ORIGINAL ARTICLES

Differences in Generalist and Specialist Physicians' Knowledge and Use of Angiotensin-Converting Enzyme Inhibitors for Congestive Heart Failure

Marshall H. Chin, MD, MPH, Peter D. Friedmann, MD, MPH, Christine K. Cassel, MD, Roberto M. Lang, MD

OBJECTIVE: **To quantify the extent and determinants of underutilization of angiotensin-converting enzyme (ACE) inhibitors for patients with congestive heart failure, especially with respect to physician specialty and clinical indication.**

DESIGN: **Survey of a national systematic sample of physicians.**

PARTICIPANTS: **Five hundred family practitioners, 500 general internists, and 500 cardiologists.**

MEASUREMENTS AND MAIN RESULTS: **Physicians' choice of medications were determined for four hypothetical patients with left ventricular systolic dysfunction: (1) new-onset, symptomatic; (2) asymptomatic; (3) chronic heart failure, on digitalis and diuretic; and (4) asymptomatic, post–myocardial infarction. For each patient, randomized controlled trials have demonstrated that ACE inhibitors decrease mortality or the progression of symptoms. Among the 727 eligible physicians returning surveys (adjusted response rate 58%), approximately 90% used ACE inhibitors for patients with chronic heart failure who were already taking digitalis and a diuretic. However, family practitioners and general internists chose ACE inhibitors less frequently ($p \leq .01$) than cardiologists for the other indications. Respective rates of ACE inhibitor use for each simulated patient were new-onset, symptomatic (family practitioners 72%, general internists 76%, cardiologists 86%); asymptomatic (family practitioners 68%, general internists 78%, cardiologists 93%); and asymptomatic, post–myocardial infarction (family practitioners 58%, general internists 70%, cardiologists 94%). Compared with generalists, cardiologists were more likely ($p \leq .05$) to increase ACE inhibitors to a target dosage (45% vs 26%) and to tolerate systolic blood pressures of 90 mm Hg or less (43% vs 15%).**

CONCLUSIONS: **Compared with cardiologists, family practitioners and general internists probably underutilize ACE inhibitors, particularly among patients with decreased ejection fraction who are either asymptomatic or post–myocardial infarction. Educational efforts should focus on these indications and emphasize the dosages demonstrated to lower mortality and morbidity in the trials.**

KEY WORDS: **angiotensin-converting enzyme (ACE) inhibitor; congestive heart failure; physician behavior; specialty; quality of care.**

J GEN INTERN MED 1997;12:523–530.

Received from the Section of General Internal Medicine (MHC, PDF, CKC) and Section of Cardiology (RML), Department of Medicine, University of Chicago (Ill.) Medical Center. Dr. Cassel is now with the Mount Sinai Medical Center in New York.

Presented in part at the annual meeting of the Society of General Internal Medicine, Washington, DC, May 3, 1996, and American College of Cardiology, Anaheim, Calif., March 18, 1997.

Funded by a grant-in-aid from the American Heart Association of Metropolitan Chicago. Dr. Chin is supported by National Institutes of Health/National Institute on Aging Geriatric Academic Program Award 5-K12-AG-00488.

Address correspondence and reprint requests to Dr. Chin: University of Chicago Medical Center, Section of General Internal Medicine, 5841 S. Maryland Ave., MC 6098, Chicago, IL 60637.

The appropriate role of generalist and specialist physicians in the care of patients is controversial.[1] It is generally assumed that the sickest, most complicated patients, as well as patients with rare disorders, benefit most from specialty care. However, the majority of patients with chronic diseases such as heart failure, diabetes, or chronic obstructive pulmonary disease initially are not severely ill, and are therefore first seen by the generalist physician. The most cost-effective threshold for specialty referral and the optimal mix of generalist and specialist care remain unknown.[2]

Congestive heart failure is an ideal model to study variation in physicians' practice patterns among patients with chronic disease. This syndrome is common and presently the domain of both generalist and specialist physicians. Advances in cardiac transplantation and hemodynamically titrated therapy have made some of the sickest patients clear candidates for referral to cardiologists.[3] Recently, however, multicenter trials of angiotensin-converting enzyme (ACE) inhibitors have modified the standard of treatment for a broad range of patients with heart failure.[4] These medications have been found to decrease mortality in patients with chronic heart failure and ejection fractions of 0.35 or less,[5] decrease progression to hospital admission or death in patients with ejection fractions of 0.35 or less who are asymptomatic,[6] and decrease mortality in asymptomatic patients who have suffered myocardial infarctions and have ejection fractions of 0.40 or less.[7] The Agency for Health Care Policy and Research, the American College of Cardiology, and the American Heart Association all currently recommend the use of

