, which are more costly in terms of resources and beneficiary exposure to higher radiation doses. A lower ratio, expressed as a percentage, represents fewer low-value images ordered after incident back pain visits. In the multivariate analysis, the dependent variable was binary indicating if a low-value image was ordered after the back pain visit.

The independent variable of interest was clinician type: PCMD or PCNP. PCMDs were identified by their Medicare Part B specialty codes: 01 = general practice, 08 = family medicine, 11 = internal medicine, 38 = geriatric medicine; NPs were identified using code 50. As described in the sampling frame, specialty NPs were excluded. To control for beneficiary severity of illness, we used 30 Elixhauser comorbidities (Elixhauser, Steiner, Harris, & Coffey, 1998), beneficiary age, and disability status. We did not include controls for beneficiary sex or race as low-value back imaging is an adverse event for all beneficiaries, and the effect of race and gender should not be controlled away. Because there is significant regional variation in health care spending (Institute of Medicine, 2013) and low-value care utilization (Colla et al., 2015; Segal et al., 2014), we controlled for geographic region using the HRRs described above.

There is some evidence that group practice habits play a significant role in the resource utilization of individual clinicians (Brown & Brown, 2011; Han et al., 2013). We included the clinician's organization in our models, which were represented by the Tax Identification Number (TIN) (Research Data Assistance Center, 2018). Although this is an imperfect proxy to measure organizational influence, TINs provide the best available information from claims data. We controlled for clinician sex as a clinician attribute and ED setting because back pain presenting to the ED may indicate high clinical acuity that warrants an image. Since the low-value back imaging measure is sensitive to case size, we also included a covariate for the count of back pain visits attributed to each individual clinician.

Analysis

Analysis started by computing descriptive statistics followed by random effects modeling that accounted for clustering of beneficiaries by clinicians. The models supported a random clinician effect, reflecting the random nature of clinicians in the study relative to a nationally representative sample and fixed effects for the other covariates, including organization. MRIs and CTs were ordered with insufficient frequency to support multivariate analysis, but were examined in the descriptive analysis.

Covariates included predictors at the beneficiary and clinician levels, organization and region and whether the visit occurred in the ED. The initial model included only the random effect for the individual clinicians, allowing an examination of the variation in low-value imaging between clinicians. Subsequent models progressively added fixed effects for the beneficiary and clinician characteristics, ED setting, organizations (TINs), geographic region (HRR), and back pain visit volume. A post hoc power analysis of the PCNP group suggests sufficient power to detect significant differences in the low-value imaging rates between PCNPs and PCMDs if the margin is 3.0 percentage points or greater. We used SAS software, version 9.4, for statistical analyses (SAS Institute Inc.).

Findings

The analytic sample for this study consists of 45,295 beneficiaries with uncomplicated low back pain, seen by 5,013 clinicians. The vast majority of the beneficiaries are assigned to PCMDs (96.5%), and the rest to PCNPs (3.5%). Given the unequal sample sizes, we tested for the equivalence of variances and found no differences.

Beneficiary characteristics in Table 2 demonstrate that those treated by PCNPs are 4.2 years younger than those treated by PCMDs (mean age: 66.13 years vs. 70.34 years) and are more likely to be white (91.4% vs. 88.2%) and live with a disability (44.5% vs. 29.3%). PCNP beneficiaries have significantly higher rates of mental health conditions (depression: 20.6% vs. 14.7%, psychiatric conditions: 13.5% vs. 9.5%) than PCMD beneficiaries and more cases of chronic lung conditions (25.3% vs. 21.3%), but fewer cases of complicated hypertension (6.3% vs. 9.1%) and peripheral vascular disease (10.2% vs. 12.9%) than PCMD beneficiaries. Additionally, PCNP beneficiaries in this sample tend to use more health care than PCMD beneficiaries. During 2012, significantly more PCNP beneficiaries visited the ED (39.2% vs. 29.9%) and with greater frequency (2.19 visits vs. 1.72 visits) than PCMD beneficiaries.

