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A new approach to the comparative analysis of health systems: invasive treatment for heart disease in the US, France, and their two world cities

MICHAEL K. GUSMANO*
Mailman School of Public Health, Columbia University, USA
VICTOR G. RODWIN
Robert F. Wagner Graduate School of Public Service, New York University, USA
DANIEL WEISZ
World Cities Project, International Longevity Center-USA, USA
DHIMAN DAS
City University of New York, USA

Abstract: Cross-national comparisons that assess dimensions of health system performance indicate that the US provides higher rates of revascularization procedures than France and other developed nations, but we believe these findings are misleading. In this paper, we compare the use of these procedures in the US, France and their two world cities, Manhattan and Paris. In doing so, we address a number of limitations associated with existing cross-national comparisons of heart disease treatment. After adjusting for the prevalence of disease in these nations and cities, we found that residents of France aged 45–64 years receive more revascularization procedures than residents of the US and that Parisians receive more revascularizations than residents of Manhattan. Older residents 65 years and over (65+) in the US receive more of these procedures than their French counterparts, but the differences are not nearly as great as previous studies suggest. Moreover, our data on Manhattan and Paris where the population and level of health resources are more comparable, indicate that older Parisians obtain more revascularization procedures than older Manhattanites. Finally, we found that the use of revascularization procedures is significantly lower in Manhattan among persons without private health insurance and among racial and ethnic minorities.

Misleading impressions often follow from addressing the wrong questions. For example, many comparative studies of public expenditure across wealthy nations conclude that the United States is a welfare 'laggard' (Wilensky, 1975;

*Corresponding author: Michael K. Gusmano, Assistant Professor of Health Policy and Management, Mailman School of Public Health, Columbia University, 600 West 168th Street, New York, NY 10032, USA. Email: mkg2104@columbia.edu

Flora and Heidenheimer (eds), 1981).Yet, once one broadens the analytic telescope to include indirect, as well as direct forms of social welfare, Christopher Howard (1993) argues, effectively, that America's 'hidden welfare state' is no laggard. Instead of asking why the US relies on indirect, versus direct, social welfare spending, too many studies focus on why its share of public expenditure is lower. This misleading impression of the American welfare state is problematic because it is impossible to explain welfare policy differences, or to identify policy lessons from the experiences of other nations, if we cannot describe accurately their policies and programs. Marmor and colleagues (2005: 341) argue that 'learning *about* the experiences of other nations is a precondition for understanding why change takes place, or for learning *from* that experience'. Too often, however, comparative studies of the welfare state fail to provide sufficient information *about* the experiences of other nations.

We are struck by similar lacunae in the literature on cross-national comparisons of health care systems, which often suffer from a lack of attention to detail and inaccurate descriptions of health care systems abroad. For example, a common claim is that the US is an 'outlier' among developed nations because its health care system encourages greater use of surgery (Technology Change in Health Care Network, 2001). This is either interpreted as a reason for great concern because surgery is expensive, or a reason to celebrate because the US system offers greater access to cutting-edge technology. In either case, simple comparisons of surgery rates among wealthy nations are misleading because they rarely account for differences in the prevalence of morbidity.

In this paper, we compare the use of revascularization in the US, France, and their two world cities, Manhattan and Paris.[1] Once we account for differences in rates of heart disease across these countries and cities, we find that, in contrast to previous studies, residents of the US and Manhattan actually receive *fewer* revascularizations than do residents of France and Paris. Moreover, our analysis of individual-level hospital data in Manhattan and Paris indicates that the lower aggregate rates in Manhattan are driven by barriers to care faced by people without health insurance and racial and ethnic minorities. Our findings suggest that, if the US wants to reduce spending on revascularizations, it should focus more on public health efforts that address the underlying causes of heart disease, and less on finding ways to limit access to these services.

The importance of heart disease

Despite a recent decline, ischemic heart disease (IHD) remains the world's leading cause of death as well as a major contributor to health care expenditures. France has a much lower IHD mortality rate (78.4 per 100,000) than most

1 The terms 'world cities' and 'global cities' have been used interchangeably to mean cities at the center of the global economy, or hubs in the international world of transnational corporations, financial services, and information exchange (Hall, 1984; Sassen, 1981).

other nations belonging to the Organisation for Economic Cooperation and Development (OECD) and less than half that of the US (163.4) (French Ministry of Health, 1999; US National Center for Health Statistics, 1999) – a phenomenon often dubbed the 'French paradox' (Renaud and Gueguen, 1998).

Cross-national comparisons that assess dimensions of health system performance indicate that the US provides higher rates of revascularization procedures – cardiac catheterization, percutaneous transluminal coronary angioplasty (PTCA) and coronary artery bypass graft surgery (CABG) – than France and other OECD nations (OECD, 2000). A study based on the most recent state-of-the art international comparison on the use of high-tech interventions concludes that the US is more aggressive than Canada, Scotland, Sweden, Israel, Australia, and Denmark in providing revascularization procedures following heart attacks (Technology Change in Health Care Network, 2001).

