

SEVENTEENTH ANNUAL
HERBERT LOURIE MEMORIAL LECTURE ON HEALTH POLICY
**Variations Among Regions and Hospitals
in Managing Chronic Illness: How Much
Care Is Enough?**

John E. Wennberg

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With colleague Alan Gittelsohn, PhD, Wennberg developed a strategy for studying population-based rates of health resource allocation and utilization known as small area analysis. Their studies of variations in population-based rates of resources and utilization in Vermont in the early 1970s led to the national analyses of the Dartmouth Atlas Project. Wennberg and Albert E. Mulley, MD, were co-founders of the Foundation for Informed Medical Decision Making, a non-profit corporation providing objective scientific information to patients about their treatment choices. Dr. Wennberg is a graduate of Stanford University, the McGill Medical School, and the Johns Hopkins School of Public Health.

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Policy Brief

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Patterns of Variation: The Dartmouth Atlas Project

Classic epidemiology looks at what happens to people who live in a defined region over time. For example, birth rate, the number of births that occur among populations over a year, is a common statistic that we're all familiar with. Since the early 1990s we have conducted research at Dartmouth Medical School to convert that classic epidemiologic perspective into looking at what is happening in terms of the health care system itself. We ask how much care people are getting in different regions of the country. We want to know the patterns of that care. And we want to get into the causes of so-called *unwarranted variation*, that is, differences that cannot be explained on the basis of patient illness, the dictates of scientific medicine, or the preferences of patients. Those three key words—*illness*, *preference*, and *science*—ultimately don't explain very much of the variation we see.

We began the Dartmouth Atlas Project in 1993 as a study of health care markets in the United States, measuring variations in health care resources and their utilization among geographic areas. In recent years we have expanded our research agenda to include the resources and utilization among patients at specific hospitals. We use very large claims databases from the Medicare program and other sources to define where people go for medical care, what kind of care they receive, and whether increasing

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investments in health care resources and their use result in better health outcomes.

Data and Standards of Effective Practice

The main source of our research data is Medicare, the government insurance program that covers virtually every American over age 65. The Medicare program maintains complete, accurate, and well documented records of hospitalizations, including each patient's residence by ZIP code and the hospital the patient was admitted to. These files give us a reliable indication of the geographic patterns of health care use throughout the whole population of the United States, because research indicates that the patterns of where Medicare patients seek care is similar to patterns among younger patients (Wennberg and Gittelsohn 1980).

At the beginning of the Dartmouth Atlas Project, we defined 3,436 hospital service areas (HSAs), naturally occurring health care markets—geographic clusters of ZIP codes in which at least half of the hospital care received by Medicare patients is provided by a hospital or hospitals within the ZIP code cluster.

Then we aggregated the HSAs, based this time on the geographic patterns of travel for tertiary care (specifically, major cardiovascular surgery and neurosurgery), into 306 hospital referral regions (HRRs). Most of the examples of patterns of care discussed in this policy brief are based on analysis of HRRs. For more information about data and methodology, see the Appendix.

To define standards of effective care we employed the Health Plan Employer Data and Information Set (HEDIS), a set of standardized performance measures developed by the National Committee for Quality Assurance (NCQA) to track performance among managed care plans. HEDIS monitors more than 60 different performance measures of effective care in the United States, covering a broad range of important health care issues (for

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more information go to <http://www.ncqa.org>). Using these quality measures, we can determine which types of care are underused.

We use distribution graphs to chart variations in how health care is delivered among the 306 HRRs. Each dot on the graph represents an HRR; the variable being studied is displayed on the vertical axis.

We use the term *rate* to mean the number of events or amount of resources divided by the number in the population. For example, if an area with 100,000 enrollees has 810 hip fracture repairs, then the rate of hip fracture repair is 8.1 per 1,000 Medicare enrollees. The *ratio of rates to the U.S. average* is an HRR's rate divided by the national rate. Ratios can be interpreted as a percent. For example, if an area's ratio is 1.56, then that area's rate is 56 percent higher than the national average; if an area's ratio is .64, then that area's rate is 36 percent below the national average. For details, go to the Dartmouth Atlas of Health website at <http://www.dartmouthatlas.org/faq.php>.

1. Variation Based on Medical Need: Hip Fracture

When looking at patterns of practice across the United States, sometimes, but rarely, the variation actually reflects medical need. The classic example of that is the hospitalization rate for people with hip fractures.

