Published in final edited form as:

Am Heart J. 2010 March ; 159(3): 477–483. doi:10.1016/j.ahj.2009.12.015.

Trends in echocardiography utilization in the Veterans Administration Healthcare System

Kingston Okrah, MD^{a,b}, Mary Vaughan-Sarrazin, PhD^{b,c}, and Peter Cram, MD, MBA^{b,c}

^aDivision of Cardiovascular Medicine, Department of Internal Medicine, University of Iowa Carver College of Medicine, Iowa City, IA

^bCenter for Research in the Implementation of Innovative Strategies for Practice (CRIISP), Iowa City Veterans Administration Medical Center, Iowa City, IA

^cDivision of General Internal Medicine, Department of Internal Medicine, University of Iowa Carver College of Medicine, Iowa City, IA.

Abstract

Background—There is growing concern over the impact of accelerating use of diagnostic imaging services on health care spending. Echocardiography is an important cardiovascular imaging procedure, but little is known about trends in its use or utilization. We examine trends in the utilization of echocardiography in a national health care system.

Methods—We used administrative data from the Veterans Healthcare Administration (VA) from 2000 to 2007 to identify patients receiving regular medical care (VA users) or echocardiograms at the VA. We then examined the number of echocardiograms performed each year within the VA and echocardiogram utilization (rates per 1,000 VA users). We examined changes in echocardiogram use and utilization over time and potential overuse of echocardiography.

Results—The number of echocardiograms increased from 92,269 in 2000 to 195,767 in 2007 (a 112.2% increase). Alternatively, echocardiogram utilization remained relatively stable, increasing from 68.8 per 1,000 VA users in 2000 to 71.5 per 1,000 VA users in 2007 because the number of VA users increased by 104.2% over the study period. The mean number of scans per year in echocardiogram recipients remained constant at 1.1/y, and the proportion of recipients receiving multiple scans remained constant at <10%.

Conclusions—Use of echocardiography in the VA increased dramatically between 2000 and 2007, but utilization rates increased only modestly. Our results suggest that, within the VA, growth in the use of echocardiography resulted from an increase in the number of patients receiving care from the VA on regular basis rather than the performance of a greater number of echocardiograms on a fixed patient population.

Since its introduction into clinical practice in the 1960s, echocardiography has become a mainstay for assessing the structure and function of the heart, with capabilities of studying the myocardium, pericardium, and valvular structures, as well as evaluating regional wall

motion at rest and during pharmacologic stress.¹ Echocardiography is noninvasive, can be performed at the bedside, and is well suited for use in serial studies. For example, in the assessment of heart failure, echocardiography is a reliable, reproducible, and safe technique with many important features, such as Doppler, strain rate imaging, and cardiac motion analysis.² As such, it has become an invaluable tool in the diagnosis, guidance of therapy, and assessment of prognosis for several cardiac diseases including heart failure, ischemic heart disease, and valvular heart disease.

The use of echocardiography in the assessment of specific cardiovascular disorders is supported by recent guidelines.^{3,4} Not only is echocardiography useful to physicians and patients, but also echocardiography is relatively well reimbursed by third-party payers. For example, Medicare reimbursement for echocardiography ranges between \$110 and \$570 depending on the details of the study and the setting where the procedure is performed.⁵

The noninvasive nature of echocardiography combined with the substantial reimbursement has led to growing concern about potential overuse of this important technology. For example, the Medicare Payment Advisory Committee has cited echocardiography and other diagnostic imaging tests as important drivers of growth in health care spending.⁶ Despite both the clinical and economic importance of echocardiography, there have been few studies examining recent trends in echocardiography use, particularly from the perspective of an integrated health care system.^{7–9}

Our broad objective was to examine trends in both the use and utilization of echocardiography in a large integrated health care delivery system operating under a fixed global budget. More specifically, we used inpatient and outpatient administrative data from the Veterans Healthcare Administration (VA) to examine the characteristics of veterans receiving echocardiography and to examine evidence of potential overuse of echocardiography.