When we examine age-adjusted rates of revascularization, without attempting to account for national and city-level differences in disease prevalence, our findings are consistent with those we have noted, but when we adjust for the prevalence of disease in these two nations and their world cities, the contrast between our findings and those of previous comparisons are striking. We found that residents of France aged 45–64 years receive more revascularization procedures than residents of the US and that Parisians receive more revascularizations than residents of Manhattan. Older residents 65 years and over (65+) in the US receive more of these procedures than their French counterparts, but the differences are not nearly as great as previous studies suggest. Moreover, our data on Manhattan and Paris, where the population and level of health resources are more comparable, indicate that older Parisians obtain more revascularization procedures than older Manhattanites. Consistent with our previous findings, the use of these procedures is significantly lower among women (Weisz *et al.*, 2004). Finally, the use of revascularization procedures is significantly lower in Manhattan among persons without private health insurance and among racial and ethnic minorities, which may account for the lower aggregate rates in comparison to Paris.

Before elaborating on these findings, we explain the rationale for our new approach to the comparative analysis of health systems, particularly the value of supplementing a traditional cross-national comparison with city-level analysis.

The purposes and limitations of cross-national analysis

What is the purpose of comparing health systems and polices in different nations? Some scholars seek to understand the evolution and effects of different health systems and policies (Boychuk, 1999; Tuohy, 1999). Others seek to learn about policies, programs, or practices that might be transferred from one nation to another (Rodwin, 1987; White, 1995). Our analysis, like the studies we noted at the outset of this paper, serves a third purpose – to evaluate the 'performance' of different health systems with respect to such dimensions as service use or access, or health outcomes. Most efforts to evaluate health system performance are based on data assembled by organisations such as the OECD, WHO, the World Bank, and the United Nations (UNICEF and UNDP) (Anderson and Hussey, 2001; Reinhardt *et al.*, 1999; World Bank, 1993; World Health Organization, 2000).

As we have argued elsewhere (Rodwin and Gusmano, 2002), there are at least two limitations associated with comparing health system performance among nations. First, there are enormous variations in population health and health system performance within nations (Ginsberg, 1996). Second, it is difficult to disentangle the relative importance of health systems from other determinants of health and the use of health care services, including the socio-cultural characteristics and neighborhood contexts of the populations whose health is measured.

Cross-national studies that attempt to evaluate the impact of health system characteristics on the use of revascularization procedures suffer from three additional limitations. First, cross-national studies often reflect a misunderstanding of how US data are coded and aggregated.[2] Second, most studies do not adjust treatment rates for differences in the prevalence of IHD. Third, although deaths due to IHD disproportionately affect people 65 years and over (85% in the US; 87% in France) (Lakatta, 2002; National Institute of Health and Medical Research, 2001; National Vital Statistics Report, 1999), most cross-national comparisons do not focus on older people (Houterman *et al.*, 2002).

To address these limitations, we supplement conventional comparisons of the US and France with a more focused analysis of their world cities. We compare mortality, morbidity, and treatment modalities for IHD among two age cohorts (45–65 years and 65+) of residents in the US, France, and the 'urban cores' (Rodwin and Gusmano, 2002) of their largest 'city-regions' (Scott, 2001) – Manhattan and Paris. These cities have heterogeneous populations and a dense concentration of renowned medical centres. In this respect, they are more similar in socio-demographic characteristics and levels of health care resources than their respective nations (Table 1).

2 The documentation in the 'data sources' of the OECD CD Rom states that: 'The rates presented for coronary artery bypass discharges relate to the number of procedures as opposed to the numbers of patients. A separate procedure code is employed for arterial and for venous conduit bypasses, thus a single coronary bypass patient can be counted as receiving more than one bypass procedure if both types of grafts are performed. For example the bypass procedure discharge rate (presented in this database) for 1992 was 184.8 per 100,000 population, but the discharge rate (for patients) was only 121.9 per 100,000.' Clearly in one year CABG patients do not undergo, on average, 1.5 open heart procedures (184.8/121.9). In short, if we examine the procedure codes in the national dataset, we will over count the number of bypass procedures performed each year. If we examine, instead, the number of patients who receive bypass surgeries, the discharge rate we produce will be more accurate – comparable with the rate generated by the French national dataset.

Table 1. National and city-level characteristics

Indicator	Manhattan	US	Paris	France
Population characteristics				
Total population	1.5 million	281 million	2.1 million (1999)	57.3
Percent of population >65 yr of age	13.9	12.6	15.4	16.1
Population density/sq. mile	64860	79.4	51829	284.9
Percent living below poverty (1/2 median household income)	28.4 (1994)	NA	12.7 (1994)	NA
Percent foreign-born	28.4	10.4	22.7	5.6
Health care system				
No. of practicing physicians per 10,000 population[1]	85.5 (2004)	27	85	30
No. of acute hospital beds 1000 population	5.5 (2002)	3.1	7.0 (2002)	4.3
No. of cardiologists per 10,000	2.4	0.6	2.3	1
No. of thoracic surgeons per 10,000	0.5	0.14	0.1	0.03
Health status				
Infant mortality rate per 1000 live births (2003)	6.5	6.9	3.6[2]	2.8
Life expectancy at 65 yr of age, males[3]	17	16.4	17.7	16.9
Life expectancy at 65 yr of age, females [1]	20.1	19.4	21.7	21.3