The incidence of hip fracture varies somewhat in the United States, for reasons that are not clear. While you might expect that more people in the Northeast break their hips, perhaps because of poor traction in winter ice and snow, the fact is that a higher proportion of people break their hips in the South Central and Southeastern states than in other states. As a result, the rate of hospitalization for hip fractures differs slightly across HRRs. However, virtually everyone who breaks a hip spends time in a hospital. This is one of the rare examples where illness essentially drives the hospitalization rate.

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Why can we say that? On the basis of clinical logic: people who break their hips nearly always go to the doctor because they're in a great deal of pain and they can no longer walk. They don't stay home wondering whether they should go or not. When they get to the doctor, it's pretty easy to diagnose a broken hip, and an X-ray will confirm the fracture. So there's no uncertainty about the diagnosis. Finally there's no uncertainty about whether or not you hospitalize the patient. Virtually everybody with a broken hip is hospitalized. Thus, treatment of a hip fracture becomes a baseline from which we can say, this is the pattern of practice that we should see if medical necessity is driving care.

2. Variations Resulting from Underuse of Effective Care

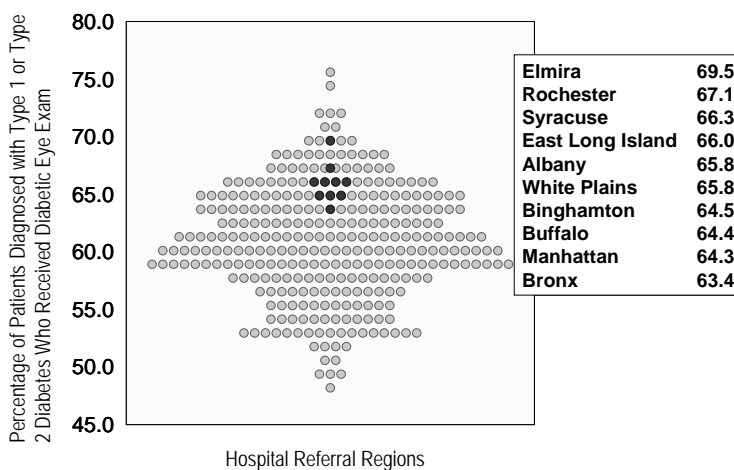
Sometimes variation reflects the underuse of effective care, care that should be given. In the United States we are systematically underusing effective care.

Effective Care: Beta-Blocker After Heart Attack

Effective care refers to services of proven effectiveness. For example, administering beta-blocker treatment to patients who have had heart attacks really saves lives, based on evidence from clinical trials (Gottlieb, McCarter, and Vogel 1998). Furthermore, taking a beta-blocker if you have a heart attack does not involve a lot of tradeoffs; you get better with no complications. So it can be spoken of as effective care, something that should be done. The normatively correct rate for beta-blockers after heart attack is everyone who has a heart attack, with certain clinically identifiable exceptions. But in its annual report, *The State of Health Care 2005*, NCQA states that the rates of beta-blocker treatment after a heart attack by commercial plans, Medicare, and Medicaid were 96.2 percent, 94.0 percent, and 84.8 percent, respectively, in 2004. Failure to provide effective care such as this is an error of omission.

The HEDIS standard for comprehensive care for diabetics includes an annual eye exam to detect diabetic retinopathy, which is a leading cause of blindness. Figure 1 shows a distribution graph of patients who were given diabetic eye exams in 2001 in each of the 306 HRRs. The graph summarizes three features of the data: (1) no region approaches 100 percent compliance with the standard; (2) there is substantial variation in rates between the highest and lowest regions; and (3) that variation is not caused by a few outliers but is pervasive and widespread across the country. This is typical of most effective care measures. We've never found anywhere that comes close to 100 percent compliance.

Figure 1. Variations in Rate of Diabetic Eye Exams, United States, 2001



Overall, in regard to the pattern of variation around the country, we're somewhere in the zone of underuse (McGlynn et al. 2003). We haven't reached optimal use. Effective care is cheap; a beta-blocker doesn't cost very much, nor does an eye exam. The irony is that we don't do the things that we ought to do, and we spend a lot of money that doesn't go toward getting those things done.

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3. Variations Reflecting Patient or Provider Preference

Preference-sensitive conditions involve tradeoffs among the available options. There's more than one treatment, and the outcomes are different. Treatment choices should be based on an informed patient's own values.

a. Patient Preference: Breast Cancer

The surgical options for treating a woman with an early-stage breast cancer are an example of treatment choices that ought to be preference-sensitive. Most women could either be treated with a lumpectomy, a simple excision of the tumor, or with a removal of the breast, a mastectomy. The main outcome, in terms of life expectancy, is approximately identical irrespective of which treatment one takes. However, the *other* outcomes are quite different. The woman who chooses a mastectomy faces the loss of her breast, and probably the further choice of reconstructive surgery or a prosthesis. Women who choose lumpectomy will almost certainly receive radiation therapy and might have chemotherapy. Moreover, there's a statistical chance that the cancer will recur and require a second procedure, usually a mastectomy. The evidence is clear that survivorship is the same. Not surprisingly, it turns out that different women have different opinions about which treatment they would prefer.