ACE inhibitors for patients with heart failure and left ventricular ejection fractions of 0.35 or less in their respective clinical practice guidelines.[8,9]

A variety of studies originating from randomized controlled trials,[10,11] single institutions,[12,13] localized geographic areas,[14] and the pharmaceutical industry[15] suggest that physicians greatly underutilize ACE inhibitors. Given the prevalence of congestive heart failure, thousands of patients would benefit if physicians prescribed these therapeutic agents appropriately. However, these studies were completed either before or shortly after the major multicenter trials demonstrating the benefit of ACE inhibitors were published, particularly among asymptomatic populations. Also, few investigators have attempted to determine physician and patient factors associated with underutilization,[13,15] and whether underdosing occurs.[16]

Therefore, we surveyed physicians about their knowledge of ACE inhibitors to explore whether underutilization of these medications persists. We aimed to determine whether patterns of self-reported use of ACE inhibitors vary by specialty type and other attitudinal, cognitive, and demographic attributes of the physicians, as well as by indication for the medication and the severity of the patient's illness.

METHODS

Study Population

Between October 1995 and May 1996, we mailed an 8-page survey to a national systematic sample of 500 family practitioners, 500 general internists, and 500 cardiologists chosen from the American Medical Association Physician Masterfile. All physicians were office-based and in clinical practice. Nonrespondents were sent two further mailings and a reminder letter.

Data Collection

We presented three written case simulations of patients who had reduced ejection fraction, all based on recent data from large randomized, controlled trials demonstrating the survival and morbidity benefits of ACE inhibitors. Cases described were an asymptomatic patient,[6] a patient with chronic heart failure on digitalis and a diuretic,[5] and an asymptomatic patient who was post–myocardial infarction (see Appendix A).[7] The physiologic and laboratory data used in each simulation were the mean values reported for the patients of the corresponding clinical trial. After each case simulation, we asked the physicians about which medication or medications, if any, they would prescribe at that time, as well as how much they perceived that these agents would alter survival or morbidity.

We also presented another simulation of a patient's initial presentation and follow-up visit to the office with symptomatic heart failure and ejection fraction equal to 0.35. We asked what drug the physician would choose at each visit, assuming that a medication needed to be selected. For this particular case simulation, we credited physicians with choosing an ACE inhibitor if they prescribed this medication at either the first or second office visit in the hypothetical scenario.

We also inquired about how the physician decides what the final dose of the ACE inhibitor should be, what is the lowest systolic blood pressure he or she is willing to tolerate, and at what serum creatinine and potassium levels the doctor tends to avoid prescribing ACE inhibitors. We instructed the physicians to think about their own heart failure patients with left ventricular systolic dysfunction as they completed the questionnaire. We also asked each physician to estimate rates of cough, hyperkalemia, renal failure, and hypotension among patients taking ACE inhibitors, and to rate the utility of different sources of information regarding heart failure medications.

We obtained demographic information from both the survey and the Masterfile. We also inquired about the number of patients with congestive heart failure that each physician treats. We assigned eligible physicians into the specialty group listed in the Masterfile to allow comparisons between respondents and nonrespondents. Agreement between self-designated specialty and Masterfile specialty was 94% for eligible physicians. Moreover, 75% of the Masterfile-designated cardiologists stated that at least 90% of their patients had cardiac problems. In contrast, only 0.5% of the family practitioners and 4% of the general internists had this percentage of cardiac patients in their practices.

Statistical Methods

We compared characteristics of respondents and nonrespondents using the Cochran-Mantel-Haenszel χ^2 statistic stratified by specialty. For comparisons across specialty groups, we used χ^2 tests for categorical variables, and analysis of variance for continuous variables. We used stepwise multivariable logistic regression to determine independent factors associated with the use of ACE inhibitors for each case simulation. In these analyses, we automatically adjusted for the physician's gender, geographic region, and number of years since graduation from medical school, as well as the number of patients with congestive heart failure in each doctor's practice. All specialty dummy variables were also included. For the remaining candidate variables, we used entry criterion $p \leq .10$ and stay criterion $p \leq .05$, two-tailed.

RESULTS

Survey Response Rate

Of the 1,500 physicians in the original sample, 91 had incorrect addresses or had died. The remaining 1,409 physicians comprised 727 eligible physicians who returned usable surveys; 97 physicians who returned surveys but were ineligible because they had either retired or no longer took care of patients (69), or were neither a cardiologist, a family practitioner, nor a general internist (28); and 585 physicians who did not return the survey

and consequently had unknown eligibility. Thus, our crude response rate (usable surveys per assumed eligible patients) was 727/1,312 = 55%. We then calculated an adjusted response rate based on standard techniques.[17] Among the 824 physicians returning questionnaires, 727 (88%) were eligible. Applying this same percentage to the 585 physicians with unknown eligibility, we estimated that 516 were eligible. Thus, the adjusted response rate (usable surveys per estimated eligible patients) was 727/1,243 = 58%. The remaining results are based on the unadjusted denominators of physicians.

