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THE MORTALITY EFFECTS OF COST CONTAINMENT UNDER UNIVERSAL HEALTH INSURANCE: THE JAPANESE EXPERIENCE

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Abstract: For over four decades, Japan has offered universal health insurance. Despite the demand subsidy entailed, it has kept costs low by regulatorily capping the amounts it pays doctors, particularly for the most modern and sophisticated procedures. Facing subsidized demand but stringently capped prices on the most complex procedures, Japanese physicians have had little incentive to invest in specialized expertise. Instead, they have invested in small private clinics and hospitals.

The resulting proliferation of primitive clinics and hospitals has cut both the number of complex modern medical procedures performed, and the number of hospitals with any substantial experience in those procedures. With a quarter of the heart disease in the US, Japan performs less than 3 percent as many coronary bypass operations and less than 6 percent as many angioplasties. Of the 855 cities in Japan, 71 percent lack any hospital with substantial experience in the sophisticated modern treatment of cerebrovascular disease, and 83 percent lack any in heart disease.

In this article, I estimate the mortality cost of this regulatorily-driven lack of expertise. Toward that end, I combine mortality data from 855 cities with information on local hospital expertise and local demographic composition. In the typical city, I find that the addition of one hospital with substantial experience in stroke patients or in modern stroke treatment would cut annual stroke mortality by 10 to 15 deaths. The addition of one hospital with substantial experience in cardiac bypass operations or angioplasties would cut annual heart attack mortality in the city by 27 to 56 deaths.

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The Japanese Experience

I. Introduction

Japan couples universal health insurance with low costs. It offers generous coverage, but pays relatively little. It should face a stratospheric burden, but incurs only modest amounts instead.

Given that Japan accomplishes this feat by capping the prices it pays its physicians, quality degradation is an obvious risk. Subsidize demand but cap prices, and sellers will degrade quality. Some facets of the degradation in Japanese medicine are well-known: the long waits, for example, or the abbreviated consultations and the mandatory return visits. The mortality costs are not.

These mortality costs follow directly from the regulatory structure of the industry. Most prominently, the government price schedule rewards Japanese doctors for investing in small clinics and hospitals rather than specialized expertise. With low prices and subsidized demand, Japanese doctors have little incentive to invest in specialized skills. Skilled or no, they can fill their days at the same government-mandated prices. Yet they do have an incentive to build simple clinics and hospitals. Admit a patient to their private institution rather than the large public hospital, and they can bundle (what are effectively) high-priced hotel stays with quotidian medical services.

The resulting proliferation of small clinics and hospitals has dramatically cut the number of doctors who provide the complex procedures at the heart of much modern medicine. Necessarily, it has also cut the number of hospitals with any substantial expertise in those procedures. With one fourth of the heart disease in the U.S., Japan performs less than 3 percent as many coronary bypass and less than 6 percent as many angioplasty procedures. Of the 855 cities in Japan, 71 percent lack any hospital with substantial expertise in the sophisticated treatment of cerebrovascular disease. Eighty-three percent lack any in heart disease.

Yet for complex modern medical procedures, a hospital's accumulated experience is crucial. At least initially, the quantity of a hospital's experience in a procedure correlates positively with clinical success. Without that accumulated expertise, the mortality rates in the associated diseases necessarily climb. Unfortunately for the critically ill patient, Japan does not do many complex procedures -- and does not have many institutions that could do them well if they tried.

In the study below, I couple data on mortality with data on hospital expertise. More specifically, I assemble information on the number of operations conducted by hospitals in cerebrovascular and heart disease in each of 855 Japanese localities. I then add mortality and demographic data, and estimate the effect of hospital expertise on deaths. Obviously, I do not attempt to measure the aggregate effect of the insurance system as a whole; if the universal insurance reduces mortality rates on another

dimension, the effect will not appear in my data. Obviously, too, the principle that patients do better in cities with sophisticated medical institutions is true everywhere, not just in Japan (e.g., Skinner, 2006 on the U.S.).

What have gone largely unrecognized, however, are the increased deaths caused by the way the Japanese cost-containment strategy increases the fraction of people without realistic access to sophisticated medical technology. I estimate the cost of this restricted access. I find that the addition of one hospital with substantial expertise in cerebrovascular disease would reduce the annual deaths from strokes in a typical city (from the current mean of 89 stroke deaths) by 10 to 15. The addition of one hospital with substantial expertise in heart disease would reduce annual deaths from heart attacks (the current mean is 52) by more than 27.

II. Health Care in Japan
A. Introduction:

The Japanese health care system intrigues. It offers universal insurance coverage, but pays relatively little. It covers (nearly) everyone for (nearly) every medical need, but costs barely 8 percent of GDP (Table 1). Per capita, it costs only $2,700. By contrast, the U.S. spends 15 percent of GDP on health care, $5,700 per capita. Even by the standards of Western Europe, Japan spends little: France spends 10 percent of GDP on health care, Germany spends 11 (Nihon Iryo, 2007).

[Insert Table 1 about here.]

And Japanese are healthy. At birth, American males can expect to live 75 years (females, 80; Table 1). Japanese males can expect to live 79 (females, 86). To be sure, Japanese do live in a more homogenous society, and face pressures closer to those of suburban whites than to those of the American urban under-class. Yet even white American males face a life expectancy of only 75 (females, 80). Even at age 40, Japanese men face a life expectancy of another 40 years (women, 46) while white American men face only 38 (women, 42).

For their medical care, Japanese can turn to 260,000 physicians, 2.0 per 1000 population (the U.S. has 700,000, or 2.3 per 1000; Table 1). These doctors work at 97,000 clinics (statutorily defined as institutions with less than 20 beds) and 9,000 hospitals (Kosei, 2007: 106). By at least some measures, they offer good facilities: 92.6 CT scanners per million people, for example, compared to 11 in Canada (Nihon Iryo, 2007: 238; data for U.S. unavailable). And they supply substantial drugs: $509 per capita, compared to $702 in the U.S. (Nihon Iryo, 2007: 217, 247, 253).

When they eventually die, both Japanese and Americans adults die principally of heart disease, strokes, and cancer -- though the mix varies a bit across the two countries (see Table 1). Americans die primarily of heart disease (222 deaths per 100,000), cancer (189 per 100,000) or strokes (51 per 100,000). Among the cancers, they most commonly die of lung cancer (54.2 per 100,000), colorectal cancer (22.2 per 100,000), or breast cancer (15.6 per 100,000). Japanese die of cancers (258 per 100,000), heart disease (137 per 100,000), or strokes (105 per 100,000). And among the cancers, they most often die of lung cancer (44.6 per 100,000), stomach cancer (39.9 per 100,000), or colorectal cancer (30.8 per 100,000).[1]

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[1] www.who.int/healthinfo/statistics/bodgbddeathdalyestimates.xls (death rates from cancer)

B. Universal Coverage:

        The Japanese national health insurance dates from the late 1950s (Ramseyer, 2009). Facing electoral challenges from a socialist and communist left, the conservative ruling party folded the existing programs into a universal national insurance plan. Formally, the "plan" was not one but several. It allocated residents to different programs by their age and employment status. Employees in large firms it registered in one set of plans, for example, and those in small firms in another. The employees of the large firms it insured with private insurers, the self-employed with municipal governments (Kameoka, 2005: 8-13).

        The plans vary modestly. Co-payments, for instance, can run from 10 to 30 percent. Still, the least generous plan requires co-payments only up to (in the mid-2000s) 140,000 yen (at the close of 2005, $1.00 = 118 yen) plus 1 percent of any excess over 466,000 yen. And the government caps even that amount for patients in the lowest income brackets (Kameoka, 2005: 8-13, 42).

        Through these plans, the government covers all residents against the cost of most major medical problems. According to political scientist John Campbell and health care specialist Naoki Ikegami (1998: 1-2), "[v]irtually the entire population is included in mandatory health insurance," and the "benefit package in all programs covers nearly all regular health care." It is, they (2008: 133) conclude, "one of the best health care systems in the world."

        Importantly for this study, the plans ostensibly cover all residents against the cost of the sophisticated cerebrovascular and heart disease procedures discussed below. When medically indicated, the plans promise to pay for cardiac bypass operations and angioplasties. Other than in very exceptional cases, a Japanese resident would not forego one of the complex treatments discussed below because he could not afford it.

C. Price Caps:

        At the same time that the Japanese government subsidizes demand, it limits supply. Through educational requirements (six years of medical education, three years of residency) and a licensing exam, it restricts the number of doctors.[2] Subsidize demand and limit supply, and financial costs should skyrocket. Yet in Japan, they do not.

