

Evolving Trends in the Use of Echocardiography

A Study of Medicare Beneficiaries

Alan S. Pearlman, MD, FACC,* Thomas Ryan, MD, FACC,† Michael H. Picard, MD, FACC,‡
Pamela S. Douglas, MD, MACC†

Seattle, Washington; Durham, North Carolina; and Boston, Massachusetts

- Objectives** We studied the use of echocardiography among Medicare beneficiaries between 1999 and 2004 to determine the rate of growth in these services and evaluate the drivers of growth.
- Background** Concerned about increasing health care costs, federal and private payers have highlighted growth in diagnostic imaging studies and begun to develop approaches to curb this growth.
- Methods** Medicare Part B Physician/Supplier Procedure Summary Master File and enrollment data from 1999 to 2004 were reviewed. Total Medicare carrier-paid spending for echocardiography services was determined from procedure volumes and allowed charges. The 5% standard analytic file of physician claims was used to evaluate geographic variations in use and to document the specialties of physicians who request and those who interpret echocardiograms.
- Results** Between 1999 and 2004, echocardiography services grew at a rate similar to that for all medical services subject to Medicare's sustainable growth rate (SGR) calculation. Increasing provision of echocardiograms in physicians' offices contributed to increased spending under the SGR. Accounting for this shift, actual annualized per capita growth in echocardiography was 7.7%. Variations in the prevalence of heart disease contributed to geographic variations in use. Although cardiologists were the most common providers of echocardiographic services, primary care physicians ordered the majority of these diagnostic procedures.
- Conclusions** Growth in the use of echocardiography is in keeping with the general growth in medical services. Nonetheless, physicians who order echocardiograms and those who provide them must work together to ensure that in the future these diagnostic services are used appropriately and not excessively. (J Am Coll Cardiol 2007;49: 2283-91) © 2007 by the American College of Cardiology Foundation

The growing use of diagnostic medical imaging procedures has attracted a good deal of attention. In its March 2005 report (1), the Medicare Payment Advisory Commission (MedPAC) noted that during the period 1999 to 2002 the average annual rate of growth of all services furnished to Medicare beneficiaries was 5.2% while imaging services grew by 10.1%/year. According to the MedPAC report, the average annual rate of growth for echocardiography was 11.8%. For certain techniques such as advanced magnetic resonance imaging, average annual growth rate was as high as 19.5%. Some experts have suggested that the bulk of growth in health spending is caused not by increasing numbers of Medicare beneficiaries, but rather by “medical

innovation” (1) and “technological change” (2). Concerned about the growth in Medicare spending in general and the rapid increase in use of diagnostic imaging services in particular, MedPAC has proposed that strategies to manage the use of imaging procedures be considered.

In the case of echocardiography (cardiovascular ultrasound), a number of factors could contribute to an increase in use. For example, growth in the Medicare population and a general aging of Medicare beneficiaries might lead to an increase in total use even if practice patterns remained unchanged. Alternatively, advances in technology or the replacement over time of older diagnostic approaches by more powerful noninvasive modalities, such as echocardiography, might result in an increased use. In addition, some new treatments (such as cardiac resynchronization and other therapies for advanced heart failure [HF]) require more precise quantitation of cardiac function and follow-up evaluation of treatment efficacy. A shift in Medicare fee for service care from the hospital setting to physician's offices would also tend to inflate the apparent numbers of services performed annually, because estimates of growth are based

From the *Division of Cardiology, Department of Medicine, University of Washington Medical Center, Seattle, Washington; †Division of Cardiovascular Medicine, Duke University Medical Center, Durham, North Carolina; and the ‡Division of Cardiology, Massachusetts General Hospital, Boston, Massachusetts. Dr. Douglas serves as a consultant to GE Healthcare. A grant from the American Society of Echocardiography supported some of the costs of data collection and analysis.

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Abbreviations and Acronyms

BETOS = Berenson-Eggers
Type Of Service

CMS = Centers for
Medicare and Medicaid
Services

HCPCS = Healthcare
Common Procedure Coding
System

HF = heart failure

RVU = relative value unit

SGR = sustainable growth
rate

on Medicare's Sustainable Growth Rate (SGR) calculation, which includes all physician services paid by Part B carriers but does not include the hospital outpatient costs that are paid by Medicare "fiscal intermediaries."

