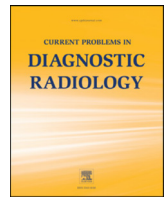




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Association and Trends in Medicare Denials and Utilization for Brain CT: Indirect Impacts by Targeted Policy Intervention?

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Twenty-five years of annual Medicare Physician/Supplier Procedure Summary (PSPS) Master File data were used to assess trends in normalized volume and claim denial rates for brain computerized tomography. Alongside growth in utilization of brain computerized tomography (services, denial rates, fell from 1999–2005 and with relatively leveled growth and less denial rate volatility thereafter. More recent trends in denial rates may be related to policy interventions initially aimed at cost and volume reduction.

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Introduction

The use of noninvasive diagnostic imaging examinations has grown considerably in Center for Medicare and Medicaid Services (CMS) beneficiaries, and particularly for brain (computerized tomography (CT)).¹ During a time of marked growth in Medicare spending, a variety of policy interventions, including the Deficit Reduction Act of 2005 and multiple procedure payment reductions beginning in 2006, were aimed for reducing both cost and volume.^{2,3} Over time, there have been decreasing Medicare denial rates for CT as a modality,⁴ but without body part stratification. Investigators have examined policies aimed at noninvasive diagnostic imaging cost and volume reduction independently from studies of trends in claims denials, and potential associations between the 2 are unknown. We aimed to assess if there is an association between annual CMS denial rates and utilization trends for brain CT examinations while also describing a temporal association with policy interventions aimed to reduce health care spending.

Methods

This retrospective study analyzed PSPS Master Files from 1994 through 2018.^{5–8} As a 100% national CMS-designated public usage file that contains no private identifiable information, analysis of PSPS

Master Files is exempt from institutional review board oversight. These files contain all national annual Medicare Part B fee-for-service claims service counts, aggregated by combinations of service, billing provider specialty, denied claims, and site of service. The number of total and denied claims corresponding to brain imaging by modality (CT), as classified by Neiman Imaging Types of Service (NITOS) codes,⁹ were extracted for each year. The extraction was inclusive of CTA brain examinations and excluded all head and neck CT examinations. To avoid double counting of services with separate technical and professional component billing, we focused only on global and professional service claims.

For each year, annual total and denied service counts were normalized to annual Medicare Part B enrollment to calculate utilization rates per 100,000 beneficiaries.¹⁰ The compound annual growth rate (CAGR) from 1994 to 2018 was calculated for brain CT. Annual service payment denial rates, and the relative percent change from 1994 to 2018 were also calculated. To determine if there is a non-linear relationship between brain CT utilization rates and denial rates, a generalized additive model using thin plate regression splines as the smooth term basis was postulated.

To assess the relationship between policy interventions and annual service payment denial rate for brain CT examinations, linear spline regression models were evaluated using year as an explanatory variable, with statistical cut points, or knots, placed at 1999, representing the beginning of a region of denial rate decline, and 2005 as the beginning of a region relative denial rate stability.

The threshold for assessing statistical significance was set at two-sided alpha =0.05. Initial PSPS Master Files analysis was performed using SAS 9.1 statistical software (SAS Institute Inc., Cary, NC).

Declaration of Competing interest: All authors declare no conflicts of interest.

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TABLE 1
Brain CT utilization per 100,000 medicare fee-for-service beneficiaries and annual denial rates from 1994–2018

Year	Total (exams/ 100,000 beneficiaries)	Denial rate
1994	8,728	8.8%
1995	9,159	8.4%
1996	9,682	8.8%
1997	10,490	10.3%
1998	10,947	10.0%
1999	11,737	12.2%
2000	12,380	11.9%
2001	12,922	10.7%
2002	13,455	9.2%
2003	13,701	7.0%
2004	14,401	6.4%
2005	15,090	5.6%
2006	16,033	5.8%
2007	16,735	6.0%
2008	17,326	5.8%
2009	17,668	5.7%
2010	17,916	6.6%
2011	18,148	5.8%
2012	18,212	6.3%
2013	18,016	6.4%
2014	18,181	5.7%
2015	18,522	6.1%
2016	18,777	6.6%
2017	19,174	7.0%
2018	19,287	8.2%

Subsequent analysis was performed using R version 3.4.3 (Vienna, Austria) and Excel 2016 for Windows (version 16.0.4738.1000, Microsoft).

Results

Table 1 details annual brain CT utilization and denial rates. Brain CT utilization per 100,000 Medicare fee-for-service beneficiaries demonstrated a 3.2% CAGR annual increase from 1994 (8728 examinations per 100,000 Medicare fee-for-service beneficiaries) to 2018 (19,287 examinations per 100,000).