Methods

Data sources

We used VA Patient Treatment Files and Outpatient Care Files to identify all echocardiograms performed between fiscal year 2000 and 2007. The Patient Treatment File contains discharge abstract data for all patients hospitalized in VA medical centers. Key data elements include patient demographics, admission dates, primary and secondary diagnoses, and procedures performed during hospitalization (eg, echocardiography) as defined by *International Classification of Diseases Ninth Revision, Clinical Modification (ICD-9-CM)* codes. The Outpatient Care File contains administrative data on all outpatient encounters at VA clinics. Data elements include dates of visits, type of clinic (eg, primary care, mental health), diagnoses defined by *ICD-9-CM* codes, and procedures performed at each encounter defined by Current Procedural Terminology codes. All encounters include patient unique identifiers that allow merging of information across the databases.

Patient population

Because we were interested in both annual echocardiography use (ie, total numbers of studies performed) and utilization (ie, number of echocardiograms performed per 1,000 eligible patients), it was necessary for us to identify both the number of echocardiograms performed each year and the number of patients receiving regular medical care from the VA (aka “VA users”), as such individuals would represent the population that was eligible to receive an echocardiogram during that year.

For each fiscal year, we identified all echocardiograms performed in the inpatient and outpatient settings: echocardiograms performed in the inpatient setting were identified using *ICD-9-CM* code 88.72; and echocardiograms performed in the outpatient setting were identified using Current Procedural Terminology codes 93307 (transthoracic echocardiogram complete without Doppler and color flow), 93320 (Doppler add-on), 93325 (color flow add-on), and 93308 (transthoracic echocardiogram follow-up or limited study). We did not include stress and transesophageal echocardiography because of the specialized indications for these procedures. We also examined the primary diagnosis associated with each echocardiogram that was performed using *ICD-9-CM* codes to identify the 10 most common indications for echocardiography during the study period.

We identified all potential candidates for echocardiography in each year (VA users). *VA users* were defined as patients receiving care in the VA during a given fiscal year with 2 or more primary care clinic visits during the year. Patients with fewer than 2 primary care clinic visits in a particular fiscal year were not considered VA users because such patients are unlikely to receive consistent medical care from VA, are likely to have other sources for medical care outside the VA, and thus would have a high probability of receiving an echocardiography from a private sector source if one was required. For example, prior analyses have demonstrated that most patients with infrequent VA use seek care from the VA primarily for pharmacy services¹⁰ and receive the majority of their ongoing medical care from the private sector.¹¹ Inclusion of this population could erroneously inflate the denominator in our study and consequently artificially reduce estimates of echocardiography utilization rates.

Data analysis

We first compared the demographic characteristics and comorbid conditions of veterans who received one or more echocardiogram between 2000 and 2007 to the characteristics of veterans who did not receive any echocardiogram using the Pearson χ^2 test of independence for categorical variables and the Student *t* test for continuous variables. We identified the number of comorbid conditions for each patient and compared the mean number of comorbid conditions for veterans who received echocardiograms to that of veterans who did not receive an echocardiogram using the Student *t* test. Second, we examined whether the characteristics of echocardiogram recipients had changed over time by comparing the demographics and comorbid conditions of echocardiogram recipients in 2000 to recipients in 2007 using similar statistical methods.

Third, we examined trends in both echocardiogram use (absolute number of echocardiograms) and utilization (echocardiograms per 1,000 eligible patients per year). Changes in use and utilization rates over adjacent years were evaluated using the Mantel-Haenszel χ^2 test for trends.