Echocardiography is a robust family of non-invasive diagnostic imaging tests for which published evidence documents utility in virtually every type of acquired and congenital heart disease and in the assessment of patients with a range of cardiovascular

symptoms or signs (3). To understand the rate of growth in echocardiography procedures, to compare this with other types of heart imaging services, and to investigate some of the potential drivers of increasing use, we studied trends in the use of echocardiography services by Medicare beneficiaries between 1999 and 2004. We hypothesized that: 1) the actual rate of growth in use and Medicare spending for echocardiography services has not exceeded growth of other diagnostic services but rather is consistent with growth in health services in general; 2) neither the number of echocardiography services/beneficiary nor the proportion of patients undergoing repeat studies has changed appreciably; 3) regional variations in use are not random and might reflect the prevalence of underlying cardiovascular disease; and 4) "self-referral" (4) is not the primary reason for growth in echocardiography services.

Methods

Medicare carrier-paid echocardiography services from 1999 to 2004 were reviewed using the national Centers for Medicare and Medicaid Services (CMS) Part B Physician/Supplier Procedure Summary Master File and enrollment data for each of those years. These files summarize all Medicare fee-for-service carrier-paid claims for each calendar year, by Healthcare Common Procedure Coding System (HCPCS) code, modifiers, carrier and locality, provider specialty, and type and place of service. The Part B Physician/Supplier Procedure Summary Master File does not include payments (made through Medicare "fiscal intermediaries") to hospital outpatient facilities or services provided in Medicare Advantage (managed care) plans. With the CMS Berenson-Eggers Type Of Service (BETOS) category for echocardiography and other heart imaging procedures, the volume of services provided to beneficiaries in Medicare fee-for-service plans was evaluated. Notably, stress echocardiography services were not analyzed in the present study, because stress echocardiography is considered (by CMS) as a "test" rather than an "imaging" procedure and therefore not included in the BETOS category for heart imaging procedures. On the

basis of HCPCS modifiers, claims were assigned to "professional component," "technical component," or "global" (professional component + technical component) categories. The quantity of services was determined in 2 ways. First, the number of echocardiography procedures was counted to determine how often Medicare was billed for these services. Second, the number of 2005 relative value units (RVUs) for each procedure was tallied, to determine the quantity of services provided on the basis of a constant RVU scale. Because RVU values can change from year to year, the change in spending was decomposed into parts by calculating the impact of changes in RVUs from 1999 values to 2005 values.

In addition, actual Medicare spending under this program was calculated from Medicare allowed charges, which include program payments made by Medicare itself and also beneficiary coinsurance/deductible amounts. The Medicare allowed charge represents the dollar figure that enters into the SGR calculation. Medicare carrier-paid claims for echocardiography and other diagnostic heart imaging procedures were tabulated both by numbers of services provided and by total Medicare allowed charges for those services. Cross-sectional differences in use were evaluated as a function of geography and patient demographics. To assess possible effects of disease prevalence on the use of echocardiography services, the prevalence of congestive HF (obtained from 2004 claims in the 5% sample standard analytic file) was matched with the rates of echocardiography use on a state-by-state basis. Because geographic variations in volumes of services provided to Medicare beneficiaries have been ascribed to variations in physician supply (5,6), the number of cardiologists obtained from the 2003 Area Resource File also was included in this analysis.

To determine whether increased use of echocardiography reflects provision of more services/person or is due to more persons being evaluated, the 5% sample standard analytic file of physician claims from 2001 to 2004 was used to evaluate the location, diagnoses, and demographics of echocardiography use. These files reflect all claims and enrollment data for roughly 1.8 million Medicare beneficiaries. To avoid "double counting," only professional component and global claims for echocardiographic imaging services were considered; "add on" services and technical-component-only claims were not included.

To evaluate trends in the ordering and provision of echocardiograms, uniform provider identification numbers were used to assess the self-reported specialties of both physicians requesting echocardiographic studies and physicians providing the diagnostic services.