Eligibility rates for family practitioners, general internists, and cardiologists were 83%, 87%, and 93%, respectively. Response rates for these same physicians were 51%, 58%, and 57%, a nonsignificant difference with $p = .10$ (Table 1). Compared with respondents, nonrespondents were less likely ($p \leq .001$) to be board-certified. Within each individual case simulation, the choice of medications was similar across waves 1–3 of the survey, supporting the reliability of the findings.

Utilization of Angiotensin-Converting Enzyme Inhibitors by Specialty

More than 88% of the physicians in each specialty group used ACE inhibitors for symptomatic patients with chronic heart failure who were already receiving digitalis and a diuretic. However, family practitioners and general internists chose ACE inhibitors less frequently ($p \leq .01$) than cardiologists for the other indications (Fig. 1). Respective rates of ACE inhibitors use for each simulated patient were new-onset, symptomatic (family practitioners 72%, general internists 76%, cardiologists 86%); asymptomatic (family practitioners 68%, general internists 78%, cardiologists 93%); and asymptomatic, post–myocardial infarction (family practitioners 58%, general internists 70%, cardiologists 94%).

Table 1. Demographic Characteristics of Survey Respondents, by Specialty*

Characteristic	Family Practitioners	General Internists	Cardiologists
n	210	250	259
Male gender, %	83	77	91
Board certification, %	80	73	92
Geographic region, %			
Northeast	13	22	28
North Central	27	25	23
South	35	27	27
West	25	24	21
Possession	0	1	1
Age, %			
Under 35 years	7	7	3
35–44	38	41	38
45–54	31	29	33
55–64	13	17	18
65 and over	11	6	8

**Percentages may not total 100% because of rounding.*

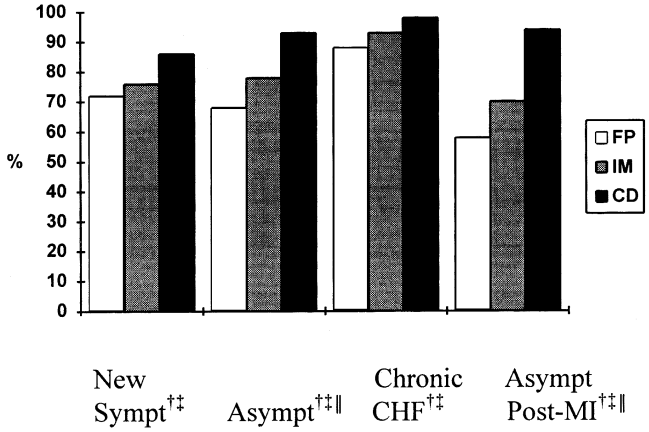

FIGURE 1. Percentage of physicians using angiotensin-converting enzyme inhibitors for four simulated patients with ejection fractions of 0.35 or less: (1) new-onset, symptomatic; (2) asymptomatic; (3) chronic heart failure, on digitalis and diuretic; (4) asymptomatic, post–myocardial infarction. FP indicates family practitioners; IM, internal medicine generalists; CD, cardiologists; †$p \leq .01$, cardiologists compared with family practitioners; ‡$p \leq .01$, cardiologists compared with general internists; ‖$p \leq .05$, general internists compared with family practitioners.

Factors Associated with Physicians' Use of Angiotensin-Converting Enzyme Inhibitors

In bivariate analyses, cardiologists were more likely to prescribe ACE inhibitors than were family practitioners, with the odds ratio (OR) for the different case simulations ranging from 2.4 in the new-onset, symptomatic case to 11.0 for the asymptomatic, post–myocardial infarction patient (Table 2). To a lesser extent, general internists were also more apt to use these medications than family practitioners. Other factors associated with the use of ACE inhibitors in bivariate analyses included board certification, more recent graduation from medical school, increased number of patients with heart failure, perceived utility of original research articles, and more optimistic perception of the ability of medications to reduce the absolute and relative risks of mortality or progression of symptoms among patients with heart failure. Higher perceived rates of side effects from ACE inhibitors were associated with decreased use of these medications in the simulation of the patient with chronic heart failure and reduced ejection fraction. The gender and region of the physician were not correlated with the use of ACE inhibitors.

