Volume Title: Health Care Issues in the United States and Japan

Volume Author/Editor: David A. Wise and Naohiro Yashiro, editors

Volume Publisher: University of Chicago Press

Volume ISBN: 0-262-90292-7

Volume URL: http://www.nber.org/books/wise06-1

Conference Date: May 1-3, 2003

Publication Date: September 2006

Title: A Comparison of the Quality of Health Care in the United States and Japan

Author: Haruko Noguchi, Yuichiro Masuda, Masafumi Kuzuya, Akihiko Iguchi, Jeffery Geppert, Mark McClellan

URL: http://www.nber.org/chapters/c7364

7

A Comparison of the Quality of Health Care in the United States and Japan
Treatment and Outcomes for Heart Attack Patients

Haruko Noguchi, Yuichiro Masuda, Masafumi Kuzuya, Akihiko Iguchi, Jeffery Geppert, and Mark McClellan

7.1 Introduction

Heart disease is the leading cause of death in the United States, and acute myocardial infarctions (AMIs), or, more colloquially, "heart attacks," are directly or indirectly responsible for most of these deaths. In Japan, as in the United States, heart disease has become one of the significant causes of death. Approximately more than one-third of those with heart diseases died of AMI in 1998 (the death ratios per 0.1 million caused by AMI are 43.3 for males, 34.3 for females, and 38.7 for both sexes; Health and Welfare Statistics Association 2000). Though death from AMI remains less common in Japan than in the United States, the increasing incidence of AMI and the overall aging of Japanese society suggests that heart

Haruko Noguchi is an associate professor in the Faculty of Social Sciences at Toyo Eiwa University. Yuichiro Masuda is a medical doctor in the Department of Geriatrics, Graduate School of Medicine, Nagoya University. Masafumi Kuzuya is a medical doctor and professor in the Department of Geriatrics, Graduate School of Medicine, Nagoya University. Akihiko Iguchi is a professor in the Graduate School of Medicine, Nagoya University. Jeffery Geppert is a senior research associate at Social Policy and Health Economics Research and Evaluation (SPHERE) and a member at Acumen, LLC, as well as a senior research analyst at the Center for Health Policy at Stanford University. Mark McClellan is the administrator of the Centers for Medicare and Medicaid Services, an associate professor of economics and of medicine at Stanford University, and a research associate of the National Bureau of Economic Research.

This project received substantial financial support from the Pfizer Health Research Foundation, the Japan Foundation Center for Global Partnership (through Japan Center for Economic Research), the Health Care Financing Administration (through California Medical Review, Inc.), and the National Institute on Aging. We greatly appreciate all the medical facilities that collaborated in this project. The project was approved by these medical facilities and the Ethics Committee of the Department of Geriatrics, Nagoya University. All errors are our own.

attacks may become a significant health problem in the future, much as cancer is now.

This study had several main objectives. The first was to create a data set containing information on treatments and outcomes among AMI patients in Japan, comparable to the Cooperative Cardiovascular Project (CCP)[1] in the United States. The CCP is a major policy initiative to improve the quality of care for Medicare beneficiaries with AMI undertaken by the Health Care Financing Administration (currently called the Center for Medicare and Medicaid Services). The second objective was to investigate variation between the United States and Japan in the quality of health care for elderly patients (age sixty-five or over) with AMI, with respect to treatments and outcomes and controlling for chart-based detailed clinical information. In this study, we divide medical procedures performed on AMI patients into high-tech and low-tech treatments. We define *high-tech treatments* as those with large fixed or marginal costs and *low-tech treatments* as those with relatively low fixed and marginal costs. Low-tech treatments, in principle, could be provided by virtually any medical facility (McClellan and Noguchi 1998). Both types of procedures are used widely enough to contribute substantially to patient outcomes and hospital expenditure.

This paper is organized as follows. Section 7.2 reviews related previous research. Section 7.3 justifies the empirical specification we use in this study. Section 7.4 describes the data on patient characteristics and treatments received. Section 7.5 uses a bivariate probit procedure to investigate the determinants of patient outcomes and hospital expenditure, mainly focusing on treatment differences. Section 7.6 discusses our findings and concludes.

7.2 Previous Research

Cardiac catheterization, a procedure that visualizes blood flow to the heart muscle through continuous radiologic images of the flow of dye injected into the coronary arteries, is the first step for an important set of high-tech intensive treatments for heart attack. If this procedure detects substantial blockages, it may be followed by a revascularization procedure

1. During the national phase of the CCP project, HCFA conducted standardized abstractions of the medical records of all Medicare beneficiaries hospitalized with AMI over an eight-month period at essentially all hospitals in the United States that had not participated in a four-state pilot phase. The eight-month sampling frame was continuous at each hospital, and all sampling occurred between April 1994 and July 1995. Marciniak et al. (1998) provide more details on CCP goals, sampling and data collection strategy, and methods used to assure standardization and completeness of the medical record reviews. Altogether, charts were abstracted for approximately 180,000 AMI patients. These data were linked to Medicare administrative records (enrollment and hospitalization files), which have been used in previous observational studies of AMI practices and outcomes but do not include the clinical details present in the medical record abstracts. The enrollment files include comprehensive all-cause mortality information from Social Security records.

intended to improve blood flow to the heart. The two common revascularization procedures are angioplasty (PTCA, or percutaneous transluminal coronary angioplasty), which involves the use of a balloon (or stent, recently) at the end of a catheter to eliminate blockages, and bypass surgery (CABG, or coronary-artery bypass graft surgery), a major open-heart surgical procedure to bypass the area of blockage.

Despite the importance of heart attacks for population health and the importance of these intensive procedures for health care resources use, the procedures have been studied in only a limited number of randomized clinical trials. Several trials examined the effectiveness of bypass surgery in the early 1980s and angioplasty in the following years. In general, these trials found limited mortality benefits in a few subgroups of patients treated. Trials of bypass surgery versus no intensive procedures included Brown et al. (1981), Takekoshi, Murakami, and Nakajima (1983), and Koshal et al. (1988). Trials of angioplasty included Erbel et al. (1986), Simmoons et al. (1988), TIMI Study Group (1989), and Zijlstra et al. (1993). But most of these studies focused primarily on the immediate use of angioplasty, rather than on its use at all during the episode of treatment for heart attack. Reflecting changes in expectations about treatment benefits, recent trials have focused on narrower questions about use of the intensive procedures, such as the timing of catheterization (e.g., Califf and TAMI VA Study Group 1991), the choice between angioplasty and bypass surgery, and the use of catheterization in very narrow subsets of patients (e.g., VANQWISH Study Group 1998).

Nonetheless, the procedures have become much more widely used in heart attack patients for several reasons. First, the equipment quality and personnel skill involved in the procedure has improved substantially since the time of the trials, leading to much lower complication rates. Second, trials on many types of heart disease patients, such as women and the elderly, were regarded as too costly to justify additional studies given the previous trial results. Third, as experience accumulated, fewer and fewer patients were willing to be randomized for such an important decision as an intensive cardiac procedure. As with many other intensive medical technologies, these heart procedures are now used in a much broader range of patients than have been explicitly supported by randomized trials.

Consequently, these procedures have been studied frequently using observational methods. In Japan, there have also been several observational studies on the effects of intensive procedures on patient outcomes, that is, by the Japanese Society of Interventional Cardiology. Studies based on direct comparisons of treated and nontreated patients have generally found that intensive cardiac procedures like bypass surgery were associated with significant and substantial mortality reductions in these additional patients, even after accounting for observational difference. For example, using the propensity-score methods reviewed in the following, Rosenbaum and Rubin (1984) estimate a large improvement in functional status and in survival for patients with heart disease undergoing bypass surgery. In contrast, observational studies using new statistical methods, such as instrumental variables (IV; e.g., McClellan, McNeil, and Newhouse 1994; McClellan and Newhouse 1997; McClellan and Noguchi 1998, 2001) and general method of moments (GMM; e.g., McClellan and Staiger 2000a,b) have found small mortality effects that appear to be due at least in part to other associated treatments. The estimation methods appear to matter for the results in this case, and the source of the discrepancy in the results—either in differences in biases or differences in the subpopulations included in the effect estimates—is unclear. These sorts of inconsistencies have plagued observational studies of treatment effects and limited their relevance for clinical practice and policies intended to influence it. Either IV or GMM is appropriate for population-based data with enough variation among patients and medical facilities such as the CCP, but not for data with a small number of observations and little variation, like the data we collected in Japan for this project.

First, therefore, we use a bivariate probit procedure in order to examine the effects of cardiac catheterization as a high-tech procedure on patient outcomes and hospital expenditures. Second, we will also focus on low-tech treatments during hospitalizations, such as aspirin, beta-blockers, calcium channel blockers, and smoking cessation. Unlike high-tech treatments, these drug treatments have been studied in a large number of randomized clinical trials since the 1980s (e.g., Lewis, Davis, and Archibald 1983; ISIS-2 Collaborative Group 1988; Kober et al. 1995; MERIT-HF 1999; and CIBIS-II 1999). The recent update of the 1999 ACC/AHA (American Heart Association/American College of Cardiology) guidelines originally released in 1996 collected scientific evidence regarding the benefits and risks of these drugs, including both randomized trial and observational studies. The ACC/AHA guidelines for AMI patients recommend aspirin use and smoking cessation during hospitalization, and aspirin, beta-blockers, and angiotensin converting enzyme (ACE) inhibitors at discharge. The ACC/AHA states that encouraging these procedures will contribute to improving survival probabilities in the population. This statement is consistent with conclusions from several studies based on the CCP (e.g., Jencks et al. 2000; Frances et al. 2000; Shilipak et al. 2001; Shlipak et al. 2002).

Using the exclusion and inclusion criteria for these treatments from the ACC/AHA guidelines (table 7A.1), we will examine how many patients were identified as good candidates for aspirin, beta-blockers; calcium channel blockers; and smoking cessation during hospitalization and how they were actually treated.[2]

2. For thrombolytic drugs—IV nitrogen and ACE inhibitors—the complete indicators for exclusion or inclusion criteria to determine ideal or good candidates are not available in our Japanese data.