Results

Growth in use of echocardiography. Figure 1 summarizes changes in numbers of services and Medicare enrollees, professional service RVUs, and Medicare allowed charges for all services subject to the SGR system for the years 1999



Figure 1 Trends in Imaging Services Subject to the Sustainable Growth Rate Limit During the 6-Year Study Period (1999 to 2004)

Upper left bar graph showing numbers of services during the study period. All imaging services are depicted in light blue bars and subdivided into “heart imaging” (red bars) and “non-heart imaging” services (imaging services not involving evaluation of the heart [yellow bars]). Heart imaging services are further subdivided into echocardiography services (dark blue bars) and “other heart imaging” (including nuclear, computed tomography, and magnetic resonance imaging of the heart but excluding echocardiography services [green bars]). The same format is used in the 2 lower panels. Upper right line graph demonstrating total number of Medicare enrollees during each year of the study period. Lower left bar graph showing the total number of professional service relative value units (RVUs) during the years of the study, expressed in constant 2005 RVU values and calculated by applying professional service RVUs (Current Procedural Terminology modifier –26) to every service except technical-component-only services; this excludes all technical components and costs of supplies such as imaging agents and isotopes. Lower right bar graph showing total Medicare allowed charges during the years of the study.

to 2004. Over this time period, the number of echocardiographic services rose by an average of 10.6%/year, a rate lower than that of other heart imaging services (14.2%/year) but higher than the rate of growth of non-heart imaging services (5.9%/year). The number of Medicare beneficiaries grew by an average of 2.3%/year between 1999 and 2004, contributing to the growth in echocardiography (and other medical services). Expressed in terms of professional service RVUs (which more closely reflect numbers of services than do total RVUs, because the latter are affected by shifts in site of service), the average annual rate of growth of echocardiography services was 9.9%, similar to the rate of growth of imaging services in general (9.5%). Total Medicare allowed charges for echocardiography grew by 10.9%/year, a rate similar to the average annualized rate of growth (11.2%) for

all services covered under the SGR but not as high as the rates of growth of all heart imaging (14.9%) and non-heart imaging (14.5%) services.

Growth in Medicare spending for echocardiography. Changes in payment and RVUs for the 4 most commonly performed procedures (which together account for 99% of all echocardiographic services provided) are summarized in Table 1. In 1999, echocardiography accounted for 57% of the Medicare dollars spent for cardiac imaging services; in 2004, this percentage fell to 48%. Medicare carrier-paid spending for echocardiography increased by 68% between 1999 and 2004; this is the net result of several factors. Increases in the conversion factor accounted for approximately 8% of the increase in Medicare payments for echocardiography services, whereas decreases in RVUs for

Table 1 Changes in Payment and RVUs, 1999 to 2004

HCPCS	Description	Change in Allowed Charges	Change in Payment/ Current-Year RVU (Conversion Factor)	Change in Value of RVU/Service	Increase in Constant 2005 RVUs
Total	Total echocardiography	68%	8%	-16%	84%
93307	Echo exam of heart (transthoracic)	55%	9%	-19%	75%
93325	Doppler color flow add-on	112%	7%	-3%	104%
93320	Spectral Doppler add-on	62%	8%	-18%	84%
93312	Echo transesophageal	68%	8%	-16%	84%

Total also includes the remaining codes in the Berenson-Eggers Type of Service category, accounting for 1% of charges. Source: Analysis of Medicare physician/supplier procedure summary master file, 1999 to 2004.

HCPCS = Healthcare Common Procedure Coding System; RVU = relative value unit.

the various echocardiography codes tended to reduce Medicare expenditures for all echocardiographic services by approximately 16%. If the decline in RVUs/echocardiographic service is accounted for by holding RVUs constant at 2005 levels, then total RVUs for echocardiography services grew by 84% between 1999 and 2004.

Because technical component costs for echocardiography services performed in the hospital outpatient department are paid through Medicare “fiscal intermediaries,” these costs are not counted in the SGR. If the same services were provided in a physician’s office, however, then the technical component costs would be paid by the Medicare carrier and counted in the SGR. Technical component costs are larger than physician work components for all echocardiography services, so that site of service shifts from hospital facilities to physician offices would tend to inflate Medicare carrier-paid spending for echocardiography out of proportion to the numbers of services provided. Table 2 demonstrates that between 1999 and 2004, base imaging services (primarily transthoracic and transesophageal echocardiography) grew by an average of 9%/year. “Add on” Doppler services grew at a slightly higher rate of 11%/year. Rates of growth were higher in the “non-facility” (physician office or independent diagnostic testing facility) setting than in either hospital inpatient or outpatient settings. Figure 2 demonstrates that between 1999 and 2004, the percentage of transthoracic echocardiography imaging and Doppler procedures done in the office setting increased, whereas the percentage done in hospital inpatient and outpatient settings declined. Because Medicare carriers pay for the technical component of

office-based echocardiography services but not for hospital-based services, this shift in reimbursement from professional component bills (for services performed in hospital settings) to total component bills (for services provided in physician’s offices) resulted in a net 12.5% increase in carrier-paid RVUs (Table 3).