In multivariable analyses adjusting for the physician's gender, geographic region, years since graduation, and number of patients with heart failure in the practice, specialty differences were still significant (Table 3). Cardiologists were more likely than family practitioners to use ACE inhibitors with an adjusted OR ranging from 2.1 in

Table 2. Factors Associated with Physicians' Use of Angiotensin-Converting Enzyme Inhibitors*

Covariate / Professional Characteristics	*n* (%)†	Unadjusted Odds Ratios with 95% Confidence Intervals: Newly Symptomatic	Asymptomatic	Chronic CHF	Asymptomatic, Post-MI
Specialty‡					
Family practice	211 (29)	—	—	—	—
General internal medicine	252 (35)	1.2 (0.8, 1.9)	1.7 (1.1, 2.5)§	1.8 (0.9, 3.4)	1.7 (1.1, 2.4)‖
Cardiology	264 (36)	2.4 (1.5, 3.8)‖	6.0 (3.4, 10.4)‖	8.6 (2.9, 25.3)‖	11.0 (6.2, 19.6)‖
Board certified	594 (82)	1.8 (1.2, 2.8)‖	3.4 (2.2, 5.1)‖	3.0 (1.6, 5.6)‖	1.8 (1.2, 2.8)‖
Years since graduation from medical school (per 10 years)	727	0.8 (0.7, 0.9)‖	0.6 (0.5, 0.7)‖	0.6 (0.4, 0.7)‖	0.8 (0.7, 1.0)§
>50 patients with congestive heart failure in the practice	358 (51)	1.9 (1.3, 2.7)‖	2.0 (1.3, 2.9)‖	2.0 (1.1, 3.8)§	2.0 (1.4, 2.9)‖

**Bivariate correlates of the use of ACE inhibitors for four simulated patients with ejection fractions of 0.35 or less: new-onset, symptomatic; asymptomatic; chronic congestive heart failure (CHF), on digitalis and diuretic; and asymptomatic, post–myocardial infarction (MI).*

†*The sample size for each case simulation varies slightly depending on the amount of missing data.*

‡*Odds ratios with family practice as the baseline.*

§$p \leq .05$

‖$p \leq .01$

the new-onset, symptomatic case to 10.0 for the vignette of the asymptomatic, post–myocardial infarction patient. General internists also used these medications more often than family practitioners in the asymptomatic case with an adjusted OR of 1.9.

Estimates of Rates of Side Effects from Angiotensin-Converting Enzyme Inhibitors

Estimated rates of renal failure and hypotension from ACE inhibitors were slightly higher ($p \leq .01$) among cardiologists than generalist physicians. However, the mean differences were clinically insignificant, varying by two percentage points across specialties. When the multivariable models for use of ACE inhibitors were also adjusted for estimated rates of cough, hyperkalemia, renal failure, and hypotension, cardiologists still used this class of medications more frequently than family practitioners in all case simulations. General internists also utilized these medications more often than family practitioners in the asymptomatic scenario. For the entire sample of physicians, the mean estimated rates (±SEM) of side effects were cough, 17% (±0.6%); hyperkalemia, 7% (±0.3%); renal failure, 6% (±0.2%); and hypotension, 11% (±0.4%).

Dosage of Angiotensin-Converting Enzyme Inhibitors

Several differences in attitudes about dosage of ACE inhibitors were apparent among the specialties (Table 4).

Table 3. Independent Factors Associated with Physicians' Use of Angiotensin-Converting Enzyme Inhibitors*

Covariate	Adjusted Odds Ratios with 95% Confidence Intervals†: Newly Symptomatic	Asymptomatic	Chronic CHF	Asymptomatic, Post-MI
General internal medicine‡	1.1 (0.7, 1.8)	1.9 (1.1, 3.3)	2.2 (0.9, 5.4)	1.5 (1.0, 2.4)
Cardiology‡	2.1 (1.2, 3.5)	5.5 (2.7, 11.2)	5.5 (1.6, 18.5)	10.0 (5.3, 18.8)
Board certified	—	2.5 (1.4, 4.4)	—	—
Perceived rate of hyperkalemia§	—	—	0.7 (0.6, 0.9)	—
Estimated absolute risk reduction‖	—	—	—	1.7 (1.4, 2.1)
Estimated relative risk reduction‖	—	1.7 (1.5, 1.9)	1.9 (1.5, 2.4)	0.9 (0.8, 1.0)
Model *c* statistic	0.63	0.86	0.90	0.76

**Independent correlates of the use of ACE inhibitors for four simulated patients with ejection fractions of 0.35 or less: new-onset, symptomatic; asymptomatic; chronic congestive heart failure (CHF), on digitalis and diuretic; and asymptomatic, post–myocardial infarction (MI).*