7.3 Empirical Specification and Measurements

In this section, we explain our empirical specification for estimating the effects of high-tech and low-tech treatments after hospitalization on outcomes and medical expenditures and for investigating the variation in the quality of care across countries. Cardiac catheterization can be considered as the entry procedure for further intensive revascularization procedures. The mean and median durations between hospital admission and catheterization in our data are eight days and twenty-four hours, respectively. Thus, we use seven-day catheterization to measure the effects of high-tech procedures on outcomes and expenditure.

We will apply a bivariate probit procedure for evaluating the impacts of seven-day catheterization on the following dichotomous dependent variables: thirty-day and one-year mortality, and ninety-day and one-year hospital readmission for any cause. A seemingly unrelated regression method is used for the continuous dependent variables: ninety-day and one-year medical expenditures and length of stay from the first hospital admission[3] (Maddala and Lee 1976; Maddala 1983; Greene 1993, 1998). We use these dependent variables as measures for evaluating the quality of care for AMI patients. In addition to seven-day catheterization, we include five low-tech procedures into our model as explanatory variables: use of thrombolytics, aspirin, beta-blockers, and ACE inhibitors and smoking cessation during hospital stay. We expect these low-tech procedures to be highly correlated with aggressive high-tech procedures. All regressions are controlled for patient demographic and chart-based comorbidity and severity measures.

There are a couple of major reasons for adopting a bivariate probit procedure in this study: (a) we suspected that the simple least squares procedure would produce inappropriate estimates because the dependent variables are binominal (0 or 1); (b) for estimating the effects of seven-day catheterization on patient outcomes and hospital expenditure, one single regression analysis including catheterization as an explanatory variable will be inappropriate and statistically biased as whether a patient undergoes cardiac catheterization within seven days after admission is endogenous. Seven-day catheterization would be highly correlated with patient characteristics and other drug use so that the independence among explanatory variables cannot be assumed to hold in the simple least squares method. Therefore, it is appropriate to assume a bivariate distribution for two probabilities: the likelihood a patient undergoes seven-day catheterization and the likelihood a patient dies or is readmitted within a certain period after discharge.

3. As regards the length of hospital stay, like hospital expenditure, ninety-day and one-year total durations of stay are ideal as measuring patient outcomes. However, the lengths of hospital stay after the first readmission are available only for limited number of patients in Japanese data.

The key regression formulas are the following:

(1) $y_1^* = \beta_1 X_1 + \varepsilon_1 \quad y_1 = 1 \text{ if } y_1^* > 0, 0 \text{ otherwise}$

(2) $y_2^* = \beta_2 X_2 + \varepsilon_2 \quad y_2 = 1 \text{ if } y_2^* > 0, 0 \text{ otherwise},$

where $\varepsilon_1 \sim N(0,1)$, $\varepsilon_2 \sim N(0,1)$, $\text{cov}(\varepsilon_1, \varepsilon_2) = \rho$; y_1^* and y_2^* show unobserved underlying index determining seven-day catheterization and patient outcomes; y_1 and y_2 are the observed patterns of seven-day catheterization and patient outcomes; and, finally, X_1 and X_2 include patient demographic characteristics, comorbidity, severity, and drug treatments. The dependent variables, y_1^* and y_2^* themselves cannot be directly observed. However, with respect to regression formula (1), y_1 equals 1 if the patient underwent seven-day catheterization and 0 otherwise. Also, with respect to regression formula (2), y_2 equals 1 if the patient dies or is readmitted to the hospital within a certain period after discharge and 0 otherwise. The independent variables, X_1 and X_2, include patient demographic characteristics; severity and comorbid measures; and drug use such as thrombolytics, aspirin, beta-blockers, and ACE inhibitors; and smoking cessation during hospital stay. The residuals from the two regressions, ε_1 and ε_2, were assumed to have the standard normal distribution. In other words, we assumed the expected values were $E(\varepsilon_1) = E(\varepsilon_2) = 0$, and the distributions were $\text{Var}(\varepsilon_1) = \text{Var}(\varepsilon_2) = 1$. The covariance of ε_1 and ε_2 was to be $\text{Cov}[\varepsilon_1, \varepsilon_2] = \rho$. We introduce the bivariate predicted probabilities as follows:

Φ_{11}: seven-day catheterization ($y_1 = 1$) and the patient dies or is readmitted ($y_2 = 1$)

Φ_{10}: seven-day catheterization ($y_1 = 1$) and the patient does not die or is not readmitted ($y_2 = 0$)

Φ_{01}: no seven-day catheterization ($y_1 = 0$) and the patient dies or is readmitted ($y_2 = 1$)

Φ_{00}: no seven-day catheterization ($y_1 = 0$) and the patient does not die or is not readmitted ($y_2 = 0$)

The log-likelihood function to be maximized in terms of β_1, β_2, and ρ is

(3) $$\ln L(\beta_1, \beta_2, \rho) = \sum y_1 y_2 \ln \Phi_{11} + \sum y_1(1 - y_2) \ln \Phi_{10} + \sum (1 - y_1) y_2 \ln \Phi_{01} + \sum (1 - y_1)(1 - y_2) \ln \Phi_{00}.$$

Note that because the hospital expenditure variable is continuous, we will utilize a seemingly unrelated regression procedure that assumes a bivariate probability distribution based on a linear regression rather than the bivariate probit procedure.

7.4 Data

Charts were abstracted for 371 AMI patients admitted to ten medical facilities located in an urban area of Aichi prefecture in Japan. Charts were carefully reviewed by research nurses and physicians, with all sampling taking place between January and December 1995. The CCP includes Medicare enrollees, most of whom are sixty-five years and older. The population in this study was comparable, with 190 patients (out of 371) age sixty-five years and older. The median number of patients admitted to each medical facility within the study period was 23, and the median number of catheterizations performed was eighteen. We followed standardized procedures for abstracting medical records, similar to those used by the Health Care Financing Administration (HCFA) for the CCP. The record abstracts contain over 100 comorbidity and severity measures. The CCP's expert advisory panel believed that these measures collectively summarize all of the major associated diseases, functional status impairments, and aspects of AMI severity that would influence the appropriateness of major AMI treatment decisions and health outcomes.

For the U.S. sample, we extracted 889 patients from sixteen hospitals. These patients were chosen out of approximately 180,000 CCP patients with the goal of making the U.S. sample comparable to the Japan sample. First, we selected five metropolitan statistics areas (MSAs) in the United States with rates of AMI incidence similar to Aichi prefecture (between 190 and 200 per 100,000 per year). Second, because the Japanese data only includes catheterization facilities, we excluded noncatheterization hospitals (defined as hospitals that performed fewer than four catheterizations per year, the minimum number of catheterizations in the Japanese data). Thus, we extracted patients hospitalized in medical facilities providing care with a similar level of technology in both countries. The median number of CCP patients admitted to each hospital was eighty, and the median number of catheterizations performed at each hospital was thirty-three. Therefore, the number of patients and catheterizations per year in each hospital are several times larger in the United States. Sampling for the CCP occurred between April 1994 and July 1995 at essentially all hospitals in the United States, which is slightly different than the sampling time frame for the Japanese data. A major technological change—the aggressive use of stent for PTCA or percutaneous coronary intervention (PCI)—occurred in 1996 to 1997 in both countries, but the difference in time frames between the studies would not likely affect our results. Note that all the results obtained in this study are not necessarily generalizable because all the included hospitals are high-volume catheterization hospitals in urban areas. Also, note that the following statistical analyses of the CCP data are weighted by the number of patients in each MSA.

7.4.1 Patient Heterogeneity

Table 7.1 illustrates the data elements in record abstracts from the CCP and Japanese data. This highlights some of fundamental problems in observational analyses based on direct comparisons of treated and nontreated patients. The table shows that the fraction of patients who underwent catheterization was approximately 45 percent in the United States and 78 percent in Japan. In the United States, catheterized patients were more likely to be younger and male, although the gender gap of treatments in the Japanese data is trivial. This may explain why there are so few studies on the effect of gender on disease outcomes in Japan (e.g., Oe et al. 2002) or on treatment differences by gender. In contrast, the gender gap in the treatment of coronary artery disease in the United States has been widely explored, although the reasons for the disparity remain inconclusive. (See, for example, Harrold et al. 2003; Bertoni et al. 2004; Weisz, Gusmano, and Rodwin 2004; Hochman et al. 1999; and Rodwin and Gusmano 2002.) Demographic differences between treated and nontreated patients were described in previous studies based on less-detailed administrative records (e.g., McClellan, McNeil, and Newhouse 1994). Rates of some of the additional comorbidity and severity variables are also reported; treated and nontreated patients differ substantially in almost all of these dimensions, with catheterized patients generally appearing to be in better health. Catheterized patients are much more likely than noncatheterized patients to be in good functional status (e.g., independent mobility). Also, they are generally less likely to have serious comorbid diseases like prior heart failure, posterior vitreous detachment (PVD) or claudication, cerebral hemorrhage, renal failure, and liver failure. The only exception is in the prevalence of chest pain due to heart problems prior to the AMI, which is a common indication for catheterization. Patients undergoing catheterization were much more likely to be alert and oriented on initial admission, to have no signs of serious heart failure (e.g., high heart rate or low blood pressure), and to have good kidney function as shown by nonelevated blood nitrogen. With literally hundreds of variables that describe patient characteristics, interpreting the cumulative consequences of the differences for outcomes is difficult. For this reason, we constructed a summary indicator of disease comorbidity and severity. The Killip class is based on a number of clinical characteristics related to the extent of heart failure in an AMI patient. This measure has been shown to provide a reliable predictor of short-term AMI mortality. Killip classes 3 and 4 indicate moderate and severe heart failure, while Killip classes 1 and 2 indicate relatively mild heart failure. As table 7.1 shows, catheterized patients in both countries are much more likely to be in the lowest Killip class. These results provide clear evidence that patient heterogeneity is a fundamental challenge for

Table 7.1 Key variable definitions and summary statistics for patient characteristics