However, our research indicates that local medical opinion has a strong influence on the choice of treatment. The variation in rates that we see in the Medicare population goes from almost nobody getting a lumpectomy in some regions to upwards of 50 percent of women in other regions. This can be traced back to differences in recommendations from the local physicians as to what course of treatment should be taken. A good deal of our research, which I do not address in detail here, shows that informing patients about treatment options actually leads to decisions more in line with the patients' individual preferences.

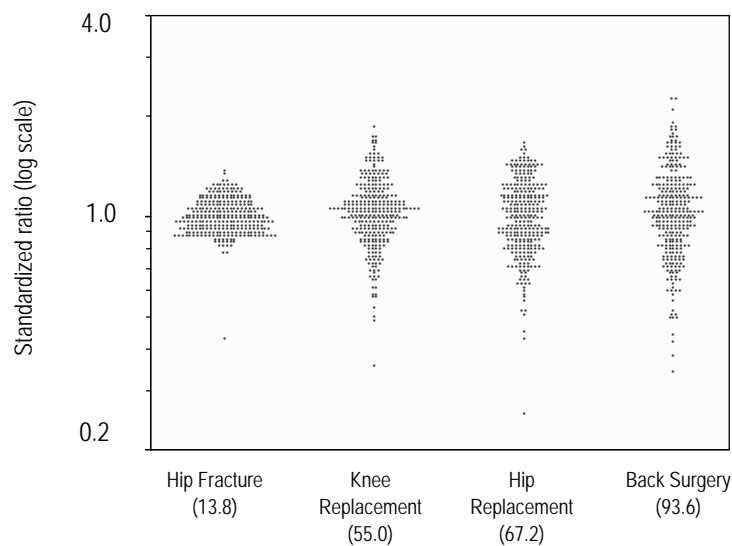
b. Patient Preference and the Limits of Scientific Evidence: Prostate Cancer

On the other hand, there's a lot of clinical uncertainty about the actual outcomes of the treatment options for prostate cancer, including watchful waiting, radiation, and radical prostatectomy. The patient has to deal not only with the fact that outcomes of surgery are different from those of radiation or medical management, but also with the evidence that it is not clear whether he will live longer with one treatment or another. This demonstrates a second category of issues, the need to make patients understand the limits of scientific evidence when they're making these decisions.

c. Provider Preference: Orthopedic Surgery

Choosing among valid surgical options obviously should be based on the patient's own preferences, but provider opinion often determines which treatment is used. Here are a couple of examples.

Figure 2. Rates of Four Orthopedic Procedures among Medicare Enrollees, 2000-2001



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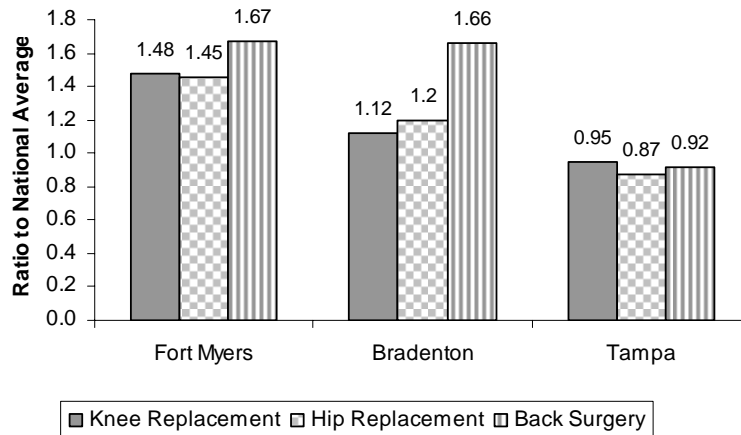
Figure 2 illustrates the hospitalization rate for four different orthopedic procedures; each dot represents an HRR. From left to right are the hospitalization rates of hip fracture, knee replacement, hip replacement, and back surgery. The chances of having back surgery vary much more than the chances of being hospitalized for hip fracture. Most of the variation among the different procedures is associated with the information exchange relationship between the doctor and the patient regarding which treatment options to use. One example is back pain, and the decision whether to treat it with surgery or with medical management.