Roughly one-half of the growth in the volume of echocardiography service RVUs can be attributed to the combined effects of shifting site of service and increasing numbers of Medicare fee-for-service beneficiaries. If site of service is held constant and growth in the Medicare population is considered, growth in echocardiography services between 1999 and 2004 increased by 45%, as demonstrated in Table 4. This indicates an average annual growth rate of 7.7%. **Growth in repeat studies.** Using the 5% standard analytic file of physician claims for 2001 to 2004 (the only data available to us for this beneficiary-level analysis), growth in echocardiography services was due almost entirely to increases in the numbers of persons served, with a small contribution from the higher use of spectral and color Doppler “add on” codes. Table 5 demonstrates that the mean number of echocardiograms/individual having an echocardiogram was relatively constant at 1.3/year. Of patients having at least 1 echocardiogram in a given year, 80% of them had only 1 scan/year, and this figure remained constant from 2001 to 2004. If analysis is restricted to patients undergoing evaluation in the office setting only, only 10% of subjects having an echocardiogram in a given year underwent a second echocardiography evaluation during that same calendar year. The percentages of patients

Table 2 Numbers of Echocardiography Services by Site and Type of Service, 1999 and 2004

Site of Service	1999 Services, Millions				2004 Services, Millions				Average Annual Change			
	Inpt	Outpt & ER	Office, IDTF	Total	Inpt	Outpt & ER	Office, IDTF	Total	Inpt	Outpt & ER	Office, IDTF	Total
All echo procedures	5.36	1.94	4.74	12.74	8.23	2.93	9.88	21.11	9%	9%	16%	11%
Base imaging services	1.98	0.70	1.62	4.55	2.88	0.99	3.26	7.15	8%	7%	15%	9%
“Add-on” services	3.37	1.23	3.12	8.17	5.33	1.93	6.62	13.92	10%	9%	16%	11%

Base imaging services include transthoracic and transesophageal echocardiography (echo) imaging services in both adults and children and a number of less commonly performed cardiac ultrasound services that are included in the Berenson-Eggers Type of Service category for heart imaging procedures. Current Procedural Terminology codes 93307 and 93312 made up 99% of the total base imaging services. “Add-on” services include spectral Doppler and Doppler color flow imaging services, which cannot be performed as “stand-alone” procedures but rather are done in conjunction with a base imaging service. Total numbers in all echo procedures cells might not match the sum of component numbers, owing to rounding as well as small omitted categories (unknown and undefined sites of service) and services not classifiable as either “base” or “add-on” codes. Source: Analysis of Medicare Physician/Supplier Procedure Summary Master File, 1999 to 2004.

ER = emergency room; IDTF = Independent Diagnostic Testing Facility; Inpt = hospital inpatient; Outpt = hospital outpatient.

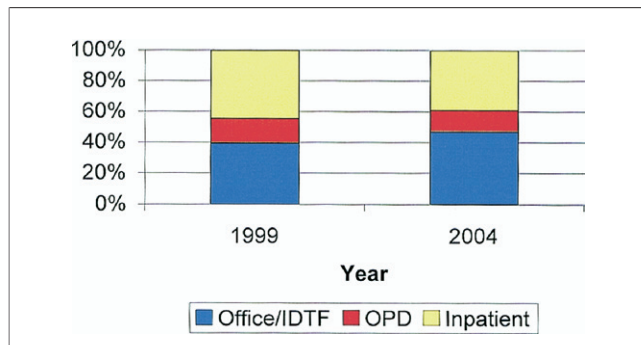


Figure 2 Use of Echocardiography Services (Both Imaging and “Add On” Doppler Services) by Site of Service

The frequencies with which these services were provided in various sites of service are shown for the years 1999 and 2004. IDTF = independent diagnostic testing facility; Inpatient = hospital inpatient; Office = physician’s office; OPD = hospital outpatient department.

having multiple scans/year were also constant over the time period investigated. Thus, the growth in total echocardiography volume cannot be explained by more frequent repetition of echocardiographic services in individual patients.