†*Stepwise multivariable logistic regression with entry criterion* $p \leq .10$ *and stay criterion* $p \leq .05$*, automatically adjusting for physician's gender, geographic region, years since graduation from medical school, number of patients with heart failure in the practice, specialty dummy variables, and the other independent covariates.*

‡*Odds ratios with family practice as baseline.*

§*Adjusted odds ratio per 5% increase in perceived rate of hyperkalemia from taking an ACE inhibitor.*

‖*Adjusted odds ratio per 10% risk reduction for the following respective outcomes: asymptomatic patient—development of symptoms or signs of heart failure within 3 years; patient with CHF—death within 3–4 years; asymptomatic patient who is post-MI—death within 3–4 years.*

Table 4. End Points for Dosing Angiotensin-Converting Enzyme Inhibitors*

End Point	Family Practitioners, % (n = 211)	General Internists, % (n = 252)	Cardiologists, % (n = 264)
No symptoms of CHF	45†	39	33
No signs of CHF	50†	46	39
Specific dose	26	27	45†‡
Specific blood pressure	36	48§	55†
Side effects	29	29	38†‡

**Responses to question "When you start an angiotensin-converting enzyme inhibitor for congestive heart failure, how do you decide what the final dose of the medication should be? (Circle all that apply)"*

†$p \leq .05$, *cardiologists compared with family practitioners.*

‡$p \leq .05$, *cardiologists compared with general internists.*

§$p \leq .05$, *general internists compared with family practitioners.*

Cardiologists were more likely ($p \leq .05$) than family practitioners or general internists to titrate these medications to a specific dose, a specific blood pressure, or to the point of side effects. Family practitioners used lack of symptoms or signs of heart failure as end points more frequently than cardiologists. In addition, the cardiologists were more likely to tolerate a systolic blood pressure of 90 mm Hg or less (43% vs 15% for the generalists, $p \leq .001$). More than 25% of the physicians in each specialty tended to avoid prescribing ACE inhibitors when the serum creatinine level was 176.8 μmol/L (2.0 mg/dL) or higher.

Utility of Sources of Information About Heart Failure Medications

When asked to rate the utility of different sources of information for choosing medications for patients with heart failure, the cardiologists found original research articles and review articles to be more helpful ($p \leq .01$) than did the generalist physicians (Table 5). The family practitioners and general internists rated colleagues more highly than the cardiologists did.

DISCUSSION

All physicians in this study tended to prescribe ACE inhibitors to patients with symptomatic heart failure already receiving digitalis and a diuretic, but family practitioners and general internists tended to underutilize these medications in other subsets of patients with reduced ejection fractions, including the asymptomatic patient, the asymptomatic patient who is post–myocardial infarction, and the newly symptomatic patient with heart failure. Differences across specialties were most striking among asymptomatic and post–myocardial infarction patients.

What could explain the differences in the use of ACE inhibitors across specialties, particularly among asymptomatic patients? Even after adjusting for the number of patients with heart failure that each physician treats, the estimated relative risk reduction from using medications in each case simulation, and the estimated rates of side effects from ACE inhibitors, cardiologists were still more likely to use these agents.

Nonetheless, we cannot rule out a number of other potential causes. For example, different physicians may require different amounts of scientific evidence to modify their practice. Generalist physicians may be aware of the latest studies, but might be withholding judgment pending more data. Or, differences between the types of patients with heart failure cared for by generalists and cardiologists may explain part of the variation in the pattern of drug selection. Perhaps patients cared for by generalist physicians are less likely to afford ACE inhibitors.

We suspect, however, that ineffective dissemination of information about the specific role of ACE inhibitors in patients with asymptomatic heart failure is probably also playing a role.[18] Compared with cardiologists, generalist physicians found original research articles less helpful and their colleagues' advice more useful.

Our data also suggest underdosing of ACE inhibitors. In the various clinical trials, the doses of the ACE inhibitors were generally increased to a target dose whenever tolerated. Trials currently in progress are testing the efficacy of lower doses.[19] Until these results are reported, an evidence-based approach to medicine advocates using the

Table 5. Utility of Sources of Information for Selection of Medications for Heart Failure*

Source of Information	Family Practitioners (n = 206)	General Internists (n = 244)	Cardiologists (n = 263)
Colleagues	1.6 ± 0.05†‡	1.9 ± 0.05§	2.2 ± 0.06
Continuing medical education	1.3 ± 0.04‡	1.5 ± 0.04	1.5 ± 0.04
Drug companies	2.6 ± 0.06‡	2.8 ± 0.05	2.7 ± 0.05
Original research articles	2.3 ± 0.06	1.9 ± 0.05‡	1.6 ± 0.05†§
Practice guidelines	2.0 ± 0.06	2.0 ± 0.05	2.0 ± 0.05
Review articles	1.7 ± 0.05	1.6 ± 0.04	1.4 ± 0.04†§
Textbooks	2.2 ± 0.06	2.1 ± 0.06	2.1 ± 0.05