Fourth, we assessed whether echocardiography utilization had changed over time in both unadjusted and adjusted analyses using multivariable logistic regression models. Models included one observation for each eligible VA patient in each year, and the dependent variable was set to 1 if the patient received an echocardiogram during the year and 0 if otherwise. Risk-adjusted models controlled for patient demographics and preexisting comorbid conditions, allowing us to examine changes in echocardiogram use after controlling for patient factors (eg, age) that we expected to influence the use of echocardiography. Preexisting comorbid conditions were defined based on algorithms described by Quan et al¹² and Elixhauser et al¹³ and were identified based on diagnoses present on all VA encounters within the 12 months preceding the date of receipt of an echocardiogram. Specific conditions included congestive heart failure (CHF), cardiac arrhythmias, valvular heart disease, acute myocardial infarction (AMI), cerebrovascular disease or stroke, chronic obstructive pulmonary disease (COPD), diabetes, and hypertension. Models also included fixed effects for VA hospital networks (ie, Veterans Integrated Service Network) to account for regional variations in the use of echocardiography. To examine potential regional variation in echocardiography utilization across the VA, we estimated echocardiography utilization rates for each of the 22 and 21 individual Veteran Integrated Service Networks (VISNs) for 2000 and 2007, respectively, to characterize the range of geographic variability in echocardiography utilization.

Fifth, we investigated potential overuse of echocardiography by examining the mean number of echocardiograms received per echocardiogram recipient per year and the proportion of echocardiogram recipients receiving multiple echocardiograms for each year of the study period.

Finally, we performed sensitivity analysis in which we used alternative definitions for identifying VA users. In particular, we repeated our analyses described above while defining VA users as patients with 1 primary care visit per year, as well as those with no primary care visit per year.

The authors had full access to data and take full responsibility for its integrity. All authors have read and agree to the manuscript as written. No extramural funding was used to support this work. All analyses were conducted using SAS statistical software version 9.1 (SAS Institute, Cary, NC). The authors are solely responsible for the design and conduct of this study, all study analysis, the drafting and editing of the paper, and its final contents. The study was approved by both the University of Iowa Institutional Review Board and the Research and Development Committee at the Iowa City VA Medical Center.

Results

Patient characteristics

Between 2000 and 2007, a total of 1,159,725 echocardiograms were performed in the VA, with the annual number of echocardiograms ranging from 92,269 in 2000 to 195,767 in 2007 (Figure 1). During the same period, the number of patients receiving care increased from 1,341,071 in 2000 to 2,739,215 during 2007 (Figure 1).

Compared with VA users who did not receive echocardiograms, echocardiogram recipients were significantly older and more likely to be of white or black race (Table I). Not surprisingly, echocardiogram recipients were also significantly more likely to have many comorbid conditions that might result in the need for an echocardiogram including CHF, valvular heart disease, stroke, AMI, COPD, and cardiac arrhythmias (with a mean number of comorbidities of 4.9) (Table I). In our comparison of patients who received echocardiograms in 2000 to recipients in 2007 (Table II), we found that patient demographics were generally similar over time but that the prevalence of most comorbid conditions was higher in 2007 as compared with 2000 ($P < .0001$). Table III shows the 10 most common diagnosis associated with receipt of an echocardiogram during the study period. We found that the most common diagnostic codes listed as indications for echocardiography were chronic ischemic heart disease (ICD-9 code 414, 11.1% of all echocardiographs), evaluation of chest pain or dyspnea (ICD-9 code 786, 8.8%), and screening for ischemic heart disease (ICD-9 code V81, 8.2%), with the 10 most common codes responsible for 67.8% of all echocardiograms performed.

Trends in the use and utilization of echocardiography

The total number of echocardiograms performed annually increased by 112.2% over the study period from 92,269 in 2000 to 195,767 in 2007 (Figure 1). The number of VA users during this period increased by 104.2% from 1,341,071 in 2000 to 2,739,215 in 2007. Between fiscal years 2000 and 2004, there was a significant ($P < .0001$) decline in utilization of echocardiography from 68.8 echocardiograms per 1,000 VA users per year in 2000 to 63.3 echocardiograms per 1,000 in 2004 (Figure 2), followed by a subsequent increase in utilization to 71.5 per 1,000 in 2007. Looking at the data from a slightly different perspective, the percentage of VA users who received at least one echocardiogram during a single year declined from 6.2% of all VA users in fiscal year 2000 to 5.8% in 2004 before subsequently increasing to 6.4% in fiscal year 2007 (Table IV). In unadjusted regression analyses, we found that the odds of a VA user receiving an echocardiogram was lower during years 2001 through 2006 compared with 2000 (the referent) but was higher during 2007. In additional regression models that adjusted for changes in patient demographics and comorbidities as well as clustering of patients within hospital networks, the odds of receiving an echocardiogram appeared relatively stable throughout the study period (Table IV).