        To control its costs, the Japanese government caps the prices it pays its doctors, hospitals, and drug companies. Every other year, representatives of the Ministry of Health, Labor & Welfare (MHLW) negotiate a fee schedule with industry leaders -- primarily, representatives of the physician trade association, the Japan Medical Association (JMA; Campbell & Ikegami, 1998: ch. 6). Through this schedule, they detail the amount the government will pay doctors for their services. By all accounts, they set the rates low. According to Campbell & Ikegami (1998: 147), they set them at about one quarter of the level the service would cost in the U.S.

        Ministry officials also meet regularly with representatives of the pharmaceutical industry. Again, they negotiate the prices the government will pay. And again, they

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[2] Ishi ho [Physicians Act], Law No. 201 of 1948, Secs. 11, 16-2 (residency), Sec. 2 (licensing exam). As explained below, the government traditionally also limited physician advertising, limited the number of beds per locality, banned corporate ownership of hospitals, and deferred to physician opposition to new public hospital construction.

negotiate low amounts. Doctors (who often sell the drugs to the patients directly) then prescribe massive amounts. Although Japanese spend less per capita than Americans (as noted above), given the low prices the total disguises a large quantity.

D. Preliminary Effects:

When observers study the effect of the price caps in Japan, to date they focus primarily on wait times, visit lengths, and visit frequencies. To be sure, the effects there are substantial. Most physicians allocate their services by queue. They take no appointments, and treat patients on a first-come-first-served basis. When patients do make an appointment, it avails them little. According to a 2005 MHLW survey, only 45 percent of the patients who arrive at a hospital without an appointment see a doctor within 30 minutes. Another 23 percent see him within the next 30 minutes. With an appointment, the fraction able to see a doctor within 30 minutes rises only to 53 percent.[3]

Patients typically consider physician quality highest at the bigger public hospitals, and there they wait even longer. There, only 22 percent of the walk-in patients see a doctor within 30 minutes. Another 22 percent see one in the next 30 minutes, another 32 percent wait 1 to 2 hours, and a quarter wait over 2 hours.[4]

When finally a patient does see a doctor, he disappears almost immediately. Facing subsidized demand but fixed prices, doctors maximize income by seeing as many patients as possible a day. This, of course, is equivalent to spending as little time with each as possible. According to one common Japanese adage, "you wait three hours for a three-minute consult" (see Ikegami, 2004). The adage exaggerates, but only barely.

And experiencing only minimal doctor contact, patients return -- again and again. With reimbursement a function of visit quantity, doctors also increase income by seeing patients as often as possible. Should a patient need medication for a given period, a physician might prescribe enough only for half the time necessary. When the patient reappears for the rest of the prescription, he would bill the government for another visit.[5]

III. Physician Investments:
A. Introduction:

And yet, by capping the amount it pays its doctors, the Japanese government causes a phenomenon far more pernicious. The caps do not just increase the delays, reduce visit lengths, or generate extra visits. They also induce Japanese doctors to invest in physical instead of human capital. Rather than spend extra years in specialist training, they build small, primitive clinics and hospitals. The resulting proliferation of small institutions has then dispersed complex illnesses over so many doctors and institutions that few accumulate the experience they need to treat them most successfully.

B. Specialization:

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[3] www.mhlw.go.jp/toukei/saikin/hw/jyuryo/05/kekka2.html.

[4] www.mhlw.go.jp/toukei/saikin/hw/jyuryo/05/kekka2.html.

[5] Not all patients reappear, of course -- if they think their symptoms gone. As a result, a significant fraction of patients take their medication for less than the full medically prescribed period. This, in turn, has accelerated the evolution of drug-resistant strains of bacteria.

1. <u>Incentives</u>. -- The fee schedule does not just suppress fees; it also skews them. At the same time that it depresses prices, it diverts revenue <u>away</u> from doctors who invest in specialized expertise; it diverts it <u>toward</u> those who invest in private clinics and small hospitals. As Campbell & Ikegami (1998: 84, 173-74) write, it "makes inexpensive primary care relatively profitable and expensive high-tech procedures unprofitable." The "[c]ontinued domination by the JMA" of health policy, they explain, has "left hospital services, especially high-tech medicine and nursing, poorly reimbursed, with no provision for capital investment or administrative overhead."

Effectively, the fee schedule eliminates the financial incentive for doctors to specialize. Because the universal coverage boosts demand while the licensing regime cuts supply, Japanese physicians can fill their days at government rates. They will fill their days at government rates if they spend years acquiring specialty and subspecialty sills. And they will fill their days at government rates if they invest in no specialty training at all.

Contrast the U.S. An American doctor who chooses family practice will spend a few years in residency, and then (after three years in private practice) earn $200,000. Should he specialize more narrowly he will spend longer training, but earn more thereafter. Indeed, to become a heart surgeon, he would spend many more years in residency, but then make over $500,000.[6] In effect, he invests in his human capital at the outset, and earns on a return on that investment over the rest of his career (Dranove & Satterwaite, 1991: 52).

2. <u>The effect on specialization.</u> -- In effect, the Japanese government has eliminated much of the return that doctors might otherwise earn on their human-capital investments. Suppose a doctor considers entering a five-year sub-specialty residency. If he does, the government will not pay him a higher fee. Yet by subsidizing demand, it ensures that he has sufficient patients without it. Skilled or no, specialist or no, he can fill his days with patient visits, and collect for each visit the prescribed fee.

Predictably, most Japanese doctors choose not to acquire any specialized expertise.[7] They do what they must for their basic license, but no more. Of the 19,000 JMA members in Tokyo (56 percent of all Tokyo doctors), barely 1,100 are board-certified.

Equally predictably, the few doctors who do specialize disproportionately sell their services in sectors outside of the government insurance program. Of the 1,100 certified Tokyo doctors, 200 sell cosmetic-related services (like plastic surgery) not covered by the national insurance. Put otherwise, where 6 percent of all Tokyo JMA doctors obtain board certification, a full 40 percent of the approximately 500 Tokyo JMA doctors in the cosmetic services market do (Ramseyer, 2009). There, they sell their

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[6] http://www.allied-physicians.com/salary_surveys/physician-salaries.htm.

[7] Basic logic also suggests that the fee schedule will lower the quality of people entering the medical services industry. If (as seems likely) the brightest science students are most attracted toward the complex modern procedures, then a fee schedule that holds down the reimbursement rate on those procedures will disproportionately push the most talented science students away from a career in medicine. for suggestive evidence consistent with this hypothesis, see Ramseyer (2009).

services at market prices. Consumers want specialized expertise, and in sectors outside the national insurance system they can -- and do -- bid for that expertise in the market.

Not so in the insured sector. Earning no returns to specialization, physicians treat (virtually) any ailment a patient might bring. Typically, they advertise services in multiple fields. Often, they advertise services in completely unrelated fields like internal medicine and surgery. Tokyo physician Takushi Kudo, for instance, holds himself out as an internist, orthopedic surgeon, cardiologist, dermatologist, allergist, rheumatologist, pulmonologist, gastroenterologist (including endoscopies), and nephrologist -- and claims to practice rehabilitation medicine and physical therapy besides (JMA, 2004: 456).

3. <u>The effect on hospital ownership</u>. -- Japanese physicians may not invest in specialized expertise, but they do invest in clinics and small hospitals. Through these institutions, they effectively run inns and sell the government high-priced lodging. Because the government pays for many in-patient services at rates that generate at least a market return on beds, facilities, and buildings, they build and buy clinics and hospitals. Of all practicing doctors in Japan, 28 percent own their own institutions. Of all doctors in Tokyo, 26 percent do (Kosei, 2006b).

Given the rates the government pays, Japanese doctors keep their patients long. U.S. hospitals keep in-patients a mean 6.5 days. In Japan, hospitals and clinics keep them 36.3 days. Even Denmark, the U.K., and Germany keep patients only a mean 5.2, 7.2, and 10.4 days (Nihon iryo, 2007: 243).

The Japanese tax regime adds to the clinic's advantage. With a top marginal rate of 50 percent, the estate tax gives successful doctors a strong incentive not to leave their children liquid assets.[8] Instead, the doctors invest in clinics or hospitals that they transfer as functioning units to physician children. In theory, a sensible estate and gift tax regime would tax the <u>inter vivos</u> transfer at the same rate as the equivalent cash bequest. In practice, the Japanese tax regime does not. Doctors can far more readily avoid the estate tax by conveying clinics or hospitals to their children as working operations.