	United States						Japan					
	Total		No 7-day cath		7-day cath		Total		No 7-day cath		7-day cath	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Demographic characteristics												
Female	0.460	(0.499)	0.514	(0.500)	0.388	(0.488)	0.332	(0.472)	0.333	(0.475)	0.331	(0.472)
Black	0.127	(0.333)	0.163	(0.370)	0.079	(0.270)	—	—	—	—	—	—
Age in years	73.904	(9.653)	76.028	(9.945)	71.073	(8.469)	73.379	(6.494)	75.470	(7.766)	72.266	(5.416)
Severity measures												
Killip class 1	0.529	(0.499)	0.437	(0.497)	0.651	(0.477)	0.771	(0.421)	0.600	(0.494)	0.867	(0.341)
Killip class 2	0.125	(0.331)	0.138	(0.345)	0.108	(0.310)	0.052	(0.223)	0.091	(0.290)	0.031	(0.173)
Killip class 3	0.319	(0.467)	0.398	(0.490)	0.215	(0.412)	0.131	(0.338)	0.236	(0.429)	0.071	(0.259)
Killip class 4	0.027	(0.162)	0.028	(0.164)	0.026	(0.160)	0.046	(0.210)	0.073	(0.262)	0.031	(0.173)
Treatment measures												
Catheterization during stay	0.450	(0.498)	0.037	(0.190)	1.000	(0.000)	0.779	(0.416)	0.364	(0.485)	1.000	(0.000)
1-day catheterization	0.168	(0.374)	0.000	(0.000)	0.391	(0.489)	0.589	(0.493)	0.000	(0.000)	0.903	(0.297)
7-day catheterization	0.429	(0.495)	0.000	(0.000)	1.000	(0.000)	0.653	(0.477)	0.000	(0.000)	1.000	(0.000)
30-day catheterization	0.445	(0.497)	0.030	(0.169)	1.000	(0.000)	0.737	(0.442)	0.242	(0.432)	1.000	(0.000)
90-day catheterization	0.445	(0.497)	0.030	(0.169)	1.000	(0.000)	0.768	(0.423)	0.333	(0.475)	1.000	(0.000)
1-year catheterization	0.445	(0.497)	0.030	(0.169)	1.000	(0.000)	0.768	(0.423)	0.333	(0.475)	1.000	(0.000)
angioplasty during stay	0.169	(0.375)	0.012	(0.108)	0.378	(0.486)	0.537	(0.500)	0.152	(0.361)	0.742	(0.439)
1-day angioplasty	0.078	(0.268)	0.000	(0.000)	0.183	(0.387)	0.411	(0.493)	0.000	(0.000)	0.629	(0.485)
7-day angioplasty	0.159	(0.366)	0.002	(0.044)	0.371	(0.484)	0.489	(0.501)	0.030	(0.173)	0.734	(0.444)
30-day angioplasty	0.164	(0.370)	0.010	(0.099)	0.371	(0.484)	0.516	(0.501)	0.106	(0.310)	0.734	(0.444)
90-day angioplasty	0.164	(0.370)	0.010	(0.099)	0.371	(0.484)	0.532	(0.500)	0.152	(0.361)	0.734	(0.444)
1-year angioplasty	0.164	(0.370)	0.010	(0.099)	0.371	(0.484)	0.532	(0.500)	0.152	(0.361)	0.734	(0.444)

(continued)

Table 7.1 (continued)

	United States						Japan					
	Total		No 7-day cath		7-day cath		Total		No 7-day cath		7-day cath	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Cardiac bypass surgery during stay	0.111	(0.315)	0.002	(0.044)	0.257	(0.438)	0.011	(0.102)	0.000	(0.000)	0.016	(0.126)
1-day cardiac bypass surgery during stay	0.010	(0.100)	0.000	(0.000)	0.024	(0.152)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
7-day cardiac bypass surgery during stay	0.083	(0.276)	0.000	(0.000)	0.194	(0.396)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
30-day cardiac bypass surgery during stay	0.111	(0.315)	0.002	(0.044)	0.257	(0.438)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
90-day cardiac bypass surgery during stay	0.111	(0.315)	0.002	(0.044)	0.257	(0.438)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
1-year cardiac bypass surgery during stay	0.111	(0.315)	0.002	(0.044)	0.257	(0.438)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
Angiotensin-converting-enzyme during stay	0.369	(0.483)	0.385	(0.487)	0.349	(0.477)	0.315	(0.466)	0.230	(0.424)	0.358	(0.482)
Warfarin during stay	0.183	(0.387)	0.155	(0.362)	0.220	(0.415)	0.166	(0.373)	0.032	(0.177)	0.237	(0.427)
Heparin > 4000 U during stay	0.707	(0.455)	0.573	(0.495)	0.885	(0.320)	0.897	(0.305)	0.823	(0.385)	0.934	(0.249)
Thrombolytics during stay	0.158	(0.365)	0.103	(0.304)	0.231	(0.422)	0.315	(0.466)	0.210	(0.410)	0.370	(0.485)
Aspirin during stay	0.753	(0.432)	0.629	(0.484)	0.916	(0.278)	0.711	(0.455)	0.574	(0.499)	0.782	(0.415)
IV nitrogen during stay	0.551	(0.498)	0.433	(0.496)	0.709	(0.455)	0.757	(0.430)	0.734	(0.445)	0.769	(0.423)
Beta-blocker during stay	0.428	(0.495)	0.323	(0.468)	0.567	(0.496)	0.062	(0.242)	0.017	(0.131)	0.084	(0.279)

Angiotensin-converting-enzyme at discharge	0.321	(0.467)	0.370	(0.484)	0.270	(0.445)	0.297	(0.459)	0.236	(0.429)	0.330	(0.473)
Warfarin at discharge	0.199	(0.399)	0.192	(0.395)	0.206	(0.405)	0.153	(0.361)	0.000	(0.000)	0.229	(0.423)
Aspirin at discharge	0.668	(0.471)	0.571	(0.496)	0.770	(0.422)	0.686	(0.465)	0.482	(0.504)	0.784	(0.413)
Beta-blocker at discharge	0.314	(0.464)	0.259	(0.439)	0.371	(0.484)	0.083	(0.276)	0.073	(0.262)	0.088	(0.284)
Calcium channel blocker at discharge	0.428	(0.495)	0.484	(0.500)	0.368	(0.483)	0.404	(0.492)	0.382	(0.490)	0.414	(0.495)
Smoking cessation during stay	0.074	(0.262)	0.065	(0.247)	0.087	(0.282)	0.079	(0.272)	0.138	(0.351)	0.029	(0.171)
Outcome measures												
Died within 1 day	0.066	(0.249)	0.102	(0.303)	0.018	(0.134)	0.042	(0.201)	0.061	(0.240)	0.032	(0.177)
Died within 7 days	0.143	(0.350)	0.201	(0.401)	0.066	(0.248)	0.068	(0.253)	0.106	(0.310)	0.048	(0.215)
Died within 30 days	0.198	(0.399)	0.278	(0.448)	0.092	(0.289)	0.121	(0.327)	0.197	(0.401)	0.081	(0.273)
Died within 1 year	0.318	(0.466)	0.445	(0.497)	0.150	(0.357)	0.289	(0.455)	0.318	(0.469)	0.274	(0.488)
In-hospital death from 1st admission	0.182	(0.386)	0.250	(0.433)	0.092	(0.289)	0.158	(0.366)	0.288	(0.456)	0.089	(0.285)
90-day total expenditure in PPP$	11841.520	(13761.830)	9427.900	(12093.490)	15059.680	(15141.540)	24,503	(17,207)	14,699	(12.054)	28,354	(17,560)
1-year total expenditure in PPP$	15180.470	(17928.130)	13056.990	(16696.120)	18011.780	(19107.910)	28,938	(17,977)	21,330	(15,760)	31,790	(18,102)
90-day readmission	0.292	(0.455)	0.294	(0.456)	0.289	(0.454)	0.425	(0.498)	0.250	(0.444)	0.491	(0.505)
1-year readmission	0.421	(0.494)	0.438	(0.497)	0.397	(0.490)	0.712	(0.456)	0.450	(0.510)	0.811	(0.395)
Length of stay from 1st hospital admission	8.514	(100.819)	7.902	(97.621)	9.332	(103.970)	32.314	(30.267)	36.424	(45.256)	30.144	(17.786)
Number of observations	889		508		381		190		66		124	

Notes: For United States, tables gives weighted mean values by the number of patients in each metropolitan statistical area. PPP = purchasing power parity.

observational studies that rely on direct comparisons of catheterized and noncatheterized patients.

7.4.2 Treatment Heterogeneity

Table 7.1 also shows that outcomes may differ between catheterized and noncatheterized patients due to differences in treatments other than catheterization. Our medical reviews include substantial information on a range of treatments besides cardiac procedures, especially drug treatments, which might influence outcomes.

First, regarding high-tech treatments, the table shows that Japanese patients tend to be more aggressively treated than the CCP patients. Among the CCP patients, 45 percent receive an angioplasty and 17 percent are catheterized, whereas the rates of these intensive treatments among the Japanese patients are 78 percent and 54 percent, respectively. Also, the timing of clinical decision making for intensive procedures is much earlier in Japan than in the United States. Within twenty-four hours after hospital admission, almost 60 percent of patients in Japan were treated by catheterization, and 40 percent were treated with angioplasty; the comparable rates among CCP patients were only 17 percent and 8 percent, respectively. Our findings are consistent with previous studies showing that, compared to other developed countries, angioplasty has rapidly spread in Japan since it was first performed in 1980 (Sasakuri et al. 1997), and rates of PCI following cardiac catheterization are much higher in Japan (e.g., Nippon Shinkekkan Intervention Gakkai Gakujutsu Iinkai 1993; Endo and Koyanagi 1994). These previous studies also found that the ratio of angioplasty to cardiac bypass surgery is much higher in Japan. Our results are consistent with the previous results. We find that in the United States, 17 percent of patients were treated with angioplasty and 11 percent with bypass surgery, whereas the rates in Japan were 54 percent and only 1 percent, respectively.[4] This extremely high ratio may be caused by alarmingly high mortality from cardiac bypass surgery in the early stage of diffusing bypass technology in Japan (Sezei et al. 1970; Hayashi 1972; Asada et al. 1970) and more-attractive reimbursement for angioplasty than bypass surgery (Yoshikawa et al. 2002).