Furthermore, PCNPs are significantly more likely to manage first-time low back pain in the ED than PCMDs (9.3% vs. 1.7%). The distribution of back pain visits across the clinician types is also dissimilar. More back pain visits are attributed to individual PCMDs (mean = 12.4 visits, range = 5–104, median = 10, SD = 9.35) than PCNPs (mean = 7.0 visits, range = 5–25, median = 7, SD = 3.85).

Low-value back x-rays, MRIs, and CTs were ordered for 23.8% (SD = 0.43) of all back pain visits, while low-value MRIs and CTs were ordered at a rate of 7.5% (SD = 0.26). Within the ED, PCNPs order significantly fewer low-value back images (41%) than PCMDs (44%), yet in non-ED settings, their rates are equal (PCNP: 24%; PCMD: 24%, $p < .0001$). Table 3 shows that PCNPs (26.5%) order low-value images for back pain slightly more often than PCMDs (24.5%). While less pronounced, this difference is also found in the ordering of MRIs and CT scans as PCNPs order MRIs and CTs for low back pain slightly more often than PCMDs (8.4% vs. 7.7%). None of these differences were significantly different.

As seen in Table 4, results from the initial model demonstrate statistically significant random clinician variance (0.015, $p < .0001$), meaning there is sufficient variability of receiving a low-value image between the clinicians to warrant an investigation of the underlying drivers. When organization is added to the model, the clinician variance decreases (0.0003) and is not significant, suggesting that individual clinicians are no longer significantly different from each other when organization (TIN) is accounted for. Here, we see PCNP emerges as a significant fixed effect. The fifth model, which includes HRR, indicates that PCNPs are 2.9 percentage points ($p < .01$) more likely than PCMDs to

Table 2 – Beneficiary Demographic Characteristic, by Primary Care Clinician Type* ($N = 45,295$).

	Physician Beneficiaries	Nurse Practitioner Beneficiaries	Statistical Significance
Beneficiary sample, *N*	43,700	1,595	-
Proportion of sample	96.5	3.5	-
Demographics			
Mean age, y	70.34	66.13	***
Female	60.72	62.88	
White	88.20	91.35	***
Eligible for Medicare & Medicaid	4.40	3.64	
Disability	29.30	44.45	***
Utilization			
Inpatient admission in 2012	12.20	12.1	
Mean outpatient visits	5.24	6.49	***
Emergency department visit in 2012	29.90	39.18	***
Mean emergency department, visits	1.72	2.19	***
Elixhauser comorbidities			
Iron deficiency anemia	10.6	9.9	
Arthritis	5.7	5.71	
Blood loss anemia	0.7	0.6	
Congestive heart failure	6.6	5.96	
Chronic pulmonary disease	21.3	25.3	***
Coagulopathy	2.2	1.8	
Depression	14.7	20.6	***
Diabetes	11.9	12.5	
Diabetes, complicated	9.9	8.5	
Hypertension	63.7	63.1	
Hypertension, complicated	9.1	6.3	***
Hypothyroidism	9.1	9.1	
Liver disease	2.5	2.7	
Lymphoma	0.2	0.1	
Fluid and electrolyte disorders	9.0	9.0	
Metastatic cancer	0.4	0.7	
Neurodegenerative disorders	8.1	8.6	
Obesity	12.2	14.1	*
Paralysis	1.1	1.4	
Peripheral vascular disorder	12.9	10.2	***
Psychoses	9.5	13.5	***
Pulmonary circulation disorders	2.7	3.1	
Renal failure	6.9	6.0	
Solid tumor without metastasis	1.2	0.8	
Peptic ulcer disease	0.1	0.0	
Valvular disease	9.2	7.8	*
Weight loss	1.9	2.8	*

*$p < .05$, ** $p < .01$, ***$p < .001$.

