

Variation in the Use of Echocardiography

CONTEXT. Geographic variation in population-based rates of invasive cardiac procedures has been described. However, little is known about variation in rates of non-invasive testing for cardiovascular disease. Echocardiography is the second most common cardiac diagnostic procedure.

PRACTICE PATTERN EXAMINED. Population-based rates of echocardiography, adjusted for age, sex, and race, in the United States.

DATA SOURCE. 5% sample of Medicare Part B.

RESULTS. 1 in 10 Medicare beneficiaries underwent echocardiography in 1995. Rates of echocardiography varied by state from 5% in Oregon to 15% in Michigan. Rates tended to be lowest in the Northern Great Plains, the Pacific Northwest, and the Rocky Mountains states. Among the 25 largest metropolitan areas, substantial variation was also apparent. For example, one fourth of Medicare beneficiaries in Miami, Florida, received echocardiography, and this proportion was more than four times greater than that seen in Seattle, Washington.

CONCLUSION. The likelihood of Medicare beneficiaries having echocardiography is influenced by where they live.

Variation in the provision of health services was first pointed out in the early 1970s.¹ More recently, geographic variation in population-based rates of invasive cardiac procedures, including coronary angiography,^{2,3} coronary artery bypass grafting (CABG),²⁻⁶ and percutaneous coronary interventions,^{2,5} has been described. For instance, one study⁵ showed that rates of CABG varied more than sixfold across ZIP codes in Los Angeles County, California. Variation persists even when large geographic units are considered. Among Medicare beneficiaries, rates of cardiac catheterization, CABG, and percutaneous transluminal coronary angioplasty vary more than threefold across the United States.^{2,3} Such regional variation in the use of invasive procedures has also been demonstrated among survivors of acute myocardial infarction.⁷

Less is known about geographic variation in the use of noninvasive cardiac diagnostic testing. Wennberg and colleagues⁸ previously showed that in northern New England, population-based rates of imaging stress testing varied 3.5-fold by hospital service area and rates of nonimaging stress testing varied by a factor of more than 4.

After electrocardiography (EKGs), the most common cardiac diagnostic procedure is echocardiography (also known as cardiac ultrasonography, or ECHO). Echocardiography provides information about both the structure and the function of the heart, and this information is useful for establishing a diagnosis; assessing prognosis; and determining optimal therapy for several indications, including heart failure, ischemic heart disease, and valve disease.⁹ Echocardiography is noninvasive, is relatively inexpensive, and has few risks. Thus, it is frequently used—the number of echocardiographic studies performed in Medicare beneficiaries increased 143% from 1986 to 1989.¹⁰ Not surprisingly, there is concern about overuse.¹¹ Only a relatively small proportion of echocardiographic studies results in a significant change in clinical management.¹²

The abstract of this paper is available at ecp.acponline.org.

PATTERNS OF PRACTICE

F. LESLIE LUCAS, PHD

Research Associate

*Maine Medical Center
Portland, Me*

DAVID E. WENNBERG, MD, MPH

Senior Researcher

*Maine Medical Center
Portland, Me*

*Maine Medical Assessment
Foundation
Manchester, Me*

DAVID J. MALENKA, MD

Associate Professor of Medicine

*Dartmouth-Hitchcock Medical
Center
Lebanon, NH*

*Effective Clinical Practice.
1999;2:71-75.*

We performed this study to answer two questions: What proportion of the Medicare population receives echocardiography each year? How much does the use of echocardiography vary in the United States?

Methods

We used the 5% sample from Medicare Part B to identify all Medicare beneficiaries who had echocardiography in 1995 [Current Procedural Terminology (CPT) codes 93307–93325]. Beneficiaries enrolled in risk-contract HMOs and those younger than 65 years of age were excluded. If a beneficiary had more than one echocardiographic procedure in 1995, only the first was counted. The period of eligibility for each beneficiary in the sample was ascertained and used to calculate person-years of observation. The unit of analysis was the hospital referral region (HRR)⁴; HRRs are the geographic units of health care for the delivery of tertiary care services and are centered around major metropolitan areas. Each echocardiographic procedure was assigned to the HRR in which the beneficiary resided rather than to the HRR in which the service was delivered. Thus, echocardiography done on a New York City resident in a Miami hospital was attributed to the New York HRR.