Sometimes there are also huge differences in the likelihood of having common surgical procedures between regions that are geographically quite close. In 2004, we reported on variations in the rates of knee replacement, hip replacement, and back surgery operations in four Florida HRRs (Weinstein et al. 2004). As Figure 3 illustrates, in the Fort Myers HRR, the rate of knee replacements was about 48 percent higher than the national average; in Tampa, which is only a few miles away, the rate was 5 percent lower than the national average. The most likely etiological factor here was the differences in the medical opinions of the physicians in those regions.

You might surmise that these rates would correlate with the supply of orthopedic surgeons—but in fact there is no such correlation. And the reason that I believe that's occurring is that orthopedic surgeons can do lots of different things: knee replacements, back surgery, carpal tunnel repairs, sports medicine, and so on. Surgeons, even once they're specialized in a particular body area or system, become further specialized in certain procedures. So people find doctors or surgeons who concentrate on doing hips, or back surgery, or something else. And differences in individual opinions are sufficiently strong to override any correlation between surgeons and rates of surgical activity. This shows at least some indirect evidence, I think, of

the power of the decision process in directing clinical inputs and clinical outcomes.

Figure 3. Surgical Signatures for Three Florida HRRs



We don't know what the true demand for these operations would be if informed patient choice was playing a role in decision making. We really don't know what the optimal rate of any of these procedures is. This is an unfortunate complication, because the assumption is that there is some rational basis for the rate. We do know that when decision aids are carefully constructed for patients and patients are fully informed, the decisions are different than when that's not happening. Interestingly, patients who are fully informed tend to choose surgery less often. At the same time, their decisions become better aligned with their values. In other words, in the case of breast cancer, someone who is really concerned about the risk of recurrence is more likely to choose mastectomy after an informed decision choice process, whereas someone who is really concerned about loss of her breast is more likely to choose lumpectomy.

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4. Supply-Sensitive Care: Variations Based on Capacity

In 1961, Milton Roemer found that, in the presence of widespread health insurance, the per capita supply of hospital beds in a community is a major influence on the hospital utilization rate; more beds means more admissions and longer hospital stays. This has become known as Roemer's law, and it illustrates supply-sensitive care with respect to the frequency of treatment of patients with chronic illness, including hospitalizations for medical conditions, stays in intensive care, visits to physicians, referrals to specialists, and imaging and other tests.

For example, I talked earlier about the low variation in rates of hospital admissions for hip fractures. What happens when we relate the regional bed supply, that is, acute care beds per capita, to the hospitalization rate for hip fractures and a medical condition such as congestive heart failure? Rates of hospitalization for hip fracture basically don't have any relationship with capacity: the incidence of the condition, not the capacity of the system, drives the utilization rate.

This is not so for medical conditions. For chronically ill patients, more hospital beds means more hospitalization.

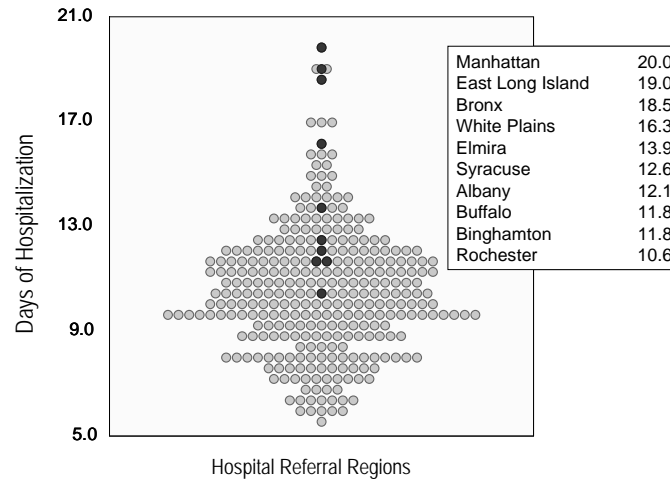
Hospitalization for Chronic Illness

Figure 4 shows the distribution of the average number of days in hospitals per decedent during the last six months of life. In some regions this average is about three weeks, but in other HRRs the average is six days—a three- or four-fold difference.

Why do we focus so much on end-of-life care? Because all of these people have exactly the same prognosis: they were all dead at the end of the study period. Therefore, it's very unlikely that illness differences explain the variations in intensity of care. Otherwise you'd have to conclude that people are deader in

Manhattan than anywhere else in the country, which seems highly unlikely.

Figure 4. Patient Days in Hospital during the Last Six Months of Life, Medicare Decedents, 2001



Variations of Care Within and Between Communities: The Last Six Months of Life

The useful thing about Medicare data is that we can find everyone who died while enrolled in Medicare, and by going backward in time determine when and where they were hospitalized in the last two years of their lives. Almost everybody who has a serious chronic illness is hospitalized at least once. We assigned these people to the hospital they used most frequently. It turns out that when we assign them to the hospital they most frequently use, about 85 to 90 percent of all the inpatient activity for that patient occurs at that hospital. This then becomes a measure of the relative use rate of that individual.