Fewer doctors today acquire clinics and hospitals than in the past. A recent Stanford study attributes this shift to culture. Younger physicians, it explains, are not "interested in clinic-based medicine," because "the escalation of land prices in Japan has made the creation of clinics by young doctors financially prohibitive," and young doctors "are attracted to ... sophisticated medical equipment" at the bigger hospitals (Yoshikawa, <u>et al.</u>, 1996b: 27).

In fact, the shift stems from regulation. As of 2005, only ten of the 47 Japanese prefectures (as a whole) remained below the government-imposed caps on the number of allowable beds (Kokuritsu shakai, 2006: 428 tab. 229). Faced with a binding cap, doctors could acquire a clinic or hospital only by buying an existing one.

Effectively, the regulatory structure bifurcates the medical community into doctors with own private clinics and hospitals, and doctors who staff hospitals. Because the government price schedule rewards investments in clinics and small hospitals but not specialized expertise, the best-paid doctors will be those with their own institutions. Many of the rest will simply stay on hospital staff until they save enough to build or buy a clinic of their own.

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[8] Sozokuzei ho [Inheritance Tax Act], Law 73 of 1950, Sec. 16.

4.   Political economy. -- The political dynamic behind the fee schedule is straightforward. As noted earlier, the MHLW negotiates the schedule with the JMA. And the doctors who dominate the JMA are the doctors with the clinics and small hospitals. Where Japan has 270,000 physicians, the JMA includes only 164,000 (61%). But where national data estimate that 77,000 operate their own hospital or clinic, the JMA claims 85,000 owner-operators on its roster. Either the MHLW is under-counting owners, or the JMA is over-counting. Either way, virtually all owner-operators must join the JMA.[9]

If ever government involvement suggested a "capture theory" of regulation, this was it. Through negotiations with the JMA, the government sets the prices it will pay the members of the JMA for their services. As one might expect, it adds a variety of anti-competitive restraints as well: caps on new beds in each locality, advertising restrictions, higher charges on patients who try to consult with a sophisticated hospital without first visiting a small clinic, a ban on standard corporate hospital ownership, and -- informally -- a frequent capitulation to local physician opposition to the construction of new public hospitals.[10] In Campbell & Ikegami's (1998: 174) words: "office-based physicians and the government have become de facto allies in maintaining the status quo by preventing the encroachment of hospitals and the expensive high-tech medicine that they promote."

5.   Preliminary confirmation from income data. -- To illustrate one effect of these dynamics, consider physician tax returns from 2004.[11] Through that year, the Japanese National Tax Authority published the names, addresses, and tax liabilities of all taxpayers who paid more than 10 million yen in taxes -- at the end-of-2004 exchange rate of 102.68 yen/$, about $97,000.[12] To pay that $97,000, a taxpayer would have needed to earn about $390,000.[13] In 2004, about 73,000 taxpayers "made" this high-income taxpayer (HIT) list. Because the 2003 Privacy Protection Act bans the further release of the information, this is the most recent list publicly available.[14]

I take this tax information, and couple it with biographical information from the JMA directory (JMA, 2004). Ideally, I would match the HIT list to biographical

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[9] Data on total physicians from Kosei (2006) for 2004; data on JMA membership from its webside, www.med.or.jp for 2006.

[10] See Kokuritsu shakai, 2006: 428 tab. 229 (bed caps), Iryo ho [Medical Services Act], Law No. 205 of 1948, Sec. 6-5 (advertising restrictions), Yashiro, et al., 2006: 28 (surcharge on hospital visits), Iryo ho, supra, at Sec. 7(3) (corporate ban).

[11] I use the list as published by the Tokyo shoko risaachi (TSR), a D&B affiliate. TSR uses the list in its credit-rating activities.

[12] TSR (2005). For a fuller discussion of this data base, along with the effect of various tax-planning and -evasion strategies on its reliability, see Nakazato, Ramseyer & Rasmusen (2006a, 2006b) and Ramseyer (2009).

[13] The calculations behind this statement are detailed in Nakazato, Ramseyer & Rasmusen (2006a, 2006b).

[14] Kojin joho no hogo ni kansuru horitsu [Act Relating to the Protection of Personal Information], Law No. 57 of 2003.

information on a random sample of all physicians. Unfortunately, no source publishes a directory of all physicians. I use the JMA directory as the best alternative.[15]

I do not randomly sample the JMA directory. JMA physicians are older than others, and age obviously correlates with income. Instead, I take all Tokyo JMA members at the most active phase of their careers -- those born between 1955 and 1967. This yields a population of 2,200 doctors, which I then match against the similarly aged physicians on the HIT list.

As Table 2 shows, hospital staff doctors are much less likely than clinic and hospital owners to earn enough to land on the HIT list. According to Panel A, in 2004 14.5 percent of the Tokyo JMA doctors in this age cohort not on hospital staff appeared on the list. Of those on staff at hospitals, only 2.6 percent did.

[Insert Table 2 about here.]

In Panel B of Table 2, I regress taxable income on a doctor's status on a hospital staff along with several controls. Because the income is censored below at 10 million yen, I use tobit. Additionally, I regress appearance on the HIT list (as a dummy variable) on the same variables with probit. For controls, I add age, age squared, university attended (the public universities are more selective than the private), and sex.

In all specifications, those physicians who work as hospital staff earn less than their peers. The moral is simple, and confirms the common wisdom in the Japanese medical community: to succeed financially, a physician must leave his position on the staff of a large public hospital and buy or build a clinic or hospital of his own.

6. The effect on hospital construction. -- These owner-physicians -- the most successful of the doctors and the dominating influence within the JMA -- fight the construction of larger and more sophisticated hospitals. American physicians lobby for municipal hospitals because they need places to admit their patients. JMA physicians face no such incentive. Instead, they earn the most if they keep their patients out of the hospital and in their own clinic. To them, a community hospital is simply a more sophisticated competitor for their most lucrative customers. Often, they fight plans to build new municipal hospitals in their cities. Often, the government defers.

Basic industrial-organization theory suggests several additional effects that lie outside the scope of this article. Throughout the 1970s, small retailers in Japan tried to block the construction of large stores (Tsuruta & Yahagi, 2002). Predictably, the restrictions helped maintain the income of these incumbent retailers. To the extent they succeeded, they also raised consumer prices, limited consumer choice, and retarded the development of more efficient distribution methods. The pricing schedule and anticompetitive restraints presumably cause similar phenomena in the medical services industry.

IV. Mortality Effects
A. Introduction:

As the proliferation of generalist clinics shapes the accumulation of medical experience, it necessarily shapes the care patients receive as well. Because it dissipates

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[15] For a fuller discussion of this data base, along with the ways in which it is and is not representative of all physicians generally, see Ramseyer (2009).

complex illnesses among nearly 100,000 small clinics, it sharply reduces the number of doctors and hospitals with any substantial experience in the more sophisticated modern procedures. Yet many of these procedures stand at the core of the modern assault on the pathologies that claim so many Americans and Japanese lives: bypass operations and angioplasty for heart disease, for example, carotid angioplasty and endarterectomy to prevent strokes, or the complex operations and chemotherapies for cancer.

These technologically intensive procedures save lives. Although a few early studies suggested that some of the more complex procedures brought only modest returns (McClellan, McNeil & Newhouse, 1994), more recent work indicates that many generate large benefits.[16] Indeed, they lie at the heart of the procedures that the U.S. medical system provides so extraordinarily well (Cutler & Mas, 2004).

Doctors and hospitals perform these complex procedures best if they bring accumulated experience. Obviously, the amount of experience necessary depends on the procedure, and the marginal benefit of additional experience will decline as volume increases (Kawabuchi & Sugihara, 2006). Repeatedly, however, studies show that a hospital needs a reservoir of experience to perform these complex procedures effectively.[17]

Japanese hospitals and doctors perform many of the complex procedures far less often than their U.S. peers. In 2005, for example, American doctors performed 469,000 cardiac bypass (CABG) operations and 1.27 million angioplasties. Although Japan had about a quarter the number of deaths from heart disease (see Table 1), Japanese doctors performed less than 3 percent of the U.S. bypass operations (12,000), and less than 6 percent of the angioplasties (70,000-100,000).[18] Of the 855 cities in Japan (dataset described in Subsec. B., below), 71 percent lacked any hospital with substantial experience in cerebrovascular disease, and 83 percent lacked any with substantial experience in heart disease (with "experience" as defined in Subsec. C., below).

