AJR FOCUS ON:

Diagnostic Imaging Examinations Interpreted by Nurse Practitioners and Physician Assistants: A National and State-Level Medicare Claims Analysis

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OBJECTIVE. Nonphysician providers (NPPs) increasingly perform imaging-guided procedures, but their roles interpreting imaging have received little attention. We characterize diagnostic imaging services rendered by NPPs (i.e., nurse practitioners and physician assistants) in the Medicare population.

MATERIALS AND METHODS. Using 1994–2015 Medicare Physician/Supplier Procedure Summary Master Files, we identified all diagnostic imaging services, including those billed by NPPs, and categorized these by modality and body region. Using 2004–2015 Medicare Part B 5% Research Identifiable File Carrier Files, we separately assessed state-level variation in imaging services rendered by NPPs. Total and relative utilization rates were calculated annually.

RESULTS. Between 1994 and 2015 nationally, diagnostic imaging services increased from 339,168 to 420,172 per 100,000 Medicare beneficiaries (an increase of 24%). During this same period, diagnostic imaging services rendered by NPPs increased 14,711% (from 36 to 5332 per 100,000 beneficiaries) but still represented only 0.01% and 1.27% of all imaging in 1994 and 2015, respectively. Across all years, radiography and fluoroscopy constituted most of the NPP-billed imaging services and remained constant over time (e.g., 94% of all services billed in 1994 and 2015), representing only 0.01% and 2.1% of all Medicare radiography and fluoroscopy services. However, absolute annual service counts for NPP-billed radiography and fluoroscopy services increased from 10,899 to 1,665,929 services between 1994 and 2015. NPP-billed imaging was most common in South Dakota (7987 services per 100,000 beneficiaries) and Alaska (6842 services per 100,000 beneficiaries) and was least common in Hawaii (231 services per 100,000 beneficiaries) and Pennsylvania (478 services per 100,000 beneficiaries).

CONCLUSION. Despite increasing roles of NPPs in health care across the United States, NPPs still rarely interpret diagnostic imaging studies. When they do, it is overwhelmingly radiography and fluoroscopy. Considerable state-to-state variation exists and may relate to local care patterns and scope-of-practice laws.

Keywords: diagnostic imaging interpretation, diagnostic imaging utilization, nonphysician providers, nurse practitioners, physician assistants

doi.org/10.2214/AJR.19.21306

Received February 14, 2019; accepted after revision June 15, 2019.

A. B. Rosenkrantz and R. Duszak, Jr., are supported by research grants from the Harvey L. Neiman Health Policy Institute.

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AJR 2019; 213:992–997

0361–803X/19/2135–992

As demand for health care services across the United States increases, nurse practitioners and physician assistants (herein collectively referred to as nonphysician providers [NPPs]) have assumed increasingly important roles in ensuring patient access—both temporally and geographically—to a variety of health care services [1–3]. In this regard, radiology is no exception, with many radiology practices using NPPs in a variety of roles to meet their many varied practice demands [1, 4–7].

NPP roles in interventional radiology and other procedure-based settings have been well documented [1, 3, 4, 8]. However, the literature investigating NPP roles in diagnostic radiology has been limited to proof-of-concept studies evaluating NPP performance in imaging interpretation and their effects on radiologist throughput [9–13]. That existing work has suggested that NPPs practicing within a limited scope while being closely supervised by radiologists are able to perform selected radiographic interpretations accurately and at a time savings to radiologists varying from 15% to 34% [9–13]. These experiences, however, are institution-specific case studies, and little information exists about how generalizable these roles may be, if at all.