In 2004, we looked, in a sort of tongue-in-cheek way, at the *US News & World Report's 2001 list of the 77 "best" hospitals for geriatric disease and chronic lung disease* (Wennberg et al. 2004). We found that the average number of days patients stayed in

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hospitals during the last six months of life ranged from around 9 days in some of the more conservative hospitals to almost a month (27 days) at the NYU Medical Center. Mount Sinai's patients had an average of 22.8 days, and New York Presbyterian's patients averaged 21.6 days. On the West Coast, UCLA's patients averaged about 16 days, while patients of UCSF and Stanford averaged about 10 days. It is interesting to note that UCSF and UCLA are in the same system, and run by the same board of regents, yet they are quite different in the way they practice medicine.

Figure 5. Days Spent in Intensive Care Unit during Last Six Months of Life among Patients Receiving Most of Their Care in One of 77 "best" US Hospitals, 2001

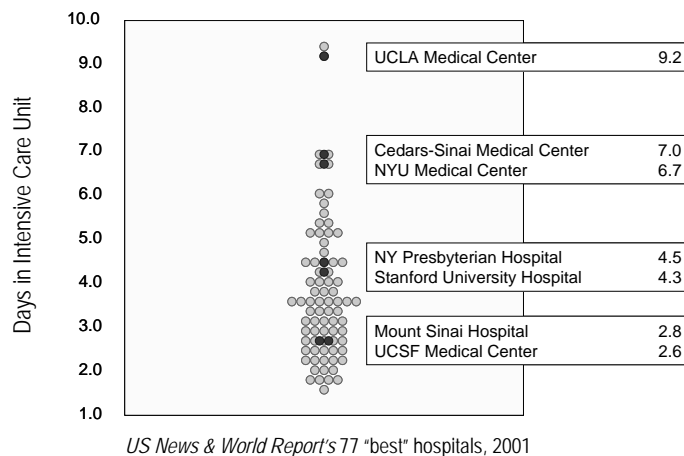


Figure 5 shows how long people spend in intensive care units (ICU) on average. It turns out that UCLA is extremely aggressive in treating chronically ill people, particularly toward the end of life—the average number of days in ICU is 9.2 per decedent. In comparison, the UCSF Medical Center kept patients in the ICU only 2.6 days. But if you talked to the physicians at those facilities they wouldn't have any idea that these variations are happening, until they see our data.

Our data about access to care, measured as people who had one or more opportunities to visit a doctor, shows very little variation.

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Almost everybody is getting into the system in Medicare. But the rate of visits to primary physicians and medical specialists varies by a factor of about five. So access is more or less uniform, but once in the system physicians treat patients very differently, depending on where they live.

Another example of how the hospital capacity influences clinical choice is total physician visits during the last six months of life. It's not surprising that visit rates—the overall number of visits, is highly related to the number of days in hospital. Once a patient is admitted to the hospital, the opportunity for physicians to visit is much greater. In some regions it is almost 60 visits; in Manhattan it's quite high. But if we focus in on the 77 academic medical centers, there are 76 visits per person in the last six months of life at NYU, 54 at Mount Sinai, 22 at UCSF, and 27 at Stanford. The Los Angeles hospitals are quite high. Again, we see huge variability. From a policy perspective it is important to understand the double influence of the supply of physicians and the capacity of the hospital. You get a quadratic effect; basically you get a real crescendo of this effect as you have more beds and more hospitals.

Variations in Per Capita Spending

We've seen good evidence that the capacity of the system, both the numbers of doctors and the numbers of hospital beds, directly influence the relative frequency with which both visits and hospitalizations occur. When we look across the United States, we see huge differences in the per capita spending in Medicare. What kinds of clinical events explain it? It's important to know because we need to understand the relative importance, in terms of the Medicare program's dilemma right now, of the variations that we've been looking at.

Figure 6 shows the relative reimbursement rates of the 306 hospital referral regions, divided into four groups by level of spending. The black dots are regions being reimbursed more than

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15 percent above the national average. The highest-reimbursement quartile in 2000-2001 were reimbursed almost \$10,000 per decedent, the lowest quartile (the white dots) reimbursed around \$4,000.