Notes: [1]These figures include all physicians in private practice and those working for public and non-profit hospitals (full-time equivalents).
[2]http://www.insee.fr/fr/ffc/docs_ffc/irsoc041.pdf
[3]Life expectancy numbers are for New York City and Paris and its first ring.
Sources: US Census, 2000, 1995; New York City Health Department, Office of Vital Statistics, Society of Thoracic Surgeons; American College of Cardiology; Ministère de l'Emploi et de la Solidarité – SESI – répertoire ADELI au 1er janvier 98; Annuaire des statistiques sanitaires et socials 2000; Chambaz, Guillaumat-Tailliet, and Hourriez (1999).

We do not argue that the comparison between these cities is a substitute for national-level comparisons; nor do we argue that it is possible to generalize to the countries on the basis of our city-level findings. Instead, we believe our city-level comparisons are an important complement to national-level analysis because, by holding a number of relevant factors more constant, we can be more confident that the differences we observe are due to differences in health system performance.

The growing importance of urban health care systems

In addition to providing an advantage over cross-national comparisons by holding constant socio-demographic characteristics and health care resources, comparing the treatment of IHD across these cities is important because the world's population is increasingly concentrated in urban areas. United Nations' estimates indicate that 60% of the population will live in cities in 2030 (United

Nations Population Division, 2001).[3] There are now at least 20 'megacities', defined by the UN as cities of over 10 million people; by 2015, there will be 23 (United Nations Population Division, 2001). Despite the growing importance of cities, there are few good descriptions of health care systems in megacities.[4]

Access to care in Manhattan and Paris

Greater barriers in access to medical care are reported in Manhattan than in Paris. This is not surprising for the population under 65 years of age because approximately 24% of this population is uninsured in contrast to a national average of 18% (Sandman *et al.*, 1997). Even among older persons (65+), about 9% in Manhattan are not covered by Medicare Part A[5] because they are recent immigrants or, for other reasons, have not met the minimum period of legal employment.[6] Even among those who qualify for Medicare, significant barriers to care are known to exist. In contrast, there are virtually no financial barriers to primary care or specialist physicians in France.

French national health insurance (NHI) covers the entire population legally residing in France (Rodwin, 2003). Co-insurance does result in out-of-pocket expenditures, but most people have always had complementary insurance that covers these expenditures through a system that resembles Medigap for US Medicare beneficiaries (Rodwin and LePen, 2005). In contrast to Medicare, French NHI does not include deductibles and pharmaceutical benefits are extensive. Moreover, patients with debilitating or chronic illness are exempted from paying coinsurance if they consult physicians who accept NHI reimbursement as payment in full.

In Paris 61% of physicians in private practice do not accept NHI reimbursement as payment in full (Caisse Primaire d'Assurance Maladie (CPAM) de Paris, 2002). If patients choose to consult with these physicians who require co-insurance, they are eligible for some coverage under complementary

3 Here 'cities' refers to 'urban agglomerations', defined by the United Nations as 'the population contained within the contours of a contiguous territory inhabited at urban density levels without regard to administrative boundaries. It usually incorporates the population in a city or town plus that in the suburban areas lying outside of but being adjacent to the city boundaries.' See: United Nations Population Division, *World Urbanization Prospects: the 1999 Revision*, 2001.

4 Although neither Manhattan nor Paris are megacities, they are the core areas of 'urban agglomerations' to which the United Nations refers in its definition of a megacity (Rodwin and Gusmano, 2006).

5 The the US, Medicare Part A helps to cover inpatient care in hospitals, hospice care, and some home health care' (www.cms.gov). Medicare Part A is available, with no premium, to persons 65 years and over who are eligible for Social Security, Railroad Retirement benefits, or who worked in a Medicare covered government job. It is also available to persons with End-Stage Renal Disease (ERSD). To be fully eligible for Social Security, a person, or their spouse, must pay Social Security payroll taxes for at least 40 quarters.

6 Estimates of Medicare Part A coverage are from: Centres for Medicare and Medicaid Services available at http://www.cms.hhs.gov.

insurance. If this raises a financial barrier, they can choose one of the remaining 39% of physicians who accept NHI rates as payment in full, or consult physicians at one of roughly 50[7] health centres that provide primary care in almost every *arrondissemen*t of the city. These centres serve as a safety net for all patients who fall through the cracks, including illegal immigrants,[8] but are used by a broad segment of Parisians.

Our comparison of invasive treatment for heart disease in Manhattan and Paris goes beyond the level of comparative analysis made possible by OECD data because it allows us to explore the role of neighborhood income and the effects of these two world city health systems on access to specialized medical services. While we cannot draw causal inferences from an ecological study, analysis of data on health status and medical care practice between Manhattan and Paris yields insights for further comparative international health services research.