Rate of echocardiography use versus prevalence of heart disease. When analyzed on a state-by-state basis, rates of use of echocardiography services grew in every state but at different rates. Use rates varied widely, with more than a 3-fold difference from lowest (0.23 per capita in Wyoming, in 2004) to highest (0.75 per capita in Florida and New Jersey). The geographic variation in rates of echocardiography services seemed to be related to differences in the prevalence of cardiovascular disease. Figure 3 plots by state the number of echocardiographic services per capita against the prevalence of congestive HF. By least squares regression, more than one-half of the state-to-state variation in use is explained by differences in the prevalence of HF ($r^2 = 0.59$). When the number of cardiologists/1,000 Medicare beneficiaries was also considered and the rate of echocardiography use compared with both the supply of cardiologists and the prevalence of HF, the correlation with echocardiography use rates did not change appreciably ($r^2 = 0.60$). With a 2-step regression analysis, both the supply of

cardiologists and the prevalence of HF were statistically significant predictors of echocardiography use ($p < 0.001$). Although preliminary, this observation suggests that in this population multiple factors might influence echocardiography use.

Trends in the provision of echocardiography. The specialty distribution of physicians providing echocardiography services is summarized in Table 6. In 2004, cardiologists submitted claims for 75% of the Medicare allowed charges for echocardiography services, with internists making up the next most common specialty providing these services (15%). The specialty distribution was similar in 1999.

Table 7 summarizes the self-reported specialty of physicians requesting echocardiograms in Medicare beneficiaries in 2004. Notably, cardiologists ordered only 29% of the studies. Generalists and non-cardiologist specialists requested 71% of all echocardiograms, with primary care physicians (internists and general practitioners) requesting the majority of these studies (56%).

Discussion

This study of echocardiography use in Medicare beneficiaries demonstrates that the rate of growth in echocardiography services during the period 1999 to 2004 was comparable to the rate of growth of medical services in general and not disproportionately higher. After accounting for increasing numbers of Medicare beneficiaries, changes in the conversion factor, adjustments in Medicare RVUs, and shifts in service from hospitals to physician’s offices, the volume of echocardiography services rose by 45% over the study period, representing an annualized growth rate of 7.7%. In addition, neither the percentage of patients having repeat studies in the same year nor the number of repeated studies/person having an echocardiogram has increased. Large state-by-state variations in use rates are evident, but these seem related at least in part to variations in the prevalence of cardiovascular disease. Although cardiologists provide most echocardiography services, primary care physicians and non-cardiology specialists order the large majority of these services.

Table 3 Impact of Site-of-Service Shift, 1999 to 2004

HCPCS	Description	Total 2005 RVUs (Millions)			2005 RVU Values, per Service	
		Using 1999 Site Mix	Using 2004 Site Mix	Increase Due to Site Shift	Total Component	Professional Component Only
Total	Total echocardiography	36.1	40.6	12.5%		
93307	Echo exam of heart	18.3	20.5	12.2%	5.39	1.30
93325	Doppler color flow add-on	8.6	10.0	16.3%	3.22	0.11
93320	Spectral Doppler add-on	8.2	9.1	11.0%	2.37	0.54
93312	Echo transesophageal	0.6	0.6	-1.9%	7.14	3.07
Other	All other	0.3	0.3	1.1%		

Medicare carriers pay for both technical and professional components when services are provided in “non-facility” settings (physician offices and independent diagnostic testing facilities) but only for professional components when services are provided in hospital settings. Because the technical components are higher than the professional components for all echocardiography services, a shift from facility to non-facility service site leads to an increase in Medicare carrier spending. Source: Calculated from Medicare Physician/Supplier Procedure Summary Master File, 1999 to 2004.

Abbreviations as in Table 1.