National radiology societies have opined that imaging interpretation should fall entirely within the domain of radiologists rather than NPPs. Attendees of radiology's 2003 Intersociety Conference, for example, explicitly

TABLE 1: 1994 Nonphysician Provider (NPP)-Billed Diagnostic Services by Modality and Body Region

Body Region	Percentage of NPP-Billed Services					
	CT	MRI	Nuclear Medicine	Ultrasound	Radiography and Fluoroscopy	Total
Brain	0.02	0.00	0.00	0.00	0.00	0.02
Head and neck	0.00	0.00	0.00	1.00	2.04	3.04
Spine	0.02	0.01	NA	0.00	6.05	6.08
Heart	0.00	0.00	0.00	0.71	NA	0.71
Chest	0.02	0.00	0.00	0.00	44.55	44.57
Abdomen and pelvis	0.00	0.00	0.00	4.23	4.81	9.04
Extremity	0.01	0.00	0.00	0.33	34.06	34.39
Breast	NA	0.00	NA	0.15	2.01	2.15
Total	0.06	0.01	0.00	6.41	93.52	100.00

Note—Numbers reported are rounded to the nearest hundredth. NA indicates that code mapping not applicable for that modality and body region combination.

TABLE 2: 2015 Nonphysician Provider (NPP)-Billed Diagnostic Services by Modality and Body Region

Body Region	Percentage of NPP-Billed Services					
	CT	MRI	Nuclear Medicine	Ultrasound	Radiography and Fluoroscopy	Total
Brain	0.10	0.04	0.00	0.00	0.00	0.14
Head and neck	0.09	0.00	0.00	0.59	0.97	1.65
Spine	0.07	0.41	NA	0.00	13.06	13.53
Heart	0.00	0.00	0.10	0.56	NA	0.67
Chest	0.14	0.00	0.00	0.06	15.86	16.06
Abdomen and pelvis	0.24	0.02	0.04	1.83	6.68	8.81
Extremity	0.02	0.24	0.00	1.58	56.56	58.40
Breast	NA	0.00	NA	0.00	0.72	0.73
Total	0.66	0.71	0.15	4.62	93.86	100.00

Note—Numbers reported are rounded to the nearest hundredth. NA indicates that code mapping not applicable for that modality and body region combination.

stated that "image interpretation by radiology physician extenders is not appropriate" [1]. More recently, the American College of Radiology (ACR) stated that if the 2016 Department of Veterans Affairs (VA) proposal for advanced practice registered nurses [14] to interpret images without physician oversight were enacted, it "could seriously compromise the care of our nation's military veterans" [5]. In contrast to the VA, in nonfederal practice settings, restrictions on NPP scopes have largely been determined at the state level [5]. Some of these state-level scope-of-practice laws and rules preclude NPPs from rendering diagnostic radiology services.

The frequency with which NPPs provide diagnostic radiology services nationally and regionally is unknown. As discussion continues regarding the optimal role of NPPs in radiology practices, this information could help inform discussions and future policy. For these reasons, we aimed to characterize diagnostic imaging services rendered by NPPs in the Medicare population and to study state-level variations in the provision of these services.

Materials and Methods

Our analysis of national aggregate claims Medicare public use files and individual beneficiary-level Medicare claims files was performed in a HIPAA-compliant manner as approved by the institutional review board of the ACR.

As used in prior studies [3, 15–19], we initially obtained annual Physician/Supplier Procedure Summary Master Files from the Centers for Medicare & Medicaid Services (CMS) from 1994 through 2015. These public use files contain a 100% summary of all Part B fee-for-service claims for approximately 33 million beneficiaries enrolled in the traditional fee-for-service Medicare indemnity program and are aggregated annually by Healthcare Common Procedure Coding System codes, provider specialty codes, total submitted services and charges, and other modifiers [20]. As performed in an earlier study [21], we further categorized billed imaging services by modality and body region using the Neiman Imaging Types of Service (NITOS) coding system [22].

Next, to assess state-level variation in NPP billing for diagnostic radiology interpretive services and also as used in a prior study [23, 24], we obtained Medicare Part B 5% Research Identifiable File (RIF) Carrier Files from 2004 through 2015. The 5% RIF Carrier Files include all Medicare fee-for-service claims associated with a 5% national sample of Medicare beneficiaries. This more robust dataset includes many more claims-level fields and permits a determination of the geographic location where a service was rendered.