We found significant variability in echocardiography utilization across VISNs (Table V). For example, in 2000, utilization rates ranged from 48.7 to 84.4 per 1,000; and in 2007, rates ranged from 51.3 to 90.3 per 1,000 VA users.

Trends in repeated studies

Table VI demonstrates that the mean number of echocardiograms per echocardiogram recipient remained relatively constant at 1.1 echocardiograms per recipient per year throughout the study period. Among VA users who received at least one echocardiogram during a given year, 91.3% received one echocardiogram, 7.4% received 2 echocardiograms, and 1.3% received 3 or more echocardiograms during a single year. Overall, the proportion of VA users receiving multiple echocardiograms per year increased gradually over time ($P < .0001$).

In sensitivity analyses using a more liberal definition to identify VA users (ie, all patients with one or more VA visit), we found, as expected, that echocardiography utilization rates were lower for each year; but we found that the overall trend in echocardiography utilization was generally similar.

Discussion

In an analysis of VA administrative data, we found that use of echocardiography doubled between 2000 and 2007. Interestingly, and in contrast to our expectation, echocardiography utilization remained relatively constant over our study period. Alternatively, we did find evidence that, since 2004, echocardiogram utilization may be accelerating and an increasing proportion of patients may be receiving multiple studies.

A number of our study findings merit further discussion. First, it is important to delve deeper into the reason why echocardiogram use increased whereas utilization remained relatively constant. Despite a 112% increase in the absolute number of echocardiograms performed in the VA between 2000 and 2007, we found that utilization per 1,000 VA users grew by only 3.9% over the study period; utilization remained stable largely because of the 104% increase in patients receiving care at the VA during the study period. The dramatic rise in VA users over the study period appears to have been driven by a number of legislative changes that expanded the proportion of military veterans eligible for VA medical care including passage of the Veterans' Health Care Eligibility Reform Act (PL 104–262) in 1996 and, subsequently, between 1997 and 2003, an administrative decision by the VA to preemptively enroll all eligible veterans in the VA.¹⁴ Thus, we suspect that a dramatic increase in VA users but a relatively slower increase in echocardiography capacity resulted in the transient drop in echocardiogram utilization that we observed between 2000 and 2004. This potential mechanism is supported by reports of problems with access to ambulatory care services within the VA as a result of the legislative changes reported above.¹⁵

Second, it is important to consider our results in light of changes in clinical practice guidelines. In 2003, the American College of Cardiology, the American Heart Association, and the American Society of Echocardiography released an update of guidelines on the clinical application of echocardiography.³ At the same time, in 2003, the VA adopted Joint Commission for Accreditation of Healthcare Organizations guidelines recommending ejection fraction assessment for CHF and AMI patients.⁴

It is likely that these guidelines impacted both echocardiogram use and utilization, although it is difficult to independently examine the impact of these changes given the simultaneous changes in VA eligibility criteria described above.

Third, it is important to acknowledge the different financial incentives that exist for echocardiograms performed in the VA as compared with the private sector. Physicians who provide care in the VA health care system are salaried. Thus, the effect of financial incentive to provide or deny care to patients might differ from the fee-for-service system that dominates the private sector.¹⁶ A number of studies have reported varying trends in utilization of several diagnostic procedures depending on the prevailing payment systems.^{17,18} We believe that the relatively constant odds of receiving an echocardiogram across our 8-year study period likely reflect an array of factors including VA echocardiography capacity, changes in clinical guidelines, and the VA financial structure that does not reward physicians for performing excess procedures.