* Values are percentages unless otherwise indicated. Chi-square and *t* tests significance levels.

order a low-value image for low back pain. However, when back pain visit volume is added (model 6), the difference in the rates of low-value back images ordered by PCNPs and PCMDs narrows to a 2.1 percentage point margin and is no longer significant. It should be noted that the sample size discrepancy between

Table 3 – Unadjusted Per-Clinician Low-Value Back Imaging Rates, by Primary Care Clinician Type

	Physicians	Nurse Practitioners
Beneficiary sample, *N*	43,700	1,595
Clinician sample, *N*	4,779	234
Low-value back imaging rates*		
X-ray/MRI/CT,%	24.5	26.5
Interquartile range	(11.1 - 37.5)	(7.1 - 40.0)
MRI/CT,%	7.7	8.4
Interquartile range	(0 - 14.3)	(0 - 16.7)

CT, computed tomography; MRI, magnetic resonance imaging.
Significance was tested with *t* tests and was not significant.

* Represents the average rate of individual clinician rates of low-value back imaging.

Table 4 – Estimates From Random Effects Models Predicting Low-Value Back Images Ordered by Primary Care Nurse Practitioners and Primary Care Physicians (N = 45,295 Beneficiaries and 5,013 Clinicians)

	Model 1 Intercept Only	Model 2 Model 1 + Clinician Predictors	Model 3 Model 2 + Beneficiary Predictors	Model 4 Model 3 + Organization	Model 5 Model 4 + Hospital Referral Region	Model 6 Model 5 + Back Pain Visit Volume
Fixed effects						
Intercept	0.003 ***	0.003 ***	0.017 ***	0.335 ***	0.272 *	0.318 **
PCNP		0.014	0.014	0.028 *	0.029 **	0.021
ED setting			0.015 ***	0.202 ***	0.202 ***	0.200 ***
Error variance						
Clinician intercept	0.015 ***	0.015 ***	0.14 ***	0.0003	0.0002	0.0000
Model fit						
(−2) Log likelihood	50,163.63	50,132.87	49,380.06	46,691.51	46,666.36	46,623.14

ED, emergency department; PCNP, primary care nurse practitioner.
Organization was operationalized by the Tax Identification Number (TIN). This multivariate analysis used a random effects model that nested beneficiaries in clinicians included fixed effect for clinician sex, disability, beneficiary age, organization, 18 HRRs, and 30 Elixhauser comorbidities. Dependent variable was a measure that included imaging modalities of x-ray, MRI, and CT scans. Estimation Method = Laplace. Significance levels. Values based on SAS PROC GLIMMIX.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

PCNPs and PCMDs limits our ability to detect significance when the rate difference is small. Therefore, we find no detectable difference in the rates of low-value back images ordered by PCNPs and PCMDs.

Discussion and Recommendations

The purpose of this study is to assess variation in low-value back imaging between PCNPs and PCMDs while accounting for beneficiary and clinician characteristics, ED setting, organizational influence, region (HRR), and back pain visit volume. To our knowledge, this study is the first to directly compare low-value care ordering by PCNPs and PCMDs without combining PAs and NPs and using a large, nationally representative sample of Medicare beneficiaries. Overall, we find approximately one-fifth of primary care beneficiaries with back pain receive low-value imaging, consistent with the range (13%−29%) of low-value back imaging rates reported in primary care (Hong, Ross-Degnan, Zhang, & Wharam, 2017; Pham, Landon, Reschovsky, Wu, & Schrag, 2009). Similar to others, results reveal a statistically significant clinician-level variation in low-value imaging (Hong et al., 2017; Tan, Zhou, Kuo, & Goodwin, 2016), which is partially accounted for by organizational factors, supporting the evidence that organizations play a part in the prevalence of low-value imaging (Schwartz, Zaslavsky, Landon, Chernew, & McWilliams, 2018). In addition, we find that PCNPs are significantly more likely to evaluate back pain in the ED than PCMDs. The ED setting is associated with higher diagnostic imaging rates relative to primary care (Larson, Johnson, Schnell, Salisbury, & Forman, 2011; Mills, Raja, & Marin, 2015), a trend which likely accounts for the slightly higher unadjusted rate of low-value back images ordered by PCNPs, compared to PCMDs. However, after controlling for relevant factors, we find no detectable significant difference in the rates of low-value back images ordered by PCNPs and PCMDs.