**On 4-point Likert scale (1 = very useful, 2 = moderately useful, 3 = mildly useful, 4 = not useful). Results reported as mean ±SE.*

†$p \leq .01$, *cardiologists compared with family practitioners.*

‡$p \leq .01$, *general internists compared with family practitioners.*

§$p \leq .01$, *cardiologists compared with general internists.*

higher dosages that have already been proved to reduce mortality and morbidity.[9] In addition, the major practice guidelines and some heart failure experts argue that many physicians have been too cautious in using ACE inhibitors, particularly among patients with relative hypotension or renal insufficiency.[8,9,19] Patients with asymptomatic hypotension or moderate renal insufficiency might benefit from the adequate dosage of these medications.[20,21]

Our study has several limitations. The major limitation is that it is a simulation-based survey that does not examine actual physician behavior.[22] We measured knowledge and attitudes about medication use. However, given this hypothetical "test" situation in which the social desirability bias would be to increase the number of "correct" answers, we are probably overestimating the use of ACE inhibitors compared with actual clinical practice. Nonetheless, there is no reason to expect any differential bias across specialties.

Our study has several strengths. We used a national sample of physicians. Our response rate is comparable or higher than that of other physician surveys of prescribing behavior.[23–25] In addition, we used a level of clinical detail in the case simulations that would be extremely difficult to replicate with other methodologies on a national level, allowing us to describe prescribing behavior for patients with heart failure across a range of illness severity.

Several different types of interventions may improve physicians' use of ACE inhibitors in patients with heart failure. First, intensive educational efforts,[26] practice guidelines,[27] and carefully designed incentives to increase the practice of evidence-based medicine[28,29] may improve the use of these medications. However, it is extremely difficult to alter physicians' practice styles.[30]

Second, early specialty consultation might be encouraged. Knowledge increases rapidly, and tends to be adopted first by specialists. Nonetheless, we cannot extrapolate from our data that continuing care from a specialist, especially among the least sick patients, will necessarily lead to better outcomes.

Third, coordinated multidisciplinary interventions and disease management programs for heart failure, of which medication guidelines are an integral part, could improve the appropriateness of drug selection and decrease hospital readmissions and costs.[31,32] These programs' effects on noncardiac outcomes also need to be analyzed, particularly as so many older patients have multiple comorbid conditions.[1]

The best solution for one health care system may not be generalizable to other organizations. Therefore, it may be prudent to allow each health care delivery system to devise the specific manner in which the care of its patients with heart failure is coordinated among different health care providers. Because congestive heart failure is the most common cause of hospitalization in the Medicare population,[33] flexible practice arrangements with easy access to specialists may reduce costs as well as improve outcomes.

The authors thank Nicholas Christakis, MD, PhD, MPH, for his helpful review of the manuscript.