Geographic rates were defined by using the number of persons in an HRR who received echocardiography as the numerator and the total number of person-years contributed by beneficiaries in that HRR as the

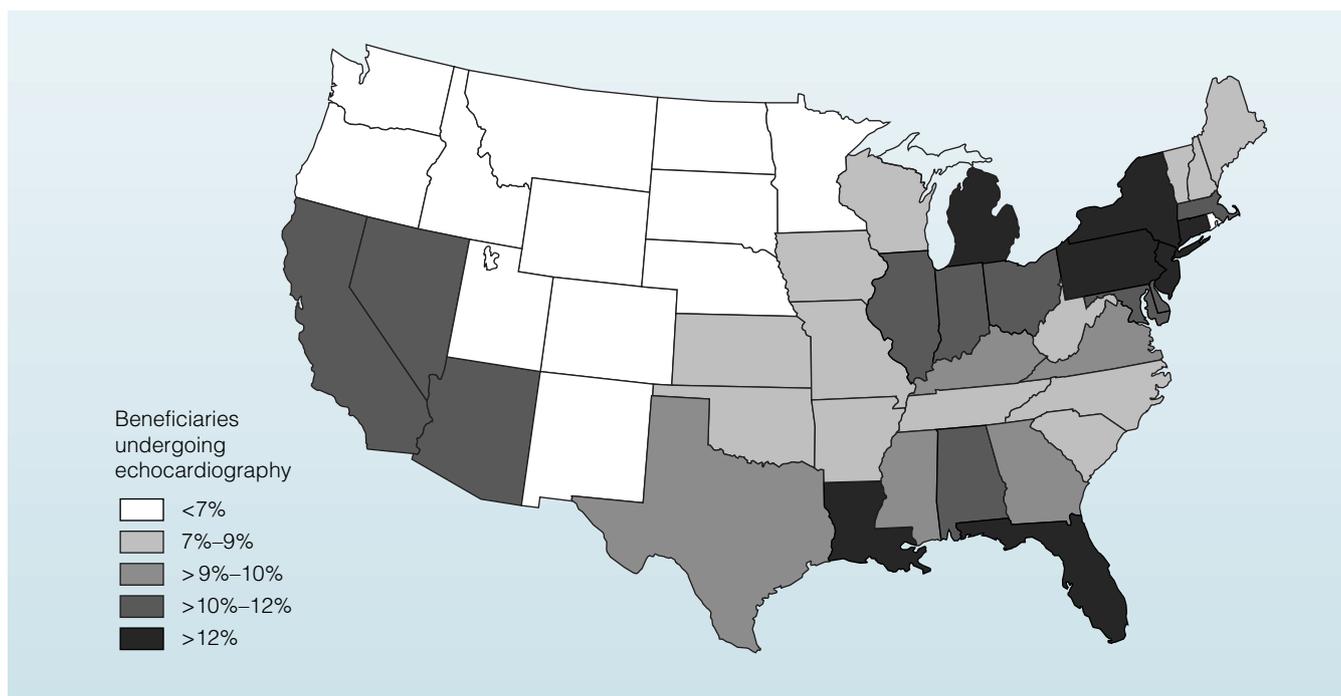
denominator. We used the indirect method to adjust rates for age, race, and sex.¹³ Observed and expected counts for HRRs were then cumulated to obtain approximate state rates, although some HRRs cross state borders. For ease of presentation, rates are expressed as percentages.

We used descriptive statistics to assess variation in echocardiography rates. In addition, to minimize any effect of small numbers of events in an HRR on the variability of the rates, we repeated the analysis using only the HRRs corresponding to the 25 largest metropolitan areas.