Fourth, it is important to view our results in the context of prior studies assessing echocardiogram use. Our study found a more modest growth in echocardiography utilization rates (3.9% growth over 8 years) compared with studies examining utilization of echocardiography in the private sector.^{7,8,19,20} In a population-based study examining trends in the utilization of echocardiography between 1975 and 1987 among residents of Olmsted County in Minnesota, Ballard et al¹⁹ noted a 600% increase in utilization over a 12-year period. Another study examining the use of echocardiography among Medicare beneficiaries reported a 7.7% annual growth in the volume of echocardiography services between 1999 and 2004 after accounting for growth in the Medicare population.⁷ In their study evaluating trends in diagnostic imaging in a large health plan in Washington State, Smith-Bindman et al²¹ noted a 10% annual growth in echocardiography utilization. In contrast, the odds of a VA user receiving an echocardiogram remained relatively constant during our study period. The mean number of echocardiograms per recipient was lower (1.1/y) and the proportion of recipients receiving multiple scans was also lower (<10%) compared with 1.3/y and >20%, respectively, reported in the study by Pearlman et al.⁷ This raises an important question of whether echocardiogram is being overused in the private sector or underused in the VA. Future work should consider use of medical record review to better characterize the indications for echocardiography and how the indications may be changing over time as well as an estimation of the “right” number of echocardiograms in a particular clinical population.

A number of additional findings merit brief discussion. It is interesting to consider whether the growth in echocardiography utilization is greater (or smaller) than growth in the utilization of other procedures. Although Smith-Bindman et al found a 14% annual increase in computed tomography utilization, 26% annual increase in magnetic resonance imaging utilization, 5% annual increase in ultrasound utilization, and no significant change in utilization of nuclear medicine, we are unaware of studies broadly assessing trends in imaging utilization in the VA. It is also important to mention the geographic variability in echocardiography utilization in the VA system that we observed. For both 2000 and 2007, we observed that certain VISNs had echocardiography utilization rates that were almost double the rates in other VISNs despite ostensibly serving similar patient populations and

operating under the same administrative structure. Our results mirror the geographic variability in echocardiography and other imaging utilization that has been observed among Medicare beneficiaries^{22,23} and also in overall utilization of hospital services in the VA system.²⁴ The geographic variation that we observed is nevertheless somewhat striking given that the VA lacks the financial incentives to perform more (or less) procedures and that VA medical centers are governed by a single administrative structure—the Veterans Health Administration.²⁵

Study limitations

Our study has a number of limitations that warrant mention. First, our reliance on administrative data may have limited our ability to identify echocardiograms that were performed but not coded. Likewise, our reliance on administrative data limits our ability to completely assess the indications and/or appropriateness of procedures, although this is clearly an area for future study. Furthermore, we are unable to identify the “right” number of echocardiographs for our clinical population. Second, the study is limited by incomplete information about echocardiograms that VA users may receive in the private sector, although we focused our study on patients receiving regular care from the VA (ie, at least 2 primary care visits per year) in an effort to minimize this potential source of bias. In addition, we repeated our analysis using alternative definitions for VA user including patients with one primary care visit per year or no primary care visit per year. Third, we relied solely on VA administrative data. Thus, generalizing findings from the VA to the private sector must be done with caution. That said, the VA is the largest integrated health care delivery system within the United States and thus offers valuable insight into trends in echocardiography use that may not be available from other data sources. In addition, it provides a perspective on utilization of echocardiography outside of the fee-for-service environment that dominates the US health care system. Given the current concerns regarding growth in imaging procedures, such knowledge will help guide decisions as we attempt to grapple with the unrelenting growth in health care spending.