The observable implication follows: Because accumulated hospital experience improves treatment outcomes, mortality rates from heart and cerebrovascular disease should be highest in areas without hospitals that can claim a large reservoir of experience in treating these diseases. After all, as Cutler (2007: 1089; see Guadagnoli, et al., 2000) put it in the U.S., "patients are generally taken to the nearest hospital after an MA [heart attack], and where one is admitted affects what is done -- even several months later." The principle that patients do best in areas with sophisticated hospitals clearly applies in the U.S., of course (Cutler, 2007). But it also applies in Japan: as I show below, people are substantially more likely to die from heart and cerebrovascular disease in areas

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[16] The literature is massive, but a few of the studies include, e.g., Cutler (2007); Hemingway, et al. (2001, 2008); Faxon (2008); Normand, et al. (2001); Guadagnoli, et al. (2000). Obviously, they do not always generate benefits. The procedures themselves carry risks, and when not medically indicated the expected benefits do not outweigh those risks.

[17] See Ho (2000); Jollis, et al. (1994); Yamada, et al. (2002); McGrath, et al. (2000). Kawabuchi & Sugihara (2006) argue that the experience of the doctor matters rather than that of the hospital.

[18] Japan figures: Sezai, et al. (2007) and Yomiuri (2008) on number of bypass operations; Yomiuri (2008) and Shukan Asahi (2008) on number of angioplasties. U.S. figures: American Heart Association (2008).

without sophisticated hospitals than in areas with them. Unfortunately, the small clinics and hospitals crowd out such sophisticated institutions in most of Japan.

B. Data:
        1. Data sources. -- To explore these issues, I turn to municipal-level data. Japan comprises 47 prefectures, and these prefectures include both cities and other areas. I treat each city as an observation, and the other areas in each prefecture as an additional observation. Because Tokyo is so large (and technically not a city), I treat each ward (ku) within Tokyo as a distinct observation. Through this procedure, I create a database of 855 observations.
        For each locality, I obtain demographic data from the Statistics Bureau of the Ministry of Internal Affairs and Communications (www.stat.go.jp; Somu sho, 2007). I also turn to this source for most of the local infrastructural variables used in the two-stage estimates.
        I take information on the number of deaths and on life expectancy from the statistics bureau of the MHLW (2006a, 2006b).
        I obtain data on hospital experience from two private sources. The Japanese government requires medical institutions to report the number of operations they do for certain specified procedures. The Shukan Asahi (2008) magazine obtained this information from local government offices, and used it to rank those with more than 50 cerebrovascular procedures. The Yomiuri (2008) surveyed medical institutions to obtain analogous data. I use the Shukan Asahi for hospital experience with cerebrovascular disease, and the Yomiuri for experience with heart disease.

        2. Diseases studied. -- I focus on cerebrovascular disease and heart disease. Cancers present an obvious alternative. After all, they kill a large fraction of the Japanese population, but do respond to sophisticated modern medical regimes. I nonetheless ignore them for this study, because I examine the effect of the price caps in universal insurance on mortality patterns -- while an increasing number of wealthier Japanese have effectively opted out of the national insurance altogether for their cancer treatments.
        The Japanese government licenses only a subset of chemotherapy drugs for the universal health insurance.[19] Although the pharmaceutical industry continues to develop ever-more-effective chemotherapy regimes, these drugs have grown ever-more-expensive. When proven effective, the U.S. government has approved these drugs for use. Nominally out of safety concerns, however, many of them the Japanese government has refused to license for its insurance coverage.
        Denied access to the most effective treatment regimes, more and more Japanese cancer patients opt out of the universal insurance. They cannot formally opt out, of course. But rather than rely on the universal insurance for the limited chemotherapy options, they turn to a growing group of oncologists who offer the new (U.S.-licensed) treatments on a cash or private insurance basis. In part to help Japanese plan for this risk, an increasing number of insurers offer specifically "cancer insurance." Aflac was said to

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[19] For a list of licensed and unlicensed chemotherapy drugs, see www.cancerinfo.tri-kobe.org.

dominate the market; in 2007, it sold 639,000 new cancer insurance policies. [20] Importantly for this study, this phenomenon implies that the mortality patterns in cancer may reflect a mix of government-insurance and off-insurance treatments.

I know of no analogous trend toward off-insurance treatments for cerebrovascular or heart disease. The national insurance nominally covers the complex treatments discussed below. And those hospitals that do have a reservoir of experience in those treatments are overwhelmingly public institutions that accept the national insurance coverage. Mortality patterns in these diseases should instead reflect only universal-insurance-offered treatments.

C. Variables:

1. Hospital experience. --

Stroke experience: The Shukan Asahi magazine ranked hospitals by the number of stroke patients they saw in 2006. My **Stroke experience** gives the number of top 400 such hospitals in each city. The number ranges up to 16 (for Osaka); the modal value is 0. The most experienced hospital saw 969 stroke victims; the 400th hospital saw 147.

tPA experience: Shukan Asahi also identified the number of stroke victims to whom the hospitals administered tPA (tissue plasminogen activator) in 2006. tPA is a relatively recent innovation in stroke treatment. Though not generally indicated (even the hospitals using tPA most often still gave it to fewer than 2 percent of their stroke patients), if administered soon after a stroke it can sometimes be very effective. I use the administration of tPA as an index of the extent to which a hospital follows the most recent cerebrovascular procedures. My **tPA experience** variable gives the number of hospitals to have used tPA in the past year in each city. The number ranges up to 14 (for Osaka); the modal value is 0.

Bypass experience: The Yomiuri magazine identified the 229 hospitals that conducted the greatest number of cardiac bypass operations. My **Bypass experience** variable gives the number of such hospitals in each city. The number ranges up to 10 (for Sapporo); the modal value is 0. The most experienced hospital performed 227 bypass operations; the 100th hospital performed 47.

Angioplasty experience: The Yomiuri also ranked hospitals by the number of angioplasties. My **Angioplasty experience** variable gives the number of top 50 such hospitals in each city. The number ranges up to 2 (for five cities); the modal value is 0. The most experienced hospital performed 2,393 angioplasties; the 50th hospital performed 583. In the U.S. market, Jollis (1994) categorized a hospital doing 200-400 angioplasties as a low-volume (and high-mortality) hospital. Ho (2002) classified a hospital as high-volume (low-mortality) if it performed more than 400 angioplasties per year.

2. Dependent variables. -- For my dependent variable, I use the number of deaths in a city from cerebrovascular and heart disease. The source (Kosei, 2006b) divides the

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[20] It sold 1.4 million new policies (of all types) in 2007. See 2007 Annual Report, Afurakku no genjo, 2008 [The Present State of Aflac, 2008], at 6, available at www.aflac.co.jp. A web search in mid-2008 disclosed at least 8 other firms offering cancer insurance: Mitsui-Sumitomo Marine, Tokyo Marine, Sonpo Japan, Secom sonpo, AIG, AIU. American Home Direct, and Zurich.

former into three components (strokes [cerebral infarctions], subarachnoid hemorrhage, and intracerebral hemorrhage). It divides the latter into four (heart attacks [acute myocardial infarctions], other ischemic heart disease, arrhythmia and conduction injury, and heart failure).

(a) **Total cerebrovascular disease**: All deaths from cerebrovascular disease in the locality during 2006.
Strokes: The number of deaths from strokes (cerebral infarctions). Infarctions can be caused either by ischemia or by hemorrhage.
Subarachnoid hemorrhage: The number of deaths from subarachnoid hemorrhage (bleeding between one of the membranes covering the brain and the brain itself). The hemorrhage occurs either spontaneously or as a result of trauma.
Intracerebral hemorrhage: The number of deaths from intracerebral hemorrhage (bleeding that occurs when the blood vessels within the brain rupture).

(b) **Total heart disease**: The number of deaths from heart disease (excluding high blood pressure) in the locality during 2006.
Heart attacks: The number of deaths from heart attacks (acute myocardial infarctions).
Other ischemic heart disease: The number of deaths from other ischemic heart disease. The category refers to heart disease (like angina or ischemic cardiomyopathy) caused by low blood flow to an area (ischemia).
Arrhythmia & conduction injury: The number of deaths caused by heart arrhythmia and conduction injuries. The abnormal rhythm of the heart can be caused by injury (such as an ischemic infarct) to the usual conduction pathways in cardiac muscle.
Heart failure: The number of deaths from heart failure.

3. Demographic controls. --
Total population: The number of residents in the locality, as of 2005.
Age 15-64: The number of residents aged 15 to 64 in the locality, as of 2005.
Age 65 & over: The number of residents aged 65 or older in the locality, as of 2005.
More finely partitioned age data are available at the prefectural level, but not at the municipal level.