Results

More than 3 million Medicare beneficiaries (10.5% of all Medicare beneficiaries) underwent echocardiography in 1995. Of these, 85% had one procedure during the year, 12% had two procedures, and 3% had three or more procedures. Given that the average allowable charge for echocardiography is \$197, Medicare spent more than half a billion dollars on the procedure in 1995.

Figure 1 illustrates the geographic distribution across the United States. Beneficiaries living in Michigan were three times more likely than beneficiaries living in Oregon to undergo echocardiography. Three populous northeastern states—New York, New Jersey, and Pennsylvania—were among those in which echocardiography was provided most frequently. Areas in which the procedure was used least often tended to be



the Northern Great Plains, the Pacific Northwest, and the Rocky Mountain states.

Table 1 shows the summary statistics for variation in the use of echocardiography. Among the states, the average proportion of Medicare beneficiaries receiving echocardiography in 1995 was 9.1% (interquartile range, 6.9% to 10.4%).

Figure 2 shows that more variation was seen among the 25 largest metropolitan areas. In these areas, the average proportion of Medicare beneficiaries who received echocardiography was 12.2% (interquartile range, 10.1% to 13.4%). One quarter of Medicare beneficiaries living in Miami received echocardiography in 1995; this rate was more than four times greater than that for Medicare beneficiaries living in Seattle.

Discussion

We found that 1 in 10 Medicare beneficiaries had echocardiography at least once in 1995. We also found that a beneficiary's likelihood of receiving echocardiography was related to where he or she lived. The variation by state was about threefold, and the variation among the 25 largest metropolitan areas was even greater.

TABLE 1
Variation in the Use of Echocardiography among Medicare Beneficiaries in 1995

VARIABLE	GEOGRAPHIC UNIT	
	50 STATES	25 LARGEST METROPOLITAN AREAS
Proportion of Medicare beneficiaries receiving echocardiography, %		
Mean ± SD	9.1 ± 2.4	12.2 ± 4.5
Minimum	5.0	5.9
Maximum	15.1	27.3
Interquartile range	6.9–10.4	10.1–13.4

Because echocardiography is noninvasive and relatively inexpensive from a per-unit perspective, concern has been expressed about the potential for overuse.¹¹ In addition, the role of echocardiography in patient management and the effect of this procedure on outcome are uncertain.¹² One study¹⁴ found that echocardiography