Table 4 Summary of Growth in Volume and Spending, 1999 to 2004

Element		As a Percent	As a Multiplier
Components of spending change			
A	Volume growth (measured with 2005 RVUs)	84%	1.837
B	Change in payment rate (conversion factor)	8%	1.083
C	Change in value of RVUs, 1999 to 2004	-16%	0.844
D	Change in allowed charges (A × B × C)	68%	1.680
Components of volume growth			
A	Volume growth (measured with 2005 RVUs)	84%	1.837
E	Adjustment for site-of-service shift	-11%	0.889
F	Adjustment for growth in Medicare population	-11%	0.889
G	Per capita volume growth, holding site constant (A × E × F)	45%	1.452
H	G, expressed as an average annual growth rate	8%	1.077

Elements of growth are used to calculate volume growth as measured with constant 2005 RVUs. Figures in the "As a Percent" column are rounded to the nearest whole number; the "As a Multiplier" column indicates rates of change more precisely. Source: Analysis of Medicare Physician/Supplier Procedure Summary File and enrollment data, 1999 to 2004. RVU = relative value unit.

Growth in services and allowed charges. The methodology used in this study differs from some prior analyses. Other investigators (7-9) have examined use of diagnostic imaging from the standpoint of total numbers of tests. However, different tests have different costs. Thus, if a more expensive test were substituted for a less costly alternative, the true impact on Medicare spending would not be appreciated if only numbers of tests were considered. In addition, growth in the numbers of diagnostic services raises several important questions: "Are these services appropriate?", "What number of services would be correct?", and "How did these services affect clinical outcomes?" Answering these questions would require consideration of the clinical circumstances that prompted ordering of the tests, the other "downstream" services that might have been used or avoided appropriately, and how clinical outcomes might have been influenced by the diagnostic services. These questions cannot be answered from a study of an administrative database.

Because health care spending (rather than just numbers of services) has been the focus of considerable recent attention (1), we not only analyzed growth in numbers of echocardiographic services, but also examined total expenditure of

Medicare dollars. To accomplish this, allowed charges were calculated and corrected for changes in RVUs over time by using the 2005 RVUs as a constant factor. This approach allowed us to determine the magnitude of changes in Medicare spending for echocardiography services and to investigate the reasons for these changes. Although the results of this study do not tell whether the rate of growth in echocardiography services is too high, too low, or just right, they do indicate that this growth rate is similar to that of other services under the Medicare program and not disproportionately higher.

The growth in medical imaging procedures has received recent attention from regulators and lawmakers, but this issue is not new. Our data confirm that echocardiography use is growing but at a rate similar to other components of medical care. Noninvasive imaging, particularly echocardiography, plays a prominent role in the evidence-based evaluation and management of patients with a wide range of cardiovascular symptoms and diagnoses (3). Because an increasing proportion of beneficiaries carry such diagnoses as the population ages, it is not surprising that use of echocardiography, an important tool for proper diagnosis and management, is increasing. Figure 3, which demon-

Table 5 Estimated Count of Beneficiaries Using Echocardiography and Number of Scans/Beneficiary Using Echocardiography, 2001 to 2004

	2001	2002	2003	2004
Number of beneficiaries using echocardiography (persons served)	4,524,720	4,954,240	5,300,960	5,675,180
Mean scans/person served	1.33	1.32	1.32	1.30
Percent of persons served with				
1 scan	80%	80%	80%	80%
2 scans	14%	14%	14%	14%
3 scans	4%	4%	4%	4%
4 scans	1%	1%	1%	1%
5 or more scans	1%	1%	1%	1%
Total	100%	100%	100%	100%

Total persons served are based on 5% sample count × 20. Because spectral and color flow Doppler services cannot be performed independent of a base echocardiographic imaging service, Doppler "add-on" codes were omitted when calculating the number of beneficiaries receiving a scan. Note that this table counts persons served rather than scans performed, explaining why the "number of beneficiaries" listed here is less than the number of echo services in Tables 1 and 3, which list procedures rather than patients. In addition, this table extrapolates data from the 5% sample file, whereas Tables 1 and 3 summarize the complete procedure summary file. Source: Analysis of limited data set 5% sample physician/supplier standard analytic file, 2001 to 2004.