Methods

Rationale for comparing Manhattan and Paris

Beyond the differences among the US and France in their systems of health care finance and delivery, within each country there are important variations in levels of medical resources (Wennberg and Gittelsohn, 1973; Wennberg *et al*., 1987), practice patterns, and medical culture. This makes it difficult to assess the effects of these factors on revascularization rates. As we argue above, these two world cities share more characteristics and problems in common than do their nations. To the extent that there are important similarities in levels of medical resources and socio-demographic characteristics, and differences in health system characteristics, they provide a more focused framework within which to investigate differences in the treatment of IHD.

The five boroughs of New York City (population of 8 million), and Paris with its surrounding départements of Hauts de Seine, Seine Saint-Denis and Val de Marne (population 6.2 million), are the largest cities in two of the wealthiest nations in the world. Beyond considerations of scale, New York and Paris share world city status due to their concentration of high-level functions in government, business, health care, media, and the arts (Geddes, 1951). They also have the highest concentration of older persons in their respective nations, which suggests that their populations suffer disproportionately from IHD in comparison to the countries in which they are situated.

7 Personal communication. Florence Veber, Health Advisor to the Mayor of Paris, April 5, 2005.

8 On 1 January 2000, when NHI in France was extended to all those who previously fell through the cracks, the most disenfranchised population in Paris became eligible for coverage under the NHI and also received complementary coverage to cover all up-front out-of-pocket payments. Yet, even after the extension of NHI in 2000 to the approximately 3% of Parisians who were previously not covered, there are still illegal immigrants and others who make use of these centres.

The value of these city-level comparisons is enhanced when we define, carefully, our spatial units of analysis. Paris, a city of 2.1 million inhabitants living within 105 square kilometers, is small in comparison to New York City's 826 square kilometers and 8 million people. Nonetheless, it is comparable to Manhattan, in terms of population size, density and socio-demographic characteristics (Table 1) (Rodwin and Gusmano, 2002). Manhattan and Paris are also similar with respect to the concentration of medical resources. The urban core of each city has a much higher density of physicians than their suburbs. They also have a higher concentration of acute care hospital beds (public and private combined); Manhattan has 2.5 times as many beds as the other boroughs of New York City, while Paris has 1.5 times as many as its three surrounding departments.

Data sources

We obtained US data for hospital discharges and rates of PTCA and CABG from the National Hospital Discharge Survey, National Center for Health Statistics. We obtained these data for Manhattan, by area of residence, from the Statewide Planning and Research Cooperative System (SPARCS), a comprehensive inpatient hospital patient data system established in 1979 as a result of cooperation between the health care industry and the New York State Department of Health. We obtained comparable hospital discharge data for France and Paris, by area of residence, from the French Ministry of Health's Hospital Reporting System, Programme pour la Médicalisation des Systèmes d'Information (PMSI). PMSI centralizes discharge data from all French hospitals by diagnosis, procedure, age, and current address of patients. All hospitals with more than 100 beds provide data to this system. The exclusion of hospitals with fewer than 100 beds is not a problem for this study because revascularizations are not performed in smaller hospitals in Paris. For each city, we analyze data for specific diagnostic and procedure codes by gender, for age cohorts 45–64 and 65+.

We also examine mortality data from INSERM (Institut Nationale pour les Statistiques, Etudes et Recherche Médicale) and the New York City Department of Health (NYCDOH) for these codes, cohorts, and time periods. To ensure an adequate number of deaths, hospital discharges, and procedures for meaningful comparisons, we calculate four-year averages for Manhattan and Paris (1997–2000).

Logistic regression analysis

In addition to our city comparisons, we present results from multiple logistic regression models, which estimate the probability that a person hospitalized with IHD or congestive heart failure receives a revascularization procedure (PTCA or CABG). For Paris, the independent individual variables are age, gender, and number of diagnoses on the record (as a measure of severity of illness);

the neighborhood variables, at the *arrondissement* level, include indicators for income quartile and physician density.

For Manhattan, the independent individual variables are age, gender, race/ethnicity, primary payers, and number of diagnoses on the record; the neighborhood variables at the zip-code level include indicators for income quartile and physician density (Anderson, 1995).[9] We also ran a full model with secondary payers[10] as well as interactive terms relating race and zip code income, and race and insurance. These interactive terms and secondary insurance variables did not change the results, so we dropped them from the final model.

We include the variable, 'age squared', in our models in addition to continuous age variables, because the probability of revascularization increases between the ages of 45 and 75, but decreases thereafter due to increasing frailty. Because the observations on individuals from the same neighborhood may be correlated, we tested for bias due to unobserved neighborhood-level heterogeneity by estimating the models with a dummy variable for each zip code as a replacement for neighborhood-level variables. The parameter estimates for the individual characteristics were not appreciably different from those generated by the original model (Greene, 2000).[11]

Data reliability

The WHO MONICA Project highlights some of the difficulties associated with comparing death rates across populations (Tunstall-Pedoe *et al.*, 1994). For example, project investigators observed that documentation of nonfatal cardiac events were more reliable, in part because a large proportion of deaths were unclassifiable due to a lack of diagnostic information or any medical history. When categorising nonfatal episodes, they classified events as definite, possible, or 'no myocardial infarction' using only ECG criteria because cardiac enzyme criteria are not universally available and standardized (Burke *et al.*, 1989). National IHD mortality rates are clearly not uniform within countries in the MONICA study, and, as noted earlier, mortality data may not be reliable. Some have expressed concern that the differences in criteria for ascribing death to IHD in France may be the reason for the lower French rates (Artaud-Wild *et al.*, 1993; Nestle, 1994; Renaud and Gueguen, 1998).