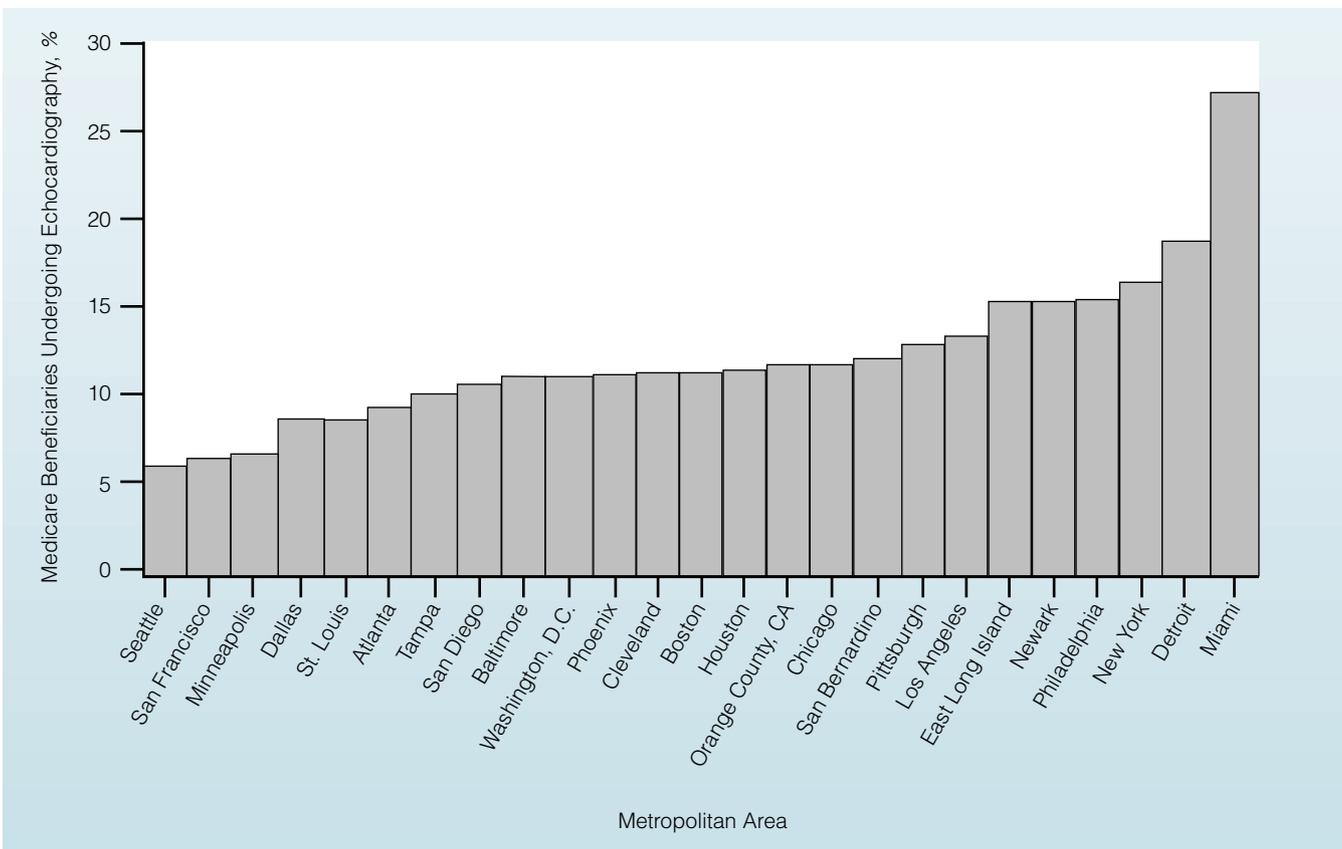


FIGURE 2. Use of echocardiography among Medicare beneficiaries in the 25 largest metropolitan areas in the United States in 1995.

was significantly less useful than the ordering physician expected. In another study,¹² only 10% to 16% of echocardiographic studies resulted in a major change in clinical management. The geographic variation seen in our study is evidence of the lack of consensus about how and in whom echocardiography should be used.

Clinicians might argue that variation in use reflects a variation in need; that is, variation in the underlying disease rate. However, by adjusting rates for age, race, and sex, we accounted for several important cardiac risk factors. In addition, it has generally been found that differences in illness burden explain a small fraction of the variation but not the major portion of it. Wennberg⁴ found that rates of CABG and percutaneous transluminal coronary angioplasty were unrelated to rates of acute myocardial infarction in HRRs (R^2 , 0.005 and 0.07, respectively).

Why does variation matter? First, variation may indicate uncertainty about the best possible diagnostic and treatment strategy for particular patients. Where consensus about diagnosis and treatment exists, variation tends to be minimized. For example, rates of hospitalization for hip fracture vary little,⁴ reflecting the virtual certainty that patients with hip fracture will seek medical attention, receive an accurate diagnosis, and be treated in the hospital. The variation seen in cardiac procedure rates implies less agreement about when and how to diagnose and treat coronary artery disease. Our finding of variation in the use of echocardiography supports this hypothesis.

Second, diagnostic testing may lead to further testing and intervention. We previously showed⁸ that rates of stress testing were strongly correlated with rates of subsequent coronary angiography and revascularization. Therefore, the true source of variation may be the decision to test rather than the decision to intervene. Because echocardiography is done for many reasons, it may lead to many intervention options, from valve surgery to medical management of congestive heart failure. However, because we could not identify the reason for echocardiography, we were unable to assess the relation of this test to the use of subsequent interventions. This issue merits further investigation.

Third, diagnostic testing is associated with costs as well as benefits. In this era of cost containment, it behooves clinicians to understand the benefits of a given test and to weigh those benefits against the test's costs. Although the \$200 per-unit cost of echocardiography does not seem exorbitant in the current marketplace, the frequency with which the procedure is used results in an annual expenditure of more than half a billion dollars in the Medicare population alone. If the decision to intervene is also dependent on the decision to test, the cost of the probable subsequent intervention should also be considered. If variation is reduced, cost savings could result.