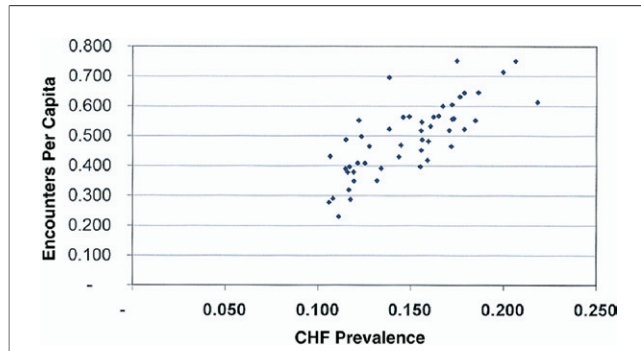


Figure 3 Scatter Graph of Per Capita Use of Echocardiography Imaging Services in 2004

Scatter graph of per capita use of echocardiography imaging services in 2004, by state (vertical axis), against the prevalence per capita of congestive heart failure (CHF) in each state (horizontal axis). Use data were taken from the Medicare Part B Physician/Supplier Procedure Summary Master File (see Methods section), total Medicare fee-for-service enrollment was taken from Medicare's state/county managed care market penetration report, and CHF prevalence was taken from the Centers for Medicare and Medicaid Services Hierarchical Coexistent Conditions risk adjustment model. Enrollment was adjusted to match carrier service areas.

strates increasing echocardiography use as the prevalence of HF increases, illustrates this point.

Geographic variations in echocardiography services. Geographic variations in the use of medical services have been recognized for many years (10,11). Studies of Medicare beneficiaries have suggested that these variations are largely due to variations in the supply of physicians (particularly specialists) and availability of services and that higher use rates do not correlate with improved quality of care or better access to care (5,6). Although a number of studies have evaluated total spending in patients with a variety of medical disorders, rates of use of cardiovascular diagnostic and therapeutic procedures have also been examined. Wennberg et al. (12) reported that variations in the rates of coronary angiography in northern New England were highly associated with the prevalence of cardiac catheterization laboratories and that revascularization rates correlated closely with rates of diagnostic angiography. In fact, such "supply sensitive care" was mentioned by MedPAC as one important source of unwarranted variation in the use of health care services (1).

Table 7 Specialty of Requesting Physicians on Echocardiography Claims, 2004

Specialty	Count of 5% Sample Claims Lines, 1000s	Fraction of Claims Lines
Total	1,068	100%
Internal medicine	382	36%
General practice	217	20%
Cardiology	312	29%
Pulmonary disease	23	2%
Nephrology	14	1%
Emergency medicine	14	1%
General surgery	13	1%
All others	92	9%

This table shows the count of lines in the 5% sample file and is not an estimate of total services provided in the entire Medicare population. A small fraction of claims were excluded, owing to blank, dummy, or otherwise unusable data for uniform provider identification numbers. Source: Analysis of Medicare 5% sample physician/supplier standard analytic file, 2004.

However, few studies have focused specifically on echocardiography. In a study of Medicare beneficiaries, Lucas et al. (13) did observe substantial variation in the rates of use of echocardiography during the year 1995. These investigators concluded that "the likelihood of Medicare beneficiaries having an echocardiogram is influenced by where they live" (13) but did not provide insights into the cause(s) of the variations they observed. Our study confirms, in a more contemporary Medicare population, wide regional variations in the rates of echocardiography use. Our preliminary results do not provide definitive proof as to the reason(s) for these variations. However, they do suggest the hypothesis that rates of use of diagnostic echocardiography might be related to the prevalence of heart disease. In our study, when the supply of cardiologists (who provide three-quarters of echocardiography services nationally) was considered in addition to disease prevalence, we found no improvement in the correlation with use rates. This observation suggests the possibility that higher rates of echocardiography use might not be due just to availability of services but also might be related to clinical factors such as the prevalence of documented or suspected heart disease. Further studies of regional variations in echocardiography use are clearly warranted, and we believe that these studies ought to consider clinical factors in addition to the supply of specialists and the availability of services.

Table 6 Specialty of Physicians Performing Echocardiography

Specialty	1999 Allowed Charges		2004 Allowed Charges		Increase, % 1999 to 2004
	\$ Millions	% of Total	\$ Millions	% of Total	
Total	\$914	100%	\$1,535	100%	68%
Cardiology	\$655	72%	\$1,155	75%	76%
Internal medicine	\$131	14%	\$223	15%	70%
Independent diagnostic testing facility	\$20	2%	\$51	3%	150%
General/family practice	\$25	3%	\$54	4%	117%
Diagnostic radiology	\$13	1%	\$13	1%	-5%
All other	\$69	8%	\$39	3%	-43%

Allowed charges are rounded to nearest million; "Increase" figures are calculated from allowed charges and rounded to nearest integer. Source: Analysis of Medicare Physician/Supplier Procedure Summary Master File, 1999 to 2004.