4. Instruments. -- To instrument the hospital experience variables, I turn to other indices of infrastructural development in the locality. The large municipal hospitals will reflect -- in part -- the willingness and ability of an area to invest in modern public services. Accordingly, I choose variables that capture some of that willingness and ability.
Medical schools: The number of medical schools in the area, in 2007 (Shobun sha, 2008).
Business establishments: The number of business establishments in the area, as of 2006.
Post offices: The number of post offices in the city, in 2005.
Parks: The number of parks in the city, in 2005.

Civic halls: The number of civic halls (<u>kominkan</u>) in the city, in 2005.
Libraries: The number of public library branches in the city, in 2005.

D. <u>Results</u>:
        1. <u>Introduction</u>. -- According to Panel A of the Table 3 summary statistics, mortality rates from cerebrovascular and heart disease are indeed higher in the areas without specialist hospitals. To construct the table, I partition the cities by whether they have a hospital experienced in tPA use (for the cerebrovascular disease deaths) and bypass operations (for the heart disease deaths) The rates for "other ischemic heart disease" are the same for both groups.   All other death rates -- whether for cerebrovascular or for heart disease -- are noticeably higher in the cities without the sophisticated hospitals.
        [Insert Table 3 about here.]
        Panel A does not hold demographic composition constant, of course. Cerebrovascular and heart diseases are conditions whose incidence rises with age, and the cities without the specialist hospitals tend to be areas with older populations. Before turning to the multiple regression estimates that hold demographics constant, however, consider Panel B. Here I give male life expectancy figures for the two populations. At each age measured, expected life expectancy is higher in the areas with specialist hospitals.   Indeed, other than the age 40 figures, the differences are statistically significant: people live longer in communities with sophisticated hospitals.

        2. <u>Regressions</u>. -- (a) <u>Introduction</u>. To explore more closely the effect of hospital experience on mortality, in Tables 4 (for cerebrovascular disease) and 5 (for heart disease) I regress the number of deaths on the hospital experience and local demographic variables. Because hospital experience is a function of the disease environment in the locality, my hospital experience variables are endogenous. Accordingly, I instrument them with a series of variables that capture a locality's investments in public infrastructure more generally. I include the two-stage estimates in Panel A, and the corresponding OLS estimates in Panel B.
        [Insert Table 4 about here.]

        (b) <u>Cerebrovascular disease.</u>   Whether I measure hospital experience by the number of stroke patients it sees in a year or by its use of tPA, cities with sophisticated hospitals see fewer deaths from cerebrovascular disease. To be sure, the amount of experience a hospital needs to treat a patient successfully will vary with the procedure. The fact that experience correlates with clinical success, however, appears across all categories of the disease, and appears in both the two-stage and OLS specifications.
        According to the two-stage estimates, each sophisticated hospital cuts cerebrovascular mortality in the area by 17 to 23 deaths per year, and specifically stroke deaths by 10 to 15 per year. According to the OLS estimates, it cuts cerebrovascular mortality by 12 to 14 deaths per year, and stroke deaths by 6 to 8. As the average city had 89.3 stroke deaths a year, this is a substantial effect.

        (c) <u>Heart disease.</u>   Hospital experience similarly reduces heart attack deaths. Whether I measure hospital experience by bypass operations or angioplasties (the

requisite amount again varies), those cities with sophisticated hospitals have fewer deaths from heart attacks. By the two-stage estimates in Panel A of Table 5, each additional sophisticated hospital reduces heart attack deaths in the city by 27 to 56 per year. By the OLS estimates in Panel B, it reduces them by 8 to 19 deaths per year. These are large effects. As the average city has only 52 heart attack deaths a year, the high-end estimate of 56 is unrealistic -- but does reflect the large size of the impact.

[Insert Table 5 about here.]

Hospital experience likewise cuts deaths from heart failure. After heart attacks, heart failure is the most common cause of death from heart disease (see Table 3), and the two-stage estimates (though not the OLS) show a large hospital experience effect on heart failure. Deaths from other ischemic heart disease and arrhythmia and conduction injury are rarer, and hospital sophistication seems not to reduce their incidence.

3. <u>Robustness checks</u>. -- (a) <u>Squared demographic terms</u>. The risk remains that my three-tier age-distribution variables fail to capture fully the effect of age on heart and cerebrovascular disease. If the better hospitals disproportionately locate in younger cities, some of the effect of age composition could then appear in the coefficient on hospital experience. Suppose, for example, that cities with relatively high fractions of over-age-65 citizens also have a relatively high fraction of the oldest citizens even within the over-age-65 group.

To address this possibility for strokes and heart attacks, in Regressions (1) and (2) of Table 6 I include the over-age-65 fraction and its square. This squared term will now capture any tendency among the high over-age-65 cities to have a large number of the very oldest citizens within the over-age-65 group. I present the results for strokes and heart attacks in Table 6: the coefficients on the hospital experience variables remain negative and highly significant, and exhibit magnitudes that track (other than for angioplasty experience) those in Tables 4 and 5.

[Insert Table 6 about here.]

(b) <u>Per capita death *rates*</u>. Because the regressions above take as their dependent variable the number of deaths, the possibility remains that the larger cities (with more deaths) skew the results. To eliminate that effect, in Regressions (3) and (4) I divide the number of stroke and heart-attack deaths by the city population. I then use that per capita death rate as my dependent variable. As explanatory variables, I add the population of the city (now uniformly insignificant) and the fraction of the population 65 or older.

Although the statistical significance of the coefficients now falls, they remain negative: the more experienced hospitals, the lower the death rate. The calculated coefficients remain statistically significant at the 10 percent level or better in three of the four specifications.

(c) <u>Dummy independent variables</u>. Does the number of sophisticated hospitals in a city matter? Or is it enough for a patient merely to have access to a few institutions? To address the issue, I create dummy variables equal to 1 if a city has at least two experienced hospitals (as defined above) for every 100,000 population. The number of such cities ranges from 64 to 85 for the four variables.

I present the results in Regressions (5) and (6). The calculated coefficients remain negative, but are now statistically significant in only two of the four specifications. Two sophisticated hospitals suffice to generate mortality benefits on some dimensions, apparently, but possibly not on all.

(d) <u>Partitioned dataset.</u> -- Finally, to return to the possibility that the age distribution variables inadequately capture the effect of age, I partition the cities into approximate demographic quartiles. I include in Quartile I those cities where the fraction of population 65 and older is under 18 percent. Quartile II includes those with 18 to 21 percent over-65 residents, III includes those with 21 to 25 percent over-65, and IV includes those with more than 25 percent over-65.

Table 7 reports the estimates for strokes and heart attacks. Although the significance levels are lower given the smaller sample sizes, the results roughly track the outcomes above. In Panel A (strokes), the coefficient on hospital experience is negative in 4 of the estimates and significantly so in 3. It is significantly positive in only 1. In Panel B (for heart attacks), the coefficient on hospital experience is negative in 5 of the 7 estimates and significantly so in 3. It is significantly positive in only 1.

[Insert Table 7 about here.]

V. <u>Additional Implications</u>
A. <u>For Aggregate Costs</u>:

Although the price caps directly reduce aggregate Japanese medical costs, these mortality patterns reduce it further still. The low caps obviously reduce the <u>per-procedure</u> cost of medical care. By eliminating many of the most severely ill patients, however, the mortality patterns reduce the <u>total number</u> of procedures billed as well.

In effect, the low caps cut aggregate costs by accelerating the time that critically ill patients die. As many observers have noted, a substantial fraction of U.S. health care costs arises in the last few months of a person's life (<u>e.g.</u>, Cutler & Miara, 1998, 2001). Typically, a patient undergoes a complex medical procedure at the outset of this last period. The procedure keeps him alive, and over the next several months he incurs additional costly expenses. Often, however, the deteriorating health that led to the first procedure at the outset of this last period eventually kills him anyway. In Japan, that patient is less likely to have survived the initial procedure.

Take cerebrovascular disease. After decades of saturated fats, lackadaisical exercise habits, and a stressful marriage, suppose a 50-year-old American executive suffers a stroke. Admitted to a leading metropolitan hospital, physicians operate on him at great cost. Through the operation, they save his life. Over the next several months, they continue the high-cost medical treatments that keep him alive. By the end of the year, though, the deterioration caused by decades of bad food, sedentary living, and a fractious marriage causes a second stroke. This time, he dies.