Figure 6. Medicare Per Capita Reimbursement, 2000-2001

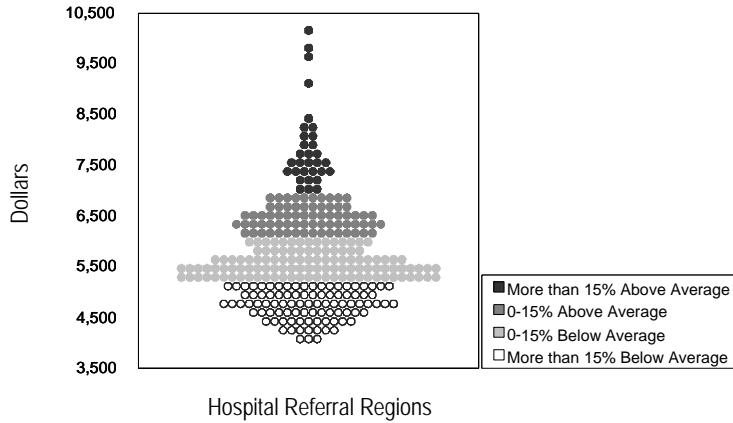
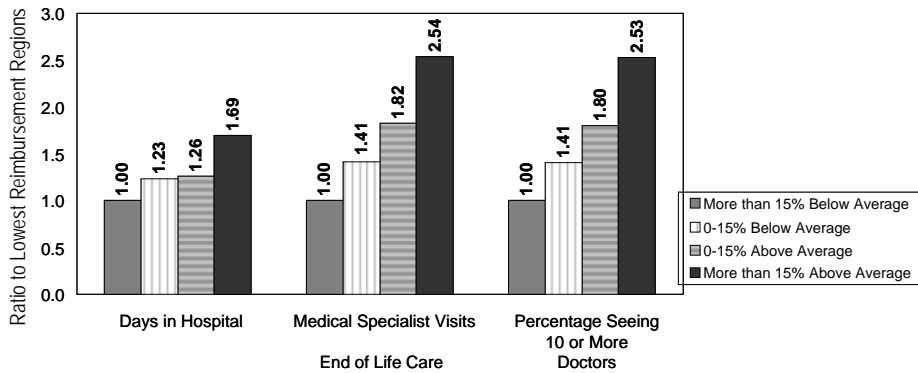


Figure 7. End-of-Life Care, in Quartiles by Level of Reimbursement, as a Ratio to Lowest-Reimbursement Quartile, 2000-2001



When you increase spending, what do you get? Figure 7 shows that you get more supply-sensitive care: hospitalizations, visits to doctors—particularly specialists—and visits to a greater number of different doctors. The gray bar, designated as spending more than 15 percent below average, is the baseline. Days in hospital are 69 percent more frequent in the high-reimbursement regions.

Medical specialists' visits are 2.5 times higher, and the percentage seeing 10 or more physicians is about 2.5 times higher. But what you don't get, basically, is more effective care (Baicker and Chandra 2004).

Effective care (see Figure 8) is essentially the same across all these regions, maybe even a little worse in the higher-spending ones. The right-hand columns show that the higher Medicare reimbursements don't buy more discretionary surgery. Effective care is essentially independent of overall spending.

Figure 8. Rates of Medicare Reimbursements, Effective Care, and Preference-Sensitive Care, in Quartiles by Level of Spending, as a Ratio to Lowest-Spending Region, 2000-2001

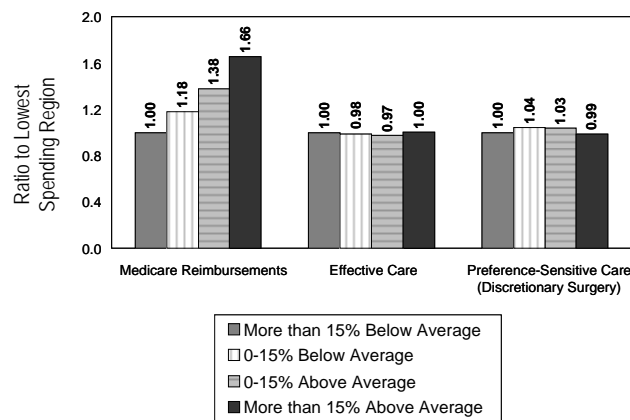


Figure 9 illustrates the huge differences in the combined costs of Medicare inpatient and physician payments in managing chronically ill patients over the last six months of life in 77 selected academic medical centers. Some of the hospitals in the sample were being reimbursed upwards of \$39,000 per person in the last six months of life, while the lower-reimbursed regions were getting around \$12,000 to \$13,000.