There was a 54.5% decrease in relative denial rate from 1999 to 2005 (12.3% in 1999 to 5.6% in 2005). The generalized additive model demonstrates a non-linear relationship between annual utilization and annual denial rates. Annual denial rates increased as annual utilization rates increased from about 8700 to about 11,700 per 100,000 Medicare beneficiaries. As utilization rates increased from about 11,700 to about 15,000 per 100,000 Medicare beneficiaries, annual denial rates decreased (Supplemental Fig 1). When utilization rates were greater than 15,000 per 100,000 Medicare beneficiaries, annual denial rates again increased.

The linear spline model showed that for each additional year, the annual denial rates increased on average by 0.8% prior to 1999 (spline estimate: 0.008; 95% CI: 0.006, 0.011; $P < 0.0001$), decreased by 1.1% between 1999 and 2005 (spline estimate: -0.019 ; 95% CI: -0.023 , -0.015 ; $P < 0.0001$), and increased by 0.1% after 2005 (spline estimate: 0.012; 95% CI: 0.010, 0.014; $P < 0.0001$) (Supplemental Table 1, Supplemental Fig 2). Figure 1 illustrates annual utilization and denial rates for brain CT examinations. Furthermore, a generalized additive model demonstrates a non-linear relationship between annual volume and denial rates for brain CT examinations (Supplemental Fig 2).

Discussion

Using aggregate Medicare claims data, the utilization of brain CT has increased over time, while payment denial rates increased until 1999, decreased between 1999 and 2005, and have remained somewhat lower and less volatile since 2005. The utilization trend is not

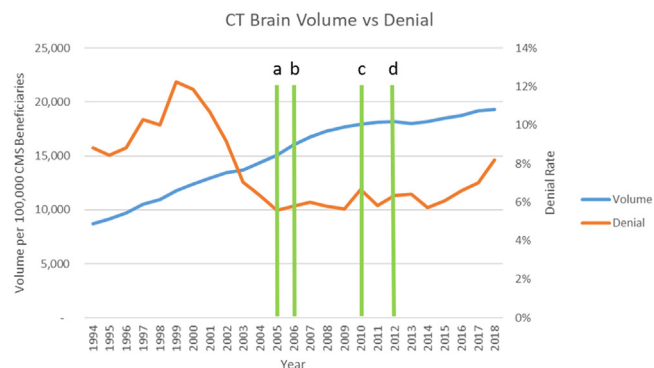


FIG 1. Utilization (blue line) and denial rate (orange line) trends of brain CT in medicare Part B fee-for-service beneficiaries from 1994–2018. Years of notable policy interventions (green vertical lines); a: Deficit Reduction Act, b: Multiple procedure payment reductions, c: Reducing imaging practice expense per hour, d: Professional component reduction of same session, secondary and subsequent examinations. (Color version of figure is available online.)

surprising given previously reported growth in noninvasive imaging in both Medicare beneficiaries and commercially insured enrollees,¹¹ which have been dominated by CT and MRI, particularly when imaging the brain.¹ The latter, however, represents a new finding that merits further consideration.

Brain CT is among the most utilized noninvasive diagnostic imaging examinations. There are numerous indications for brain CT examinations, most commonly including head trauma, headaches, change in mental status, seizures, suspected intracranial hemorrhage, and possible hydrocephalus.^{12–14} Given the extensive indications for brain imaging with CT, the continued growth in utilization from 1994 through 2018 is unsurprising.

Noninvasive diagnostic imaging costs to CMS grew rapidly in the early 2000s, reaching a peak in 2006, after which time there was a 21% decrease from that year through 2010.³ This period of growth in cost largely coincides with a period of precipitous decline in denial rates for brain CT in Medicare fee-for-service beneficiaries, from the highest percentage in 1999 (12.3%) to among the lowest percentages in 2005 (5.6%). After 2005, the linear spline model suggests that the average change in denial rate for each additional year is close to 0%. This suggests an abrupt stabilization of denial rates for brain CT during the same span of time where growth in utilization appears to taper off and CMS costs began to decline.

Utilizing the general additive statistical model, our analysis demonstrates a statistical non-linear relationship between annual volume and annual denial rates, whereby lower annual volumes of brain CT are often associated with higher rates of denial. However, when annual brain CT volumes are higher, despite the typically lower denial rates the rate of growth are nearly exponential. Thus, the exact etiology of the lower and more stable Medicare denial rates for this exam after 2005 is not completely understood. Legislative and regulatory policies have taken aim at the reduction of diagnostic imaging costs and none that directly target Medicare denial rates of diagnostic imaging.