9 Age, gender, race/ethnicity and income are what Anderson (1995) described as 'predisposing' characteristics; insurance status, physician density and zip code of residence are 'enabling' characteristics.

10 Some residents of the US have secondary, or supplementary, insurance that pays for services not covered by their primary health insurance. For example, the majority of Medicare recipients have some form of supplementary insurance that covers gaps in the Medicare benefit package and may also help cover copayments and deductibles.

11 In addition to examining the model with a dummy variable, we used STATA (version 8) to examine the variance inflation factor (VIF) as a test of collinearity (STATA command: collin). Since the VIF is less than 10 for all of our independent variables, we concluded the correlations among them are not causing unacceptable biases. For further discussion of VIF, see Greene (2000).

Addressing these concerns, we rely on hospital discharge data to test the reliability of the mortality data. These hospital discharge data can validate findings where accepted clinical diagnostic criteria exist, as in the case of AMI. Other national comparisons focus on broad categories of coronary artery disease or IHD, but these include conditions for which diagnoses are less reliable, such as congestive heart failure (CHF) (Akosah *et al*., 2001). To avoid omitting patients that might have been misdiagnosed or miscoded, we adopt a conservative strategy and identify patients using the ICD-9-CM and ICD-10 diagnostic codes for AMI and also all IHD. Examining AMI separately acts as a check on the reliability of broader categories.

Our use of SPARCS and Ministry of Health data on procedure rates for residents of Manhattan and Paris avoids a common misinterpretation of the number of CABG procedures in the US. OECD estimates are based on a sample of inpatient records from short stay-hospitals in the US (National Hospital Discharge Survey, National Center for Health Statistics), which are widely disseminated in the 'Heart and Stroke Statistical Update' of the American Heart Association. The data for cardiac revascularization (bypass - ICD 9 codes 36.1–36.3) are presented as procedures (553,000 in 1998) and as patients (336,000 in 1998). The 'procedure' variable represents the number of coded procedures recorded, but for a given operative procedure on a single patient either a single code (representing an arterial or a venous conduit bypass) or two codes (employed when a combination of arterial and venous conduits have been used) may be counted. The frequent use of two codes, for what is in fact a single operative procedure, exaggerates the number of procedures performed in the US (OECD, 2001).

Measuring treatment for IHD

To ascertain differences in invasive treatment for IHD we calculate age-adjusted rates of revascularization (PTCA and CABG) per 100,000 population for two cohorts: those 45–65 years and those 65 years and over. We do not examine diagnostic cardiac catheterization or coronary angiography rates since they are performed as outpatient procedures in both countries and data on their volume are unreliable.

Assessing the relationship between treatment rates and disease prevalence

To assess the relationship between treatment rates and the prevalence of IHD, we present a simple index based on the ratio of procedure rates to AMI hospital discharge rates.[12] Although the true prevalence of ischemic heart disease in any

12 To test the sensitivity of this index, we also examine the ratio of procedure rates to: (1) hospital discharges for all IHD, mortality rates for AMI, and mortality rates for all IHD. The relationships between Manhattan and Paris and the United States and France were comparable regardless of which variable we used in the denominator.

population will never be known since the illness may be asymptomatic, as a proxy for the prevalence of ischemic heart disease we examine both mortality and hospital discharge rates for AMI. We neither intend to suggest that every patient diagnosed with an AMI receives one of these procedures, nor do we suggest that this is the only diagnosis for which these procedures are an appropriate intervention. Examining the ratio of procedure rates to AMI hospital discharge rates is merely an attempt to adjust for the prevalence of heart disease in the two cities. While our index represents a preliminary effort limited by available data, failure to consider some measure of disease prevalence when analyzing treatment rates can be misleading (Technology Change in Health Care Research Network, 2001).[13]

Results

Mortality

Death rates from IHD in Manhattan and Paris reflect the well-known differences in mortality from IHD between the US and France. Manhattan residents exhibit higher mortality rates than their Parisian counterparts for AMI and all IHD. This contrast is more pronounced with age. For those 65 years and over, rates of mortality due to AMI in Manhattan are 53.4% higher; for those 45–64, they are 37.9% higher.

Morbidity

US and Manhattan residents exhibit a higher rate of hospitalization for AMI and ischemic heart disease than residents of France and Paris (Table 2). Once again, the contrast is more pronounced for older persons than for those 45–64. For those 65 years and over, hospital discharge rates of AMI in Manhattan are 45.4% higher; for those 45–64, they are only 28.5% higher. Thus, the comparison of hospital admission rates is consistent with the differences in mortality rates.