These spending patterns are not just a phenomenon in the last six months of life. In Figure 10, the vertical axis shows the amount spent per person in each of those hospitals in the last six months

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of life (Wennberg et al. 2004). The horizontal axis shows the amount spent in the 19th to 24th months prior to death. From the labels along that axis you can see that spending is much lower in the last 19 to 24 months—it ranges from about \$2,000 to \$7,000 per person—but notice how highly correlated it is. In other words, this effect that we’re seeing is not just at the end of life of chronically ill patients; it’s across previous periods of life in the cohort. It’s an attribute of the system, not the disease or the individual patient’s need.

Figure 9. Total Medicare Payments (Parts A&B) in Last Six Months of Life, 1999-2001

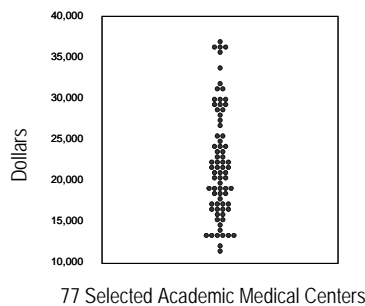
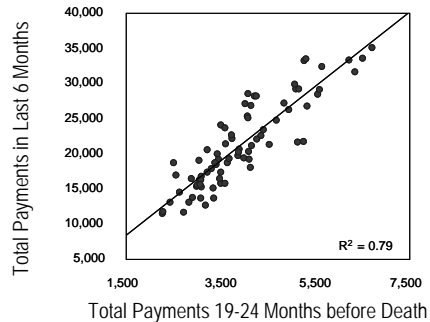


Figure 10. Association between Total Medicare Payments 19-24 Months and 0-6 Months before Death, 1999-2001



This is important for policy reasons because it says that we can use end-of-life measures of differences in spending as estimates of what the actual costs are, independent of illness. I think that has a lot of policy implications.

Is More Better?

If we increase the frequency of use of supply-sensitive care in managing chronic illness—for physician visits, hospitalizations, intensive care—are we getting more, or not?

There’s virtually no evidence from clinical trials about what the appropriate frequency of use of these services should be. Evidence-based medicine has nothing to do with this whole level of variability. You cannot go to, for example, the *Clinical Evidence Concise*, published by the British Medical Journal, and

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find even a suggestion about when to hospitalize somebody with congestive heart failure. There are no rules or guidelines. So we're stuck with having to resort to epidemiological evidence.

One of the research agendas at Dartmouth has been to ask, "If you live in a high-spending region, like Miami, do you get better outcomes than if you live in one of the lower-spending regions?" To answer that question, Edward Fisher and colleagues (2003) looked at people in the United States who were hospitalized between 1993 and 1995 for three conditions—(1) hip fractures, (2) colon cancer with a surgical procedure, and (3) heart attacks—for which there is a literature of chart reviews. They followed those people over a period of time, up to five years, and looked at the survivorship of those patients depending on whether they live in a high- or a low-reimbursement region. Dividing the HRRs into five groups by spending level and comparing the highest reimbursement quintile to the quintile being reimbursed the least, we see that there was 61 percent more Medicare spending on people who live in Miami, Los Angeles, and Manhattan, compared to people who live in Rochester, Minnesota, and some other parts of the country. There were more doctors overall, particularly more internists and medical specialists, a few more surgeons, and fewer family practitioners. These high-cost regions are characterized as not being served by family practitioners.

But if you look at the actual survival, you see that patients with hip fractures and colon cancer and heart attacks actually had *higher* mortality rates if they lived in the higher-spending regions than if they lived in the lower-spending regions. There was no difference in patients' functional status and satisfaction with their care, and their perceptions were that their access to care was worse.

How do we interpret the intensity of care when we don't see any marginal advantage? Is it really good to see 10 or more doctors when you have a chronic illness? Regions where patients see lots

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of doctors actually do relatively poorly on the effective care quality measures like beta-blockers and diabetic eye exams. The simple interpretation, the most direct hypothesis, is that if you have a lot of people involved in the patient's care, no one is in charge and no one guides overall care. The consequences of failing to give some of these things like beta-blockers could be behind the variation that we're seeing in terms of mortality. Medical error is common in hospitals, and if you hospitalize people twice as often, you're going to have twice as many medical errors.

We may have actually over-invested in care management of chronic illness. Our data seem to support the conclusion that, for longitudinal performance over fixed periods of time, and with relatively satisfactory performance on available quality measures, low-reimbursement, low-resource input, low-utilization regions or hospitals should be viewed as normatively better than regions that are on the higher side of the equation.