Our study is descriptive in nature and has several limitations. First, because we used Medicare data, our results are not applicable to younger populations, which may include many persons who require echocardiography for such conditions as congenital defects and valve disease. Second, the statistical stability of small area rates has been questioned. However, no HRR had fewer than 46 observed events nor fewer than 73 expected events. Limiting our analysis to the 25 largest HRRs, in which statistical stability was not a problem, actually increased variation.

In summary, we found substantial variation in population-based rates of use of echocardiography. Which rate is the correct rate? Are low-rate areas underserved, are high-rate areas overserved, or is neither of these possibilities true? These are questions for further study.

Take-Home Points

- **Patterns of utilization of common diagnostic procedures are not well known.**
- **In 1995, 1 in 10 Medicare beneficiaries received echocardiography.**
- **In the United States, the proportion of Medicare beneficiaries receiving echocardiography ranged from 5% in Oregon to 15% in Michigan.**
- **One quarter of residents of Miami underwent echocardiography; this proportion is more than four times that of Seattle.**
- **Differences in underlying disease rates are unlikely to be large enough to explain variation of this magnitude.**

References

1. Wennberg J, Gittelsohn A. Small area variations in health care delivery: a population-based health information system can guide planning and regulatory decision-making. *Science*. 1973;182:1102-8.
2. Kuhn EM, Hartz AJ, Baras M. Correlation of rates of coronary artery bypass surgery, angioplasty, and cardiac catheterization in 305 large communities for persons age 65 and older. *Health Serv Res*. 1995;30:425-36.
3. Chassin MR, Brook RH, Park RE, et al. Variations in the use of medical and surgical services by the Medicare population. *N Engl J Med*. 1986;314:285-90.
4. Wennberg JE. *The Dartmouth Atlas of Health Care in the United States*. Chicago: American Hospital Publishing; 1998.
5. Carlisle DM, Valdez RB, Shapiro MF, Brook RH. Geographic variation in rates of selected surgical procedures within Los Angeles County. *Health Serv Res*. 1995;30:27-42.
6. Gittelsohn A, Powe NR. Small area variations in health care delivery in Maryland. *Health Serv Res*. 1995;30:295-317.
7. Pilote L, Califf RM, Sapp S, et al. Regional variation across the United States in the management of acute myocardial infarction. *N Engl J Med*. 1995;333:565-72.

8. Wennberg DE, Kellett MA, Dickens JD Jr, Malenka DJ, Kielson LM, Keller RB. The association between local diagnostic testing intensity and invasive cardiac procedures. *JAMA*. 1996;275:1161-4.
9. ACC/AHA Committee on Clinical Application of Echocardiography. ACC/AHA guidelines for the clinical application of echocardiography. *Circulation*. 1997;95:1686-744.
10. Frye RL. Does it really make a difference? *J Am Coll Cardiol*. 1992;19:468-70.
11. Feigenbaum H. Evolution of echocardiography. *Circulation*. 1996;93:1321-7.
12. Calenda P, Jain P, Smith LG. Utilization of echocardiography by internists and cardiologists: a comparative study. *Am J Med*. 1996;101:584-91.
13. Kahn HA, Sempos CT. *Statistical Methods in Epidemiology*. New York: Oxford Univ Pr; 1989.
14. Kim R, Chakko S, Myerburg RJ, Kessler KM. Clinical usefulness and cost of echocardiography in patients admitted to a coronary care unit. *Am J Cardiol*. 1997;80:1273-6.

Grant Support

This work was part of the Dartmouth Atlas of Health Care and was supported by the Robert Wood Johnson Foundation.

Correspondence

F. Leslie Lucas, PhD, Division of Health Services, Maine Medical Center, Department of Medicine, 22 Bramhall Street, Portland, ME 04102; e-mail: LUCASL@mail.mmc.org.