Table 7.1 shows that patients who receive catheterization are more likely to receive a variety of other beneficial treatments in both countries. For example, during hospitalization they are much more likely to receive aspirin, which has been directly shown to reduce AMI mortality (92 versus 63 percent in the United States and 78 versus 57 percent in Japan); they are more

4. Previous studies (e.g., Nippon Shinkekkan Intervention Gakkai Gakujutsu Iinkai 1993; Endo and Koyanagi 1994) found that the ratio of angioplasty to bypass surgery is almost 5 to 1, on average, but it varies among regions—4 to 1 in the eastern region of Japan and 8 to 1 in the western region. Therefore, the results based on the data from collaborative medical centers in this study are extremely biased, with respect to the use of cardiac bypass surgery.

likely to receive thrombolytic or "clot-busting" drugs, which help dissolve the blood clot that causes the AMI (23 versus 10 percent in the United States and 37 versus 21 percent in Japan); and they are more likely to receive beta-blockers, which reduce the workload of the heart (57 versus 32 percent in the United States and 8 versus 2 percent in Japan). Catheterized patients in both countries are also more likely to receive protective drug treatments after discharge that might improve long-term outcomes, including aspirin and beta-blockers. But, in the United States, catheterized patients are slightly less likely to receive ACE inhibitors both during hospitalization and at discharge. These drugs are used primarily in patients with chronic heart failure (that is, patients who have had more severe AMIs). In the Japanese data, catheterized patients are more likely to receive them. In addition to these observed treatments, there are probably many other unobserved treatments and environmental influences that might differ for catheterized versus noncatheterized patients and also contribute to outcome differences.

7.4.3 Outcome Differences

The final section of table 7.1 shows the consequences of catheterization as well as of these differences in individual characteristics and treatments for patient outcomes. Not surprisingly, the differences are large, yet these differences are much larger in the United States than Japan. Noncatheterized patients have one-year mortality rates 31 percentage points higher (46 versus 15 percent) in the United States and 5 percentage points higher (32 versus 27 percent) in Japan. Large mortality differences appear at one day (10 percent versus 2 percent in the United States and 6 percent versus 3 percent in Japan) and increase steadily. These results suggest that catheterized patients have much lower mortality risks for all time intervals after AMI than noncatheterized patients, but many other treatment differences may also contribute to the observed mortality differences.

Although patients we focus on in this study are sixty-five and older and so are covered by similar fee-for-service reimbursement systems in both countries, medical facilities in the Japanese data have weaker incentives for cost containment. One-year hospital expenditures, calculated using purchasing power parity, are higher for catheterized patients in both countries ($18,011 versus $13,057 in the United States, $31,790 versus $21,330 in Japan). In general, the mean length of stay from the first hospital admission is much shorter in the United States than in Japan (nine days versus thirty-two days). The longer length of hospital stay is one of the major causes of higher expenditures in Japan versus the United States. Further, seven-day catheterization has a reverse effect on the length of hospital stay between the CCP and Japanese patients. A CCP patient who undergoes an intensive procedure tends to stay in a hospital longer by approximately one day compared to the one who does not, while the hospital stay for a patient in Japan is six days shorter. In our Japanese data, almost 60 percent of patients underwent catheterization immediately after hospital admission. Patients who do not undergo seven-day catheterization tend to suffer from more-severe heart attacks so that they are expected to stay in hospitals longer than catheterized patients, probably for clinical reasons.

Like the health outcome differences, however, these differences may simply reflect differences in patient characteristics or treatments other than the effect of catheterization. For example, because catheterized patients are more likely to survive, they may have higher medical expenditures independent of catheterization use. Hence, we have to examine carefully the effects of seven-day catheterization on patient outcomes and hospital expenditures, controlling for both patient and treatment heterogeneity.

7.5 Results

Table 7.2 shows the marginal effects calculated based on the results of a bivariate probit analysis for each country. Panel A of table 7.2 indicates the results of regression equation (1), with the binomial dependent variable equaling 1 when a patient underwent seven-day catheterization and 0 otherwise. Also, panel B shows the results of regression equation (2), with the binomial dependent variable equaling 1 when a patient died or was readmitted to the hospital within a certain period after discharge and 0 otherwise. Each panel in table 7.2 shows only the treatment variables of interest, and all regressions include controls for detailed patient characteristics.

7.5.1 Effects of High-Tech Procedure on the Quality of Care

First, we discuss the effects of high-tech interventions on patient outcomes, hospital expenditures, and length of stay. As shown in the panel B of table 7.2, both the CCP and Japanese data suggest that seven-day catheterization contributes to a decrease the probabilities of both mortality and readmission for all time intervals, although the impacts on ninety-day readmission is not statistically significant in either country. The effects of seven-day catheterization on mortality are much larger in the United States than in Japan. However, the difference in impacts of seven-day catheterization on thirty-day versus one-year mortality rates are almost the same in both countries (approximately 6 percentage points at one year). Further, seven-day catheterization decreases one-year readmission rates by 21 and 32 percentage points for the CCP and Japanese patients, respectively.

Figures 7.1 and 7.2 illustrate the adjusted probability of seven-day catheterization and patient outcomes by biprobit model in the United States and Japan, respectively. These figures show that the adjusted probabilities of thirty-day and one-year mortality conditional on seven-day

Table 7.2 Effects of seven-day catheterization on patient outcomes by bivariate probit analysis

	United States[a]							Japan						
	30-day mortality	1-year mortality	90-day readmission for any cause	1-year readmission for any cause	90-day expenditure	1-year expenditure	Length of hospital stay	30-day mortality	1-year mortality	90-day readmission for any cause	1-year readmission for any cause	90-day expenditure	Length of 1-year expenditure	hospital stay
							A. First equation for 7-day cath							
Thrombolytics use during stay	0.107**	0.136**	0.097	0.133	0.077**	0.077**	0.068**	1.124**	0.883**	0.416**	0.591**	0.159***	0.159***	0.156***
	(0.043)	(0.145)	(0.043)	(0.044)	(0.426)	(0.426)	(0.041)	(0.074)	(0.081)	(0.075)	(0.076)	(0.072)	(0.072)	(0.072)
Aspirin use during stay	0.574***	0.609***	0.881***	0.917***	0.251***	0.251***	0.249***	0.731***	1.518	0.407***	0.555**	0.218***	0.218***	0.207***
	(0.034)	(0.123)	(0.038)	(0.038)	(0.376)	(0.376)	(0.037)	(0.079)	(0.165)	(0.077)	(0.077)	(0.076)	(0.076)	(0.077)
Beta-blocker use during stay	0.149***	0.136***	0.193**	0.227***	0.083***	0.074***	1.221*	0.042	0.278	1.152	0.124	0.124	0.133	
	(0.033)	(0.108)	(0.033)	(0.033)	(0.322)	(0.322)	(0.031)	(0.160)	(0.085)	(0.080)	(0.164)	(0.158)	(0.158)	(0.159)
ACE inhibitor use during stay	−0.035	0.006*	0.091	0.025	0.014	0.014	0.039	−0.094	−0.350	0.908	0.032	0.030	0.030	0.024
	(0.031)	(0.110)	(0.033)	(0.032)	(0.320)	(0.320)	(0.031)	(0.084)	(0.083)	(0.154)	(0.083)	(0.079)	(0.079)	(0.079)
Smoking cessation	−0.263	−0.222	−0.193	−0.022	−0.045	−0.045	0.010	−1.538**	−1.318*	−1.290**	−1.865**	−0.399**	−0.399**	−0.393**
	(0.052)	(0.189)	(0.065)	(0.066)	(0.567)	(0.567)	(0.062)	(0.232)	(0.237)	(0.215)	(0.222)	(0.208)	(0.208)	(0.208)
							B. Second equation for patient outcomes							
7-day cath	−0.339***	−0.398*	−0.173	−0.206*	5160.540***	5634.330***	1.645***	−0.141***	−0.196**	−0.314	−0.320**	2145.305	3028.147*	−9.046**
	(0.062)	(0.078)	(0.454)	(0.255)	(1035.491)	(1339.860)	(0.552)	(0.071)	(0.093)	(0.139)	(0.122)	(1565.115)	(2096.289)	(4.930)
Thrombolytics use during stay	−0.001	−0.265	−0.014	−0.023	−981.344	−1108.269	1.085*	−0.241	−0.217	0.476	0.769	−5074.712***	−4974.383***	6.785
	(0.036)	(0.044)	(0.058)	(0.062)	(1316.630)	(1710.970)	(0.677)	(0.043)	(0.096)	(0.067)	(0.072)	(1563.686)	(2094.374)	(4.935)
Aspirin use during stay	−0.811***	−0.585	−0.725	−0.262	1364.137	3902.250***	0.897*	−1.178***	1.202	0.278	0.641*	−2149.844	−5199.518***	−7.251
	(0.054)	(0.067)	(0.089)	(0.092)	(1189.678)	(1415.314)	(0.618)	(0.059)	(0.094)	(0.081)	(0.105)	(1682.250)	(2253.177)	(5.310)
Beta-blocker use during stay	−0.242	−0.204	−0.293**	−0.103	598.790	−30.244	0.097	−0.405	0.821**	0.077	0.102	525.981	−4595.684	−7.472
	(0.030)	(0.036)	(0.050)	(0.051)	(996.926)	(1306.556)	(0.518)	(0.072)	(0.077)	(0.086)	(0.127)	(3418.078)	(4578.117)	(10.807)
ACE inhibitor use during stay	0.254	0.197	−0.203*	−0.324***	335.949	806.030	2.625***	0.610	−0.650	0.750	−0.080	−1653.425	583.776	10.267***
	(0.031)	(0.039)	(0.054)	(0.054)	(987.849)	(1297.685)	(0.517)	(0.058)	(0.089)	(0.128)	(0.094)	(1700.296)	(2277.349)	(5.400)
Smoking cessation	−2.921	0.008	−0.058	0.215	−2682.285*	−1695.446	−0.194	−0.122	−0.279	−4.559	−12.649	−4844.199	−6110.899	2.115
	(0.052)	(0.064)	(0.099)	(0.101)	(1750.316)	(2287.076)	(1.021)	(0.095)	(0.119)	(0.118)	(0.160)	(4523.262)	(6058.381)	(14.280)
Rho	−0.938***	−0.861***	−0.998***	−0.101***				0.791	0.942	0.635	0.170**			
	(0.161)	(0.238)	(0.036)	(2.764)				(0.023)	(0.794)	(2.123)	(1.850)			
Log likelihood	−558.936	−591.000	−654.000	−725.000	−10194.701	−10449.257	−3443.423	−74.500	−172.1966	−158.0251	−144.000	−2031.413	−2079.705	−989.014

Notes: Standard errors in parentheses. For biprobit analyses, the marginal effect of each explanatory variable is calculated as $f(\beta_1 X_1) \cdot$ coefficient for panel A; and $f(\beta_2 X_2) \cdot$ coefficient for panel B. Each equation is controlled for patient demographic characteristics, comorbidity and severity measures. For medical expenditure, seemingly unrelated regression method is used, since dependent variables are continuous.