For both national aggregate and state-level analyses, frequency data were normalized for enrollment to calculate rates of utilization per 100,000 Medicare beneficiaries for each year. Percentage changes in utilization rates over time were calculated for service families for all providers as well as those specifically for NPPs. For the purposes of this study, the term "state" refers to the 50 states and the District of Columbia. Analysis was performed using SAS software (version 9.4, SAS Institute) and Excel for Windows 2011 (Microsoft).

Results

Between 1994 and 2015, diagnostic imaging services utilization rates for Medicare fee-for-service beneficiaries across the nation increased from 339,168 to 420,172 per 100,000 Medicare beneficiaries (an increase of 24%). During this same period, diagnostic imaging services billed by NPPs increased from 36 to 5332 per 100,000 beneficiaries (an increase of 14,711%). Despite that increase, NPP-billed diagnostic imaging represented only 0.01% and 1.27% of all such services in 1994 and 2015, respectively.

Between 1994 and 2015 nationally, radiography and fluoroscopy constituted most of the NPP-billed imaging services, accounting for 94% of all services billed in both 1994 and 2015 (Tables 1 and 2). However, NPP-billed radiography and fluoroscopy services represented only 0.01% and 2.1% of all Medicare radiography and fluoroscopy services. The divide between NPPs billing for radiography and fluoroscopy services versus NPPs billing for other modalities is best illustrated in Figure 1. Although radiography and fluoroscopy's percentage of NPP-billed services remained constant over time at approximately 94%, absolute annual service counts for radiography and fluoroscopy interpretations rendered by NPPs increased from 10,899 to 1,665,929 between 1994 and 2015. Of all imaging modalities, radiography and fluoroscopy represented the greatest increase in absolute services billed. All other modalities showed more modest changes in absolute numbers.

Nationally, the body regions for which NPPs most frequently interpreted diagnostic imaging examinations in 1994 were the chest (5194 services, 45% of all services), extremity (4008 services, 34%), abdomen and pelvis (1054 services, 9%), and spine (708 services, 6%). The greatest changes by 2015 (as compared with 1994) were seen with an increase in extremity imaging (1,036,643 services, 58%), representing an increase of 24% absolute numeric change in percentage from 1994, and a decrease in chest imaging (285,016 services, 16%), representing a decrease of 29% (absolute change). All other imaged body regions showed relatively constant percentages of total imaging volumes over time.