13 In 2000, both the European Society of Cardiology and the American College of Cardiology recommended changing the diagnostic criteria for AMI to include raised troponin T concentrations in addition to changes in electrocardiograms or coronary intervention. The use of this new diagnostic tool may increase the number of people diagnosed with AMI, but this change should not influence our results. First, our data are from 1997–2000, before these professional associations issued their new recommendations. Second, there is no evidence that the examination of troponin T concentrations is more prevalent in one of these cities. Third, we conducted a sensitivity analysis in which we substitute other measures of heart disease in the denominator of our index (hospitalizations for all IHD, mortality due to AMI, and mortality due to all IHD). The results did not change when we used these alternative measures of heart disease.

Table 2. Age-adjusted mortality and residence-based hospital discharge rates: 1997–2000[1]

	Mortality			Hospital discharges		
Acute myocardial infarction (ICD-9=410)	Rate/ 100,000	Rate/ 100,000	Percent difference in rate	Rate/ 100,000	Rate/ 100,000	Percent difference in rate
Nation	**USA**	**France**		**USA**	**France**	
45–64	33.9	17.9	47.2*	265.2	164.9	60.8*
65+	169.6	79.4	53.2*	504.5	267.2	88.8*
Urban core	**Manhattan**	**Paris**		**Manhattan**	**Paris**	
45–64	15.3	9.5	37.9*	107.6	76.9	28.5*
65+	146.4	67.9	53.4*	235.7	128.7	45.4*
All ischemic heart disease (ICD 9 = 410–414)	Rate/ 100,000 (*N*)	Rate/ 100,000 (*N*)	Percent difference in rate	Rate/ 100,000 (*N*)	Rate/ 100,000 (*N*)	Percent difference in rate
Nation	**USA**	**France**		**USA**	**France**	
45–64	69.4	24.5	64.7*	817.3	536.5	34.4*
65+	432.2	146.7	66.1*	1311.2	743.4	43.4*
Urban core	**Manhattan**	**Paris**		**Manhattan**	**Paris**	
45–64	49.9	14.1	71.7*	448.3	267.8	40.2*
65+	518.9	144	72.2*	788.1	364.2	53.8*

Notes: $*$=significant at $p<0.05$ level.
[1]Rates are averaged over 4-year period. Age adjustment is based on US 2000 population.
Sources for mortality data: US – Centres for Disease Control and Prevention, National Vital Statistics Report; Manhattan – Office of Vital Statistics, New York City Department of Health; France and Paris – Institut Nationale pour les Statistiques, Etudes et Recherche Medicale (INSERM).
Sources for hospital discharge data: USA – National Hospital Discharge Survey; Manhattan – Statewide Planning and Research Cooperative System (SPARCS); France and Paris – French Ministry of Health's Hospital Reporting System: *Programme pour la Médicalisation des Systèmes d'Information (PMSI)* (PMSI).

Procedure rates

When we examine age-adjusted rates of revascularization without attempting to account for national- and city-level differences in disease rates, our findings are consistent with previously reported national findings. The age-adjusted rate of revascularization per 100,000 is significantly higher (53.1%) in the US than France for persons 65 years and over and for persons 45–64 years old (44.5%) (Table 3).

In Manhattan and Paris, the difference in the age-adjusted rates of revascularization per 100,000 is consistent with the national figures for persons 65 years and over (21.4% higher in Manhattan than Paris), but the difference between these cities is not as great as the difference between the two nations. The rate of revascularization per 100,000 for persons 45–64 years old, however, is actually *higher* in Paris than Manhattan (2%), despite significantly higher rates of AMI and IHD among residents of Manhattan.

When we use our index to adjust for the prevalence of disease in the two nations and cities, the contrast between our city-level findings and those

Table 3. Age-adjusted revascularization procedures: 1997–2000[1]

Combined revascularization procedures	Rate/100,000 (*N*)	Rate/100,000 (*N*)	
	United States	France	Percent difference
45–64 age cohort	376 (365500)	208.7 (44773)	44.5%*
65+ age cohort	493.9 (476500)	231.7 (62185)	53.1%*
	Manhattan	Paris	Percent difference
45–64 age cohort	195.7 (1068)	200.2 (1567)	−2**
65+ age cohort	299.1 (1538)	235.1 (2122)	21.4*

Notes: *significant at $p<0.05$ level.
**significant at $p<0.05$ level, Paris>Manhattan.
[1]Average rates over four-year period
Sources: USA – National Hospital Discharge Survey; Manhattan – Statewide Planning and Research Cooperative System (SPARCS); France and Paris – French Ministry of Health's Hospital Reporting System: *Programme pour la Médicalisation des Systèmes d'Information (PMSI)* (PMSI).