In part, medical costs are low in Japan because fewer such executives live to suffer the second stroke. More than in the U.S., they die from the first instead. Most communities in Japan do not even have sophisticated emergency rooms, much less hospitals with extensive experience in cerebrovascular care.[21] When the executive had

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[21] Data on Japanese emergency rooms are available on www2.health.ne.jp/hospital. On the categorization of Japanese

his first stroke, his wife would have called the ambulance. It would have taken him to the local emergency room, but most emergency rooms are a surgeon with an x-ray machine. The surgeon would have given him a few drugs, and promptly he would have died anyway.

B. For Life Expectancy:

Japanese do live long. As Table 1 illustrates, a 40 year-old Japanese man can expect to live another 40 years. A white American man can expect only 38. Yet the discussion above suggests that perhaps Japanese do not live long lives because of their health care system. Perhaps they live long despite it.

Life expectancy depends on many factors, of which sophisticated medical care is but one. Of those factors, it is not even the most important. Clean water, sanitation, and treatments for infectious diseases all matter too (Cutler & Miller, 2004; Cutler, et al., 2006), and on these factors the U.S. and Japan do not markedly differ. Smoking matters as well -- and Japanese do still smoke more than Americans.

But food and exercise also matter. Japanese eat less saturated fat, and eat less generally. Given urban geography, they walk much farther. As a result, they stand considerably trimmer than most Americans. Among Americans, 34.1 percent are overweight (BMI of 25-30) and 32.2 percent are obese (BMI over 30). Among Japanese, only 20.3 percent are overweight and barely 3.1 percent obese (WHO, 2008).

Excess weight takes a large toll. At age 40, an overweight man can expect to live 3 fewer years. An obese man can expect 7 fewer (Peeters, et al., 2003). A large part of the longer Japanese life expectancy, perhaps, merely reflects body composition patterns.

VI. Conclusions

Universal health insurance boosts demand. Giving free medical care to people who would otherwise do without, it increases the resources with which people bid for the services. Necessarily, it increases both the quantity of services people buy and the price they pay for each unit of service. Necessarily, it increases the aggregate amount of resources people spend.

Among wealthy capitalist societies, Japan spends relatively little on health care. In part, it caps its expenses by capping the amount it pays for each procedure at a quarter of what insurers pay in the U.S. Some variation on such caps will probably inhere in any universal insurance program anywhere. Otherwise, voters would simply refuse to pay the bill.[22]

Yet if caps inhere, so too will lower quality. Boost demand, limit supply, and cap prices -- and sellers will respond by degrading quality. Some aspects of the quality

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emergency rooms, see Kyukyu byoin to wo sadameru shorei [Ministerial Order on the Designation of Emergency Hospitals, etc.], Min. Order 8 of 1964.

[22] This is expressly empirical rather than normative study. I do not write to advocate -- even implicitly -- more generous public access to the services in Japan. Resources are scarce, and what the government offers as part of any universal health insurance program will necessarily reduce consumer purchases elsewhere. What the appropriate level of government-insurance benefit might be is beyond the scope of this article.

degradation in Japanese medicine are well known: the long waits; the perfunctory consultations; the need to return repeatedly for prescription renewals.

Less well-known are the mortality costs. Obviously, the insurance may or may not generate offsetting reductions in mortality that do not appear here. What does appear are the effects of the regulatorily-driven lack of specialized expertise. Fundamentally, Japanese physicians have little incentive to specialize. Specialized or no, they will fill their day at the same prices. Effectively, they earn no returns on any investments they make in their expertise.

With no reason to invest in human capital, Japanese doctors invest in their physical capital instead. They build simple clinics and hospitals with modest numbers of beds, and boost their incomes by bundling hotel stays with basic medical services. The financial effects are unambiguous: the doctors with the clinics and hospitals earn the highest incomes in the Japanese system.

Yet with patients housed in simple, small clinics and hospitals, fewer doctors perform complex modern medical procedures, and fewer hospitals acquire a large reservoir of experience in such procedures. Indeed, Japanese doctors perform less than 3 percent as many coronary bypass operations as American doctors, and 6 percent as many angioplasties. If done well these procedures save lives, but clinical success correlates with experience. Hospitals that do not do them often, do not do them well.

As a result, Japanese lucky enough to live near a sophisticated hospital face better odds of surviving a stroke or heart attack. A hospital with extensive experience in cerebrovascular disease will save 10 to 15 stroke patients a year. One with extensive experience with heart disease will save 27 to 56 heart attack patients.

Unfortunately, given the fee-schedule-driven proliferation of small clinics, few Japanese are so lucky. Most Japanese cities sport no hospitals with the requisite expertise: 71 percent have no hospital with substantial sophisticated cerebrovascular disease experience, and 83 percent have none in heart disease. Japanese hospitals perform few complex procedures, and few hospitals have the experience necessary to perform them successfully if they tried.

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Table 1: Summary Statistics (Part A)

	Japan	U.S.
Physicians[a] (number)	259,336	700,287
Physicians (per 1,000)	2.0	2.4
Health care spending[b] (amount)	$343.8B	$1,660.7B
Health care spending (% GDP)	8.0%	15.2%
Health care spending (per capita)	$2694	$5711
% population 65+[c]	20.1	12.4
Cancer deaths[d] (number)	325,941	553,888
Cancer deaths (per 100,000)	258.3	188.6
Heart disease deaths[d] (number)	173,125	652,486
Heart disease deaths (per 100,000)	137.2	222.2
Stroke deaths[d] (number)	132,874	150,004
Stoke deaths (per 100,000)	105.3	51.1
Mean in-patient hospital stay (days)[e]	36.3	6.5

	Japan[f]		U.S.[g] (all)		U.S. (white)	
	Male	Female	Male	Female	Male	Female
Life expectancy (at birth)	78.6	85.5	74.7	80.0	75.3	80.4
Life expectancy (at 40)	39.9	46.4	37.2	41.5	37.6	41.8

Sources:

[a] Nihon iryo kikaku, ed., Iryo hakusho [Medical White Paper] 232-33 (Tokyo: Nihon iryo kikaku, 2007) (2004 data).

[b] Nihon iryo kikaku, ed., Iryo hakusho [Medical White Paper] 246-47 (Tokyo: Nihon iryo kikaku, 2007) (2003 data).

[c] Kosei rodo sho, ed., Kosei tokei yoran [Public Health Summary Statistics] (Tokyo: Kosei tokei kyokai, 2007) (tab. 1-7, 2005 data); United States, Age Distribution, 2000. www.censusscope.org/US/chart_age.html.

[d] Kosei rodo sho, ed., Kosei tokei yoran [Public Health Summary Statistics] (Tokyo: Kosei tokei kyokai, 2007) (tab. 1-26, 2004 data); Melonie Heron, Deaths: Leading Causes for 2004, National Vital Statistics Repprts, Nov. 20, 2007 (tabs. 1, C, 2004 data).

[e] Nihon iryo kikaku, ed., Iryo hakusho [Medical White Paper] 243 (Tokyo: Nihon iryo kikaku, 2007) (2004 data).

[f] Kosei rodo sho, ed., Seimei hyo (Kanzen seimei hyo), 19 kai [Life Tables (Complete Life Tables), 19th ed.] (2005 data), at www.mhlw.go.jp/toukei/saikin/hw/life/20th/index.html

[g] Elizabeth Arias, United States Life Tables, 2003, National Vital Statistics Reports, Apr. 19, 2006 (Tab. A, 2003 data).

Table 2: Determinants of Physician Incomes

A. Fraction of doctors on HIT list:

Hospital staff (737 doctors)	.026
Not hospital staff (1362 doctors)	.145

B. Regressions:

Dependent variable:	Ln Tax 2004 Tobit	Ln Tax 2004 Tobit	2004 HIT Probit	2004 HIT Probit
Hospital staff	−.8559	−.8419	−.8888	−.8740
	(7.72)***	(7.55)***	(8.38)***	(8.16)***
Age	.3297	.3115	.2121	.1881
	(1.08)	(1.02)	(0.66)	(0.58)
Age squared	−.0036	−.0035	−.0023	−.0020
	(1.05)	(0.99)	(0.63)	(0.56)
Public univ grad		−.1911		−.2113
		(2.17)**		(2.29)**
Male		.0553		.0752
		(0.51)		(0.65)
n	2099	2079	2099	2079
Pseudo R^2	.06	.06	.07	.07

Notes: Coefficients, followed by the absolute value of the t- or z-statistics on the line below. All specifications include a constant term. *, **, ***: significant at the 10, 5, and 1 percent levels.
The dataset includes all Tokyo JMA members born between 1955 and 1967, and not practicing cosmetic surgery.