Conclusions

We found that, among VA users, the use of echocardiography doubled between 2000 and 2007 but that echocardiogram utilization remained relatively constant, providing a measure of reassurance for those concerned about rapid growth in the use of imaging studies. Alternatively, we did find evidence that, since 2004, echocardiogram utilization has been accelerating and repeated imaging of patients has been on the rise. There is a wide range of geographic variability in echocardiography utilization in the VA. In summary, we found dramatic growth in echocardiography use over an 8-year period, but little evidence of an increase in echocardiography utilization.

Acknowledgments

Disclosures

Funding sources: Dr Okrah receives fellowship stipend and tuition support from the Cardiovascular Interdisciplinary Research Training Grant, Iowa Cardiovascular Center, University of Iowa Carver College of Medicine. Dr Cram has an appointment in the Center for Research in the Implementation of Innovative Strategies in

Practice (CRIISP) at the Iowa City VA Medical Center, which is funded through the Department of Veterans Affairs, Veterans Health Administration, Health Services Research and Development Service. Dr Cram is supported by a K23 career development award (RR01997201) from the NCRR at the NIH and the Robert Wood Johnson Physician Faculty Scholars Program.

References

1. Krishnamoorthy VK, Sengupta PP, Gentile F, et al. History of echocardiography and its future applications in medicine. *Crit Care Med*. 2007; 35:S309–S313. [PubMed: 17667454]
2. Troughton RW, Prior DL, Frampton CM, et al. Usefulness of tissue doppler and color M-mode indexes of left ventricular diastolic function in predicting outcomes in systolic left ventricular heart failure (from the ADEPT study). *Am J Cardiol*. 2005; 96:257–262. [PubMed: 16018853]
3. Cheitlin MD, Armstrong WF, Aurigemma GP, et al. ACC/AHA/ASE 2003 guideline update for the clinical application of echocardiography: summary article. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines for the Clinical Application of Echocardiography). *J Am Soc Echocardiogr*. 2003; 16:1091–1110. [PubMed: 14566308]
4. Joint Commission on Accreditation of Healthcare Organizations. Performance measures. Available at: http://www.jcaho.org/pms/core+measures/cr_hos_cm.htm.
5. Federal Register. 2008 Nov 19.73(224)
6. MedPAC. Medicare payment policy. Washington (DC): MedPAC; 2005. Medicare Payment Advisory Commission. Report to the Congress.
7. Pearlman AS, Ryan T, Picard MH, et al. Evolving trends in the use of echocardiography: a study of Medicare beneficiaries. *J Am Coll Cardiol*. 2007; 49:2283–3229. [PubMed: 17560294]
8. Pearte CA, Myerson M, Coresh J, et al. Atherosclerosis Risk In Communities Study. Variation and temporal trends in the use of diagnostic testing during hospitalization for acute myocardial infarction by age, gender, race, and geography (the Atherosclerosis Risk In Communities Study). *Am J Cardiol*. 2008; 101:1219–1225. [PubMed: 18435947]
9. Levin DC, Rao VM, Parker L, et al. Recent trends in utilization of cardiovascular imaging: how important are they for radiology? *J Am Coll Radiol*. 2005; 2:736–739. [PubMed: 17411920]
10. Zhu, SC.; Gardner, JA.; Hendricks, A. Heath Care financing and economics data brief #2004–10. Boston: VA Boston Health Care System Research and Development; 2004. How many enrollees come to VA just for pharmacy?.
11. Wright SM, Petersen LA, Lamkin RP, et al. Increasing use of Medicare services by veterans with acute myocardial infarction. *Med Care*. 1999; 37:529–537. [PubMed: 10386565]
12. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. *Med Care*. 2005; 43:1130–1139. [PubMed: 16224307]
13. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. *Med Care*. 1998; 36:8–27. [PubMed: 9431328]
14. The House Committee on Veterans' Affairs. Assessing the impact of public law 104–262, “the Veterans' Health Care Eligibility Reform Act of 1996”. Available at: veterans.house.gov/democratic/budget/impact.htm
15. Schall MW, Duffy T, Krishnamurthy A, et al. Improving patient access to the Veterans Health Administration's primary care and specialty clinics. *Jt Comm J Qual Saf*. 2004; 30:415–423. [PubMed: 15357131]
16. Oddone EZ, Petersen LA, Weinberger M, et al. Contribution of the Veterans Health Administration in understanding racial disparities in access and utilization of health care: a spirit of inquiry. *Med Care*. 2002; 40:13–113. [PubMed: 11789629]
17. Burkhardt JH, Sunshine JH. Utilization of radiologic services in different payment systems and patient populations. *Radiology*. 1996; 200:201–207. [PubMed: 8657910]
18. Mitchell JM. Utilization trends for advanced imaging procedures: evidence from individuals with private insurance coverage in California. *Med Care*. 2008; 46:460–466. [PubMed: 18438193]