The finding that PCNPs and PCMD order low-value back images at the same rate is a new contribution to a body of conflicting evidence (Dietrich et al., 2018; Hughes et al., 2015; Mafi et al., 2016). However, results should be understood in the context of study limitations, particularly the lack of clinical granularity in claims data impairing the ability to detect low-value care with complete accuracy. However, the consensus-based Choosing Wisely recommendations deem the images as low value under most circumstances. In addition, this study was unable to account for unobserved differences of beneficiaries between clinician groups, preference for clinician type, or health care access barriers, such as waiting time and geographic proximity. To minimize this bias, the analysis focused on a homogenous beneficiary population and included demographics and comorbidities to control for observable differences.

Also, while this study developed a method to identify specialty NPs within claims data, it was not possible to detect these clinicians with 100% accuracy. It is likely that a few specialty NPs remain in the sample and therefore could have increased the rate of low-value imaging for PCNPs. Further development of methods to identify specialty NPs and PAs within claims data is needed to better distinguish primary care from specialty care NPs. In addition, the sampling discrepancy between PCNPs and PCMDs potentially impacts statistical power and impairs our ability to detect significant differences in imaging rates when the margin is 3 percentage points or smaller. This suggests that a larger sample size could allow the detection of a smaller effect than this study permits. Regardless, it is unclear if differences of this magnitude are of actual clinical significance.

This study has implications for the Medicare program and claims-based research. First, the practice of incident-to billing confounds the results of all studies using Medicare claims that require the accurate attribution of service to clinician. Incident-to billing is a common practice in which NP-provided care is billed by a physician to achieve reimbursement at the higher physician rate, as opposed to 85% of the physician rate if the care is billed by an NP. Incident-to billing is estimated to affect 5% of all claims (O'Donnell & Bloniarz, 2018), but Medicare coding procedures do not allow the identification of which claims are billed incident-to. Second, we found that 34% of imaging claims were missing referring clinician identifiers, which affected our ability to accurately attribute diagnostic services to the clinicians that ordered them. Although we employed procedures to overcome this challenge, this problem also needs to be addressed by Medicare.

Together these changes would substantially improve Medicare claims data and the ability to use them for quality of care studies. In fact, the Medicare Payment Advisory Commission (MedPAC) recently took steps to improve data quality by recommending the elimination of incident-to billing and adding specialty designation codes for NPs and PAs on all claims (Medicare Payment Advisory Commission, 2019). We encourage MedPAC to also recommend policies to ensure referring clinicians are identifiable on all diagnostic services. These changes would significantly strengthen the rigor of claims-based research across a broad range of topics.

Conclusions

Our findings affirm that both individual clinicians and organizations play important roles in the prevalence of low-value imaging (Hong et al., 2017; Schwartz et al., 2018; Tan et al., 2016), and demonstrate that there is no detectable significant difference in the rates of low-value back images ordered by PCMDs and PCNPs. While evidence suggests that specialty care uses more low-value services than primary care (Colla et al., 2015; Hong et al., 2017), our findings confirm that low-value imaging remains a common practice in primary care for both PCNPs and PCMDs and highlight the need for continued collaborative programs at the clinician and organization levels to reduce the use of unnecessary services.

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Supplementary materials

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.outlook.2019.05.005.

Appendix A

Table A.1.