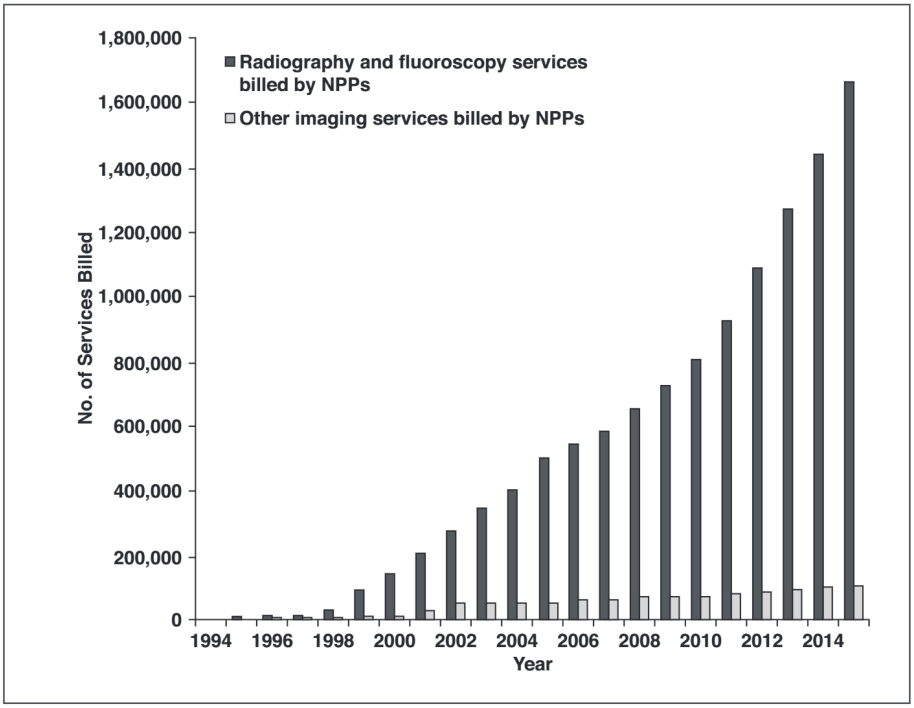

Fig. 1—Year-to-year annual changes in billed Medicare fee-for-service for diagnostic imaging services by nonphysician providers (NPPs) by modality (radiography and fluoroscopy vs other imaging services) from 1994 to 2015.
A, Bar graph compares radiography and fluoroscopy services billed by NPPs with other imaging services billed by NPPs.
B, Graph compares radiography and fluoroscopy services billed by NPPs with all radiography and fluoroscopy services billed by physicians and all other health care professionals.

At the state level, the percentage of all diagnostic imaging services rendered by NPPs was less than 2.0% in all states in 2004 (mean, 0.4%) and increased to less than 4.5% in all states in 2015 (mean, 1.6%) (Fig. 2). Although uncommon nationally, NPP-billed imaging over that entire 12-year period was most common in South Dakota (7987 services per 100,000 beneficiaries, representing 2.5% of all services billed in that state), Alaska (6842 services per 100,000 beneficiaries, 2.3%), and North Carolina (5929 services per 100,000 beneficiaries, 1.8%). NPP-billed imaging was least common in Hawaii (231 services per 100,000 beneficiaries, 0.2%), Pennsylvania (478 services per 100,000 beneficiaries, 0.2%), and New Jersey (516 services per 100,000 beneficiaries, 0.1%). Similar to the marked variation in state-to-state NPP imaging utilization rates, changes in NPP utilization rates by state over time were also highly variable. The states with the greatest growth in NPP diagnostic imaging billing between 2004 and 2015 included Hawaii (increasing from 20 to 555 services per 100,000 beneficiaries, an increase of 2675%), the District of Columbia (from 55 to 1363 services per 100,000 beneficiaries, an increase of 2378%), and Maryland (from 466 to 3329 services per 100,000 beneficiaries, an increase of 614%). The states with the lowest rates of growth and one state with a decline were Maine (declining from 2060 to 1592 services per 100,000 beneficiaries, a decrease of 23%), Wisconsin (from 1578 to 1821 services per 100,000 beneficiaries, an increase of 15%), and South Dakota (from 5834 to 8196 services per 100,000 beneficiaries, an increase of 40%).

Discussion

Using two distinct large Medicare fee-for-service claims datasets, we studied billing for diagnostic imaging services rendered by NPPs across the United States at both the national and state levels over 22- and 12-year periods, respectively. Despite the increasing roles of NPPs in health care delivery across the United States, we found that NPPs only rarely render diagnostic imaging services, and as a group rendered only 1.27%