Table 4. Ratio of age adjusted revascularization rate to AMI discharge rate, 1997–2000[1]

Total procedures/AMI			
	United States	France	Percent difference
45–64 age cohort	1.42	1.70	−20%
65+ age cohort	.98	.87	11.4%
	Manhattan ratio	Paris ratio	Percent difference
45–64 age cohort	1.8	2.6	−31
65+ age cohort	1.3	1.5	−13

Note: [1]We use discharge rates for acute myocardial infarction (AMI) as a proxy for estimated disease prevalence. The index we calculate for assessing the use of these procedures is the result of dividing age-adjusted procedure rates for the population residing in each geographic area, irrespective of where they were performed, by the age-adjusted AMI discharge rates irrespective of where the hospitals are located. Thus, higher indices reflect higher levels of service in relation to our proxy for estimated morbidity.
Sources: USA – National Hospital Discharge Survey; Manhattan – Statewide Planning and Research Cooperative System (SPARCS); France and Paris – French Ministry of Health's Hospital Reporting System: *Programme pour la Médicalisation des Systèmes d'Information (PMSI).*

of previous cross-national comparisons is striking. The ratio of revascularization procedure rates to AMI discharge rates is only 11.4% higher in the US than France for persons 65 years and over. For persons 45–64 years old, the ratio of revascularization procedure rates to AMI discharge rates is actually 20% higher in France than the US (Table 4). The ratio of revascularization procedure rates to AMI discharge rates is higher in Paris than in Manhattan for persons 65 years and over (15%), and even greater for persons 45–64 years old (44%).

Table 5. Logistic regression results for characteristics associated with revascularization in paris for adults 45+ hospitalized with heart disease

	B (std. error)	Percent change in odds for unit increase in X
Age (continuous)	0.21219** (0.01)	23.6
Age squared	−0.00180** (0.00)	−0.2
Female(omitted=male)	−0.30742** (0.04)	−26.5
Income quartile of arrondissement (omitted=highest)		
Lowest	−0.23402** (0.07)	−20.9
Second	−0.26620** (0.05)	−23.4
Third	−0.14643** (0.05)	−13.6
Number of diagnoses on record (continuous)	−0.05419** (0.01)	−5.3
French IGS-2 index of severity for Paris (continuous)	−0.00549* (0.00)	−0.5
Physicians/1000 zip code population	0.00176 (0.01)	0.2

Notes: *0.05 level of significance.
**0.001 level of significance.
Number of observations = 31,359.

What explains the lower use based on our ratio of revascularization procedures in the US compared with France among younger adults, and Manhattan compared with Paris among all adults? One possibility is that residents of France, and to a greater extent Paris, receive too many of these procedures as a result of supplier induced demand made possible by universal coverage, coupled with few restrictions on utilization (Lucas-Gabrielli *et al.*, 2006). Another possibility is that residents of the U.S, and to a greater extent Manhattan, face greater barriers to specialty care than their French counterparts, and therefore do not receive enough of these procedures. As we discuss in the concluding section of the paper, our data do not allow us to comment on appropriateness of care, but previous studies suggest that large geographic variations in the rates of these services in the US are attributed to factors other than disease prevalence (Pilote *et al.*, 1995). These have included age (Pashos *et al.*, 1993), race (Ayanian *et al.*, 1993), sex (Ayanian and Epstein, 1991; Leape *et al.*, 1999), income, co-morbid conditions, location of care, and health insurance status (Carlisle *et al.*, 1997; Philbin *et al.*, 2001). Other studies point to an inverse relationship between distance to health care personnel or facilities and utilization of services (Blustein, 1993; Grumbach, 1995; Ben-Shlomo and Chaturvedi, 1995; Gregory *et al.*, 2000). We conducted logistic regression analyses to investigate the extent to which each of these factors is correlated

Table 6. Logistic regression results for characteristics associated with revascularization in Manhattan for adults 45+ hospitalized with heart disease

	B (std. error)	Percent change in odds for unit increase in X
Age (continuous)	0.22860* (0.002)	25.7
Age squared	−0.00196* (0.001)	−0.2
Female (omitted=male)	−0.32999* (0.027)	−28.1
Race/ethnicity (omitted=white)		
Black	−0.65699* (0.047)	−48.2
Hispanic	−0.23957* (0.042)	−21.3
Asian and 'other'	0.36151* (0.032)	43.5
Income quartile zip code (omitted=highest)		
Lowest	−0.42428* (0.031)	−34.6
Second	−0.29820* (0.041)	−25.8
Third	−0.24675* (0.036)	−21.9
Number of diagnoses on record (continuous)	−0.02902* (0.004)	−2.9
Insurance status (omitted=private insurance)		
Medicare	−0.37020* (0.036)	−30.9
Medicaid	−1.05268* (0.044)	−65.1
Uninsured	−0.97806* (0.075)	−62.4
Other government insurance	−0.94664* (0.711)	−61.2
Physicians/1000 zip code population	0.00062 (0.001)	0.1

Notes: *0.001 level of significance.
Number of observations = 48,306.

to rates of revascularization for residents of Paris and Manhattan (45 years and over) hospitalized with IHD or congestive heart failure.