19. Ballard DJ, Khandheria BK, Tajik AJ, et al. Population-based study of echocardiography. Time trends in utilization and diagnostic profile of an evolving technology, 1975–1987. *Int J Technol Assess Health Care*. 1989; 5:249–261. [PubMed: 10292970]
20. Chiriboga DE, Yarzebski J, Goldberg RJ, et al. A community-wide perspective of gender differences and treatment trends in the use of diagnostic and revascularization procedures for acute myocardial infarction. *Am J Cardiol*. 1993; 71:268–273. [PubMed: 8427166]
21. Smith-Bindman R, Miglioretti DL, Larson EB. Rising use of diagnostic medical imaging in a large integrated health system. *Health Aff (Millwood)*. 2008; 27:1491–1502. [PubMed: 18997204]
22. Lucas FL, Wennberg DE, Malenka DJ. Variation in the use of echocardiography. *Eff Clin Pract*. 1999; 2:71–75. [PubMed: 10538479]
23. Bhargavan M, Sunshine JH. Utilization of radiology services in the United States: levels and trends in modalities, regions, and populations. *Radiology*. 2005; 234:824–832. [PubMed: 15681686]
24. Ashton CM, Petersen NJ, Soucek J, et al. Geographic variations in utilization rates in Veterans Affairs hospitals and clinics. *N Engl J Med*. 1999; 340:32–39. [PubMed: 9878643]
25. Fisher ES, Wennberg DE, Stukel TA, et al. The implications of regional variations in Medicare spending. Part 1: the content, quality, and accessibility of care. *Ann Intern Med*. 2003; 138:273–287. [PubMed: 12585825]

Figure 1.

Figure 2.
Trends in echocardiography utilization rates in veterans using the VA Healthcare System between FY 2000 and 2007.

Table I

Characteristics of VA users who did and did not receive echocardiograms during the study period (FY 2000–2007)

Characteristics	Echocardiogram (n = 1049025)	No Echocardiogram (n = 16359468)	P
Age, mean $\pm$ SD, y	67.5 $\pm$ 11.6	65.1 $\pm$ 13.1	*
Male, %	96.0	94.7	*
Race [†] , %			
White	65.4	56.5	*
Black	13.6	11.1	*
Hispanic	4.3	4.4	
Other nonwhite	1.2	1.2	
Preexisting comorbid conditions, %			
CHF	16.4	6.6	*
Arrhythmia	19.7	10.9	*
Valvular disease	9.7	2.9	*
Stroke	10.9	7.1	*
MI	5.3	2.6	*
COPD	25.1	18.3	*
Diabetes	35.8	29.3	*
Hypertension	74.1	66.1	*
No. of comorbidities, mean	4.9	2.7	*

* $P < .0001$.

[†] Race does not add up to 100% because of missing race data.

Table II

Characteristics of veterans receiving echocardiograms in FY 2000 compared with FY 2007

FY			
Characteristics	2000 (n = 83597)	2007 (n = 175661)	P
Age, mean $\pm$ SD, y	67.7 $\pm$ 11.2	67.3 $\pm$ 11.7	
Male, %	96.3	95.6	
Race [†] , %			
White	68.3	67.0	
Black	13.6	14.7	
Hispanic	3.8	4.7	
Other nonwhite	0.6	1.5	
Preexisting comorbid conditions, %			
CHF	8.6	16.9	*
Arrhythmia	12.8	21.1	*
Valvular disease	3.6	10.6	*
Stroke	7.9	11.0	*
MI	2.8	5.0	*
COPD	19.4	25.1	*
Diabetes	29.2	38.1	*
Hypertension	65.6	76.4	*
No. of comorbidities, mean	4.9	5.1	

* $P < 0.0001$.[†] Race does not add up to 100% because of missing race data.