Table A.1 – Low Back Pain Diagnostic Codes With Imaging Codes

ICD-9 Code	Diagnosis	CPT Imaging Codes
724.2	Lumbago	X-rays:
724.5	Unspecified backache	72,010
722.52	Degeneration of lumbar or lumbosacral intervertebral disc	72,020
724.3	Sciatica	72,100
721.3	Lumbosacral spondylosis without myelopathy	72,110
739.3	Nonallopathic lesion of lumbar region, not elsewhere classified	72,114
847.2	Lumbar sprain and strain	72,120
722.1	Displacement of lumbar intervertebral disc without myelopathy	72,200
739.4	Non-allopathic lesion of sacral regions, not elsewhere classified	72,202
722.6	Degeneration of intervertebral disc, site unspecified	72,220
721.9	Spondylosis of unspecified site without mention of myelopathy	MRIs:
724.6	Disorders of sacrum	72,141
722.93	Other unspecified disc disorder of lumbar region	72,142
846	Sprain and strain of lumbosacral (joint) (ligament)	72,146
724.79	Other disorder of the coccyx	72,147
846.9	Unspecified site of sacroiliac region sprain and strain	72,148
846.1	Sprain and strain of sacroiliac (ligament)	72,149
738.5	Other acquired deformity of back or spine	72,156
846.8	Other specified sites of sacroiliac region sprain and strain	72,158
724.7	Unspecified disorder of coccyx	CTs:
722.32	Schmorl's nodes—lumbar region	72,131
846.2	Sprain and strain of sacrospinatus (ligament)	72,132
846.3	Sprain and strain of sacrotuberous (ligament)	72,133

CPT, current procedural terminology; ICD-9, International Classification of Diseases, Ninth Revision.

Appendix B

Table B.1., Table B.2.

Table B.1 – Stepwise Approach to Beneficiary Sampling Frame of 2013 Medicare Part B Claims for Low Back Pain

	Beneficiaries in the 2013 Full Sample N = 3,501,419	
Step 1	Back pain *n* = **836,820**	No back pain *n* = 2,668,599
Step 2	Continuously enrolled in 2013* *n* = **755,004**	Not continuously enrolled *n* = 81,816
Step 3	Back pain with E & M visit in 2013 and 2012 claims present *n* = **540,461**	No E & M in 2013 or claims in 2012 *n* = 214,543
Step 4	No chronic back pain or inpatient admission *n* = **325,546**	Back pain within past 6 months or hospital admission within 2 days after incident back pain visit *n* = 175,339
Step 5	No high-risk conditions *n* = 133,411	Meet high-risk exclusion criteria *n* = 192,135

E & M, evaluation and management visits.
Boldface indicates resulting sample size after exclusion.

* Beneficiaries were dropped in subsequent steps if they were not continuously enrolled for 12 months before or 28 days after the incident back pain visit.

Table B.2 – Stepwise Approach to Clinician Attribution of Analytic Sample of 2013 Medicare Part B Claims for Low Back Pain

	Beneficiaries in the Back Pain Sample $n = 133,411$	
Step 1	Attributed n = **112,923**	Not attributed n = 20,488
Step 2	Attributed to clinicians with sufficient cases (>5) n = **64,118**	Attributed to clinicians with insufficient cases (≤5) n = 48,805
Step 3	Attributed to PCMDs or NPs n = **45,568**	Attributed to specialists or PAs n = 18,550
Step 4	Attributed to PCMDs or PCNPs n = **45,295**	Attributed to NPs practicing in the specialties n = 273

PCMD, primary care physician; PCNP, primary care nurse practitioner.
Boldface indicates resulting sample size after exclusion.

Appendix C

Table C.1.

Table C.1 – Diagnostic Codes Used to Identify Clinically Appropriate Imaging in the Evaluation of Low Back Pain, in 2012 and 2013 Medicare Claims

Label	ICD-9 Code
External causes of injury	Any ICD-9 "E" code
Trauma	800, 839, 850–854, 860–869, 905–909, 926.11, 926.12, 929, 952, 958–959
Cancer	CCS 11–22, 24–44
IV drug abuse	304.0, 304.1X, 304.2X, 304.4X, 305.4X, 305.5X, 305.6X, 305.7X
Neurologic impairment	344.60, 729.2
Endocarditis	4210, 4211, 4219
Septicemia	038xx
Tuberculosis	01xxx
Osteomyelitis	730xx
Fever, weight loss, malaise, night sweats, anemia not due to blood loss	7,806x, 7,830x, 7,832x, 78,079, 7,808x, 2,859x
Human immunodeficiency virus (HIV)	042–044
Unspecified immune deficiencies	279.3
Intraspinal abscess	324.9, 324.1

Appendix D

Table D.1.