REFERENCES

1. Franks P, Nutting PA, Clancy CM. Health care reform, primary care, and the need for research. JAMA. 1993;270:1449–53.
2. Kassirer JP. Access to specialty care. N Engl J Med. 1994;331: 1151–3.
3. Stevenson WG, Stevenson L, Middlekauff HR, et al. Improving survival for patients with advanced heart failure: a study of 737 consecutive patients. J Am Coll Cardiol. 1995;26:1417–23.
4. Garg R, Yusuf S, Collaborative Group on ACE Inhibitor Trials. Overview of randomized trials of angiotensin-converting enzyme inhibitors on mortality and morbidity in patients with heart failure. JAMA. 1995;273:1450–6.
5. The SOLVD Investigators. Effect of enalapril on survival in patients with reduced left ventricular ejection fractions and congestive heart failure. N Engl J Med. 1991;325:293–302.
6. The SOLVD Investigators. Effect of enalapril on mortality and the development of heart failure in asymptomatic patients with reduced left ventricular ejection fractions. N Engl J Med. 1992; 327:685–91.
7. Pfeffer MA, Braunwald E, Moye LA, et al. Effect of captopril on mortality and morbidity in patients with left ventricular dysfunction after myocardial infarction. Results of the survival and ventricular enlargement trial. The SAVE Investigators. N Engl J Med. 1992;327:669–77.
8. Konstam M, Dracup K, Baker D, et al. Heart Failure: Evaluation and Care of Patients with Left-Ventricular Systolic Dysfunction. Clinical Practice Guideline No. 11. Rockville, Md: Agency for Health Care Policy and Research, Public Health Service, U.S. Department of Health and Human Services; June 1994. AHCPR publication no. 94-0612.
9. American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Guidelines for the evaluation and management of heart failure. J Am Coll Cardiol. 1995;26:1376–98.
10. Young JB, Weiner DH, Yusuf S, et al. Patterns of medication use in patients with heart failure: a report from the Registry of Studies of Left Ventricular Dysfunction (SOLVD). South Med J. 1995; 88:514–23.
11. Bourassa MG, Gurne O, Bangdiwala SI, et al. Natural history and patterns of current practice in heart failure. J Am Coll Cardiol. 1993;22(suppl A):14–9A.
12. McDermott MM, Feinglass J, Sy J, Gheorghiade M. Hospitalized congestive heart failure patients with preserved versus abnormal left ventricular systolic function: clinical characteristics and drug therapy. Am J Med. 1995;99:629–35.
13. Chin MH, Goldman L. Factors contributing to the hospitalization of patients with congestive heart failure. Am J Public Health. 1997;87:643–8.
14. Clarke KW, Gray D, Hampton JR. Evidence of inadequate investigation and treatment of patients with heart failure. Br Heart J. 1994;71:584–7.
15. Rajfer SI. Perspective of the pharmaceutical industry on the development of new drugs for heart failure. J Am Coll Cardiol. 1993; 22(suppl A):198–200A.
16. Chin MH, Wang JC, Zhang JX, Lang RM. Utilization and dosing of angiotensin-converting enzyme inhibitors for heart failure: effect of physician specialty and patient characteristics. J Gen Intern Med. 1997;12:563–6.
17. Aday LA. Designing and Conducting Health Surveys. San Francisco, Calif: Jossey-Bass Publishers; 1989:121–4.
18. Stross JK, Harlan WR. The dissemination of new medical information. JAMA. 1979;241:2622–4.
19. Packer M. Do angiotensin-converting enzyme inhibitors prolong

life in patients with heart failure treated in clinical practice? J Am Coll Cardiol. 1996;28:1323–7.
20. Massie BM, Kramer BL, Topic N. Lack of relationship between short-term hemodynamic effects of captopril and subsequent clinical responses. Circulation. 1984;69:1135–41.
21. Swedberg K, Eneroth P, Kjekshus J, Snapinn S, and the CONSENSUS Trial Study Group. Effects of enalapril and neuroendocrine activation on prognosis in severe congestive heart failure (follow-up of the CONSENSUS Trial). Am J Cardiol. 1990;66:40–5D.
22. Jones TV, Gerrity MS, Earp J. Written case simulations: do they predict physicians' behavior? J Clin Epidemiol. 1990;43:805–15.
23. Ayanian JZ, Hauptman PJ, Guadagnoli E, Antman EM, Pashos CL, McNeil BJ. Knowledge and practices of generalist and specialist physicians regarding drug therapy for acute myocardial infarction. N Engl J Med. 1994;331:1136–42.
24. Friedmann PD, Brett AS, Mayo-Smith MF. Differences in generalists' and cardiologists' perceptions of cardiovascular risk and the outcomes of preventive therapy in cardiovascular disease. Ann Intern Med. 1996;124:414–21.
25. Hlatky MA, Fleg JL, Hinton PC, et al. Physician practice in the management of congestive heart failure. J Am Coll Cardiol. 1986; 8:966–70.
26. Soumerai SB, McLaughlin TJ, Avorn J. Improving drug prescribing in primary care: a critical analysis of the experimental literature. Milbank Q. 1989;67:268–317.
27. Leape LL. Practice guidelines and standards: an overview. Qual Rev Bull. 1990;16:42–9.
28. Hillman AL, Pauly MV, Kerman K, Martinek CR. HMO managers' views on financial incentives and quality. Health Affairs. 1991; 10:207–219.
29. Kerr EA, Mittman BS, Hays RD, Siu AL, Leake B, Brook RH. Managed care and capitation in California: how do physicians at financial risk control their own utilization? Ann Intern Med. 1995;123:500–4.
30. Greco PJ, Eisenberg JM. Changing physicians' practices. N Engl J Med. 1993;329:1271–3.
31. Rich MW, Beckham V, Wittenberg C, Leven CL, Freedland KE, Carney RM. A multidisciplinary intervention to prevent the readmission of elderly patients with congestive heart failure. N Engl J Med. 1995;333:1190–5.
32. West JA, Miller NH, Parker KM, et al. A comprehensive management system for heart failure improves clinical outcomes and reduces medical resource utilization. Am J Cardiol. 1997;79:58–63.
33. Health Care Financing Review, Statistical Supplement. Baltimore, Md: U.S. Department of Health and Human Services; 1995:56.