Multiple logistic regression analysis

In Paris, the continuous age variable is positively correlated with revascularization, but, when we examine age squared, the relationship is statistically significant, but small. Similarly, the density of physicians is not related significantly to revascularization. Although we find that persons with more diagnoses on their record and people with a higher severity score are less likely to receive a revascularization, neither has a large effect on the odds of revascularization (Table 5).

The influences of gender and neighborhood-income on the odds of revascularization are, however, both significant and large. The odds of revascularization are 20.9% lower among residents of the lowest-income *arrondissements* compared with residents of the highest-income *arrondissements*. Similarly, the odds of revascularlization are 23.4% lower among residents of the second lowest and 13.6% lower among the third lowest-income *arrondissements* compared with the highest-income *arrondissements*.

As we found in a previous analysis, women are far less likely to receive revascularization than men (Weisz *et al*., 2004).

In Manhattan, we find that insurance status, race, gender, zip code of residence, and number of diagnoses are all related significantly to the probability of revascularization among residents of Manhattan diagnosed with IHD. Residents of the lowest income zip-codes are significantly less likely to receive revascularization than residents of the highest income. In Manhattan, the odds of women hospitalized with IHD receiving revascularization are 28.1% lower than among men (Table 6).

In addition to these factors, we also examine race and insurance status. The odds of revascularization among those hospitalized with IHD are 48.2% lower among African-Americans and 21.3% lower among Hispanics than Whites. In contrast, the odds are 43.5% higher among Asians and others than Whites, but, given the small number of persons in this category hospitalized for IHD, this finding requires further investigation.

The odds of revascularization for persons without health insurance are 62.4% lower than persons with private insurance. The odds are 65.1% lower among Medicaid recipients and 30.9% lower among Medicare beneficiaries, than among persons with private health insurance. The odds of revascularization are about 61% lower for persons with 'other' government health insurance, but much like the 'other' race/ethnicity category, these results may be due to small numbers.

The US and Manhattan in comparative perspective

Our findings regarding hospital discharge rates by area of patient residence, for AMI, as well as IHD, are consistent with previous cross-national comparisons of heart disease in France and the US. Death rates are higher in the US and Manhattan than in France and Paris. Likewise, based on hospital discharge rates for AMI and all IHD, there is strong evidence that the burden of IHD is significantly higher in the US and Manhattan than in France and Paris (Table 3). Moreover, the disparity in disease burden between the US and France and Manhattan and Paris increases with age, and mortality rates from all IHD are about three times as high in the US and Manhattan than in France and Paris.

A recent comparison of trends in invasive procedure use for patients with heart disease indicates that the US provides higher rates of cardiac catheterization, PTCA, and bypass surgery within one year of a heart attack compared with the other high-income OECD nations in the study (Technology Change in Health Care Network, 2001). Similarly, a comparison of the US and Canada in the GUSTO-1 study found that the rates of PTCA and CABG following AMI among Canadian patients were much lower than any of the regional rates reported for the US (Rouleau *et al*., 1993).

Our analysis of revascularization rates in the US, France, Manhattan and Paris differ markedly from the literature on cross-national comparisons. We find that US residents 45–64 years of age receive invasive procedures at a significantly lower rate than residents of France when treatment is indexed to a measure of disease prevalence. While older people (65+) in the US receive these procedures at a significantly higher rate than their French counterparts, once we account for the higher disease burden in the US it appears that residents of France (45–64 years) receive more revascularization procedures than their American counterparts. This is no longer the case once most Americans become eligible for Medicare. However, the city-level analysis, which is in many respects more refined because the cities are more similar in terms of socio-demographic characteristics and medical resources, suggests that Manhattan residents receive invasive procedures at a significantly lower rate than Parisians. The ratio of revascularization rates to AMI discharge rates is 31% higher in Paris than in Manhattan for the 45–64 year cohort and 13% higher for persons 65 years of age.

Our logistic regression analysis indicates that women and residents of lower-income neighborhoods are less likely to receive revascularization procedures in both cities. In Manhattan, insurance and race represent additional barriers. It is possible that lower rates of revascularization in the low-income *arrondissements* of Paris reflect barriers that could be attributed to race and ethnicity as well. It is illegal to collect such data in France, so it is impossible for us to investigate this question. Moreover, without patient-specific clinical data it is, of course, not possible to disentangle the role of these factors from strictly clinical criteria in explaining the use of cardiac procedures, but our findings are consistent with other studies that identify non-clinical barriers to high-tech treatment modalities in Manhattan and the U.S (Ayanian and Epstein, 1991; Ayanian *et al*., 1993; Grumach *et al*., 1995; Philbin *et al*., 2001).

Our evidence cannot address issues related to the appropriateness of care for residents of these cities or nations. Indeed, it is possible that many of the people who receive these procedures do not benefit from them. Nevertheless, our findings underscore the possibility that many people who need these procedures fail to receive them due to non-clinical barriers to medical care. Such a finding illustrates the added value of supplementing cross-national studies with city-level comparisons and appears entirely consistent with the characterisation of the US health care system as one marked by 'excess and deprivation' (Enthoven and Kronick, 1989).

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