Provision of echocardiography services. Training in echocardiography is required in all cardiovascular disease fellowships, and our study confirms that specialists in cardiovascular medicine provide about 75% of Medicare allowed echocardiography services. Multidisciplinary, peer-reviewed guidelines have been developed describing the training and experience needed for competence in echocardiography (14) and, together with board examinations and physician certification for echocardiography, represent efforts by the cardiology community to assure the quality of echocardiography. These guidelines are not specialty-specific. Widely used, evidence-based guidelines for the clinical application of echocardiography procedures also have been published (3). Although some have suggested that diagnostic imaging services provided by non-radiologists are less often of high quality than imaging services provided by radiologists (15), no credible data support that hypothesis with regard to echocardiography.

Our study also demonstrates that although cardiologists provide the large majority of echocardiography services, primary care providers or non-cardiology specialists typically request these diagnostic procedures. Because echocardiography is useful in evaluating virtually every form of heart disease and in patients in all age groups with common symptoms and signs (including but not limited to breathlessness, abnormal heart beats, and heart murmurs) that suggest cardiovascular disease (3), it is not surprising that echocardiographic studies frequently are ordered by many different kinds of health care providers. Seventy-one percent of the echocardiography procedures provided to Medicare beneficiaries in our study sample were requested by non-cardiologists (over one-half of all studies were ordered by primary care physicians), whereas only 29% were ordered by cardiologists. These data emphasize that if appropriate use of echocardiography is to be achieved, one critical component of such an effort will be education not only of cardiologists but also of a wide array of physicians and mid-level providers as to the clinical situations in which it is and is not appropriate to order echocardiographic studies.

Study limitations. Some gaps in the data source for this study might have caused overestimation or underestimation of relative use and costs of noninvasive cardiac imaging. For example, because it was not possible to allocate Medicare expenditures for radioisotopes to specific nuclear medicine procedures, in our dataset the total dollars spent on nuclear cardiology procedures did not include the radioisotope costs. In addition, billing codes specific to cardiac computed tomography services did not exist during the period of our study. Thus, the data summarized graphically in Figure 1 might tend to overestimate echocardiography's share of allowed charges for heart imaging services. Our state-by-state analysis of echocardiography use tabulated services by the state where the service was performed, but the site of primary residence defined the state population. Although probably not a major source of error, the lower use in cold weather states and higher use in southern states might in

part reflect seasonal movement of retirees from colder to warmer locations. In addition, in our preliminary analysis, only the prevalence of HF was considered as a surrogate for the prevalence of heart disease. Although echocardiography is of well-documented value in the assessment of HF, it is also valuable in a wide range of other cardiac disorders, which we were not able to include in this initial evaluation. Despite these limitations, our data establish reasonable estimates of the relative use and cost of echocardiography services in the Medicare population.

Conclusions

We share the concern of policy-makers that continuing growth in Medicare expenditures at rates exceeding that of inflation is not sustainable in the long term. However, because the actual 7.7% average annual rate of growth of echocardiography services is not out of line with the general rate of growth in health services, efforts to regulate use of echocardiography will not solve the challenge of continuing growth of Medicare services at a rate that outstrips inflation. We believe that diagnostic studies must be performed properly and for accepted indications to provide information that is most useful for patient care. We agree that efforts to develop appropriateness criteria (16-18) ought to assist requesting physicians—particularly those who do not have special training in evaluating and managing patients with complex heart disease—in using diagnostic imaging, including echocardiography, wisely and only when medically appropriate. We encourage professional societies that are actively involved in echocardiography teaching, research, and advancement of patient care to take an active role in assuring that echocardiography services are provided by well trained, experienced cardiac sonographers and physicians and that sites of service comply with accreditation programs including continuing education and quality improvement processes. In addition, professionals who provide high-quality echocardiography services must take an active role in working with health care providers who order echocardiograms to be sure that the right studies are done at the right time for the right patients and that studies are performed only if the results will impact the patient's treatment.

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Reprint requests and correspondence: Dr. Alan S. Pearlman, Division of Cardiology, Box 356422, University of Washington School of Medicine, 1959 NE Pacific Street, Seattle, Washington 98195. E-mail: apearlmn@u.washington.edu.

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