APPENDIX A

Case Descriptions

Patient 1: Initial Presentation of Heart Failure

A 65-year-old man comes into your office complaining of several weeks of shortness of breath and fatigue. He has no chest pain or dizziness. He is afebrile, blood pressure is 130/80, heart rate is regular with a rate of 80, and respiratory rate is 20. Physical examination is significant for bibasilar rales and a third heart sound. Clinically, you diagnose him with congestive heart failure.

You prescribe him a low-salt diet but feel that he also needs to be started on medication.

A. Assuming that he needs to be started on medication, what is the first medication that you would prescribe him? (Circle **one**)

a. Alpha blocker
b. Angiotensin-converting enzyme inhibitor
c. Calcium channel blocker
d. Digitalis
e. Diuretic
f. Isosorbide-hydralazine combination
g. Other
Please specify:_____

You send him home on one medication and a low-salt diet. You order an echocardiogram, which reveals an ejection fraction of 35%. He returns to your clinic in 2 weeks. He is improved, but still has some shortness of breath. Blood pressure is 125/78 and heart beat is regular with a rate of 76. On physical examination his rales have disappeared, but he has a persistent third heart sound.

B. Assuming that he needs to be started on an additional medication, what is the next medication that you would add to his regimen? (Circle **one**)

a. Alpha blocker
b. Angiotensin-converting enzyme inhibitor
c. Calcium channel blocker
d. Digitalis
e. Diuretic
f. Isosorbide-hydralazine combination
g. Other
Please specify:_____

Patient 2: Asymptomatic

You see a 59-year-old man with ischemic heart disease and an ejection fraction of 28%. His blood pressure is 125/78 mm Hg and his heart rate is 75. He is in normal sinus rhythm. He is *asymptomatic*. He is taking aspirin, but is on *no* cardiac medications for congestive heart failure.

A. Give your best guess as to this patient's percentage chance of developing symptoms or signs of congestive heart failure over the next 3 years *if he receives no additional medications during this time period.* (Fill in the blank) _____%

B. What one medication, if any, would you prescribe him *at this time* when he is *asymptomatic*? (Circle **one** answer)

a. Alpha blocker
b. Angiotensin-converting enzyme inhibitor
c. Calcium channel blocker
d. Digitalis
e. Diuretic
f. Isosorbide-hydralazine combination
g. I would not add any medications.
h. I would add a different medication.
Please specify:_____

C. If you decided to prescribe him a medication at this time, give your best guess as to this patient's percentage chance of developing symptoms or signs of congestive heart failure over the next 3 years on this medication. (Fill in the blank) _____%

Patient 3: Chronic Congestive Heart Failure

You see a 60-year-old man with chronic congestive heart failure and an ejection fraction of 25%. His blood pressure is 125/78 mm Hg and his heart rate is 80. He is in normal sinus rhythm. He has stable class II-III CHF symptoms. He is already on a diuretic and digitalis.

A. Give your best guess as to this patient's percentage chance of dying over the next 3–4 years *if he receives no additional medications during this time period.* (Fill in the blank) _____%

B. What one additional medication, if any, would you now prescribe him? (Circle **one** answer)

a. Alpha blocker
b. Angiotensin-converting enzyme inhibitor
c. Calcium channel blocker
d. Isosorbide-hydralazine combination
e. I would not add any other medications.
f. I would add a different medication.
Please specify:_____

C. If you decided to prescribe him a medication at this time, give your best guess as to this patient's percentage chance of dying over the next 3–4 years on this medication. (Fill in the blank) _____%

Patient 4: Asymptomatic Post–Myocardial Infarction

A 65-year-old man was admitted to the hospital 11 days ago with chest pain. He subsequently was diagnosed with myocardial infarction. Ejection fraction obtained during the hospitalization was 30%. He has *no* overt symptoms of myocardial ischemia or congestive heart failure. His blood pressure is 130/80 mm Hg and his heart rate is 78. He is in normal sinus rhythm.

A. Give your best guess as to this patient's percentage chance of dying over the next 3–4 years *if he receives no additional medications during this time period.* (Fill in the blank) _____%

B. What medication or medications, if any, would you tend to prescribe him? (Circle **all** that apply)

a. Alpha blocker
b. Angiotensin-converting enzyme inhibitor
c. Aspirin
d. Beta blocker
e. Calcium channel blocker
f. Digitalis
g. Diuretic
h. Isosorbide-hydralazine combination
i. I would not add any other medications.
j. I would add a different medication.
Please specify: _____

C. If you decided to prescribe him medication at this time, give your best guess as to this patient's percentage chance of dying over the next 3–4 years on this medication regimen. (Fill in the blank) _____%