[a]For United States, weighted biprobit by the number of patients in each metropolitan area.

***Significant at the 5 percent level.

**Significant at the 10 percent level.

*Significant at the 15 percent level.

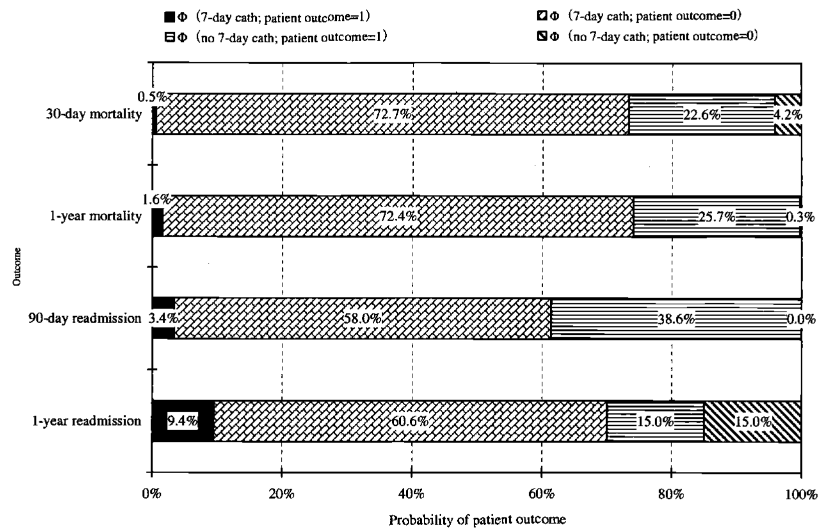

Fig. 7.1 Adjusted probability for patient outcomes conditional on seven-day catheterization by biprobit model (United States)

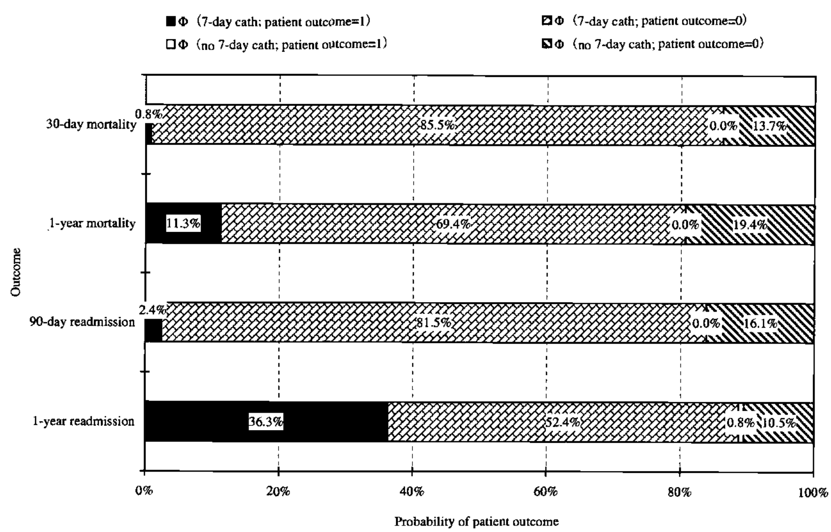

Fig. 7.2 Adjusted probability for patient outcomes conditional on seven-day catheterization by biprobit model (Japan)

catheterization are approximately 1 percent and 2 percent for CCP patients and 1 percent and 11 percent for Japanese patients. The adjusted probabilities of thirty-day and one-year readmission conditional on seven-day catheterization are approximately 3 percent and 9 percent for CCP patients and 2 percent and 36 percent for Japanese patients. Therefore, among those who undergo intensive procedures within one week, the risks of dying and being readmitted to a hospital are about the same in both countries over a relatively short time interval, but they become much larger at one year after the first hospital admission in the Japanese data compared to the CCP patients. On the other hand, the adjusted probabilities of thirty-day and one-year mortality conditional on no seven-day catheterization are approximately 23 percent and 26 percent for CCP patients and 0 percent and 0 percent for Japanese patients. As regards adjusted probabilities of thirty-day and one-year readmission conditional on no seven-day catheterization, they are approximately 39 percent and 15 percent for CCP patients and 0 percent and 1 percent for Japanese patients. Thus, among those without seven-day catheterization, the risks of dying and readmission are much larger in the CCP patients than the Japanese patients for any time interval, though the adjusted probability of readmission for the CCP patients without seven-day catheterization are dramatically improved from thirty days through the one-year time interval.

These results could be affected by the difference in the timing of clinical decision making for intensive procedures between both countries. The aggressive and quick clinical choice of intensive procedures (Sasakuri et al. 1997; Nishida, Endo, and Koyanagi 1997) tends to improve patients' outcomes over shorter intervals, while it may lead to increased risks over longer intervals. On the other hand, over all intervals, the CCP patients without intensive procedures face much higher risks of death and readmission, compared to Japanese patients without seven-day catheterization.

After adjusting for patient chart-based characteristics, seven-day catheterization increases one-year hospital expenditures by $5,634 in the United States and by $3,028 in Japan. The significantly positive impacts of such high-tech treatments may partially account for the current high health care costs in both countries. The influence of a high-tech treatment on hospital expenditures is much larger for the CCP patients. However, note there are few observations for which hospital expenditure data are available in Japan, which makes it difficult to make the correct clinical policy implications. On the other hand, seven-day catheterization tends to have an opposite effect on the length of hospital stay in the two countries. High-tech treatments increase the length of stay from the first admission by about two days for the CCP patients and decrease it by nine days for Japanese patients, which is consistent with the results from the descriptive statistics. Adjusting for patient and treatment heterogeneity tends to enlarge the effect of intensive procedures on Japanese patients' length of stay, implying that unobserved factors such as other patient characteristics and medical centers cost constraint incentives affect the results.

7.5.2 Effects of Low-Tech Treatments on the Quality of Care

Similar to table 7.1, panel A in table 7.2 shows that drug use is highly correlated with high-tech treatments. For the CCP patients, the use of thrombolytics, aspirin, and beta-blockers during a hospital stay have significantly positive correlations with seven-day catheterization. We also observe that, for Japanese patients, thrombolytics and aspirin use (but not beta-blockers) are positively correlated with high-tech treatments. Interestingly, smoking cessation is negatively related to seven-day catheterization in Japan. This suggests that those who are treated by intensive procedures are more likely to receive some low-tech treatments, and there exists treatment heterogeneity among patients. In order to adjust for the heterogeneity, we apply a bivariate probit procedure in this study. We observe that correlations calculated based on the covariance of residuals between the first and second equations, $\mathrm{Cov}(\varepsilon_1, \varepsilon_2) = \rho$, are statistically significantly different from 0 for the CCP patients, but that this is not the case for Japanese patients. This implies that the effect of treatment heterogeneity is much larger among the CCP patients.

As regards the effects of drug use on patient outcomes, aspirin use is seen to decrease thirty-day mortality rates by approximately 80 and 120 percentage points in the United States and Japan, respectively. The use of beta-blockers and ACE inhibitors also contributes to a decrease in the CCP patients' readmission rates, but this is not the case for Japanese patients. Rather, using beta-blockers and aspirin has a positive effect on one-year mortality and readmission rates, respectively, in the Japanese data.

For the CCP patients, aspirin use seems to increase one-year hospital expenditures by $3,900 and the length of hospital stay by about one day. In contrast, it is interesting that aspirin use dramatically decreases one-year hospital expenditure in Japan. Also, use of thrombolytics contributes to a decrease in both ninety-day and one-year medical expenditures. In both countries, ACE inhibitor use tends to length the duration of hospital stay.

Although most effects of drug use are not statistically significant and vary among patient outcomes as dependent variables, they appear to be more significant for CCP patients than for Japanese patients. Next, we examine which patients can be defined as good candidates for receiving aspirin, beta-blockers, no calcium channel blockers, and smoking cessation during their hospitalization and how they are actually treated. Patients are defined as good candidates according to exclusion and inclusion criteria from the ACC/AHA guidelines (table 7A.1). This tests the appropriateness of the low-tech treatments. Note that we define *ideal* or *good candidates* for not receiving calcium channel blockers, as many studies demonstrate harmful impacts on AMI patients and their use has been decreasing in the United States (Rogers et al. 1996; McClellan et al. 2001).