There are notable policy interventions that temporally coincided with the decreased, less volatile Medicare denial rates (Table 1). Chronologically, and most notably, the Deficit Reduction Act of 2005 is credited with a sharp drop in noninvasive diagnostic imaging costs in 2007.¹⁵ Next, multiple procedure payment reductions, first implemented in 2006, resulted in a 25% reduction to the technical component of same session, second and subsequent, contiguous body part, imaging examinations for CT, MRI, and ultrasound.¹⁶ During the early years of the Deficit Reduction Act and multiple procedure payment reduction, Medicare denial rates for brain CT remained relatively low and consistent from 2005 (5.6%) through 2007 (6.0%).

Additional policy interventions, which targeted the hourly practice expense, professional component of payment, and imaging equipment utilization rate, occurred over a period whereby CMS denial rates experienced very small changes from 2010 (6.6%) through 2013 (6.4%). Reducing imaging practice expense per hour was phased in from 2010 through 2013, which reflected CMS revaluating the practice expense component of the relative value unit. This decision, based on a physician survey,¹⁷ had a disproportionate effect on the technical greater than professional component of reimbursements. Subsequently, CMS applied a 25% reduction to the professional component of same session, secondary and subsequent examinations in early 2012.¹⁸ Under the Patient Protection and Affordable Care Act, the assumed utilization rate for advanced imaging equipment costing over \$1 million, increased from 50% to 75%, culminating in a decrease in technical component reimbursement.¹⁹

Finally, bundling of specific high-volume Current Procedural Terminology (CPT) codes have also influenced the revaluation in imaging reimbursement, with notable examples of myelography in 2015²⁰ and CT of the abdomen and pelvis in 2011.³ Conversely, CPT code separation has also been shown to be associated with slow growth in utilization of more costly imaging examinations, as was seen after 2011 with shifts in utilization of extremity nonvascular ultrasound by non-radiologists towards more focused, less costly, radiology driven examinations.²¹ The implementation of CPT code alterations also temporally coincides with a stage of low and even annual denial rates for brain CT examinations.

Although each of the interventions intended to decrease Medicare imaging costs by targeting various components related to radiology payment, the volatility associated with annual denial rates prior 2005 was blunted during invention implementation. As seen with formularies, insurance company determination to deny payment for a service drives care away from that service by influencing physician practice patterns.²² Similarly, high denial rates of imaging examinations, could impact physician practice patterns in advanced imaging ordering, which has potential implications on patient access. The converse may also be true that low denial rates allow for increased access to imaging. This sustained period of lower denial rates, since 2005, potentially allowed for continued patient access to CT brain imaging for Medicare beneficiaries while at the same time legislative and regulatory interventions achieved the primary intention to defray Medicare costs. Assessing the effect of policy interventions take time and 2021 CMS claims data is not yet available so it is difficult to know what, if any, effects the 2020 Final Rule might have on imaging volumes, though it will be important to monitor any potential relationship with imaging claims denial rates, including brain CT.²³

This study has limitations. While we have identified trends in brain CT imaging utilization and Medicare denial rates, we have only established an association between multiple policy interventions and annual denial rates. Our data demonstrates a non-linear relationship between annual volume and denial rates for brain CT examinations. However, the association identified by our analysis does not necessarily reflect causality. Though the policy interventions discussed above appear to have achieved some measures of success in terms of decreasing growth in brain CT utilization and more importantly cost to Medicare, it is unclear what, if any, indirect consequence they have on denial rates for brain CT examinations. The growth in brain MRI volume over our study period may also contribute to the decreased growth in brain CT. One potential explanation for the reduced claims denial rate volatility is improvements in billing compliance and efficiency, possibly related to more widespread electronic medical record implementation. Additionally, our data is comprised exclusively of Medicare fee-for-service beneficiaries. It is also unclear if workload, workflow, and/or manpower at CMS could have had any impact on denial rates. Relevant data from private insurers might help to elucidate how trends in brain CT denial rates compare to the

Medicare data, and potentially provide further insight into the effect of policy intervention.

Conclusion

Although growth in the utilization of brain CT in Medicare beneficiaries occurred from 1994 through 2018, utilization rates began to level off in 2005. Medicare denial rates, peaking in 1999, experienced a precipitous decline through 2005, during the period of rapid growth of nondiagnostic imaging costs to CMS. After 2005, annual denial rates of brain CT experienced a steadier average change in annual denial rate each year. This coincided with multiple policy interventions aimed at decreasing Medicare medical imaging cost and volume. Our results suggest an association between Medicare denial rates and imaging utilization of brain CT examinations. Perhaps the suite of policy interventions targeting the cost and the latter has indirectly impacted the former.

Disclosures

The authors declare that they had full access to all of the data in this study and the authors take complete responsibility for the integrity of the data and the accuracy of the data analysis.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1067/j.cpradiol.2022.07.009](https://doi.org/10.1067/j.cpradiol.2022.07.009).