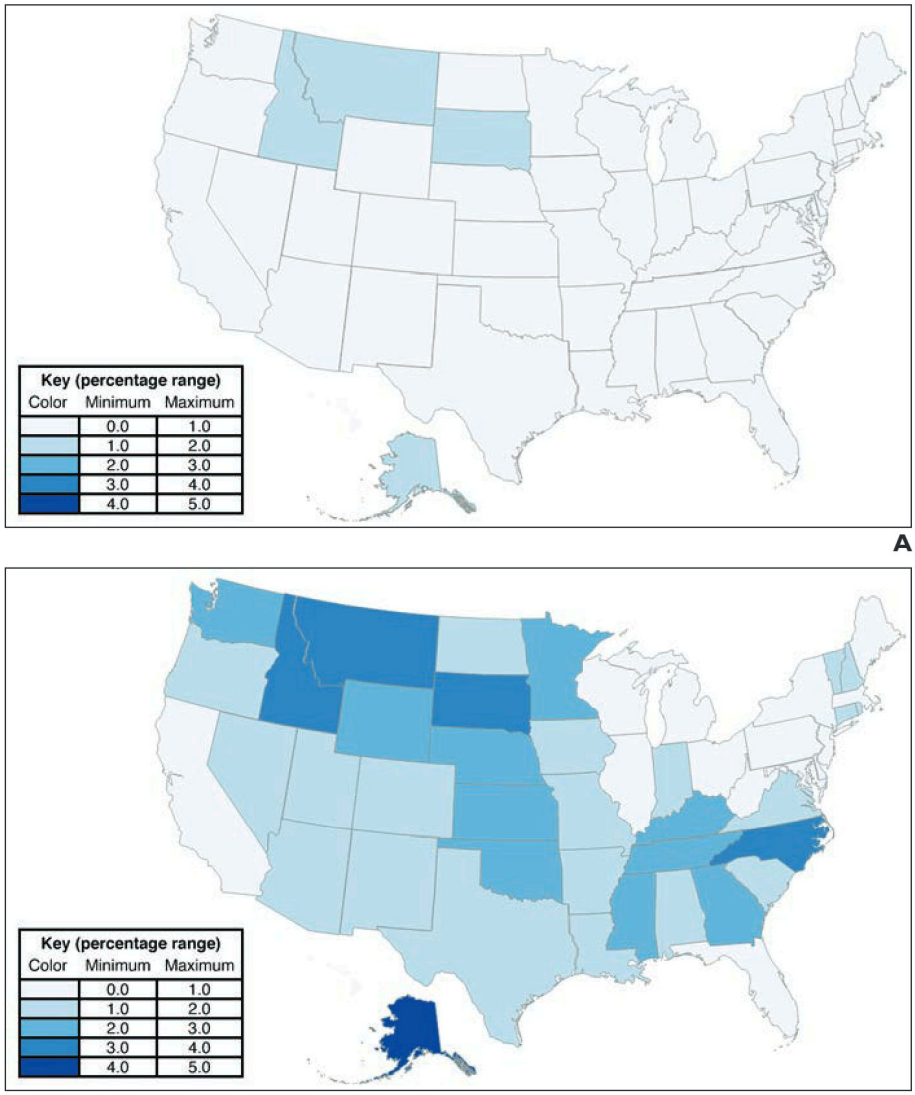

Fig. 2—Maps show percentages of all Medicare fee-for-service diagnostic imaging interpretation services billed by nonphysician providers compared with those of physicians and all other health care professionals by year. **A** and **B,** Maps show data for 2004 (**A**) and 2015 (**B**).

of all diagnostic imaging interpretations in 2015. Over that time, however, the absolute frequency of NPP imaging interpretation services increased from 36 services per 100,000 beneficiaries in 1994 to 5332 services per 100,000 beneficiaries in 2015. Although these rates are small compared with diagnostic imaging utilization rates per year overall (from 339,168 to 420,172 per 100,000 Medicare beneficiaries), the relative growth (an increase of 14,711%) is in stark contrast to more modest overall national growth in diagnostic imaging utilization rates (an increase of 24%).

We additionally found considerable state-to-state variation in the rates at which NPPs bill for diagnostic imaging interpretation services. How much of this variation is related to local care patterns and scope-of-practice laws is not clear and cannot be determined from our claims-based analysis. States vary considerably in the scope of what service NPPs are permitted to perform. In full-practice states, such as Alaska and Hawaii, state practice laws permit NPPs to evaluate patients, diagnose, order and interpret diagnostic tests, and prescribe medications. In reduced-practice states, such as Arkansas and Illinois, state practice laws either require a collaborative agreement with a physician (and in some states other professionals such as dentists or podiatrists) or limit one or more elements of NPP practice. In restricted-practice states, such as California and North Carolina, state practice laws require career-long supervision or team management by a physician or other provider. States in which NPP diagnostic imaging billing was most common were mixed, with South Dakota and Alaska designated as full-practice states and North Carolina designated as restricted practice. This picture was similarly mixed for states where billing was least common, with New Jersey and Pennsylvania designated as reduced-practice states and Hawaii designated as a full-practice state.