Sources: Iji koron sha, Iseki soran: Higashi Nihon ban [Physician Directory: Eastern Japan Edition] (Tokyo: Iji koron sha, 2004); Tokyo shoko risaachi, Zenkoku kogaku nozeisha meibo [Roster of High-Income Taxpayers] (CD-ROM) (Tokyo: Tokyo shoko risaachi, 2005).

Table 3: Summary Statistics (Part B)

A. Mortality Rates, by Hospital Experience

	If **tPA exp** > 0	If **tPA exp** = 0
Cerebrovascular Disease Rate	.00099	.00121
Stroke Rate	.00060	.00075
Subarachnoid Hemorrhage Rate	.00011	.00013
Intracerebral Hemorrhage Rate	.00025	.00030

	If **Bypass exp** >0	If **Bypass exp** =0
Heart Disease Rate	.00129	.00159
Heart Attack Rate	.00034	.00043
Other Ischemic Heart Disease Rate	.00022	.00022
Arrhythmia & Conduction Injury Rate	.00016	.00021
Heart Failure Rate	.00042	.00057

Notes: Rates are (number of deaths)/(total population). **tPA experience** and **ByPass experience** are as defined in the text. 642 jurisdictions have **tPA experience** =0, and 213 jurisdictions have **tPA experience** >0. 702 jurisdictions have **ByPass experience** =0, and 153 jurisdictions have **ByPass experience** >0.

B. Male Life Expectancy, by Hospital Experience

	If **tPA exp** >0	If **tPA exp** =0	Sig. level (2 tail)
At birth	77.742	77.588	.025
At 20	58.332	58.204	.051
At 40	39.132	39.059	.230
At 65	17.555	17.490	.094
At 80	7.978	7.920	.031

	If **Bypass exp** >0	If **Bypass exp** =0	Sig. level (2 tail)
At birth	77.746	77.600	.045
At 20	58.338	58.213	.075
At 40	39.139	39.063	.240
At 65	17.572	17.489	.045
At 80	8.000	7.917	.004

Notes: 585 jurisdictions have **tPA experience** =0, and 287 jurisdictions have **tPA experience** >0. 640 jurisdictions have **ByPass experience** =0, and 232 jurisdictions have **ByPass experience** >0.

Sources: Kosei rodo sho, ed., Heisei 18 nen, Jinko dotai shibo tokei [2006: Vital Statistics on Population and Deaths] (Tokyo: Kosei tokei kyokai, 2006) (CD-ROM); Kosei rodo sho, ed., Waga kuni no seimei hyo [Life Expectancy in Our Country] (Tokyo: Kosei tokei kyokai, 2006) (CD-ROM); Somu sho, ed., Tokei de miru shikuchoson no sugata [Municipalities Through Statistics] (Tokyo: Nihon tokei kyokai, 2007); Shobunsha, ed., Daigaku juken annai, 2008 [Introduction to University Entrance Examinations, 2008] (Tokyo: Shobunsha, 2007); Yomiuri shinbun sha, ed., www.yomiuri.co.jp/iryou/medi/jitsuryoku (2008); Shukan Asahi, ed., Shujutsu su de wakaru ii byoin [Good Hospitals, Identified by the Number of Operations], Shukan Asahi, Feb. 2008.

Table 4: Hospital Experience and Mortality -- Cerebrovascular Disease

A. <u>Two-Stage Estimates</u>

	Dependent variable			
	Total cere-brovascular Disease	Strokes	subarach-noid hemorrhage	intra-cerebral hemorrhage
Stroke experience	-22.824	-14.919	-3.046	-6.954
	(6.64)***	(6.31)***	(4.75)***	(5.84)***
Total population	-.0005	-.0005	-.0001	-.0000
	(1.36)	(1.95)*	(1.96)*	(0.12)
Age 15-64	.0002	.0002	.0002	-.0000
	(0.41)	(0.80)	(1.93)*	(0.09)
Age 65 & over	.0070	.0047	.0007	.0015
	(17.07)***	(16.69)***	(9.38)***	(10.67)***
n	855	855	855	855
Adjusted R^2	.97	.96	.93	.95

	Dependent variable			
	Total cere-brovascular Disease	Strokes	subarach-noid hemorrhage	intra-cerebral hemorrhage
tPA experience	-17.371	-10.889	-2.072	-6.249
	(5.55)***	(5.11)***	(3.49)***	(5.72)***
Total population	-.0001	-.0002	-.0001	.0001
	(0.37)	(1.02)	(1.20)	(0.65)
Age 15-64	-.0003	-.0001	.0001	-.0001
	(0.70)	(0.28)	(1.13)	(0.90)
Age 65 & over	.0066	.0044	.0007	.0014
	(16.93)***	(16.69)***	(8.87)***	(10.39)***
n	855	855	855	855
Adjusted R^2	.97	.96	.93	.96

Table 4 (Continued)

B. OLS Estimates:

	Total cere-brovascular Disease	Strokes	subarach-noid hemorrhage	intra-cerebral hemorrhage
	Dependent variable			
Stroke experience	-12.653 (7.31)***	-6.539 (5.55)***	-1.703 (5.23)***	-4.328 (7.17)***
Total population	-.0002 (0.53)	-.0002 (0.98)	-.0001 (1.41)	.0001 (0.54)
Age 15-64	-.0002 (0.57)	-.0001 (0.36)	.0001 (1.33)	-.0001 (0.83)
Age 65 & over	.0066 (17.10)***	.0044 (16.65)***	.0007 (9.15)***	.0014 (10.47)***
n	855	855	855	855
Adjusted R^2	.97	.96	.93	.96

	Total cere-brovascular Disease	Strokes	subarach-noid hemorrhage	intra-cerebral hemorrhage
	Dependent variable			
tPA experience	-13.693 (7.84)***	-7.683 (6.46)	-1.450 (4.37)***	-4.718 (7.74)***
Total population	-.0001 (0.16)	-.0002 (0.77)	-.0001 (1.04)	.0001 (0.91)
Age 15-64	-.0004 (0.95)	-.0002 (0.59)	.0001 (0.94)	-.0002 (1.20)
Age 65 & over	.0065 (16.99)***	.0043 (16.69)***	.0006 (8.81)***	.0014 (10.29)***
n	855	855	855	855
Adjusted R^2	.97	.96	.93	.96

Notes: Coefficients, followed by the absolute value of the t-statistic in parenthesis below. All specifications include a constant term. *, **, ***: statistically significant at the 10, 5, and 1 percent levels, respectively.
In the two-state estimates, the hospital experience variable is instrumented by **Medical schools**, **Business establishments**, **Post offices**, **Parks**, **Civic halls**, and **Libraries**.

Sources: See Table 3.

Table 5: Hospital Experience and Mortality -- Heart Disease

A. <u>Two-Stage Estimates</u>

			Dependent variable		
	Total Heart Disease	Heart Attacks	Other Ischemic Heart Dis.	Arrhythmia & Conduction Injury	Heart Failure .
Bypass experience	-18.761	-27.262	18.943	9.942	-25.796
	(3.63)***	(8.56)***	(3.97)***	(4.25)***	(6.45)***
Total population	-.0013	.0006	-.0022	.0000	.0006
	(3.07)***	(2.40)**	(5.86)***	(0.09)	(1.91)*
Age 15-64	.0011	-.0007	.0026	-.0002	-.0008
	(2.23)**	(2.42)**	(5.74)***	(0.82)	(2.13)**
Age 65 & over	.0094	.0014	.0035	.0011	.0022
	(20.22)***	(4.92)***	(8.18)***	(5.33)***	(6.00)***
n	855	855	855	855	855
Adjusted R^2	.98	.89	.70	.73	.90

			Dependent variable		
	Total Heart Disease	Heart Attacks	Other Ischemic Heart Dis.	Arrhythmia & Conduction Injury	Heart Failure .
Angioplasty experience	-58.870	-56.090	25.087	34.930	-73.075
	(3.39)***	(5.49)***	(1.66)*	(4.33)***	(5.16)***
Total population	-.0009	.0011	-.0026	-.0002	.0011
	(2.22)**	(4.57)***	(7.18)***	(0.86)	(3.20)***
Age 15-64	.0007	-.0014	.0031	.0000	-.0014
	(1.35)	(4.84)***	(7.24)***	(0.19)	(3.55)***
Age 65 & over	.0090	.0009	.0039	.0013	.0016
	(19.18)***	(3.17)***	(9.49)***	(6.05)***	(4.30)***
n	855	855	855	855	855
Adjusted R^2	.98	.90	.72	.70	.88

Table 5 (Continued)