Table 7.3 summarizes the fraction of patients who are ideal or good candidates for each drug based on clinical records and the probability that ideal or good candidates were actually treated. Figure 7.3 illustrates the probability, among ideal or good candidates, of receiving various treatments. Table 7.3 shows that the rates of ideal or good candidates vary

Table 7.3	Ideal/good candidates for medications during stay			
	United States		Japan	
Variable	Mean	Standard deviation	Mean	Standard deviation
Ideal/good candidate for aspirin	0.481	(0.500)	0.684	(0.466)
Actually treated by aspirin	0.799	(0.401)	0.732	(0.445)
Ideal/good candidate for beta-blocker	0.256	(0.437)	0.637	(0.482)
Actually treated by beta-blocker	0.408	(0.493)	0.088	(0.284)
Ideal/good candidate for no calcium channel blocker	0.328	(0.470)	0.826	(0.380)
Actually treated by calcium channel blocker	0.421	(0.495)	0.426	(0.496)
Ideal/good candidate for smoking cessation	0.127	(0.333)	0.405	(0.492)
Actually treated by smoking cessation	0.372	(0.485)	0.179	(0.390)
Candidate for CLASS I	0.408	(0.492)	0.121	(0.327)
Actually treated by catheterization	0.554	(0.498)	0.783	(0.422)
Candidate for CLASS IIa but not CLASS I	0.341	(0.474)	0.879	(0.327)
Actually treated by catheterization	0.356	(0.480)	0.778	(0.417)
Candidate for CLASS IIb only	0.096	(0.294)	0.000	(0.000)
Actually treated by catheterization	0.387	(0.490)	0.000	(0.000)
Number of observations	974		190	

Note: For United States, table shows weighted mean values by the number of patients in each metropolitan area.

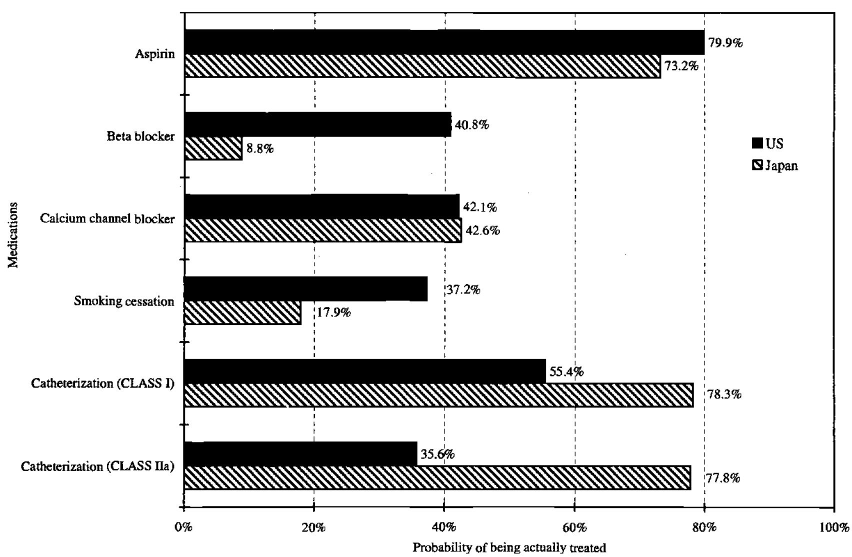

Fig. 7.3 Probability of being actually treated by medications among ideal or good candidates (United States and Japan)

widely between the two countries. Note that the disparity between the two countries in the fraction of individuals who are ideal or good candidates may be caused by missing information on exclusions and inclusion criteria. For aspirin, beta-blockers, no calcium channel blockers, and smoking cessation, the rates of ideal or good candidates tend to be much higher for Japanese patients than for CCP patients: 68 percent versus 48 percent, 64 percent versus 26 percent, 83 percent versus 33 percent, and 41 percent versus 13 percent, respectively. The fraction of patients actually treated, among those identified as ideal or good candidates, is very alike, except the use of beta-blockers and smoking cessation.

For Japanese patients, the underuse of beta-blockers and smoking cessation, relative to CCP patients, is noticeable, although the fraction of patients identified as ideal or good candidates tends to be large in Japan. Previous studies have explained the underuse of beta-blockers in Japan in various ways. Provocative vasomotor studies of Japanese patients found a higher incidence of inducible spasm and greater vasoconstriction of nonspastic segments than Caucasian studies (Beltrame, Sasayama, and Maseri 1999; Pristipino et al. 2000). Therefore, in Japan, cardiologists may avoid using beta-blockers that could lead to an incidence of inducible spasm in order to avoid unnecessary critical complications. On the other hand, Wang and Stafford (1998) emphasized the effects of nonclinical factors on beta-blocker use, such as age, unnecessary fear of complications without medical evidence, and regional and physicians' characteristics. Also, Wang and Stafford (1998) pointed out that uninsured patients are more likely to undergo beta-blocker treatments that cost much less than other treatments in the United States. Because we focus on elderly patients at age sixty-five and older in this study, both CCP and Japanese patients are reimbursed by similar fee-for-service reimbursement systems in both countries. Therefore, the underuse of beta-blockers would be expected partly because of the weaker incentives for cost containment in Japan.

Finally, compared to drug use, it would be difficult to justify criteria for identifying ideal or good candidates for high-tech treatments. However, according to guidelines by ACC/AHA (table 7A.1), we define three types of candidates for catheterization: usually indicated, always acceptable and considered useful/effective (CLASS I); acceptable, of uncertain efficiency and may be controversial, weight of evidence in favor of usefulness or efficacy (CLASSIIa); and acceptable, of uncertain efficiency and may be controversial, not well established by evidence, can be helpful and probably not harmful (CLASSIIb). In the data, almost all patients are classified into either CLASS I or CLASSIIa. While the fraction of patients identified as CLASS I, that is, relatively ideal candidates, is higher for the CCP than Japanese patients (41 percent versus 12 percent), the fraction in CLASSIIb, that is, good candidates, is higher for Japanese patients (88 percent versus 34 percent). For patients classified into either CLASS I or CLASSIIa, figure 7.3 shows that Japanese patients are 1.5 to 2 times as likely to be catheterized than the CCP patients.

Therefore, we conclude that the patterns of ideal or good candidates for drug use according to ACC/AHA guidelines are very alike between two countries. The CCP patients are more aggressively treated by beta-blockers than Japanese patients, and we observe that collaborative medical centers in the data tend to perform intensive procedures more often.

7.6 Discussion

The CCP is the first major undertaking of the Health Care Quality Improvement Program (HCQIP) from 1992 to 1998 administered by the HCFA. Under this project, peer review organizations in all states encouraged health care providers to improve their systems of care for given quality indicators for patients with AMI. The new data collected by the HCQIP show that the quality of care for each clinical indicator varies from state to state and region to region. As regards AMIs, the data suggest that prescribing beta-blockers and aspirin for patients who have had a heart attack would be a course of action that could save hundreds to thousands of lives each year. One sign of the success of the CCP pilot project in Alabama, Connecticut, Iowa, and Wisconsin was an increase in the use of beta-blockers for heart attack patients, following dissemination of the study's results, from 47 percent to 68 percent (Centers for Medicare and Medicaid Services 2000).

The HCQIP and the CCP are considered models of public health policy. The HCQIP identified twenty-four process-of-care measures[5] that are strongly supported by clinical science and are widely accepted standards of care. These standards relate to primary prevention, secondary prevention, or the treatment of the six medical conditions including AMI, breast cancer, diabetes, heart failure, pneumonia, and stroke. Therefore, the purpose of this study is to help improve health care policies in Japan where there has not yet been established a system for collecting nationwide–individual-level clinical data.

We create a database comparable to the CCP, and we focus our investi-

5. For measurements indicating the quality of care for patients with AMI, the following indexes are used: administering aspirin to a beneficiary within twenty-four hours of the beneficiary's admittance to a hospital (national median is 84 percent); prescribing aspirin when a beneficiary is discharged (national median is 85 percent); administering a beta-blocker to a beneficiary within twenty-four hours of the beneficiary's admittance to a hospital (national median is 64 percent); prescribing beta-blockers when a beneficiary is discharged (national median is 72 percent); prescribing ACE inhibitors for patients with decreased left ventricular ejection fraction (national median is 71 percent); providing smoking cessation counseling to patients in the hospital (national median is 40 percent); the length of time before a patient receives angioplasty in minutes (national median is 120 minutes); and the length of time before a patient receives thrombolytic therapy in minutes (national median is 40 minutes; Jencks et al. 2000).

gation on the variation in the quality of health care with respect to treatments and outcomes between the United States and Japan, controlling for chart-based detailed clinical information on elderly patients, sixty-five years old and over, with AMI. Our main conclusions are as follows.

First, we found that there is significant heterogeneity among patients and in treatments that could influence the quality of care among elderly AMI patients. In both the United States and Japan, catheterized patients were more likely to be younger and in better health. Interestingly, the differences in treatment between men and women in Japan are trivial, as compared with treatment differences by gender in the United States. Also, Japanese patients tend to be more aggressively treated by angioplasty following catheterization than the CCP patients.

Comparison of national health systems may provide an insight into the effects of health system characteristics on the different treatment patterns in the United States and Japan. In the United States, inpatient care for older persons is only partially covered by Medicare, and beneficiaries could not receive prescription drug coverage for ambulatory care until recently, unless they had beforehand purchased supplemental insurance or hold coverage from a former employer. Medicare's diagnosis-related group (DRG) payment system for hospitals fixes the payment at the time a patient is admitted to the hospital. Thus, since DRG was adopted in 1984, it might appear to provide strong incentives to providers to limit costs. On the other hand, under the Japanese universal health insurance system, all medical facilities are reimbursed on a fee-for-service basis according to an official fee schedule (*shinryo hoshu*). Manipulation of the fee schedule serves as one of the primary mechanisms by which the Ministry of Health, Labour and Welfare regulates the supply of medical care, utilization rates, and aggregate health care expenditure. So far, in Japan, medical providers have no socioeconomic incentive to distinguish treatments for female from male patients. Also, the upward trend in reimbursement for intensive cardiac treatment has translated into increased availability of the procedures and has motivated health care providers to utilize the high-tech procedures.

Second, after adjusting for chart-based patient characteristics and variation in treatments, we observe that high-tech treatments would significantly improve patient outcomes and would increase hospital expenditures but that the effects are much larger for the CCP patients than the Japanese patients.