We believe that our work focusing on diagnostic imaging interpretations rendered by NPPs complements a variety of prior works examining the role of NPPs in radiology services more broadly. Several articles by multiple authors have highlighted the increased role of NPPs performing paracentesis and thoracentesis procedures, percutaneous biopsy, central venous access, and gastrojejunostomy tube placement, all with increasing frequency [2–4, 19, 25–27]. Focusing on skeletal radiography and fluoroscopy services rendered by NPPs and primary care physicians (PCPs) between 2003 and 2015, Mizrahi et al. [28] recently reported a 441% increase in diagnostic imaging interpretation rates by NPPs, but a 34% decrease by PCPs. With regard to referrals for diagnostic imaging services, Hughes et al. [29] reported that NPPs order advanced imaging 1.3 times more frequently than PCPs for similar patients during office-based encounters.

Our work shows the need for NPP employers to consider formally defining potential NPP roles within radiology services through NPP training programs that comport with NPP scope of practice in their specific states. The radiologist community has for many years strongly supported training programs for radiologist assistants (RAs) [1, 30]. These highly trained professionals can help radiology practices in many ways, but because they are not recognized as qualified health care professionals by Medicare, they are not able to bill independently for their services [31, 32]. For this reason, many radiology practices have turned to NPPs to improve patient access to procedural and clinical evaluation and management services [7, 11, 33]. However, there are no nationally recognized formal radiology training programs or curricula for nurse practitioners or physician assistants. Thus, the radiology training they receive, if any, is customized on the

basis of their practice settings and is often performed in an ad hoc manner by their employer physicians or hospitals. The growth in both procedural services and evaluation and management services as well as in diagnostic radiology services described herein suggests the need for not only formal and standardized but also narrowly focused and highly supervised, imaging-specific training programs for these professionals, such as those that exist for radiologic technologists aspiring to become RAs.

As with any retrospective study using administrative claims data, ours has several limitations. First, although we used two distinct but complementary datasets, our analysis focused exclusively on Medicare fee-for-service beneficiaries. Our work cannot necessarily be generalized to services rendered by NPPs for privately insured patients. Second, because we relied only on claims data (rather than on actual medical records), we are unable to determine the various roles that NPPs played in the provision of these services (e.g., whether they consulted radiologists or other physicians during their interpretations). As a corollary, the claims data did not include information about the specialty of the employer practice or employer specialty; thus, we were unable to determine clinical practice patterns such as whether NPPs worked for radiology practices, emergency physicians, orthopedic surgeons, or multispecialty clinics. Third, the validated NITOS code mapping system we used grouped radiography and fluoroscopy, and we were unable to perform a separate analysis of radiography compared with fluoroscopy without creating our own (and therefore potentially less valid) code mapping system. Finally, our retrospective use of claims data precludes us from definitively imputing causation. Although scope-of-practice laws likely substantially contributed to the state-level variation we described, we acknowledge that other factors, such as state-level medicolegal climates, may be at play.

Conclusion

Using Medicare claims data, we have shown that NPP roles in rendering diagnostic imaging interpretation services across the United States are increasing. However, when compared with the overall numbers of diagnostic imaging interpretations, NPPs still rarely render diagnostic imaging services. When they do, it is most frequently for radiography and fluoroscopy; however, the frequency of the services rendered by NPPs—compared with those for radiography and fluoroscopy overall—is extremely low. Although considerable state-to-state variation exists in the rates in which NPPs render diagnostic imaging services, these rates are also uniformly low and are likely in part related to unique state-level scope-of-practice laws and regulations. At present, the near-term likelihood of NPPs appropriating substantial market share in diagnostic imaging is very low.

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