Table D.1 – Testing of Concentration of Care Thresholds to Identify Specialist Nurse Practitioners

	Full Sample	75%	60%	50%
NPs (% sample dropped)	267	234 (–12%)	229 (–14%)	217 (–19%)
NP Visits (% sample dropped)	1,868	1,595 (–15%)	1,554 (–17%)	1,472 (–21%)
PCNP, mean per-clinician LVI rate[*]	29.1%	26.5%	26.9%	26.5%
PCNP-PCMD rate difference[^]	4.8***	2.1 (NS)	2.7*	2.5 (NS)

LVI, low-value imaging; NP, nurse practitioner; NS, nonsignificant; PCMD, primary care physician; PCNP, primary care nurse practitioner.
Significance levels.
$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

* Represents the average rate of individual clinician rates of low-value imaging.

† Represents the difference in rate between PCNPs and PCMDs, controlling for other factors, expressed in percentage points.

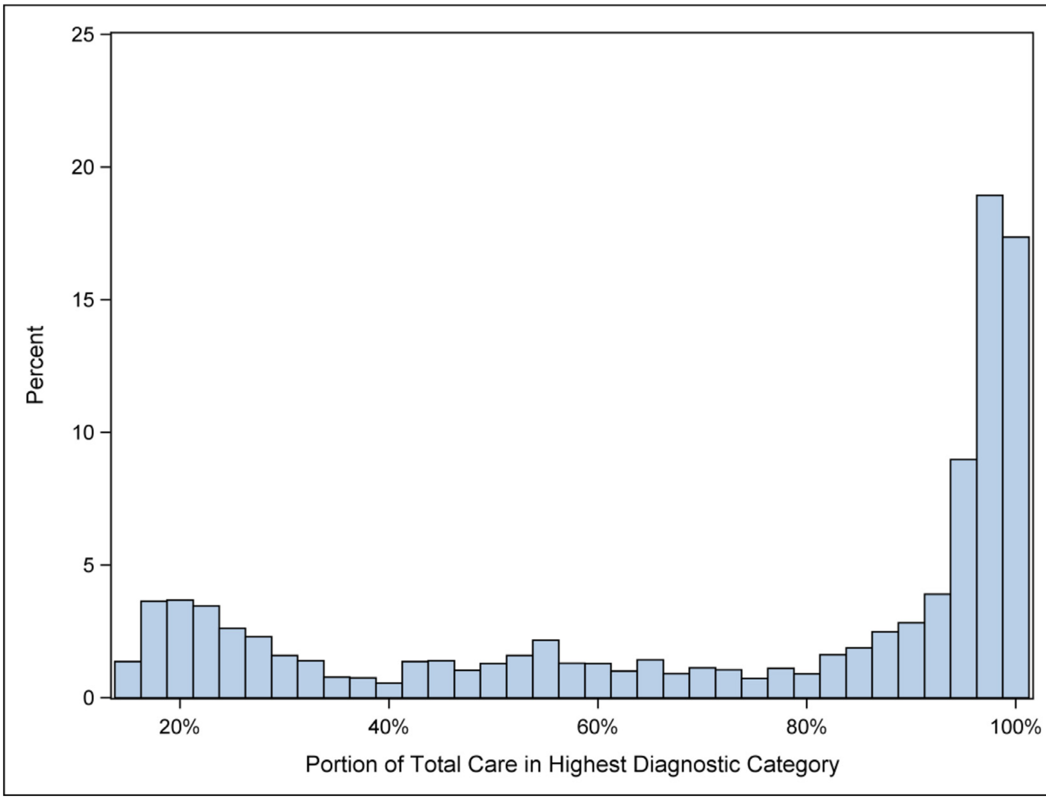

Figure D.1 – Distribution of concentration of care in top diagnostic category, specialist physicians (*N* = 16,760 visits).