References

- Rosman DA, Duszak R Jr., et al. Changing utilization of noninvasive diagnostic imaging over 2 decades: an examination family-focused analysis of medicare claims using the neiman imaging types of service categorization system. *AJR Am J Roentgenol* 2018;210:364–8.
- Nguyen TH, Milburn JM, et al. Medicare for all: considerations for neuroradiologists. *AJNR Am J Neuroradiol* 2020;41:772–6.
- Levin DC, Rao VM, et al. The sharp reductions in medicare payments for noninvasive diagnostic imaging in recent years: will they satisfy the federal policymakers? *J Am Coll Radiol* 2012;9:643–7.
- Lu MT, et al. Secondary interpretation of CT examinations: frequency and payment in the medicare fee-for-service population. *J Am Coll Radiol* 2016;13:1096–101.
- Iglehart JK. Health insurers and medical-imaging policy—a work in progress. *N Engl J Med* 2009;360:1030–7.
- Prabhakar AM, Misono AS, et al. Medicare utilization of CT angiography from 2001 through 2014: continued growth by radiologists. *J Vasc Interv Radiol* 2016;27:1554–60.
- Cox K, Duszak R Jr., et al. Reassessing medicare trends in diagnostic CT colonography after achieving CPT code category I status. *Abdom Radiol (NY)* 2016;41:1357–62.
- Moreno CC, Hemingway J, et al. Changing abdominal imaging utilization patterns: perspectives from medicare beneficiaries over two decades. *J Am Coll Radiol* 2016;13:894–903.
- Harvey L. Neiman health policy institute neiman imaging types of service. Available from: <http://www.neimanhpi.org/neiman-imaging-types-of-service-nitos/>. Accessed: 11/09/2020
- Harvey L. Neiman health policy institute medicare beneficiary enrollment tool. Available from: <https://neimanhpi.org/medicare-beneficiary-enrollment-tool>. Accessed: 11/09/2020
- Hong AS, Levin D, et al. Trends in diagnostic imaging utilization among medicare and commercially insured adults from 2003 through 2016. *Radiology* 2020;294:342–50.
- Malatt C, Zawaideh M, et al. Head computed tomography in the emergency department: a collection of easily missed findings that are life-threatening or life-changing. *J Emerg Med* 2014;47:646–59.
- Glass T, Ruddy RM, et al. Traumatic brain injuries and computed tomography use in pediatric sports participants. *Am J Emerg Med* 2015;33:1458–64.
- Zonfrillo MR, Kim KH, Arbogast KB. Emergency department visits and head computed tomography utilization for concussion patients from 2006 to 2011. *Acad Emerg Med* 2015;22:872–7.
- Levin DC, Rao VM, et al. The disproportionate effects of the deficit reduction act of 2005 on radiologists' private office MRI and CT practices compared with those of other physicians. *J Am Coll Radiol* 2009;6:620–5.
- MLN Matters number: SE0665 revised. 2006; Available from: <https://www.cms.gov/Outreach-and-Education/Medicare-Learning-Network-MLN/MLNMattersArticles/Downloads/SE0665.pdf>. Accessed: 11/09/2020
- American College of Radiology Summary of the 2010 Medicare physician fee schedule final rule Available from: <http://www.acr.org/Secondary/MainMenuCategories/NewsPublications/FeaturedCategories/CurrentACRNews/archive/2010MPFSFR.aspx>. Accessed: 11/09/2020

18. American College of Radiology MPPR policy applied to professional component in 2012 Available from: <http://www.acr.org/HomePageCategories/news/ACRNews-Center/MPPR-policy-applied-to-professional-component-in-2012.aspx>. Accessed: 11/09/2020
19. Meltzer CC. Summary of the affordable care act. *AJNR Am J Neuroradiol* 2011;32:1165–6.
20. Chokshi FH, Tu RK, et al. Myelography CPT coding updates: effects of 4 new codes and unintended consequences. *AJNR Am J Neuroradiol* 2016;37:997–9.
21. French RJ, Rosman DA, et al. Changes in current procedural terminology coding and its effect on specialty-level utilization of musculoskeletal ultrasound. *Curr Probl Diagn Radiol* 2020.
22. Shenolikar R, Bruno AS, et al. Sensitivity of medication use to formulary controls in medicare beneficiaries: a review of the literature. *Am Health Drug Benefits* 2011;4:465–74.
23. Wang KY, Hirsch JA, et al. Implications of the revisions and revaluation of office/outpatient evaluation and management codes for neuroradiology reimbursement. *AJNR Am J Neuroradiol* 2020;41:1160–4.