Third, the aggressive and quick clinical choice to use an intensive procedure tends to improve patients' outcomes in the shorter time interval, but it may lead to increased risks in the longer time period.

Fourth, a CCP patient who undergoes an intensive procedure tends to stay in a hospital longer compared to the one who does not, while a patient who undergoes an intensive procedure in Japan is inclined to stay in the hospital for a shorter period. This apparent difference between Japan and the United States may be a result of patient characteristics that are unobserved in the data, as well as the economic incentives of the respective health care systems. In the Japanese data, almost 60 percent of patients underwent catheterization immediately after hospital admission. Those who were not treated by seven-day catheterization are typically in very critical condition, leading to longer hospital stays. Also, under the universal coverage system in Japan, patients may have an economic incentive to stay longer in hospitals, particularly when they have no informal or unpaid caregivers (such as relatives) or sufficient financial resources to afford formal home care. Lately, in order to shorten the length of hospital stay and decrease medical expenditure, the Ministry of Health, Labour and Welfare raised the coinsurance rate for insured care services from 10 percent to 15 percent when a patient occupies an acute-care bed for more than 180 days.

Fifth, the patterns of ideal or good candidates according to ACC/AHA guidelines are very similar between the two countries, except beta-blocker use, smoking cessation, and catheterization. The CCP patients are more aggressively treated with beta-blockers and smoking cessation than Japanese patients, while we observe that collaborative medical centers in the Japanese data tend to perform intensive procedures more often. The underuse of beta-blockers in Japan was also found by previous studies and was attributed to clinical and socioeconomic causes.

The data collected for this study may not be representative of the AMI population in Japan, as the data only contain patients admitted to high-volume and high-tech hospitals in a specific region. The statistically insignificant results mentioned in the preceding reveal the shortcomings of the current data. In order to overcome these shortcomings, our goal is to expand the hospitals and patients covered by this project in the future.

Appendix

Table 7A.1 **Exclusions and inclusions criteria for various medications eligibility during hospitalization**

Variable	Definition	Variable	Definition
IG_ASA	Good candidate for aspirin If XC31809 = 1 or XBSTOOL = 1 or XBLEED = 1 or XCOAGULP = 1 or XC11806 = 1 or XPLT1 = 1 or XDXLIV = 1 or XULCER = 1 or XHEMAC = 1 or XYLCRE91 = 1 or XCANCER = 1 or XTERMIL then excluded from ideal/good candidates for aspirin during hospitalization.	XC31809	Allergy to aspirin
		XBSTOOL	Evidence of bleeding on admission or during hospitalization
		XBLEED	History of internal bleeding
		XCOAGULP	Coagulopathy (history of bleeding disorder or INR > 1)
		XC11806	Warfarin on admission
		XPLT1	Platelet count < 100K
		XDXLIV	Chronic liver disease
		XULCER	Peptic ulcer disease
		XHEMAC	Hematocrit < 30% or hemoglobin (Hgb) < 10g
		XYLCRE91	Highest creatinine > 3mg/Dl
		XCANCER	Metastatic cancer
		XTERMIL	Terminal illness
IG_BBK	Good candidate for beta blocker If XSHOCK = 1 or XSYST = 1 or XCOND = 1 or XASTHMA = 1 or XBRDYPLS = 1 or XLVEF1 = 1 or XLVEF2 = 1 or XCHF = 1 or XCOPD = 1 or XDEMENT = 1 or XC18004 = 1 or XC1225 = 1 or XCANCER = 1 or XTERMIL = 1 then excluded from ideal/good candidates of beta-blocker during hospitalization. Note: If XCOND1 = 1 or XCOND2 = 1 or XCOND3 = 1 or XCOND4 = 1 then XCOND = 1	XSHOCK	Hypotension or shock during hospitalization
		XSYST	Systolic blood pressure on admission < 100mmHg
		XCOND1	RBBB, any EKG, and left fascic block, any EKG
		XCOND2	RBBB and left fascic blocks
		XCOND3	RBBB, any EKG, and left fascic blocks
		XCOND4	RBBB and any left fascic blocks
		XCOND	Conduction disorder
		XASTHMA	Asthma during hospitalization
		XBRDYPLS	Bradycardia or pulse on admission < 60 beats/min.
		XLVEF1	LVEF < 35%
		XLVEF2	LVEF < 50%
		XCHF	Pulmonary edema or CHF unless LVEF > 50%
		XCOPD	History of COPD
		XDEMENT	Dementia

		XC18004	Antidepressant on admission
		XC12225	Insulin on admission
		XCANCER	Mestastatic cancer
		XTERMIL	Terminal illness
IG_CBK	Good candidate for no CA+ If XANYFIB = 1 or X@$CHST = 1 then excluded from and if XLVEF5 = 1 or XSHOCK = 1 or CBKINC1 = 1 or XCOND = 1 or XBRADY = 1 then included to ideal/good candidates of no calcium channel blockers with low LVEF during hospitalization.	XANYFIB	Any atrial fibrillation
		X24CHST	Recurrent chest pain
		XLVEF5	Inclusion: LVEF $< 40\%$
		XSHOCK	Inclusion: Hypotension or shock during hospitalization
		CBKINC1	Inclusion: Pulmonary edema or CHF unless LVEF $\geq 50\%$
		XCOND	Inclusion: Conduction disorder
		XBRADY	Inclusion: Bradycardia
ID_SMK	Ideal candidate for smoking cessation If XSMOKE = 1 then excluded from good candidates of smoking cessation during hospitalization.	XSMOKE	Not a current smoker
CCLASS1A[a]	Candidate for CLASS I If CCLASS1 = 1 then included in good candidates for CLASS I	CCLASS1	Inclusion: Recurrent chest pain or ischemia by stress test
CCLASS1B[b]	Candidate for CLASS IIa but not CLASS I If CHF = 1 or XLEVF4 = 1 or CHF = 1 or P_REVAC = 1 then included as ideal candidates for catheterization.	XLVEF4	Inclusion: LVEF $\leq 40\%$
		CHF	Inclusion: CHF
		P_REVAC	Inclusion: Pre-revascularization
CCLASSIC[c]	Candidate for CLASS IIb only If CCLASS1 = 1 then included in good candidates for CLASS IIb.	XQWAVEMI	Inclusion: Non Q wave Mis.

Source: Ryan et al. (1999).

[a]CLASSI = usually indicated, always acceptable and considered useful/effective.

[b]CLASSIIa = acceptable, of uncertain efficiency and may be controversial; weight of evidence in favor of usefulness/efficacy.

[c]CLASSIIb = acceptable, of uncertain efficiency and may be controversial; not well established by evidence, can be helpful and probably not harmful.

References

Asada, S., K. Ogawa, S. Tsushima, K. Nakamura, and S. Hashimoto. 1970. Shinkinkosoku setsujo no ichirei-sobo benchikan shijutsu ga dojini shinko sareta chikenrei ni tsuite [Results of open heart surgery in severe cases of heart diseases and discussion on the improvement of operative results]. *Kyobu Geka* 23 (12): 847–59.

Beltrame, J. F., S. Sasayama, and A. Maseri. 1999. Racial heterogeneity in coronary artery vasomotor reactivity: Differences between Japanese and Caucasian patients. *Journal of the American College of Cardiology* 33 (6): 1442–52.

Bertoni, A. G., D. E. Bonds, J. Lovato, D. C. Goff, and F. L. Brancati. 2004. Sex disparities in procedure use for acute myocardial infarction in the United States, 1995 to 2001. *American Heart Journal* 147 (6): 1054–60.

Brown, C. A., A. M. Hutter, Jr., R. W. DeSanctis, H. K. Gold, R. C. Leinbach, A. Roberts-Niles, W. G. Austen, and M. J. Buckley. 1981. Prospective study of medical and urgent surgical therapy in randomizable patients with unstable angina pectoris: Results of in-hospital and chronic mortality and morbidity. *American Heart Journal* 102 (6): 959–64.

Califf, R. M., and TAMI VA Study Group. 1991. Evaluation of combination thrombolytic therapy and timing of cardiac catheterization in acute myocardial infarction. *Circulation* 83:1543–56.

The Cardiac Insufficiency Bisoprolol Study (CIBIS-II). 1999. CIBIS-II: A randomized trial. *Lancet* 353:9–13.

Centers for Medicare and Medicaid Services. 2000. Medicare gets first database measuring quality of medical care delivered to beneficiaries. http://www.cms.hhs.gov/media/press/release.asp?Counter=385.

Endo, M., and H. Koyanagi. 1994. CABG: Sekai no Doko to Honpo no Jittai [CABG: The world trends and the Japanese realities]. *Nihon Rinsho* 52 (Suppl. Pt. 1): 961–69.

Erbel, R., T. Pop, K. J. Henrichs, K. Von Olshausen, C. J. Shuster, H. J. Rupprecht, C. Steuernegel, and J. Meyer. 1986. Percutaneous transluminal coronary angioplasty after thrombolytic therapy: A prospective controlled randomized trial. *Journal of the American College of Cardiology* 8:485–95.

Frances, C., H. Noguchi, W. Browner, B. Bassie, and M. McClellan. 2000. Are we inhibited? Renal insufficiency should not preclude the use of ACE inhibitors for patients with acute MI and depressed left ventricular function. *Archives Internal Medicine* 160 (17): 2645–50.

Greene, W. H. 1993. *Econometric analysis.* 2nd ed. New York: Macmillan.

———. 1998. Gender economics courses in liberal arts colleges: Further results. *Journal of Economic Education* 29 (4): 291–300.

Harrold, L. R., D. Lessard, J. Yarzebski, J. H. Gurwitz, J. M. Gore, and R. J. Goldberg. 2003. Age and sex differences in the treatment of patients with initial acute myocardial infarction: A community-wide perspective. *Cardiology* 99 (1): 39–46.

Hayashi, H. 1972. Kyoshinsho ni tisuru kankekka chokusetsu hogoho ni yoru ichi chikenrei [Present status and the future of coronary surgery]. *Kokyu To Junkan* 20 (5): 377–83.