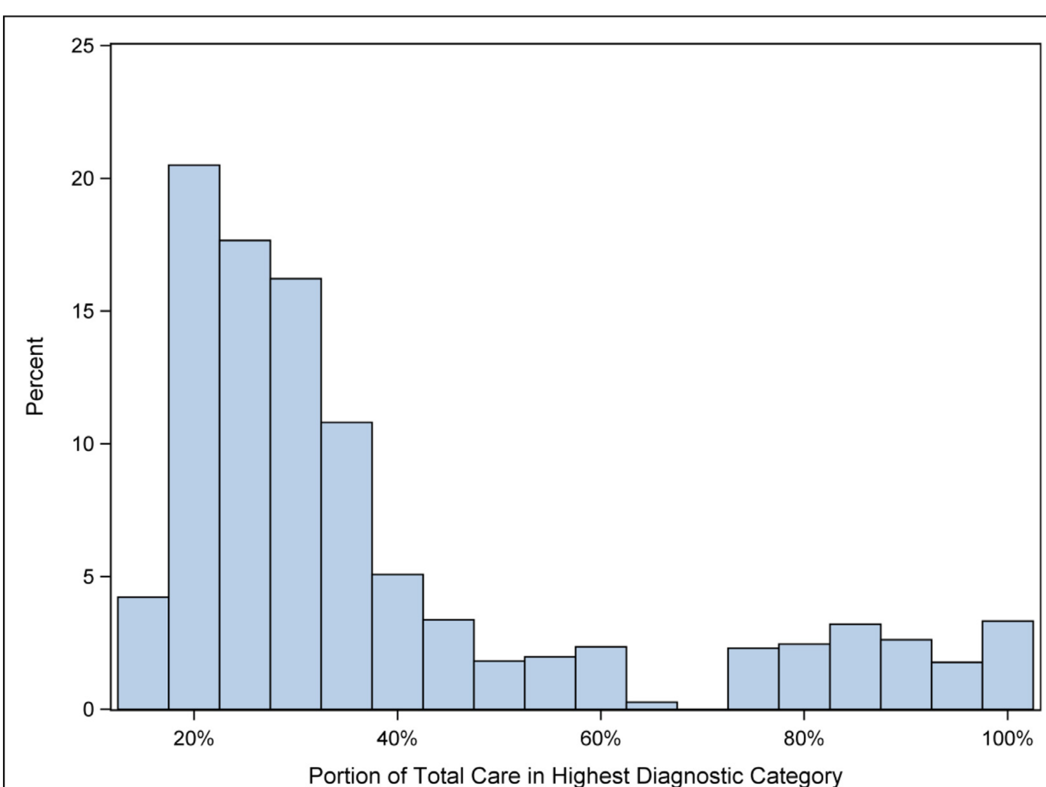

Figure D.2 – Distribution of concentration of care in top diagnostic category, nurse practitioners (*N* = 1,868).

To identify specialty NPs, we first examined the specialist physicians' distribution of the concentration of care over 14 major diagnostic categories. Specialists were defined by Part B specialty codes and excluded emergency room and generalist physicians. Concentration of care for specialists ranges from 1 to 100, with an average of 72.8% and a median of 91%. As seen in Figure D.1., we find specialist distribution of care concentration is skewed to the right with a long left tail and 60% of specialist-managed back pain visits outside of the ED are attributed to specialist physicians who provide 75% of their care in one diagnostic category. We also tested a definition of 85% of care provided in two diagnostic areas, but found little variation in the two definitions.

The statistics and distribution of NP concentration of care look appropriately different from specialists, because NPs generally practice in primary/urgent/emergency care settings where they provide a broad scope of care across many diagnostic areas. NP concentration of care ranges from 13% to 99% with a mean of 38.7% and a median of 30%. As seen in Figure D.2., the distribution of concentration of care provided by NPs is skewed to the left with a defined group in the upper tail. We determined graphically that a 75% threshold would capture that group, which is supported by the data from our analysis testing alternative concentration of care thresholds (60% and 50%). As shown in Table 1, the minor change in the multivariate results was not substantial enough to warrant a consequential 20% reduction in sample size. When we applied the 75% threshold to the NP sample, we identified and excluded 33 specialty NPs that provide 75% of their care in one diagnostic area.

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