Table III

Ten most common indications for echocardiography, 2000–2007

Indication	Frequency (%)
Chronic ischemic heart disease	11.06
Evaluation of chest pain	8.81
Screening for ischemic heart disease	8.23
Endocarditis	8.22
Heart failure	7.32
Abnormal heart murmurs	5.73
Myocarditis	5.68
Cardiac arrhythmias	5.24
Hypertension	4.78
Observation for suspected cardiac disease	2.78

Table IV

Odds ratio (95% confidence interval [CI]) of a VA user receiving an echocardiogram in the VA over time

Veterans receiving echocardiograms						
Fiscal year	n	% of VA users	Crude OR (95% CI)	P	Adjusted OR (95% CI)	P
2000	83597	6.23	1.0		1.0	
2001	99511	6.12	0.98 (0.97–0.99)	<.0001	0.99 (0.98–1.00)	.0006
2002	113777	6.00	0.96 (0.95–0.97)	<.0001	0.99 (0.98–1.00)	.0013
2003	127861	5.84	0.93 (0.92–0.94)	<.0001	1.00 (0.99–1.01)	.0120
2004	139609	5.76	0.92 (0.91–0.93)	<.0001	0.95 (0.94–0.96)	<.0001
2005	156032	5.86	0.94 (0.93–0.95)	<.0001	0.95 (0.94–0.95)	<.0001
2006	152977	6.05	0.97 (0.96–0.98)	<.0001	0.95 (0.95–0.96)	<.0001
2007	175661	6.41	1.03 (1.02–1.04)	<.0001	1.01 (1.00–1.02)	.0063

Adjusted model adjusted for age, gender, race, CHF, arrhythmia, valvular heart disease, myocardial infarction, stroke, COPD, hypertension, and diabetes.

Table V

Echocardiography utilization rates for individual VISNs in the VA system for years 2000 and 2007

Year			
2000		2007	
VISN	Echos per 1000 VA users	VISN	Echos per 1000 VA users
1	66.8	1	61.8
2	52.8	2	70.1
3	61.9	3	72.2
4	63.8	4	59.4
5	84.4	5	84.7
6	58.9	6	64.2
7	51.2	7	51.5
8	48.7	8	54.2
9	80.2	9	78.7
10	60.0	10	52.2
11	64.9	11	65.4
12	57.4	12	66.5
13	66.9	15	68.5
14	66.5	16	58.1
15	58.3	17	57.0
16	62.7	18	62.2
17	62.0	19	51.3
18	55.7	20	67.1
19	64.2	21	90.3
20	77.7	22	84.2
21	71.1	23	60.0
22	65.9		

Mean number of echocardiograms per VA echocardiogram recipient and the percentage of echocardiogram recipients receiving multiple echocardiograms

Table VI

Fiscal year	2000	2001	2002	2003	2004	2005	2006	2007
No. of veterans using echocardiography	83597	99511	113777	127861	139609	156032	152977	175661
Mean echocardiograms/echocardiogram user	1.10	1.10	1.10	1.10	1.10	1.11	1.11	1.11
Percentage of echocardiogram recipients with								
1 Echocardiogram	91.2	91.7	91.6	91.5	91.6	91.2	90.6	90.7
2 Echocardiograms	7.6	7.1	7.2	7.2	7.1	7.4	7.9	7.7
3 Echocardiograms	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.2
4 Echocardiograms	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3
5 Echocardiograms	0.0	0.0	0.0	0.1	0.1	0.2	0.1	0.1