Health and Welfare Statistics Association. 2000. *Journal of Health and Welfare Statistics* Tokyo: Health and Welfare Statistics Association.

Hochman, J. S., J. E. Tamis, T. D. Thompson, W. D. Weaver, H. D. White, F. Van de Werf, P. Aylward, E. J. Topol, and R. M. Califf for the Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes IIb Investigators. Sex, clinical presentation, and outcome in patients with acute coronary syndromes. *New England Journal of Medicine* 341 (4): 226–32.

Second International Study of Infarct Survival (ISIS-2) Collaborative Group. 1988. Randomized trial of intravenous streptokinase, oral aspirin, both, or neither among 17,187 cases of suspected acute myocardial infarction. *Lancet* 2 (8607): 349–60.

Jencks, S. F., T. Cuerdon, D. R. Burwen, B. Fleming, P. M. Houck, A. E. Kussmaul, D. S. Nilasena, D. L. Ordin, and D. R. Arday. 2000. Quality of medical care delivered to Medicare beneficiaries: A profile at state and national levels. *Journal of the American Medical Association* 284:1670–76.

Kober, L., C. Torp-Pedersen, J. E. Carlsen, H. Bagger, P. Eliasen, K. Lyngborg, J. Videbaek, D. S. Cole, L. Auclert, and N. C. Pauly. 1995. A clinical trial of the angiotensin-converting-enzyme inhibitor trandolapril in patients with left ventricular dysfunction after myocardial infarction. Trandolapril Cardiac Evaluation (TRACE) Study Group. *New England Journal of Medicine* 333 (25): 1670–76.

Koshal, A., D. S. Beanlands, R. A. Davies, R. C. Nair, and W. J. Keon. 1988. Urgent surgical reperfusion in acute evolving myocardial infarction: A randomized controlled study. *Circulation* 78 (3 Pt. 2): I171–I178.

Lewis, H. D., J. W. Davis, and D. G. Archibald. 1983. Protective effects of aspirin against acute myocardial infarction and death in men with unstable angina: Results of a Veterans Administration cooperative study. *New England Journal of Medicine* 309 (7): 396–403.

Maddala, G. S. 1983. *Limited-dependent and qualitative variables in econometrics.* Cambridge, UK: Cambridge University Press.

Maddala, G. S., and L. F. Lee. 1976. Recursive models with qualitative endogenous variables. *Annals of Economic and Social Management* 5 (4): 525–45.

Marciniak, T., E. Ellerbeck, M. J. Radford, T. F. Kresowik, J. A. Gold, H. M. Krumholz, C. I. Kiefe, R. M. Allman, R. A. Vogel, and S. F. Jencks. 1998. Improving the quality of care for Medicare beneficiaries with acute myocardial infarction. *Journal of the American Medical Association* 297 (17): 1351–57.

McClellan, M., N. Every, A. M. Garber, P. Heidenreich, M. Hlatky, D. P. Kesseler, J. Newhouse, and O. Saynina. 2001. Technological change in heart attack care in the United States. In *Technological change in health care,* ed. M. McClellan and D. Kessler, 21–54. Ann Arbor: University of Michigan Press.

McClellan, M., B. J. McNeil, and J. Newhouse. 1994. Does more intensive treatment of acute myocardial infarction reduce mortality? Analysis using instrumental variables. *Journal of the American Medical Association* 272 (11): 859–66.

McClellan, M., and J. Newhouse. 1997. The marginal costs and benefits of medical technology. *Journal of Econometrics* 77 (1): 39–64.

McClellan, M., and H. Noguchi. 1998. Technological change in heart-disease treatment: Does high tech mean low value? *The American Economic Review* 88 (2): 90–96.

———. 2001. Validity and interpretation of treatment effect estimates using observational data: Treatment of heart attacks in the elderly. Stanford University. Unpublished Manuscript.

McClellan, M., and D. Staiger. 2000a. Comparing hospital quality at for-profit and not-for-profit hospitals. In *The changing hospital industry: Comparing not-for-profit and for-profit institutions,* ed. D. Cutler, 93–112. Chicago: University of Chicago Press.

———. 2000b. Comparing hospital quality of health care providers. In *Frontiers in health policy research,* ed. A. Garber, 113–36. Boston: MIT Press.

Metoprolol CR/XL Randomized Intervention Trial in Congestive Heart Failure

(MERIT-HF). 1999. Effect of metoprolol CR/XL in chronic heart failure. *Lancet* 353:2001–07.

Nippon Shinkekkan Intervention Gakkai Gakujutsu Iinkai. 1993. Iinnkai anketo hokoku kekka ni tsuite [Report on the survey conducted by the Japanese Intervention Association in 1993]. *Shinkekkan* 8:465.

Nishida, H., M. Endo, and H. Koyanagi. 1997. Nippon no gejo wo domiruka [What can we think of the current status of treatments for patients with cardiovascular disease in Japan?] *Mebio* 14 (12): 25–34.

Oe, K., M. Shimizu, H. Ino, M. Yamaguchi, H. Terai, K. Hayashi, M. Kiyama, K. Sakata, T. Hayashi, M. Inoue, et al. 2002. Effects of gender on the number of diseased vessels and clinical outcome in Japanese patients with acute coronary syndrome. *Circulation Journal* 66 (5): 435–40.

Pristipino, C., J. F. Beltrame, M. L. Finocchiaro, R. Hattori, M. Fujita, R. Mongiardo, D. Cianflone, T. Sanna, S. Sasayama, and A. Maseri. 2000. Major racial differences in coronary constrictor response between Japanese and Caucasians with recent myocardial infarction. *Circulation* 101 (10): 1102–08.

Rausenbaum, P., and D. Rubin. 1984. Reducing bias in observational studies using subclassification on the propensity score. *Journal of the American Statistical Association* 79:516–24.

Rodwin, V. G., and M. K. Gusmano. 2002. The World Cities Project: Rationale, organization, and design for comparison of megacity health systems. *Journal of Urban Health* 79:445–63.

Rogers, W. J., N. C. Chandra, W. French, J. M. Gore, C. T. Lambrew, and A. J. Tiefenbruunn. 1996. Trends in the use of reperfusion therapy: Experience from the Second National Registry of Myocardial Infarction (NRMI2). *Circulation* 194 (8): Abstract.

Ryan, T. J., E. M. Antman, N. H. Brooks, et al. 1999. ACC/AHA guidelines for the management of patients with acute myocardial infarction: 1999 update: A report of the American College of Cardiology/American Heart Association task force on practice guidelines. http://www.acc.org.

Sasakuri, S., Y. Hosoda, T. Watanabe, K. Takazawa, I. Hayashi, T. Yamamoto, K. Minami, H. Miyagawa, and T. Fukuda. 1997. Graft selection in coronary artery bypass surgery in the aged. *Nippon Kyobu Gaka Gakkai Zasshi* 45 (3): 384–86.

Sezai, Y., A. Yamazaki, H. Inoue, S. Ogawa, and H. Sakai. 1970. Kandomyaku no chokusetsu shijitsu, ditaidomyakuhen ni yoru jokodaidomyaku-kandomyaku dypass heno ichi shorei [Direct coronary artery surgery—Case report of aortocoronary bypass utilizing femoral artery autograft]. *Koyobugeka* 23 (12): 888–97.

Shilipak, M., C. Frances, H. Noguchi, B. Massie, and M. McClellan. 2001. Comparison of the effects of angiotensin converting-enzyme inhibitors and beta-blockers on survival in elderly patients with reduced left ventricular function after myocardial infarction. *American Journal of Medicine* 110 (6): 425–33.

Shlipak, M., P. Heidenreich, H. Noguchi, B. Warren, and M. McClellan. 2002. Associations of renal insufficiency with treatment and outcomes after myocardial infarction in the elderly. *Annals of Internal Medicine* 137 (7): 555–62.

Simmoons, M. L., A. E. R. Arnorld, A. Betriu, D. P. DeBono, J. Col, F. C. Dougherty, R. Von Essen, H. Lambertz, J. Lubsen, B. Meier, et al. for the European Cooperative Study Group for Recombinant Tissue-Type Plasminogen Activator (rTPA). 1988. Thrombolysis with tissue plasminogen activator in acute myocardial infarction: No additional benefit from immediate percutaneous angioplasty. *Lancet* 1 (8579): 197–203.

Takekoshi, N., E. Murakami, and M. Nakajima. 1983. Clinical characteristics and prognosis of patients with unstable angina treated medically and surgically—re-

sults in patients with ST-segment elevation and depression. *Japanese Circulation Journal* 47 (4): 495–502.
Thrombolysis in Myocardial Infarction (TIMI) Study Group. 1989. Comparison of invasive and conservative strategies after treatment with intravenous tissue plasminogen activator in acute myocardial infarction. *New England Journal of Medicine* 320:618–27.
VANQWISH Study Group. 1998. Design and baseline characteristics of the Veterans Affairs Non-Q-Wave Infarction Strategies In-Hospital (VANQWISH) trial. *Journal of the American College of Cardiology* 31 (2): 312–20.
Yoshikawa, A., H. Noguchi, S. Ide, A. Koike, T. Maruyama, N. Uemura, A. Urae, and T. Nambu. 2002. The causes and consequences of technological change in the treatment of acute myocardial infarction in Japan. In *Technological change in health care,* ed. M. McClellan and D. Kessler, 156–83. Ann Arbor: University of Michigan Press.
Wang, T. J., and R. S. Stafford. 1998. National patterns and predictors of β-blocker use in patients with coronary artery disease. *Archives of Internal Medicine* 158 (17): 1901–06.
Weisz, D., M. K. Gusmano, and V. G. Rodwin. 2004. Gender and the treatment of heart disease in older persons in the United States, France, and England: A comparative, population-based view of a clinical phenomenon. *Gender Medicine* 1 (1): 29–40.
Zijlstra, F., et al. 1993. A comparison of immediate coronary angioplasty with intravenous streptokinase in acute myocardial infarction. *New England Journal of Medicine* 328:680–84.

This Page Intentionally Left Blank