B. OLS Estimates

	Total Heart Disease	Heart Attacks	Other Ischemic Heart Dis.	Arrhythmia & Conduction Injury	Heart Failure
	Dependent variable				
Bypass experience	-.371	-8.669	-.764	6.567	-1.251
	(0.14)	(5.54)***	(0.31)	(5.32)***	(0.64)
Total population	-.0009	.0010	-.0026	-.0000	.0011
	(2.34)**	(4.17)***	(7.24)***	(0.26)	(3.73)***
Age 15-64	.0006	-.0012	.0031	-.0001	-.0015
	(1.32)	(4.47)***	(7.33)***	(0.44)	(4.28)***
Age 65 & over	.0090	.0011	.0039	.0012	.0017
	(20.34)***	(4.06)***	(9.54)	(5.75)***	(5.22)
n	855	855	855	855	855
Adjusted R^2	.98	.91	.72	.73	.91

	Total Heart Disease	Heart Attacks	Other Ischemic Heart Dis.	Arrhythmia & Conduction Injury	Heart Failure
	Dependent variable				
Angioplasty experience	2.953	-19.186	2.919	8.461	6.157
	(0.51)	(5.62)***	(0.55)	(3.10)***	(1.45)
Total population	-.0009	.0011	-.0026	-.0002	.0011
	(2.34)**	(4.90)***	(7.26)***	(0.93)	(3.85)***
Age 15-64	.0006	-.0014	.0031	.0001	-.0015
	(1.31)	(5.29)***	(7.36)***	(0.32)	(4.45)***
Age 65 & over	.0090	.0009	.0039	.0013	.0017
	(20.46)***	(3.43)***	(9.57)***	(6.34)***	(5.19)***
n	855	855	855	855	855
Adjusted R^2	.98	.91	.72	.73	.91

Notes: Coefficients, followed by the absolute value of the t-statistic in parenthesis below. All specifications include a constant term. *, **, ***: statistically significant at the 10, 5, and 1 percent levels, respectively.

In the two-state estimates, the hospital experience variable is instrumented by **Medical schools**, **Business establishments**, **Post offices**, **Parks**, **Civic halls**, and **Libraries**.

Sources: See Table 3.

Table 6: Robustness Checks --
Alternative Two-Stage Specifications

A. Strokes *Dependent var.:*	(1) Strokes (Number)	(2) Strokes (Number)	(3) Strokes (Per cap.)	(4) Strokes (Per cap.)	(5) Strokes (Number)	(6) Strokes (Number)
Stroke experience (No. hospitals)	-24.024 (6.50)***		-.00003 (1.81)*			
Stroke exp. (Dummy var.)					-865.340 (2.95)***	
tPA experience (No. hospitals)		-15.121 (4.52)***		-.0000 (1.46)		
tPA experience (Dummy var.)						-72.950 (1.43)
Total population	.0006 (38.85)***	.0005 (42.42)***	.0000 (1.17)	.0000 (0.76)	.0004 (27.63)***	.0005 (83.54)***
Fraction 65 & Over	1985.629 (10.38)***	1916.754 (10.47)***	.0043 (32.63)***	.0043*** (32.79)	288.677 (4.62)	320.151 (11.86)
Fr. 65 & Over Sq'd	-3557.58 (8.78)***	-3421.929 (8.82)***				
n	855	855	855	855	855	855
Adjusted R^2	.90	.91	.57	.58	.11	.90

B. Heart Attacks *Dependent var.:*	(1) Ht.Attack (Number)	(2) Ht.Attack (Number)	(3) Ht.Attack (Per cap.)	(4) Ht.Attack (Per cap.)	(5) Ht.Attack (Number)	(6) Ht.Attack (Number)
Bypass experience (No. hospitals)	-34.073 (9.57)***		-.00004 (2.03)**			
Bypass experience (Dummy var.)					-886.377 (3.03)***	
Angioplasty exp. (No. hospitals)		-.150.113 (5.99)***		-.0001 (1.87)*		
Angioplasty exp. (Dummy var.)						-21417 (0.45)
Total population	.0004 (39.09)***	.0004 (27.39)***	.0000 (1.12)	.0000 (0.33)	.0003 (21.44)***	.0003 (1.84)*
Fraction 65 & Over	910.019 (6.25)***	573.919 (2.81)***	.0021 (19.28)***	.0020 (18.52)***	203.031 (3.29)***	18977 (0.38)
Fr. 65 & Over Sq'd	-1606.807 (5.21)***	-981.014 (2.28)**				
n	855	855	855	855	855	855
Adjusted R^2	.85	.73	.32	.32	--@	--@

Notes: Coefficients, followed by the absolute value of the t-statistic in parenthesis below. All specifications include a constant term. *, **, ***: statistically significant at the 10, 5, and 1 percent levels, respectively. @ Stata did not calculate an R2.
In Regressions (3) and (4), the dependent variable is the number of deaths per capita. In Regressions (5) and (6), the hospital experience variable is equal to 1 if the number of experienced hospitals (as defined in the text) is greater than 2 per 100,000 population.
The hospital experience variable is instrumented by **Medical schools**, **Business establishments**, **Post offices**, **Parks**, **Civic halls**, and **Libraries**.

Sources: See Table 3.

Table 7: Robustness Checks --
Partitioned Two-Stage Specifications

A.   Dependent Variable: Strokes

Age Quartiles:	I	II	III	IV .
Stroke experience	-5.439	.0028	-20.481	6.070
	(1.16)	(0.00)	(4.33)***	(0.48)
Total population	-.0006	-.0003	.0016	.0039
	(1.98)**	(0.57)	(1.76)*	(2.61)***
Age 15-64	.0007	.0001	-.0026	-.0053
	(1.99)**	(0.10)	(2.49)***	(3.00)***
Age 65 & over	.0033	.0038	.0039	.0008
	(6.71)***	(3.94)***	(2.77)***	(0.44)
n	213	189	183	270
Adjusted R^2	.98	.96	.94	.95

Age Quartiles:	I	II	III	IV .
tPA experience	-5.401	2.568	-19.295	26.948
	(1.70)*	(0.58)	(4.22)***	(2.01)**
Total population	-.0005	-.0002	.0018	.0038
	(1.97)**	(0.47)	(2.08)**	(2.37)**
Age 15-64	.0006	-.0000	-.0027	-.0053
	(1.95)*	(0.01)	(2.69)***	(2.79)***
Age 65 & over	.0032	.0036	.0032	.0011
	(7.25)***	(4.31)***	(2.39)**	(0.61)
n	213	189	183	270
Adjusted R^2	.98	.96	.94	.93

B.   Dependent Variable: Heart Attacks

Age Quartiles:	I	II	III	IV .
Bypass experience	-26.077	.921	-6.667	-69.919
	(4.97)***	(0.22)	(0.87)	(5.31)***
Total population	.0001	.0003	.0026	-.0024
	(0.25)	(0.83)	(3.40)***	(1.67)*
Age 15-64	-.0005	-.0005	-.0033	.0031
	(0.90)	(1.21)	(3.75)***	(1.83)*
Age 65 & over	.0035	.0016	-.0001	.0041
	(4.28)***	(2.59)***	(0.11)	(2.62)***
n	213	189	183	270
Adjusted R^2	.93	.93	.87	.89

Age Quartiles:	I	II	III	IV .
Angioplasty experience	-63.706	47.555	-21.079	(dropped)
	(4.36)***	(3.47)***	(1.65)	
Total population	.0011	.0001	.0024	-.0004
	(2.90)***	(0.27)	(3.19)***	(0.40)
Age 15-64	-.0014	-.0003	-.0032	.0004
	(3.03)***	(0.76)	(3.64)***	(0.31)
Age 65 & over	.0009	.0019	.0003	.0030
	(1.46)	(2.79)***	(0.22)	(2.42)**
n	213	189	183	270
Adjusted R^2	.94	.91	.87	.93

Table 7 (Continued)

Notes: The database is partitioned into approximate quartiles on the basis of the fraction of the population aged 65 or older. Aged 65+/Total Population is under .18 for Quartile I, from .18 to under .21 for Quartile II, from .21 to under .25 for Quartile III, and .25 and over for Quartile IV.

Coefficients, followed by the absolute value of the t-statistic in parenthesis below. All specifications include a constant term. *, **, ***: statistically significant at the 10, 5, and 1 percent levels, respectively.

The hospital experience variable is instrumented by **Medical schools**, **Business establishments**, **Post offices**, **Parks**, **Civic halls**, and **Libraries**.

Sources: See Table 3.