Newly Released Hospital-Specific Data

The Dartmouth Project has begun to make available hospital-specific data for all U.S. hospitals, starting with California, on our web site, <http://www.dartmouthatlas.org>. This data enables direct comparisons of the efficiency of individual hospitals in treating patients with chronic illness based on the Medicare claims from hospitals and their associated physicians. The results make it possible to compare and rate market areas as well as individual hospitals on the efficiency with which they use health care resources.

In November 2005, my colleagues and I published an article, based on our hospital-specific data for California, in which we compared per capita spending in the last two years of life in Los Angeles and Sacramento. In Los Angeles, Medicare spent 67 percent more money than Sacramento—74 percent more for physician payments, and 67 percent for inpatients. Decedents in

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Los Angeles used 61 percent more hospital beds, 2.3 times more ICU beds, and 89 percent more physician labor input. And what was the outcome? They have worse quality care in Los Angeles than in Sacramento.

On all these relative efficiency criteria, Sacramento is a reasonable benchmark for asking questions about what's going on in Los Angeles. Similar benchmarks are available in regions throughout the country: Rochester, New York, provides a benchmark for Syracuse, for example.

Policy Issues

As a result of this recent work, hospital-specific performance measures are now available for comparing patterns of practice in managing chronic illness. As we wrote in 2002, in reference to Medicare:

We have identified three categories of unwarranted variation affecting the quality and efficiency of care supported by the Medicare program. To address these shortcomings, we propose the following goals for Medicare reform: (1) eliminate under-provision of effective care; (2) establish patient safety; (3) reduce scientific uncertainty through outcomes research; (4) establish shared decision making for preference-based treatments, chronic disease management, and end-of-life care; (5) establish accountability for capacity; and (6) promote conservative practice when greater care is wasteful if not harmful. (Wennberg, Fisher, and Skinner 2002, W105)

The first policy challenge will be to debate and find out whether you can get any consensus on this interpretation, because it's quite radical.

The next challenge would be to set the dynamics in place to reallocate excess capacity in a system that is suffused with (a) fee-for-service and (b) supply-induced demand. It's a real

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problem. My hope lies in the Section 646 (of the Medicare Modernization Act, MMA) demonstration projects, which enable providers to come forward with suggestions on how to reform Medicare reimbursement systems to accommodate the change. Otherwise, it could be chaotic.

If we take this data serious, there's a lot of hard work ahead. The general rule in my experience has been about 10 years of denial of data, five years of blaming somebody else for the problem, and finally a crisis in which they say "Maybe we should roll up our sleeves and get to work." We don't have that kind of time in terms of the train wreck that Medicare is heading toward—that our whole system is heading toward.

Chronic disease is one of the major problems affecting all of us as we age, and we need to come to terms with the fact that our system is running in the wrong direction. We need to bring in some rational process improvement for learning what the preferred pathways are for managing chronic illness. And it will take all of us to do that kind of work.

Appendix

The Medicare program maintains exhaustive records of hospitalizations, which makes it possible to define the patterns of use of hospital care. When Medicare enrollees are admitted to hospitals, the program's records identify both the patients' place of residence (by ZIP code) and the hospitals where the admissions took place (by unique numerical identifiers). These files provide a reliable basis for determining the geographic pattern of health care use, because research shows that the migration patterns of patients in the Medicare program are similar to those for younger patients (<http://www.dartmouthatlas.org/faq/geogappdx.pdf>).

HSAs = hospital service areas are local health care markets for hospital care. An HSA is a collection of ZIP codes whose residents receive most of their hospitalizations from the hospitals in that area. HSAs were defined by assigning ZIP codes to the hospital area where the great proportion of their Medicare residents were hospitalized. Minor adjustments were made to ensure geographic continuity. This process resulted in 3,436 HSAs.

HRRs = hospital referral regions represent regional health care markets for tertiary medical care. Each HRR contains at least one hospital that performs major cardiovascular procedures and neurosurgery. HRRs were defined by assigning HSAs to the region where the greatest proportion of major cardiovascular procedures were performed. The process resulted in 306 hospital referral regions. For details on HSAs and HRRs, go to <http://www.dartmouthatlas.org/faq/geogappdx.pdf>.

The Geographic Query Finder at <http://www.dartmouthatlas.org/data/finder.shtml> enables consumers to locate ZIP codes by HSA and HRR, HSAs by HRR and state, and HRRs by state, based on year 2004 ZIP codes.

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Rate = the number of events or amount of resources divided by the number in the population. For example, if an area with 100,000 Medicare enrollees has 810 hip fracture repairs, then the rate of hip fracture repair is 8.1 per 1,000 enrollees. For rare events, the rate is often re-scaled to events per 100,000 persons. For details, go to <http://www.dartmouthatlas.org/faq/appdx.pdf>.

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